**Fishery Data Series No. 12-53**

# Southeast Alaska 2011 Herring Stock Assessment Surveys

**by**

**Kyle Hebert**

**September 2012**

**Alaska Department of Fish and Game** **Divisions of Sport Fish and Commercial Fisheries**

## Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |

**Weights and measures (English)**

| | |
|---|---|
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |

**Physics and chemistry**

| | |
|---|---|
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

**General**

| | |
|---|---|
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat. or long. |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

**Measures (fisheries)**

| | |
|---|---|
| fork length | FL |
| mideye-to-fork | MEF |
| mideye-to-tail-fork | METF |
| standard length | SL |
| total length | TL |

**Mathematics, statistics**

| | |
|---|---|
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | *e* |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular ) | ° |
| degrees of freedom | df |
| expected value | *E* |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_2$, etc. |
| minute (angular) | ' |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

*FISHERY DATA REPORT NO. 12-53*

# SOUTHEAST ALASKA 2011 HERRING STOCK ASSESSMENT SURVEYS

by
Kyle Hebert
Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

September 2012

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

*Kyle Hebert*
*Alaska Department of Fish and Game, Division of Commercial Fisheries,*
*802 3rd St, Douglas, AK 99811-0024, USA*

*This document should be cited as:*
*Hebert, K. 2012. Southeast Alaska 2011 herring stock assessment surveys. Alaska Department of Fish and Game, Fishery Data Series No. 12-53, Anchorage.*

# TABLE OF CONTENTS

**Page**

# TABLE OF CONTENTS (Continued)



# LIST OF TABLES

# LIST OF FIGURES

# LIST OF FIGURES



# LIST OF APPENDICES

# ABSTRACT

Pacific herring, *Clupea pallasii*, is important to many marine species found in Southeast Alaska and is also harvested in fisheries for commercial bait, commercial sac roe, commercial spawn-on-kelp, subsistence spawn-on-branches, subsistence spawn-on-kelp, personal use, and research/cost-recovery purposes. The Southeast Alaska Herring Management plan (5 AAC 27.190.(3)) requires the Alaska Department of Fish and Game to assess the abundance of mature herring for each stock before allowing commercial harvest. Included here are results of stock assessment surveys completed primarily during 2011, including summaries of herring spawn deposition surveys and age-weight-length sampling, which are the principle model inputs used to forecast herring abundance. Spawn deposition surveys were conducted in seven areas, including Sitka Sound, Seymour Canal, Craig, Hobart Bay-Port Houghton, Hoonah Sound, Ernest Sound, and West Behm Canal. Surveys were not conducted in Tenakee Inlet or Lynn Canal due to limited spawning (Tenakee) or protracted spawn duration (Lynn Canal). In all nine areas, during 2011, a total of 155.8 nautical miles of spawn were mapped along shorelines. In 2011, post-fishery biomass estimates, combined for all stocks, totaled 228,780 tons, which was the second highest over the period 1980-2011.

During the 2010–11 season, winter bait fisheries were opened in Craig and Ernest Sound with guideline harvest levels totaling 1,616 tons. Gillnet sac-roe fisheries were open in Seymour Canal and West Behm Canal with guideline harvest levels totaling 2,111 tons. A purse seine sac-roe fishery was open in Sitka Sound with a guideline harvest level of 19,490 tons. Spawn-on-kelp fisheries were open in Craig, Hoonah Sound, and Ernest Sound. No commercial fisheries were opened in Hobart Bay-Port Houghton, Tenakee Inlet, Kah Shakes/Cat Island, or Lynn Canal in 2010–11. Herring harvested commercially during the 2010–11 season totaled 20,444 tons, not including herring pounded for spawn-on-kelp fisheries.



Key words: Pacific herring, *Clupea pallasii*, Southeast Alaska, spawning populations, dive surveys, stock assessment, fishery


# INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) instituted a herring research project in 1971 to evaluate herring *Clupea pallasii* stocks in Southeast Alaska. This project was developed in response to greater demands on the resource by the commercial bait and developing sac roe fisheries. The goal of the project is to provide the biological data necessary for the scientific management of the region's herring stocks.

A variety of survey techniques have been used in the past to assess herring stocks in Southeast Alaska, including aerial visual estimates, hydroacoustic surveys, and spawn deposition surveys using SCUBA. Data generated during these stock assessment surveys, along with data collected for age, weight, and length estimates, are used directly in the management of all commercial herring fisheries conducted in Southeast Alaska. Data are input into one of two different stock assessment models used to estimate spawning biomass and to forecast mature herring abundance. These models include an age-structured analysis (ASA) model and a biomass accounting model.

Historically biomass estimates and abundance forecasts of mature herring in Southeast Alaska were based on either hydroacoustic surveys or the product of estimates of egg density and area of spawn deposition (called "spawn deposition" method). Currently the ASA model is used for herring populations with longer (i.e. generally a minimum of 10 years) time series of stock assessment data and the biomass accounting model may be used for all other stocks where fisheries occur. These two models are not mutually exclusive of the spawn deposition method. Spawn deposition data is an important element of ASA and biomass accounting models. A primary difference between the two approaches is the amount of data required to conduct the respective analyses. Biomass estimates derived from the spawn deposition method use only the most recent spawn deposition data, and do not factor in trends in age composition or weight at age. A conversion factor based on an estimate of the number of eggs per ton of herring, is

applied to the total egg estimate to compute spawning biomass. In contrast, the ASA model uses a time series of age compositions and weight at age in conjunction with estimates of spawn deposition to estimate biomass. Biomass accounting, which does not require a data time series, is based on spawn deposition estimates adjusted for natural mortality, age-specific growth, and recruitment. A more detailed explanation of the ASA and biomass accounting models and how the objective estimates are used in these models are provided by Carlile et al. (1996).

Since 1993 the ASA model has been used to estimate and forecast the abundance of herring for four major Southeast Alaskan herring stocks: Sitka, Seymour Canal, Revillagigedo Channel (Kah Shakes/Cat Island/Annette Island), and Craig. The ASA model was used for Tenakee Inlet beginning in 2000. These five potential commercial harvest areas or spawning populations have a sufficiently long time series of data to permit the use of ASA for hind casting historical biomass and forecasting future biomass. Other areas, which may support significant herring fisheries but lack data time series suitable for ASA, are candidates for biomass accounting. This approach began in 1996 and has been used to generate forecasts for West Behm Canal, Ernest Sound, Hobart Bay/Port Houghton, and Hoonah Sound. Age-structured analysis and biomass accounting models are mentioned here to provide historical perspective and because they are important elements of the overall stock assessment of herring in Southeast Alaska. Although results from these models are not discussed in this report, key data inputs for these models are presented. The primary intent of this report is to document data collected during winter 2009 through spring 2010 and provide historical perspective by presenting general trends in Southeast Alaska herring populations.

The principal outputs from all models are forecasts of mature herring biomass for the ensuing year. These forecasts are compared to stock-specific threshold biomass levels to determine whether a fishery will be allowed in a particular area. This biomass forecast is coupled with appropriate exploitation rates to determine the allowable harvest and allocations for commercial quotas for each fishery are determined by the appropriate regulations and management plans.

# METHODS AND PROCEDURES

## AERIAL AND SKIFF SURVEYS

A combination of aerial and skiff surveys were used to record spawning activities during the spring, to document spawn timing, and estimate the distance of shoreline that received herring spawn for all major spawning areas (Figure 1), and for many minor spawning areas in Southeast Alaska. Aerial surveys began prior to historical first spawning dates and also documented approximate numbers and locations of herring predators, such as birds, sea lions, and whales. Once concentrations of predators were observed, generally indicating presence of herring, aerial and skiff surveys were conducted more frequently (i.e. daily or multiple flights per day) to ensure accurate accounting of herring distribution and herring spawn. Observed herring spawn (milt) was documented on a paper chart during each survey and then later transferred to computer mapping software to measure shoreline receiving spawn. A chart containing the cumulative shoreline that received spawn during the duration of the spawning event was used as the basis for targeting and designing the spawn deposition dive surveys.

## SPAWN DEPOSITION SURVEYS

Optimal timing of spawn deposition surveys is about 10 days after the first significant spawning event of the season in each spawning area. This usually allows adequate time for herring to

complete spawning and marine mammals to leave the area while minimizing the time eggs are subjected to predation or wave action that may remove eggs from the spawning area. To account for egg loss from the study site prior to survey, a 10% correction factor is applied to the estimate of total egg deposition. This value is an estimate based on several studies have been conducted to estimate herring egg loss from deposition areas in British Columbia (for example see Schweigert and Haegele (2001); Haegele (1993a-b)) and Prince William Sound. These studies found that the extent of egg loss due to predation and physical environmental stresses depends upon several things, including length of time since deposition, depth, and kelp type. Historically, a correction factor based on 10% egg loss prior to survey has been used in Southeast Alaska, British Columbia, and Prince William Sound, however some more recent studies suggest that 25–35% may be more appropriate. Since length of time since egg deposition is key to the extent of egg loss, a serious attempt was made to conduct surveys within 10 days; however at times surveys were delayed slightly to balance survey schedule times for other spawning areas, or to accommodate schedules of survey participants. Surveys conducted after a 10-day period may result in underestimates of egg deposition and overall biomass.

## Shoreline Measurement

Spawn documented during aerial surveys was transcribed in ArcGIS (version 9.3)[1] over raster images of nautical charts published by the National Oceanic and Atmospheric Administration (NOAA). Spawn was drawn to conform to the shoreline so that any given segment of shoreline that received spawn had an approximately equal chance of being sampled during the dive survey. This required that shoreline features be smoothed without adhering closely to the shore on a small scale, but also without drawing sweeping straight lines that did not adequately capture enough detail to design a meaningful survey.

Shoreline measurement and transect placement can be subjective and depends on the location of spawn deposition relative to the shoreline, bottom contour and depth, and map resolution. Fine measurement of a convoluted shoreline may substantially increase measurements of spawn but may not be appropriate for instances when spawn deposition does not closely follow the shoreline. In such situations, less resolution is used for measurements and transects are placed perpendicular to a "theoretical" shoreline so they intersect the spawn in a meaningful way. Conversely, spawn may closely follow a convoluted shoreline, requiring finer resolution of measurements, and transects are placed perpendicular to the actual shoreline contingent upon physical features such as depth, bottom slope, and distance to the opposite shore. For example, a steep sloped shoreline with a narrow band of spawn habitat (e.g. some areas of Sitka Sound) requires much finer shoreline mapping as opposed to an area with broad shallow waters (e.g. Craig) interspersed with rocks and reefs at some distance from shore.

Although the same procedure and patterns of drawing spawn were followed as in past years, the process requires that judgment be used based on knowledge and experience of the local spawning areas. The intent of drawing a smoothed spawn line is to produce a survey area that is oriented along the spawn and is such that transects laid perpendicularly to the spawn line will sample the entire width of the spawn, without biasing the estimate. A second objective of measuring the spawn observed along shorelines is to obtain an estimate of spawn length, which factors into the estimate of overall spawn area, and is discussed more below.

[1] [1] This and subsequent use of product names in this publication are included for completeness, but do not constitute product endorsement.

Once the spawn shoreline was established, a single linear measurement of the shoreline was made using XTools Pro, a measuring tool extension used within ArcGIS. The shoreline was divided evenly into 0.10 nautical mile segments, which were then randomly selected for transect placement. Therefore, transects were placed no closer than 0.10 nmi relative to each other.

## Sample Size

The number of transects selected was proportional to the linear distance of spawn and followed at a minimum the average of suggested sampling rates listed in Table 1. Sampling rates in Table 1 were estimated using data from previous surveys. The statistical objective of the spawn deposition sampling was to estimate herring egg densities (per quadrate) so that the lower bound of a 90% confidence interval was at least within 30% of the mean egg density. This would also achieve the objective of estimating the total spawn deposition at a particular location with the specified precision. A one-sided confidence interval was used because there is more of a concern with avoiding overestimating, rather than avoiding underestimating the densities of spawn deposition. The number of transects were frequently increased beyond the minimum suggested rate to increase transect distribution, potentially reduce variance, and efficiently use scheduled vessel time.

The desirable number of transects is estimated as follows:

$$n = \frac{\left( S_b^2 - \frac{S_2^2}{\overline{M}} + \frac{S_2^2}{\overline{m}} \right)}{\left( \frac{x\overline{d}}{t_\alpha} \right)^2 + \frac{S_b^2}{N}}; \qquad (1)$$

where,

$n$ = number of transects needed to achieve the specified precision;

$S_b^2$ = estimated variance in egg density among transects;

$S_2^2$ = estimated variance in egg density among quadrates within transects;

$\overline{M}$ = estimated mean width of spawn;

$\overline{m}$ = estimated mean number of 0.1 m quadrates per transect;

$x$ = specified precision, expressed as a proportion (i.e. 0.3 = 30%);

$\overline{d}$ = overall estimated mean egg density;

$t_a$ = critical t value for a one-sided, 90% confidence interval; and,

$N$ = estimated total number of transects possible within the spawning area.

## Field Sampling

Transect direction was determined by comparing the dive location to a chart with the spawn shoreline, and setting a compass bearing perpendicular to the spawn shoreline. Transects began at the highest point of the beach where eggs were observed and continued down to a depth in the sub tidal zone until no further egg deposition was observed, or to a maximum of 21 m (70 fsw)

of depth. The portion of transects above the waterline were surveyed by walking until the water reached diving depth (usually 2 to 3 feet), at which point diving commenced. Dives were limited to 21 m because deeper dives severely limit total bottom time for SCUBA divers and pose safety risks when conducting repetitive dives over several days. All diving was conducted in compliance with procedures and guidelines outlined in the ADF&G Dive Safety Manual (Hebert 2006). Normally, little if any herring egg deposition occurs deeper than 21 m.

A two-stage sampling design, similar to that of Schweigert et al. (1985), was used to estimate the density of herring eggs. The field sampling procedure entailed two-person dive teams swimming along transects and recording visual estimates of the number of eggs within a 0.1 $m^2$ sampling frame placed on the bottom at 5-meter intervals. To help estimate the number of eggs, estimators used a reference of 40,000 eggs per single layer of eggs within the sampling frame, which was determined mathematically using measurements of average egg diameter and frame dimensions. Addition data recorded included substrate type, primary vegetation type upon which eggs were deposited (Appendices A and B, respectively), percent vegetation coverage within the sampling frame, and depth. Since sampling frames were spaced equidistant along transects, the record of the number of frames was also used to compute transect length.

## VISUAL ESTIMATE CORRECTION

Since visual estimates rather than actual counts of eggs within the sampling frame are recorded, measurement error occurs. To minimize bias and the influence of measurement error on estimates of egg deposition within each frame, estimator-specific correction coefficients were used to adjust egg estimates either up or down depending on an estimators tendency to underestimate or overestimate. Correction coefficients were estimated by double sampling (Jessen 1978) frames independent of those estimates obtained along regular spawn deposition transects. Samples for correction coefficients were collected by visually estimating the number of eggs within a 0.1$m^2$ sampling frame and then collecting all of the eggs within the frame for later more precise estimation in a laboratory. To collect the eggs, divers removed the vegetation (e.g., kelp) along with the eggs and preserved them with 100% salt brine solution.

Correction coefficients were calculated as the ratio of sums of laboratory estimates to an estimator's visual estimates. To reduce potential of highly variable correction coefficients, minimum sample size guidelines were used. Data from the years 2009, 2010, and 2011 were used if there were at least a total of six samples for each estimator and kelp type, with at least three samples in at least two of the three years. If this was not satisfied, then samples from prior years were added until the minimum sampling guideline was met. The intent of these sampling guidelines was to achieve a reasonably adequate sample size to minimize variation, but also to develop correction coefficients that reflected an estimator's tendency to estimate high or low in the most recent years.

Estimator/kelp-specific correction coefficients were applied to egg estimates when the appropriate kelp type matched. For example, the "large brown kelp" correction coefficient was applied when kelp types that fit that description were encountered, and the "eel grass" correction coefficient was applied when eelgrass was encountered. When loose eggs or eggs adhering to bare rock were encountered within the frame, an estimator-specific correction coefficient based on the average of all estimator/kelp-specific correction coefficients was applied.

## ESTIMATES OF TOTAL EGG DEPOSITION

Total egg deposition for a particular spawning area ($t_i$) was estimated as follows:

$$t_i = a_i \bar{d}_i \tag{2}$$

where $a_i$ is the estimated total area ($m^2$) on which eggs have been deposited; and $\bar{d}_i$ is the estimated mean density of eggs per 0.1 $m^2$ quadrate, extrapolated to 1 $m^2$ area (eggs/$m^2$) at spawning area *i*. The total area on which eggs have been deposited ($a_i$) is then estimated as,

$$a_i = l_i \bar{w}_i \ , \tag{3}$$

where $l_i$ is the total length of shoreline receiving spawn (determined from aerial and skiff surveys); and $w_i$ is the mean width of spawn, as determined by the mean length of transects conducted at spawning area *i*.

The mean egg density (eggs/$m^2$) at area *i* ($\bar{d}_i$) is calculated as,

$$\bar{d}_i = 10 \cdot \left[ \frac{\sum_h \sum_j \sum_k v_{hijk} c_{hk}}{\sum_h m_{hi}} \right] \tag{4}$$

where $v_{hij}$ is the visual estimate of egg numbers by estimator *h*, at area *i*, quadrate *j*, on kelp type *k*. The $c_{hk}$ term refers to a diver-specific, kelp-specific correction factor to adjust visual estimates made by estimator *h* on kelp type *k; $m_{hi}$* is the number of quadrates visually estimated by estimator *h* at area *i*. Since egg estimates are made within 0.1 m quadrates, multiplying by 10 expresses the mean density in per 1.0 $m^2$. Estimator/kelp-specific correction **Error! Bookmark not defined.**factors ($c_{hk}$) are calculated as follows:

$$c_{hk} = \frac{r_{hk}}{q_{hk}} ; \tag{5}$$

where $q_{hk}$ is the sum of visual estimates of eggs for estimator *h* on kelp type *k*; and, $r_{hk}$ is the sum of laboratory estimates of eggs collected from quadrates that were visually estimated by estimator *h* on kelp type *k*.

## SPAWNING BIOMASS ESTIMATION

The total number of eggs per spawning area is a key element used in forecasting herring spawning biomass. Although estimated spawning biomass is not an input for the ASA or biomass accounting models, it does provide a static value in a given year (unlike ASA-derived estimates), which is useful for comparison among years to track broad, relative changes in abundance.

The conversion of eggs to spawning biomass is calculated either using the stock-specific fecundity-to-weight relationship for the areas where fecundity estimates are available (Sitka Sound, Seymour Canal, Craig, Kah Shakes-Cat Island), or for all other stocks, the fecundity-to-weight relationship from the closest spawning stock where fecundity estimates are available (Table 2). The estimate for each area is calculated as follows:

$$b = h_{\bar{g}} * \bar{g} ; \tag{6}$$

where,

$b$ = estimated total spawning biomass;

$h_{\bar{g}}$ = number of fish of mean weight in the area; and,

$\bar{g}$ = mean weight of fish for each area, weighted by age composition

The number of fish of mean weight ( $h_{\bar{g}}$ ) is calculated as follows:

$$h_{\bar{g}} = \frac{\left(\frac{t}{L}\right) * 2}{f_{\bar{g}}}; \tag{7}$$

where,

$L$ = egg loss correction factor (0.9), which accounts for an estimated 10% egg mortality between the time eggs are deposited and spawn deposition surveys are conducted; and,

$f_{\bar{g}}$ = estimated fecundity of fish of mean weight, using equations listed in Table 2.

## AGE AND SIZE

Herring samples were collected from a combination of skiff surveys, aerial surveys, research surveys, commercial fisheries, and test fisheries from major stocks located throughout Southeast Alaska. Collection gear varied with location and included purse seines, gillnets, cast nets, and bottom trawls. Cast nets were used when fish were in shallow water during active spawning. Herring sampled from commercial fisheries were collected from individual harvesters or tenders while on the fishing grounds. Dates and geographic locations of all samples were recorded.

Based on multinomial sampling theory (Thompson, 1987), a sample size of 511 ages is considered sufficient to assure age composition estimates that deviate no more than 5% (absolute basis) from the true value, with an alpha level of 0.10 (i.e. the chances of rejecting a true value is about 10 percent). The minimum sampling goal was set at about 525 fish so that 500 aged scales would be obtained, from each commercial fishery (i.e. purse seine or gillnet samples) and each spawning stock (i.e. cast net samples).

All samples were packaged and labeled in 5-gallon buckets and frozen for later processing in the laboratory. After thawing samples in the laboratory, the standard length (mm) of each fish (tip of snout to posterior margin of the hypural plate) was measured. Fish were weighed on an electronic balance to the nearest tenth of a gram.

A scale was removed from each fish for age determination. The preferred location is on the left side anterior to the dorsal fin or beneath the left pectoral fin. Scales were cleaned and dipped in a solution of 10% mucilage and placed unsculptured side down on glass slides. Aging was conducted by viewing scale images on a microfiche projector to count annuli. Age data for some years (1980-1998) were obtained by viewing scales through a dissecting microscope, varying the light source for optimum image of the annuli. The fish were assigned an anniversary date for each completed growing season. All samples were collected before growth resumed in the spring, and scales were aged based on the number of summer growth periods observed. For example, if a herring hatched in the spring of 1991 and was collected in the fall of 1992, two growing seasons had occurred (age-2). If the herring had been collected in the spring of 1993 before growth had resumed, it was also recorded as age-2. Scales were spot-checked by a second

reader for age verification, and if agreement between readers was less than 80%, the entire sample was re-aged. For a detailed description of aging methods see Oxman and Buettner, 2012.

## Aging Methods Drift

In November 2010 a serious bias was discovered within the results of age estimates for the period 1999-2010. The bias affected samples of all herring stocks in Southeast Alaska. The bias was caused by an unintentional change in the interpretation of patterns observed on the scale, or "method drift". The correct aging protocol defined an annulus as a band that clearly wraps continuously around the focus of the scale. However, over the period 1999-2010, the protocol shifted by including juvenile checks and false checks as annuli in addition to true annuli. Checks are bands that partially wrap around the focus and represent interruptions during the growth period and do not signifying a completed year of growth. To determine the extent of the method drift, the correct aging method was used to re-age a subsample of archived scales that were aged during the period the incorrect method was applied. The maximum length of this period was known because scales were aged by a single reader and it was assumed that the incorrect method may have been used throughout this period. All scales in the subsample were read by viewing enlarged scales images on a microfiche projector, following the procedure in Oxman and Buettner, 2012. Results from the re-aging subsamples indicated that herring ages were increasingly over estimated over the period 1999-2010. Therefore, a project was initiated to re-age all archived scales from this period for cast net and commercial samples of the major herring stocks in the region. This required re-aging over 60,000 scales. The department's Mark, Tag and Age Laboratory conducted all re-aging of scales for this project. Archived scales could not be located for the year 2000, and were not re-aged. Results for 2000 are presented; however aging data is potentially biased slightly high.

## Condition Factor

Condition factor (CF) was calculated to provide a general indication of overall condition of fish based on body proportion. Condition factor was based on the method described in Nash et al., 2006 and was estimated as follows:

$$CF = \left( \frac{w}{l^3} \right) * 100; \tag{8}$$

where,

$w$ = whole body wet weight in grams; and,
$l$ = standard length in millimeters.

## Sea Temperature

Daily sea surface temperature was recorded in spawning areas for most stocks using submerged Onset Stowaway Tidbit™ temperature loggers. Depth of temperature recorders ranged from about 5 feet MLLW to 10 feet MLLW. Temperature was recorded daily at 6-hour intervals for a minimum of one year and up to ten years, depending on spawning area. For each spawning area, mean, minimum and maximum sea temperature values were calculated for each year using datasets that spanned an entire year (365 consecutive days). Overall annual mean temperature was calculated as the mean of all daily values. Mean annual minimum temperatures and mean annual maximum temperatures were calculated as the mean of the minimum or maximum values that occurred during each annual cycle.

## COMMERCIAL FISHERIES

During the 2010–11 season, several commercial herring fisheries were conducted in Southeast Alaska. Products resulting from these fisheries included food and bait, sac roe, and spawn on kelp. Threshold biomass levels have been established, which are intended to reduce the risk of sharp declines in abundance due to recruitment failure, and to maintain adequate herring abundance for predators. Commercial harvest of herring is not permitted unless the forecast of mature herring meets or exceeds the threshold. In Southeast Alaska, a threshold has been established for each herring stock supporting a commercial fishery. For Sitka Sound and West Behm Canal, threshold levels were based on 25% of estimated average unfished biomass (AUB) as determined through simulation models (Carlile 1998a; Carlile 2003). In the case of Sitka Sound, the threshold was subsequently increased by the Board of Fisheries on two occasions (1997 and 2009) to provide additional protection to help alleviate concerns about subsistence uses of the resource. For the Tenakee Inlet stock, 25% of AUB was estimated, however because the value was lower than the existing threshold of 3,000-tons, the existing threshold was retained (Carlile 1998b). For all other stocks in Southeast Alaska, thresholds were established after considering estimates of abundance, historical knowledge of stock size and distribution, and manageability of minimum quotas. Threshold levels during the 2010–11 season ranged from 1,000 tons (Hoonah Sound) to 25,000 tons (Sitka Sound).

### Management Strategy

The following management plan was in place for the 2010–11 Southeast Alaska commercial herring fisheries. It was adopted by the Alaska Board of Fisheries at its January 1994 meeting.

5 AAC 27.190. *HERRING MANAGEMENT PLAN FOR STATISTICAL AREA A.* For the management of herring fisheries in Statistical Area A, the department:

(1) shall identify stocks of herring on a spawning area basis;

(2) shall establish minimum spawning biomass thresholds below which fishing will not be allowed;

(3) shall assess the abundance of mature herring for each stock before allowing fishing to occur;

(4) except as provided elsewhere, may allow a harvest of herring at an exploitation rate between 10 percent and 20 percent of the estimated spawning biomass when that biomass is above the minimum threshold level;

(5) may identify and consider sources of mortality in setting harvest guidelines;

(6) by emergency order, may modify fishing periods to minimize incidental mortalities during commercial fisheries.

# RESULTS

## AERIAL AND SKIFF SURVEYS

Aerial and skiff surveys of herring activity, herring spawn, and marine mammal/bird activity were conducted at major stock locations beginning on March 14, 2011 in Sitka Sound and ending on June 5, 2011 in Lynn Canal. Notes of activity related to herring or herring spawning were recorded in logs, which are presented in Appendix C. Surveys were conducted by staff in each

area office (Ketchikan, Petersburg, Sitka, Juneau, Yakutat) and covered major and traditional herring spawning locations within each management area. Spawning timing for each major spawning area, including dates of first, last, and major spawning events, is summarized in Figure 2. Aerial surveys were conducted in several minor spawning areas, but where no spawn deposition surveys were completed due to low level of spawning (see Appendix C). The department also documented a total of 5.8 nmi of herring spawn on Annette Island in 2011. No aerial surveys were conducted in Yakutat Bay during 2011, due to lack of funding.

## SPAWN DEPOSITION SURVEYS

In 2011, spawn deposition surveys were conducted in the Craig, Ernest Sound, Hobart Bay/Port Houghton, Hoonah Sound, Seymour Canal, Sitka Sound, and West Behm Canal. Surveys began in Craig on April 14, and were completed in Seymour Canal on May 10 (Table 3). Survey site locations, spawn, and transect locations are presented in Appendix D. Egg estimates by transect for each spawning area are presented in Table 4.

A summary of the 2011 survey results, including spawn mileage, average transect length, area of egg deposition, egg density, estimated egg deposition, and estimated spawning biomass is presented in Table 5. For comparison of 2011 spawning stock abundance to prior years, estimates of spawning biomass are presented in Figures 3 to 8.

The total documented spawn for major spawning areas in Southeast Alaska in 2011 was 155.8 nmi (Table 5). This did not include spawning in minor spawning areas, or around Annette Island, or Yakutat (see Appendix C for a detailed accounting of minor spawn areas throughout Southeast Alaska).

### Visual Estimate Correction

Minimum sample size guidelines (at least three samples per kelp type for the most recent three years) were met using data from 2009 through 2011 for most (7 of 8) estimators. Correction coefficients applied to 2011 spawn deposition visual estimates ranged from 0.833 to 3.186, and are presented in Table 6.

Visual review of plots depicting observed versus laboratory estimates of eggs revealed an apparent linear relationship. Although individual estimators may generally estimate higher or lower than laboratory estimates, there appeared to be no clear pattern or tendency of greater divergence of observed estimates from laboratory estimates as the magnitude of estimates increased, as studies of other species has found (see Jones and Quinn 1998). Therefore, an overall ratio of sums, across the entire range of estimate values, was considered to adequately represent patterns of estimators and was used to calculate correction coefficients.

## AGE AND SIZE

A combined total of 8,314 herring were sampled from all stocks and gear types (cast net, purse seine, pound, gillnet) during the 2010–11 season. Of these, 8,019 herring were processed to determine age, weight, length and sex. The reduction of sample size was due to fish that could not be aged due to regenerated or data was otherwise unusable.

Samples of the spawning population were taken using cast nets from Craig, Ernest Sound, Hobart Bay/Port Houghton, Hoonah Sound, Lynn Canal, Seymour Canal, Sitka Sound, and West Behm Canal. Samples of the spawning population were collected throughout the geographic extent of the active spawn in most spawning areas (Figures 9-17). For most spawning areas,

collection of samples from the spawning population was also distributed throughout the duration of spawning, or was focused on the most intense spawning events (Figure 2). Two areas where this was not achieved in 2011 are Tenakee Inlet and Lynn Canal, where samples were not obtained (Tenakee Inlet) or samples were difficult to obtain due to a sporadic and protracted spawning event (Lynn Canal).

Samples were obtained from commercial fisheries for all areas where fisheries were conducted in 2010-11. Fisheries sampled included Craig winter bait, Craig spawn on kelp, Sitka sac roe, Sitka winter test fishery, Ernest Sound winter bait, Hoonah Sound spawn on kelp, Seymour Canal gillnet sac roe, and West Behm Canal gillnet sac roe. Samples were obtained opportunistically from vessels or tenders, during or shortly after the fisheries. Sample locations during fisheries are also shown in Figures 9-17.

The minimum sample goal of 500 aged fish per sampling event (gear-fishery combination) was met or exceeded in most cases (Tables 7 and 8). In one case, West Behm Canal (commercial gillnet) sample size was not achieved due to very low fishing effort.

## Age Composition

Results of re-aging scales using standardized methods revealed that during the period 1999-2002, aging bias was minimal in the previously aged data. However, during the period 2003-2005, ages from previously aged scales were found to have been over estimated predominantly by one year, and during the period 2006-2010 ages from previously aged scales were found to have been over estimated predominantly by two years. By 2004 and continuing through 2010, ages of age-3 herring (as determined from re-aging) appeared to have been systematically over estimated by at least one year. This was evident from the re-aging process and from observations that age-3 herring were rarely found in cast net samples beginning in 2004, though they were commonly observed in years prior to 2004. Ages of older herring were also over estimated during 2003-2010, as evidenced from re-aging scales and from an observed abrupt shift to higher percentages of age-8+ herring during this period prior to scale re-aging (Hebert, 2009).

Upon completion of re-aging archived scales, a different pattern emerged in age compositions for all stocks than existed before re-aging. A primary difference was that substantial proportions of age-3 and age-4 herring were observed in cast net and commercial samples during 2009-10 (Tables 12-20; Figures 18-27), and during the period 2003-2010. It is now evident that age-3 and age-4 herring were present in the mature population and their apparent absence reported previously was due entirely to the drift of the scale reading method. When age compositions of re-aged data are plotted as a time series, cohorts are now relatively easy to follow through time, with age-3 proportions generally increasing at age-4 and then gradually decreasing with subsequent years (Figures 28-36). This is the expected progression, since between age-3 and age-4 more fish become mature than die from natural or fishery mortality, followed each year by fewer additions from maturation, but steady removals due to mortality. Prior to the scale re-aging project, herring appeared to mature later in life, because although mature age-3 fish were not observed in samples, cohorts were clearly present in subsequent years. And, herring appeared to live considerably longer, well past age-8, than was observed in the past. Now it is clear from re-aged data that the absence of age-3 fish was a mistake and because ages of older fish were over estimated as well, the maturation rates and the survival rates that had been estimated prior to scale re-aging were incorrect as well.

The proportions of age-3 recruitment entering the mature component of each stock each year seem to fluctuate similarly, with high and low years synchronized in many instances (Figure 36). The proportion of age-3 recruitment also appears to be related to the latitude of the spawning stock and the sea water temperature (Table 9, Figure 37). The median proportion of age-3 herring in the mature population appears to decrease with the latitude of the spawning stock, although the correlation is weak ($r^2$=0.54) (Figure 38). Additionally, there are weak positive correlations between median proportion of age-3 mature herring and, 1) mean annual sea surface temperature ($r^2$=0.45), and 2) mean minimum annual sea temperature ($r^2$=0.55) (Figures 39 and 40). There was no correlation between the proportion of age-3 herring and mean maximum annual sea temperature; however there appears to be a dome-shaped relationship, where highest median recruitment occurred around 14.5º C and the median recruitment was much lower at mean maximum annual temperatures around 13º C or 15º C (Figure 41).

## Size-at-Age

Based on cast net samples in 2011, there is a clear distinction between mean weight-at-age for most age-classes for Sitka Sound spawning herring, and all other herring stocks in Southeast Alaska (Figure 42). The divergence between Sitka Sound herring weight-at-age and other stocks in the region increases with age. There also appears to be a difference in weight-at-age among major Southeast Alaska stocks other than Sitka Sound. Herring from some stocks appear to have consistently higher mean weights-at-age, across all ages, than others. Tests of significance were not performed as the primary intent of this report is to present 2011 data with general observations of trends and characterization of stocks.

Length-at-age follows similar patterns as weight-at-age. Although the distinction between Sitka Sound herring mean length-at-age and other Southeast Alaska stocks is clear, it is not as great as observed for mean weight-at-age (Figure 43). The ranking of stocks for both mean length-at-age, and mean weight-at-age is very similar. This is not surprising as weight is expected to be highly correlated with length. The separation gap between Sitka Sound and other stocks (for both length and weight) increases with age. This is likely an indication that growth rate for Sitka Sound herring is greater than for other stocks in the region. The differences could be a result of different environmental conditions, genetic distinction, or a combination of both. The smallest herring in Southeast Alaska are from Ernest Sound, followed by West Behm Canal.

Trends in weight-at-age are variable among stocks (Figures 44 to 52). For some stocks, trends in weight-at-age are not available as re-aging of scales is in progress. For other stocks, a common pattern is evident: weight-at-age of age-3 herring has been stable, while older ages appear to have steadily declined. The decline appears to greater as age-class increases. The exception is Sitka Sound, where weight-at-age has increased over the past 20 years.

Another apparent pattern is that weight-at-age of age-4+ herring has declined more in the southernmost stocks (Craig and West Behm Canal) than in northern stocks. Weight-at-age of age-4+ herring in Sitka Sound, Hoonah Sound and Seymour Canal appear to be increasing or stable.

To determine whether changes in weight-at-age have resulted from changes in length-at-age, or other reasons, condition factors were calculated. Condition factors were calculated to index the physical dimensions of herring (i.e. weight-to-length ratio) over time, to roughly gauge herring health. Condition factors were calculated for Sitka Sound and Craig to compare fish condition from an area where weight-at-age has been increasing (Sitka) to an area where weight-at-age has

been decreasing (Craig). Mean condition factors of herring in Sitka Sound appear to be stable or increasing over the period 1990–2011 (Figure 53), while mean condition factor in Craig has generally decreased over the period 1998-2011, but appears to have increased in recent years (Figure 54).

### Sitka Sound Winter Test Fishery

Winter sampling was conducted in Sitka Sound by the department in late January through early February 2011 using a purse seine. The purpose of the Sitka winter sampling is generally to provide data to update weight-at-age used to calculate the final 2011 ASA-model forecast of the mature population. The Sitka winter test fishery does not cover a wide geographical area or sample from a large number of herring schools, and therefore is not expected to provide an accurate estimate of age composition. Data collected from the test fishery in 2011 was not used to update the Sitka Sound herring forecast for 2011. This was because the change in forecast using the updated weight-at-age data was negligible compared to the announced guideline harvest level. The 2011 Sitka forecast was based on the biomass accounting model because re-aged historical data was not yet available for ASA-modeled forecasting. Typically, the ASA model is used to produce a preliminary forecast of herring biomass in Sitka, and a final forecast is calculated using winter test fishery data, which is believed to increase accuracy of forecasts. Department analysis has shown that using weight-at-age from the winter immediately preceding the spring of the forecast results in the most accurate forecasts (ADF&G unpublished data). The final forecast and guideline harvest level of mature herring in Sitka Sound for 2011 was 97,449 tons and 19,490 tons, respectively.

## COMMERCIAL FISHERIES

Commercial harvest was permitted in an area only if the forecasted spawning biomass met or exceeded a minimum threshold (Table 10). If that threshold was met, then a sliding-scale harvest rate of between 10 and 20 percent of the forecasted spawning biomass was calculated to determine the appropriate harvest level. A summary of locations, harvest levels, and periods of harvest is presented in Table 11.

### Sac Roe Fisheries

Commercial sac roe fisheries were conducted in the Sitka Sound, Seymour Canal, and West Behm Canal areas during 2011. There were no sac roe fisheries in the Hobart Bay-Port Houghton, Kah Shakes/Cat Island, or Lynn Canal areas because spawning biomass was estimated to be below threshold.

#### *Seymour Canal*

The Seymour Canal commercial gillnet fishery opened April 26, 2011 at 8:00pm and closed on May 11, 2011 at 11:59pm. One processor and 12 permit holders participated in the fishery. Due to confidentiality regulations actual harvest numbers cannot be made public, although a significant amount of the 835-ton guideline harvest was not taken in the fishery.

#### *Sitka Sound*

The guideline harvest level (GHL) was achieved with five competitive openings, ranging from 55 minutes to 4 hours and 40 minutes in duration. The first opening (4 hour, 40 minutes), occurred March 31 north of Middle Island; approximately 1,555 tons of herring were harvested with about 13.3% roe by weight. The second opening (1 hours, 10 minutes) occurred on April 1

in the Crescent Bay area; about 5,293 tons were harvested with roe percentage about 12.5%. The third opening (55 minutes) occurred on April 4 in Eastern Channel; about 5,145 tons were harvested with roe percentage of 13.8%. The fourth opening (1 hours, 30 minutes) occurred on April 7 in Eastern Channel; about 4,159 tons were harvested with roe percentage of 15.0%. The fifth and final opening (2 hours, 45 minutes) occurred on April 7 in Eastern Channel/Silver Bay; about 3,277 tons were harvested with roe percentage of 12.8%. The total harvest was 19,419 tons.

#### *West Behm Canal*

The fishery was opened on April 11 at 10:30am and closed on April 14 at 1:30pm. A significant amount of the GHL was not taken, although the actual harvest amount is confidential due to fewer than three processors participating in the fishery.

#### *Hobart Bay-Port Houghton*

There were no commercial fisheries opened in the Hobart Bay-Port Houghton area in 2011.

### Winter Bait Fisheries

During the 2010-11 season, winter food and bait fisheries were opened near Craig and Ernest Sound. Both areas were opened on December 1, 2010 and closed by regulation on February 28, 2011. Harvest amount is confidential due to fewer than three participants in the fishery.

### Spawn-on-Kelp Pound Fisheries

Three areas were open to the commercial harvest of spawn on kelp (SOK) during the 2010–11 season: Hoonah Sound, Craig, and Ernest Sound. Spawn on kelp was harvested from Hoonah Sound and Craig. There was no harvest from Ernest Sound.

#### *Hoonah Sound*

A total of 89 closed pounds were actively fished, of which 86 were single-permit pounds, 2 were double-permit pounds, and one was an experimental pound. About 194 tons of SOK was harvested.

#### *Craig*

A total of 34 closed pounds were actively fished, of which 15 were single-permit, and 19 were double-permit pounds. About 70 tons of SOK were harvested.

#### *Ernest Sound*

The spawn-on-kelp fishery opened to purse seining on April 1, 2011; however there was no participation in the fishery and no SOK harvest.

### Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2010–11 season, no herring were harvested for fresh bait pounds or tray-pack in Southeast Alaska.

### Test Fisheries

The sole herring test fishery conducted in Southeast Alaska during the 2010–11 season was in Sitka Sound, for bait, using purse seine gear during late January and early February, 2011. A total of 60 tons of herring were harvested from the areas northeast of Middle Island and around the Gavanski Islands.

# DISCUSSION

## Spawn Deposition

Spawning population biomass estimates, as calculated from spawn deposition estimates, increased between 2010 and 2011 for four of seven stocks that were surveyed in Southeast Alaska. In two of these areas the increases from were substantial (change at least 20%). These areas include the stocks near Sitka and Craig. Although error surrounding biomass estimates was not calculated, the magnitudes of these increases were large and likely reflect actual changes of the spawning population levels. In Seymour Canal and Hobart Bay-Port Houghton, modest increases were observed or spawning biomass did not change appreciably since 2010. For these areas, based on the low magnitude of change, it is less clear whether the apparent increase in biomass reflects an actual change in the population, because estimates are likely within the probable error range surrounding the estimates.

Areas where estimated spawning population biomass decreased between 2010 and 2011 include Ernest Sound, Hoonah Sound, and West Behm Canal. The decline was relatively substantial in Ernest Sound, suggesting an actual change to the population. Biomass estimates for 2011 for Hoonah Sound and West Behm Canal were not substantially less than for 2010 (18% and 7% of 2010 values, respectively). For these areas, it is less clear whether a true change to the population occurred.

It is unknown whether the changes in estimated spawning biomass over the past year are primarily due to population fluctuations, or a function of estimate variation, or both. Although error estimates were not calculated for spawn deposition estimates, it is possible that large fluctuations in estimates were due in part to variability. Therefore, estimates of spawning biomass presented in this report, which are based primarily on egg deposition estimates (as opposed to model-derived results), are useful for providing a general view of trends in stock size but should not necessarily be considered the most accurate estimate of stock size in any given year. For all major herring stocks in Southeast Alaska, the results of ASA or biomass accounting models are considered to provide a more accurate estimate of spawning biomass. A primary reason that the ASA model is considered to be more appropriate when fully evaluating stocks is that it incorporates other sources of data (primarily age composition), and combines a long time series of data to estimate spawning biomass, whereas spawn deposition-derived estimates rely on a single year of spawn deposition data. An advantage of using biomass estimates derived from spawn deposition is that they provide a consistent time series with fixed historical values, unlike ASA model derived hind cast estimates, which change with each model run.

The general trend for herring biomass in Southeast Alaska, based on spawn deposition estimates, is increasing over the period 1980 to 2011 (Figure 8). This is true whether or not the largest stock in the region, Sitka Sound, is included. Biomass estimates from 2011, for all stocks combined, and for all stocks combined except Sitka Sound, are 132% and 63%, respectively, higher than the long-term average (1980–2009). The general trend of spawning stock size for most spawning areas where data is available in Southeast Alaska is either increasing or stable (Figures 3 to 7). Biomass levels in some areas have fluctuated widely over the past few decades and are currently at low levels. This pattern is true for Tenakee Inlet and Hobart Bay-Port Houghton. The large fluctuations in population level make it difficult to discern a trend. Another exception to the general increasing biomass trend in the region is the Kah Shakes-Cat Island area, where significant spawn has not been observed since 2001. However, since stock assessment surveys

are not conducted around the Annette Island Indian Reserve—an area where substantial herring spawning occurs that is adjacent to the Kah Shakes-Cat Island area—the trend in spawning stock size for this greater area is unclear. Overall, spawn deposition estimates for 2011 suggest that abundance of herring in Southeast Alaska remains at a high level relative to the period 1980–2010.

## Age Composition

Estimates of age composition continued to follow patterns that are generally expected, that is that age-3 fish were observed in samples of the spawning population, and the proportion of cohort sizes progress as expected with increases due to maturation and decreases due to natural mortality. In 2010 the re-aging project for scales collected during the period 1999-2010 substantially changed the estimated age composition for the region's herring stocks. Whereas prior to the re-aging of scales, herring appeared to begin maturing at age-4 and older and surviving until 13-14 years of age, after the re-aging of scales, herring appear to begin maturing at age-3 and surviving to about 10-11 years of age. The results of the re-aged scales were more aligned with historical patterns observed for herring age composition in Southeast, in other regions of Alaska, and along the west coast of North America.

The data resulting from re-aged scales indicate that the proportion of age-3 recruitment into the mature population has fluctuated widely, depending on the stock, but some patterns are evident. Although the proportion of mature age-3 herring is different among stocks in any given year, the direction of change from year to year is often the same. In other words, in years when the proportion of age-3 fish is high or low for one stock, it is usually relatively high or low for all or most stocks. This suggests that age-3 recruitment into the mature segment of each stock is influenced by a common factor (e.g. biological or physical conditions in the marine environment). The scale of influence may be greater than Southeast Alaska, as very similar recruitment patterns have been observed in the past for Sitka Sound and Prince William Sound (Carls and Rice 2007).

Recruitment of mature age-3 herring may be connected to the latitude of the spawning stock. There appears to be a break between two categories of median age-3 recruitment among stocks: 20-25% for stocks south of latitude 56 degrees (Craig, West Behm Canal, Ernest Sound, and Kah Shakes), and 4-11% for stocks at 57 degrees and northward (Sitka, Hobart Bay, Seymour Canal, Hoonah Sound, Tenakee Inlet, and Lynn Canal). Not surprisingly, the north-south delineation appears related to sea temperature, which decreases with increasing latitude. Age-3 median recruitment is generally highest where mean annual temperature and mean minimum temperature are highest; however since the correlation is weak, other factors linked to latitude may play a role as well. Interestingly, the mean maximum sea temperature appears to have a non-linear relationship to median age-3 recruitment. This relationship suggests that an optimal maximum sea temperature exists around 14.5 C and at higher or lower sea temperature, the median proportion of mature age-3 herring is less. It is beyond the scope of this report to further explore if an actual relationship exists between recruitment success and sea temperature, or biological explanations of such a relationship; however the patterns in the data are suggestive enough to warrant additional investigation.

# ACKNOWLEDGEMENTS

Much credit goes to Detlef Buettner (Herring Aging Supervisor), who was instrumental in discovering the aging methods drift, and worked diligently with Mark Olsen, Cathy Robinson, John Barton, Kristeen Brooks, Jamison Clark, and Ruby Young of the Mark, Tag and Aging Laboratory to re-age many thousands of herring scales.

Sherri Dressel (Region I Biometrics Supervisor) advised on calculation of spawn deposition estimates. Jan Rumble (Region I Herring-Dive Fisheries Research Assistant Biologist) assisted with spawn deposition survey design. Jim Craig and Ericka Love (Region I Publications Section staff) provided advice and support for report formatting and editing.

Many department divers and boat officers contributed to the successful completion of the spawn deposition dive surveys. The dive team included Jeff Meucci, Bo Meredith, Sherri Dressel, Troy Thynes, Scott Kelley, Dave Gordon, Jan Rumble, Justin Breese, Scott Walker, Eric Coonradt, and Kyle Hebert. Thanks to Captain Kevin Kivisto, Lito Skeek, and Erin Watkins for their safe and skillful operation of the dive support vessel, *R/V Kestrel*.

# REFERENCES CITED


Carlile, D. W. 1998a. Estimation and evaluation of a harvest threshold for management of the Sitka herring sac roe fishery based on a percentage of average unfished biomass. Alaska Department of Fish and Game, Division of Commercial Fisheries Regional Information Report 1J98-18, Juneau.

Carlile, D. W. 1998b. Estimation and evaluation of a harvest threshold for management of the Tenakee Inlet herring bait fishery based on a percentage of average unfished biomass. Alaska Department of Fish and Game, Division of Commercial Fisheries Regional Information Report 1J98-21, Juneau.

Carlile, D. W. 2003. Estimation and evaluation of a harvest threshold for a W. Behm Canal herring fishery based on a percentage of average unfished biomass. Alaska Department of Fish and Game, Division of Commercial Fisheries Regional Information Report 1J03-02, Juneau.

Carlile, D. W., R. L. Larson, and T. A. Minicucci. 1996. Stock assessments of Southeast Alaska herring in 1994 and forecasts for 1995 abundance. Alaska Department of Fish and Game, Division of Commercial Fisheries Regional Information Report 1J96-05, Juneau.

Carls, M.G. and S.D. Rice. 2007. Prince William Sound herring: An updated synthesis of population declines and lack of recovery. Exxon Valdez Oil Spill Restoration Project 050794 Final Report, Chapter 3.

Haegele, C.W. 1993a. Seabird predation of Pacific herring, *Clupea pallasi*, spawn in British Columbia. Canadian Field-Naturalist 107:73–82.

Haegele, C.W. 1993b. Epibenthic invertebrate predation of Pacific herring, *Clupea pallasi*, spawn in British Columbia. Canadian Field-Naturalist 107:83–91.

Hebert, K. 2009. Southeast Alaska 2009 herring stock assessment surveys. Alaska Department of Fish and Game, Fishery Data Series No. 09-72, Anchorage.

Hebert, K. 2006. Dive Safety Manual. Alaska Department of Fish and Game, Special Publication No. 06-39. Anchorage.

Jessen, R. J. 1978. Statistical survey techniques. John Wiley & Sons. New York.

Jones, E. L. and T. J. Quinn. 1998. Observer accuracy and precision in aerial and foot survey counts of pink salmon in a Southeast Alaska stream. North American Journal of Fisheries Management 18:832–846.

Nash, R. D. M., A. H. Valencia, and A. J. Geffen. 2006. The origin of Fulton's condition factor – setting the record straight. Fisheries 31:236-238.

Oxman, D.S. and D. Buettner. *In prep*. 2012. Southeast Alaska Pacific herring *Clupea pallasi* age, weight, length and sex sampling. Alaska Department of Fish and Game.

Schweigert, J. and C. Haegele. 2001. Estimates of egg loss in Pacific herring spawning beds and its impact on stock assessments. Proceedings of the International Herring Symposium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks.

Schweigert, J. F., C. W. Haegele, and M. Stocker. 1985. Optimizing sampling design for herring spawn surveys in the Strait of Georgia, B.C. Canadian Journal of Fisheries and Aquatic Sciences 42:1806–1814.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. American Statistician. 41:42–46.

# TABLES AND FIGURES

Table 1.–Transect sampling rates used for 2011 herring spawn deposition surveys.

| Area | Estimated Target Transects per Nautical Mile of Spawn[a] | | | |
|---|---|---|---|---|
| | Based on 1994 Analysis | Based on 1997 Analysis | Based on 2000 Analysis | Average |
| Sitka | 0.2 | 0.6 | 0.3 | 0.4 |
| West Behm Canal | — | 0.4 | 1.7 | 1.1 |
| Seymour Canal | 2.8 | 2.4 | 1.2 | 2.1 |
| Craig | 0.8 | 3.1 | 1.3 | 1.7 |
| Hobart/Houghton | 4.5 | 1.7 | 3.6 | 3.3 |
| Ernest Sound | 1.9 | 5 | 3.5 | 3.5 |
| Hoonah Sound | 2.9 | 1 | 0.7 | 1.5 |
| Tenakee Inlet | 5.1 | 1.2 | 1.6 | 2.6 |
| **Average** | 2.6 | 1.9 | 1.7 | 2.1 |

[a] Values represent the number of transects that will produce a lower bound of the one-sided 90% confidence interval interval that is within 30% of the mean egg density.

Table 2.–Fecundity relationships used for estimating 2011 herring spawning biomass for stocks in Southeast Alaska.

| Sampling year | Stock sampled | Fecundity equation | Stocks to which Fecundity Equation was applied in 2011 |
|---|---|---|---|
| 2005 | Sitka Sound | fecundity = -3032.0 + 198.8*weight | Sitka, Tenakee Inlet, Hoonah Sound |
| 1996 | Seymour Canal | fecundity = -1573.3 + 222.4*weight | Seymour Canal, Hobart Bay/Port Houghton, Lynn Canal |
| 1996 | Craig | fecundity = -1092.3 + 210.5*weight | Craig |
| 1996 | Kah Shakes/Cat Island | fecundity = -1310.0 + 202.1*weight | Ernest Sound, West Behm Canal |

Table 3.–Dates of 2011 herring spawn deposition surveys conducted in Southeast Alaska.

| Survey area | Survey Leg | Survey Dates |
|---|---|---|
| Craig | I | April 14–15 |
| Sitka Sound | I | April 18– 20 |
| West Behm Canal | I | April 23 |
| Ernest Sound | I | April 24 |
| Hoonah Sound | II | May 5–6 |
| Hobart Bay/Port Houghton | II | May 8–9 |
| Seymour Canal | II | May 9–10 |
| Tenakee Inlet | | NO SURVEY |
| Lynn Canal | | NO SURVEY |

Table 4.–Summary of herring egg estimates (in thousands) by transect for 2010 spawn deposition surveys conducted in Southeast Alaska.

| | Craig | | Ernest Sound | | Hobart/Houghton | | Hoonah Sound | | Seymour Canal | | Sitka Sound | | Tenakee Inlet | | West Behm | | Lynn Canal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transect Number | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count | egg estimate | frame count |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 586 | 15 | 68 | 6 | 396 | 10 | | | 1,232 | 25 | | |
| 2 | 0 | 2 | 0 | 1 | 211 | 4 | 789 | 10 | 699 | 12 | 413 | 6 | | | 227 | 6 | | |
| 3 | 525 | 18 | 0 | 1 | 604 | 14 | 0 | 1 | 473 | 13 | 108 | 6 | | | 85 | 8 | | |
| 4 | 82 | 10 | 0 | 1 | 66 | 9 | 1,683 | 18 | 322 | 8 | 3,288 | 45 | | | 365 | 16 | | |
| 5 | 0 | 1 | 0 | 1 | 86 | 23 | 154 | 5 | 867 | 7 | 1,448 | 8 | | | 19 | 11 | | |
| 6 | 2,080 | 23 | 66 | 6 | 13 | 11 | 90 | 5 | 985 | 18 | 70 | 3 | | | 129 | 10 | | |
| 7 | 2,561 | 25 | 0 | 1 | 51 | 16 | 115 | 4 | 800 | 9 | 360 | 10 | | | 91 | 9 | | |
| 8 | 140 | 17 | 324 | 23 | 508 | 15 | 0 | 1 | 128 | 14 | 1,001 | 6 | | | 44 | 5 | | |
| 9 | 51 | 20 | 12 | 5 | 0 | 2 | 0 | 1 | 0 | 1 | 144 | 11 | | | 457 | 8 | | |
| 10 | 4,005 | 28 | 435 | 12 | 1 | 2 | 92 | 6 | 532 | 9 | 3,704 | 18 | | | 295 | 6 | | |
| 11 | 1,022 | 17 | 341 | 13 | 633 | 8 | 443 | 10 | 64 | 4 | 680 | 15 | | | 64 | 3 | | |
| 12 | 1,768 | 22 | 250 | 14 | 901 | 18 | 8 | 5 | 666 | 11 | 359 | 21 | | | 150 | 4 | | |
| 13 | 1,938 | 23 | 447 | 10 | 133 | 26 | 244 | 18 | 941 | 14 | 6,072 | 22 | | | 484 | 6 | | |
| 14 | 67 | 10 | 560 | 10 | 61 | 3 | 4,424 | 19 | 378 | 11 | 2,474 | 30 | | | 1,907 | 22 | | |
| 15 | 355 | 16 | 321 | 11 | 567 | 8 | 2,094 | 28 | 1,707 | 21 | 438 | 10 | | | 206 | 11 | | |
| 16 | 11,270 | 55 | 252 | 4 | 3 | 4 | 670 | 12 | 1,428 | 16 | 325 | 8 | | | 33 | 4 | | |
| 17 | 6,615 | 51 | 1,057 | 31 | 136 | 6 | 2,575 | 33 | 41 | 4 | 0 | 1 | | | 171 | 5 | | |
| 18 | 3,316 | 25 | 876 | 16 | 497 | 12 | 1,008 | 24 | 396 | 4 | 1,969 | 19 | | | 744 | 4 | | |
| 19 | 4,290 | 26 | 262 | 8 | 0 | 5 | 646 | 13 | 1,363 | 8 | 982 | 6 | | | 178 | 3 | | |
| 20 | 1,221 | 24 | 173 | 8 | 32 | 13 | 482 | 12 | 1,766 | 14 | 642 | 7 | | | 466 | 5 | | |
| 21 | 800 | 14 | 324 | 17 | 27 | 11 | 746 | 10 | 405 | 4 | 2,569 | 20 | | | 170 | 5 | | |
| 22 | 592 | 14 | 110 | 11 | 18 | 11 | 778 | 13 | 503 | 7 | 6,319 | 56 | | | 156 | 4 | | |
| 23 | 7,367 | 19 | 42 | 13 | | | 487 | 7 | 789 | 6 | 1,620 | 13 | | | 246 | 3 | | |
| 24 | 2,388 | 17 | 530 | 17 | | | 2,336 | 29 | 590 | 4 | 3,902 | 21 | | | 254 | 2 | | |
| 25 | 36 | 8 | 0 | 1 | | | 1,583 | 32 | | | 1,847 | 8 | | | 286 | 2 | | |
| 26 | 502 | 24 | 0 | 1 | | | 107 | 8 | 1,577 | 14 | 415 | 10 | | | 251 | 7 | | |
| 27 | 6,178 | 9 | 0 | 1 | | | | | 0 | 1 | 634 | 13 | | | 74 | 2 | | |
| 28 | 974 | 7 | 0 | 1 | | | | | 4,891 | 41 | 156 | 3 | | | 161 | 3 | | |
| 29 | 18 | 5 | | | | | | | 291 | 9 | 5,379 | 51 | | | 278 | 6 | | |
| 30 | 1,434 | 17 | | | | | | | 362 | 6 | 974 | 13 | | | 0 | 1 | | |
| 31 | 941 | 7 | | | | | | | 331 | 4 | 4,434 | 48 | | | | | | |
| 32 | 9 | 3 | | | | | | | 395 | 4 | 311 | 9 | | | | | | |
| 33 | 1,044 | 25 | | | | | | | | | 1,564 | 17 | | | | | | |
| 34 | 186 | 17 | | | | | | | | | 1,093 | 14 | | | | | | |
| 35 | | | | | | | | | | | 1,305 | 24 | | | | | | |
| 36 | | | | | | | | | | | 1,141 | 9 | | | | | | |
| 37 | | | | | | | | | | | 52 | 7 | | | | | | |
| 38 | | | | | | | | | | | 5,529 | 17 | | | | | | |
| 39 | | | | | | | | | | | 3,114 | 20 | | | | | | |

-continued-

Table 4.–Page 2 of 2.

| | Craig | | Ernest Sound | | Hobart/Houghton | | Hoonah Sound | | Seymour Canal | | Sitka Sound | | Tenakee Inlet | | West Behm | | Lynn Canal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Transect Number** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** | **egg estimate** | **frame count** |
| 40 | | | | | | | | | | | 2,500 | 23 | | | | | | |
| 41 | | | | | | | | | | | 1,337 | 12 | | | | | | |
| 42 | | | | | | | | | | | 92 | 6 | | | | | | |
| 43 | | | | | | | | | | | 127 | 6 | | | | | | |
| 44 | | | | | | | | | | | 1,068 | 18 | | | | | | |
| 45 | | | | | | | | | | | 5,743 | 49 | | | | | | |
| 46 | | | | | | | | | | | 423 | 9 | | | | | | |
| 47 | | | | | | | | | | | 2,373 | 16 | | | | | | |
| 48 | | | | | | | | | | | 205 | 12 | | | | | | |
| 49 | | | | | | | | | | | 0 | 2 | | | | | | |
| Average | 1,876 | 18 | 228 | 9 | 207 | 10 | 852 | 13 | 766 | 10 | 1,622 | 16 | 385 | 24 | 307 | 7 | 650 | 45 |

Table 5.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2011.

| Spawning Stock | Number of Transects Completed | Average Length of Transects (m) | Nautical Miles of Spawn Observed | Area of Survey ($m^2$) | Average Egg Density (eggs/$m^2$) | Total eggs in survey area (trillions) | Mean weight (g) (weighted by age composition) of fish in spawning population | Estimated fecundity of fish of mean weight | Estimated number of fish | 2011 escapement (tons) |
|---|---|---|---|---|---|---|---|---|---|---|
| Craig | 34 | 88.2 | 14.8 | 2,418,494 | 1,062,907 | 2.571 | 81.5 | 16,060 | 355,688,632 | 31,949 |
| Ernest Sound | 28 | 42.7 | 8.1 | 640,230 | 267,117 | 0.171 | 55.1 | 9,826 | 38,676,880 | 2,349 |
| Hobart/Houghton | 22 | 50.5 | 4.2 | 392,456 | 204,830 | 0.080 | 94.5 | 19,444 | 9,187,473 | 957 |
| Hoonah Sound | 26 | 65.2 | 12.6 | 1,521,276 | 653,091 | 0.994 | 122.2 | 21,266 | 103,822,138 | 13,989 |
| Seymour Canal | 31 | 49.0 | 12.7 | 1,153,258 | 781,463 | 0.901 | 88.5 | 18,111 | 110,583,438 | 10,789 |
| Sitka Sound | 50 | 79.4 | 78.3 | 11,513,921 | 1,021,360 | 11.760 | 145.4 | 25,865 | 1,010,379,214 | 161,904 |
| Tenakee Inlet | 0 | — | 1.0 | — | — | — | — | — | — | — |
| West Behm Canal | 30 | 34.3 | 17.9 | 1,138,177 | 447,680 | 0.510 | 66.5 | 12,126 | 93,375,109 | 6,843 |
| Lynn Canal | 0 | — | 6.2 | — | — | — | — | — | — | — |
| Total | 221 | — | 155.8 | 18,777,812 | — | 16.986 | — | — | 1,721,712,883 | 228,780 |
| Average | 25 | 58 | — | 2,682,545 | 634,064 | 2.427 | 93.4 | 17,528 | — | — |

Table 6.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2011. Data was combined for years 2009 through 2011 unless otherwise noted.

| | Estimator initials | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kelp type | BM | DG | JB | JM | KH | SD | TT | SW[a] |
| Eelgrass | 1.428 | 0.833 | 0.905 | 1.202 | 0.850 | 1.198 | 1.277 | 1.246 |
| n = | 11 | 22 | 17 | 24 | 28 | 24 | 16 | 11 |
| Fucus | 2.096 | 1.322 | 1.859 | 1.107 | 1.099 | 1.687 | 1.738 | 3.186 |
| n = | 11 | 21 | 15 | 20 | 21 | 16 | 19 | 11 |
| Fir kelp | 1.881 | 1.483 | 1.085 | 1.273 | 0.977 | 1.464 | 1.259 | 1.849 |
| n = | 15 | 19 | 17 | 23 | 22 | 19 | 19 | 13 |
| Hair kelp | 1.977 | 1.308 | 1.616 | 1.394 | 1.002 | 1.345 | 1.313 | 2.158 |
| n = | 14 | 19 | 21 | 26 | 25 | 23 | 20 | 15 |
| Large brown kelp[b] | 1.597 | 1.384 | 1.804 | 1.251 | 1.445 | 1.643 | 2.230 | 2.229 |
| n = | 12 | 19 | 20 | 24 | 26 | 23 | 18 | 13 |
| Average[c] | 1.796 | 1.266 | 1.454 | 1.245 | 1.075 | 1.467 | 1.563 | 2.134 |

[a] Data from years 2010 and 2011.

[b] Values applied to *Laminara, Agarum, Alaria*, 3-ribbed kelp, 5-ribbed kelp, *Macrocystis*.

[C] Values are applied to estimates of eggs that are loose, on rock, or on unclassified kelp types.

Table 7.–Summary of samples collected from Southeast Alaska herring stocks in 2010–11.

| | **Commercial Fishery** | | | **Survey** | **Test Fishery** | |
|---|---|---|---|---|---|---|
| **Stock** | **Herring gillnet** | **Pound** | **Purse seine** | **Cast net** | **Purse seine** | **Total** |
| Craig | – | 530 | 531 | 540 | – | 1,601 |
| Ernest Sound | – | – | 531 | 540 | – | 1,071 |
| Hobart/Houghton | – | – | – | 527 | – | 527 |
| Hoonah Sound | – | 540 | – | 540 | – | 1,080 |
| Lynn Canal | – | – | – | 530 | – | 530 |
| Seymour Canal | 525 | – | – | 524 | – | 1,049 |
| Sitka Sound | – | – | 525 | 600 | 561 | 1,686 |
| Tenakee Inlet | – | – | – | – | – | – |
| West Behm Canal | 270 | – | – | 500 | – | 770 |
| Total | 795 | 1,070 | 1,587 | 4,303 | 561 | 8,314 |

Table 8.–Summary herring samples aged for Southeast Alaska stocks in 2010–11.

| | Commercial Fishery | | | Survey | Test Fishery | |
|---|---|---|---|---|---|---|
| **Stock** | **Herring gillnet** | **Pound** | **Purse seine** | **Cast net** | **Purse seine** | **Total** |
| Craig | – | 518 | 515 | 529 | – | 1,562 |
| Ernest Sound | – | – | 481 | 514 | – | 995 |
| Hobart/Houghton | – | – | – | 501 | – | 501 |
| Hoonah Sound | – | 527 | – | 537 | – | 1,064 |
| Lynn Canal | – | – | – | 461 | – | 461 |
| Seymour Canal | 522 | – | – | 507 | – | 1,029 |
| Sitka Sound | – | – | 515 | 592 | 546 | 1,653 |
| Tenakee Inlet | – | – | – | – | – | – |
| West Behm Canal | 262 | – | – | 492 | – | 754 |
| Total | 784 | 1,045 | 1,511 | 4,133 | 546 | 8,019 |

Table 9.–Proportion of mature age-3 herring (cast net, 1988–2011), latitude and mean sea temperature of herring spawning stocks in Southeast Alaska.

| **Stock** | **Latitude (decimal degrees)** | **Median proportion of mature age-3 herring** | **Mean proportion of mature age-3 herring** | **Mean annual sea temperature ($^0$C)** | **Mean minimum annual sea temperature ($^0$C)** | **Mean maximum annual sea temperature ($^0$C)** |
|---|---|---|---|---|---|---|
| Kah Shakes | 55.0300 | 21% | 27% | 8.6 | 5.9 | 14.7 |
| Craig | 55.4770 | 20% | 22% | 9.0 | 4.7 | 14.1 |
| WBC | 55.4846 | 24% | 30% | 8.8 | 5.3 | 14.3 |
| Ernest Sound | 55.8307 | 25% | 29% | — | — | — |
| Sitka | 57.0079 | 9% | 17% | 8.6 | 4.9 | 13.8 |
| Hobart Bay | 57.4308 | 4% | 13% | 7.1 | 3.9 | 12.9 |
| Seymour Canal | 57.5923 | 10% | 16% | 6.7 | 3.0 | 13.3 |
| Hoonah Sound | 57.6001 | 7% | 15% | 7.9 | 2.0 | 15.0 |
| Tenakee Inlet | 57.7381 | 11% | 11% | 7.8 | 1.9 | 15.0 |
| Lynn Canal | 58.6402 | 10% | 14% | 7.1 | 2.6 | 15.4 |

Table 10.–Summary of Southeast Alaska herring target levels for the 2010–11 season.

| Area | Minimum spawning biomass threshold (tons) | Forecast (tons) | Target Exploitation Rate (%) | Guideline harvest level (tons)[a] |
|---|---|---|---|---|
| Craig | 5,000 | 17,886 | 15.2 | 2,710 |
| Ernest Sound | 2,500 | 5,080 | 12.1 | 613 |
| Hobart Bay/Port Houghton | 2,000 | 253 | — | — |
| Hoonah Sound | 1,000 | 15,073 | 20.0 | 3,015 |
| Seymour Canal | 3,000 | 6,697 | 12.5 | 835 |
| Sitka Sound | 25,000 | 97,449 | 20.0 | 19,490 |
| Tenakee Inlet | 3,000 | — | — | — |
| West Behm Canal | 6,000 | 11,864 | 12.0 | 1,418 |
| Lynn Canal | 5,000 | — | — | — |
| Kah Shakes | 6,000 | — | — | — |

[a] Represents total target exploitation for all fisheries on a particular stock; actual allocations by fishery are determined according to Alaska Administrative Code Title 5 under 5 AAC 27.160, 27.185, and 27.190.

Table 11.–Summary of commercial herring harvest during the 2010–11 season. Blacked out values signify confidential data due to fewer than three participants (either permit holders or processors).

| Fishery | Gear | Area | District | Opening[a] | Closing[b] | Harvest (tons)[c] |
|---|---|---|---|---|---|---|
| Winter food and bait | Purse seine | Craig | 3/4 | 1–Dec–10 | 28–Feb–11 | 308 |
| Winter food and bait | Purse seine | Tenakee Inlet | 12 | Not Open | | – |
| Winter food and bait | Purse seine | Ernest Sound | 7 | 1–Dec–10 | 28–Feb–11 | [redacted] |
| Winter food and bait | Purse seine | Hobart Bay | 10 | Not Open | | – |
| Sub-total | | | | | | [redacted] |
| Sac roe | Purse seine | Sitka Sound | 13 | 31–Mar–11 | 9–Apr–11 | 19,419 |
| Sac roe | Purse seine | Lynn Canal | 11 | Not Open | | – |
| Sac roe | Gillnet | Seymour Canal | 11 | 26–Apr–11 | 11–May–11 | [redacted] |
| Sac roe | Gillnet | Hobart Bay | 10 | Not Open | | – |
| Sac roe | Gillnet | Kah Shakes | 1 | Not Open | | – |
| Sac roe | Gillnet | West Behm Canal | 1 | 11–Apr–11 | 14–Apr–11 | [redacted] |
| Sub-total | | | | | | [redacted] |
| Spawn on kelp | Pound | Hoonah Sound | 13 | 6–Apr–11 | 24–Apr–11 | 194 |
| Spawn on kelp | Pound | Tenakee Inlet | 12 | Not Open | | 0 |
| Spawn on kelp | Pound | Ernest Sound[d] | 7 | 1–Apr–11 | – | 0 |
| Spawn on kelp | Pound | Craig | 3 | 17–Mar–11 | 11–Apr–11 | 70 |
| Sub-total | | | | | | 264 |
| Test fishery–bait | Purse seine | Sitka | 13 | 31–Jan–11 | 7–Feb–11 | 60 |

[a] For spawn-on-kelp fisheries, represents start of seining and transferring herring into pounds.

[b] For spawn-on-kelp fisheries, represents end of removing SOK from pounds.

[c] Values expressed in tons of whole herring, except for spawn-on-kelp fisheries, values are tons of eggs-on-kelp product.

[d] Area opened to open pound gear only, but there was no fishing effort.

Table 12.–Summary of age, weight, and length for the Sitka Sound herring stock in 2010–11.

| | | Age Category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 39 | 152 | 134 | 142 | 77 | 48 | 592 |
| | percent age composition | 7% | 26% | 23% | 24% | 13% | 8% | 100% |
| | average weight (g) | 72.7 | 101.8 | 115.3 | 145.7 | 150.2 | 171.6 | 125.0 |
| | standard dev. of weight (g) | 13.3 | 20.5 | 22.6 | 28.0 | 31.1 | 34.4 | 36.0 |
| | average length (mm) | 179.6 | 198 | 206 | 220 | 223 | 237 | 210 |
| | variance of length (mm) | 82.0 | 116 | 161 | 111 | 128 | 187 | 334 |
| commercial purse seine–spring | number of fish | 49 | 129 | 124 | 115 | 75 | 23 | 515 |
| | percent age composition | 10% | 25% | 24% | 22% | 15% | 4% | 100% |
| | average weight (g) | 86.8 | 115.6 | 133.6 | 163.9 | 182.0 | 207.4 | 141.0 |
| | standard dev. of weight (g) | 32.7 | 20.7 | 28.4 | 31.1 | 28.7 | 26.7 | 42.0 |
| | average length (mm) | 185.5 | 200 | 209 | 221 | 229 | 240 | 211 |
| | variance of length (mm) | 243.0 | 109 | 162 | 141 | 98 | 141 | 360 |
| test fishery purse seine–winter | number of fish | 172 | 246 | 98 | 24 | 4 | 2 | 546 |
| | percent age composition | 32% | 45% | 18% | 4% | 1% | 0% | 100% |
| | average weight (g) | 84.3 | 99.7 | 115.8 | 142.6 | 144.3 | 229.1 | 99.0 |
| | standard dev. of weight (g) | 14.2 | 16.3 | 22.6 | 38.0 | 49.6 | 26.4 | 25.0 |
| | average length (mm) | 181 | 189 | 196 | 209 | 208 | 249 | 188 |
| | variance of length (mm) | 78 | 87 | 141 | 363 | 693 | 5 | 181 |

Table 13.–Summary of age, weight, and length for the Craig herring stock in 2010–11.

| | | Age Category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Age category** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net –spring | number of fish | 157 | 171 | 109 | 34 | 48 | 10 | 529 |
| | percent age composition | 30% | 32% | 21% | 6% | 9% | 2% | 100% |
| | average weight (g) | 62.3 | 72.6 | 89.7 | 100.5 | 110.8 | 122.3 | 79.0 |
| | standard dev. of weight (g) | 11.9 | 14.8 | 15.3 | 18.7 | 18.6 | 34.3 | 22.0 |
| | average length (mm) | 172.4 | 179 | 192 | 197 | 203 | 209 | 183 |
| | variance of length (mm) | 75.1 | 89 | 77 | 104 | 57 | 287 | 195 |
| commercial pound –spring | number of fish | 219 | 159 | 73 | 28 | 26 | 13 | 518 |
| | percent age composition | 42% | 31% | 14% | 5% | 5% | 3% | 100% |
| | average weight (g) | 59.6 | 76.9 | 93.3 | 106.2 | 115.7 | 128.1 | 76.0 |
| | standard dev. of weight (g) | 13.7 | 15.0 | 19.6 | 21.0 | 19.5 | 25.6 | 24.0 |
| | average length (mm) | 169.1 | 180 | 191 | 197 | 204 | 210 | 179 |
| | variance of length (mm) | 113.8 | 77 | 111 | 98 | 83 | 117 | 236 |
| commercial seine–winter | number of fish | 184 | 166 | 78 | 22 | 40 | 25 | 515 |
| | percent age composition | 36% | 32% | 15% | 4% | 8% | 5% | 100% |
| | average weight (g) | 63.6 | 79.4 | 103.0 | 109.0 | 119.0 | 127.1 | 82.0 |
| | standard dev. of weight (g) | 14.9 | 15.9 | 17.6 | 25.3 | 20.1 | 15.8 | 27.0 |
| | average length (mm) | 167.8 | 179 | 191 | 196 | 203 | 207 | 179 |
| | variance of length (mm) | 133.9 | 98 | 94 | 201 | 107 | 40 | 311 |

Table 14.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2010–11.

| | | Age Category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 11 | 11 | 47 | 158 | 213 | 61 | 501 |
| | percent age composition | 2% | 2% | 9% | 32% | 43% | 12% | 100% |
| | average weight (g) | 57.9 | 70.9 | 86.0 | 93.0 | 98.6 | 101.4 | 94.0 |
| | standard dev. of weight (g) | 18.0 | 18.0 | 16.6 | 19.2 | 18.0 | 21.2 | 20.0 |
| | average length (mm) | 163.0 | 176 | 190 | 193 | 197 | 200 | 194 |
| | variance of length (mm) | 181.8 | 62 | 108 | 115 | 88 | 97 | 158 |
| commercial gillnet–spring | number of fish | | | | | | | |
| | percent age composition | | | | | | | |
| | average weight (g) | | | NO FISHERY | | | | |
| | standard dev. of weight (g) | | | | | | | |
| | average length (mm) | | | | | | | |
| | variance of length (mm) | | | | | | | |

Table 15.–Summary of age, weight, and length for the Ernest Sound herring stock in 2010–11.

| | | Age Category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 130 | 257 | 42 | 50 | 31 | 4 | 514 |
| | percent age composition | 25% | 50% | 8% | 10% | 6% | 1% | 100% |
| | average weight (g) | 43.1 | 53.7 | 65.1 | 73.1 | 71.1 | 84.6 | 54.0 |
| | standard dev. of weight (g) | 8.8 | 10.7 | 12.6 | 11.5 | 11.6 | 11.7 | 14.0 |
| | average length (mm) | 154.7 | 165 | 176 | 184 | 181 | 194 | 165 |
| | variance of length (mm) | 74.1 | 77 | 117 | 53 | 54 | 32 | 172 |
| commercial seine–winter | number of fish | 144 | 278 | 25 | 15 | 15 | 4 | 481 |
| | percent age composition | 30% | 58% | 5% | 3% | 3% | 1% | 100% |
| | average weight (g) | 49.7 | 65.4 | 72.9 | 85.5 | 82.4 | 86.1 | 59.0 |
| | standard dev. of weight (g) | 10.6 | 11.9 | 18.3 | 10.5 | 14.5 | 12.1 | 16.0 |
| | average length (mm) | 152.6 | 165 | 170 | 179 | 177 | 177 | 160 |
| | variance of length (mm) | 69.0 | 87 | 141 | 41 | 66 | 104 | 179 |

Table 16.–Summary of age, weight, and length for the Hoonah Sound herring stock in 2010–11.

| | | Age Category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 8 | 86 | 75 | 199 | 117 | 52 | 537 |
| | percent age composition | 1% | 16% | 14% | 37% | 22% | 10% | 100% |
| | average weight (g) | 61.9 | 89.7 | 101.6 | 109.1 | 118.2 | 133.4 | 108.0 |
| | standard dev. of weight (g) | 11.5 | 14.5 | 18.6 | 18.5 | 20.6 | 26.1 | 23.0 |
| | average length (mm) | 171.8 | 193 | 199 | 204 | 209 | 218 | 203 |
| | variance of length (mm) | 194.5 | 90 | 97 | 81 | 103 | 185 | 171 |
| commercial pound –spring | number of fish | 19 | 112 | 90 | 160 | 102 | 44 | 527 |
| | percent age composition | 4% | 21% | 17% | 30% | 19% | 8% | 100% |
| | average weight (g) | 72.3 | 99.7 | 114.4 | 123.1 | 132.5 | 152.4 | 118.0 |
| | standard dev. of weight (g) | 16.5 | 18.4 | 17.1 | 21.2 | 25.9 | 35.5 | 28.0 |
| | average length (mm) | 176.8 | 194 | 202 | 205 | 208 | 218 | 202 |
| | variance of length (mm) | 160.7 | 110 | 67 | 82 | 127 | 284 | 183 |

Table 17.–Summary of age, weight, and length for the Tenakee Inlet herring stock in 2010–11.

| | | Age category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net –spring | number of fish | NO SAMPLES OBTAINED | | | | | | |
| | percent age composition | | | | | | | |
| | average weight (g) | | | | | | | |
| | standard dev. of weight (g) | | | | | | | |
| | average length (mm) | | | | | | | |
| | variance of length (mm) | | | | | | | |
| commercial seine–winter | number of fish | NO FISHERY | | | | | | |
| | percent age composition | | | | | | | |
| | average weight (g) | | | | | | | |
| | standard dev. of weight (g) | | | | | | | |
| | average length (mm) | | | | | | | |
| | variance of length (mm) | | | | | | | |

Table 18.–Summary of age, weight, and length for the Seymour Canal herring stock in 2010–11.

| | | Age category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 19 | 46 | 79 | 199 | 133 | 31 | 507 |
| | percent age composition | 4% | 9% | 16% | 39% | 26% | 6% | 100% |
| | average weight (g) | 58.4 | 72.6 | 82.2 | 90.1 | 95.0 | 108.7 | 88.0 |
| | standard dev. of weight (g) | 12.1 | 20.7 | 17.0 | 19.8 | 20.9 | 22.1 | 22.0 |
| | average length (mm) | 164.8 | 175 | 184 | 189 | 190 | 198 | 186 |
| | variance of length (mm) | 136.0 | 191 | 114 | 133 | 149 | 159 | 191 |
| commercial gillnet–spring | number of fish | 0 | 11 | 65 | 238 | 156 | 52 | 522 |
| | percent age composition | 0% | 2% | 12% | 46% | 30% | 10% | 100% |
| | average weight (g) | 0.0 | 109.6 | 116.6 | 118.6 | 121.9 | 129.6 | 120.0 |
| | standard dev. of weight (g) | 0.0 | 11.8 | 12.0 | 13.2 | 14.9 | 16.3 | 14.0 |
| | average length (mm) | 0.0 | 193 | 198 | 199 | 200 | 204 | 199 |
| | variance of length (mm) | 0.0 | 50 | 46 | 55 | 62 | 83 | 61 |

Table 19.–Summary of age, weight, and length for the West Behm Canal herring stock in 2010–11.

| | | Age category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 99 | 284 | 50 | 39 | 19 | 1 | 492 |
| | percent age composition | 20% | 58% | 10% | 8% | 4% | 0% | 100% |
| | average weight (g) | 51.6 | 65.8 | 76.6 | 84.4 | 91.2 | 83.7 | 66.0 |
| | standard dev. of weight (g) | 10.7 | 14.1 | 17.6 | 15.5 | 16.9 | 0.0 | 17.0 |
| | average length (mm) | 161.4 | 174 | 181 | 189 | 192 | 190 | 174 |
| | variance of length (mm) | 94.6 | 110 | 139 | 98 | 86 | 0 | 179 |
| commercial gillnet–spring | number of fish | 2 | 78 | 47 | 68 | 60 | 7 | 262 |
| | percent age composition | 1% | 30% | 18% | 26% | 23% | 3% | 100% |
| | average weight (g) | 98.6 | 93.1 | 106.0 | 111.4 | 112.8 | 122.9 | 105.0 |
| | standard dev. of weight (g) | 12.6 | 16.6 | 17.3 | 11.7 | 13.3 | 17.4 | 17.0 |
| | average length (mm) | 193.5 | 188 | 195 | 200 | 199 | 212 | 195 |
| | variance of length (mm) | 84.5 | 98 | 95 | 62 | 73 | 106 | 112 |

Table 20.–Summary of age, weight, and length for the Lynn Canal herring stock in 2010–11.

| | | Age category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Gear type/season** | **Parameter** | **3** | **4** | **5** | **6** | **7** | **8+** | **Total** |
| survey cast net–spring | number of fish | 9 | 45 | 111 | 169 | 85 | 42 | 461 |
| | percent age composition | 2% | 10% | 24% | 37% | 18% | 9% | 100% |
| | average weight (g) | 47.4 | 69.9 | 83.6 | 94.1 | 97.1 | 105.0 | 84.0 |
| | standard dev. of weight (g) | 15.9 | 16.4 | 18.3 | 19.5 | 18.5 | 20.4 | 26.0 |
| | average length (mm) | 152 | 172 | 182 | 188 | 189 | 195 | 180 |
| | variance of length (mm) | 328 | 132 | 106 | 146 | 120 | 126 | 358 |

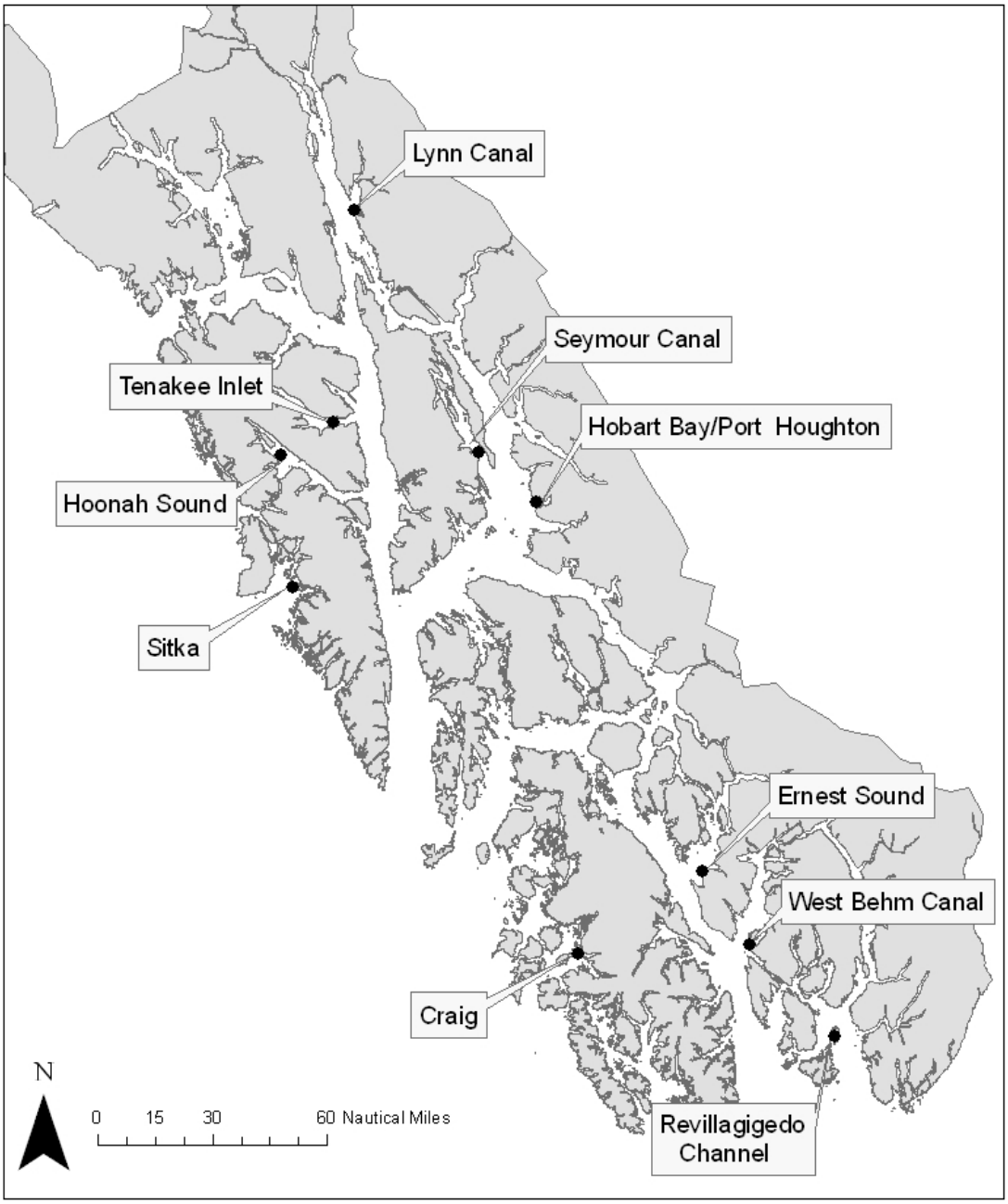



Figure 1.–Locations of major herring spawning areas in Southeast Alaska.

| Stock | 31-Mar | 1-Apr | 2-Apr | 3-Apr | 4-Apr | 5-Apr | 6-Apr | 7-Apr | 8-Apr | 9-Apr | 10-Apr | 11-Apr | 12-Apr | 13-Apr | 14-Apr | 15-Apr | 16-Apr | 17-Apr | 18-Apr | 19-Apr | 20-Apr | 21-Apr | 22-Apr | 23-Apr | 24-Apr | 25-Apr | 26-Apr | 27-Apr | 28-Apr | 29-Apr | 30-Apr | 1-May | 2-May | 3-May | 4-May | 5-May | 6-May | 7-May | 8-May | 9-May |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Craig | | 1.3 | 2.0 | X | 4.0 | 8.6 | 5.5 | 1.0 | 0.0 | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sitka Sound | | | | 0.1 | 0.1 | 2.8 | 3.8 | 7.2 | 6.6 | 9.7 | 8.6 | 15.7 | 28.4 | 37.7 | 23.1 | 16.0 | 15.5 | 5.8 | 0.7 | 0.0 | | | | | | | | | | | | | | | | | | | |
| West Behm Canal | | | | | | | | 0.1 | 0.0 | 0.5 | 6.0 | 5.1 | 0.9 | 0.3 | 0.0 | X | | | | | | | | | | | | | | | | | | | | | | | | |
| Revilla Channel[a] | | | | | | | | | | | 0.1 | 1.0 | 1.0 | 0.5 | 0.3 | 1.3 | 3.3 | 3.0 | 1.5 | 0.0 | X | | | | | | | | | | | | | | | | | | |
| Ernest Sound | | | | | | | | | | | | | | 0.2 | 0.0 | 0.0 | X | 0.5 | 2.1 | 1.3 | 0.0 | 0.0 | 0.0 | | | | | | | | | | | | | | | | |
| Hoonah Sound | | | | | | | | | | | | | | | | | | | | | | 3.1 | 5.8 | 4.2 | 0.7 | 0.0 | X | X | X | X | 1.6 | X | | | | | | | |
| Seymour Canal | | | | | | | | | | | | | | | | | | | | | | | | | 0.2 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 | 10.0 | 2.5 | 0.9 | 0.0 |
| Lynn Canal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.7 | 0.6 | 0.1 | 0.0 | X | 0.0 | X | 0.0 | 0.0 | 0.0 | 0.0 |
| Hobart Bay/Port Houghton | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.0 | 0.8 | 5.1 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |
| Tenakee Inlet[b] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | 0.0 | X | X | 1.1 |

| continued | 9-May | 10-May | 11-May | 12-May | 13-May | 14-May | 15-May | 16-May | 17-May | 18-May | 19-May | 20-May | 21-May | 22-May | 23-May | 24-May | 25-May | 26-May | 27-May | 28-May | 29-May | 30-May | 31-May | 1-Jun | 2-Jun | 3-Jun | 4-Jun | 5-Jun | 6-Jun | 7-Jun | 8-Jun | 9-Jun | 10-Jun |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lynn Canal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | X | 0.0 | X | 1.3 | 0.5 | 1.1 | X | 0.0 | X | 0.0 | X | X | 0.0 | 0.3 | 1.1 | 0.3 | 0.0 | X | X | X | 0.1 |

[a] Samples not collected as nearly all spawning occurred in Annette Island Reserve, which his outside State of Alaska fishery management jurisdiction.

Figure 2.–Spawn timing of herring stocks in Southeast Alaska during spring 2011. Values indicate daily measurements of nautical miles of active spawn recorded during aerial surveys. Shaded area depict dates when cast-net samples were taken. Dates with "X" indicate no aerial survey was conducted. Boxed areas indicate duration of spawning (first to last dates).

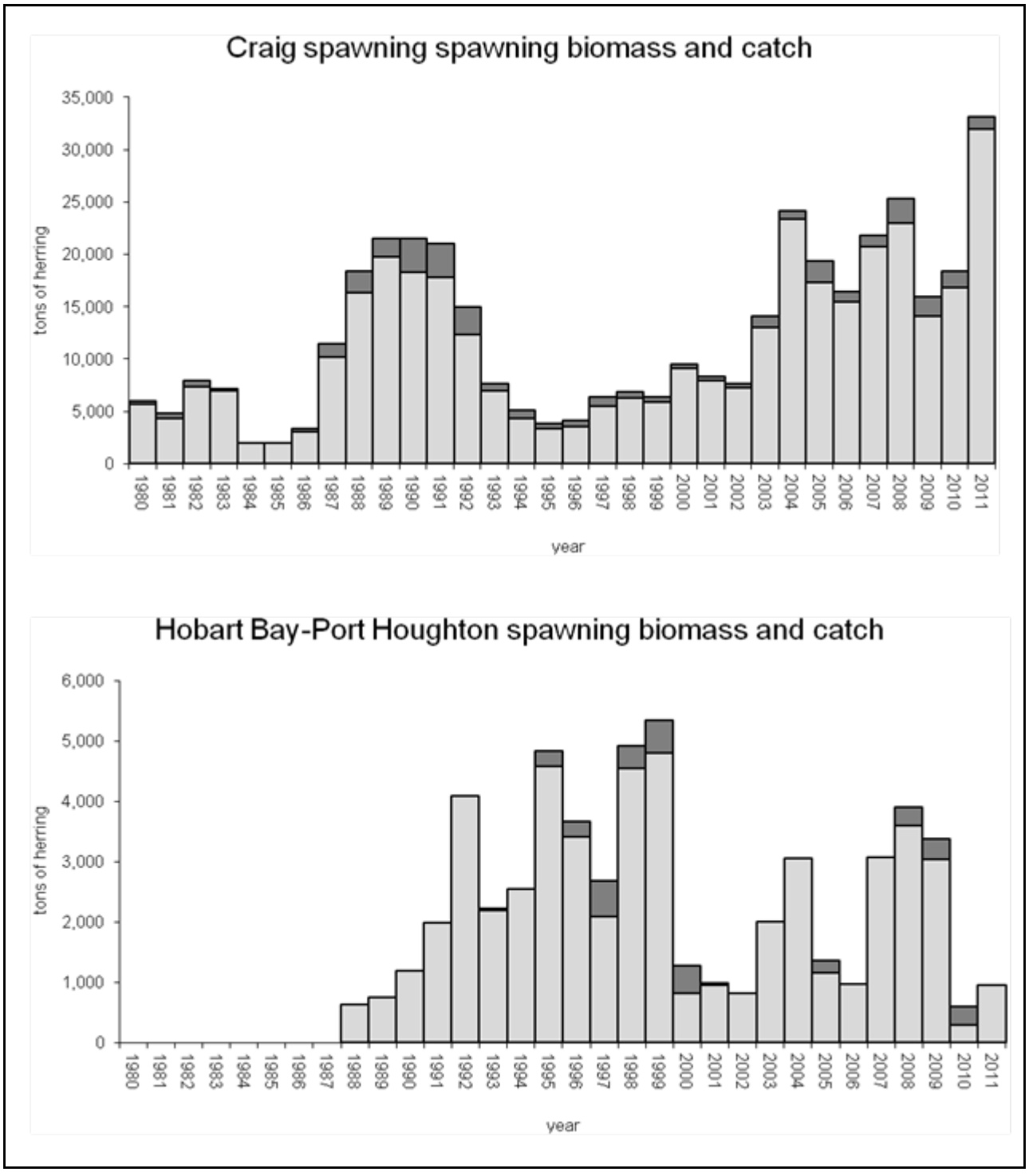



Figure 3.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Craig and Hobart Bay-Port Houghton areas, during 1980–2011.

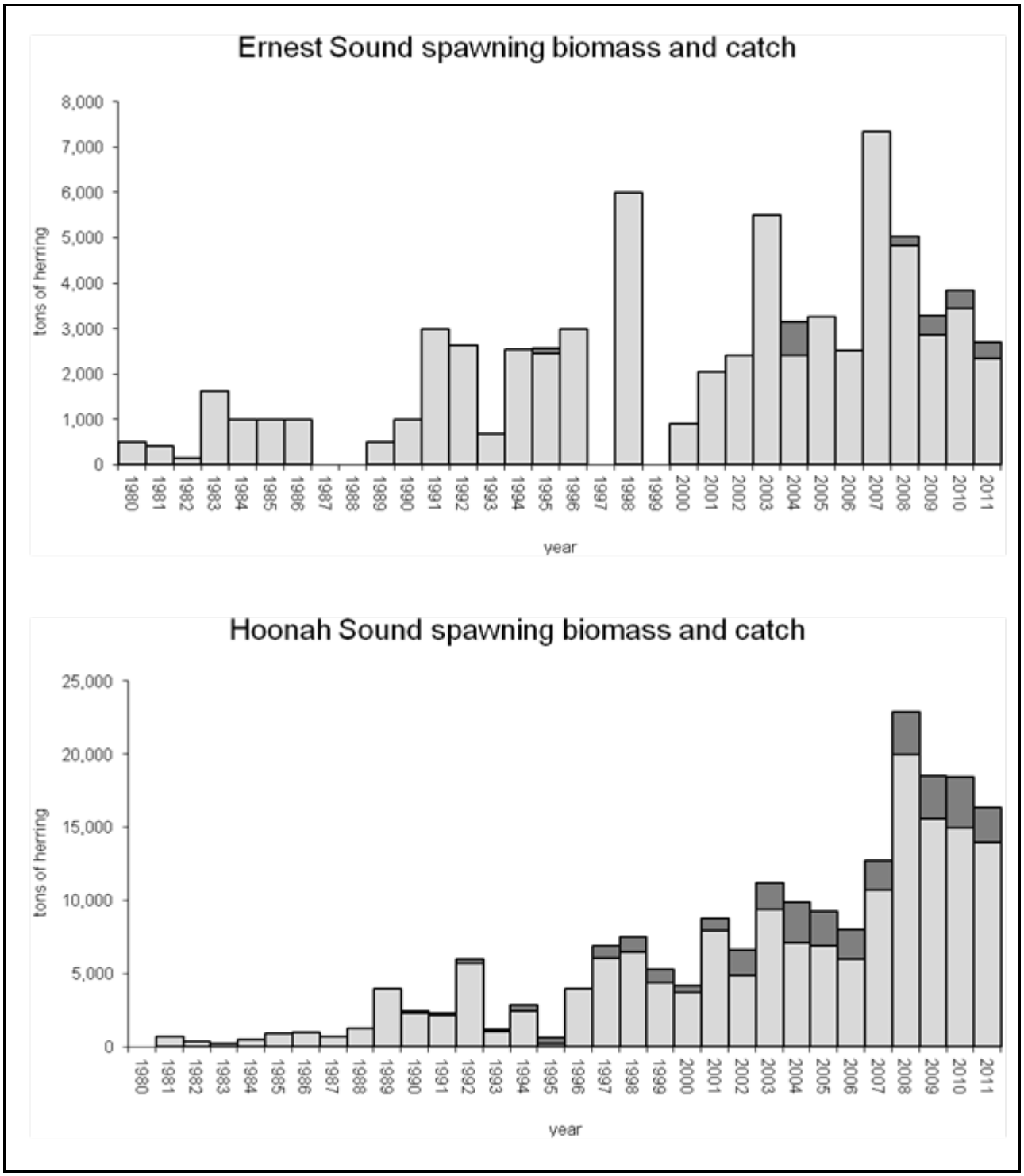



Figure 4.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2011.

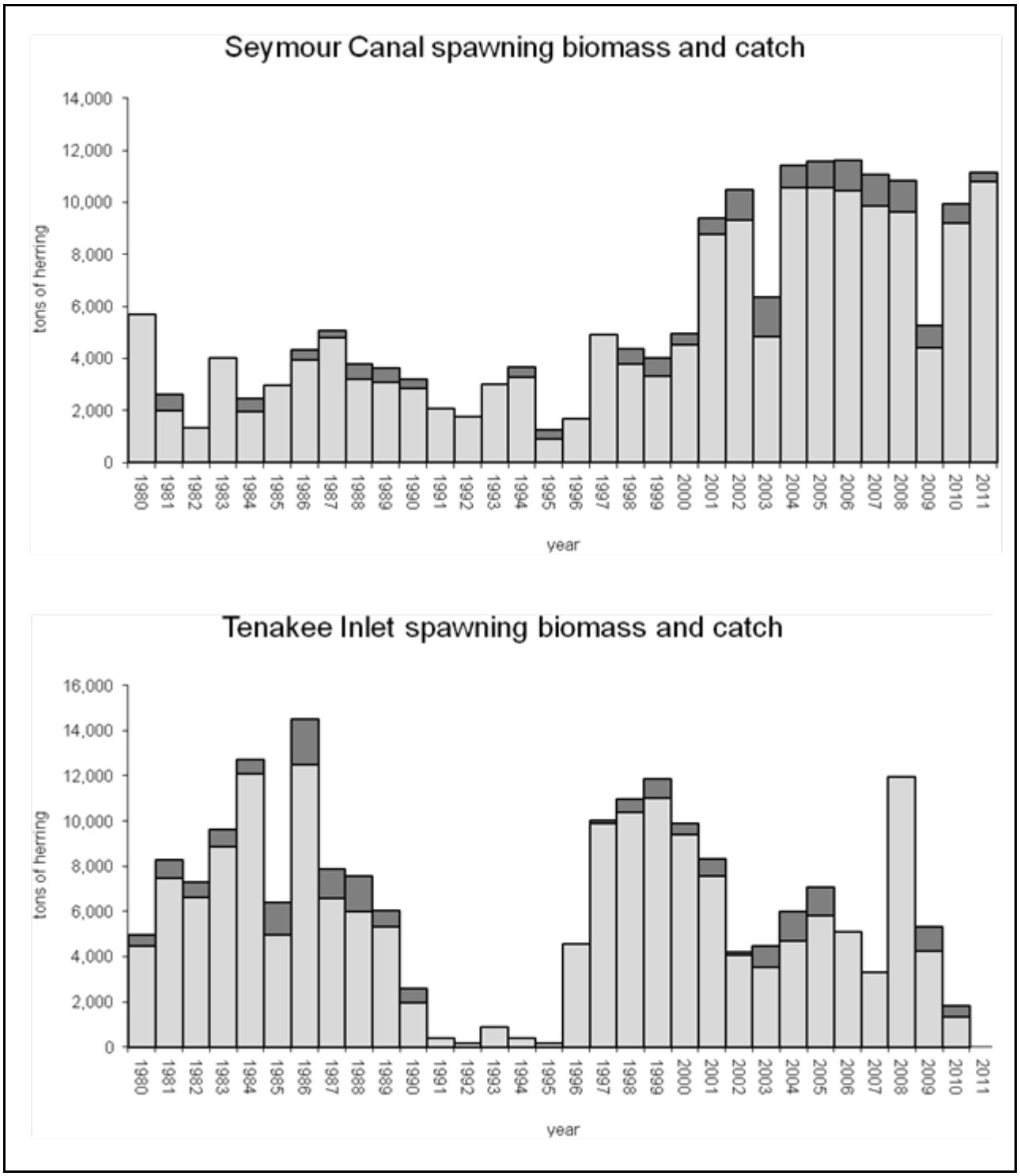



Figure 5.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Tenakee Inlet and Seymour Canal areas, during 1980–2011.

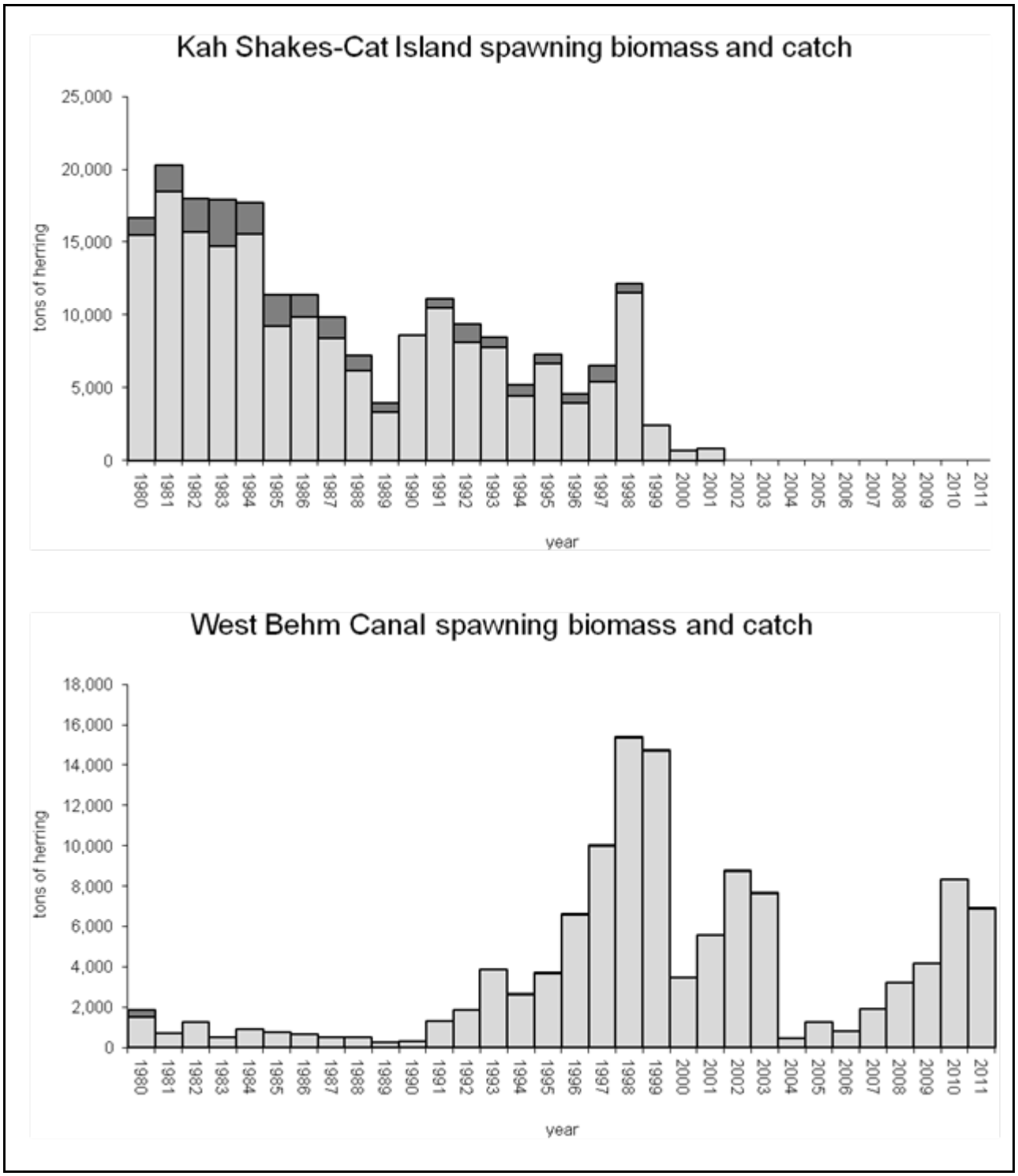



Figure 6.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the West Behm Canal and Kah Shakes-Cat Island areas, during 1980–2011.

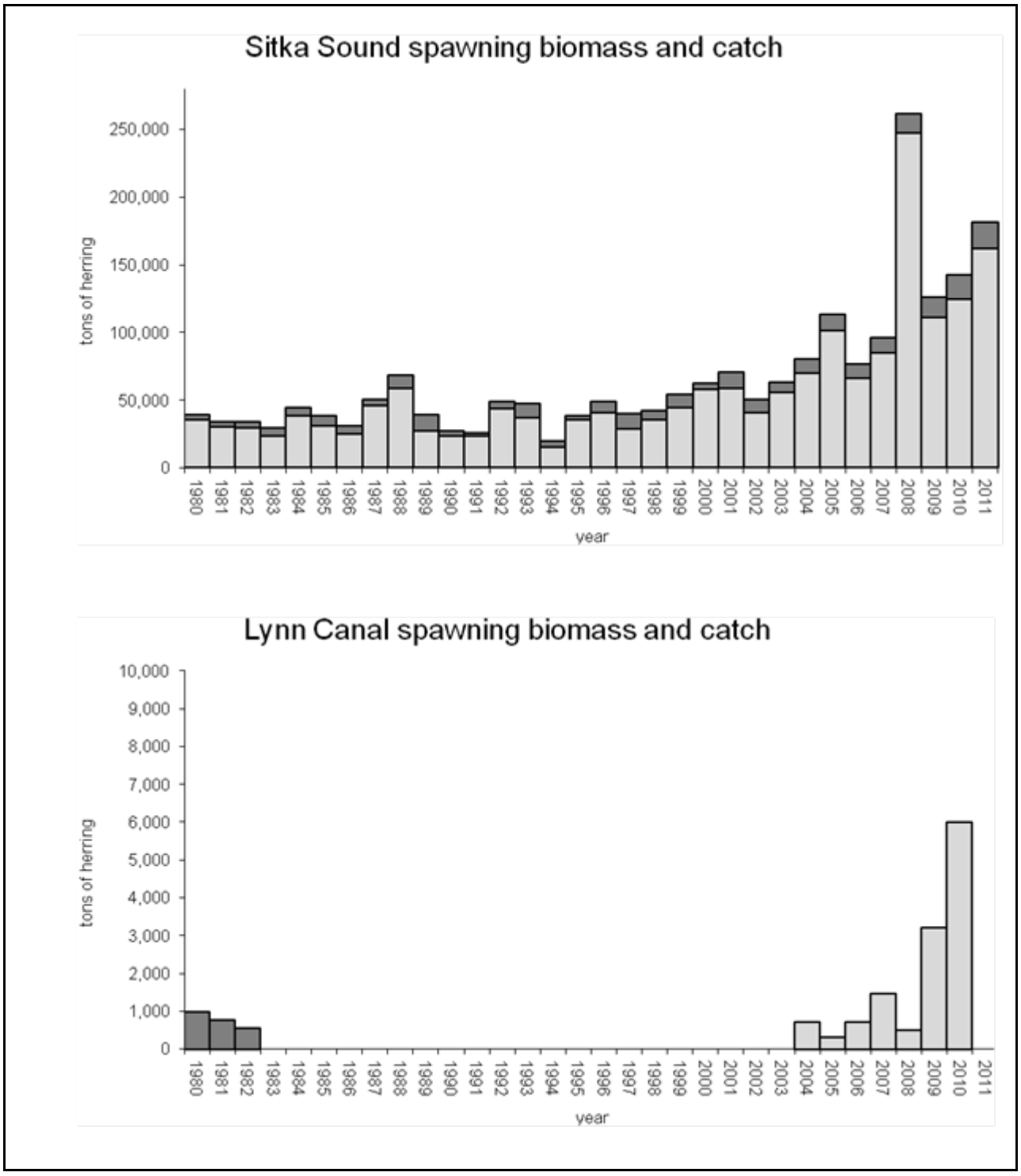



Figure 7.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2011. Estimates of spawning biomass for Lynn Canal prior to 2004 area not presented due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

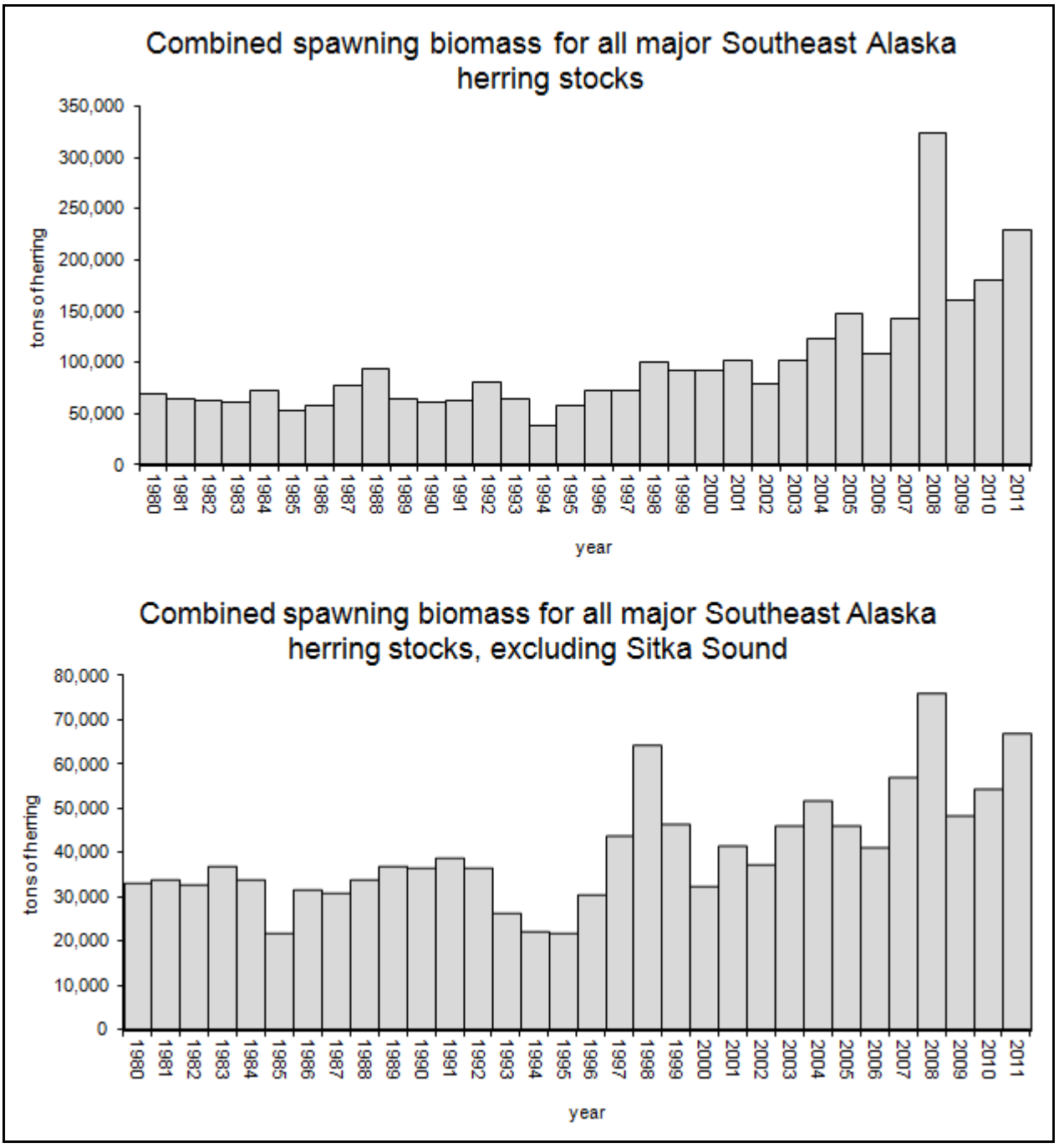



Figure 8.–Combined post-fishery spawning biomass, based on spawn deposition surveys, or hydro-acoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2011. Estimates of spawning biomass for Lynn Canal area not included due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

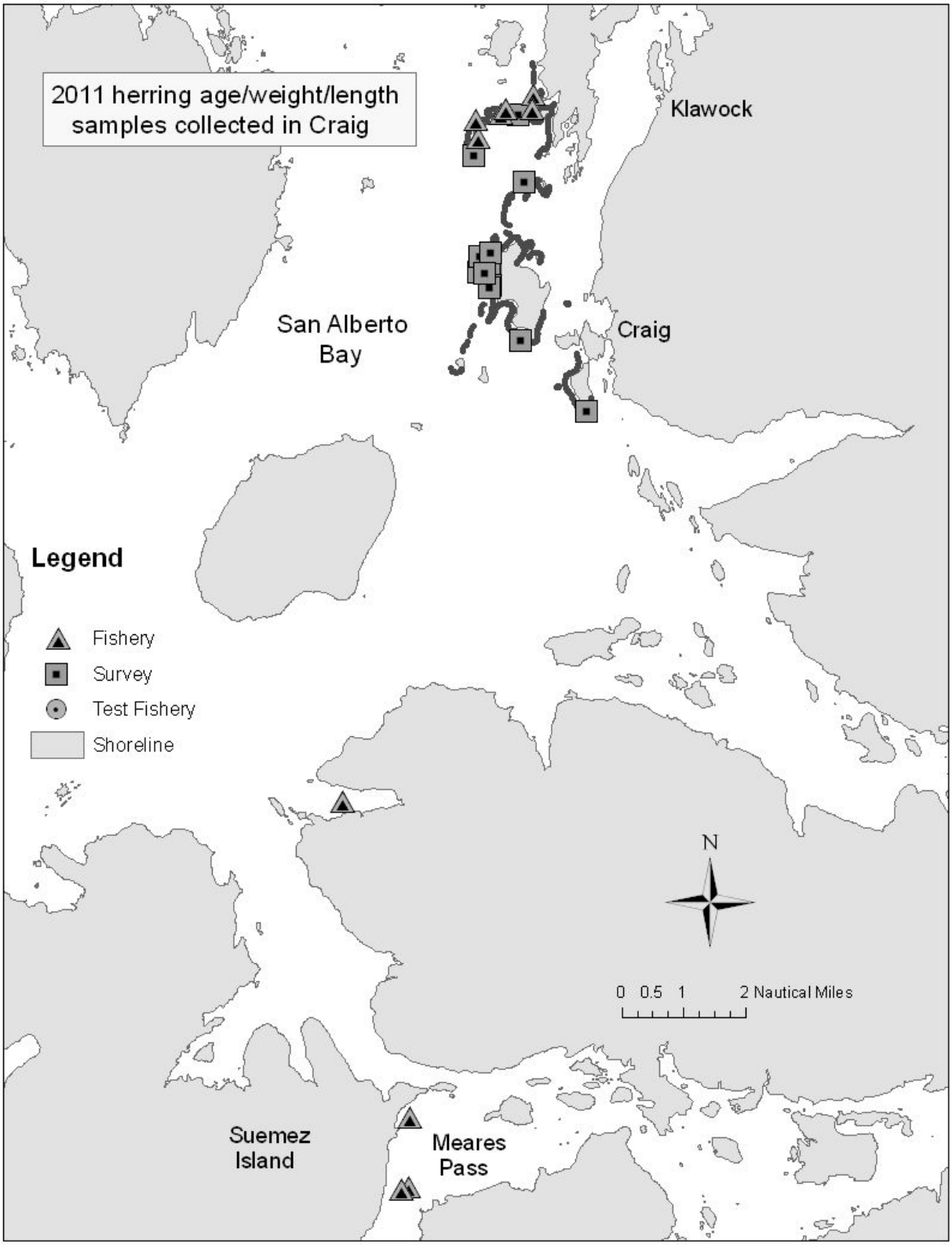



Figure 9.–Locations of herring samples collected for estimates of age and size for the Craig herring stock, 2011. Cumulative herring spawn denoted by thick gray line along shoreline.

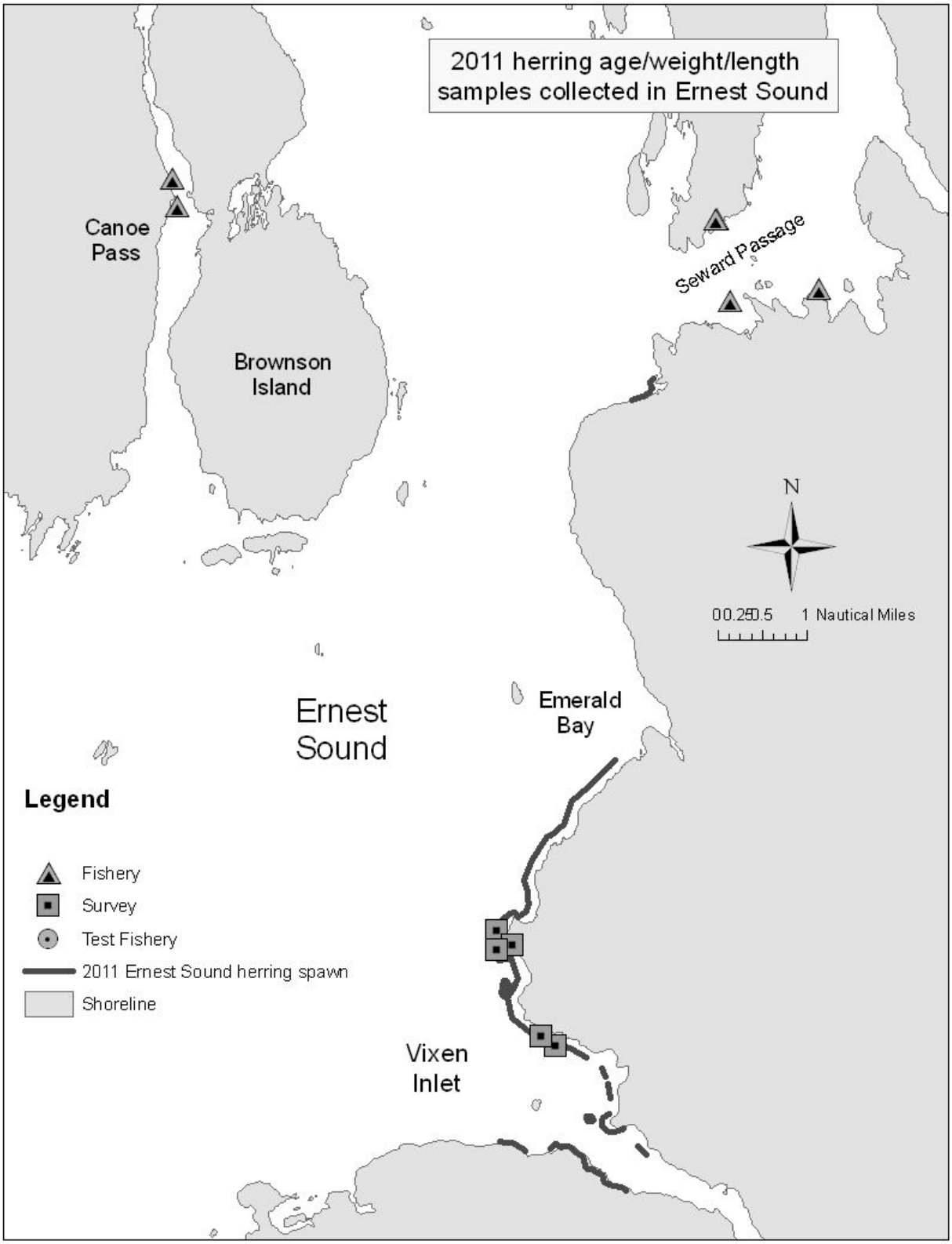



Figure 10.–Locations of herring samples collected for estimates of age and size for the Ernest Sound herring stock, 2011.

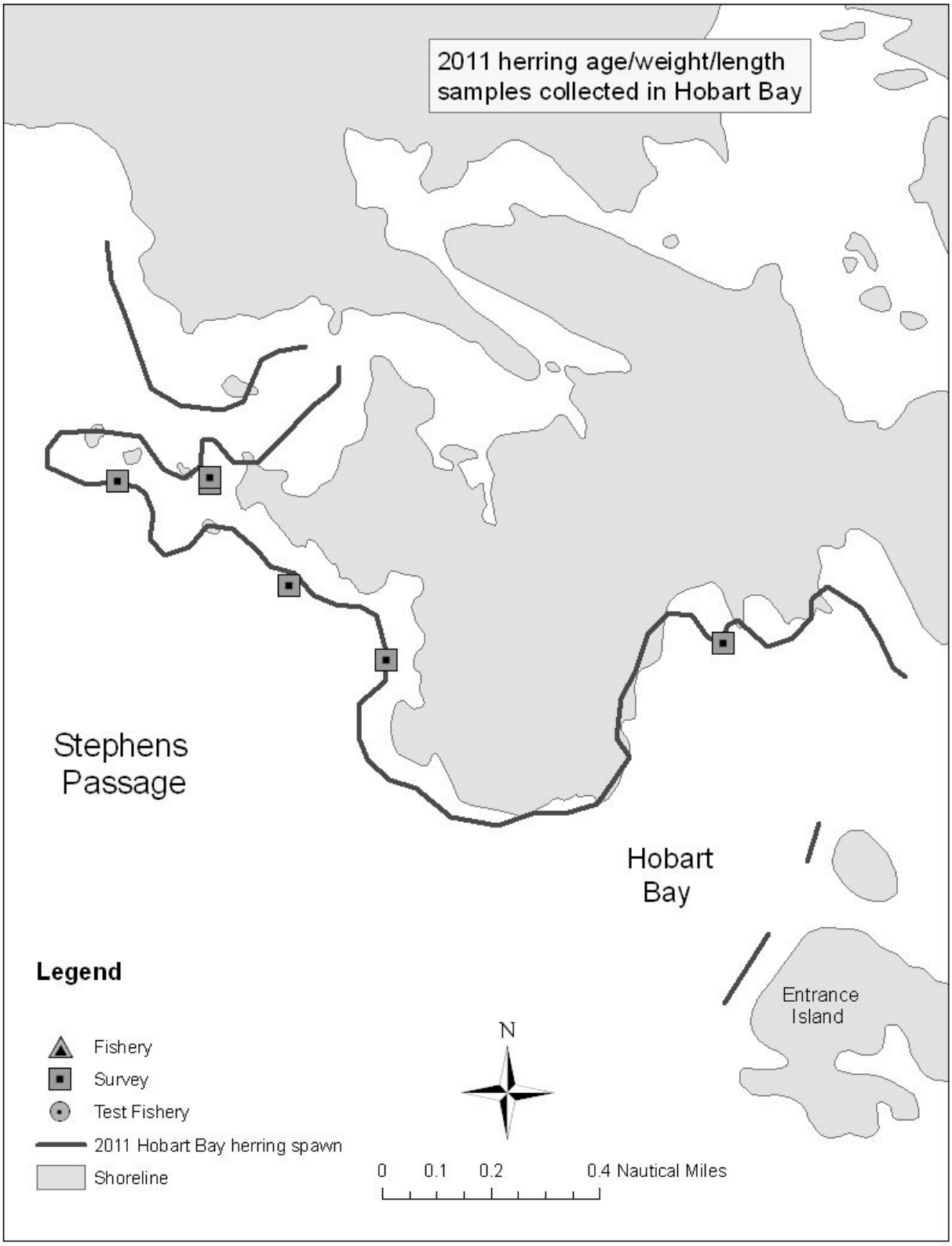



Figure 11.–Locations of herring samples collected for estimates of age and size for the Hobart bay-Port Houghton herring stock, 2011.

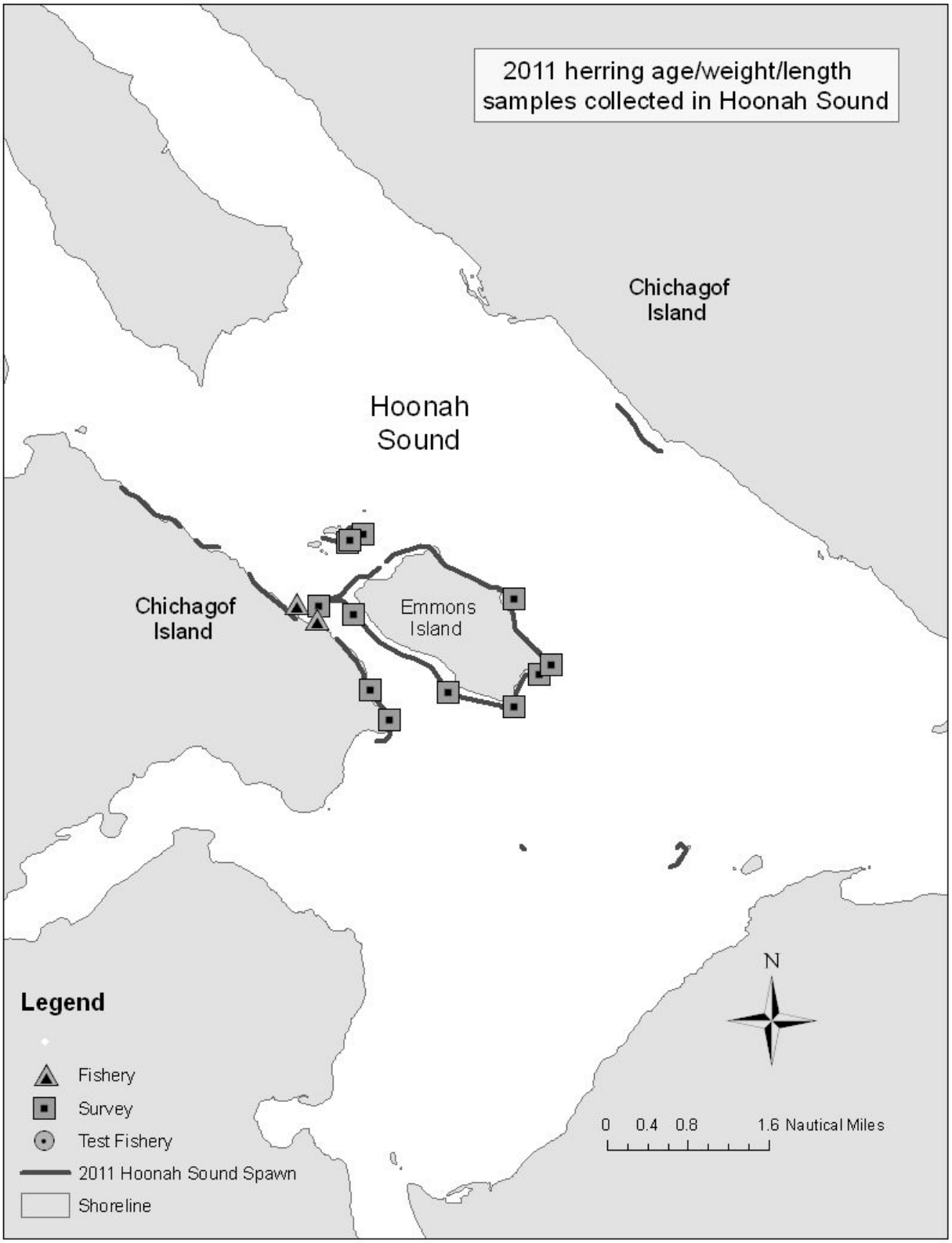



Figure 12.–Locations of herring samples collected for estimates of age and size for the Hoonah Sound herring stock, 2011.

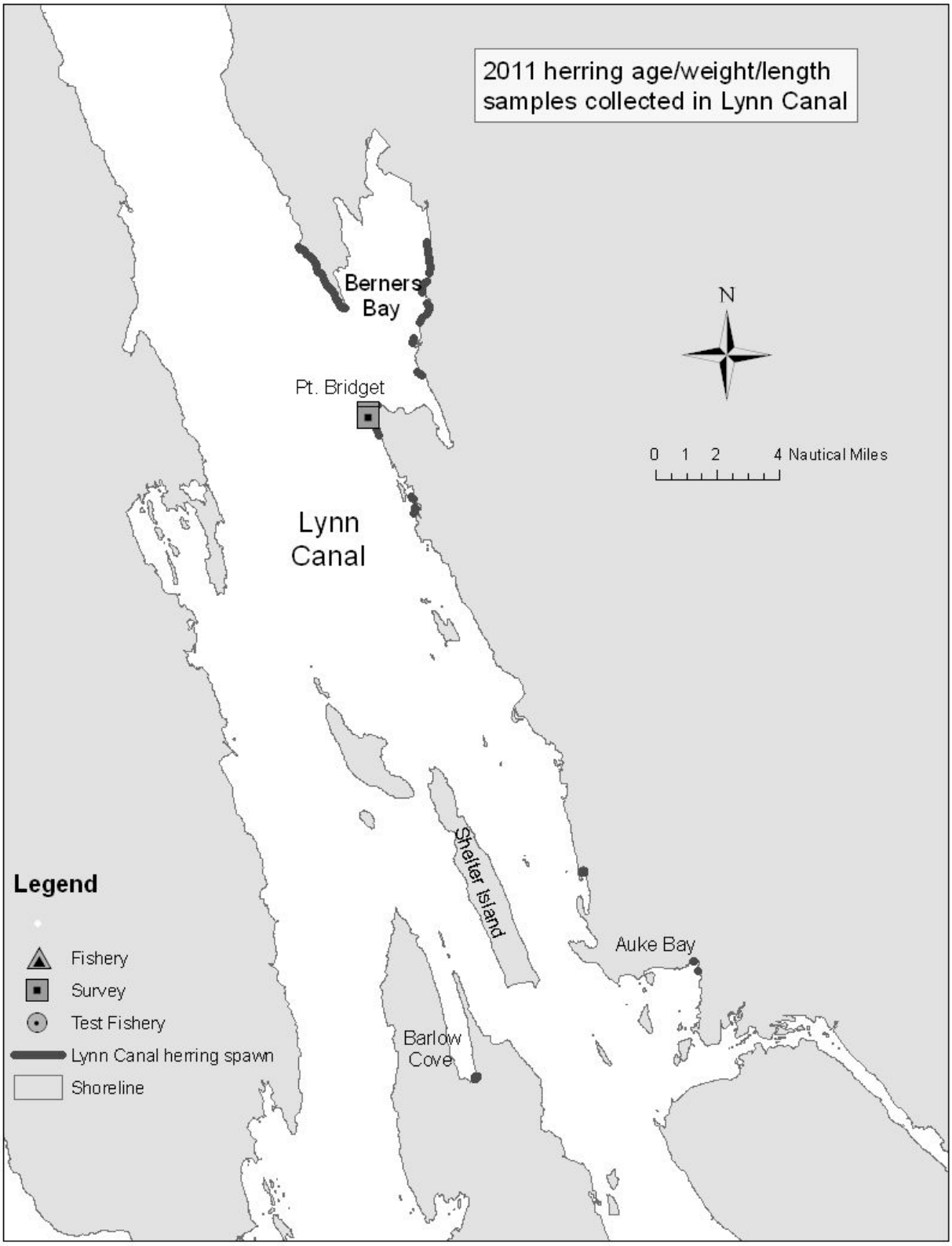



Figure 13 .–Locations of herring samples collected for estimates of age and size for the Lynn Canal herring stock, 2011.

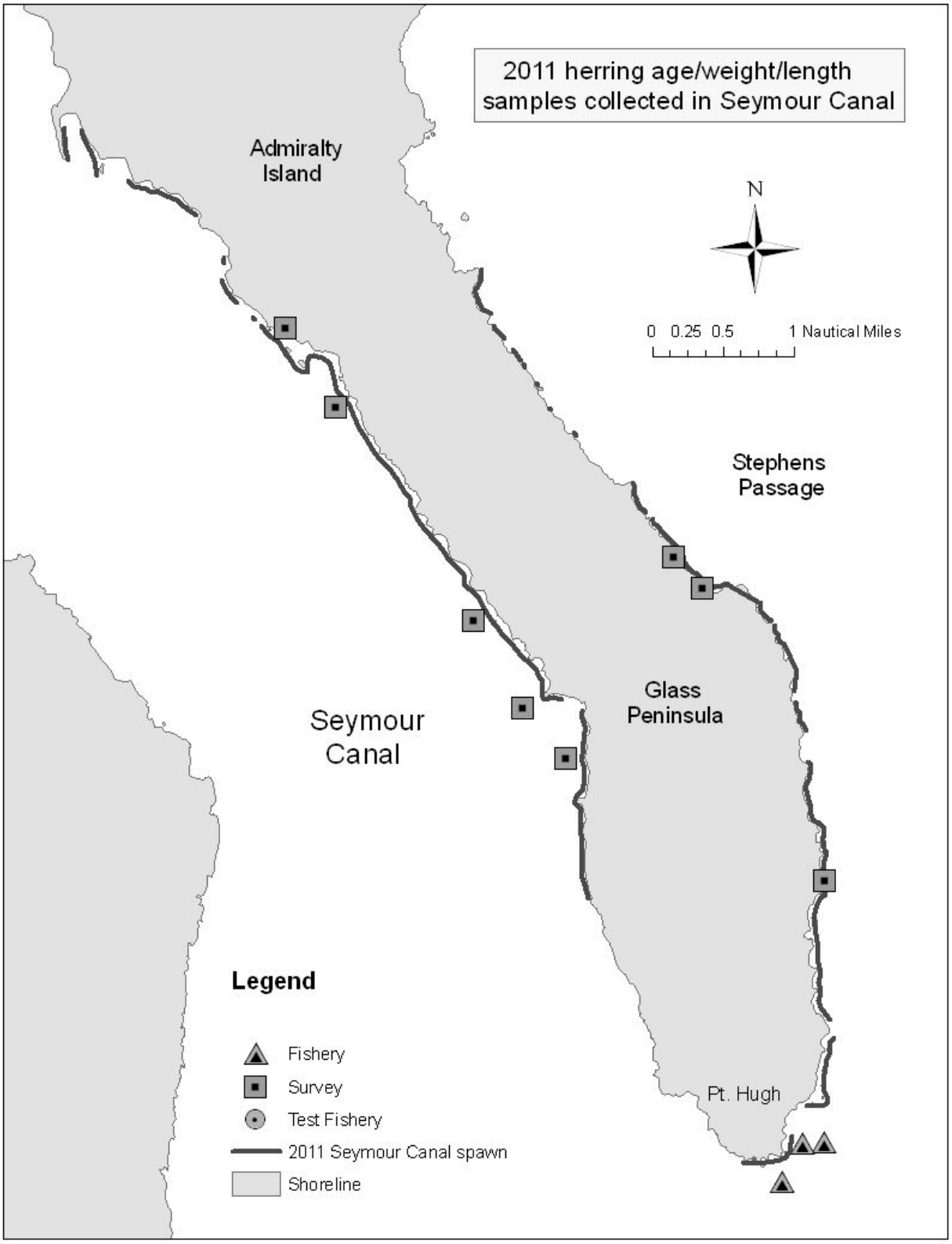



Figure 14.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock, 2011.

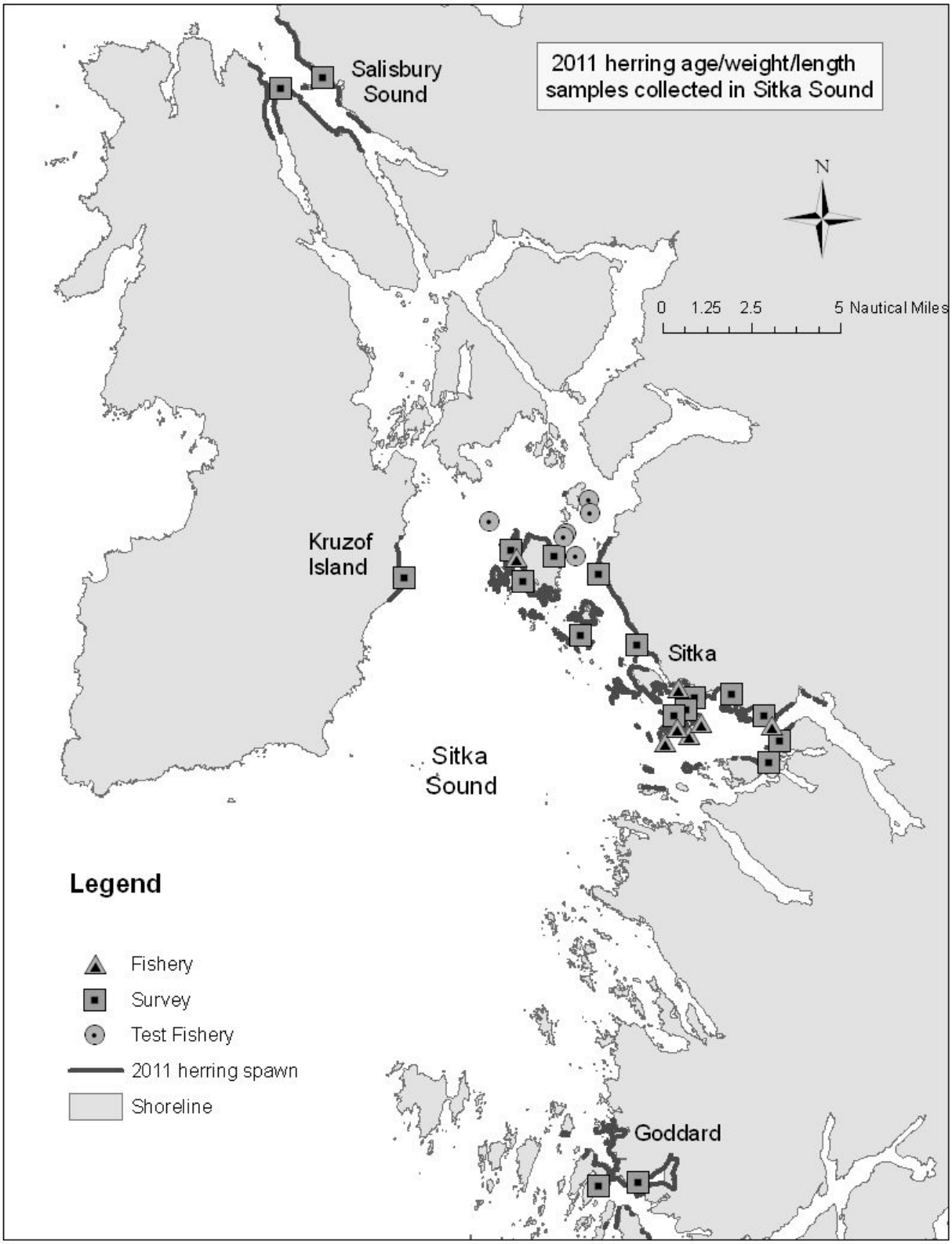



Figure 15.–Locations of herring samples collected for estimates of age and size for the Sitka Sound herring stock, 2011.

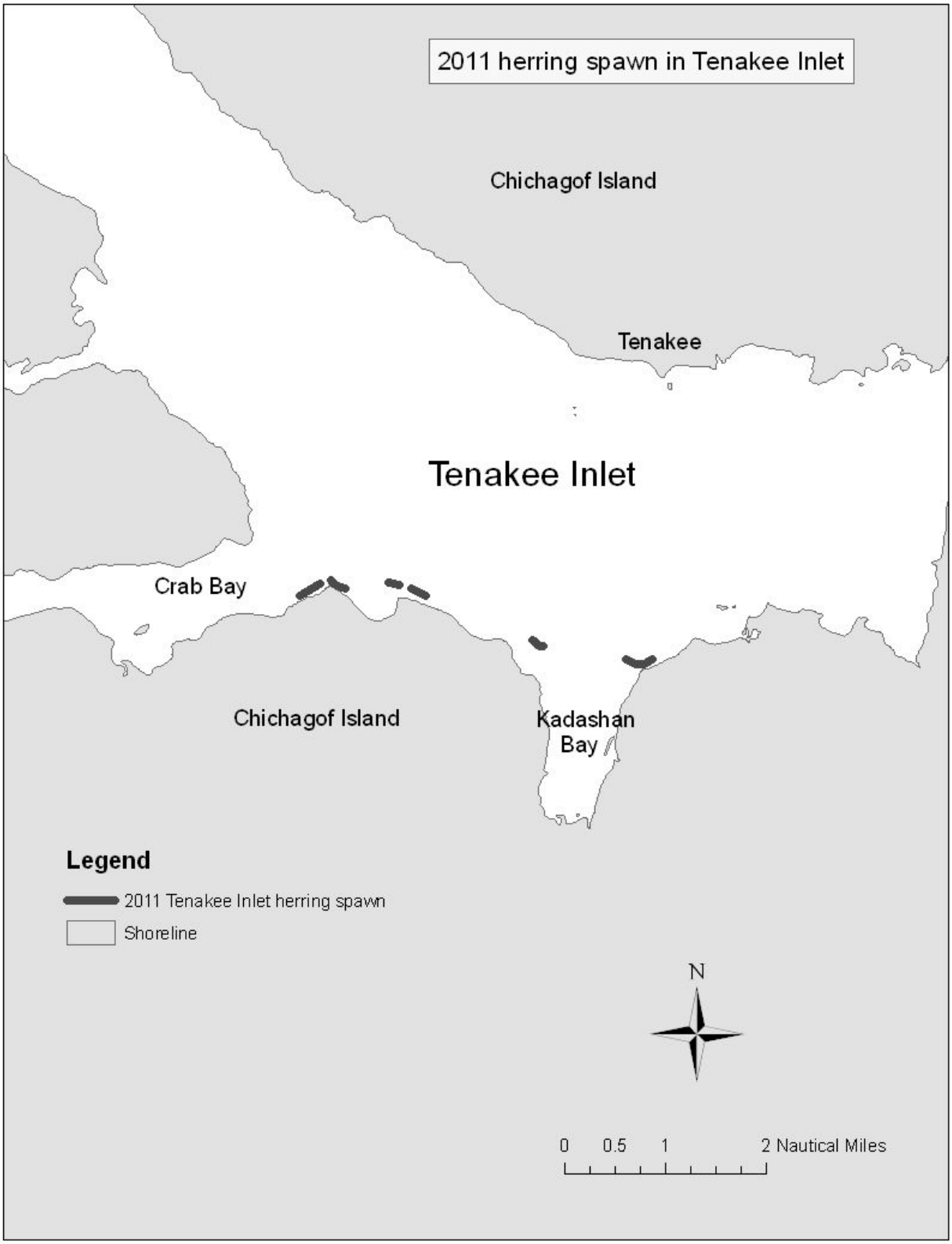



Figure 16.–Location of herring spawn for the Tenakee Inlet herring stock, 2011. No age/length/weight samples were obtained during 2011 and no spawn deposition survey was conducted.

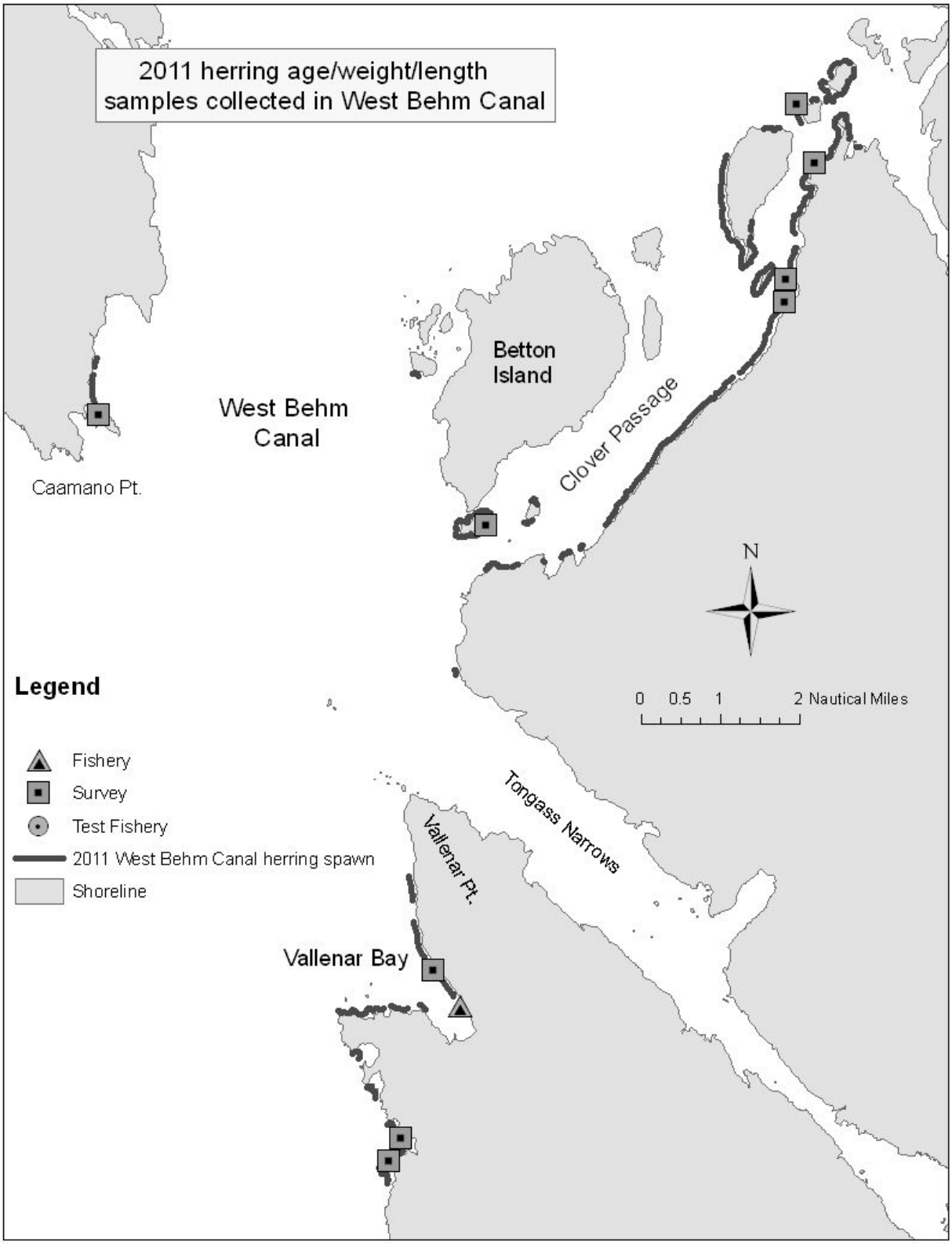



Figure 17.–Locations of herring samples collected for estimates of age and size for the West Behm Canal herring stock, 2011.

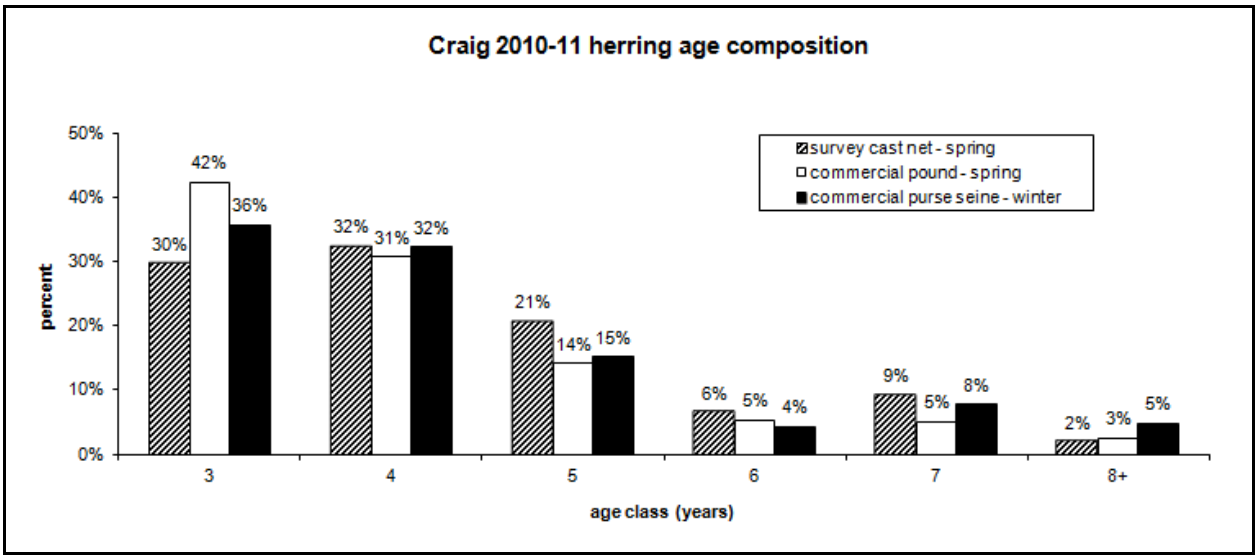



Figure 18.–Age composition for Craig herring stock in 2010–11.

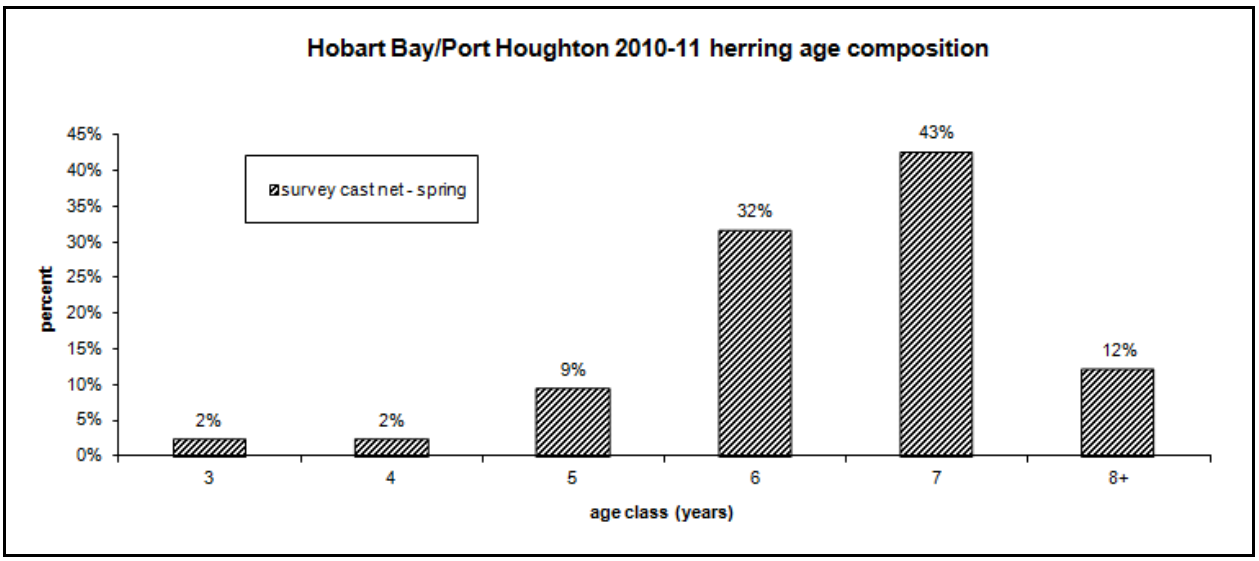



Figure 19.–Age composition for Hobart Bay/Port Houghton herring stock in 2010–11.

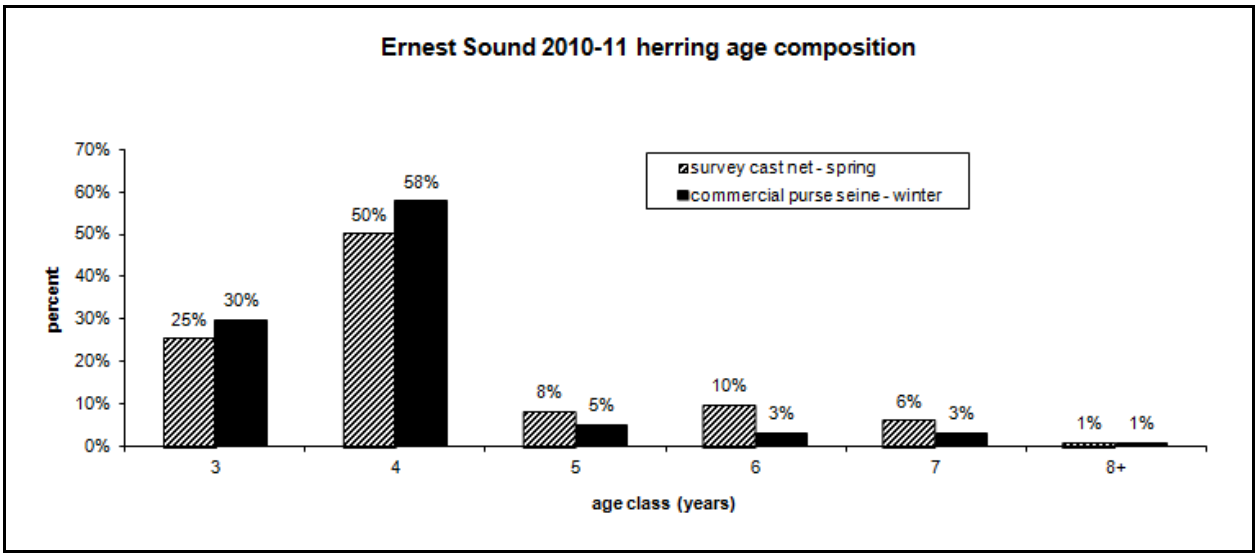



Figure 20.–Age composition for Ernest Sound herring stock in 2010–11.

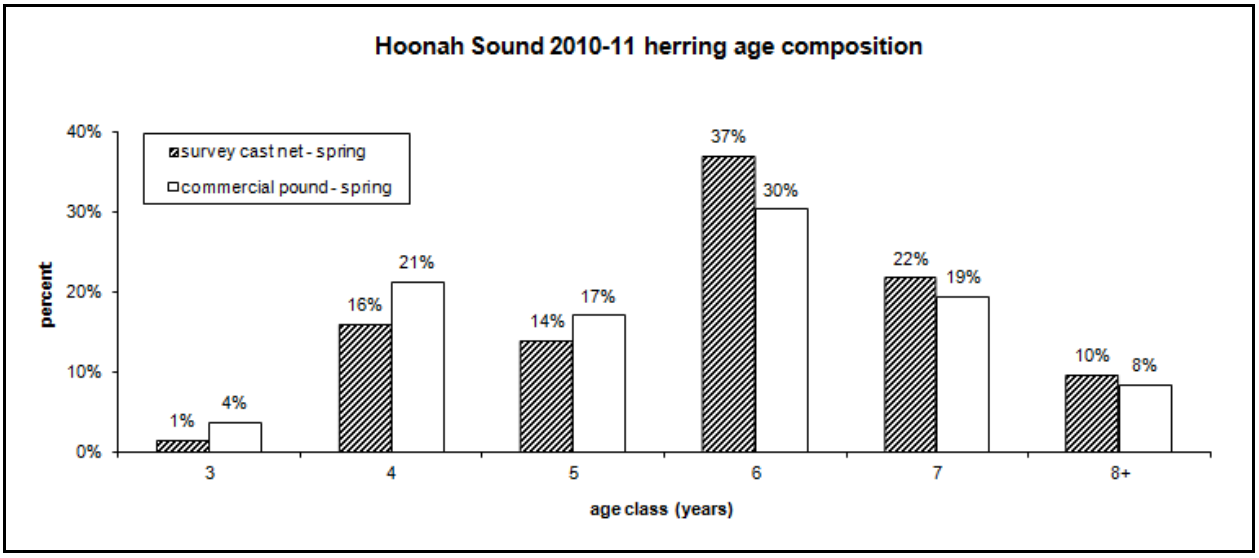



Figure 21.–Age composition for Hoonah Sound herring stock in 2010–11.

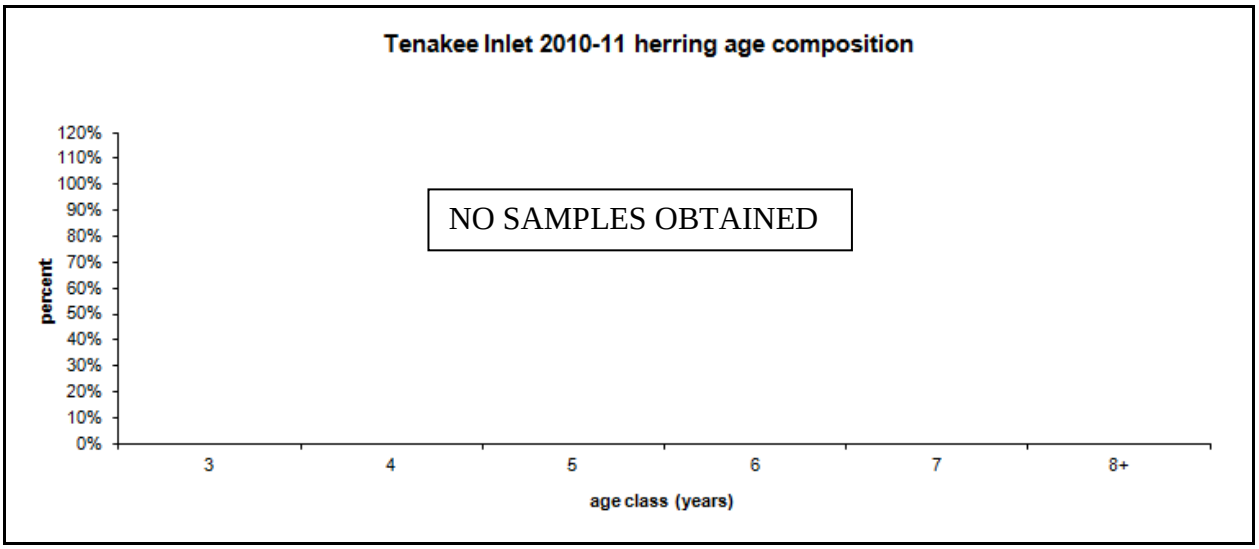



Figure 22.–Age composition for Tenakee Inlet herring stock in 2010–11. No samples were obtained due to short spawning duration, and no commercial fishery opened in 2010-11.

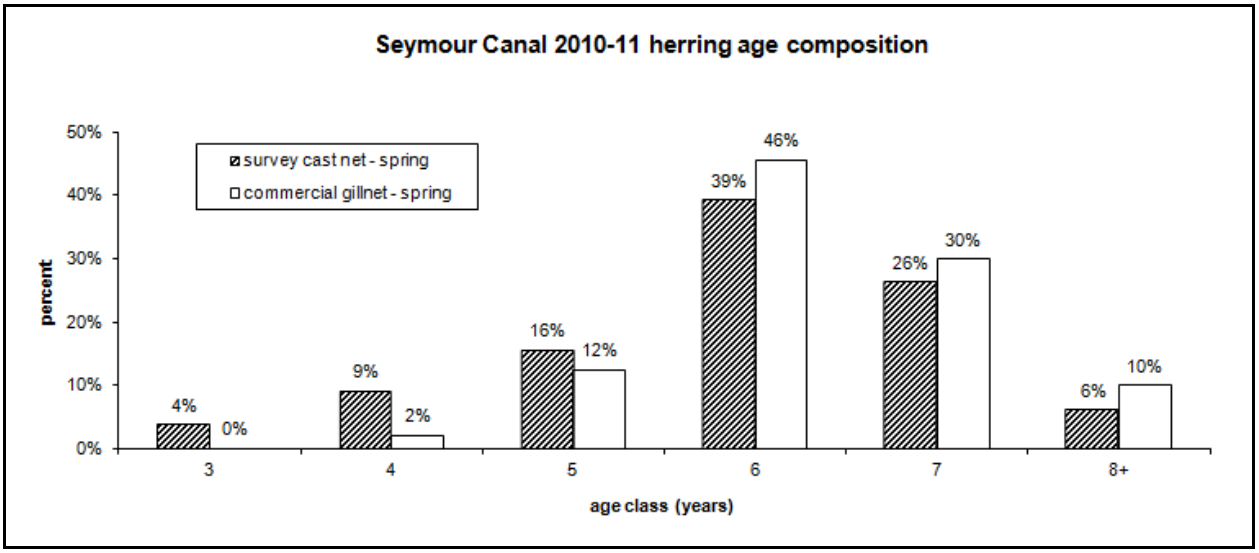



Figure 23.–Age composition for Seymour Canal herring stock in 2010–11.

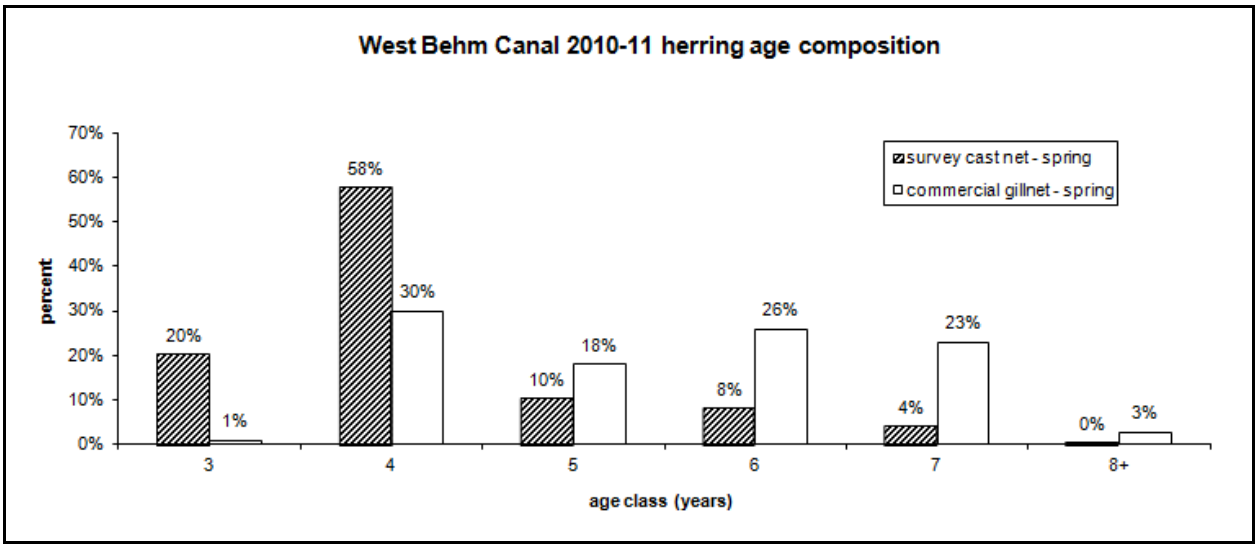



Figure 24.–Age composition for West Behm Canal herring stock in 2010–11.

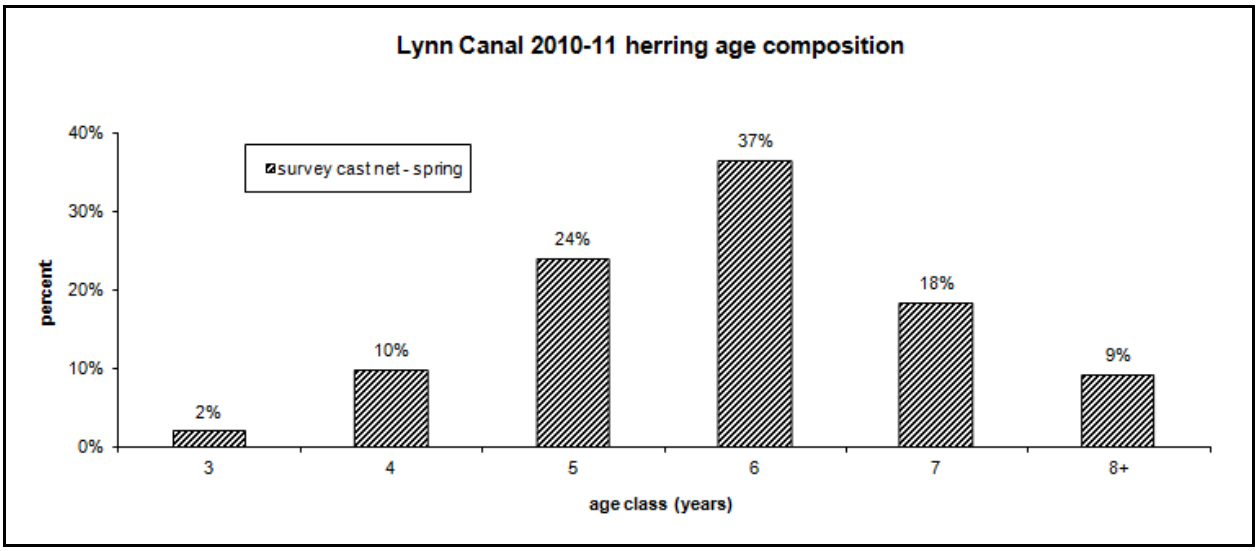



Figure 25.–Age composition for Lynn Canal herring stock in 2010–11.

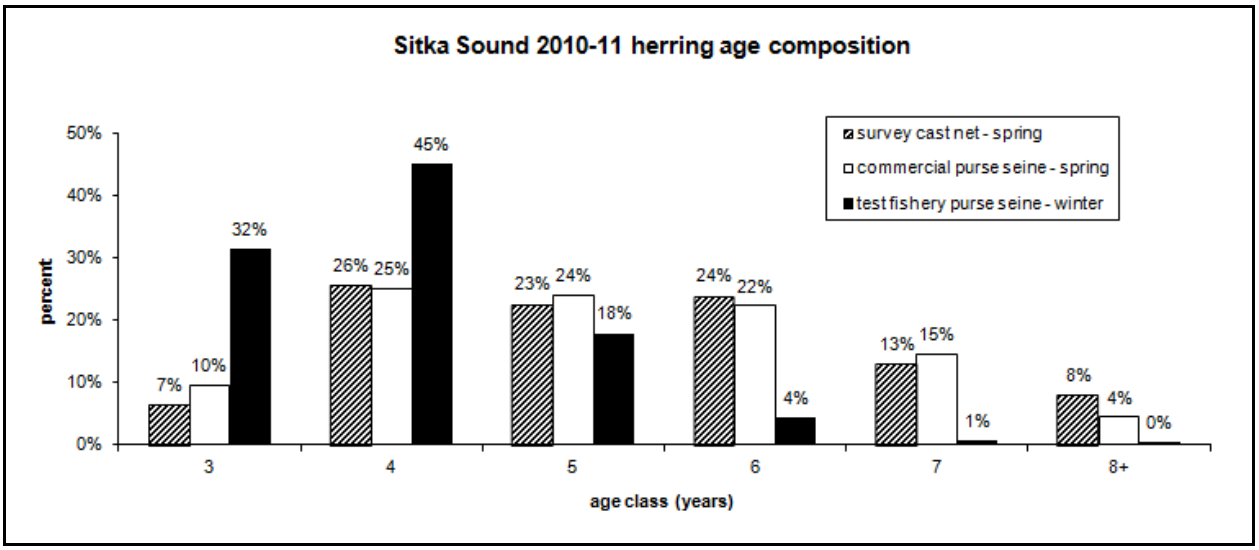



Figure 26.–Age composition for Sitka Sound herring stock in 2010–11.

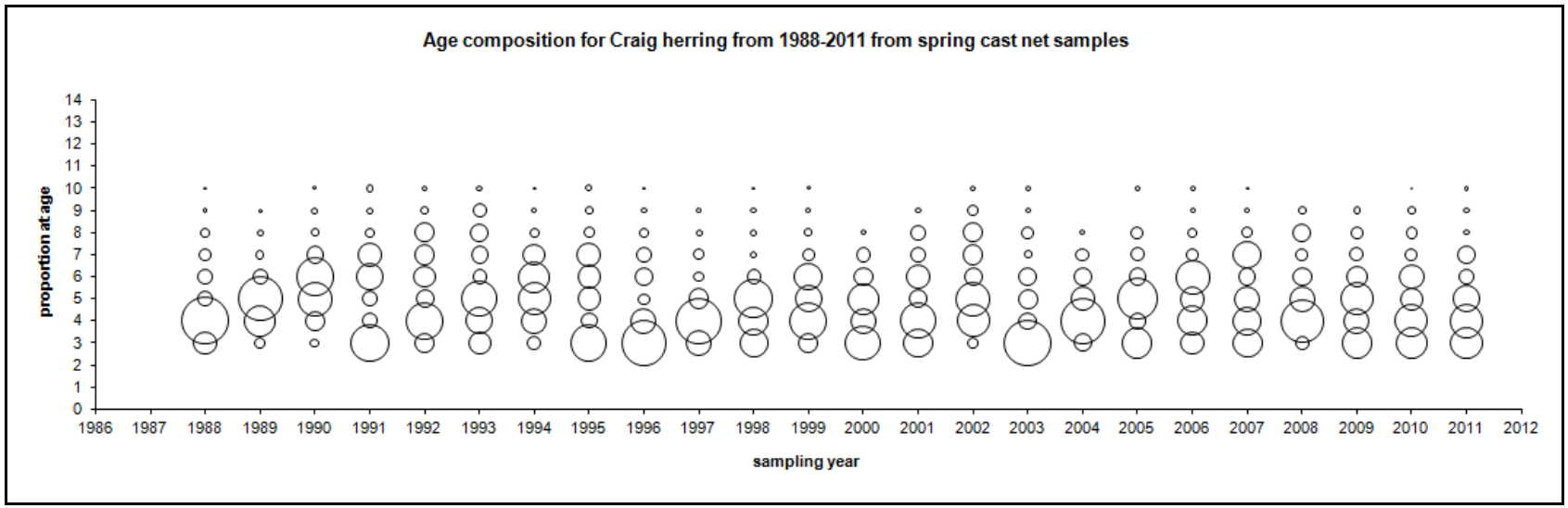





Figure 27.–Age composition from sampling data for the Craig herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

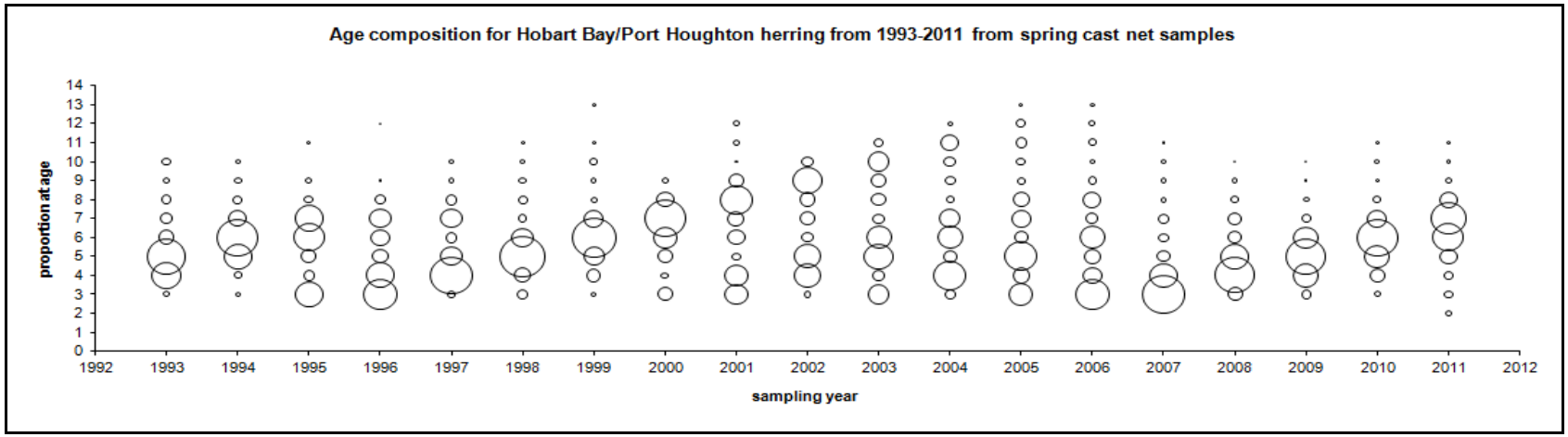



Figure 28.–Age composition from sampling data for the Hobart Bay/Port Houghton herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

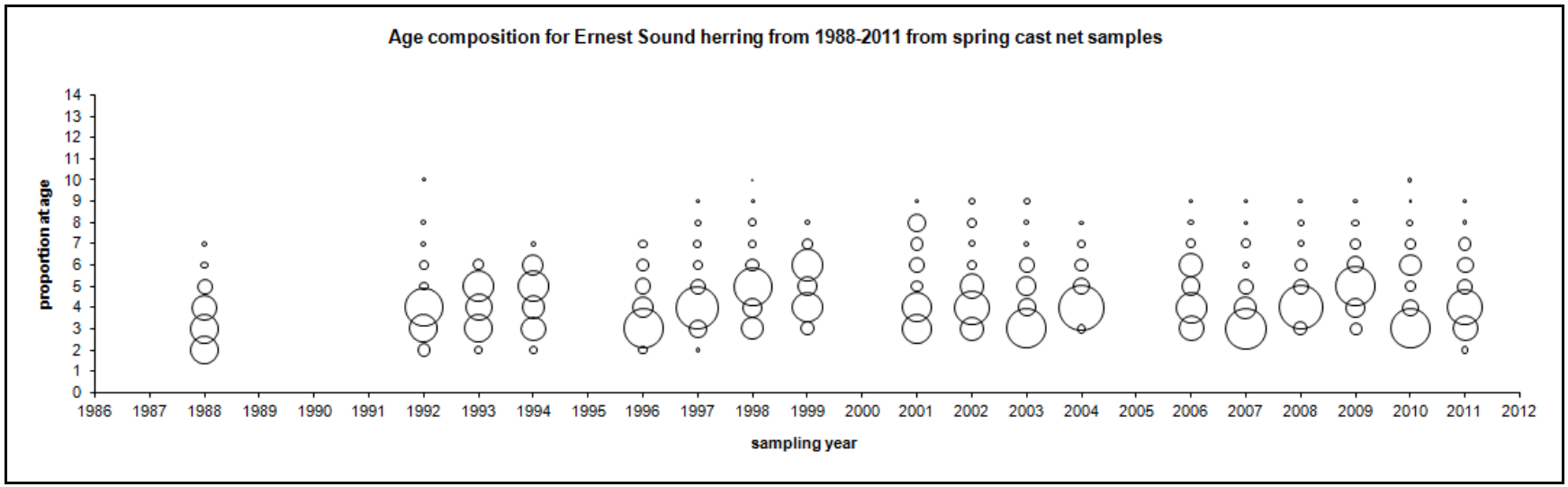



Figure 29.–Age composition from sampling data for the Ernest Sound herring stock.



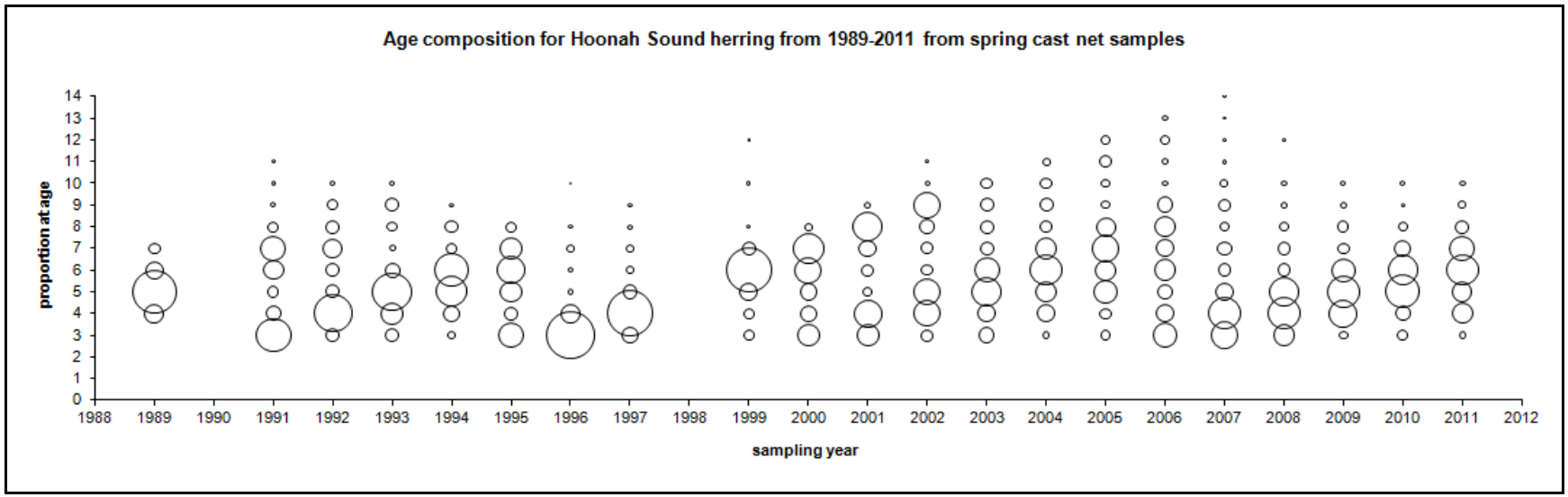



Figure 30.–Age composition from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

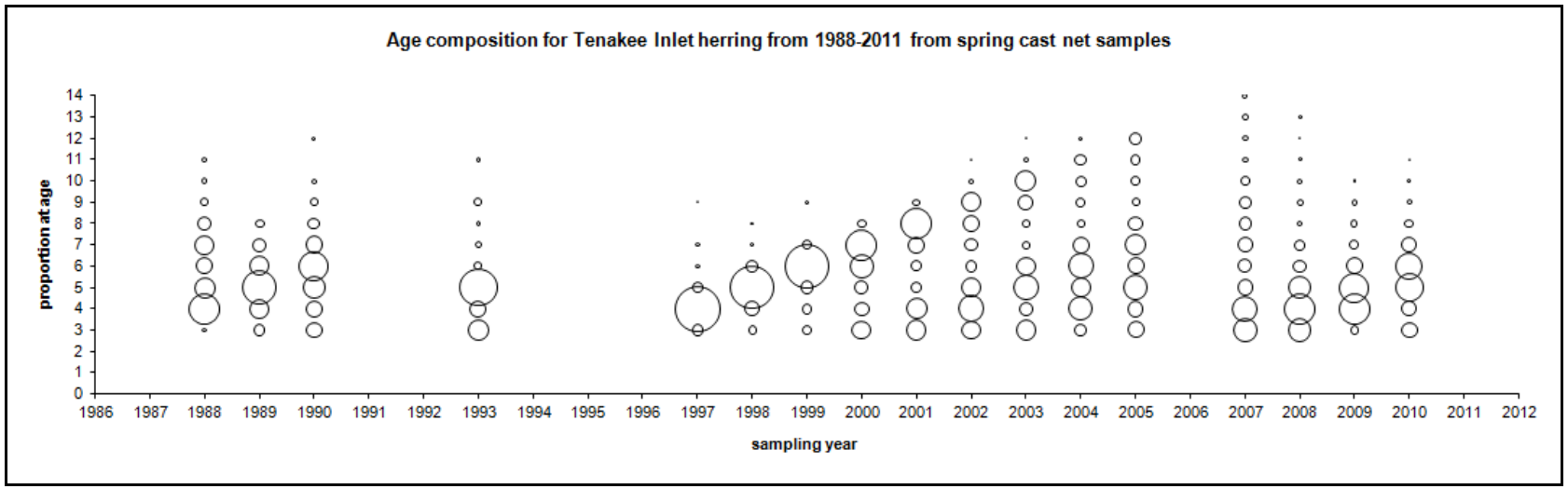



Figure 31.–Age composition from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.



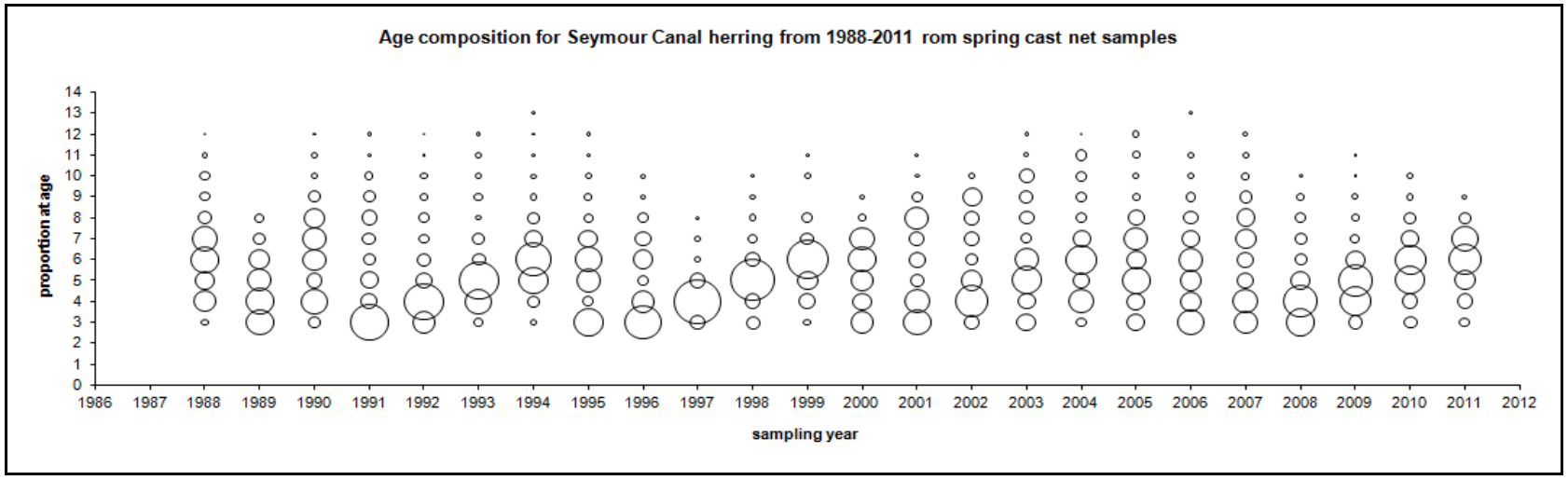



Figure 32.–Age composition from sampling data for the Seymour Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

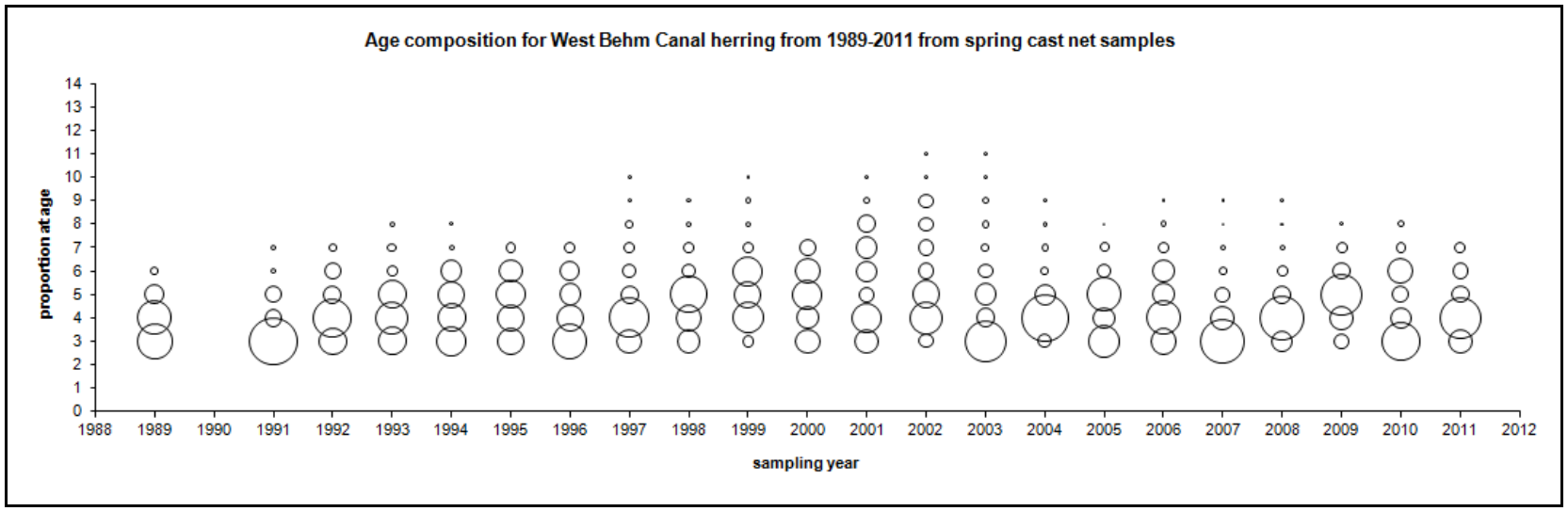



Figure 33.–Age composition from sampling data for the West Behm Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.



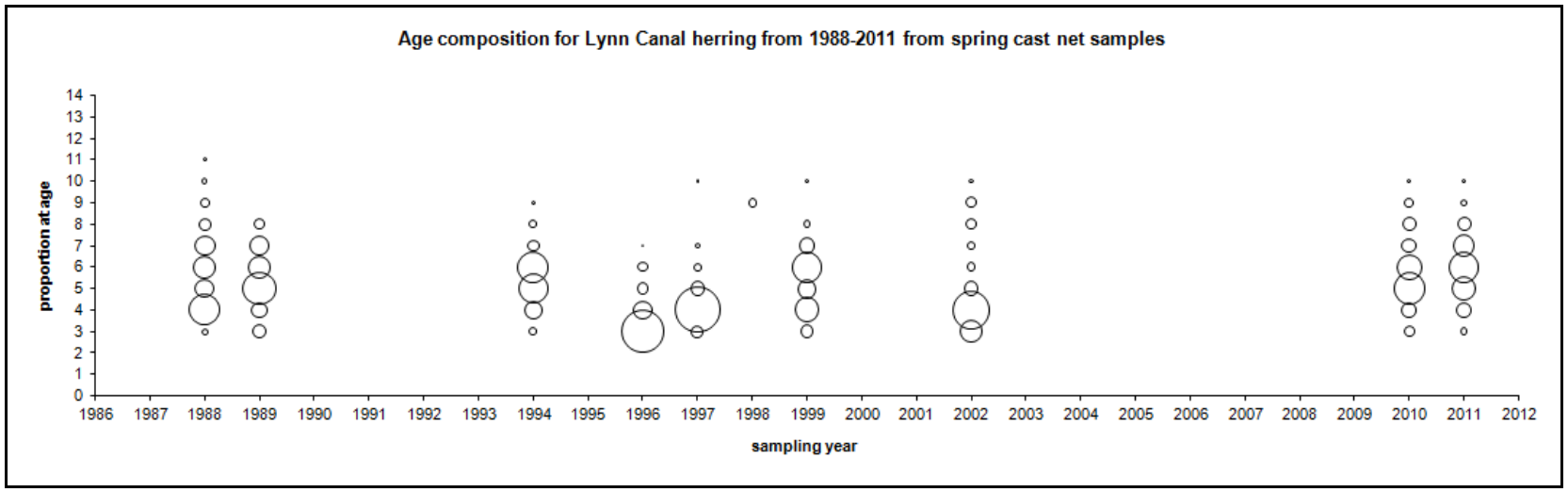



Figure 34.–Age composition from sampling data for the Lynn Canal herring stock.

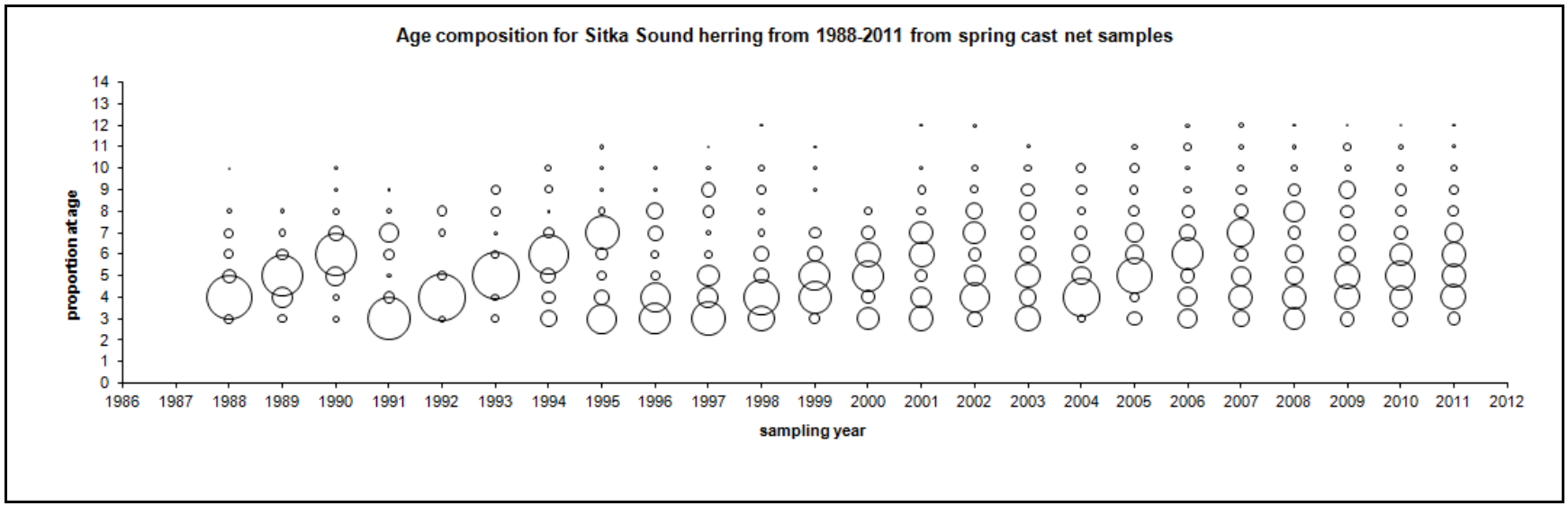



Figure 35.–Age composition from sampling data for the Sitka Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

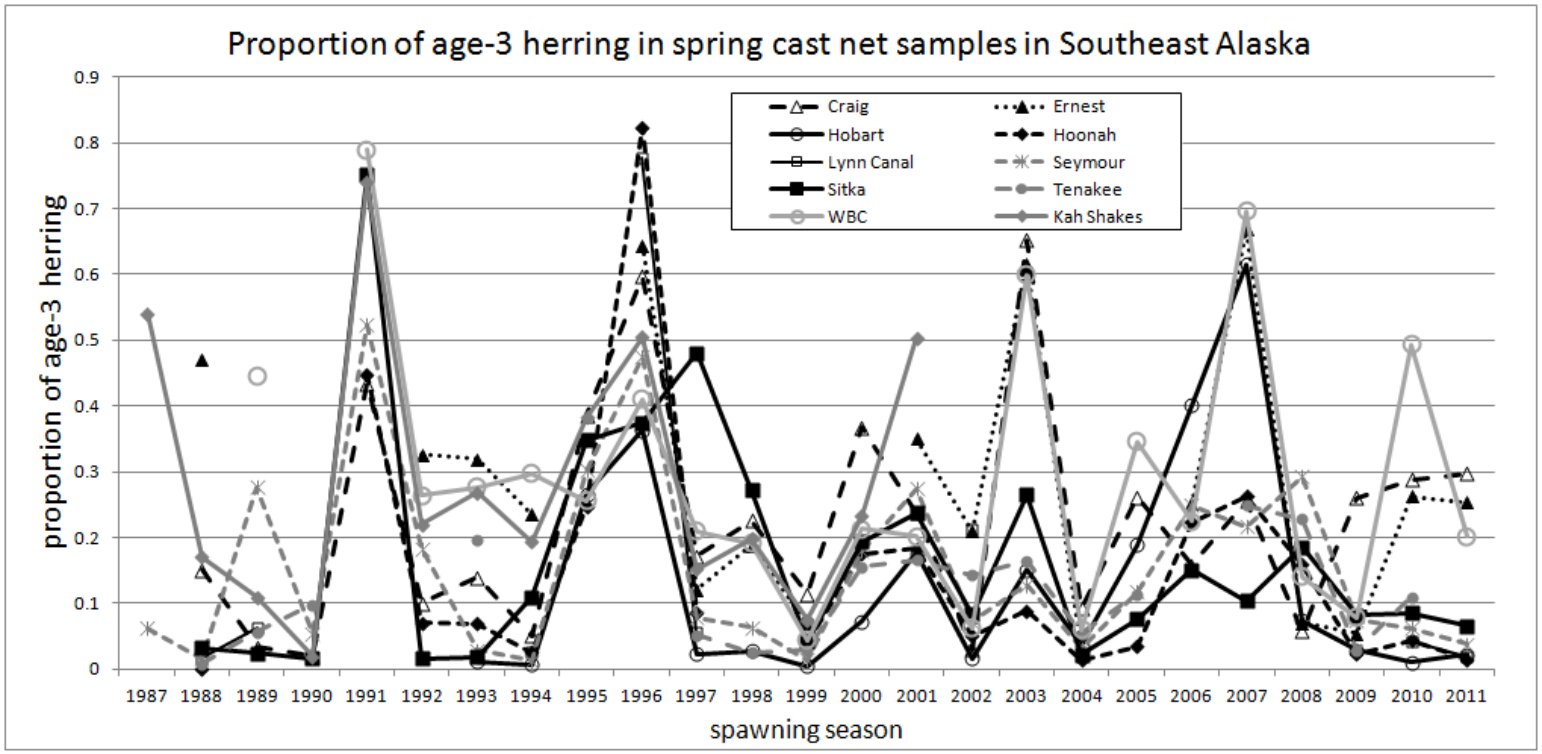



Figure 36.–Proportion of age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

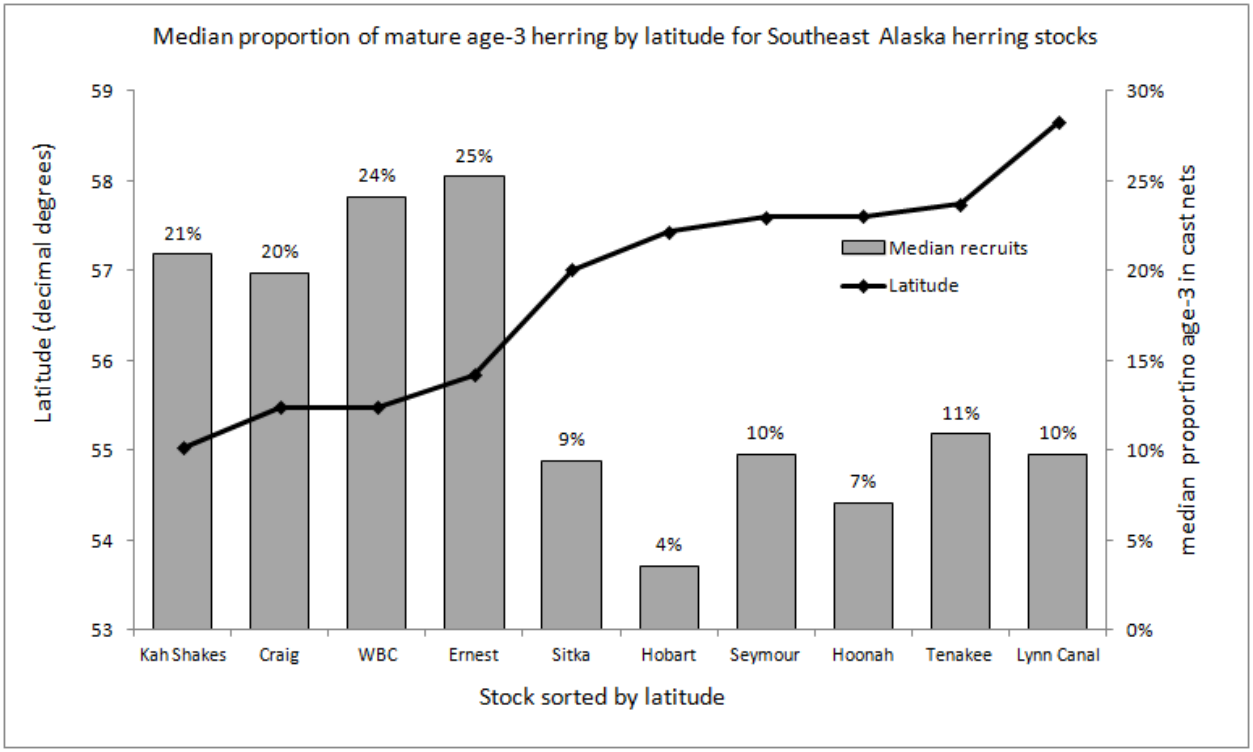



Figure 37.–Median proportion of age-3 herring in spring cast nest samples (1988–2011) and latitude of spawning populations for stocks in Southeast Alaska.

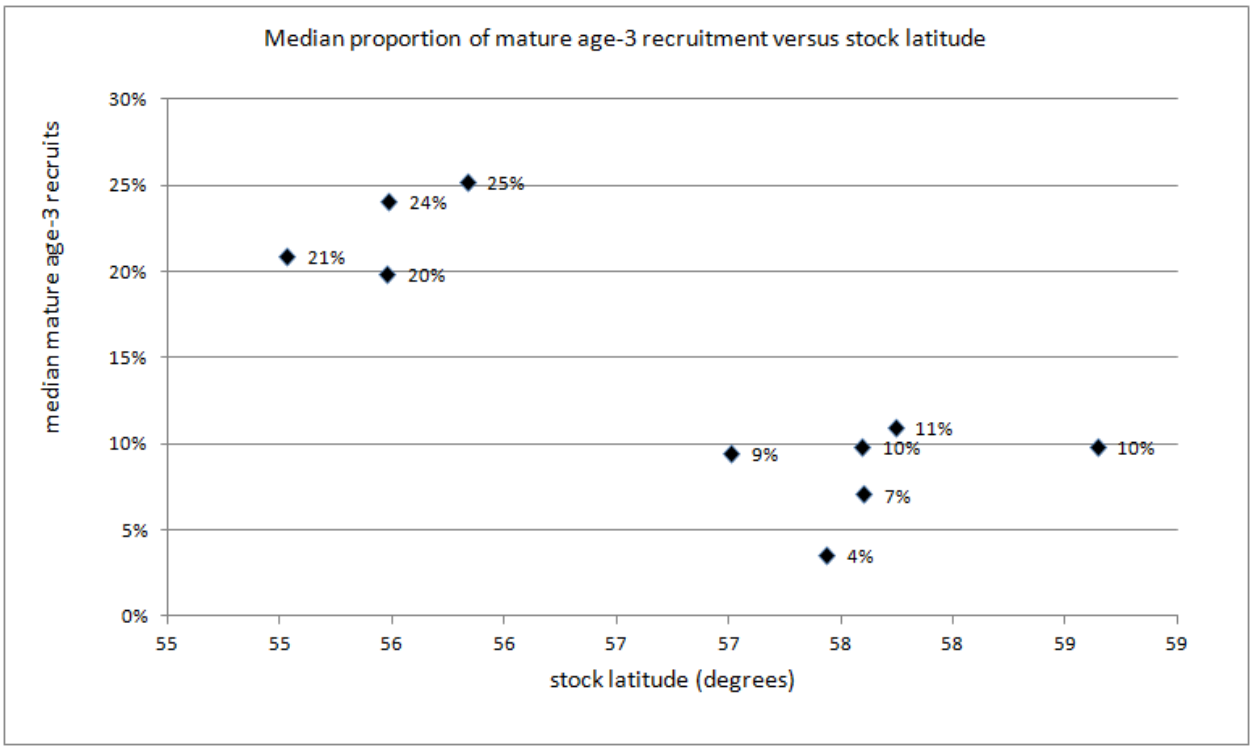



Figure 38.–Proportion of age-3 herring in spring cast nest samples versus stock latitude of spawning stocks in Southeast Alaska.

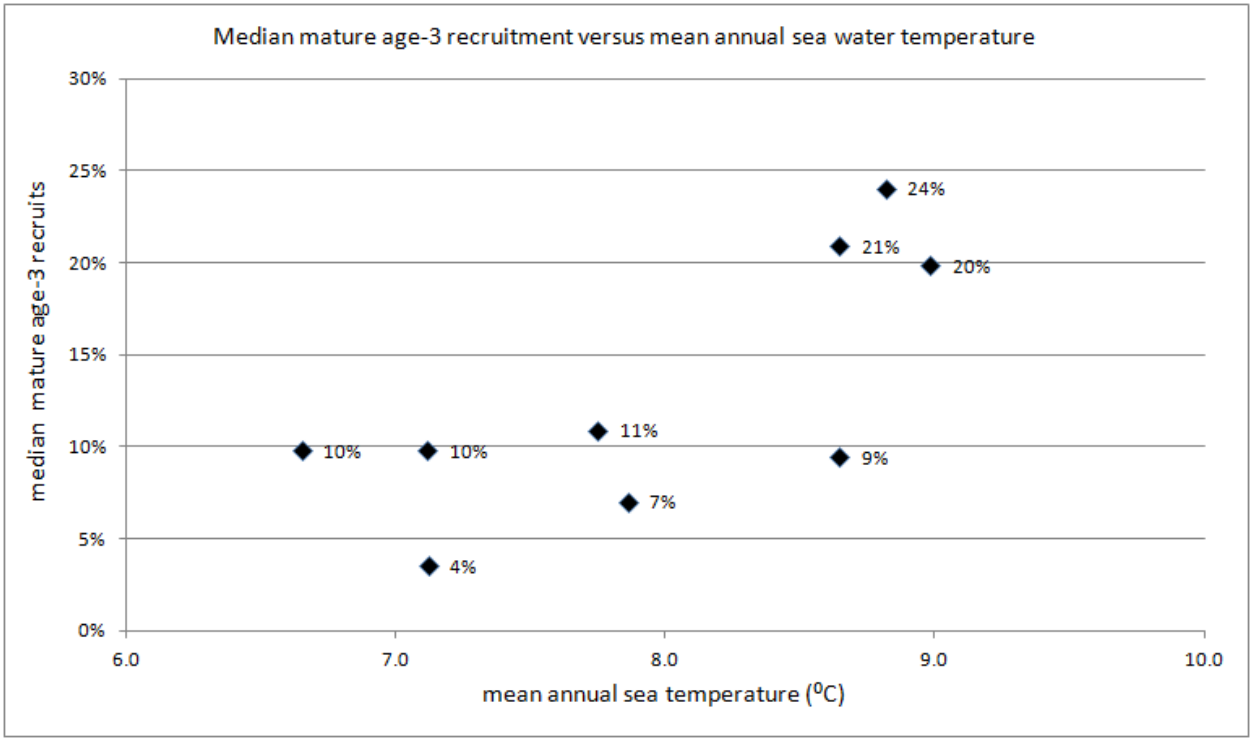



Figure 39.–Median proportion of age-3 herring in spring cast nest samples versus mean annual sea water temperature at location of spawning stocks in Southeast Alaska.

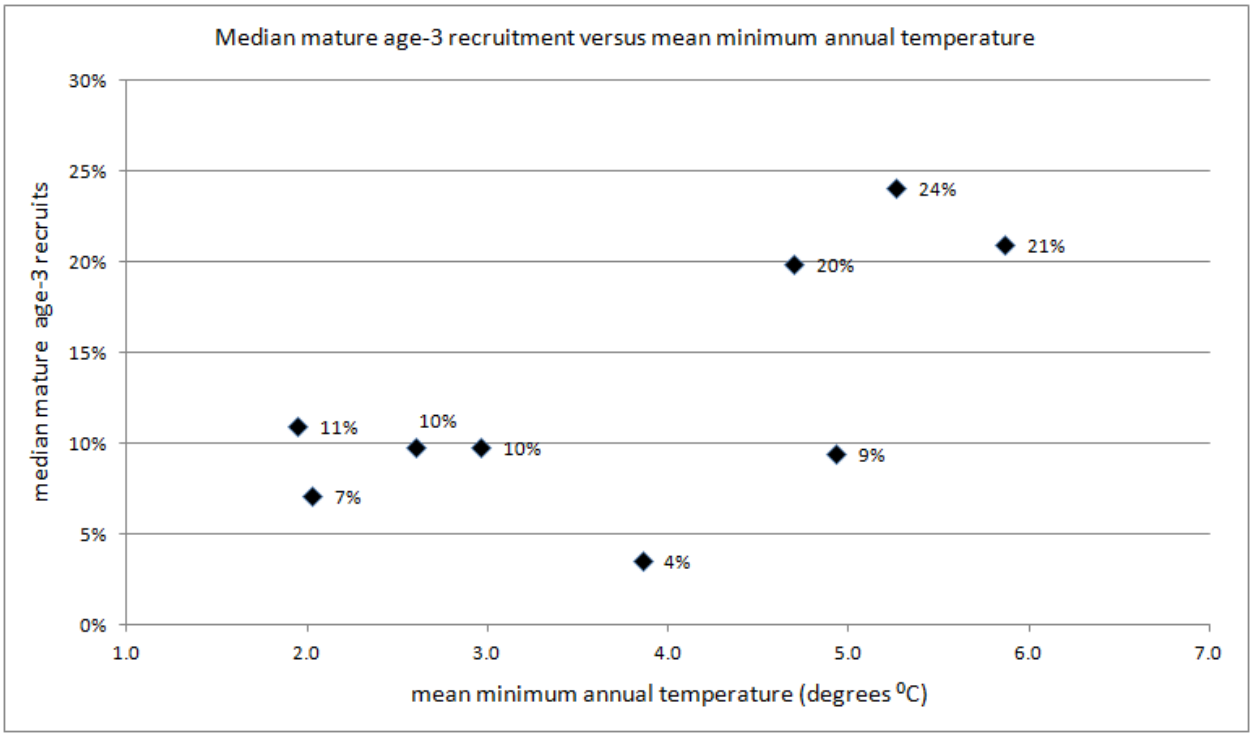



Figure 40.–Median proportion of age-3 herring in spring cast nest samples versus mean minimum annual sea water temperature at location of spawning stocks in Southeast Alaska.

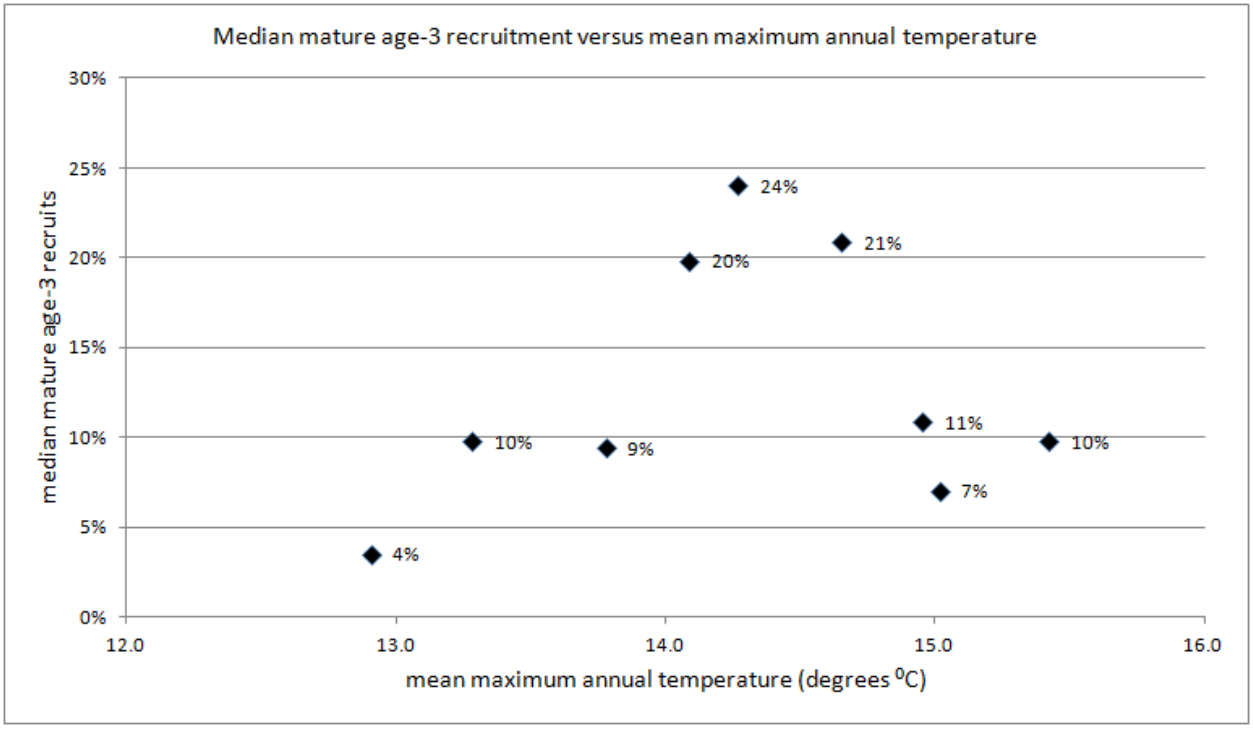



Figure 41.–Median proportion of age-3 herring in spring cast nest samples versus mean maximum annual sea water temperature at location of spawning stocks in Southeast Alaska.

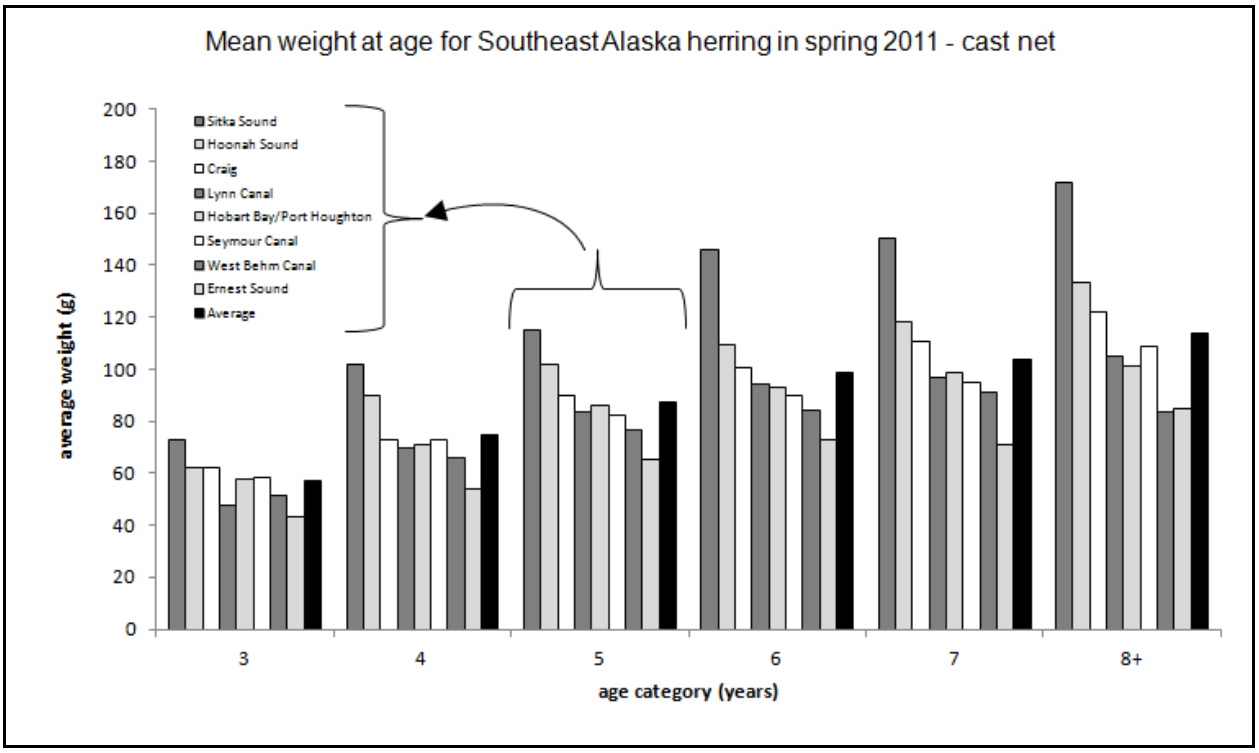



Figure 42.–Mean weight-at-age for Southeast Alaska herring stocks in spring 2011.

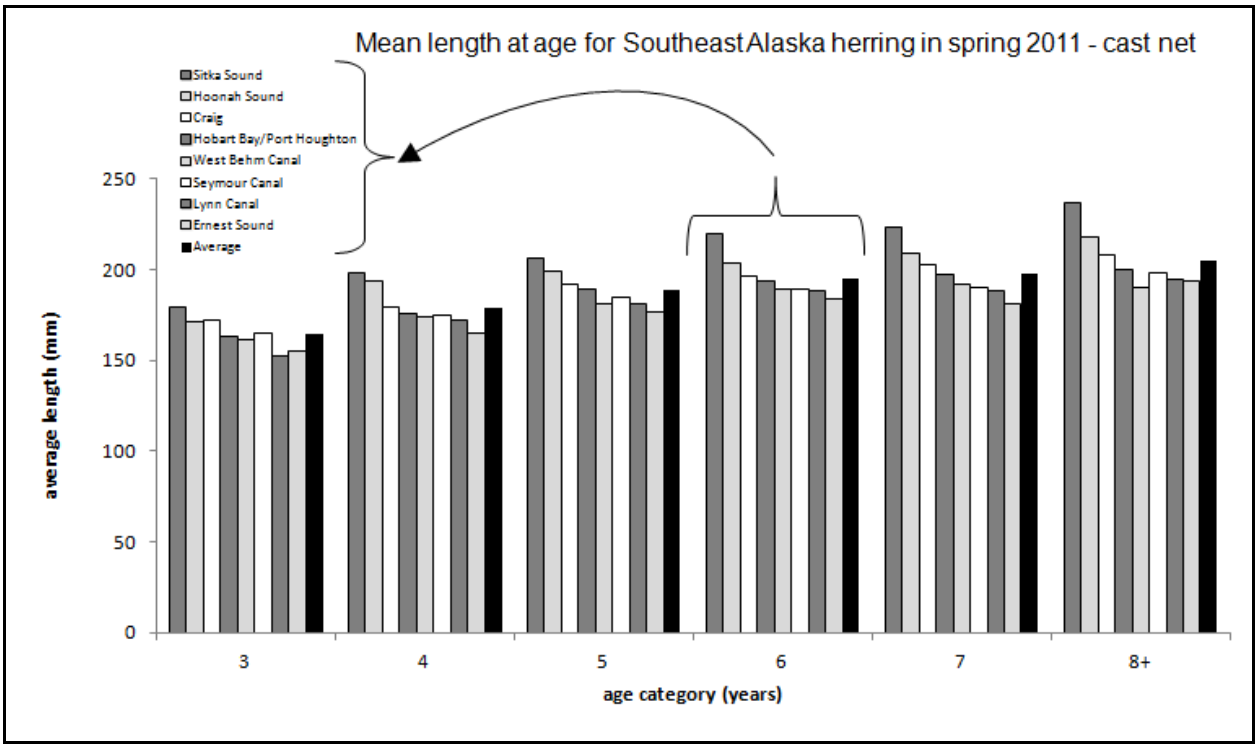



Figure 43.–Mean length at age for Southeast Alaska herring stocks in spring 2011.

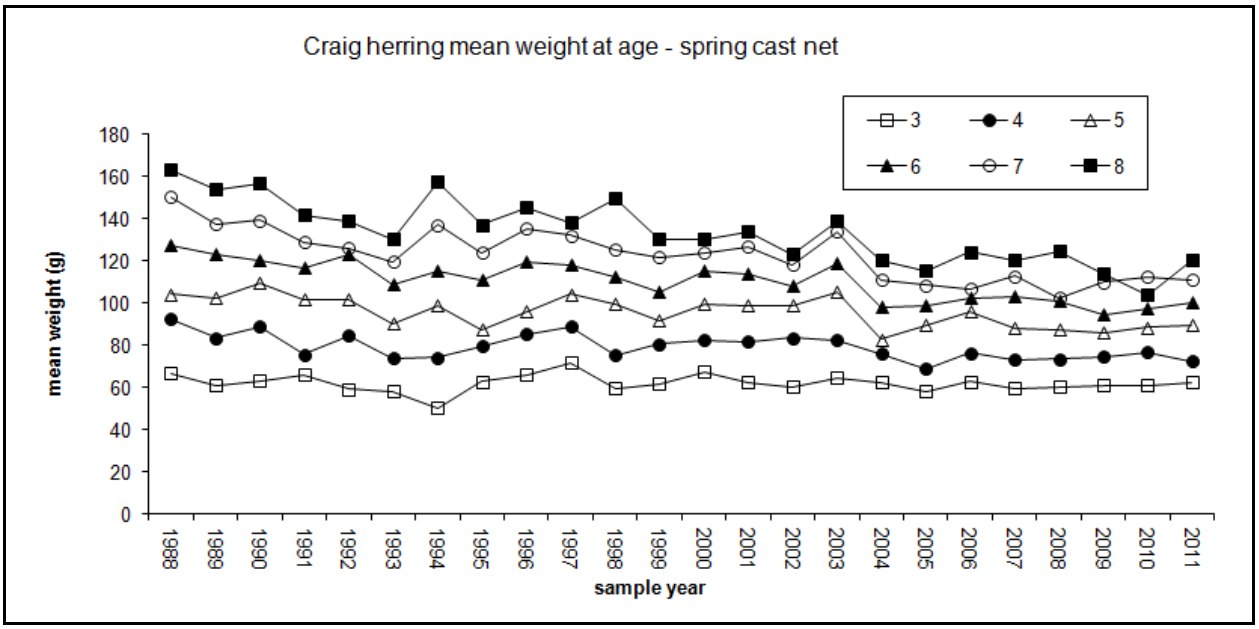



Figure 44.–Mean weight-at-age of the Craig herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

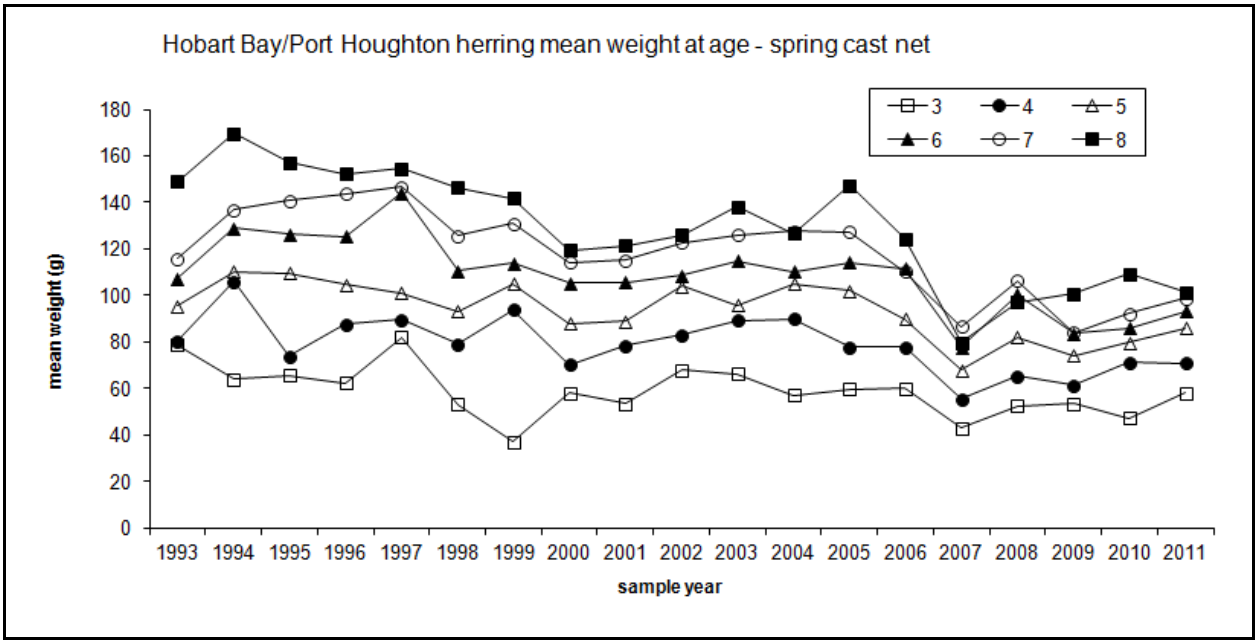



Figure 45.–Mean weight at age of the Hobart Bay/Port Houghton herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

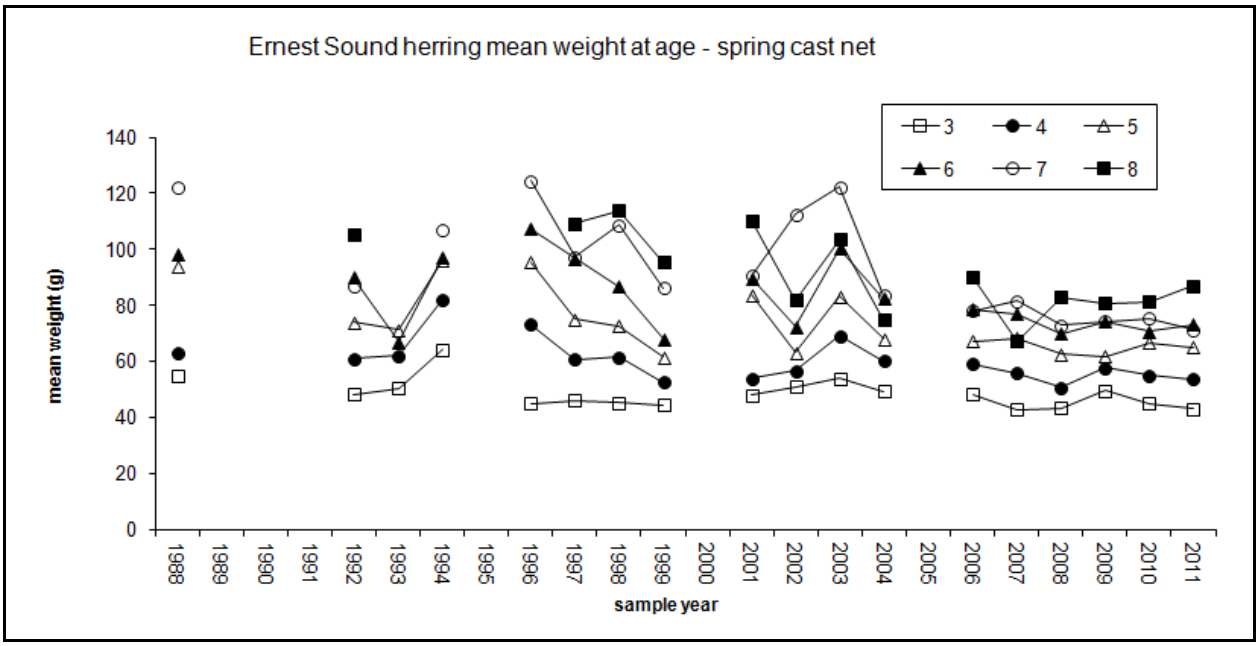



Figure 46.–Mean weight at age for the Ernest Sound herring spawning population.

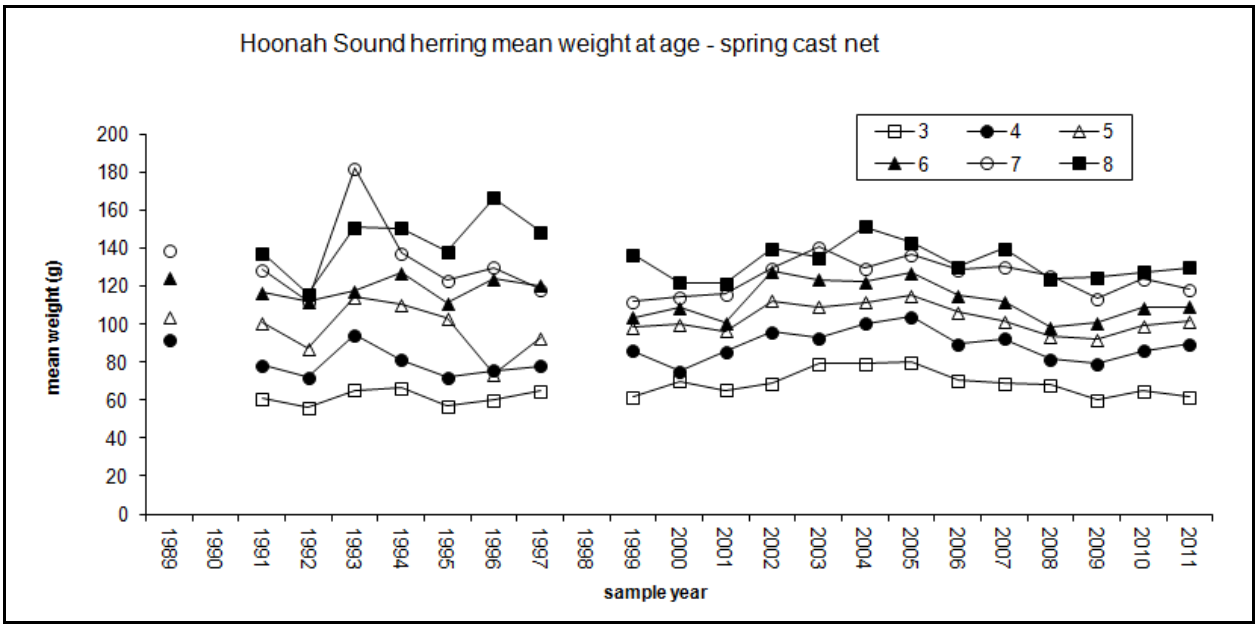



Figure 47.–Mean weight at age for the Hoonah Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

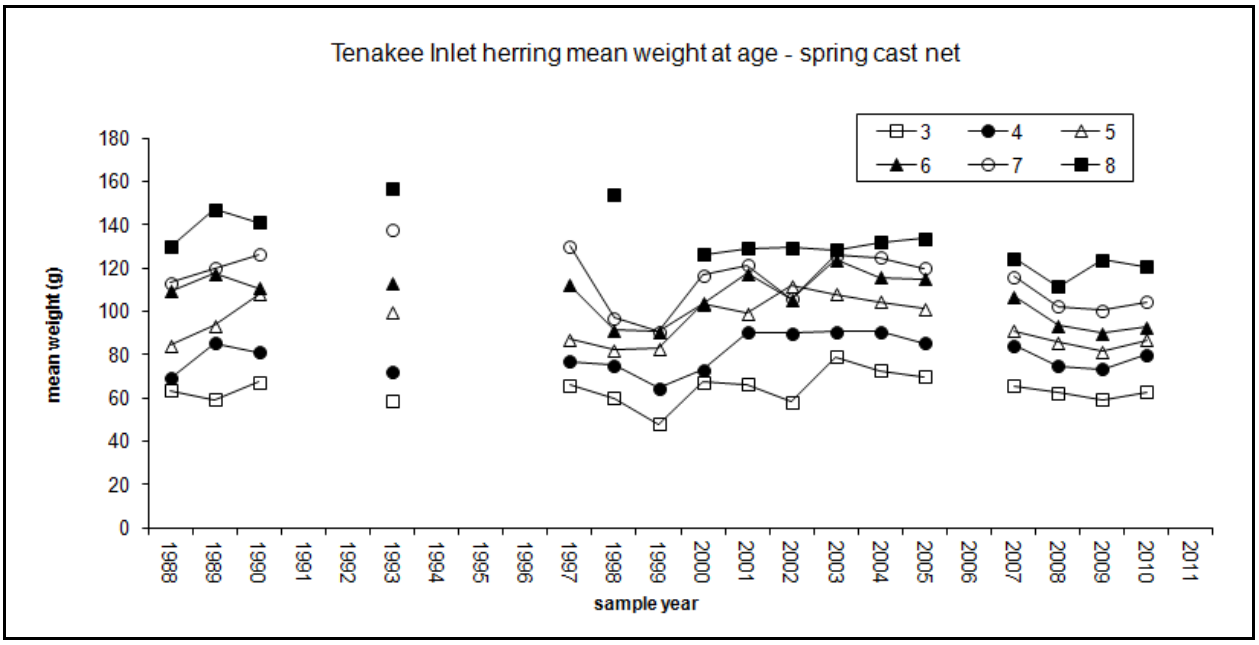



Figure 48.–Mean weight at age for the Tenakee Inlet herring stock. No samples collected in 2001 due to short spawning duration. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

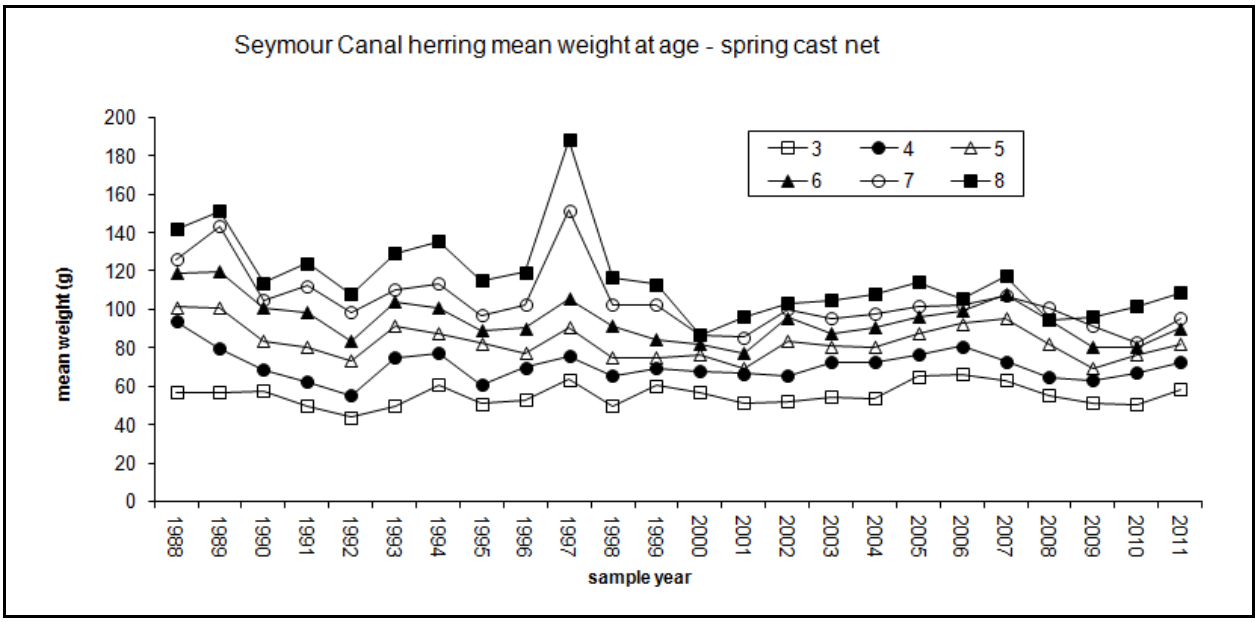



Figure 49.–Mean weight at age for the Seymour Canal herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

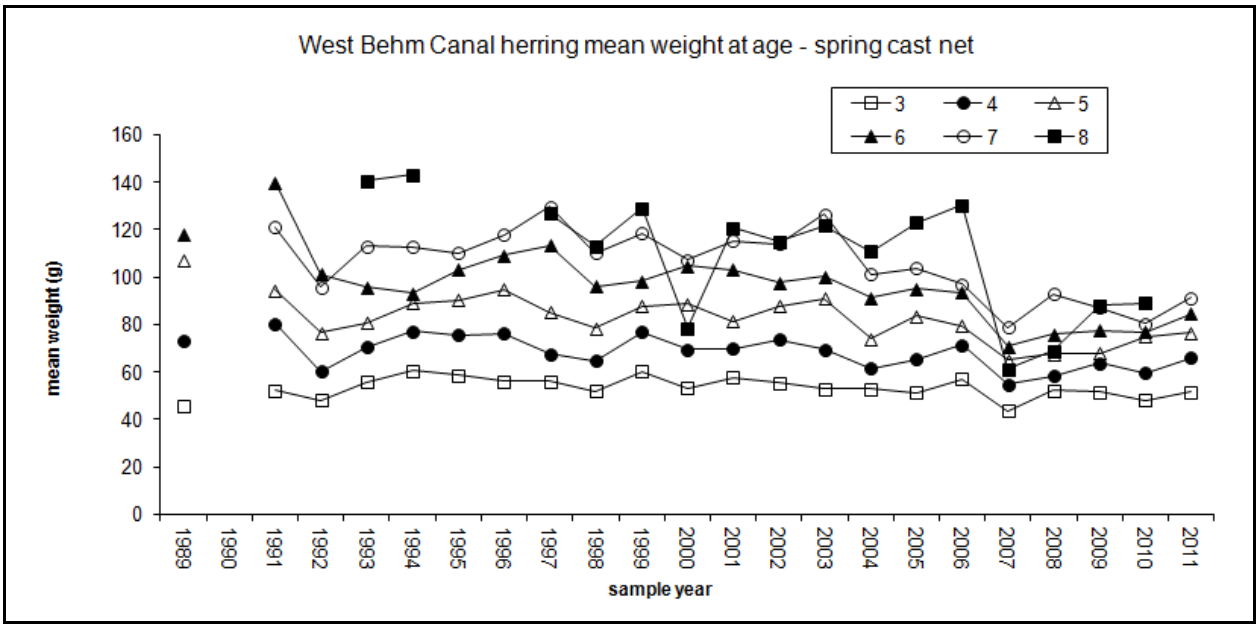



Figure 50.–Mean weight at age for the West Behm Canal herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

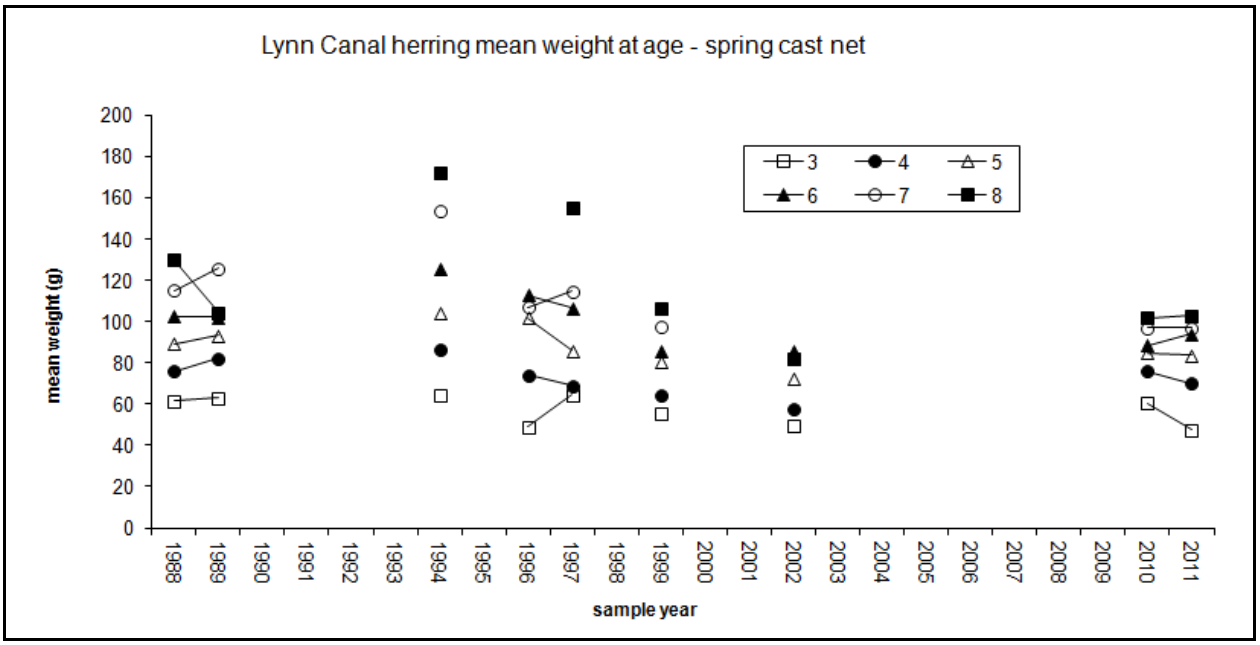



Figure 51.–Mean weight at age for the Lynn Canal herring spawning population.

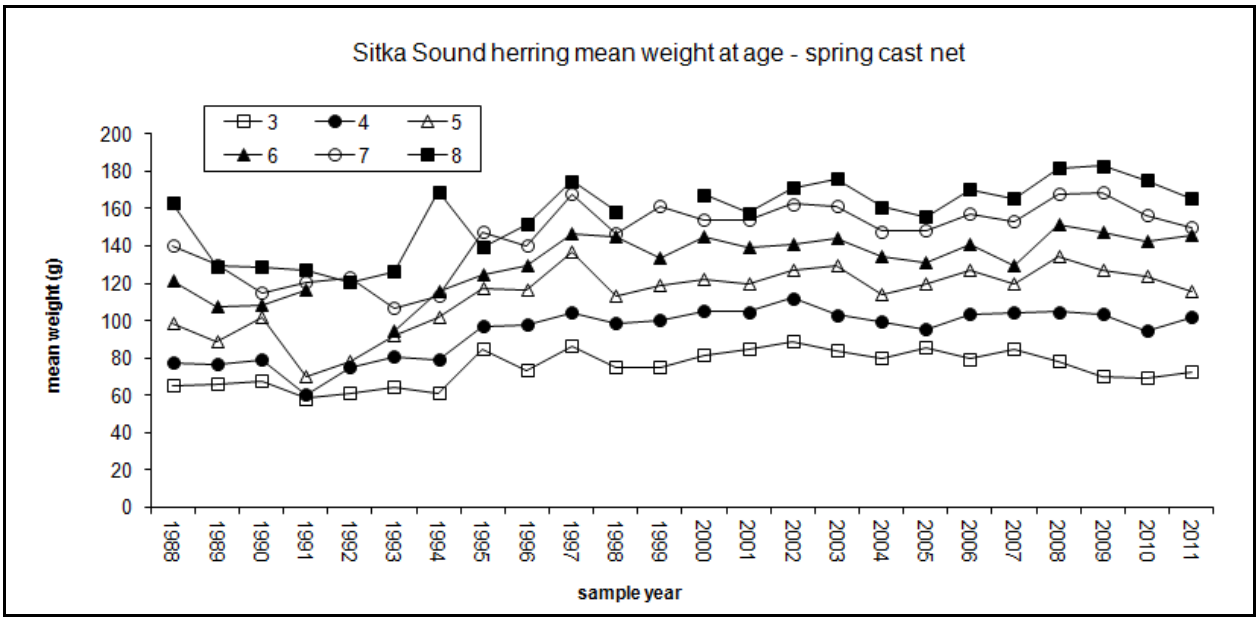



Figure 52.–Mean weight at age for the Sitka Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

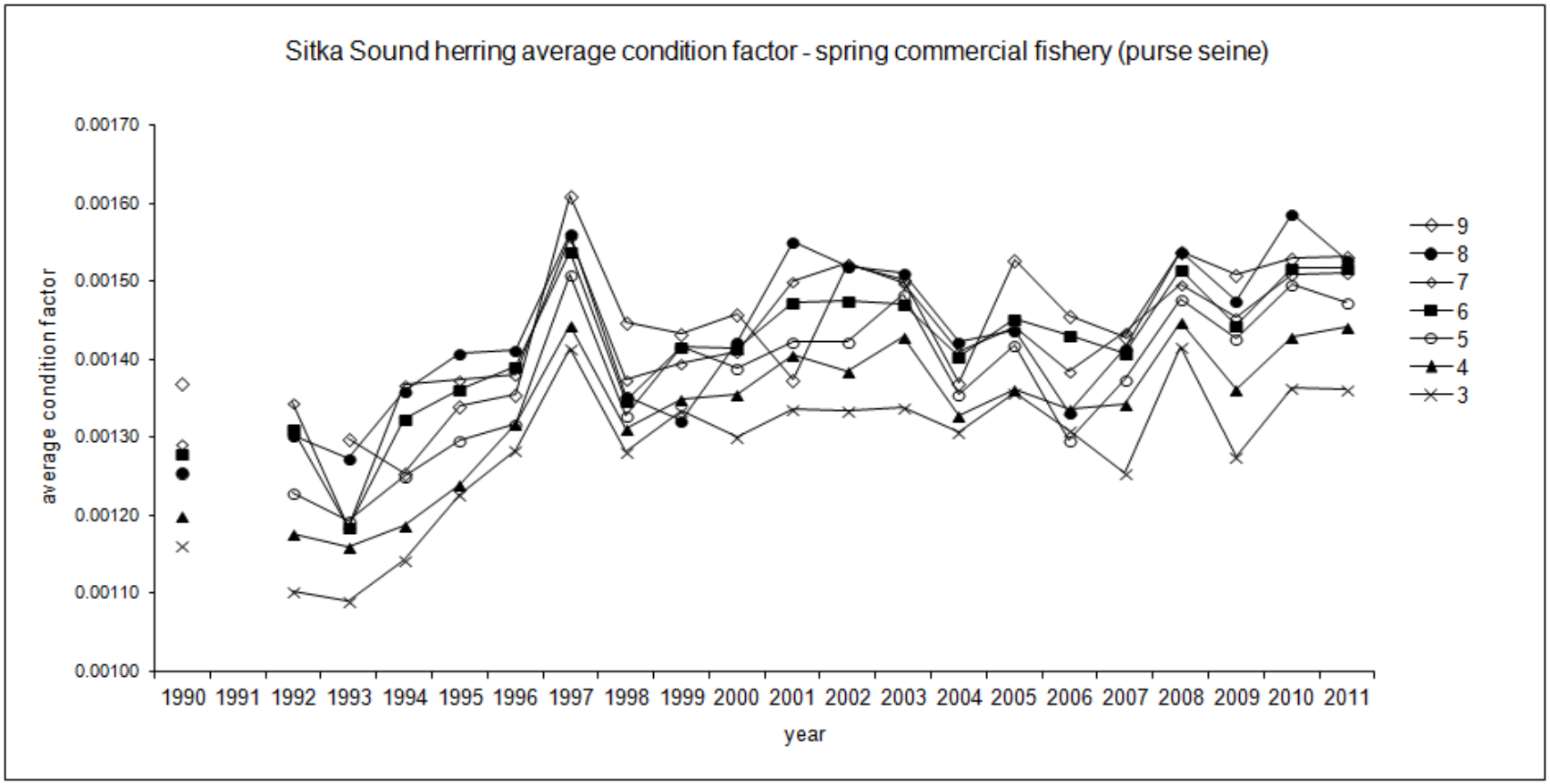



Figure 53.–Mean condition factors of age-3 through age-9 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning.

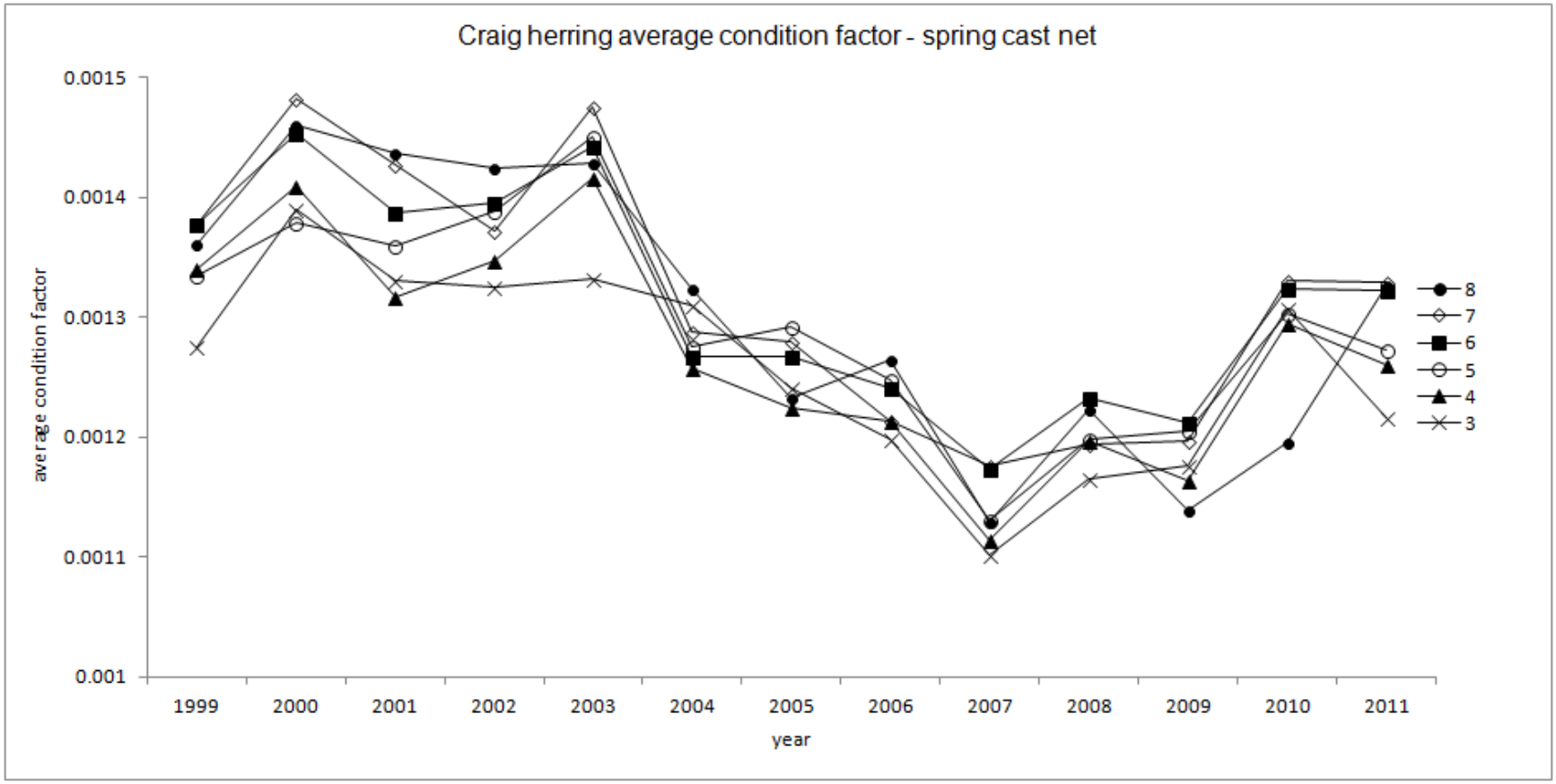



Figure 54.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

# APPENDICES

Appendix A1.–Key to vegetative substrate types used for herring spawn deposition survey.

| Code | Expanded code | Species included | Latin names |
|---|---|---|---|
| AGM | Agarum | Sieve kelp | *Agarum clathratum* |
| ALA | Alaria | Ribbon kelps | *Alaria marginata, A. nana, A. fistulosa* |
| ELG | Eel grass | Eel grass, surfgrasses | *Zostera marina, Phyllospadix serrulatus, P. scouleri* |
| FIL | Filamentous algae | Sea hair | *Enteromorpha intestinalis* |
| FIR | Fir kelp | Black pine, Oregon pine (red algae) | *Neorhodomela larix, N.oregona* |
| FUC | Fucus | Rockweed | *Fucus gardneri* |
| HIR | Hair kelp | Witch's hair, stringy acid kelp | *Desmarestia aculeata, D. viridis* |
| LAM | Laminaria | split kelp, sugar kelp, suction-cup kelp | *Laminaria bongardiana, L. saccharina, L. yezoensis (when isolated and identifiable)* |
| LBK | Large Brown Kelps | Five-ribbed kelp, three-ribbed kelp, split kelp, sugar kelp, sea spatula, sieve kelp, ribbon kelp | *Costaria costata, Cymathere triplicata, Laminaria spp., Pleurophycus gardneri, Agarum, Alaria spp.* |
| MAC | Macrocystis | Small perennial kelp | *Macrocystis sp.* |
| NER | Nereocystis | Bull kelp | *Nereocystis leutkeana* |
| RED | Red algae | All red leafy algae (red ribbons, red blades, red sea cabbage, Turkish washcloth) | *Palmaria mollis, P. hecatensis, P. callophylloides, Dilsea californica, Neodilsea borealis, Mastocarpus papillatus, Turnerella mertensiana* |
| ULV | Ulva | Sea lettuce | *Ulva fenestrata, Ulvaria obscura* |
| COR | Coralline algae | Coral seaweeds (red algae) | *Bossiella, Corallina, Serraticardia* |

Appendix B1.–Key to bottom types used for herring spawn deposition survey.

| Code | Expanded code | Definition |
|---|---|---|
| RCK | Bedrock | Various rocky substrates > 1 m in diameter |
| BLD | Boulder | Substrate between 25 cm and 1 m |
| CBL | Cobble | Substrate between 6 cm and 25 cm |
| GVL | Gravel | Substrate between 0.4 cm and 6 cm |
| SND | Sand | Clearly separate grains of < 0.4 cm |
| MUD | Mud | Soft, paste-like material |
| SIL | Silt | Fine organic dusting (very rarely used) |
| BAR | Barnacle | Area primarily covered with barnacles |
| SHL | Shell | Area primarily covered with whole or crushed shells |
| MUS | Mussels | Area primarily covered with mussels |
| WDY | Woody debris | Any submerged bark, logs, branches or root systems |

Appendix C1.–Aerial and skiff herring spawn surveys by date, near Craig (Ketchikan Management Area), Southeast Alaska in 2011.

3-18-11

No spawn seen. Sea lions and bird activity were seen near Alberto Islands, Entrance Point and the eastern shore of San Fernando Island. 12 herring pounds were seen in the herring pounding area.

3-25-11

An extensive skiff survey was completed today and no herring spawn was seen. The most active area was waters south of Cape Ildefonso where approximately 10 whales were working. No other activity was seen.

3-26-11

No active spawn was seen. A skiff survey was conducted that continued to see good concentrations of whales. 10 active herring pounds were seen on the grounds.

3-31-11

No Active spawn was seen. The Craig area showed significant change since the last survey was conducted. Numerous herring schools were seen around Fish Egg Island, the inside of the outer Alberto Islands and on the northwest shore of Wadleigh Island. Whales and sea lions were actively feeding on the schools. Large pods of sea lions were dispersed throughout the pounding area, Fish Egg Island and Abbess Island. Approximately 36 pounds are on the grounds.

4-1-11

Approximately **1.25 nautical miles of spawn** observed on the western shore of Fish Egg Island. Large schools of fish can be seen around Fish Egg Island. Herrings, Sea Lions, birds and Whales were seen around Fish Egg Island, the Alberto Islands, the western shore of Wadleigh Island, all around Abbess Island and in the northern waters of Shinaku Inlet. Over 15 whales and more than 525 sea lions were actively feeding on the schools of herring. Approximately 45 pounds are on the grounds.

Fisherman participating in the 2011 Craig/Klawock spawn-on-kelp herring pound fishery are advised to mobilize to the grounds as soon as possible.

4-2-11

Approximately **2 nautical miles of spawn** observed on the western shore of Fish Egg Island. Schools of fish, herring and whales can be seen around Fish Egg Island, the Alberto Islands, the western shore of Wadleigh Island and south of Abbess Island. Approximately 26 active pounds are on the grounds. Herring are in the pounding area and are being introduced into herring.

4-4-11

Approximately **4 nautical miles of spawn** was observed around Fish Egg Island. Schools of fish, herring and whales can be seen around Fish Egg Island and the Alberto Islands. Much of the sea lion and herring activity that was observed on Saturday has moved out of the pounding area. Approximately 26 active pounds are on the grounds.

-continued-

4-5-11

Approximately **8.6 nautical miles of spawn** was observed around Fish Egg Island, Clam Island, Klawock Reef, and the outer Alberto Islands. Schools of fish, herring and whales can be seen around Fish Egg Island and throughout the herring pounding area. Purse seine vessels were actively fishing and filling herring pounds. Approximately 26 active pounds are on the grounds. We now have approximately **9.1 nautical miles** of herring spawn in the Craig Area.

4-6-11

Approximately **5.5 nautical miles of spawn** was observed around Fish Egg Island, Clam Island, Klawock Reef, and the Alberto Islands. Schools of fish, herring and whales can be seen around Fish Egg Island and throughout the herring pounding area. Purse seine vessels were actively fishing and filling herring pounds. Approximately 26 active pounds are on the grounds. We now have approximately **15 nautical miles** of herring spawn in the Craig Area.

4-7-11

Approximately **1 nautical mile of spawn** was observed around Fish Egg Island and the Alberto Islands. All indications are that the major herring spawn is over. We now have approximately **15 nautical miles** of herring spawn in the Craig Area. The department plans on surveying the area one more day.

4-8-11

All indications are that the herring spawn is over in Craig. No more department aerial surveys are planned.

Appendix C2.–Aerial and skiff herring spawn surveys by date, in Revilla Channel (Ketchikan Management Area), Southeast Alaska in 2011.

3-18-11

No spawn seen with minimal sea lion and bird activity around Annette Island. A survey of Cat and Dog Islands and the Kah Shakes area was done. No herring or herring activity was seen in state waters.

3-22-11

No spawn was observed. Sea lion and bird activity seen around Annette Island. A survey of Cat and Dog Islands was done. No herring or sea mammal activity was seen in state waters.

3-25-11

No active spawn was seen. Sea lions were seen around Annette Island in small concentrations. A survey was completed of Cat Island, Mary Island and the Kah Shakes shoreline. No herring or herring activity was seen in states waters.

3-30-11

No active spawn was seen. Several schools of herring were seen on the beach on the northern side of Crab Bay, on Annette Island. Several pods of sea lions were seen on the south end of Ham Island and several more pods were seen on the south end near Annette Point. Spawning seems eminent. There was no herring or predator activity in state waters.

3-31-11

No active spawn was seen. The Annette Island gillnet flee was actively fishing and during the survey, six nets were in the water just north of Crab Bay. There was significant sea lion activity on the south side of Ham Island into Cascade Inlet, and down the Annette shoreline to Crab Bay. 10 sea lions were also seen at Annette Point. No herring or herring spawn was seen. There was no herring or predator activity seen in state waters.

4-1-11

No active spawn was seen. The Annette Island gillnet fleet was actively fishing during the survey and 12 nets were in the water just north of Crab Bay. There was significant sea lion activity on the south side of Ham Island into Cascade Inlet, and down the Annette shoreline to Crab Bay. Sea lions were also seen from Annette Point to Tamgass Harbor. No survey was conducted in state waters.

4-2-11

No active spawn was seen. The Annette Island gillnet fleet was actively fishing during the survey and 23 nets were in the water just north of Crab Bay. Most of the sea lion and fish activity was in from Cascade Inlet to Annette Point. No survey was conducted in state waters.

4-4-11

No active spawn was seen. The Annette Island gillnet fleet was actively fishing during the survey and 6 nets were in the water just north of Crab Bay. Most of the sea lion and fish activity was right around crab bay. No herring was seen in state waters.

-continued-

4-6-11

No active spawn was seen. The Annette Island gillnet fleet was actively fishing during the survey and 10 nets were in the water just north of Crab Bay. Most of the sea lion and fish activity was near or north of Crab Bay. No survey was conducted in State Waters.

4-8-11

No herring spawn seen. Sea lion activity was seen north of Crab Bay on Annette Island. No survey was done in state waters.

4-10-11

Weather conditions were overcast skies, moderate winds with occasional rain and snow squalls. A **small spawn** was seen on Annette Island near Point Davidson. Fish were also seen in the area. No herring or herring activity was seen in State waters.

4-11-11

An aerial survey was conducted today around Annette Island. Weather conditions were overcast skies, moderate winds with occasional rain and snow squalls. Approximately **1 mile of spawn** was seen on Annette Island near Point Davidson. No herring or herring activity was seen in State waters.

4-12-11

Approximately **1 mile of spawn** was seen on Annette Island near Point Davidson. No herring or herring activity was seen in State waters. Weather conditions were fog, clouds, heavy winds and rain.

4-13-11

Approximately **.5 mile of spawn** was seen on Annette Island near Point Davidson. No herring or herring activity was seen in State waters.

4-14-11

Approximately **.25 mile of spawn** was seen on Annette Island near Point Davidson. No herring or herring activity was seen in State waters.

4-15-11

Approximately **1.25 miles of spawn** was seen on Annette Island near Point Davidson and near Crab Bay. No herring or herring activity was seen in State waters.

-continued-

4-16-11

Approximately **2.5 miles of spawn** was seen on Annette Island near Crab Bay. Approximately **¼ mile of active herring spawn** was seen on the northeast shore of Mary Island. Due to the spawn drift observed in the area, it is estimated that more spawn had occurred previously in the area. Approximately **½ mile of active herring spawn** was seen just north of Kirk Point which is located south of Kah Shakes Cove. Due to the spawn drift in the area it is estimated that additional spawn had occurred in the area. The department will be conducting skiff surveys on these areas to document any missed spawn.

4-17-11

Approximately **3.0 miles of spawn** was seen on Annette Island near Crab Bay. No Spawn was seen in state waters.

4-18-11

Approximately **1.5 miles of spawn** was seen on Annette Island near Crab Bay. No Spawn was seen in state waters.

4-19-11

No spawn was seen on Annette Island or in state waters.

Total spawn around Annette Island and in state waters

Annette Is.–5.8 nautical miles of spawn.

Revilla Channel–0.4 nautical miles of spawn.

Appendix C3.–Aerial and skiff herring spawn surveys by date, in West Behm Canal (Ketchikan Management Area), Southeast Alaska in 2011.

3-18-11

Due to report of fish in the area a partial survey was done today. No active spawn was seen. Sea lions were seen at Vallenar Point, around Clover Island (located in Clover Pass), north of the Tatoosh Islands and on the western shore of Betton Island. The Cleveland Peninsula was not surveyed. Bird activity was at high levels from Survey Point along the western shore of Betton Island to the Tatoosh Islands.

3-22-11

No active spawn was seen. Sea lions were seen in fairly large concentrations in Tongass Narrows from the Seley Log Mill to Rosa Reef. Additional concentrations of sea lions were seen in Clover Pass around Clover Island. No survey was conducted on the Cleveland Peninsula.

3-25-11

No active spawn was seen. Sea lions were seen in fairly large concentrations in Tongass Narrows from Ward Cove to Survey Point. Small numbers of sea lions were seen around Tatoosh Islands and Caamano Point. I whale was seen in Tongass Narrows and one in Clover Pass.

3-27-11

No active spawn was seen. A total of 70 sea lions were seen in the West Behm Canal area. Two were just north of Totem Bight and 10 were just south of Pond Reef. A pod of 15 were seen near Survey Point. Scattered pods of sea lions and a whale were in between the north side of Pup Island and Clover Island, in Clover Passage. There were 20 sea lions on the Cleveland Peninsula shoreline with 12 of those outside the northern entrance to Bond Bay. Another whale was seen in between Guard Island and Betton Island.

3-30-11

No active spawn was seen. The survey showed a decrease in predator activity. 1 whale was observed in open water between the southern end of Betton Island and Guard Island. There was a pod of 8 sea lions seen on the north end of Pup Island. The state vessel Mediea is now scheduled to be in West Behm Canal on Saturday, April 2, 2011.

4-1-11

No active spawn was seen. Fish were seen along with whales along the eastern shore of Vallenar Bay. Sea lions were also seen from Totem Bight to Survey Point. Sea lion and bird activity has increased in the Tatoosh Island area. The state vessel Mediea is scheduled to be in West Behm Canal on Saturday morning, April 2, 2011. Department personnel will be conducting herring sonar work throughout West Behm Canal Saturday

-contiuned-

4-2-11

No active spawn was seen. Small schools of fish were seen in Tongass Narrow and Vallenar Bay. Overall, very little fish activity was observed. Department personnel conducted a complete sonar survey of the area and saw very little buildup of herring. Another sonar survey will be conducted on Monday, April 4.

4-4-11

No active spawn was seen. Schools of fish and sea lions were seen in Tongass Narrow, Clover Pass and Vallenar Bay. Fish activity has increased slightly. Department personnel conducted a partial sonar survey of the area and saw a small buildup of herring in Vallenar Bay and Clover Pass. Another sonar survey will be conducted when activity increases.

4-5-11

No active spawn was seen. Schools of fish and sea lions were seen in Tongass Narrows, Clover Pass and Vallenar Bay. Fish activity has continued to increase. The state vessel Medeia is in Ketchikan and will continue sonar surveys when activity increases.

4-6-11

No active spawn was seen. Schools of fish and sea lions were seen in Tongass Narrows, Clover Pass and Vallenar Bay. Fish activity continues to increase. The state vessel Medeia conducted a sonar survey today in Tongass Narrows, Clover Pass and Vallenar Bay. Schools of fish in small numbers were seen in Tongass Narrows, the mouth of Clover Pass and in Vallenar Bay.

4-7-11

There was a **small herring spawn** that most likely occurred the evening of Wednesday, April 6, 2011 south of Point Higgins. Herring have been observed leading the beach on Revilla Island from Pond Reef to Knudson Cove. Sea lions have also been seen throughout the area. Several schools of fish were sampled by department biologists with a large variation of results. Herring were also seen on the southwest shore of Betton Island. Some schools were 30-50 gram fish with a small percentage of ripe fish and other schools were 60-110 gram fish with a large proportion of ripe fish.

A **small spawn approximately 1/8** nautical mile was observed in Vallenar Bay which most likely occurred the evening of Wednesday April 6, 2011. No milt was observed, but eggs were documented on the beach. This spawn was light and is thought to be from the small schools of fish the department has been tracking the last few days in Vallenar Bay. Herring and sea lions are still in Vallenar Bay and around Vallenar Point.

4-8-11

The West Behm Canal sac roe herring fishery is now on notice that a fishery could occur with a 2 hour warning.

-continued-

Today's aerial and sonar surveys showed increased numbers of herring schools in Tongass Narrows, on Revilla Island from Pond Bay to Knudson Cove, and throughout Clover Passage. Based on samples taken yesterday and today, many of these fish are ripe and very close to spawning. One sample today taken by ADFG biologists in Clover Passage consisted of 22 fish that were ripe and averaged 66 grams. It is unclear how representative of the overall biomass this sample was.

A few schools were seen on Vallenar Bay along with 15 sea lions. Increased numbers of herring schools were seen along the west side of Betton Island and around the Tatoosh Islands. Today's surveys showed a large increase into areas open for commercial fishing.

4-9-11

The West Behm Canal sac roe herring fishery is now on notice that a fishery could occur with a 2 hour warning.

Today's skiff survey showed a **1/2 mile of spawn** in Clover Pass that is estimated to have occurred last night. Herring were seen in Tongass Narrows, on Revilla Island from Pond Reef to Knudson Cove, and throughout Clover Passage and the Tatoosh Islands. Today's surveys showed continued herring increases into areas open for commercial fishing. Very little activity was seen in on the Cleveland Peninsula and in Vallenar Bay.

4-10-11

The West Behm Canal sac roe herring fishery is now on notice that a fishery could occur with a 2 hour warning.

Today's aerial and sonar surveys showed approximately **6 miles of spawn** in Clover Passage along the Revilla Island shoreline from Clover Pass Resort to Moser Bay. Spawn was seen around Grant Island, Joe Island, Clover Island, Pup Island, and around several of the islands around Moser Bay. Large numbers of schools of herring were seen in Clover Pass on the Revilla Shoreline from Point Higgins to Salmon Falls Resort. Large numbers of schools were also seen around the Islands near Moser Bay and in Moser Bay.

All of the herring spawn and the majority of schools of herring were in waters closed for commercial fishing. Fish were seen around the northwest shore of Betton Island and around the Tatoosh Islands. Fish were seen near the beach on the northwest shore of Betton Island in only two areas, and were in very small concentrations. Very little activity was seen in on the Cleveland Peninsula and in Vallenar Bay.

4-11-11

The West Behm Canal sac roe herring fishery is now open as of 10:30 am.

Today's aerial and sonar surveys showed approximately **3 miles of spawn** in Clover Passage along the Revilla Island shoreline from Clover Pass Resort to Moser Bay. Spawn was seen around Grant Island, Joe Island, Clover Island, Pup Island, and around several of the islands around Moser Bay. Large numbers of schools of herring were seen throughout the spawning area and in the mouth of Clover Pass.

-continued-

Approximately **2 mile of spawn** was seen in Vallenar Bay and from South Vallenar Point to Grant Cove on the back side of Gravina Island. A **small spawn** was also seen on one of the Tatoosh Islands. Fish were also seen in Vallenar Bay and around the NW side of Betton Island. Very little activity was seen in on the Cleveland Peninsula and in Vallenar Bay.

4-12-11

Today's aerial survey showed approximately **.25 miles of spawn** in Clover Passage. Approximately **.5 miles of spawn** was seen in Vallenar Bay. A **small spawn** was also seen in Bond Bay on the Cleveland Peninsula.

4-13-11

Today's aerial survey showed approximately .**25 miles of spawn** in Vallenar Bay.

4-14-11

No activity was seen today. The West Behm Canal sac roe herring fishery is now closed.

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Sitka Sound (Sitka Management Area), Southeast Alaska in 2011.

**March 14: 08:40–10:20** Gordon/Case/Coonradt. Spotting conditions were generally good with northeast winds 15-25 knots and mostly cloudy. This extensive survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. No herring were seen. All areas to the south of Sitka were quiet with minimal bird and sea lion activity. North of Sitka there were 25 sea lions inside of Katlian Bay, 17 sea lions along the shoreline from Lisianski Point to Dog Point, 18 sea lions near Crosswise Island in Nakwasina Sound, 25 sea lions east of the Siginaka Islands, 10 sea lions off northern Big Gavanski Island, 10 sea lions in Eastern Bay, and 18 sea lions in Hayward Strait. Additionally, there were 6 whales off Halibut Point. In Salisbury Sound there were 110 sea lions and 6 whales scattered near the mouth of St John Baptist Bay.

**March 15:** No aerial survey was scheduled for today.

**March 16: 10:00–11:30** Coonradt/Jensen. Spotting conditions were generally good with overcast skies and northeast winds 5 knots. No herring were seen. Today's aerial survey covered all areas of Sitka Sound, south to Dorothy Narrows and north to Salisbury Sound. All areas to the south of Sitka were quiet with minimal bird and sea lion activity. North of Sitka there were 65 sea lions inside of Katlian Bay, 29 sea lions along the shoreline from Lisianski Point to Dog Point, 7 sea lions near Crosswise Island in Nakwasina Sound, 8 sea lions east of the Siginaka

Islands, 13 sea lions in Hayward Strait, 15 sea lions off Inner Point, and 18 sea lions east of Kasiana Island. Additionally, there were 2 whales off Halibut Point. In Salisbury Sound there were 90 sea lions and 6 whales scattered from Point Kakul to the mouth of St John Baptist Bay.

**March 18: 10:15–11:40** Gordon. Spotting conditions were excellent with clear skies and light winds. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof and Salisbury Sound. No herring were seen. South of Sitka a substantial number of birds were seen scattered throughout the Eastern Channel and Silver Bay areas. In Eastern Channel, 7 sea lions and 2 whales were seen between Whale Island and the Belknap Island and in Silver Bay, 10 sea lions were seen near Herring Cove. North of Sitka there were 42 sea lions inside of Katlian Bay, 46 sea lions along the shoreline from Lisianski Point to Dog Point, 30 sea lions near Crosswise Island in Nakwasina Sound, 6 sea lions east of the Siginaka Islands, 40 sea lions in Hayward Strait, and 6 sea lions south of Chaichei Islands. Additionally, there were 5 whales east of the Gavanski Islands one whale near Kresta Point and 6 killer whales south of Border Rocks. In Salisbury Sound only 7 sea lions were spotted during the survey east of the Kane Islands. Four whales and numerous scattered birds were seen in Salisbury Sound north of Scraggy Island.

**March 19: 15:15 –16:10** Gordon. Spotting conditions were good with clear skies and northeastw winds 10 knots. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. No herring or spawn was seen. South of Sitka a herring "mud stir" was seen at the entrance to Jamestown Bay along with 35 sea lions. Six sea lions were off Silver Point and 4 whales were seen in the vicinity of Long Island. North of Sitka there were 26 sea lions inside of Katlian Bay, 10 sea lions along the shoreline from Lisianski Point to Dog Point, 20 sea lions near Crosswise Island in Nakwasina Sound, 8 sea lions in Eastern Bay, and 30 sea lions were seen north of Guide Island. The most significant change today was the presence of 40 sea lions and one whale in the south side of Crow Pass where a herring "mud stir" was visible.

–continued-

Additionally, there were approximately 30 sea lions scattered around the Chaichei Islands. In the afternoon, two seine boats attempted to obtain test samples with one sample successfully obtained near the entrance of Jamestown Bay in Crescent Bay. The seine boat working the north side of town found the herring too deep to set on and no sample was obtained.

**March 20: 10:00–11:45** Gordon. Spotting conditions were good in all areas with the exception of Salisbury Sound where winds were northeast 25-30 knots. An extensive aerial survey was conducted covering all areas of Sitka Sound, south to West Crawfish Inlet, west to St. Lazaria Island and north to Salisbury. No herring or spawn was seen. Immediately south of Sitka there was little change from yesterday's survey with approximately 25 sea lions in the Crescent Bay area and birds widely scattered throughout the Eastern Channel area. Further to the south to West Crawfish Inlet, there were no notable concentrations of herring predators. North of Sitka there was no sea lions seen in Katlian Bay or Nakwasina Sound though 20 sea lions were seen from Lisianski Point to Dog Point and 2 whales were close to shore east of Crosswise Island. Approximately 40 sea lions were seen in Eastern Bay along with one whale. The highest concentration of sea lions was seen in the southern reaches of Crow Pass where approximately 100 sea lions were gathered as well as 4 whales. Another 50 sea lions were in scattered groups in the pass between the Chaichei and Parker Islands and 50 sea lions were in scattered groups in the pass between Kasiana Island and Middle Island. Five whales were seen between Old Sitka Rocks and Middle Island. In Salisbury Sound few sea lions were seen but 7 whales were seen north of Scraggy Island.

**March 21: 09:30–10:55** Gordon/Case/Coonradt. Spotting conditions were good with clear skies and light winds. Today's aerial survey covered Sitka Sound north of Cape Burunof and Salisbury Sound. No herring or spawn was seen. Immediately south of Sitka there were 15 sea lions in the Crescent Bay area and 32 sea lions between The Eckholms and Long Island. Two whales were also seen north of Long Island. North of Sitka there were 25 sea lions off Old Sitka Rocks, 15 sea lions on the east side of Middle Island, 4 sea lions at the entrance to Katlian Bay 25 sea lions off Lisianski Point Light, 10 sea lions off the east side of Crosswise Island, 10 sea lions east of the Siginaka Islands, 45 sea lions in the pass between the Chaichei Islands and the Parker Group, and 90 sea lions in southern Crow Pass. Widely scattered small groups of sea lions were seen in the northwest areas of Sitka Sound. There were 5 whales in the area near Old Sitka Rocks, one whale east of the Siginakas, and 2 whales were in Nakwasina Sound. In Salisbury Sound a total of 24 sea lions were seen scattered in the vicinity of St. John Baptist Bay.

**March 22: 09:50–10:55** Gordon. Spotting conditions were good with mostly cloudy skies and light winds. Today's aerial survey covered Sitka Sound north of Cape Burunof. No herring or spawn was seen. To the south of Sitka the largest concentration of sea lions was in Silver Bay between Herring Cove and Bear Cove where 46 were counted. Two whales were also seen near Herring Cove. In the Eastern Channel area, there were 25 sea lions to the north of Long Island as well as one whale. North of Sitka, the distribution of sea lions remains much the same as it was the past several surveys. The largest concentration of whales and sea lions was seen in the area of Old Sitka Rocks and surrounding shorelines. Sea lions also continue to be scattered along the shoreline from the mouth of Katlian Bay into Nakwasina Sound. There were fewer sea lions than seen yesterday in the vicinity of the Chaichei Islands and Parker Group and only a few sea lions remain in the Crow Pass area.

-continued-

Approximately 20 sea lions were seen in Hayward Strait. The next aerial survey is scheduled for Wednesday, March 23.

**March 23: 09:45–10:25** Coonradt/Case. Spotting conditions were good with mostly cloudy skies and light winds. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. No herring or spawn was seen. South of Sitka the largest concentration of sea lions was in Silver Bay south of Herring Cove where 100 sea lions were counted. Two whales were also seen south of Herring Cove. In the Eastern Channel area, there were 32 sea lions north of Long Island as well as one whale, and two whales were north of Silver Point. North of Sitka, the distribution of sea lions remains much the same as it has in the past several surveys. The largest concentration of whales and sea lions was seen in the area between Old Sitka Rocks and Middle Island, and was more concentrated than previous surveys. Sea lions also continue to be scattered along the shoreline in the mouth of Katlian Bay and Nakwasina Sound. Sea lions were also seen scattered in the vicinity of the Chaichei Islands, the Parker Island Group and around Kasiana Island. Approximately 20 sea lions were seen in Hayward Strait. In Salisbury Sound there were 20 sea lions and 7 whales scattered northwest of Marine Cove.

**March 24: 09:30–10:50** Gordon/Jensen. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. No herring or spawn was seen. To the south of Sitka the largest concentration of sea lions was in Silver Bay south of Herring Cove where 115 sea lions were counted. Two whales were also seen south of Herring Cove. Bird activity is widespread throughout Silver Bay. In the Eastern Channel area, there were 60 sea lions north of Long Island as well as two whales west of Long Island. Three whales were seen in the Samsing Cove area. North of Sitka, the distribution of herring predators remains much the same as it was during yesterday's survey, except that sea lions and whales were more concentrated to the south of Halibut Point, off the north shore of Kasiana Island and the southeast side of Middle Island. Smaller groups of sea lions continue to be found scattered among the islands to the south of Middle Island. Two whales were seen in south Crow Pass and one whale was seen west of the Siginaka Islands. Salisbury Sound was not surveyed today.

**March 25: 09:25–10:35** Gordon/Case. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. The aerial survey today showed the largest concentration of sea lions in Silver Bay (180) and in the islands south and west of Middle Island (270). Whales were widely scattered throughout Sitka Sound. No herring or spawn was seen.

**March 26: 09:45–10:45** Gordon/Coonradt. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. The aerial survey today showed a similar distribution of sea lions as has been seen during the past several days. Whales were widely scattered throughout Sitka Sound. Herring were seen on the surface in Eastern Anchorage, no herring spawn was seen.

**March 27: 15:45–16:35** Gordon/Davidson. Spotting conditions were good with mostly clear skies and light winds. A limited aerial survey was conducted late in the afternoon covering areas of north Sitka Sound and Eastern Channel.

-continued-

Several large schools were seen immediately to the west of north Crow Island, and herring were seen in shallower waters in a cove on the southern end of Middle Island. Whales continue to be broadly scattered around north Sitka Sound 4 in the Eastern Bay, 2 in Promisla Bay, 2 were west of Guide Island, 2 were east of the Gavanski Islands, 1 was off of Inner Point and 1 was on the north side of Kasiana Island. Sea lions were also broadly distributed around north Sitka Sound.

**March 28: 09:30 - 9:35** Gordon/Coonradt. Spotting conditions were good with mostly clear skies and light winds. . Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. Today's aerial survey showed a similar distribution of sea lions as has been seen during the past several days. Whales were widely scattered throughout Sitka Sound. Herring were seen on the surface in Thimbleberry Bay and Aleutkina Bay, no herring spawn was seen.

**March 29: 08:30 – 10:15** Gordon/Davidson. Spotting conditions were good with overcast skies and winds southeast 10-15 knots. Today's aerial survey covered Salisbury Sound and Sitka Sound north of Cape Burunof. Herring schools were seen immediately to the east of north Crow Island, in shallower waters in a cove on east of Middle Island south of the Sitka Airport Causeway, in Aleutkina Bay and in Thimbleberry Bay. Whales continue to be broadly scattered around Sitka Sound 5 in Salisbury Sound, 1 in Promisla Bay, 1 east of Fred's Creek, 2 were along the north and east Middle Island Shoreline, 1 west of Kayak Island and 1 north of Deep Inlet. Sea lions were also broadly distributed around north Sitka Sound.

**March 30: 08:00 – 08:45** Gordon/Coonradt. Today's aerial survey covered areas of Sitka Sound north of Cape Burunof. Because of the poor weather conditions and poor visibility the survey focused primarily on identifying if herring spawn was developing. No herring spawn was seen during the survey.

**March 31: 09:45 - 10:45** Gordon/Davidson. Spotting conditions were overcast skies and southerly winds 20-25 knots. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. No herring or spawn was seen. A high concentration of sea lions and whales were seen along the perimeter of the rocks and islands south of Middle and Kasiana Islands. A number of whales were also seen in this area as well as offshore in the middle of the Sitka Sound southeast of Inner Point. A seine boat surveyed the area north of Vitskari Rocks and reported a large biomass of herring in the area.

**April 1: 08:00 - 09:15** Gordon/Coonradt. Spotting conditions were overcast skies with a low ceiling and rain. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. No herring or spawn was seen. A high concentration of sea lions and whales were seen along the perimeter of the rocks and islands south of Middle and Kasiana Islands.

**April 2: 09:00 - 10:45** Gordon/Coonradt. Spotting conditions were good with overcast skies and winds southeast 10-15 knots. Today's aerial survey covered Salisbury Sound and Sitka Sound north of Windy Passage. No herring spawn was seen however herring schools were observed in Promisla Bay, South Crow Pass, Thimbleberry Bay and Aleutkina Bay. Whales continue to be broadly scattered around Sitka Sound; 8 in Salisbury Sound, 1 in Promisla Bay, 1 east of Fred's Creek, 4 were along the south and east Middle Island shoreline, 1 north of Makhnati Island, 2 west of Povorotni Point and 2 north of Deep Inlet. Sea lions were also broadly distributed around north Sitka Sound.

-continued-

**April 3: 08:15 - 09:45** Gordon. Spotting conditions were overcast skies with southeast winds 20 knots. Today's aerial survey covered all areas of Sitka Sound north of Cape Burunof. During today's aerial survey there was **0.02 nautical miles of spawn** along the Crescent Harbor breakwater near Sheldon Jackson Hatchery. Whales and sea lions continue to be broadly distributed around Sitka Sound.

**April 4: 08:00 - 09:20** Gordon/Davidson. Spotting conditions were overcast skies with snow squalls, and southeast winds 15-20 knots. Today's aerial survey covered all areas of Sitka Sound north of Frosty Reef. During today's aerial survey there was **0.13 nautical miles of spawn** along the Crescent Harbor breakwater near Sheldon Jackson Hatchery. Herring Schools were observed inside the Sitka Harbor breakwater to the north. Large concentrations of sea lions continued to be staged on the outer rocks and islands to the south of Middle and Kasiana Islands. Whales have been observed in greater numbers in the southern areas of Sitka Sound as well.

**April 5: 08:30 - 09:40** Gordon/Coonradt. Spotting conditions were good with partly cloudy skies and calm winds. Today's aerial survey covered Sitka Sound north of Windy Passage. During today's aerial survey there were **2.8 nautical miles of spawn** along the Crescent Harbor breakwater and Totem Park Beach, and in Salisbury Sound. Herring schools were observed in Eastern Anchorage, Jamestown Bay, Thimbleberry Bay and inside the Sitka Harbor Breakwater north of town. Whales continue to be broadly scattered around Sitka Sound; 2 in Promisla Bay, and 5 were along east Middle Island shoreline. Sea lions were also broadly distributed around Sitka Sound.

**April 6: 08:05-09:50** Coonradt. Spotting conditions were good with clear skies and calm winds. Today's aerial survey covered Salisbury Sound and Sitka Sound north of Windy Passage. During today's aerial survey there were **3.8 nautical miles of active spawn** in Crescent Bay and in Salisbury Sound. Herring schools were observed in Sukoi Inlet, Entry Point and Windy Passage. Whales continue to be broadly scattered around Sitka Sound; 5 in Salisbury Sound, 2 south of the Siginaka Islands, 1 in Starrigavan Bay, 1 off Halibut Point, 1 west of Makhnati Island, 1 west of Kasiana Island, and 6 in the islands around Galanikin Island. Sea lions were also broadly distributed around south Sitka Sound.

**April 7: 08:00-09:50** Gordon/Davidson. Spotting conditions were good with overcast skies and light winds. Today's aerial survey covered Salisbury Sound and Sitka Sound north of Windy Passage. During today's aerial survey there were **7.2 nautical miles (nm) of active spawn;** 4.7 nm in Salisbury Sound and 2.5 nm in the Crescent Bay area. Herring schools were observed in Sukoi Inlet, in the bays of south Middle Island, south of Kasiana Island, along Low Island, in Thimbleberry Bay, in Aleutkina Bay and in the islands around Galanikin Island and Windy Passage. Whales and Sea Lions continue to be broadly scattered around Sitka Sound but appear more heavily concentrated in south Sitka Sound.

-continued-

**April 8: 08:40–10:30** Kelley/Coonradt. Spotting conditions were good with overcast skies and winds southeast 30 knots. Today's aerial survey covered Salisbury Sound and Sitka Sound north of Windy Passage. During today's aerial survey there were **6.6 nautical miles of active spawn** in Crescent Bay/Eastern Anchorage and in Salisbury Sound. Herring schools were observed around Low Island, in Aleutkina Bay and in Windy Passage. Whales and Sea Lions continue to be broadly scattered around Sitka Sound but appear more heavily concentrated in south Sitka Sound.

**April 9: 08:05–09:45** Gordon/Coonradt. Spotting conditions were poor; overcast skies with snow and hail, and winds southwest 15-25 knots. Today's aerial survey covered Salisbury Sound and Sitka Sound north of Crawfish inlet. During today's aerial survey there were **9.7 nautical miles of active spawn** in Crescent Bay/Eastern Anchorage, in the Channel and in Salisbury Sound. No herring schools were observed. Whales and Sea Lions continue to be broadly scattered around Sitka Sound but appear more heavily concentrated in south Sitka Sound.

**April 10: 08:45–9:30 & 14:00–15:00** Gordon. Spotting conditions were poor with overcast skies and snow, and winds southeast 15 knots. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. Today there was **8.6 nm of active spawn**; 7.9 nm in Sitka Sound and 0.7 nm in the Goddard area.

**April 11:** 1**2:00–13:15** Gordon. Spotting conditions were poor with overcast skies, snow and winds southeast 15 knots. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. Total **active spawn was 15.7 nm** with 11.6 nm in Sitka Sound proper, 3.3 nm in the Goddard area, and 0.8 nm in the Salisbury Sound area. Today spawn continued to be quite heavy in the Jamestown to Thimbleberry Bay area. New spawn on Kasiana Island and spawning has expanded on the Apple Island Group. A little spawn starting on SW Middle Island and spawn on outer Gagarin Island. Spawn expanding along Halibut Point Road shoreline to the north. Spawn expanded in Dorothy Narrows but not real heavy. Some spawn continuing in Salisbury Sound.

**April 12:** 1**0:15–11:30** Gordon/Coonradt/Case. Spotting conditions were good with overcast skies and winds southeast 15 knots. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. A total of **28.4 nm of active spawn** was mapped today; 22.6 nm in the Sitka vicinity, 4.9 nm in the Goddard area, and 0.9 nm in the Salisbury Sound area

**April 13: 08:50–10:20** Gordon/Coonradt/Jensen. Spotting conditions were good with mostly cloudy skies and light winds. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. A total of **37.7 nm of active spawn** was mapped today; 30.5 nm in the Sitka vicinity, 4.5 nm in the Goddard area, and 2.7 nm in the Salisbury Sound area

**April 14:** 9**:35–10:50** Gordon/Coonradt/Case. Spotting conditions were good with mostly clear skies and winds east 15 knots. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. A total of **23.1 nm of active spawn** was mapped today; 20.4 nm in the Sitka vicinity, 1.9 nm in the Goddard area, and 0.8 nm in the Salisbury Sound area.

-continued-

**April 15: 08:35–9:15** Gordon/Coonradt/Jensen. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Hoonah Sound. A total of **16.0 nm of active spawn** was mapped today; 12.2 nm in the Sitka vicinity, 3.3 nm in the Goddard area, and 0.5 nm in the Salisbury Sound area.

**April 16: 08:30–9:30** Gordon/Coonradt. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. A total of **15.5 nm of active spawn** was mapped today; 8.3 nm in the Sitka vicinity, 5.5 nm in the Goddard area, and 1.7 nm in the Salisbury Sound area

**April 17: 08:35–9:45** Gordon/Hebert. Spotting conditions were good with partly cloudy skies and light winds. Today's aerial survey covered all areas of Sitka Sound, south to West Crawfish Inlet **and north to Hoonah Sound**. A total of **5.8 nm of active spawn** was mapped today; 0.7 nm in the Sitka vicinity, 3.3 nm in the Goddard area, and 0.8 nm in the Salisbury Sound area.

**April 18: 10:30–11:35** Case. Spotting conditions were overcast skies with variable winds. Today's aerial survey covered all areas of Salisbury Sound and Sitka Sound, south to West Crawfish Inlet. A total of **0.7 nm of active spawn** was mapped today on Kruzof Island north of Inner Point.

**April 19: 10:40–12:15** Case. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Salisbury Sound and Sitka Sound, south to Makhnati Island and north to Hoonah Sound. **No active spawn** was observed on today's flight. A total of **1.2 nm of spawn** was mapped today by skiff all of which was in the Sitka vicinity.

**April 20: 08:30–10:00** Case. Spotting conditions were poor with mostly cloudy skies with areas of fog, and light winds. Today's aerial survey covered all areas of Salisbury Sound and Sitka Sound, south to Makhnati Island and north to Hoonah Sound. **No active spawn** was observed on today's flight of Sitka Sound.

Appendix C5.–Aerial and skiff herring spawn surveys by date, in Hoonah Sound (Sitka Management Area), Southeast Alaska in 2011.

**April 19: 10:40–12:15** Case. Spotting conditions were good with mostly clear skies and light winds. Today's aerial survey covered all areas of Salisbury Sound and Sitka Sound, south to Makhnati Island and north to Hoonah Sound. **No active spawn** was observed on today's flight. A total of **1.2 nm of spawn** was mapped today by skiff all of which was in the Sitka vicinity.

**April 20: 08:30–10:00** Case. Spotting conditions were poor with mostly cloudy skies with areas of fog, and light winds. Today's aerial survey covered all areas of Salisbury Sound and Sitka Sound, south to Makhnati Island and north to Hoonah Sound. **No active spawn** was observed on today's flight of Sitka Sound.

**April 21: 08:30–09:30** Case/Davidson. Spotting conditions were mostly cloudy skies and light winds. Today's aerial survey covered only Hoonah Sound. There were **3.1 nm of spawn** on the south and southwest side of Emmons Island and on the adjacent shoreline on Chichagof Island. There was also spawn surrounding the reef between Emmons Island and the Vixen Islands. There was 1 whale in the mouth of Poison Cove, 1 whale south of Hoggatt Reef, 3 whales off Ushk Point, and 1 whale off Ford Rock. There were 50 sea lions off Emmons Point, 40 sea lions scattered along the south side of Emmons Island, 20 sea lions on the north side of Emmons Island, and 60 sea lions and 1 whale on the north side of the Vixen Islands. There were two whales in the mouth of Patterson Bay, 20 sea lions in the mouth of Fick Cove, and 1 whale and 5 sea lions just outside of Fick Cove.

**April 22: 08:30–09:30** Case. Spotting conditions were mostly cloudy skies and light winds. Today's aerial survey covered only Hoonah Sound. There were **5.8 nm of spawn** on the south side of Vixen Islands, on Emmons Island and on the adjacent shoreline on Chichagof Island. There was 1 whale south of Hoggatt Reef, and 1 whale off Ford Rock. There were 80 sea lions off of Emmons Point, 60 sea lions scattered south of Rodgers Point, 60 sea lions in the mouth of Fick Cove and 30 sea lions on the north side of the Vixen Islands.

**April 23: 10:00–11:00** Coonradt/Gordon. Spotting conditions were mostly clear skies and light winds. Today's aerial survey covered only Hoonah Sound and Lisianski Inlet. No herring or herring spawn was observed in Lisianski Inlet. In Hoonah Sound There were **4.2 nm of spawn** on the south and southwest side of Emmons Island and on the adjacent shoreline on Chichagof Island.

**April 24: 08:15–09:00** Coonradt/Gordon. Spotting conditions were mostly cloudy skies and light winds. Today's aerial survey covered only Hoonah Sound. There were **0.7 nm of spawn** on the east side of Emmons Island and on the Rodgers Point. Large concentrations of sea lions continue to be found south of Emmons Island, south of Finger River, and the north side of the Vixen Islands.

**April 25: 08:30–08:55** Coonradt/Gordon. Spotting conditions were mostly cloudy skies and light winds. Today's aerial survey covered only Hoonah Sound. There was **no active spawn** mapped in Hoonah Sound today. Large concentrations of sea lions continue to be found south of Emmons Island, south of Finger River, and the north side of the Vixen Islands.

**April 30:** Gordon. A private pilot reported spawn in Hoonah Sound. A subsequent flight of the area mapped **1.6 nm of active spawn** on the Chichigof Island shore south of Finger River and south of Fick Cove.

**May 5:** Prior to the spawn deposition survey in Hoonah Sound, ADF&G divers mapped **1.9 additional miles** of shoreline that received spawn.

Appendix C6.–Aerial and skiff herring spawn surveys by date, at Bradfield Canal, Ernest Sound, Ship Island, Zimovia Strait and Eastern Passage, and Bear Creek, within Petersburg-Wrangell Management Area in Southeast Alaska, 2011.

Bradfield Canal

4/4 No spawn or herring observed. 91 Sea Lions; 170 Gulls; 300 Scoters.

4/6 No active spawn; 20 Sea Lions; skiff.

4/7 ~2.0 nm of active spawn, ~3.0 nm of egg deposition; 30 Sea Lions; skiff.

4/8 ~4.0 nm of active spawn; 30 Sea lions; 150 Gulls; 100 Scoters; skiff.

4/11 No active spawn or herring observed; 44 Sea lions; 1,500 Gulls; 2,200 Scoters.

4/17 Skiff survey for egg deposition; mapped approximately 7.0 nm of eggs on beach.

Ernest Sound (including Vixen Inlet/ Union Bay/Emerald Bay)

4/4 No herring activity or predators observed.

4/8 No herring activity, 39 sea lions, 1 whale.

4/11 No herring activity, 26 sea lions, 1 whale.

4/13 **Two spot spawns** reported by industry pilot.

4/14 No herring activity, 48 sea lions, 3 whales.

4/15 No herring activity, 75 seas lions, 2 whales.

4/17 **~0.5 nm of active spawn**, three schools of herring, 39 sea lions, 1 whale.

4/18 **~2.1 nm of active spawn**, 85 sea lions.

4/19 **~1.25 nm of active spawn**. two schools of herring,70 sea lions.

4/20 No herring activity, 5 sea lions.

4/21 No herring activity, 15 sea lions.

4/22 No herring activity, 9 sea lions.

Ernest Sound (Onslow/Stone/Brownson Island/Canoe Pass)

4/11 No active spawn or herring observed; 1 Whale; 50 Gulls.

4/14 No active spawn or herring observed; 125 Gulls.

4/17 No active spawn, herring, or predators observed.

Ship Island

4-9-10:

No active spawn, herring, or predators observed.

4-12-10:

No active spawn or herring observed; 2 Sea Lions; 1 Whale.

-continued-

4-15-10:

No active spawn or herring observed; 7 Sea Lions.

4-16-10:

No active spawn, herring, or predators observed.

4-17-10:

No active spawn or herring observed; 4 Sea Lions.

Zimovia St. and Eastern Passage

4/4 No active spawn or herring observed; 4,000 Scoters; Eulachon spawn on the flats.

4/8 No active spawn or herring; 1,000 Gulls, 300 Scoters; Eulachon spawn on the flats .

4/11 ~.25 nm active spawn; 2 Sea Lion; 700 Gulls; 1,000 Scoters.

4/19 No active spawn or herring observed; 750 Gulls; 3,400 Scoters.

Farragut Bay

4/18 No active spawn; two schools; 9 Sea Lions.

4/21 No active spawn; two schools; 25 Sea Lions.

4/25 No active spawn; several schools near beach; 14 Sea Lions.

4/27 No active spawn; several schools near beach; 11 Sea Lions.

4/28 No active spawn; several schools near beach; 17 Sea Lions.

4/29 No active spawn; several schools near beach; 38 Sea Lions.

4/30 No active spawn; several schools near beach; 18 Sea Lions; 1 Whale.

5/1 No active spawn; several schools near beach; 8 Sea Lions.

5/2 No active spawn; several schools near beach; 27 Sea Lions.

5/3 No active spawn; several schools near beach; 27 Sea Lions.

5/5 ~0.3 nm of active spawn; several schools near beach; 9 Sea Lions.

Hobart Bay/Port Houghton (Hobart Bay only)

4/18 No active spawn or herring observed; 41 Sea Lions; 3 Whales.

4/21 No active spawn or herring observed; 53 Sea Lions; 1 Whales.

4/25 No active spawn or herring observed; 56 Sea Lions; 1 Whales; 300 Scoters.

4/27 No active spawn, schools seen near beach; 40 Sea Lions; 1 Whale.

4/28 No active spawn, schools seen near beach; 54 Sea Lions;

4/29 No active spawn, schools seen near beach; 81 Sea Lions; 300 Scoters.

4/30 ~0.8 nm active spawn; 60 Sea Lions; 4 Whales.

-continued-

5/1 ~3.5 nm active spawn; 71 Sea Lions

5/2 No active spawn or herring observed; 15 Sea Lions; 1 Whale; 600 Gulls; 500 Scoters.

5/3 No active spawn or herring observed; 10 Sea Lions; 1,300 Gulls, 5,000 Scoters.

5/5 No active spawn or herring observed; 15 Sea Lions; 600 Gulls, 5,200 Scoters.

Hobart Bay/Port Houghton (Port Houghton)

4/18 No active spawn or herring observed; 200 Scoters.

4/21 No active spawn or herring observed; 40 Gulls.

4/25 No active spawn or herring observed; 1 Sea Lion.

4/27 No active spawn, 1 School of herring; 2 Sea Lions.

4/28 No active spawn, 2 Schools of herring; 4 Sea Lions.

4/29 No active spawn, 2 Schools of herring.

4/30 No active spawn, 4 Schools of herring; 4 Sea Lions.

5/1 No active spawn, 2 Schools of herring near beach; 1 Sea Lion.

5/2 No active spawn, 2 Schools of herring near beach; 8 Sea Lions.

5/3 No active spawn, 2 Schools of herring near beach; 7 Sea Lions.

5/5 No active spawn, herring, or predators observed.

Hobart Bay/Port Houghton (Sunset Cove/Windham Bay)

4/18 No active spawn or herring observed; 10 Sea Lions.

4/21 No active spawn or herring observed; 20 Sea Lions.

4/25 No active spawn or herring observed; 10 Sea Lions.

4/27 No active spawn or herring observed; 8 Sea Lions.

4/28 No active spawn or herring observed; 10 Sea Lions; 1 Whale.

4/29 No active spawn or herring observed; 19 Sea Lions.

4/30 No active spawn or herring observed; 10 Sea Lions.

5/1 No active spawn or herring observed; 2 Sea Lions.

5/2 No active spawn or herring observed; 20 Sea Lions.

5/3 No active spawn, herring, or predators observed.

5/5 No active spawn or herring observed; 10 Sea Lions, 1 Whale.

Gambier Bay

4/27 No active spawn; Multiple small schools near beach (Pybus); 3 Whale.

Port Camden

Not surveyed in 2011.

Appendix C7.–Aerial and skiff herring spawn surveys by date, in Seymour Canal (Juneau Management Area), in Southeast Alaska, 2011.

4/15 No herring or herring spawn and low numbers of predators were observed scattered throughout the area. 44 sea lions observed and very few birds.

4/18 No herring or herring spawn observed. Predator numbers have increased and are generally scattered. 113 sea lions and 6 humpback whales were observed. No significant bird activity.

4/20 No herring or spawn observed. 143 sea lions and 3 whales observed. Some of the predator activity was observed near Gambier Point.

4/22 No herring or spawn observed. 130 sea lions and 6 whales observed, with most activity near Pt Hugh.

4/25 Several medium sized school on Stephens shore north of Pt Hugh with a **0.15 nm spot spawn** south of Cloverleaf Rocks. 210 sea lions and 8 whales observed in the area.

4/26 0630. Many large schools of fish (≈three miles) along the Stephens shore from Pt Hugh to Pt Hugh light. A **0.11 nm intense short spawn** observed at the Dogleg. 209 sea lions and 5 whales observed.

4/26 1715. Several large schools of herring from Pt Hugh to Pt Hugh light. **Spot spawn** observed at the Dogleg dissipating. 128 sea lions and 5 whales observed

4/27 0930. Many schools along Stephens shore from Pt Hugh to Pt Hugh light. No spawn observed, 160 sea lions and 5 whales observed. Quiet along the Big Bend shoreline.

4/27 1130. Petersburg AMB survey. Schools as mentioned above, with a **spot spawn** north of Pt Hugh Light. 111 sea lions and 2 whales observed.

4/27 1400. Fewer schools than earlier in the day, but **spot spawn** at Cloverleaf Rocks. 124 sea lions and 7 whales observed along Stephens shore of lower Glass Peninsula.

4/28 Schools observed near Cloverleaf Rocks and just NW of Pt Hugh. A **small 0.14 nm active spawn** N of Pt Hugh light was observed. 35 sea lions and 10 whales observed.

4/29 Several small schools on Stephens side near Twin Islands. Large schools along shore from Pt Hugh light to south of Cloverleaf rocks, and a large school on west Pt Hugh was observed. 160 sea lions and 8 whales observed. No herring or spawn observed along Big Bend shore.

4/30 Large schools observed along Stephens shore from Pt Hugh to Pt Hugh Light. 180 sea lions and 5 whales observed.

5/1 Diminished schools along the Pt Hugh to Pt Hugh light shore, several schools north of the Dogleg on the Stephens shore, and several schools between the Swimming Pool and the D10/D11 Boundary. 161 sea lions and 3 whales observed.

5/2 Numerous schools on both sides of Glass Peninsula south of Sorethumb Cove. With a large biomass spread along shore from D10/D11 Boundary to Pt Hugh. **One small 0.11 nm, but very active intense spawn** at Point Hugh. Many sea lions and whales present.

-continued-

5/3 0730 Scattered schools of herring observed from Pt Hugh Light to just north of Pt Hugh on the Seymour side. **Two spots of active spawn** north of Pt Hugh Light, and a 0.4 nm active spawn observed at Pt Hugh. Several groups of sea lions and 3 whales observed throughout core area, with large raft of 50+ animals at Pt Hugh. Planned to use skiff anchored in Pleasant Bay to obtain samples, but tide too low to access skiff.

5/3 1245 Increased S wind, both spawns from the previous survey dissipating, did not attempt samples. Large schools on beach between Pt Hugh Light and Cloverleaf Rocks.

5/4 Large schools on shore near Cloverleaf Rocks. Concentration of predators at Pt Hugh otherwise quiet. Landed in Pleasant Bay and relocated skiff, which had drug in recent wind.

5/5 0920 **Active spawn** in Cloverleaf Rock and Blackjack Cove areas. Whales and sealions concentrated at Pt Hugh.

5/5 1105 Spawn expanding in both areas. Were dropped off at skiff and obtained spawn samples.

5/5 1600 Spawn dissipating in Cloverleaf Rocks and Blackjack Cove, but developing by Swimming Pool and to the north. Whales shifted northwards as well. Total of **2.3 nm active spawn** documented today.

5/6 0845 **Spawn observed** north of the Dogleg, Pt Hugh Light, and for **1.8 nm** north and south of Cloverleaf Rocks, and from Twin Islands to halfway between Blackjack and Pt Hugh.

5/6 1050 Spawn along Stephens shore and S of Blackjack dissipating, expanding to the north of Twin Islands. Obtained samples, ran skiff back to Juneau. Total of **8.2 nm active spawn** documented today.

5/7 Spawn observed to the north of the Dogleg, and just N of Pt Hugh on Stephens shore, dissipating north of Twin Islands, and active spawn observed just south and in Sorethumb Cove. Total of **2.5 nm active spawn** documented today.

5/8 Small spots of active spawn observed along the Stephens shore opposite Twin Islands, and an **active spot** at Midway Point. No spawn observed in Seymour Canal, predators in vicinity of Short Finger Bay. Total of **0.8 nm active spawn** documented today.

5/9 No herring or herring spawn observed. Large rafts of thousands of scoters near Cloverleaf Rocks and Blackjack Cove. Seymour spawn map dropped off to RV Kestrel in Hobart Bay. Final survey of Seymour Canal.

Appendix C8.–Aerial and skiff herring spawn surveys by date, in Tenakee Inlet (Juneau Management Area), in Southeast Alaska, 2011.

4/15 No herring or spawn observed and few predators. Few sea lions and one whale observed in Tenakee Inlet. No significant bird activity was noted in the area.

4/18 No herring or spawn observed. 35 sea lions and 4 whales observed in Tenakee Inlet, and 14 sea lions observed along the Chatham shore to Basket Bay. No significant bird activity was noted in the area.

4/20 No herring or spawn observed. 50 sea lions and 6 whales observed in Tenakee Inlet, 17 sea lions and 2 whales along Chatham shore between Dons Creek and Basket Bay.

4/22 No herring or spawn observed. 62 sea lions and 23 whales observed in Tenakee Inlet, 20 sea lions and 2 whales along Chatham shore between S Passage Point and White Rock.

4/25 No herring or spawn observed. 10 sea lions observed in Tenakee Inlet, 60 sea lions and 13 whales along Chatham shore between S Passage Pt and Basket Bay. Half of these sea lions and 12 whales were active near Basket Bay.

4/27 No herring or spawn observed. 10 sea lions and 2 whales in Tenakee Inlet, 27 sealions and 2 whales along the Chatham shore between Dons Creek and White Rock.

4/29 Two small schools of herring, one near Crab Bay and the other near Corner Point observed in Tenakee Inlet. Few sea lions and 2 whales observed. 20 sea lions observed scattered along the Chatham shore between S Passage Pt and basket Bay.

5/1 No herring or spawn observed. 19 sea lions and 6 whales observed in Tenakee Inlet – all whales together off Kadashan flats. 31 sea lions scattered along the Chatham shore between S Passage Pt and White Rock.

5/4 No herring or spawn observed. 2 whales and 4 sea lions off Kadashan flats and 8 sea lions in Finn Cove. 5 sealions observed from S Pasage Point to Point Hayes.

5/6 No herring or spawn observed. 1 whale off Kadashan, 5 sea lions off Corner Pt, and 20 sea lions observed west of S Passage Pt. 2 sea lions observed south of Little Basket Bay on Chatham shore.

5/9 Schools of herring observed west of Crab Bay LTF and in western pounding area. **Active spawn observed** on both sides of LTF, along reef on west of pounding area and either side of Kadashan flats, totaling **1.0 nm**. 10 sea lions observed between Strawberry Island and Corner Bay, and a raft of 25 at Corner Point. Chatham shore dead quiet.

5/10 Abbreviated survey, Saltery to Corner Bay, dropped off in Tenakee Springs then conducted a more extensive skiff survey. No herring or spawn observed. Picked up in Tenakee and returned to Juneau.

5/11 No herring or spawn observed. Small scattered groups of sea lions observed throughout the area. Two whales swimming along shore just south of Basket Bay.

5/13 No herring or herring spawn was observed. Predators are few in numbers and generally scattered. This is the final scheduled survey for Tenakee Inlet.

5/16 No herring or herring spawn was observed. Final final survey. Ran Tuffboat back to Auke Bay.

Appendix C9.–Aerial and skiff herring spawn surveys by date, in Lynn Canal (Juneau Management Area), in Southeast Alaska, 2011.

4/15 No herring or spawn observed. The only sea lions observed outside of Berners Bay were hauled out on Benjamin Island. Inside Berners Bay a raft of 25 sea lions was seen in deeper water near the Berners tide flats. There were 100+ gulls on the flats but these birds were not active. At this time it does not appear that eulachon have moved into freshwater. 2 whales were observed.

4/20 No herring or spawn observed. Very little predator activity observed in Lynn Canal, 53 sea lions and 2 whales observed in Berners Bay. 50 sea lions hauled out at at Benjamin Is.

4/25 One small school of herring observed at the mouth of Echo Cove, and no herring spawn observed. No sea lions in Lynn Canal, 2 whales near Mabb Island. 35 sea lions and 3 whales observed in Berners Bay. Around 40 sea lions hauled out at Benjamin Is.

4/27 Schools of herring observed in mouth of Echo Cove, Bridget Cove, Sunshine Cove, Yankee Cove, Tee Harbor, Indian Cove and Outer Point. 7 sea lions observed in Lynn Canal and 20 sea lions in Berners Bay. Eulachon observed in the lower reaches of the Berners, Lace and Antler Rivers.

4/29 No herring or spawn observed in Lynn Canal. Light spawn observed on eastern shore of Berners Bay north of Sawmill Creek **totaling 0.7 nm**. No sea lions observed anywhere and one whale in Berners Bay. Eulachon observed in the lower reaches of the Berners, Lace and Antler Rivers.

4/30 Small school of herring observed near Lena Point. Several areas of spawn along eastern shore of Berners Bay north of Sawmill Creek **totaling 0.6 nm**. Very few sea lions and 1 whale observed.

5/1 Several small schools of herring observed in Berners Bay, and a **small 0.08 nm light spawn** near Cascade Point. Lynn Canal was very quiet, and 16 sea lions and 1 whale observed in Berners Bay. Fewer eulachon observed in the rivers. 20 sea lions hauled out at Benjamin Is.

5/2 One small school of herring observed near Sawmill Creek and a large school on shore near Pt Bridget. No sea lions and 1 whale observed in Berners Bay, and one whale near Sunshine Cove.

5/4 No herring, spawn, or predators observed in Lynn Canal. Two Schools near mouth of Echo Cove and the remnants of a light spawn observed on the NE shore of Berners Bay. One whale observed at Pt Bridget.

5/6 Possible spot spawn observed in Indian Cove, and school on the beach just south of Bridget Cove. Possible light spawn on NE shore of Berners Bay near USFS cabin.

5/7 Surveyed from Pt Louisa to Auke Bay. No herring or spawn observed.

5/8 One school of herring observed by Tee Harbor off Pt Stephens, and three schools at the mouth of Echo Cove in Berners Bay. One whale observed by Mabb Island, and 7 sea lions in Berners Bay. Approximately 40 sea lions hauled out at Benjamin Island. Fresh spots of oil observed off Lena Point.

-continued-

5/9 Two small schools at E Pt St Mary, and no spawn or predators observed in Berners Bay. Several schools of herring observed in Bridget Cove and no predators north of Eagle River. Several schools of herring observed in N Tee Harbor, one in Lena Cove and several throughout

Auke Bay. A few scattered sea lions south of Eagle River and 2 whales near Lena Point.

5/11 No herring or spawn observed in Berners Bay. 4 widely scattered sea lions and two whales observed near Pt St Mary. One large deep school of herring observed offshore just north of Pt Bridget and one whale near Mabb Island. Several small schools of herring observed in north Tee Harbor, one lining the beach inside the point. An entangled whale was observed near south Shelter Island trailing a buoy directly behind it and two long sections of line as well. It appeared to have the line wrapped around its head. A NOAA enforcement boat was standing by.

5/13 No herring or herring spawn was observed. A few schools of forage fish, presumably eulachon backing out of the Berners river systems, were observed near Sawmill Creek and Echo Cove. 2 humpback whales were seen near Point Bridget and 4 whales were seen east of Benjamin Island. A small pod of killer whales was observed moving to the north at Sunshine Cove. Many seals and a group of 10 sea lions were active near the eastern shoreline of the Berners tide flat.

5/16 **1/3 nm active spawn** observed in Bridget Cove. Schools of herring observed in Bridget Cove and on E Mabb Island. Schools of herring observed in north Tee Harbor. No herring or herring spawn observed in Berners Bay.

5/17 No active spawn observed, active schools of herring in Bridget Cove an north Tee Harbor. More sea lions in the area, but could just be the phenomenal eulachon run in the Chilkat is winding down.

5/18 No active spawn observed, active schools of herring in Bridget Cove an north Tee Harbor. Several large schools were also observed in Auke Bay. Predators have increased in the Bridget Cove S Berners Bay area with 2 whales and 23 sea lions observed near Mabb Is, and a raft of 50 sea lions just inside Pt Bridget and a whale near Cascade Pt. in Berners Bay.

5/19 No active spawn. Herring schools banding the beach in Bridget Cove, and a large school observed in north Tee Harbor. Increased sea lions, but scattered. Around 100 sea lions hauled out at Benjamin Island.

5/20 No active spawn. Herring schools in Bridget Cove, and Tee Harbor.

5/22 No herring no spawn. Visibility poor, weather forced a low altitude flight. Active sea lions observed near S Bridget Cove, other predators scattered.

5/24 Herring schools observed in Tee Harbor and Bridget Cove. **Approximately 1.3 nm of active spawn** observed at Pt St Mary with 2 whales and many gulls present.

5/25 Herring schools observed in Tee Harbor, Bridget Cove and large dense schools observed just E of Pt Bridget. **0.5 nm light spawn** north of Pt St Mary.

5/26 Herring schools observed in Tee Harbor, Bridgetr Cove and E of Pt Bridget. **1.1 nm active spaw**n observed at Pt St Mary.

-continued-

5/28 Pilot reported schools of herring in Ferry Terminal Cove, Tee Harbor, Sunshine Cove, and Bridget Cove. No spawn observed.

5/30 Pilot reported schools of herring E of Pt Bridget and several schools along the Lynn Canal shore north of Pt St Mary. No spawn observed.

6/2 Skiff Survey. Herring observed along the beach both sides of Pt Bridget, active spawn south of Pt Bridget, but unable to discern northern extent as silt curtain obscured it. Mapped spawn at Pt St Mary

6/3 Skiff survey. Herring observed at Pt Bridget, approximately **a third of a mile of active spawn** south of Pt Bridget. Found spawned eggs to 0.7 nm south of Pt Bridget. Castnet 6 bucket sample from active spawn.

6/4 **1.1 nm of very active intense spawn** observed at Pt Bridget, with schools of herring observed adjacent to the spawn to the east. Several whales observed near the spawn event. One school of herring observed in N Tee Harbor.

6/5 **0.25 nm of active spawn** observed just E of Pt Bridget. No schools of herring observed, no whales in the vicinity.

6/6 Pilot reported no herring or herring spawn, few birds and no predators near Pt Bridget.

6/10-6/11 Tee Harbor local reported a **small spawn event** in north Tee Harbor and provided photos.

7/4 NMFS reported spawn on pilings of their Auke Bay dock.

7/5 Fairly heavy spawn reported in eelgrass and algae between Bay Creek and Fishermen's Bend dock.

Appendix C10.–Aerial and skiff herring spawn surveys by date, in Port Frederick, Oliver Inlet, Taku Harbor, Excursion Inlet, Barlow Cove (Juneau Management Area), in Southeast Alaska, 2011.

Port Frederick

4/15 No herring or herring spawn observed. One whale observed.

4/20 No herring, herring spawn or predators observed.

4/22 No herring or herring spawn observed. Some bird activity and 6 sea lions observed.

4/25 No herring, herring spawn or predators observed.

4/27 Numerous schools throughout Port Frederick, in Eight Fathom Bight, from the Narrows to Burnt Point, near Hoonah, and near Point Sophia. No predators observed.

4/29 Many schools observed, Eight Fathom Bight, Bear Creek to Burnt Point.

5/1 Herring schools observed from Cannery Point to Hoonah, Burnt Point, and Seagull Creek. Spot spawn just west of Bear Creek.

5/4 One school of herring observed by Pt Sophia, and several schools around Bear Creek. One whale observed in the Narrows.

5/6 No herring or spawn observed. Two whales observed west of the Narrows, and one observed north of Burnt Point.

5/9 Several school observed in Eight –Fathom Bight and North of Burnt Point. **0.4 nm of active spawn** observed between Seagull and Bear Creeks. One whale observed west of the Narrows.

5/10 Light dissipating spawn observed between Seagull and Bear Creeks. No predators observed.

5/11 Numerous small schools observed in south Port Frederick and two dissipating spot spawn on either side of Bear Creek. About **0.3 nm of active spawn** was observed at Burnt Point. Very few predators observed in the area.

5/13 Dissipating remnant of spawn south of Burnt Point, and two small active spots on the point north of Burnt Point with several small schools of herring on the beach. Numerous small schools of herring observed south of the Narrows. Few predators observed.

5/16 No herring or herring spawn observed in Port Frederick proper, many schools of herring observed south of the Narrows.

6/20 Shellfish management on dungie survey observed two spot spawns totaling 150 yards on the peninsula between North and Sough Bights just south of the Neka River.

Oliver Inlet

4/15 No herring, herring spawn or predators observed.

4/18 No herring, herring spawn or predators observed.

4/20 No herring, herring spawn or predators observed.

4/22 No herring, herring spawn or predators observed.

-continued-

4/25 No herring, herring spawn or predators observed.

4/27 Four schools observed near head of inlet. No spawn or predators observed.

4/29 Three small herring schools observed in inlet. No spawn or predators observed.

4/30 Three small herring schools observed in inlet. No spawn or predators observed.

5/1 Two small herring schools observed in inlet. No spawn or predators observed.

5/2 No herring, herring spawn or predators observed.

5/3 Three small herring schools observed in inlet. No spawn or predators observed.

5/4 Three small herring schools observed in inlet. No spawn or predators observed.

5/5 0955 One herring school observed in inlet. No spawn or predators observed.

5/5 1625 One herring school observed in inlet. No spawn or predators observed.

5/7 No herring, herring spawn or predators observed.

5/8 Several small deep schools observed outside mouth of inlet, no spawn or predators observed.

Taku Harbor

Number of times surveyed: 2

5/5 No herring, herring spawn or predators observed.

5/8 No herring or spawn observed. A raft of 25 sea lions observed in north head of harbor.

5/14-5/15 Ward Air pilot reported small active spawn just south of the entrance of Taku Harbor.

Stephens Passage

5/8 A total of **0.4 nm active spawn** observed north of Twin Points in Stephens Passage, mostly on the s facing portion of a rocky reef at approximately 57° 56.01 N. A school of herring was on the beach to the north of the spawn as well.

5/9 Station Point/ South Island – medium to large size herring school banded along shore, with a small spawn at Station Point. Herring schools lining the beach at north end of Twin Points with dissipating spawn. **0.25 nm of active spawn** on Glass Peninsula across from Midway Is.

5/23 Several hundred yards of active spawn reported by FW Protection at Pt Anmer.

Excursion Inlet/Homeshore

6/8 A Ward Air pilot reported approximately **200 yards of intense spawn** on the east shore of Excursion Inlet about a mile and a half north of the cannery, and two small spot spawns south of the cannery.

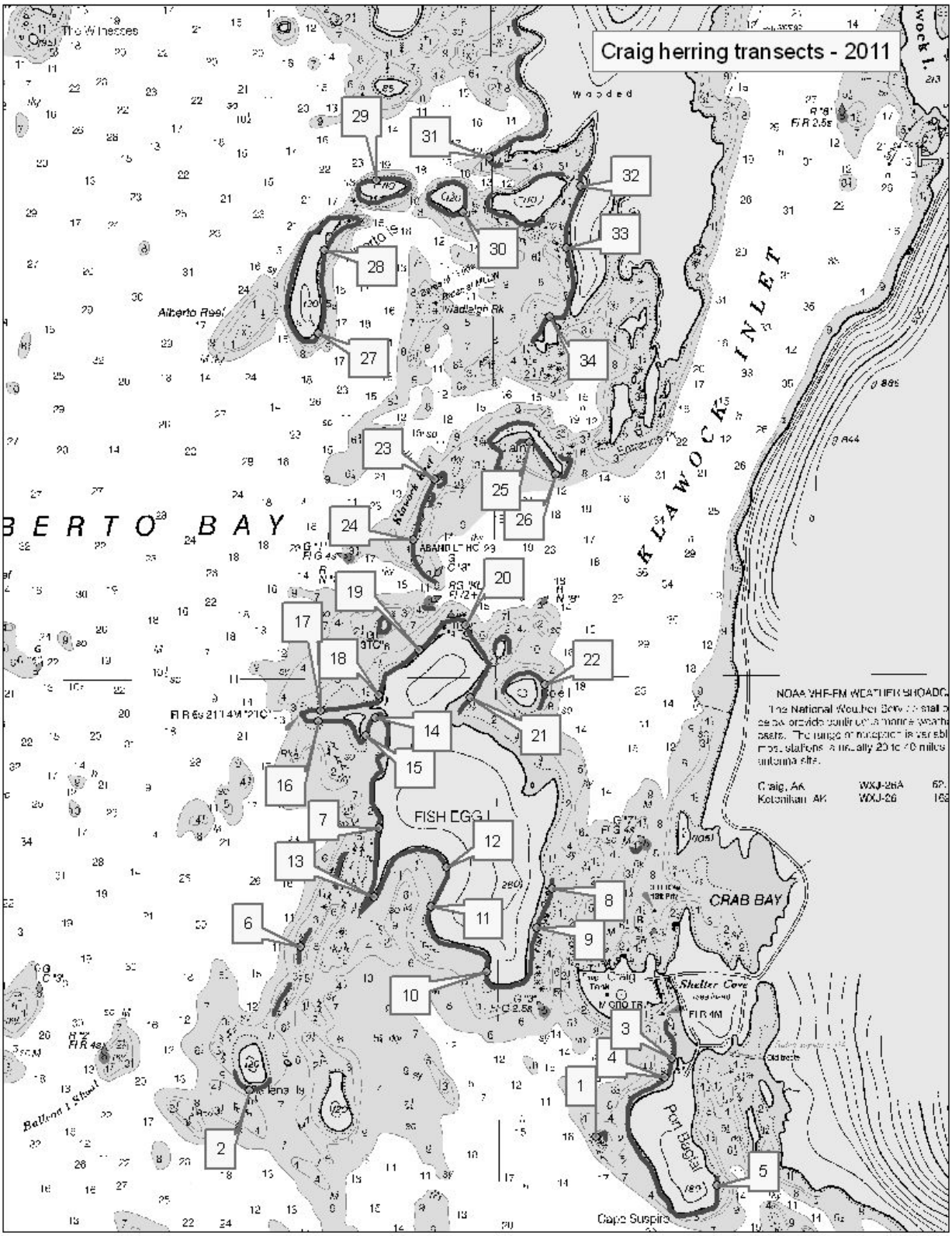
6/9 A **spot spawn** was documented on the south corner of the Homeshore Creek alluvial fan.

Barlow Cove

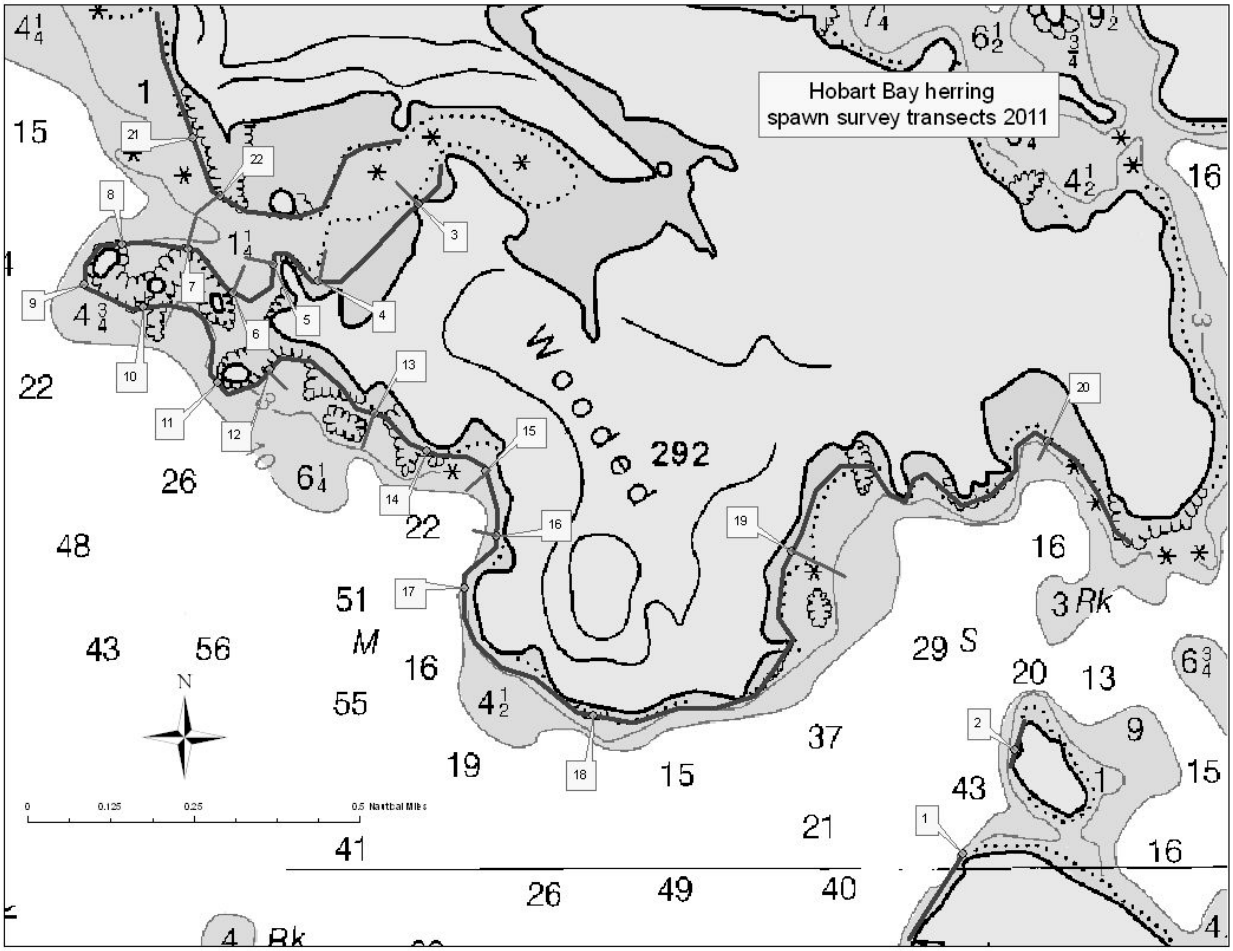
6/11 A Ward Air pilot reported **200 yards of intense spawn** at the head of Barlow Cove on the east side.

Appendix C11.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2011.

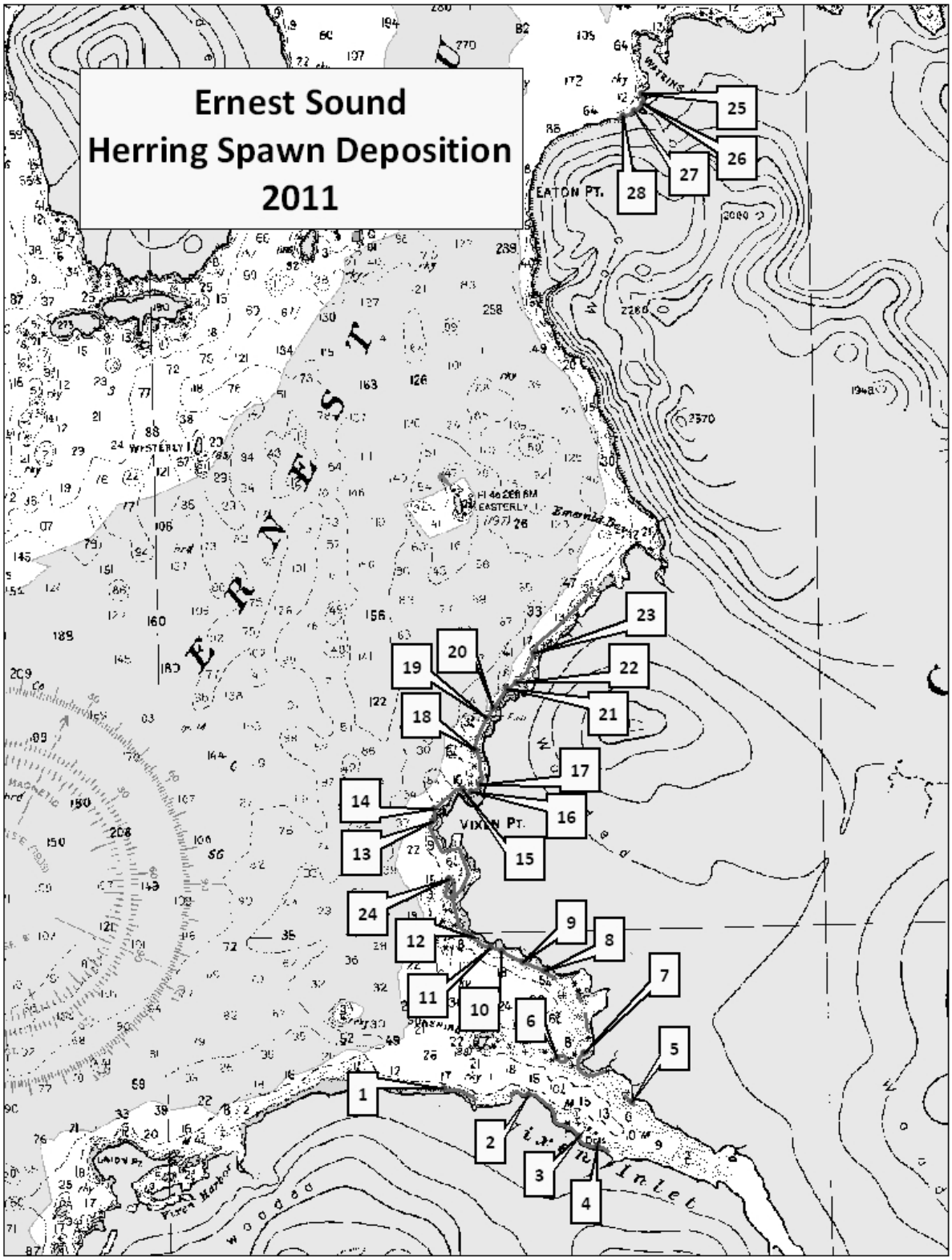
No aerial surveys were conducted in the Yakutat area in 2011 as funding was not available.



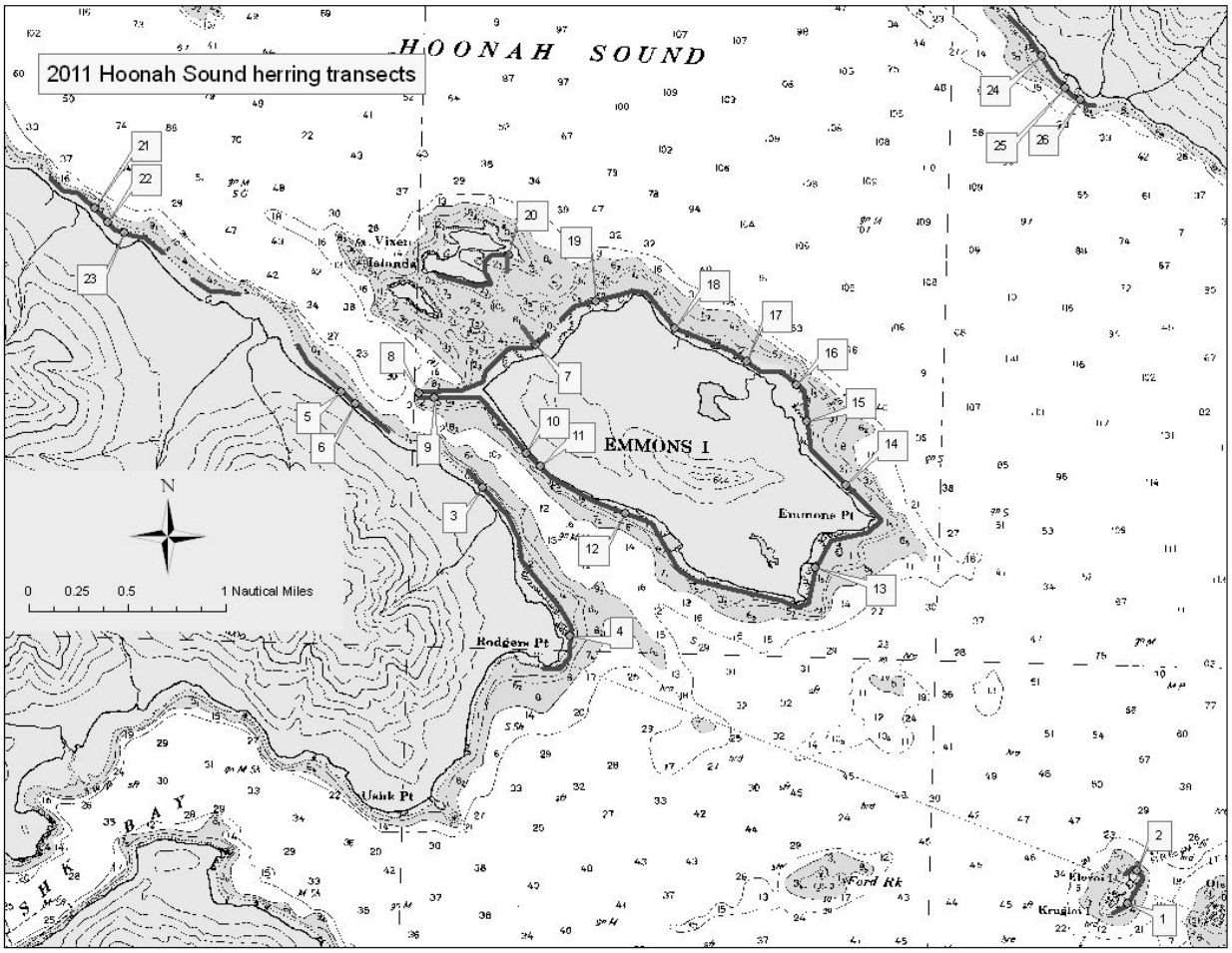

Appendix D1.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Craig herring stock in 2011.



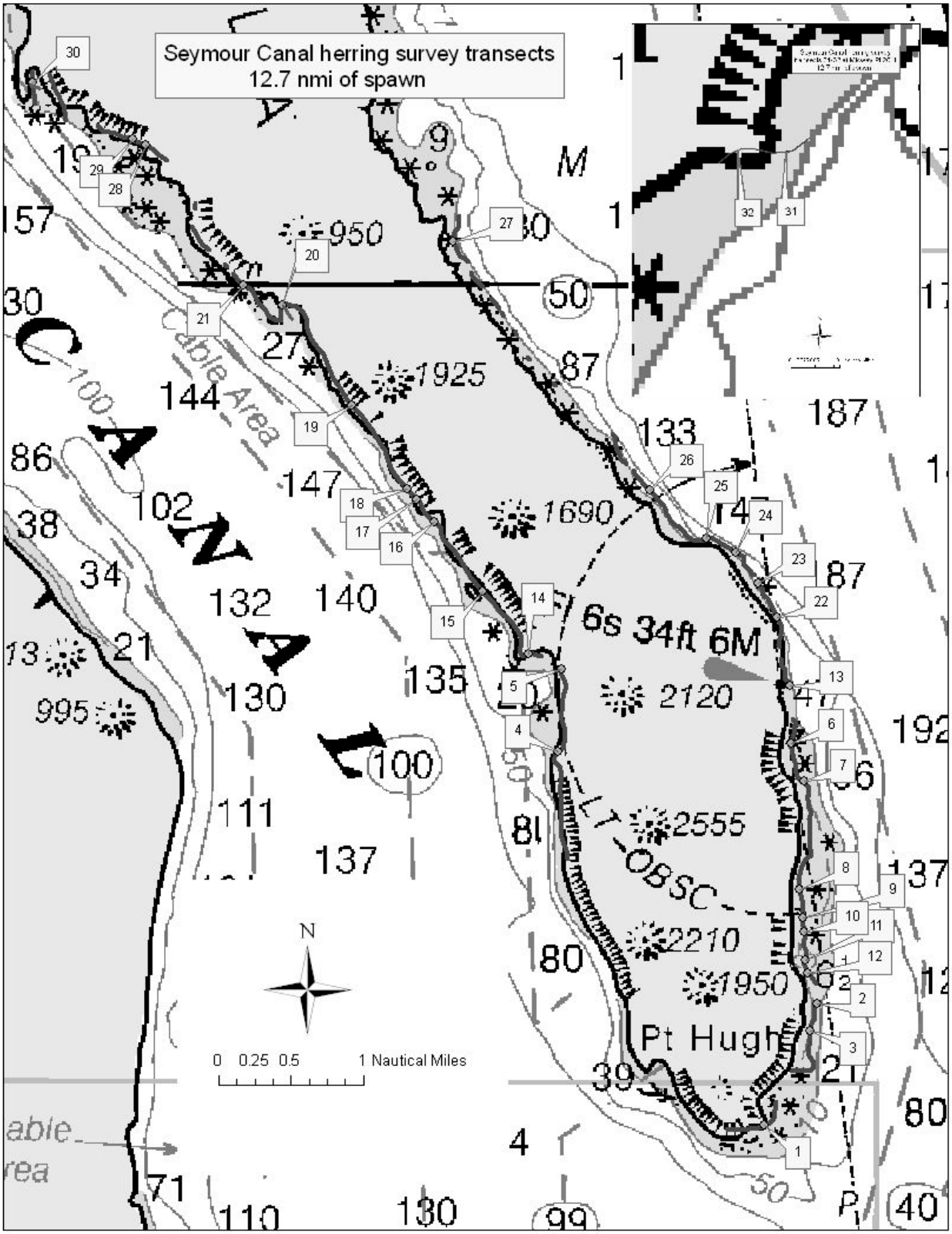

Appendix D2.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hobart Bay/Port Houghton herring stock in 2011.



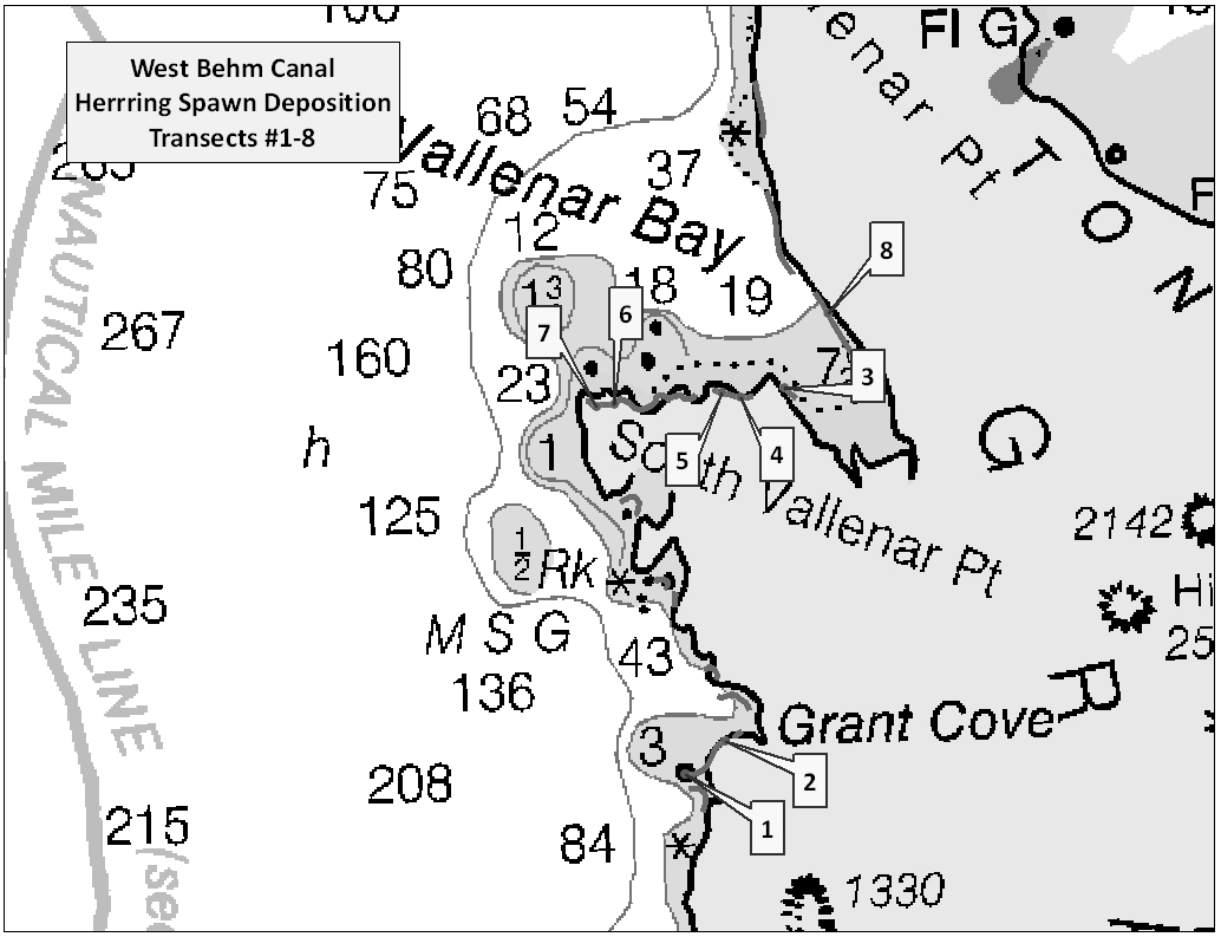

Appendix D3.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Ernest Sound herring stock in 2011.



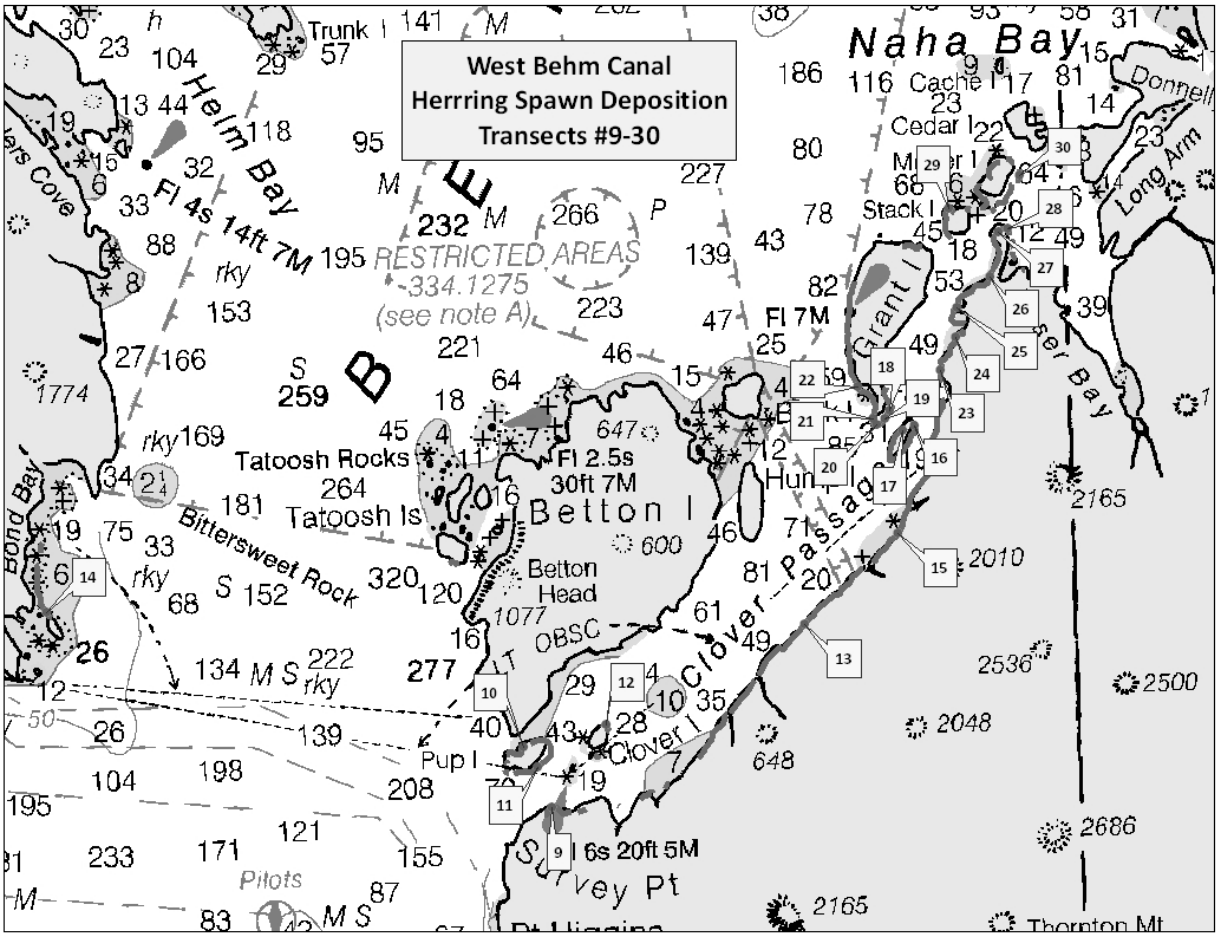

Appendix D4.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hoonah Sound herring stock in 2011.



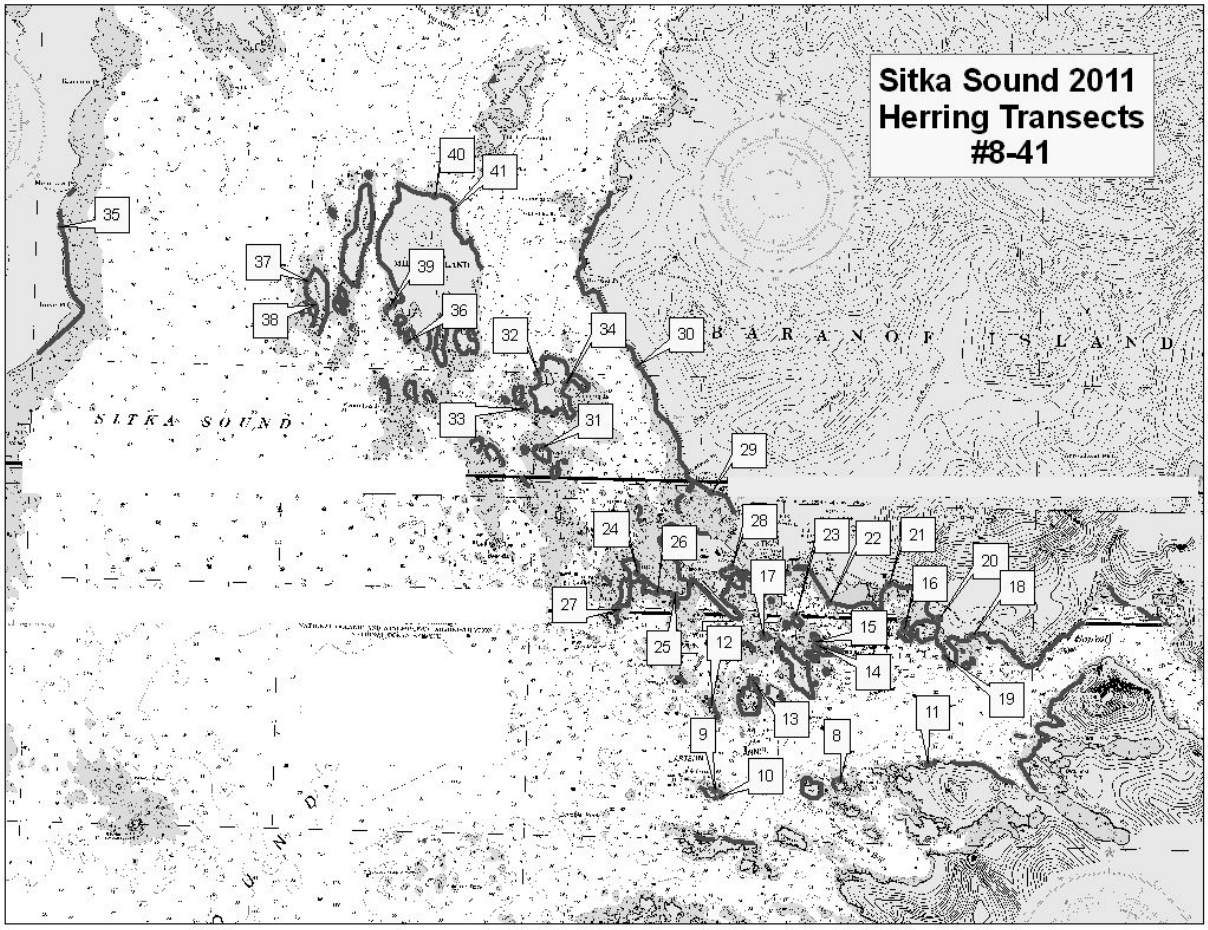

Appendix D5.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Seymour Canal herring stock in 2011.



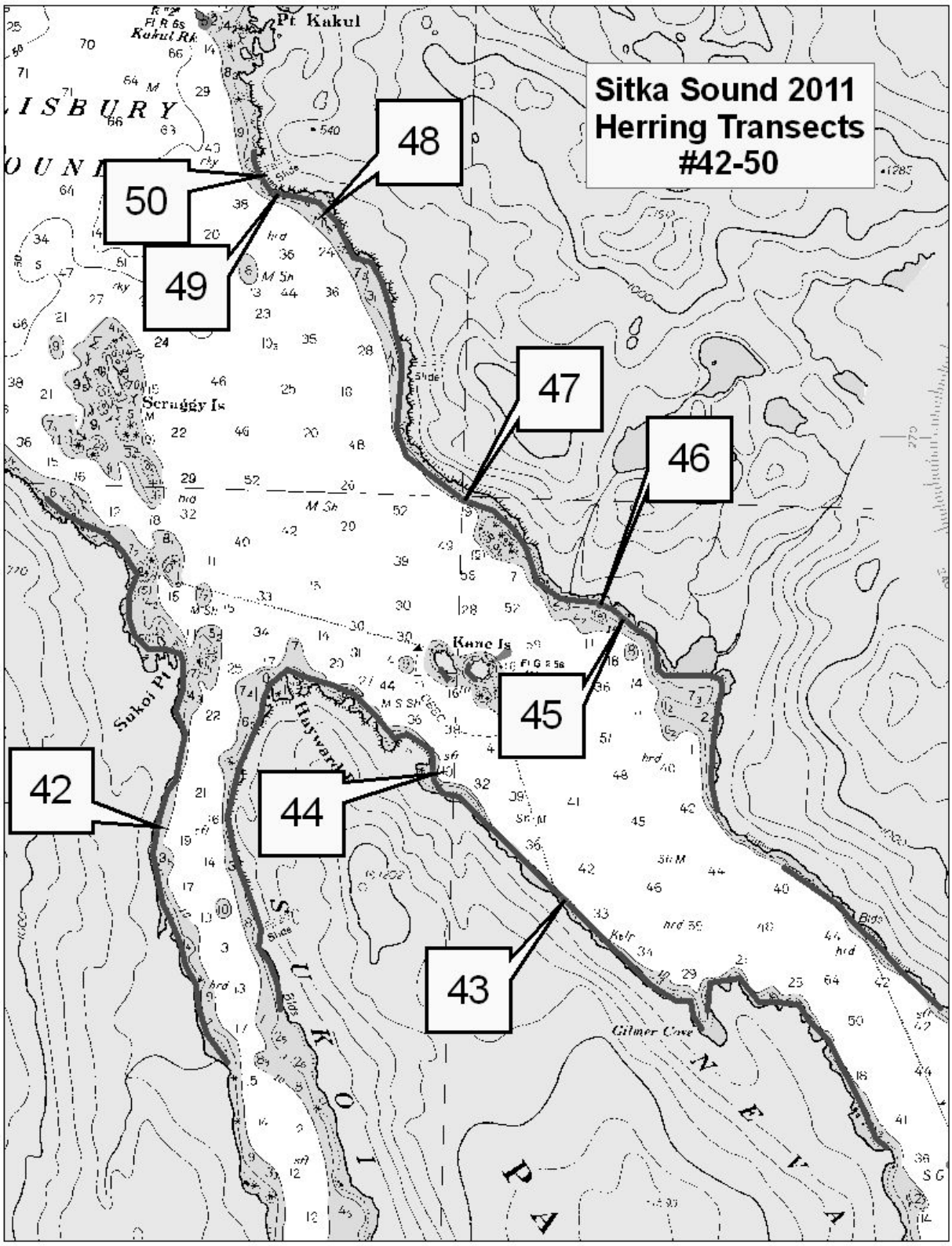

Appendix D6.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2011 (transects 1-8 only).




Appendix D7.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2011 (transects 9-30 only).




Appendix D8.–Sitka Sound only spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2011 (transects 8-41 only).




Appendix D9.–Salisbury Sound only spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2011 (transects 42-50 only).