Fishery Data Series No. 16-04

Southeast Alaska 2015 Herring Stock Assessment Surveys

by

Kyle Hebert

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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)

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, χ^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 SERIES NO. 16-04

SOUTHEAST ALASKA 2015 HERRING STOCK ASSESSMENT SURVEYS

by

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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.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review.

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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 2015, including summaries of herring spawn deposition surveys and age-weight-length sampling, which are the principle model inputs used to forecast herring abundance. In 2015 spawn deposition surveys were conducted in Sitka Sound, Craig, Kah Shakes/Cat Island, Ernest Sound, Hobart Bay-Port Houghton, Hoonah Sound, Tenakee Inlet, Seymour Canal, and Lynn Canal. The combined total cumulative shoreline where spawn was documented in 2015 for surveyed areas was 145.8 nautical miles. In 2015, post-fishery spawn deposition biomass estimates, combined for all surveyed stocks, totaled 86,023 tons.

During the 2014–2015 season, a commercial winter bait fisheries was opened in Craig with a guideline harvest level of 1,358 tons. A commercial purse seine sac-roe fishery was opened in Sitka Sound with a guideline harvest level of 8,712 tons. A commercial spawn-on-kelp fishery was open in Craig. There were no commercial gillnet fisheries opened in 2015. No commercial fisheries were opened in Seymour Canal, Hobart Bay-Port Houghton, Hoonah Sound, Tenakee Inlet, West Behm Canal, Kah Shakes/Cat Island, or Lynn Canal. Herring harvested commercially during the 2014–2015 season totaled over 9,000 tons, not including herring pounded for spawn-on-kelp fisheries; however, a specific value is not available due to confidentiality for some 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, and when data has allowed, 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 (also called "Revilla Channel," which refers to the greater Kah Shakes/Cat Island and Annette Island spawning areas), and Craig. The ASA model was used for Tenakee Inlet beginning in 2000. For these five potential commercial harvest areas or spawning populations, the time series of data has been sufficient 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 simpler modeling 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, the key data inputs for these models are presented. The primary intent of this report is to document data collected during winter 2014 through spring 2015 and to 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 typically commenced prior to the historical first date of spawning for each stock. In addition to documenting herring spawn and herring schools, estimates of numbers and locations of herring predators, such as birds, sea lions, and whales were recorded. 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. The shoreline where herring spawn (milt) was observed 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 day 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 the survey, a 10% correction factor is applied to inflate 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 in 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 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 mature biomass.

Shoreline Measurement

Spawn documented during aerial surveys was transcribed in ArcGIS (version 10)[1] over raster images of nautical charts published by the National Oceanic and Atmospheric Administration, using the NAD 1983 datum. 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

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

oriented along the spawn and is such that transects laid perpendicularly to the spawn line will sample egg density throughout 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.

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:

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

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%);
$\bar{d}$	=	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 ft), 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 2013, 2014, and 2015 were used if there were at least a total of 6 samples for each estimator and kelp type, with at least three samples in at least two of the 3 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:

$$t_i = a_i \bar{d}_i, \quad (2)$$

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

$$a_i = l_i \bar{w}_i, \quad (3)$$

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,

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

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 factors (c_{hk}) are calculated as follows:

$$c_{hk} = \frac{r_{hk}}{q_{hk}}, \quad (5)$$

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 change with each model run), 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:

$$b = h_{\bar{g}} * \bar{g}\ , \qquad (6)$$

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:

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

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 may have included purse seines, gillnets, cast nets, or 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, gear used, 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 to ensure that at least 500 readable scales would be obtained for aging, 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 five-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 early 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 2011 and was collected in the fall of 2012, 2 growing seasons had occurred (age-2). If the herring had been collected in the spring of 2013 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 (*In prep*).

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:

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

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 ft MLLW to 10 ft MLLW. Temperature was recorded daily at 6-hour intervals for a minimum of 1 year and up to 10 years, depending on spawning area. Daily mean temperature was calculated and 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 2014–2015 season, only three 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 for each commercially exploited stock, 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. For Sitka Sound and West Behm Canal, threshold levels were based on 25% of estimated average unfished biomass as determined through simulation models (Carlile 1998a, 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 the stock to help alleviate concerns over adequate subsistence opportunities to harvest the resource. For the Tenakee Inlet stock, 25% of average unfished biomass 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 2014–2015 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 2014–2015 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.

Although there are several other regulations within the Alaska Administrative Code that pertain to specific herring fisheries in Southeast Alaska, the above general management plan represents the over-arching principals with which all herring fisheries must comply in the region.

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 10, 2015, in Sitka Sound and ending on May 13, 2015, in the Juneau area. 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. Occasionally, private pilots or local residents reported observations of active spawning. 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 no spawn deposition surveys were completed in these areas due to the low level of spawning, or in the case of some areas (e.g. Bradfield Canal), because surveys conducted in previous years revealed that only a narrow band of spawning habitat exists resulting in relatively low egg deposition (see Appendix C). ADF&G also completed aerial surveys of Annette Island Reserve, while en route to other spawning areas located in state waters, but did not observe any herring spawn in 2015.

SPAWN DEPOSITION SURVEYS

During spring 2015, spawn deposition surveys were conducted in Craig, Sitka Sound, Kah Shakes/Cat Island, Ernest Sound, Hobart Bay, Hoonah Sound, Tenakee Inlet, Lynn Canal, and Seymour Canal. Surveys of areas began in Craig on April 8 and were completed in Seymour Canal on May 11 (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. No survey was conducted in West Behm Canal due to very low cumulative mileage of spawn recorded along shorelines in the traditional spawning areas, although substantial spawning was observed in areas south of traditional spawning areas, at Mountain Point and Dall's Head on Gravina Island.

A summary of the 2015 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 2015 spawning stock abundance to prior years, estimates of historical spawning biomass are presented in Figures 3–8.

The total documented spawn for major spawning areas where surveys were conducted in Southeast Alaska in 2015 was 145.8 nmi (Table 5). This did not include spawning several minor spawning areas, or Yakutat where about 12 nmi of spawn was observed during the sole survey flight of the spawning event (see Appendix C for a detailed accounting of other minor spawn areas throughout Southeast Alaska).

Visual Estimate Correction

Minimum sample size guidelines (at least 3 samples per kelp type for the most recent 3 years) were met using data from 2013 through 2015 for all (9 of 9) estimators. Correction coefficients applied to 2015 spawn deposition visual estimates ranged from 0.573 to 2.180 and are presented in Table 6.

Visual review of plots depicting observed versus laboratory estimates of eggs suggest there exist linear relationships for some estimators, but a non-linear relationship for others caused by a tendency to underestimate when egg numbers in sample frames are high. A similar non-linear pattern has been observed for aerial estimates of salmon in streams (see Jones et al. 1998), although correction coefficients were calculated as a straight ratio of known to estimated values. For herring egg correction coefficients presented here, values were calculated as an overall ratio of values summed across the entire range of lab-estimated and visually estimated values, which was considered to adequately correct visual estimates, although values may be biased low due to the non-linear relationship.

AGE AND SIZE

A combined total of 6,786 herring were sampled from all stocks and gear types (cast net, purse seine, and pound) during the 2014–2015 season. Of those, 6,673 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 scales, or due to data that was otherwise unusable.

Samples of the spawning population were taken using cast nets from Craig, Ernest Sound, Hobart Bay/Port Houghton, Seymour Canal, Sitka Sound, West Behm Canal, Tenakee Inlet, and Kah Shakes/Cat Island. 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).

Samples were obtained from commercial and test fisheries for all areas where fisheries were conducted in 2014–2015. Fisheries sampled included Craig winter bait and spawn on kelp, Sitka sac roe, and Sitka winter test fishery. Samples were obtained opportunistically from vessels or tenders, during or shortly after the fishery openings. Sample locations during fisheries are also shown in Figures 9–19.

The minimum sample goal of 500 aged fish per sampling event (gear-fishery combination) was met or exceeded in all cases (Tables 7 and 8).

Age Composition

Age composition data was obtained for most major stocks in the region. Herring samples were not obtained from Hoonah Sound due to low spawning level and therefore few opportunities to collect samples during spawning. Frequency distributions of herring ages from other spawning areas are presented in Tables 9–18 and Figures 20–29.

Distributions of ages were very similar among most southern stocks. Craig, Ernest Sound, West Behm Canal, and Kah Shakes/Cat Island areas all had very similar age distributions, with proportion of age-3 herring dominating the distribution. Excluding age-3 herring, relatively high proportions of age-5 herring and very low proportions of age-4 herring were observed in these spawning areas.

Age distributions varied among northern areas, but similarities were observed between some stocks. Most notably, Seymour Canal, Hobart Bay/Port Houghton, and Lynn Canal all had similar age compositions, comprised of relatively high proportions of age-3 and age-6 herring, and low proportions of age-4 and age-7 herring. Although considered a northern area, the age composition for Tenakee Inlet herring more closely resembled that of southern stocks, with highest proportions of age-3 and age-5 herring. Sitka Sound, also considered a northern area, also displayed an age distribution that resembled southern areas in that there were relatively high proportions of age-3 and age-5 herring; however, a difference was the high proportion of age-8+ herring, which was more consistent with northern areas.

The proportions of age-3 herring entering the mature population each year seem to fluctuate in a similar, cyclical pattern among stocks in the region, with high and low years synchronized in many instances (Figure 39). When northern and southern stocks are viewed separately, the synchronized pattern is even more apparent within each group (Figures 40 and 41). In 2014 a relatively low level of age-3 herring was observed for all stocks; however in 2015 a very high level of mature age-3 herring were observed in most spawning areas.

The relationship between the latitude of spawning stocks and the proportion of mature age-3 herring continues to be relatively strong (Table 19, Figure 42). The mean proportion of age-3 herring in the mature population is consistently lower for higher latitude stocks and higher for lower latitude stocks, and the coefficient of determination suggests a strong correlation at r^2=0.81 (Figure 43). There is also a moderate correlation between the mean proportion of age-3 mature herring and the mean minimum annual sea temperature (r^2=0.68) (Figure 44). A weak relationship exists between the mean proportion of age-3 herring and the mean annual sea surface temperature (r^2=0.52) (Figure 45). Although there is no linear correlation between the mean proportion of age-3 herring and the mean maximum annual sea temperature, graphic display reveals a possible curvilinear relationship (dome-shaped), suggesting an optimal temperature for recruitment of mature age-3 herring, around 14.5º C (Figure 46).

Size at Age

Based on cast net samples in 2015, there is a clear distinction between mean weight at age for all age-classes for Sitka Sound spawning herring, and all other herring stocks in Southeast Alaska (Figure 47). Although herring at age 3 from most stocks are comparable in size, the divergence between Sitka Sound herring weight at age and other stocks in the region increases greatly with age, as Sitka Sound herring attain a substantially higher average weight. Excluding Sitka Sound, there also appears to be a difference in weight a -age among other major Southeast Alaska stocks. Herring from some stocks appear to have consistently higher mean weights at age, across all ages, than others. For example, in 2015 Tenakee Inlet and Craig herring generally have higher weight at age across age groups than other stocks, with Ernest Sound and West Behm Canal herring among the lowest weight at age. Tests to determine whether differences were statistically significant were not performed as the primary intent of this report is to present 2015 data with general observations of trends and characterization of stocks. Herring samples were not obtained from the Hoonah Sound or Yakutat areas in 2015.

Lengths at age among spawning areas has a pattern similar to weights 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 48). The rankings of stocks both for mean length at age, and mean weight at age are very similar. This is not surprising as weight is 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 composition, or a combination of both.

Trends in weight at age are variable among stocks (Figures 49–58). For most stocks, a common pattern is evident: weight of age-3 herring has been stable over the past few decades, while those of older ages appear to have gradually declined. The decline appears to be more pronounced for older herring. Although the mean weight at age of herring is less now than it was 30 years ago; weight generally declined during the late 1980s to the early to mid-2000s but then appears to have stabilized over the past 15 years. The exception is Sitka Sound, where weight at age appears to have increased over the past 20 years, following a period of low weight at age in the early 1990s. However, data presented here only dates back to the late 1980s, which coincided with the period of low weight and condition of Sitka area herring. Another pattern that is apparent is that weight at age of age-4+ herring may have declined more in the southernmost stocks (e.g., Craig, West Behm Canal, Revilla Channel) than in northernmost stocks (e.g., Tenakee Inlet, Lynn Canal, Hoonah Sound).

To determine whether changes in weight at age were due to corresponding changes in length at age, 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 all major stocks, which are presented in Figures 59–68. Data obtained from cast net samples during active spawn events were used to calculate condition factors. Weight estimates derived from samples taking from actively spawning herring probably produce lower average values that contain more variability than would be expected from pre-spawning fish sampled during the commercial fishery; however, the overall trends in condition factor are expected to be the same. Other benefits of using data from cast net samples are that they provide a more complete and consistent time series and bias is expected to be lower than for fishery-dependent data that may be influenced by targeting larger fish.

Mean condition factors of herring from most stocks on Southeast Alaska follow the same general pattern over the last two decades: relatively low in the early 1990s, peaking in the early 2000s, followed by a decline until about 2007. Starting in 2008, condition factors for most stocks increased sharply, peaking in 2010 and then declined sharply to 2012. The condition factors calculated for 2015 are not substantially different from those observed in 2014. For most spawning areas, condition factor appears to have an upward trajectory over the past few years.

Sitka Sound Winter Test Fishery

Winter sampling was conducted in Sitka Sound during March 2, 2015 using a commercial vessel and purse seine, contracted by the department. The purpose of the Sitka winter sampling is to provide data to update the estimates of weight at age that are used in the preliminary forecast of the population, thereby allowing calculation of the final ASA-model forecast. 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. However, winter estimates of weight at age are thought 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. For 2015, the preliminary forecast of mature herring was 44,237, with a preliminary GHL of 8,712 tons. Although weight-at-age estimates were obtained from the winter test fishery, the preliminary forecast was also used as the final forecast in 2015, because data processing of the weight-at-age data from the winter sampling could not be completed in time for when the final GHL announcement was required.

COMMERCIAL FISHERIES

Commercial harvest was permitted in an area only if the forecasted spawning biomass met or exceeded a minimum threshold (Table 20). If that threshold was met or exceeded, 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. For Sitka Sound, the allowable harvest rate ranges from 12 to 20 percent of the forecasted spawning biomass. A summary of locations, harvest levels, and periods of harvest is presented in Table 21.

Sac Roe Fisheries

The only commercial sac roe fishery that was announced in 2015 was for the Sitka Sound area. There were no sac roe fisheries announced for Seymour Canal, West Behm Canal, Hobart Bay-Port Houghton, Kah Shakes-Cat Island, or Lynn Canal areas because spawning biomass was estimated to be below threshold.

Sitka Sound

The sac roe fishery was placed on two-hour notice on March 18 at 10:00 AM. The GHL was 8,712 tons. This season the fishery was conducted as a "controlled" fishery, rather than using the typical competitive openings. This means that the industry determined the level of harvest each day depending on available processing and tendering capacities, which allowed the department to set more flexible fishing times and areas. Five openings were held during the 2015 fishery. The first opening was on March 18 from 3:30 PM until 6:30 PM in the northwest part of Sitka Sound near Gagarin and Crow Islands. Approximately 2,900 tons were harvested during the first opening. The second opening occurred on March 19 from 9:00 AM until 6:00 PM in the same area as the first opening. Approximately 4,100 tons were harvested during the second opening. The third opening occurred on March 23 from 9:00 AM until 6:00 PM, also in the northwest waters of Sitka Sound. Approximately 940 tons were harvested during this opening. The fourth opening occurred on March 24 from 9:00 AM to 6:00 PM, again in the area as the first opening. Approximate harvest during this opening was 500 tons. The fifth and final opening occurred March 25 from 9:00 AM to 6:00 PM in the same area as all other openings. The 2014-15 season was closed effective 6:00 PM on March 26, 2015.

The total harvest for the season was 8,756 tons, which exceeded the GHL of 8,712 tons by just 44 tons, or 0.5% of the GHL.

Seymour Canal

There were no commercial fisheries in the Seymour Canal area during the 2014–2015 season, as the forecast was below threshold.

West Behm Canal

There were no commercial fisheries in the West Behm Canal area during the 2014–2015 season, as the forecast was below threshold.

Hobart Bay-Port Houghton

There were no commercial fisheries in the Hobart Bay-Port Houghton area during the 2014–2015 season, as the forecast was below threshold.

Kah Shakes-Cat Island

There were no commercial fisheries in the Kah Shakes-Cat Island area during the 2014–2015 season, as the forecast was below threshold.

Lynn Canal

There were no commercial fisheries in the Lynn Canal area during the 2014–2015 season, as the forecast was below threshold

Winter Bait Fisheries

During the 2014–2015 season, the only winter food and bait fishery was in the Craig area. Other winter bait areas were closed as forecasts were below threshold.

Craig

The fishery was opened in the Craig area on October 5, 2014 and was closed by regulation on February 28, 2015. Harvest information is confidential as there were fewer than 3 participants in the fishery.

Ernest Sound

There were no commercial fisheries in Ernest Sound during the 2014-15 season as the forecast was below threshold.

Tenakee Inlet

There were no commercial fisheries in Tenakee Inlet during the 2014-15 season as the forecast was below threshold.

Spawn-on-Kelp Pound Fisheries

The only area open to the commercial harvest of spawn on kelp (SOK) during the 2014–2015 season was Craig. The other SOK areas in the region, Hoonah Sound, Ernest Sound, and Tenakee Inlet, were not opened during the 2014–2015 season as the forecasted mature biomass was below threshold.

Craig

A total of 77 closed pounds were actively fished, of which 30 were single-permit pounds, 39 were double-permit pounds, and 8 were triple-permit pounds. A total of 135 permits registered and participated in the fishery. Total harvest and value are confidential due to fewer than 3 processors participating in the fishery.

Hoonah Sound

There were no commercial fisheries in Hoonah Sound during the 2014-15 season as the forecast was below threshold

Ernest Sound

There were no commercial fisheries in Ernest Sound during the 2014-15 season as the forecast was below threshold.

Tenakee Inlet

There were no commercial fisheries in Tenakee Inlet during the 2014-15 season as the forecast was below threshold

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2014–2015 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 2014–2015 season was in Sitka Sound, for bait, using purse seine gear during March 2-3, 2015. A total of 53 tons of herring were harvested in the area of Mountain Point in the northwestern part of Sitka Sound.

DISCUSSION

Spawn Deposition

After a period of building since about the late 1990s, herring spawning biomass in Southeast Alaska is now in a period of decline, which has become apparent over the past few years. The total combined spawning biomass estimated in 2015 for all of Southeast Alaska is at a level similar to that of the late 1990s, which proceeded the period of building herring biomass. The 2015 total estimated spawning population biomass in Southeast Alaska, as calculated from spawn deposition estimates, was similar to that of 2014, but with a decline of 7% relative to 2014. For individual areas, spawning biomass decreased between 2014 and 2015 for four of nine stocks that were surveyed in Southeast Alaska. For these four areas the decreases were substantial (defined here as a minimum of 20% change). The spawning areas where decreases were observed include Craig, Ernest Sound, Hobart Bay-Port Houghton, and Hoonah Sound. Although the error surrounding biomass estimates was not calculated, the magnitudes of the decreases were large enough that they probably reflect meaningful changes in the spawning population levels. For a perspective on the relative size of each stock in the region, along with relative proportion of harvest, see Figure 69.

The remaining areas, where biomass apparently increased between 2014 and 2015, included Kah Shakes/Cat Island, Seymour Canal, Sitka, Tenakee Inlet and Lynn Canal. The increases were all substantial, ranging from 20% in Sitka (relative to 2014), to an over four-fold increase in the Kah Shakes/Cat Island area.

The decrease in estimated spawning biomass for most stocks over the past year may be due to actual changes in the herring population; however, it could also be a function of estimate variation, or a combination of both. Because error estimates were not calculated for spawn deposition estimates, it is possible that the changes in biomass were due, at least in part, to estimate error. However, the consistency of the decrease in biomass observed for several stocks around there region, each determined through an independent survey, make it unlikely that estimate error could be the major cause for the general decline of herring in the region.

Estimates of spawning biomass presented in this report are based primarily on egg deposition estimates (as opposed to model-derived results), which though useful for providing a general view of trends in mature herring biomass, should not necessarily be considered the most accurate estimate of biomass in any given year. For all major herring stocks in Southeast Alaska, the results of ASA or biomass accounting models are considered to provide more reliable estimates of spawning biomass, and are the basis for forecasting herring abundance and setting harvest levels. A primary reason that the ASA model provides more reliable estimates 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 only a single year of spawn deposition data. An advantage of using biomass estimates derived from spawn deposition is that they provide a time series of fixed historical values, as opposed to ASA hind cast estimates derived from single model runs, which may be less intuitive since they change with each model run. Additionally, in some years modeling may not be completed for some stocks due to inadequate data or a very low level of spawning, which may leave gaps in the time series of estimates. Since spawn deposition surveys are conducted annually, biomass estimates derived from egg deposition provide a consistent and comparable time series to gauge trends.

Although the overall herring biomass in Southeast Alaska over the period 1980 to 2015 still indicates an increasing trend; short-term trends indicate a decline over the past few years (Figure 8). This is true whether or not the largest stock in the region, Sitka Sound, is included. The regional spawning biomass estimated for 2015 is 83% of the long-term average (1980–2014), for all stocks combined, and 62% for all stocks combined excluding Sitka Sound. The long-term trend of spawning biomass for the majority of individual spawning areas where data is available in Southeast Alaska is still increasing due principally to several years of high biomass levels in the most recent decade; however, the long-term trend is decreasing for a couple of areas (Figures 3–7). Biomass levels in some areas have fluctuated widely over the past few decades and are currently at very low levels. This is true for Ernest Sound, Hoonah Sound, Hobart Bay-Port Houghton, Tenakee Inlet, and West Behm Canal.

The spawning location in the Revilla Channel area, comprised of the Kah Shakes-Cat Island and Annette Island Reserve areas, shifted dramatically in 2015. Significant spawn had not been observed in the Kah Shakes-Cat Island area since 2001, but has been observed in Annette Island Reserve waters during this time. However, in 2015 a relatively high level of spawning was observed in state waters (in vicinity of Kah Shakes Cove, Cat Island and Mary Island), and no spawning was observed in Annette Island Reserve waters. Because the State of Alaska has no authority to enter Annette Island Reserve waters to conduct herring surveys, spawning biomass estimates for this area are based on conversions from observed miles of spawn, and suggest that herring biomass peaked in the early to mid-2000s and has declined to a relative low level since then.

Overall, spawn deposition estimates for 2015 suggest that herring spawning biomass in Southeast Alaska is at a moderately low level relative to the period 1980–2014.

Age Composition

For all stocks, estimates of age composition in 2015 continued to follow patterns that are generally expected; that is to say that the proportion of cohort sizes either grew or declined as a result of increases due to maturation or decreases due to natural mortality and that no surprising or abrupt changes were observed in relative cohort strength. These patterns lend support to the assumption that the method of aging scales from 2015 samples was consistent with those methods used in prior years, which has been a concern in prior years (see Hebert 2012a and 2012b).

The observed proportions of mature age-3 herring were relatively very high for all stocks in 2015, which follows a year of very low age-3 recruitment in 2014. The relatively high proportion of mature age-3 herring observed in 2015 offers some insight to future biomass levels, which are likely to increase as a result of this strong cohort, assuming that survival rate remains relatively steady in coming years.

The proportion of age-3 herring in the mature population typically fluctuates widely for most stocks in the region, but some patterns are evident. Although the proportion of mature age-3 herring is different among stocks in any given year, it is common for the direction of change to be the same from year to year. 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 time periods have been observed in the past when Sitka Sound and Prince William Sound displayed very similar recruitment patterns (Carls and Rice 2007).

Patterns of age composition, and in particular proportions of age-3 herring over time are also evident among stock groups within the region, which suggest that similar marine conditions may be present among certain areas within the region (Figure 70). The proportion of mature age-3 herring within each stock appears to be related to the latitude of the spawning stock. There appear to be two areas within the region where the mean proportion of age-3 herring is similar. For stocks south of latitude 56 degrees (Craig, West Behm Canal, Ernest Sound, and Kah Shakes), the mean proportion of age-3 herring is relatively high (range of 23-31%), but for stocks at 57 degrees and northward (Sitka, Hobart Bay, Seymour Canal, Hoonah Sound, Tenakee Inlet, and Lynn Canal) the proportions are relatively low (range of 13-17%). The latitudinal split is further supported by age compositions observed in 2015, which were very similar among all southern stocks, and somewhat similar among several northern stocks (Seymour Canal, Hobart Bay, Tenakee Inlet, and Lynn Canal). One stock where age compositions do not typically match either southern or northern areas, is Sitka Sound, and reasons for this are unknown.

There continues to be an inverse relationship between latitude and sea surface temperature in Southeast Alaska, which is somewhat expected. The mean proportion of age-3 herring 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 the mean proportion of age-3 herring. This relationship suggests that an optimal maximum sea temperature exists around 14.5 °C and at higher or lower sea temperature, the mean 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 consider biological explanations of such a relationship; however, the patterns in the data are suggestive enough to warrant additional investigation.

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TABLES AND FIGURES

Table 1.–Transect sampling rates used for 2015 herring spawn deposition surveys.

	Estimated Target Transects per Nautical Mile of Spawn[a]			
Area	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 that is within 30% of the mean egg density.

Table 2.–Fecundity relationships used for estimating 2015 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 2015 herring spawn deposition surveys conducted in Southeast Alaska.

Survey area	Survey Leg	Survey Dates
Kah Shakes/Cat Island	I	April 6
West Behm Canal	NA	No Survey
Craig	I	April 8
Sitka Sound	I	April 10-13, May 6-7
Ernest Sound	I	April 21–22
Hobart Bay/Port Houghton	II	May 5
Hoonah Sound	II	May 7
Tenakee Inlet	II	May 9
Lynn Canal	II	May 10
Seymour Canal	II	May 11

Table 4.–Summary of herring egg estimates (in thousands) by transect for 2015 spawn deposition surveys conducted in Sitka Sound.

	Sitka Sound 1st Survey		Sitka Sound 2nd Survey	
Transect Number	Egg estimate	Frame count	Egg estimate	Frame count
1	710	7	0	1
2	1,694	40	0	1
3	623	19	0	1
4	0	1	0	1
5	1,812	13	230	4
6	1,496	17	198	5
7	226	4	297	5
8	315	5	290	4
9	796	20	249	3
10	148	12	121	3
11	771	20	117	7
12	937	12	0	1
13	436	11	0	1
14	896	20	1	2
15	1,129	10	168	3
16	1,108	15	170	5
17	455	15	5	4
18	77	6	81	6
19	296	11	478	9
20	456	8	166	6
21	87	4	197	7
22	1,353	5	458	10
23	701	8	221	5
24	481	10	0	1
25	70	5	1	3
26	267	6	42	8
27	276	7	—	—
28	186	4	—	—
29	13	4	—	—
30	422	7	—	—
31	31	4	—	—
32	440	7	—	—
33	1,130	7	—	—
34	1,249	13	—	—
35	371	6	—	—
36	198	5	—	—
37	37	7	—	—
38	221	8	—	—
39	173	3	—	—
40	536	7	—	—
41	1,222	6	—	—
42	926	7	—	—
43	552	8	—	—
44	609	8	—	—
45	576	14	—	—
46	13	3	—	—
47	454	12	—	—
48	593	7	—	—
49	461	9	—	—
50	12	5	—	—

Note: Em-dashes indicate no survey transects planned.

Table 5.–Summary of herring egg estimates (in thousands) by transect for 2015 spawn deposition surveys conducted in Southeast Alaska (excluding Sitka Sound).

	Craig		Ernest Sound		Hobart/Houghton		Hoonah Sound		Seymour Canal		Tenakee Inlet		Kah Shakes/Cat Is.		Lynn Canal	
Transect Number	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	frame count	frame count	egg estimate	frame count	egg estimate	frame count
1	0	1	64	4	1	3	0	1	2,547	31	3,279	25	175	11	141	6
2	72	15	574	13	0	1	0	1	344	7	17	5	364	9	148	5
3	1,340	36	122	9	5	5	0	1	334	13	1,539	16	5	1	561	6
4	0	1	248	14	0	1	0	1	1,809	13	1,315	10	3,610	31	389	8
5	442	17	5	4	0	1	30	4	459	11	1,285	5	98	30	204	8
6	710	16	2	2	0	1	2	4	385	13	684	11	539	25	273	16
7	3,008	83	93	13	1	5	16	10	0	1	1,849	8	117	11	1	2
8	905	26	9	10	0	1	0	1	2,551	37	849	4	82	6	703	19
9	0	1	14	5	17	6	0	1	2,476	20	270	8	0	1	3,085	12
10	1	4	4	2	5	2	0	1	2,437	28	156	9	240	16	77	2
11	0	1	8	7	0	1	—	—	1,460	14	2	2	34	9	8	5
12	408	13	1	3	0	1	—	—	1,010	4	109	4	261	5	12	3
13	1,625	15	0	1	0	1	—	—	45	6	71	4	1,439	34	31	9
14	45	5	0	1	0	1	—	—	0	1	567	4	1,675	29	21	7
15	278	4	115	5	0	1	—	—	0	1	0	1	394	19	96	5
16	995	21	277	9	0	1	—	—	0	1	31	2	2,150	43	2	2
17	193	5	20	11	0	1	—	—	0	1	15	4	0	1	41	6
18	4	3	0	1	0	1	—	—	0	1	2,247	27	0	2	0	1
19	140	9	—	—	0	1	—	—	0	1	1,607	24	0	1	0	2
20	1,510	20	—	—	0	1	—	—	0	1	609	15	89	9	13	1
21	1,985	24	—	—	—	—	—	—	0	1	—	—	663	32	—	—
22	204	7	—	—	—	—	—	—	0	1	—	—	0	1	—	—
23	736	6	—	—	—	—	—	—	0	1	—	—	1,263	32	—	—
24	170	8	—	—	—	—	—	—	0	1	—	—	0	2	—	—
25	35	2	—	—	—	—	—	—	0	1	—	—	1,190	22	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	0	1	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Note: Em-dashes indicate no survey transects planned.

Table 6.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2015.

Spawning Stock[b]	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	Post-fishery mature biomass (tons)
Craig	25	69	11.5	1,461,043	431,690	0.701	80.3	15,801	88,700,772	7,847
Ernest Sound	18	32	5.5	322,557	136,477	0.049	58.2	11,162	8,764,371	562
Hobart/Houghton	20	9	4.4	73,339	8,297	0.001	81.0	16,451	82,200	7
Hoonah Sound	10	13	4.2	97,230	19,152	0.002	99.0	20,444	202,412	22
Seymour Canal	25	42	7.7	598,937	755,094	0.503	80.1	16,232	61,914,187	5,464
Sitka Sound total	76	44	87.9	7,142,409	578,850	4.594	122.7	21,350	430,331,705	58,183
[a]Sitka Sound – 1st	50	47	77.0	6,730,909	594,109	4.443	—	—	—	—
[a]Sitka Sound – 2nd	26	20	10.9	411,500	329,259	0.151	—	—	—	—
Tenakee Inlet	20	47	2.3	201,266	873,138	0.195	83.3	13,522	28,879,162	2,644
Kah Shakes/Cat Is.	26	74	11.9	1,623,242	375,708	0.678	62.3	11,272	120,237,227	8,251
Lynn Canal	20	31	9.4	544,025	464,355	0.281	83.1	16,902	33,214,717	3,041
Total	240	—	145.8	12,064,048	—	7.002	—	—	772,326,752	86,023
Average	27	39	—	1,340,450	415,103	0.778	83.3	15,904	—	—

[a] Two separate surveys were conducted in Sitka in 2015 because of two spawning events, so final estimates of egg deposition were calculated by summing estimates from each survey.

Not shown is West Behm Canal, an area typically surveyed annually; it was not surveyed in 2015 due to a low level of observed spawn (1.0 nm).

Table 7.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2015. Data was combined for years 2013 through 2015.

	Estimator initials[a]								
Kelp type	BM	DG	JB	JM	KH	SD	TT	EC	SK
Eelgrass	1.026	0.976	1.192	1.127	0.897	0.801	1.398	1.863	0.756
n =	29	29	29	29	29	29	29	28	29
Fucus	1.115	1.493	1.244	0.990	1.160	0.955	1.374	1.812	1.026
n =	28	28	28	28	28	28	28	28	28
Fir kelp	1.013	0.752	0.890	0.980	0.997	1.091	1.415	2.180	0.655
n =	28	28	28	27	28	28	28	28	28
Hair kelp	1.120	1.089	1.360	1.000	0.809	0.988	1.546	1.820	1.032
n =	36	36	36	36	36	36	36	36	36
Large brown kelp[b]	0.573	1.283	0.876	0.692	0.828	0.837	1.079	1.587	0.895
n =	25	25	24	25	25	25	25	25	25
Average[c]	0.970	1.118	1.112	0.958	0.938	0.934	1.362	1.852	0.873

[a] All data from years 2013 through 2015.

[b] Values applied to genera *Laminara*, *Agarum*, *Alaria*, *Cymethere*, *Costaria*, and *Macrocystis*.

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

Table 8.–Summary of samples collected from Southeast Alaska herring stocks in 2014–15.

	Commercial Fishery			Survey	Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	528	528	528	–	1,584
Ernest Sound	–	–	–	531	–	531
Hobart/Houghton	–	–	–	550	–	550
Hoonah Sound[a]	–	–	–	–	–	–
Lynn Canal	–	–	–	528	–	528
Seymour Canal	–	–	–	520	–	520
Sitka Sound	–	–	532	530	440	1,502
Tenakee Inlet	–	–	–	531	–	531
West Behm Canal	–	–	–	509	–	
Revilla Channel	–	–	–	531	–	531
Yakutat[a]	–	–	–	–	–	–
Total	–	528	1,060	4,758	440	6,786

[a] No samples collected in 2015.

Table 9.–Summary herring samples aged for Southeast Alaska stocks in 2014–15.

	Commercial Fishery			Survey	Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	528	525	528	–	1,581
Ernest Sound	–	–	–	511	–	511
Hobart/Houghton	–	–	–	550	–	550
Hoonah Sound[a]	–	–	–	–	–	–
Lynn Canal	–	–	–	518	–	518
Seymour Canal	–	–	–	518	–	518
Sitka Sound	–	–	532	540	436	1,508
Tenakee Inlet	–	–	–	531	–	531
West Behm Canal	–	–	–	442	–	
Revilla Channel	–	–	–	514	–	514
Yakutat[a]	–	–	–	–	–	–
Total	–	528	1,057	4,652	436	6,673

[a] No samples collected in 2015.

Table 10.–Summary of age, weight, and length for the Sitka Sound herring stock in 2014–15.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	261	6	109	25	29	110	540
	percent age composition	48%	1%	20%	5%	5%	20%	100%
	average weight (g)	72.1	92.8	111.3	137.0	148.6	170.9	122.1
	standard dev. of weight (g)	10.5	19.2	21.8	23.5	22.6	23.7	20.2
	average length (mm)	178	194	204	217	223	237	209
	variance of length (mm)	48	186	139	190	74	96	122
commercial purse seine–spring	number of fish	91	9	126	41	50	215	532
	percent age composition	17%	2%	24%	8%	9%	40%	100%
	average weight (g)	80.0	104.9	129.2	157.3	170.1	198.1	139.9
	standard dev. of weight (g)	11.5	27.8	23.3	26.5	22.9	26.6	23.1
	average length (mm)	179	194	204	217	225	236	209
	variance of length (mm)	45	334	103	110	112	117	137
test fishery purse seine–winter	number of fish	161	11	119	25	19	101	436
	percent age composition	37%	3%	27%	6%	4%	23%	100%
	average weight (g)	74.9	88.9	113.4	141.1	158.4	182.5	126.5
	standard dev. of weight (g)	17.5	21.2	24.9	20.3	21.9	25.9	22.0
	average length (mm)	182	194	205	221	230	239	212
	variance of length (mm)	111	105	182	80	101	142	120

Table 11.–Summary of age, weight, and length for the Craig herring stock in 2014–15.

Gear type/season	Age category	Age Category 3	4	5	6	7	8+	Total
survey cast net spring	number of fish	308	21	86	25	47	35	522
	percent age composition	59%	4%	16%	5%	9%	7%	100%
	average weight (g)	59.6	70.1	88.7	101.7	107.1	122.6	91.6
	standard dev. of weight (g)	12.7	13.5	17.1	20.0	20.1	24.8	18.0
	average length (mm)	165	173	185	195	198	206	187
	variance of length (mm)	100	63	73	92	97	88	86
commercial pound – spring	number of fish	301	12	93	33	53	35	527
	percent age composition	57%	2%	18%	6%	10%	7%	100%
	average weight (g)	61.2	73.3	94.6	109.8	124.8	136.3	100.0
	standard dev. of weight (g)	10.8	12.8	18.1	19.0	18.1	21.9	16.8
	average length (mm)	165	174	188	197	203	210	189
	variance of length (mm)	83	45	89	97	68	76	76
commercial seine–winter	number of fish	161	26	109	62	75	92	525
	percent age composition	31%	5%	21%	12%	14%	18%	100%
	average weight (g)	66.3	81.9	99.3	114.5	122.1	133.5	102.9
	standard dev. of weight (g)	10.3	14.7	17.0	20.2	17.4	17.4	16.2
	average length (mm)	167	175	185	195	200	207	188
	variance of length (mm)	64	81	86	114	78	83	84

Table 12.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2014–15.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	76	11	127	268	7	61	550
	percent age composition	14%	2%	23%	49%	1%	11%	100%
	average weight (g)	54.2	65.9	73.6	85.8	96.9	109.9	81.1
	standard dev. of weight (g)	10.9	13.4	16.3	18.0	15.4	27.3	16.9
	average length (mm)	164	170	179	189	196	203	184
	variance of length (mm)	76	63	146	154	69	191	117
commercial gillnet–spring	number of fish	NO FISHERY						
	percent age composition							
	average weight (g)							
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 13.–Summary of age, weight, and length for the Ernest Sound herring stock in 2014–15.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	271	31	85	75	29	20	511
	percent age composition	53%	6%	17%	15%	6%	4%	100%
	average weight (g)	45.9	62.2	70.0	73.9	76.0	83.9	68.6
	standard dev. of weight (g)	9.0	11.8	9.6	11.1	11.8	12.8	11.0
	average length (mm)	154	172	179	182	184	190	177
	variance of length (mm)	84	85	45	54	53	44	61
commercial pound–spring	number of fish							
	percent age composition							
	average weight (g)							
	standard dev. of weight (g)			NO FISHERY				
	average length (mm)							
	variance of length (mm)							
commercial seine–winter	number of fish							
	percent age composition							
	average weight (g)			NO FISHERY				
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 14.–Summary of age, weight, and length for the Hoonah Sound herring stock in 2014–15.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish							
	percent age composition							
	average weight (g)			NO SAMPLES OBTAINED				
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							
commercial pound –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 Tenakee Inlet herring stock in 2014–15.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	285	15	93	74	9	55	531
	percent age composition	54%	3%	18%	14%	2%	10%	100%
	average weight (g)	65.2	76.9	95.2	104.4	120.4	123.9	97.7
	standard dev. of weight (g)	11.3	9.0	17.5	17.9	20.3	18.8	15.8
	average length (mm)	172	182	193	199	206	211	194
	variance of length (mm)	56	49	83	88	72	66	69
commercial pound–spring	number of fish							
	percent age composition							
	average weight (g)				NO FISHERY			
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							
commercial seine–winter	number of fish							
	percent age composition							
	average weight (g)				NO FISHERY			
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 16.–Summary of age, weight, and length for the Seymour Canal herring stock in 2014–15.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	111	23	30	208	29	117	518
	percent age composition	21%	4%	6%	40%	6%	23%	100%
	average weight (g)	65.6	57.6	86.7	78.7	89.4	96.7	79.1
	standard dev. of weight (g)	12.8	10.7	24.1	18.1	20.6	21.6	18.0
	average length (mm)	167	162	182	178	185	191	178
	variance of length (mm)	103	91	201	143	161	140	140
commercial gillnet–spring	number of fish							
	percent age composition				NO FISHERY			
	average weight (g)							
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 17.–Summary of age, weight, and length for the West Behm Canal herring stock in 2014–15.

		Age category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	322	26	56	27	6	5	442
	percent age composition	73%	6%	13%	6%	1%	1%	100%
	average weight (g)[a]	41.3	52.1	64.9	73.2	75.4	86.2	65.5
	standard dev. of weight (g)	9.2	11.6	10.2	11.4	11.8	6.6	10.1
	average length (mm)	153	166	177	185	185	192	176
	variance of length (mm)	87	140	41	78	107	34	81
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)							

[a] weights are likely biased low due to required additional sample handling that resulted in loss of weight.

Table 18.–Summary of age, weight, and length for the Lynn Canal herring stock in 2014–15.

		Age category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	215	31	42	124	15	91	518
	percent age composition	42%	6%	8%	24%	3%	18	100%
	average weight (g)	62.9	66.2	82.0	96.2	104.5	115.5	87.9
	standard dev. of weight (g)	14.2	13.2	19.2	22.4	11.6	23.6	17.4
	average length (mm)	169	170	181	188	192	200	183
	variance of length (mm)	118	89	143	149	47	135	113

Table 19.–Summary of age, weight, and length for the Revilla Channel herring stock in 2014–15.

		Age category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	348	45	59	39	14	9	514
	percent age composition	68%	9%	11%	8%	3%	2%	100%
	average weight (g)	53.2	66.5	80.2	85.0	94.4	123.3	83.8
	standard dev. of weight (g)	11.3	16.4	18.1	16.9	19.4	23.1	17.5
	average length (mm)	161	172	182	185	191	205	183
	variance of length (mm)	87	127	118	78	133	60	101

Table 20.–Summary of age, weight, and length for the Yakutat herring stock in 2014–15.

		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)							

Table 21.–Proportion of mature age-3 herring (cast net, 1988–2015), latitude, and sea temperature (2000–2013) 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 (^oC)	Mean minimum annual sea temperature (^oC)	Mean maximum annual sea temperature (^oC)
Kah Shakes	55.0300	23%	31%	8.6	5.9	14.7
Craig	55.4770	20%	23%	9.0	4.7	14.1
WBC	55.4846	26%	31%	8.8	5.3	14.3
Ernest Sound	55.8307	28%	31%	—	—	—
Sitka	57.0079	11%	17%	8.6	4.9	13.8
Hobart Bay	57.4308	7%	14%	7.1	3.9	12.9
Seymour Canal	57.5923	10%	15%	6.7	3.0	13.3
Hoonah Sound	57.6001	7%	16%	7.9	2.0	15.0
Tenakee Inlet	57.7381	11%	13%	7.8	1.9	15.0
Lynn Canal	58.6402	6%	15%	7.1	2.6	15.4

Table 22.–Summary of Southeast Alaska herring target levels for the 2014–15 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target Exploitation Rate (%)	Guideline harvest level (tons)[a]
Craig	5,000	15,803	14.3	1,358
Ernest Sound	2,500	1,991	0.0	—
Hobart Bay/Port Houghton	2,000	110	0.0	—
Hoonah Sound	1,000	721	0.0	—
Seymour Canal	3,000	1,666	0.0	—
Sitka Sound	25,000	44,237	19.7	8,712
Tenakee Inlet	3,000	927	0.0	—
West Behm Canal	6,000	3,849	0.0	—
Lynn Canal	5,000	—	0.0	—
Kah Shakes/Cat Island	6,000	—	0.0	—

[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 23.–Summary of commercial herring harvest during the 2014–15 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	5-Oct-14	28-Feb-15	–[d]
Winter food and bait	Purse seine	Tenakee Inlet	12	Not Open		–
Winter food and bait	Purse seine	Ernest Sound	7	Not Open		–
Winter food and bait	Purse seine	Hobart Bay	10	Not Open		–
Sub-total						–[d]
Sac roe	Purse seine	Sitka Sound	13	18-Mar-15	25-Mar-15	8,756
Sac roe	Purse seine	Lynn Canal	11	Not Open		–
Sac roe	Gillnet	Seymour Canal	11	Not Open		–
Sac roe	Gillnet	Hobart Bay	10	Not Open		–
Sac roe	Gillnet	Kah Shakes	1	Not Open		–
Sac roe	Gillnet	West Behm Canal	1	Not Open		–
Sub-total						8,756
Spawn on kelp	Pound	Hoonah Sound	13	Not Open		–
Spawn on kelp	Pound	Tenakee Inlet	12	Not Open		–
Spawn on kelp	Pound	Ernest Sound	7	Not Open		–
Spawn on kelp	Pound	Craig	3	17-Mar-15	4-Apr-15	–[d]
Sub-total						–[d]
Test fishery - bait	Purse seine	Sitka	13	2-Mar-15	3-Mar-15	53

[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] Confidential data.

Figure 1.–Locations of major herring spawning areas in Southeast Alaska, where surveys or sampling of herring was conducted during 2014–15.

Stock	25-Mar	26-Mar	27-Mar	28-Mar	29-Mar	30-Mar	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
Craig			0.5	2.5	2.0	7.0	3.0	0.5											
Sitka Sound	0.3	0.3	0.8	3.8	7.6	19.0	32.3	29.3	24.5	9.5	6.2	2.8	2.9	3.3	ns	ns	ns	ns	ns
West Behm Canal					0.1	ns	0.0	0.0	ns	0.8	0.0	0.0	0.0	0.5	0.5	ns	0.5		
Revilla Channel		3.5	3.5	2.0	2.0	3.0	0.5	2.0											
Ernest Sound										0.0	ns	ns	ns	0.1	1.8	0.8	0.1	0.8	0.0
Hoonah Sound																			
Tenakee Inlet																			
Hobart/Houghton																			
Seymour Canal																			
Lynn Canal																			
Yakutat																			

Stock	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
Craig																				
Sitka Sound	0.9	0.8	0.0	ns	ns	ns	ns	ns	1.9	5.7	1.2	ns	1.2	ns	ns	ns	ns	0.0		
West Behm Canal																				
Revilla Channel																				
Ernest Sound	0.0	ns	ns	0.0																
Hoonah Sound								0.0	ns	ns	0.0	0.4	0.4	ns	ns	ns	ns	0.0	ns	ns
Tenakee Inlet	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns	0.0	1.1	1.6	0.7	0.0	ns	0.0	0.0	ns	ns	ns
Hobart/Houghton	0.0	ns	ns	ns	0.0	ns	ns	0.0	0.0	ns	ns	2.5	1.0	0.3	0.0	ns	ns	ns	ns	0.3
Seymour Canal	0.0	ns	ns	ns	0.0	ns	ns	ns	0.0	0.0	ns	0.0	0.0	0.0	0.0	0.0	0.0	ns	0.0	ns
Lynn Canal	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.0	ns	0.0	ns	ns	0.0	0.0
Yakutat								ns	ns	ns	12.0	ns	ns	ns						

continued	3-May	4-May	5-May	6-May	7-May	8-May	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
Hobart/Houghton	ns	0.0																	
Hoonah Sound	ns	0.3	0.0	1.0	0.0														
Seymour Canal	0.1	0.5	0.5	0.2	2.0	2.0	0.5	0.9	0.0										
Lynn Canal	0.0	0.5	0.8	1.5	2.3	0.5	0.0	0.0	0.2	1.3	3.7	ns							
Tenakee Inlet	ns	ns	ns	ns	0.4	ns													

continued	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
Hobart/Houghton																				
Hoonah Sound																				
Seymour Canal																				
Lynn Canal																				
Tenakee Inlet																				

Figure 2.–Spawn timing of herring stocks in Southeast Alaska during spring 2015. Values indicate daily measurements of nautical miles of active spawn recorded during aerial surveys. Shaded area depict dates when cast-net samples were taken. Boxed areas indicate duration of spawning (first to last dates of observed spawn).

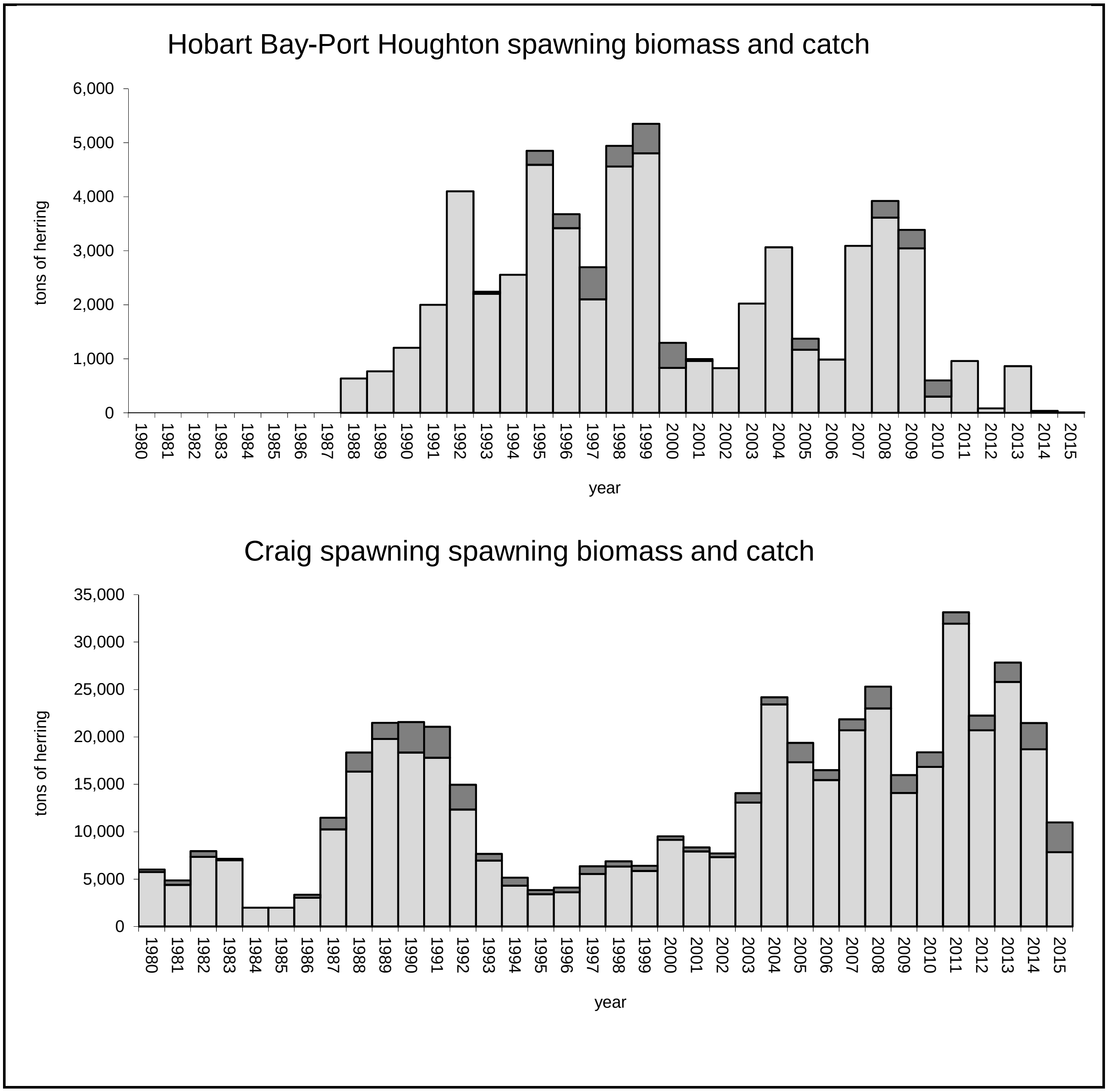

Figure 3.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Hobart Bay-Port Houghton and Craig areas, during 1980–2015.

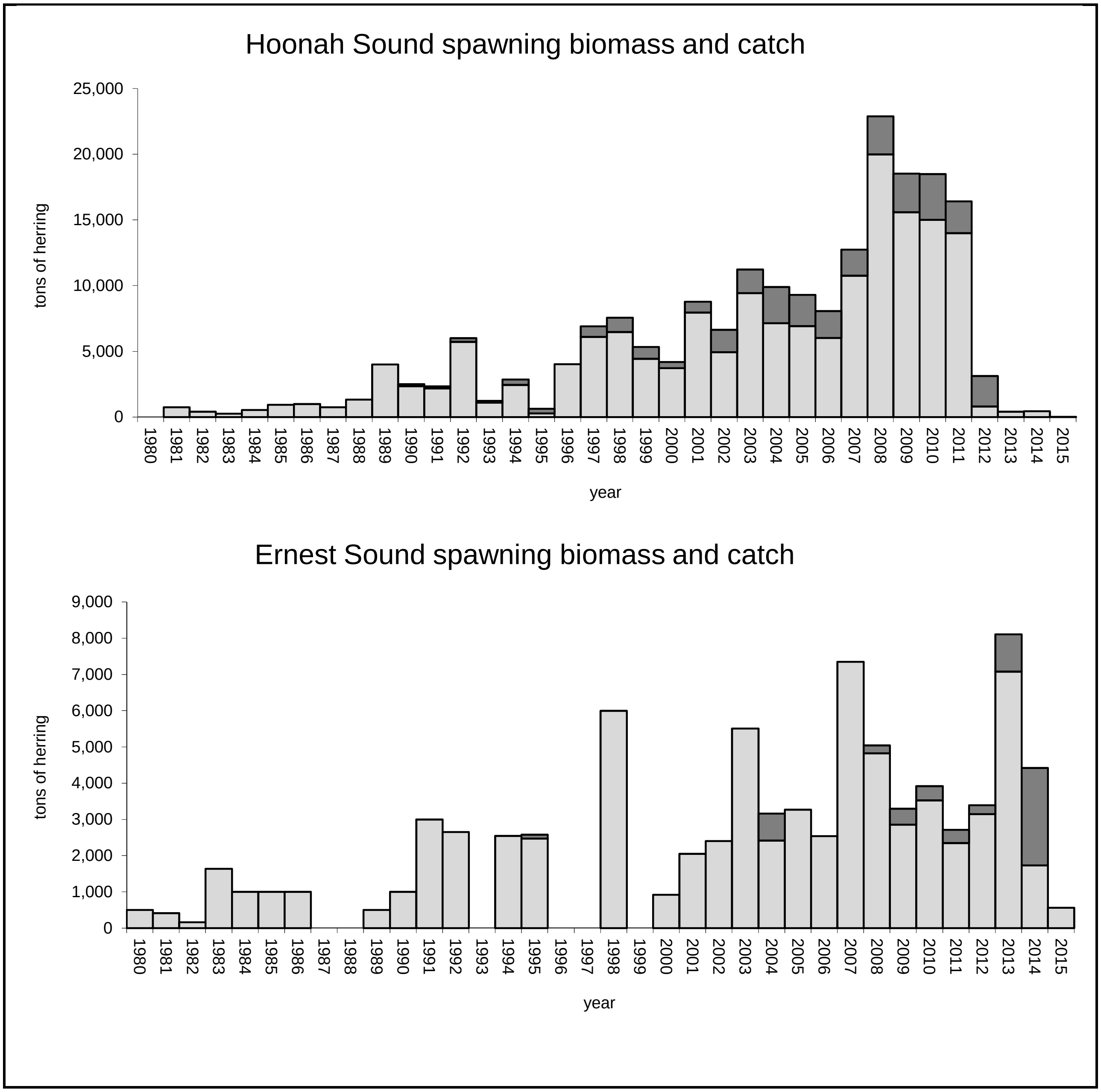

Figure 4.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Hoonah Sound and Ernest Sound areas, during 1980–2015.

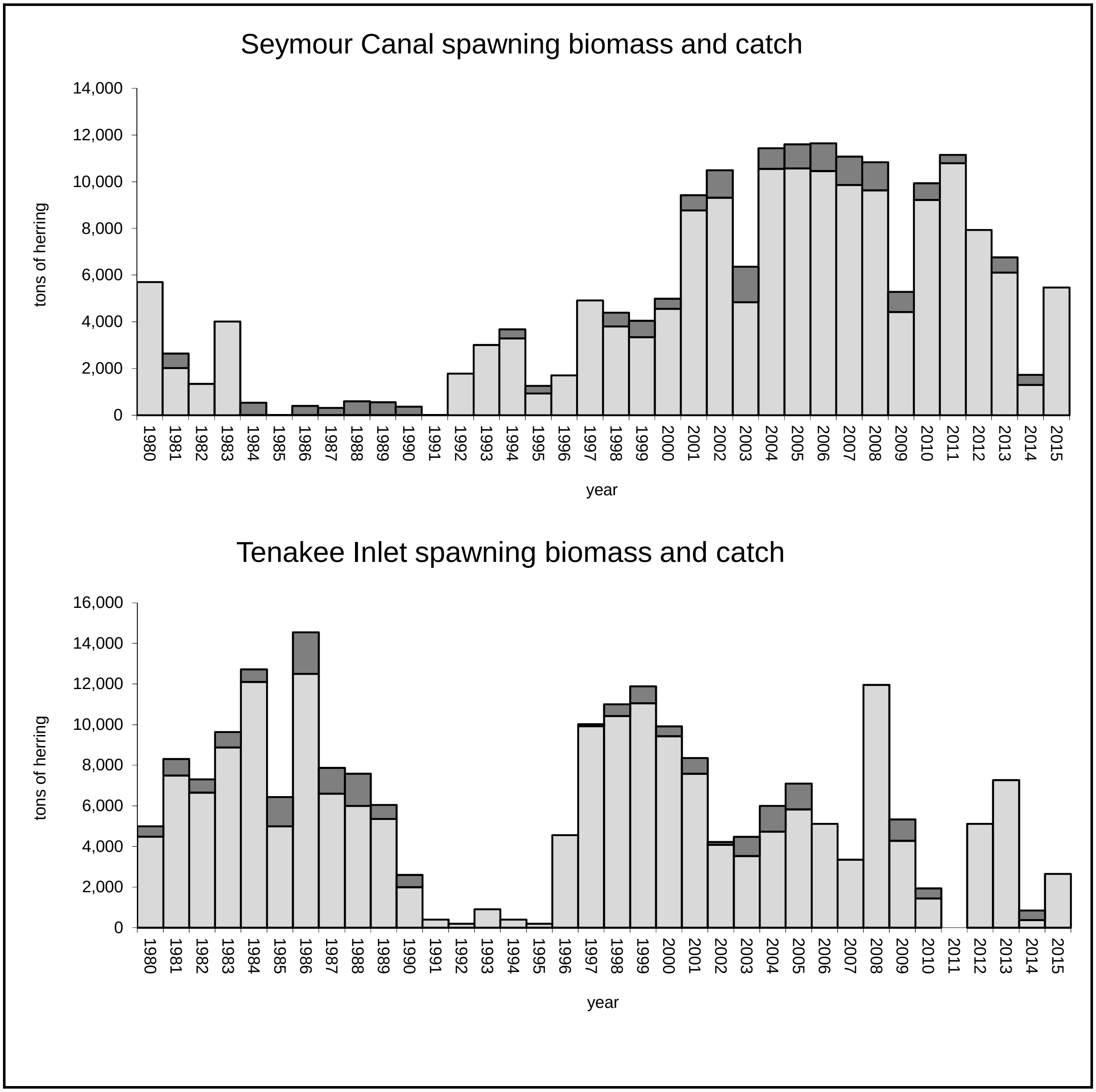

Figure 5.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Tenakee Inlet and Seymour Canal areas, during 1980–2015.

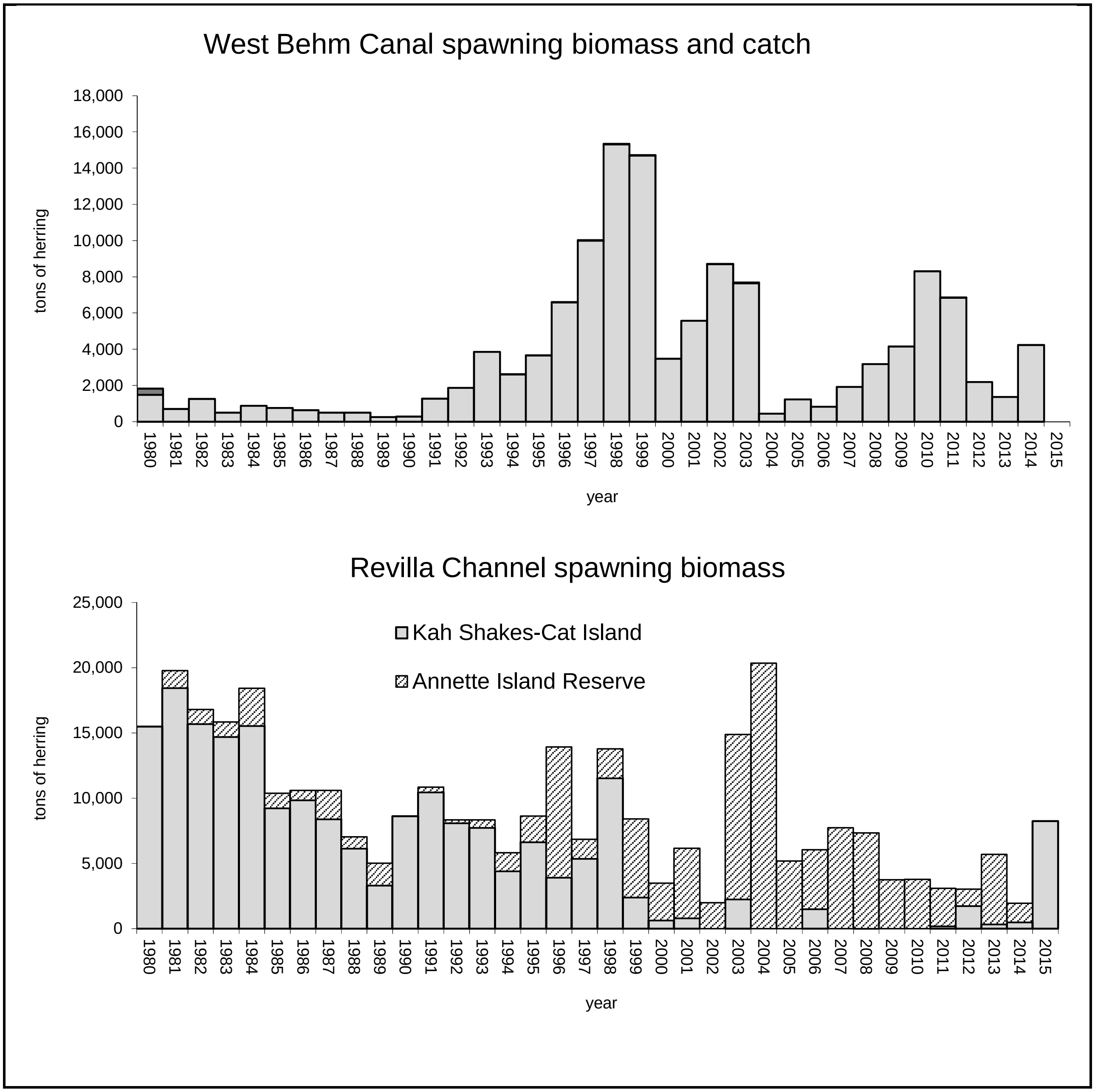

Figure 6.–Herring post-fishery spawning biomass, based on spawn deposition surveys, or hydro-acoustic surveys for stocks in the West Behm Canal and Revilla Channel (Kah Shakes-Cat Island-Annette Island) areas, during 1980–2015. Annette Island spawning biomass estimates were made as the product of the length of observed linear shoreline spawn mileage and a fixed approximated value of 500 tons of herring per nautical mileage of shoreline, based on the estimated mean value over the period 1991-2000.

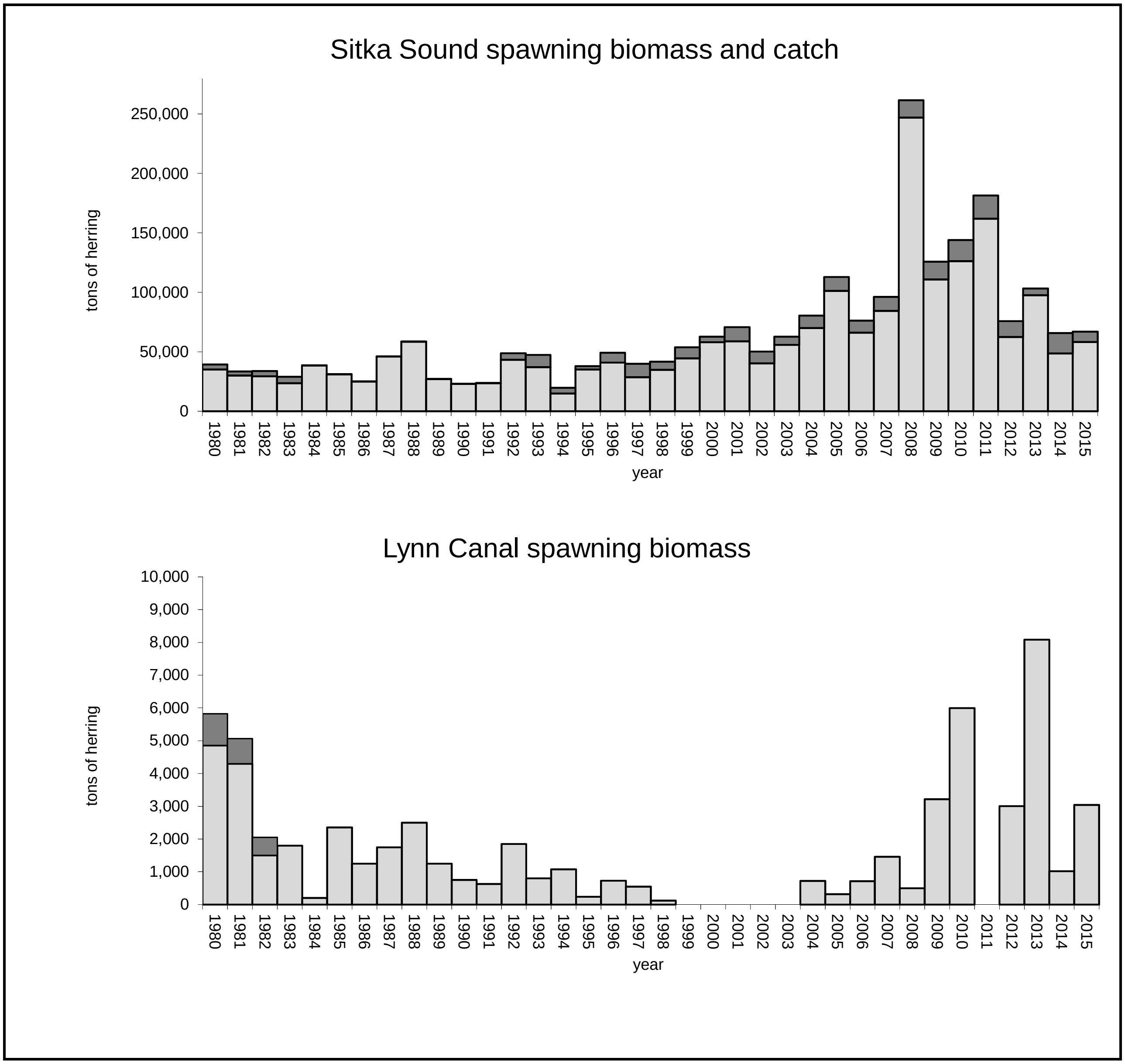

Figure 7.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2015. Estimates of spawning biomass for Lynn Canal prior to 2004 were made using a variety of methods (e.g. hydroaccoustics or visual estimates of spawn density converted to biomass), and results should be viewed as approximations.

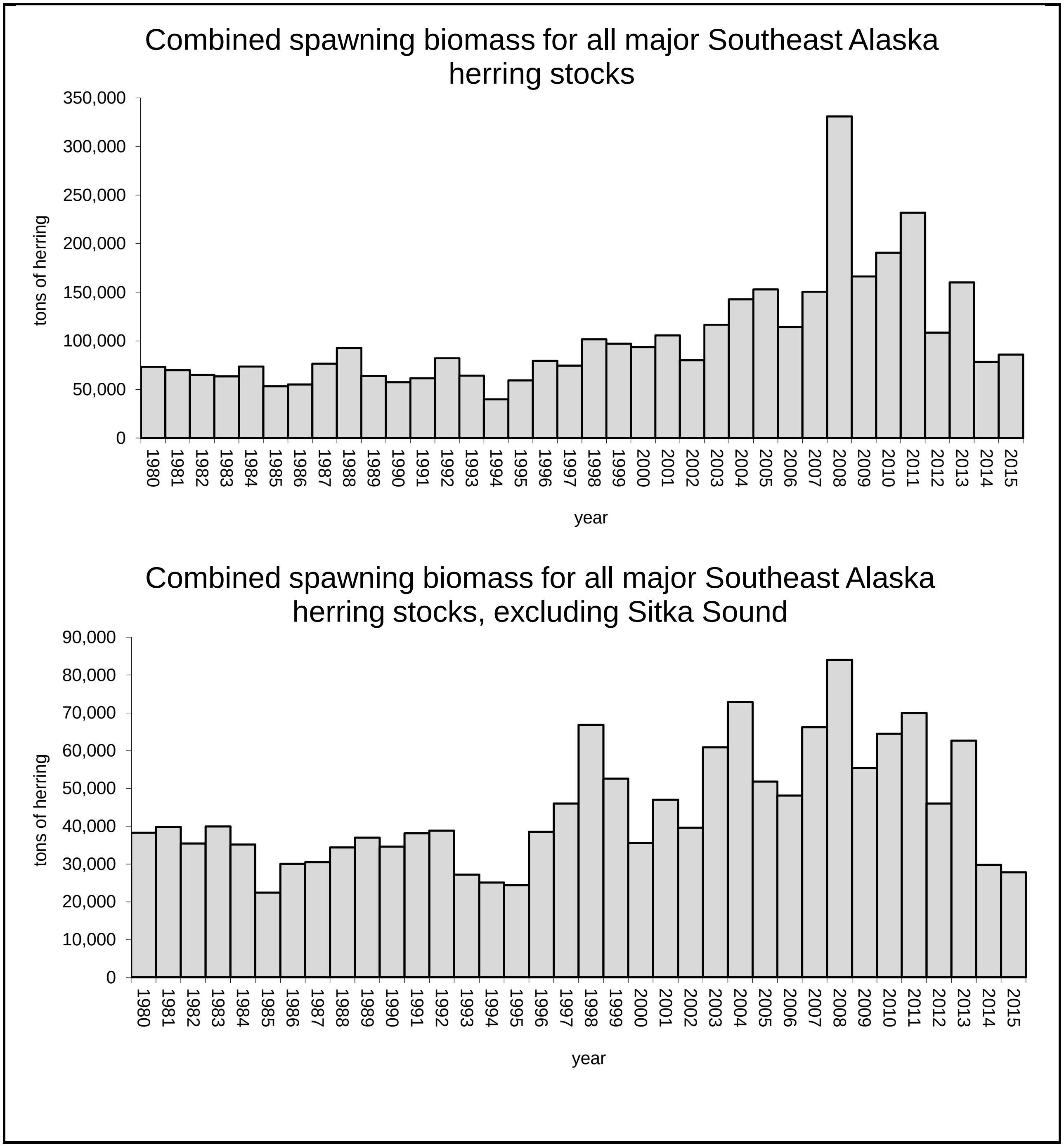

Figure 8.–Combined post-fishery spawning biomass, based on spawn deposition surveys, or hydro-acoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2015.

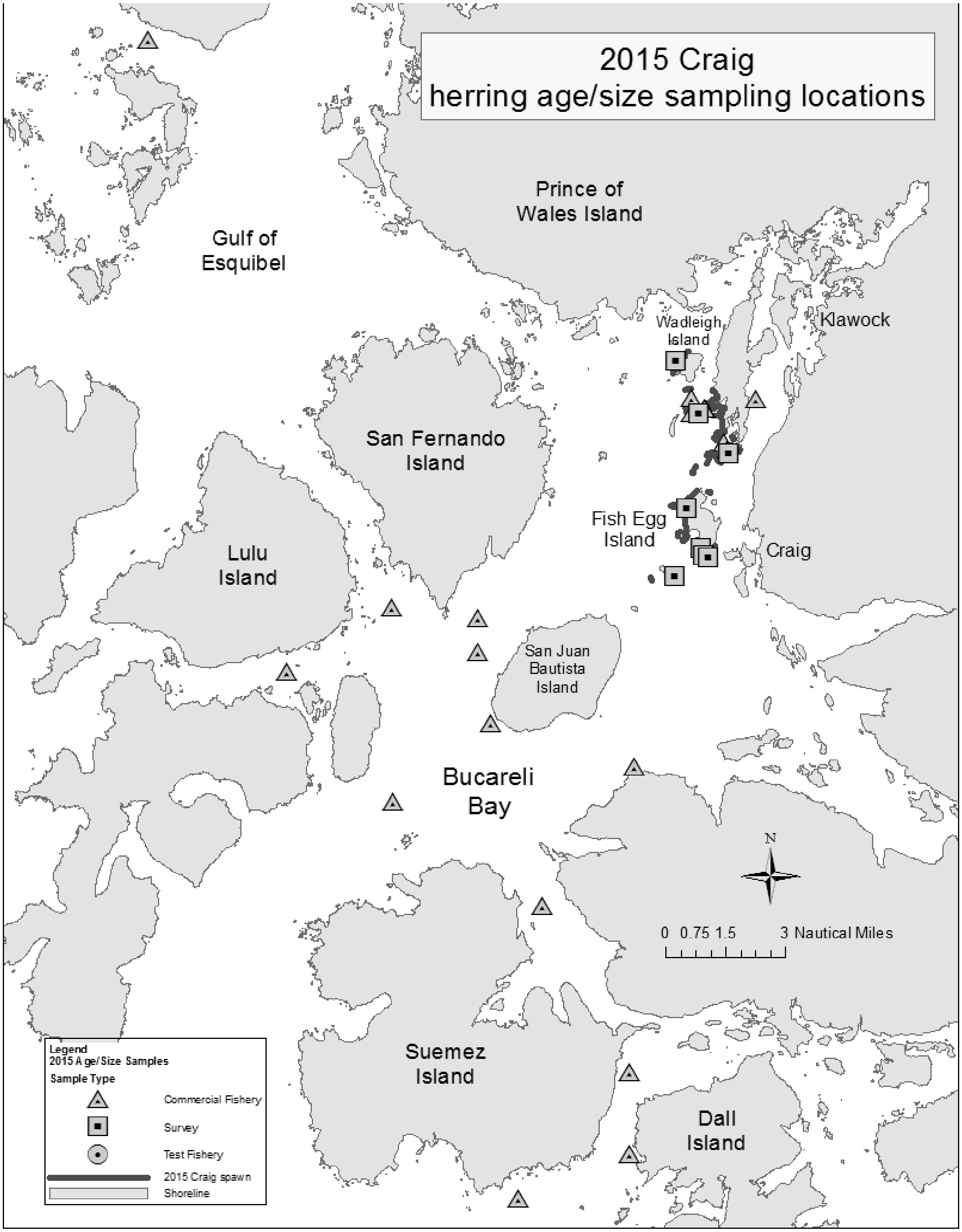

Figure 9.–Locations of herring samples collected for estimates of age and size for the Craig herring stock, 2014/2015. Cumulative herring spawn denoted by thick gray line along shoreline.

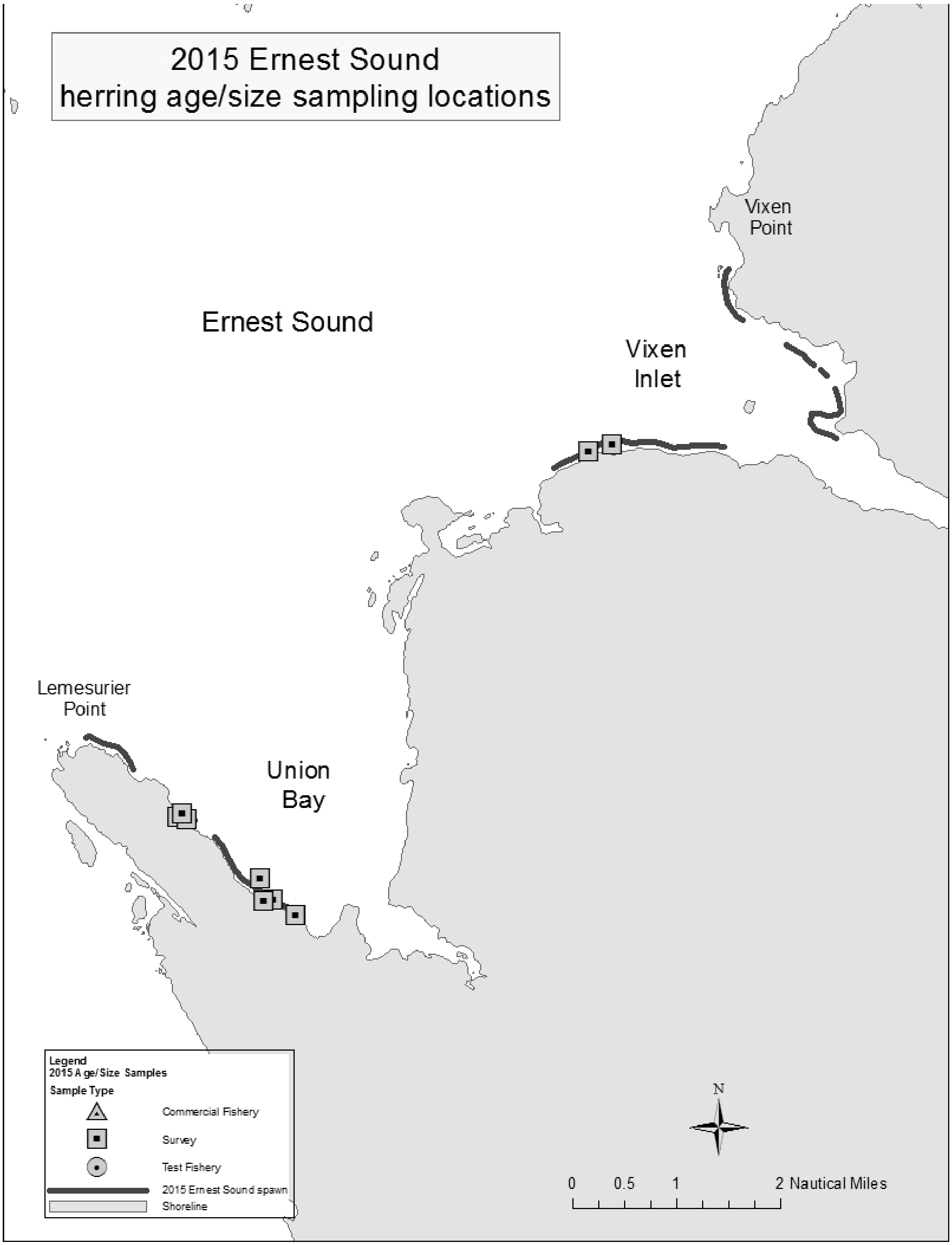

Figure 10.–Locations of herring samples collected for estimates of age and size for the Ernest Sound herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

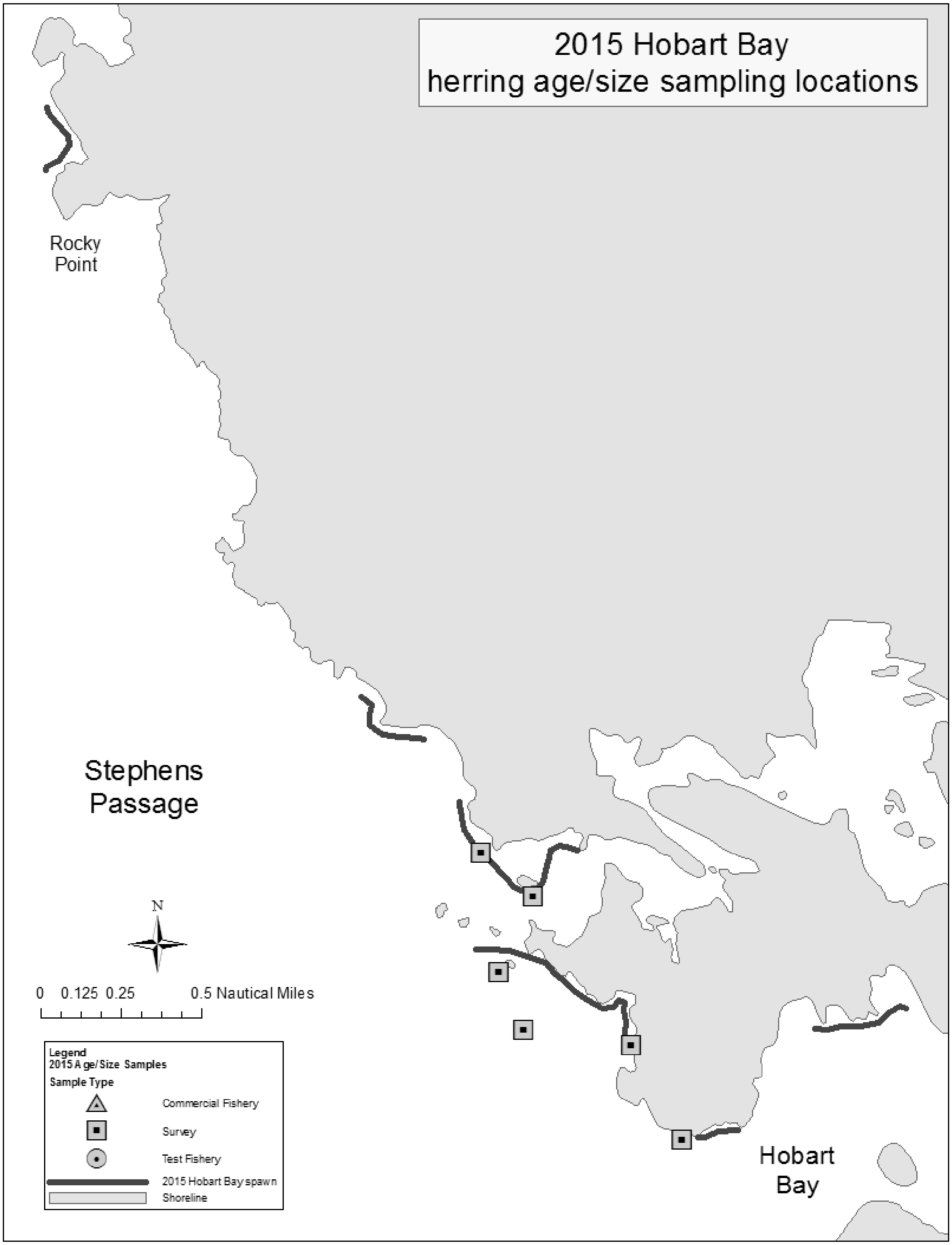

Figure 11.–Locations of herring samples collected for estimates of age and size for the Hobart bay-Port Houghton herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

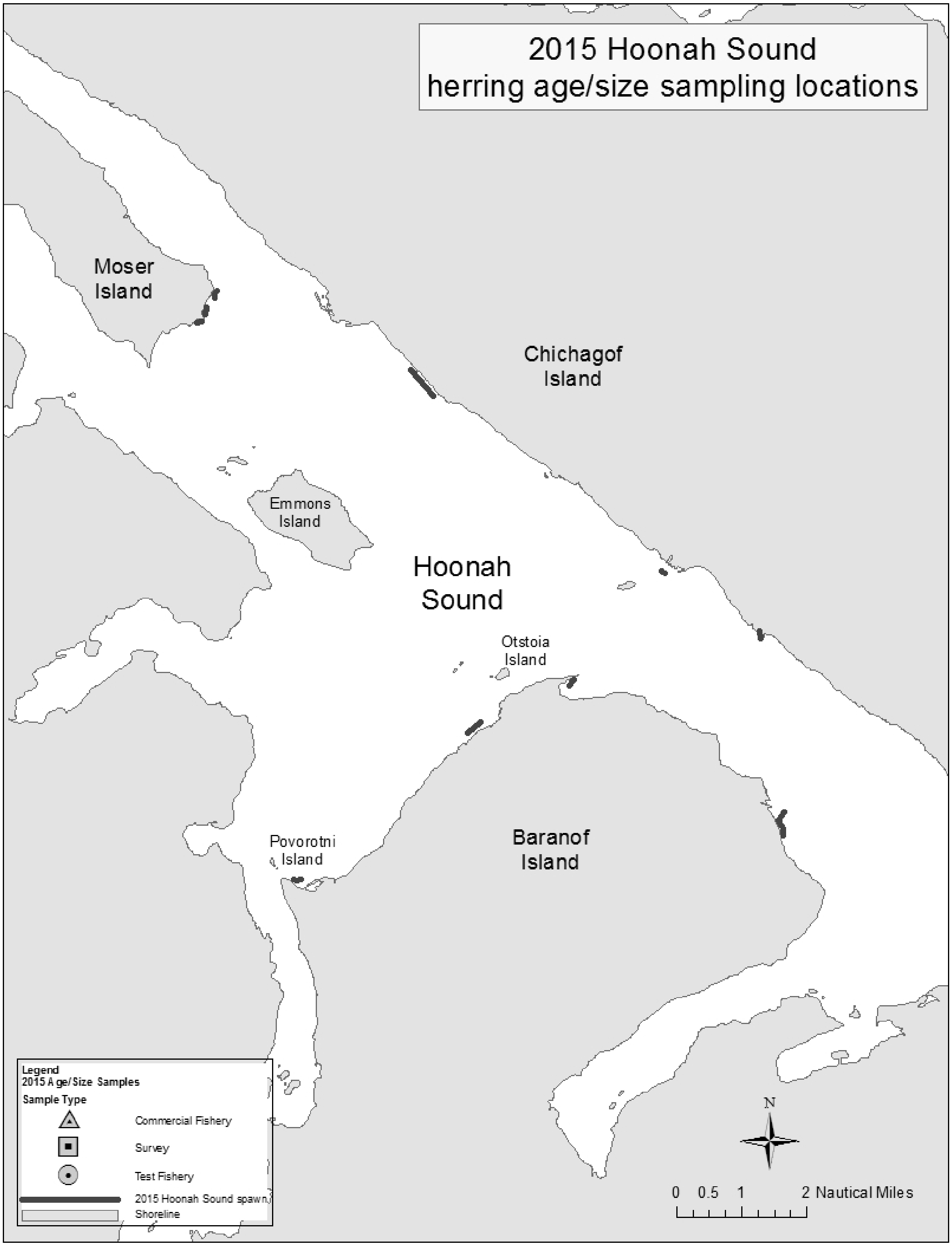

Figure 12.–Locations of herring samples collected for estimates of age and size for the Hoonah Sound herring stock, 2015. No samples were obtained for the 2015 spawning season. Cumulative herring spawn denoted by thick gray line along shoreline.

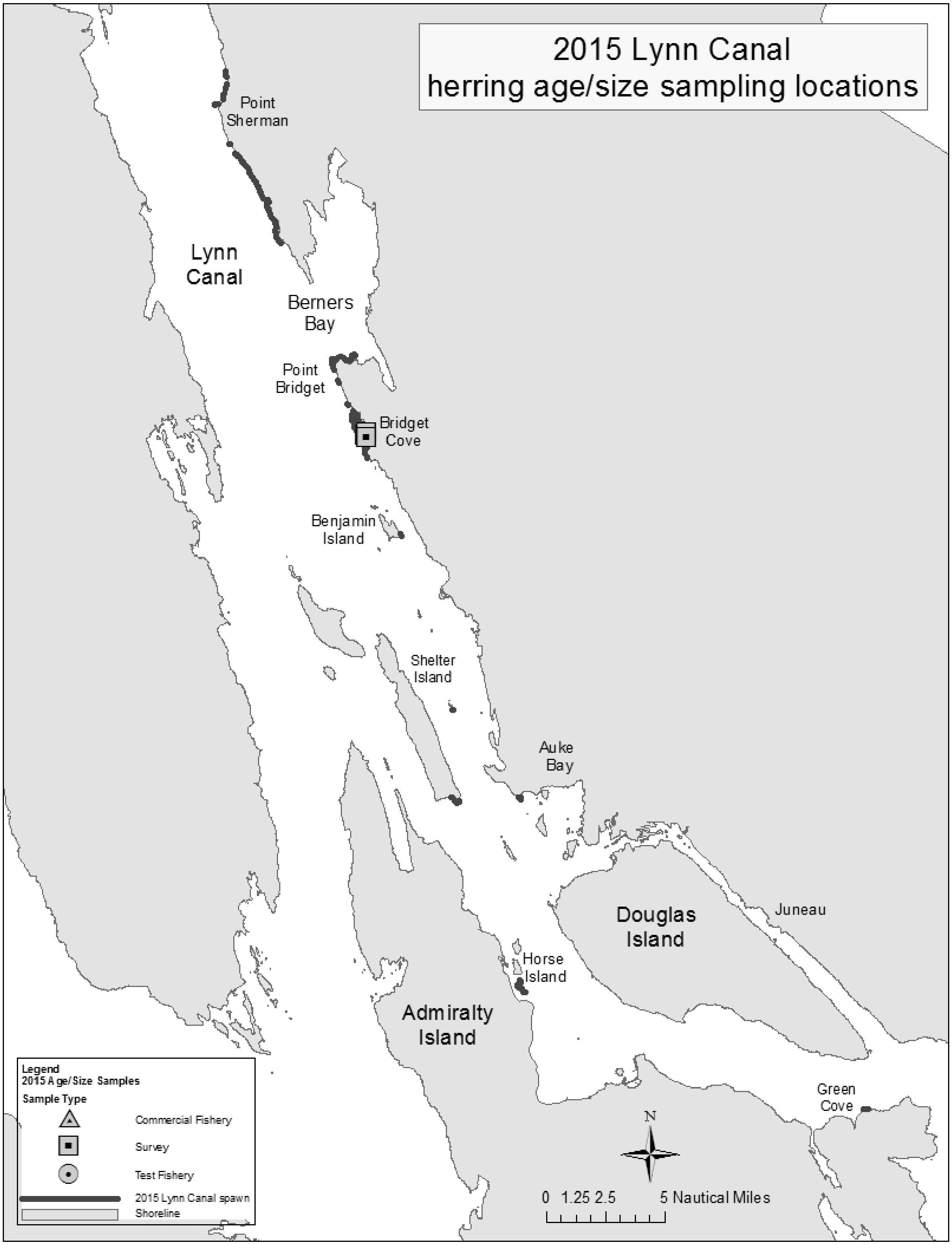

Figure 13.–Location of herring spawn for the Lynn Canal herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

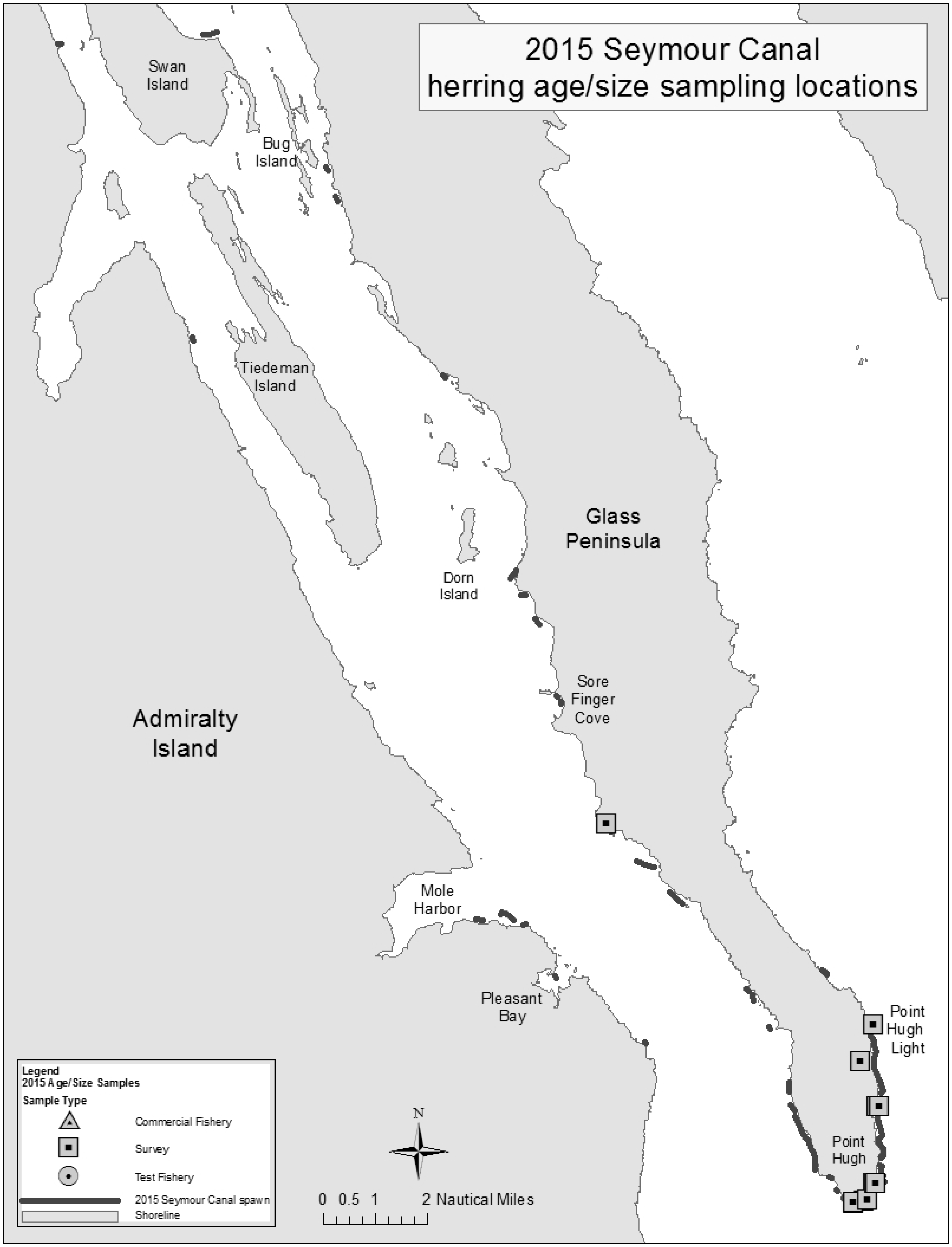

Figure 14.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

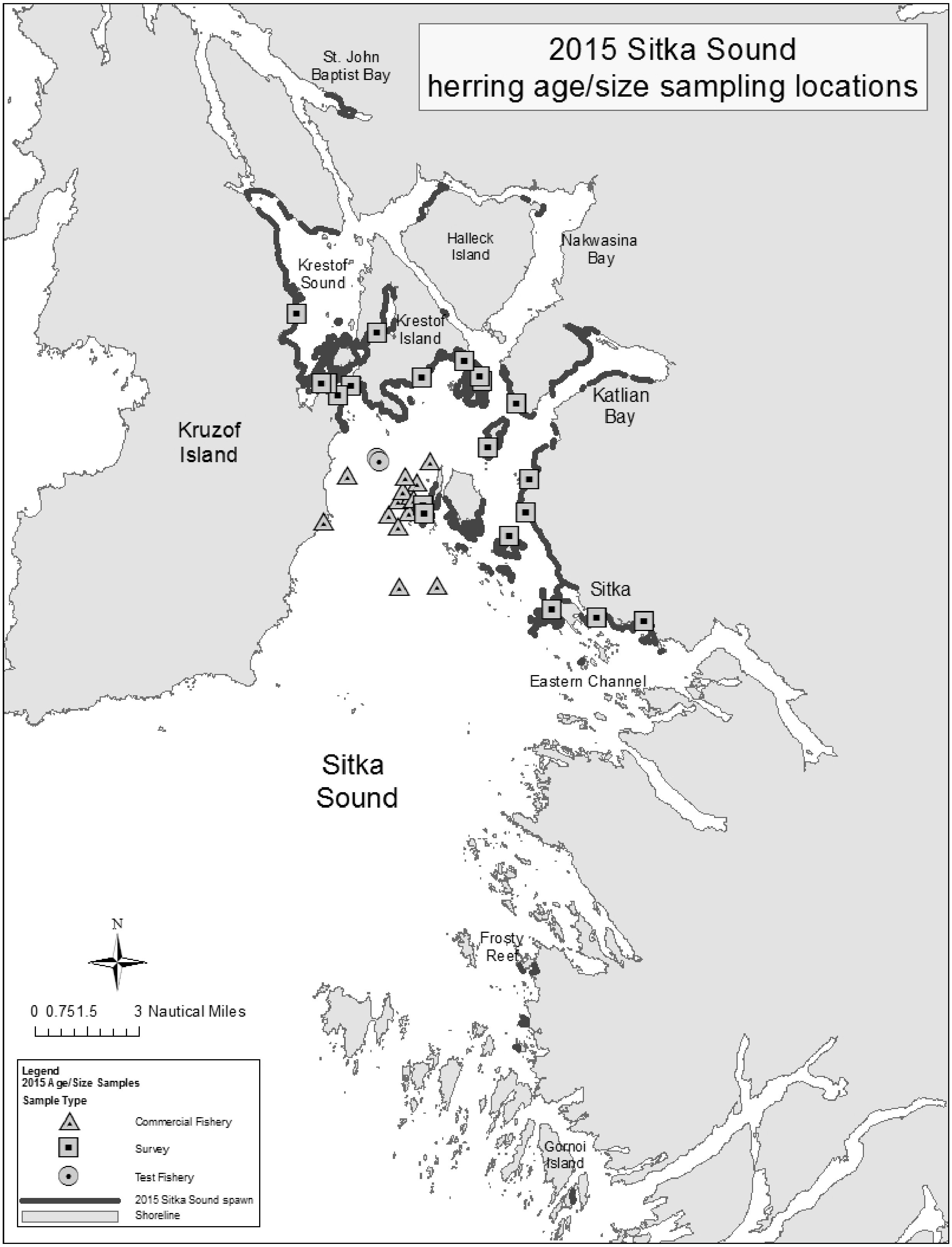

Figure 15.–Locations of herring samples collected for estimates of age and size for the Sitka Sound herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

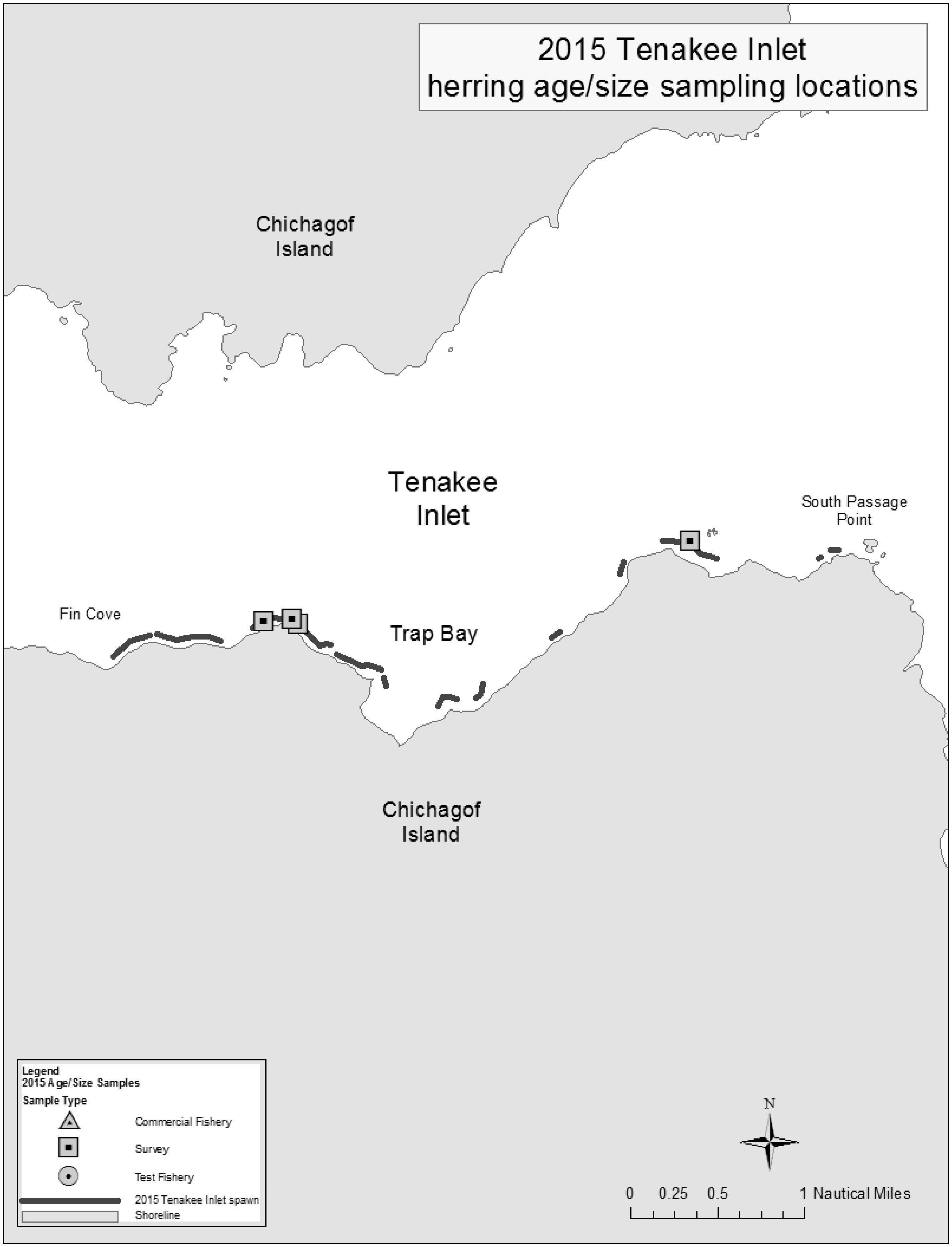

Figure 16.–Location of herring spawn for the Tenakee Inlet herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

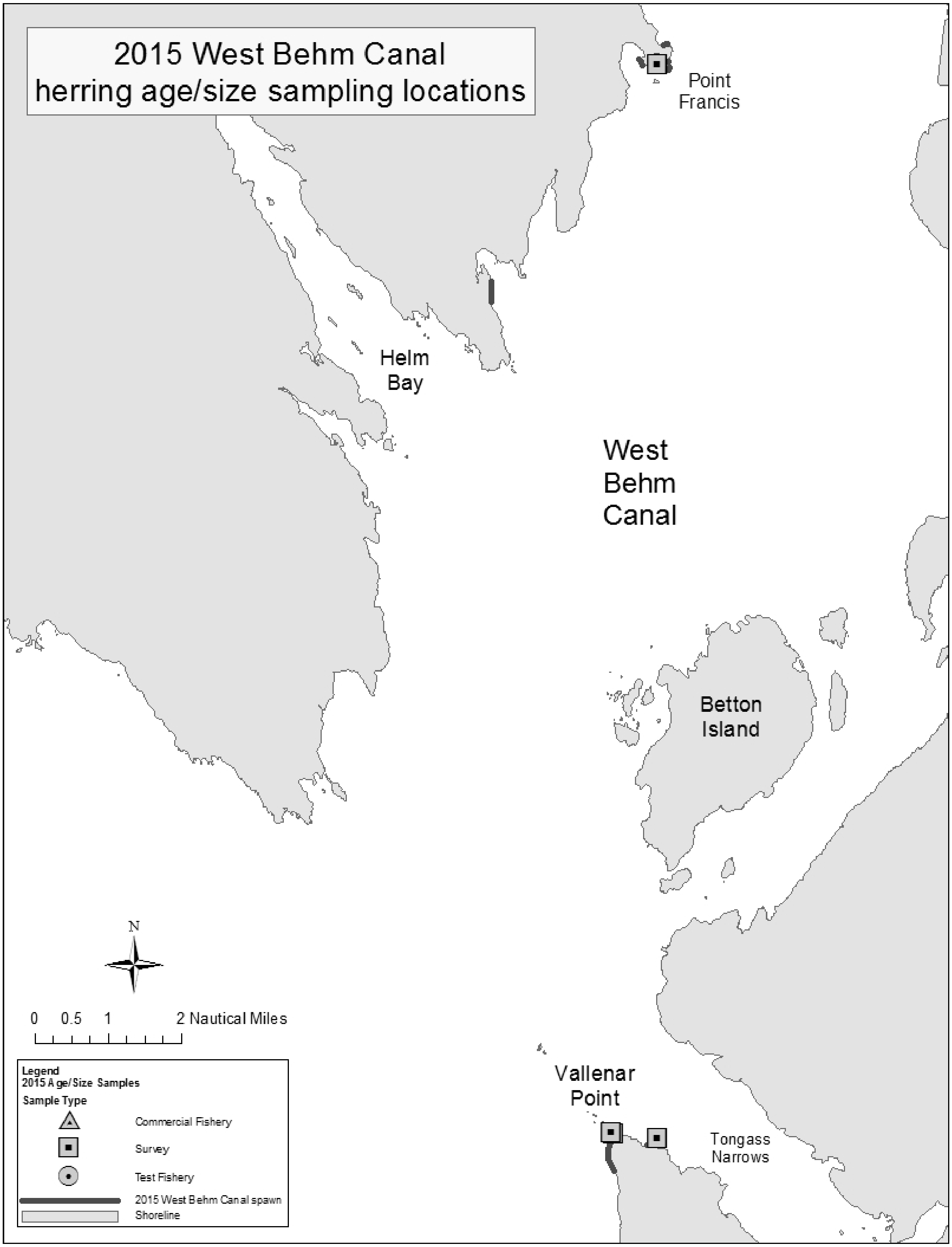

Figure 17.–Locations of herring samples collected for estimates of age and size for the West Behm Canal herring stock, 2015. Cumulative herring spawn denoted by thick gray line along shoreline.

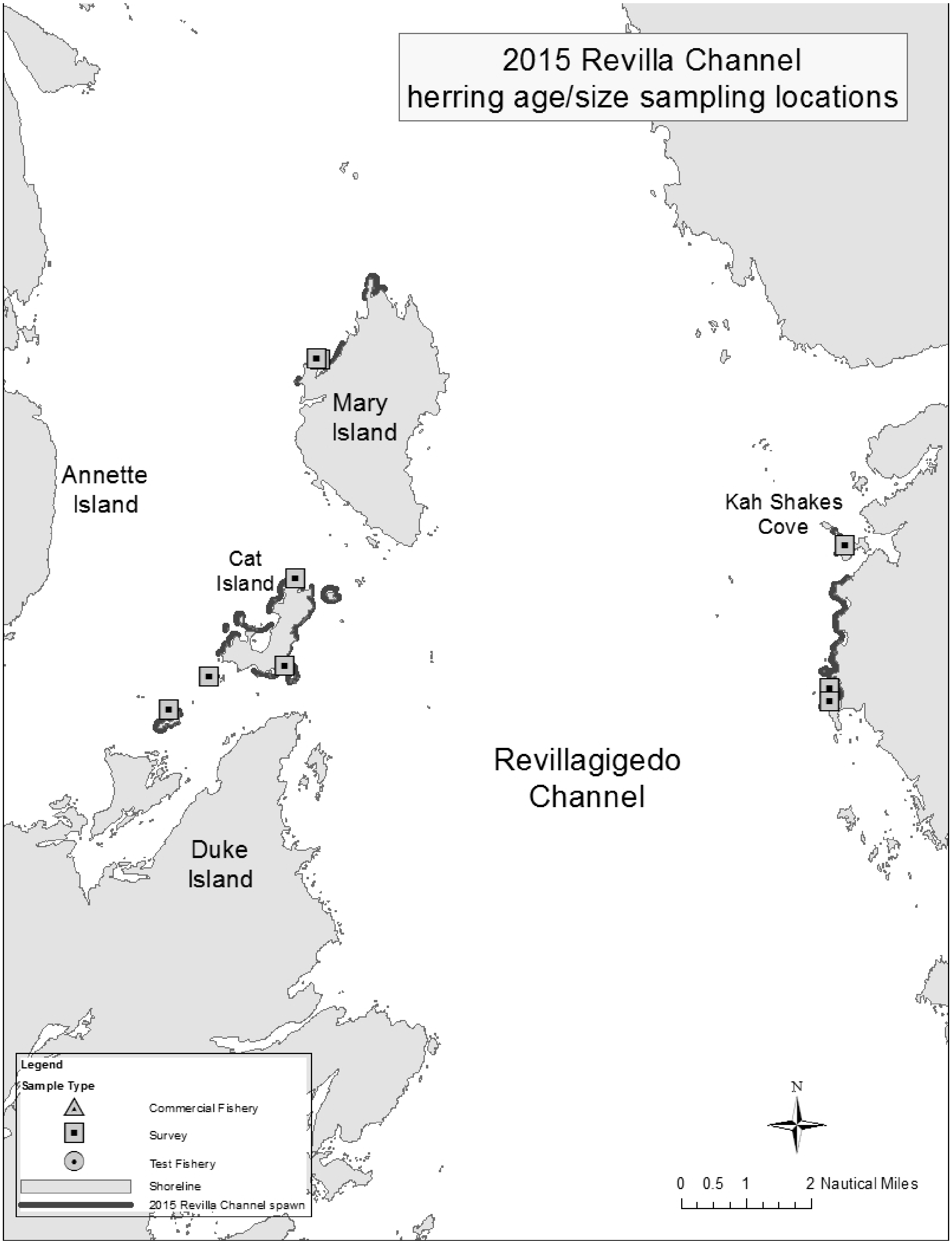

Figure 18.–Locations of herring samples collected for estimates of age and size for the Revilla Channel herring stock, 2015 (including Annette Island Reserve). Cumulative herring spawn denoted by thick gray line along shoreline.

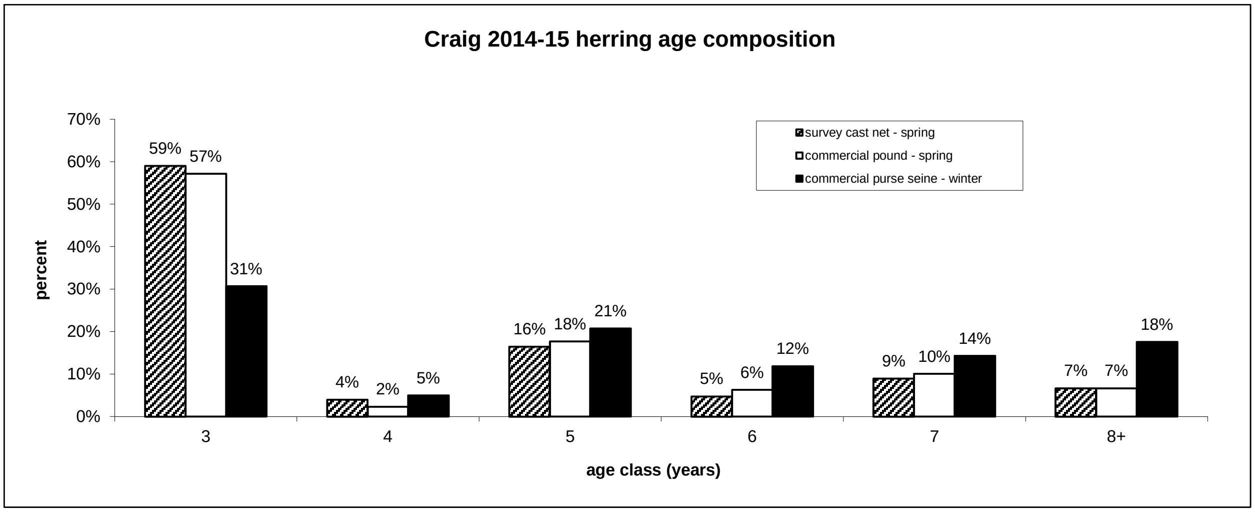

Figure 19.–Age composition for Craig herring stock in 2014–15.

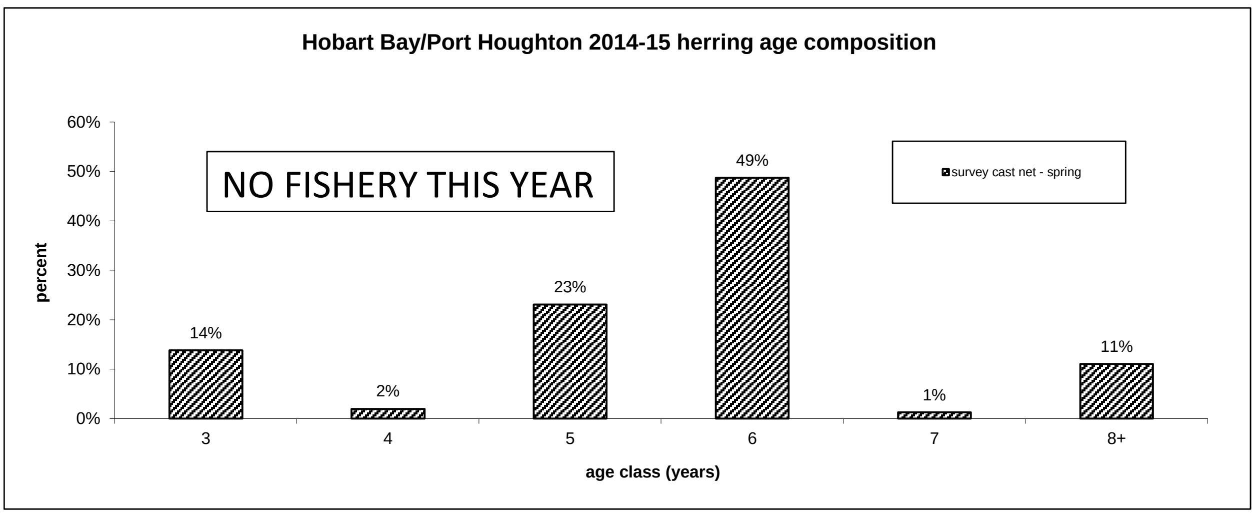

Figure 20.–Age composition for Hobart Bay/Port Houghton herring stock in 2014–15. No commercial fishery samples were obtained as no commercial fishery was opened in 2014–15.

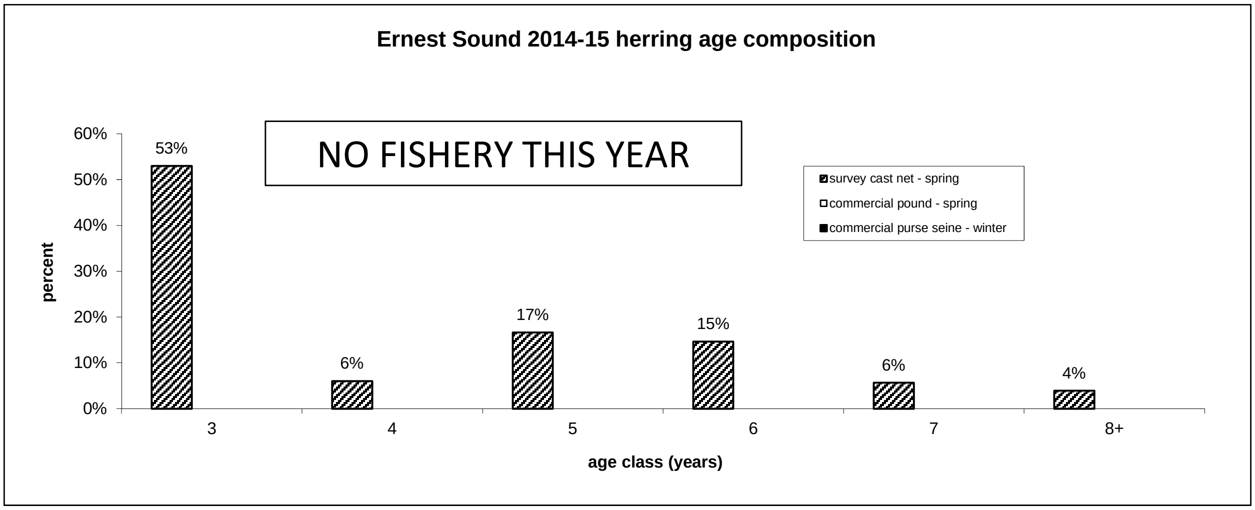

Figure 21.–Age composition for Ernest Sound herring stock in 2014–15. No commercial fishery samples obtained as no commercial fishery was opened in 2014–15.

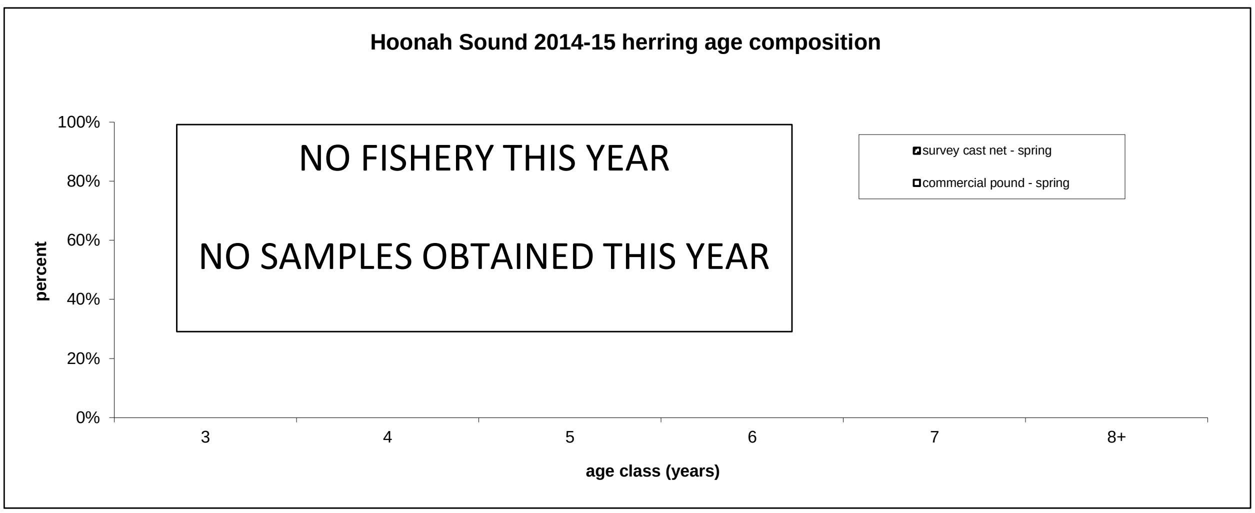

Figure 22.–Age composition for Hoonah Sound herring stock in 2014–15. No samples were obtained in 2014-15.

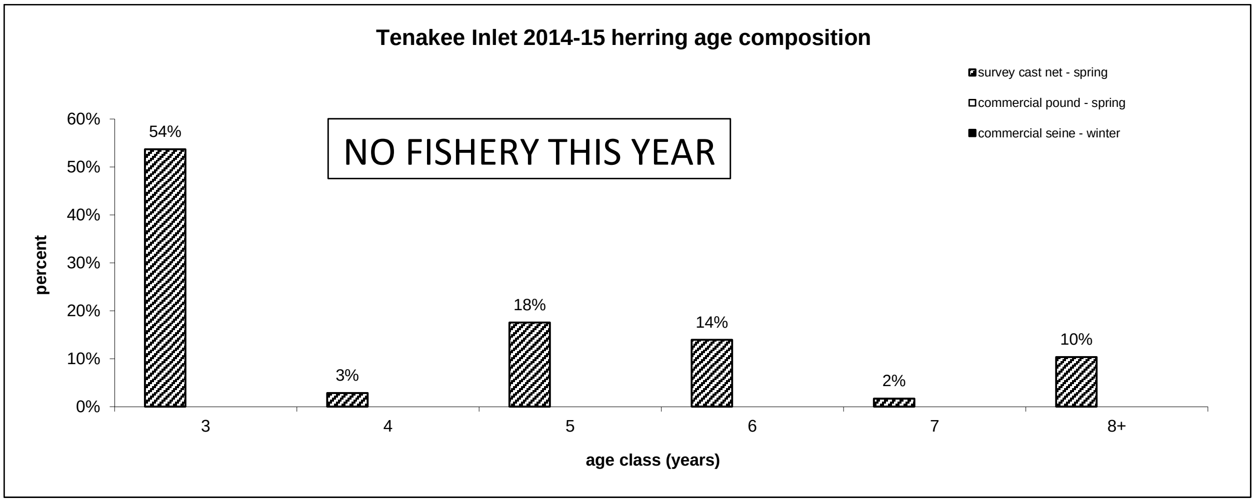

Figure 23.–Age composition for Tenakee Inlet herring stock in 2014–15. No commercial fishery samples obtained as no commercial fishery was opened in 2014–15.

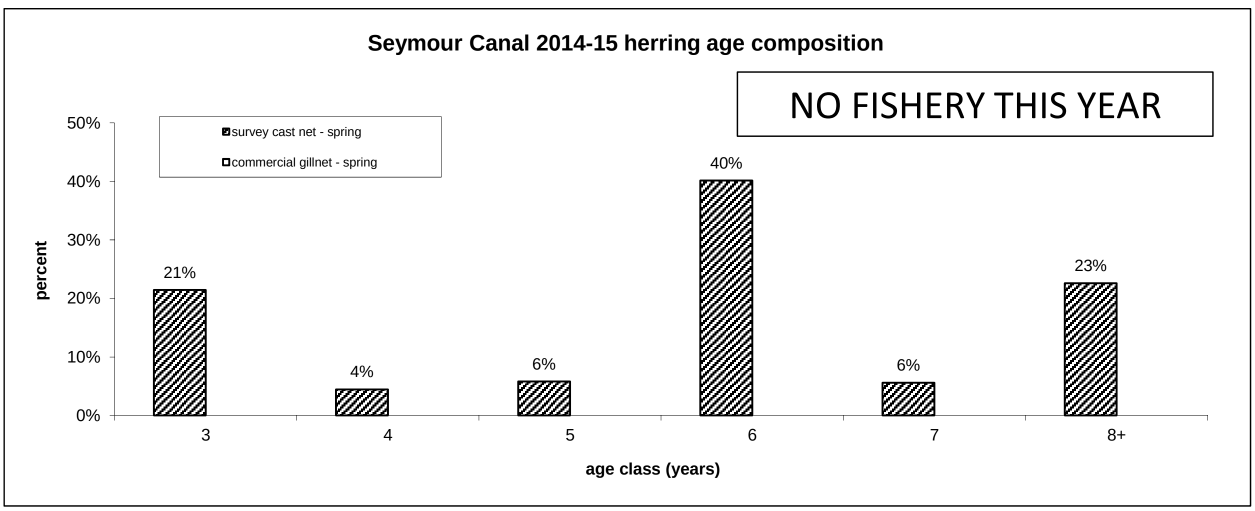

Figure 24.–Age composition for Seymour Canal herring stock in 2014–15. No commercial fishery samples obtained as no commercial fishery was opened in 2014–15.

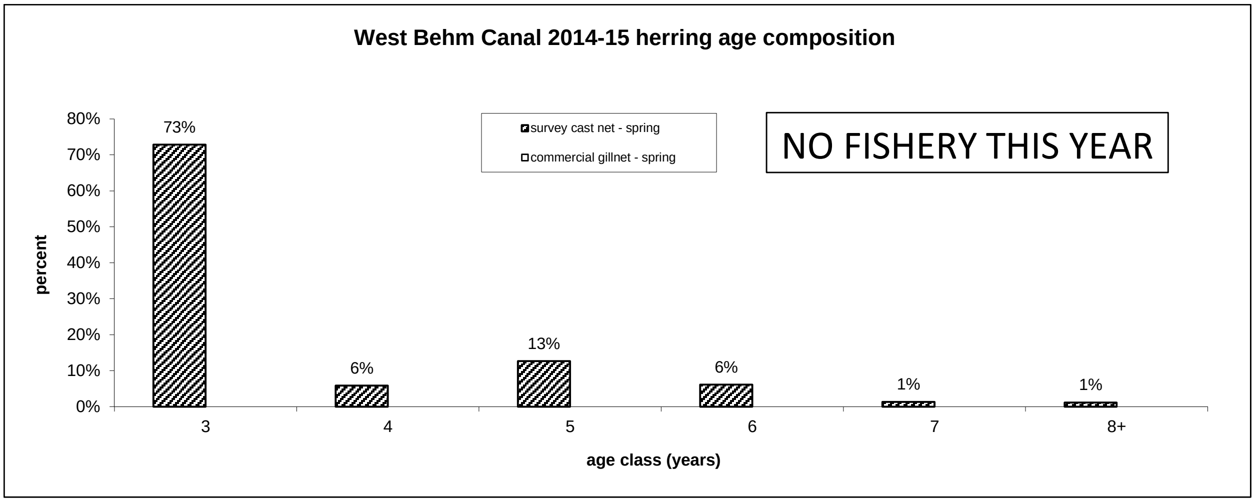

Figure 25.–Age composition for West Behm Canal herring stock in 2014–15. No commercial fishery samples were obtained as no commercial fishery was opened in 2014–15.

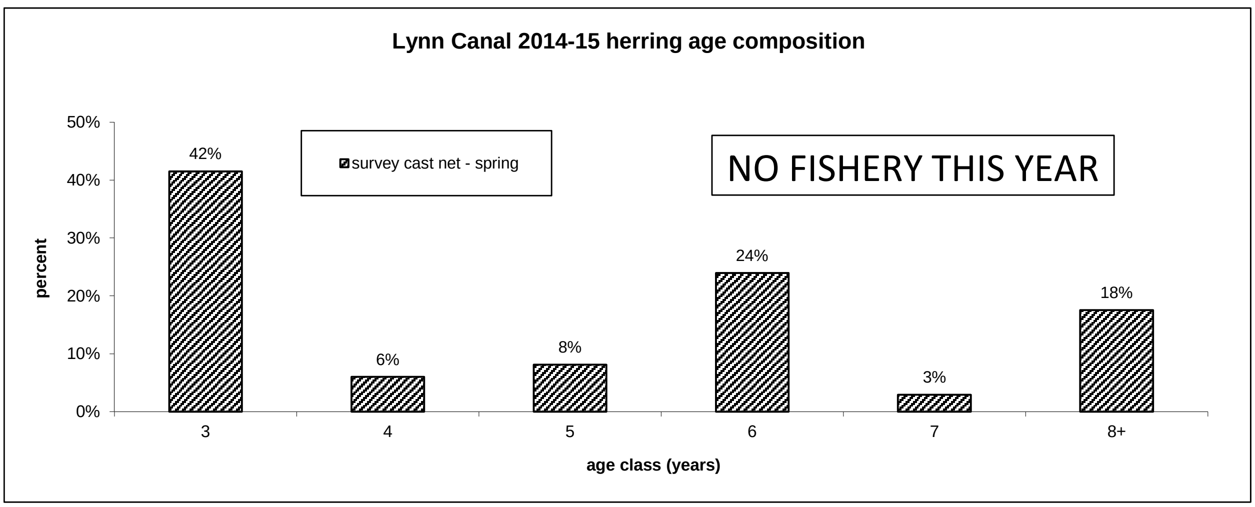

Figure 26.–Age composition for Lynn Canal herring stock in 2014–15. No commercial fishery samples obtained as no commercial fishery was opened in 2014–15.

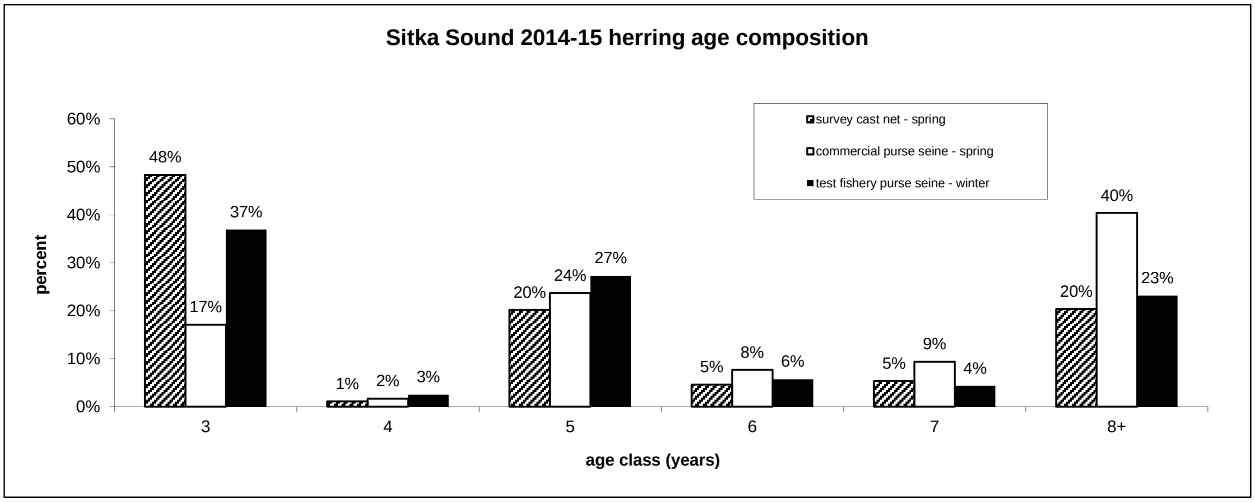

Figure 27.–Age composition for Sitka Sound herring stock in 2014–15.

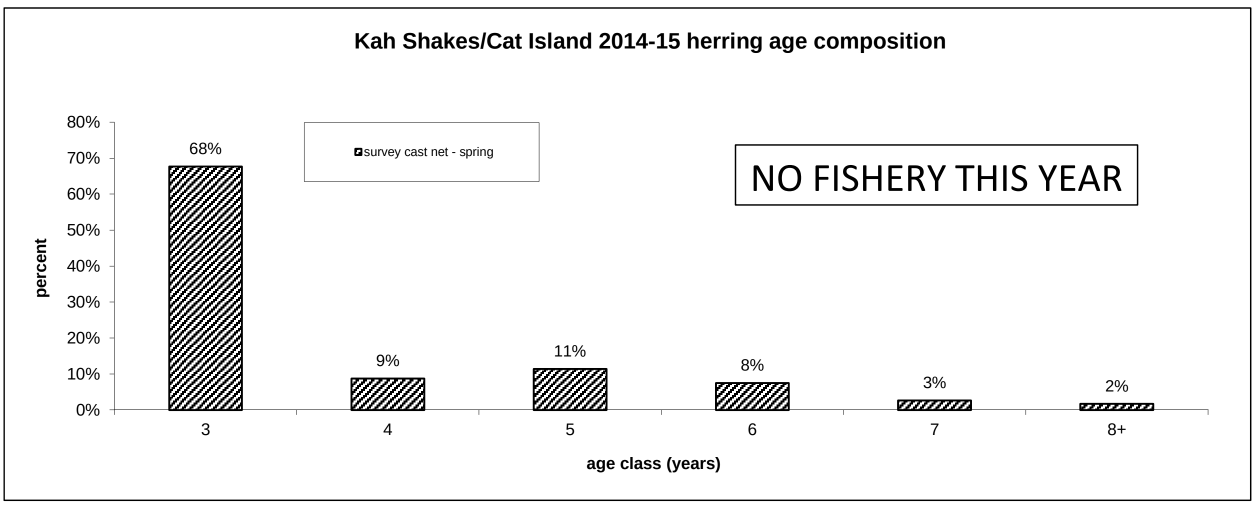

Figure 28.–Age composition for Revilla Channel herring stock (state waters only) in 2014–15. No commercial fishery samples obtained as no commercial fishery was opened in 2014–15.

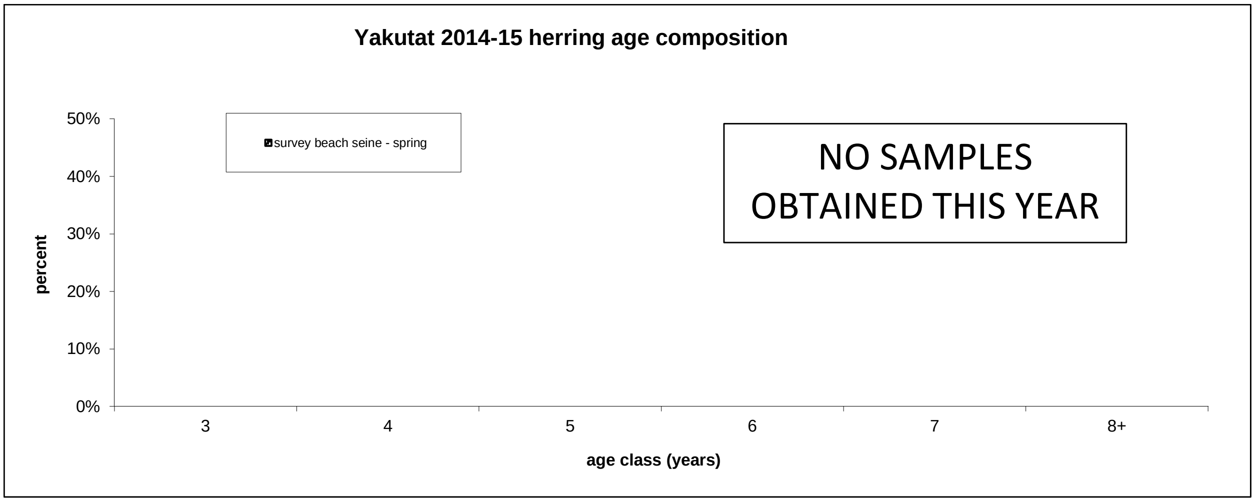

Figure 29.–Age composition for Yakutat Bay herring stock in 2014–15. No samples were obtained in 2014-15.

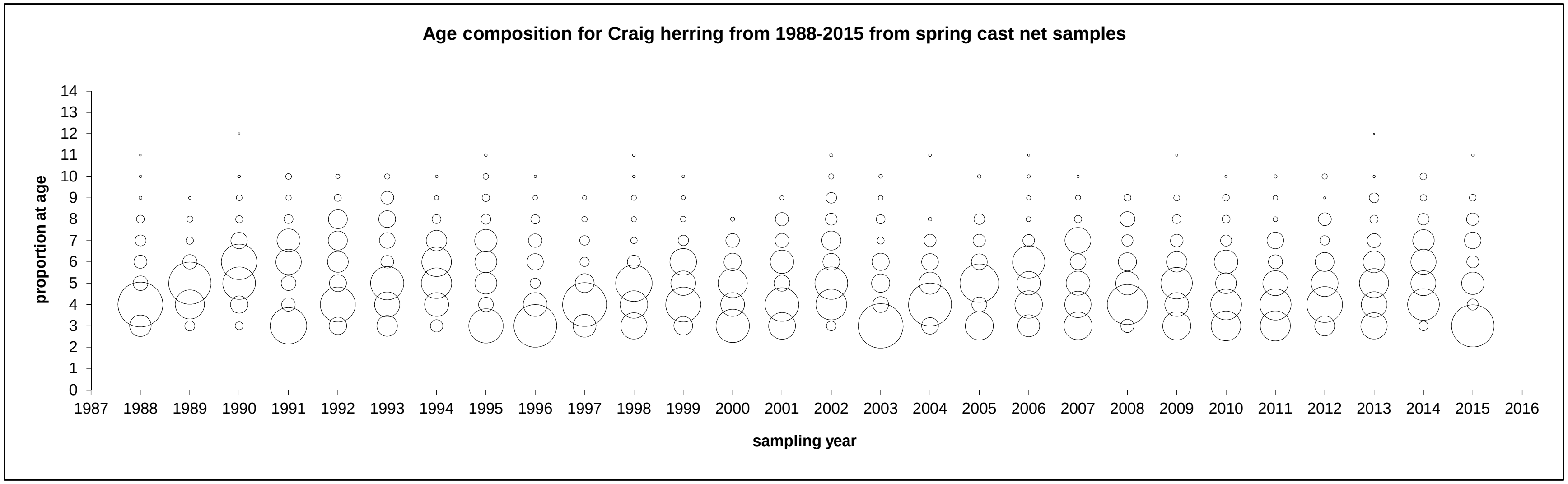

Figure 30.–Age composition from sampling data for the Craig herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

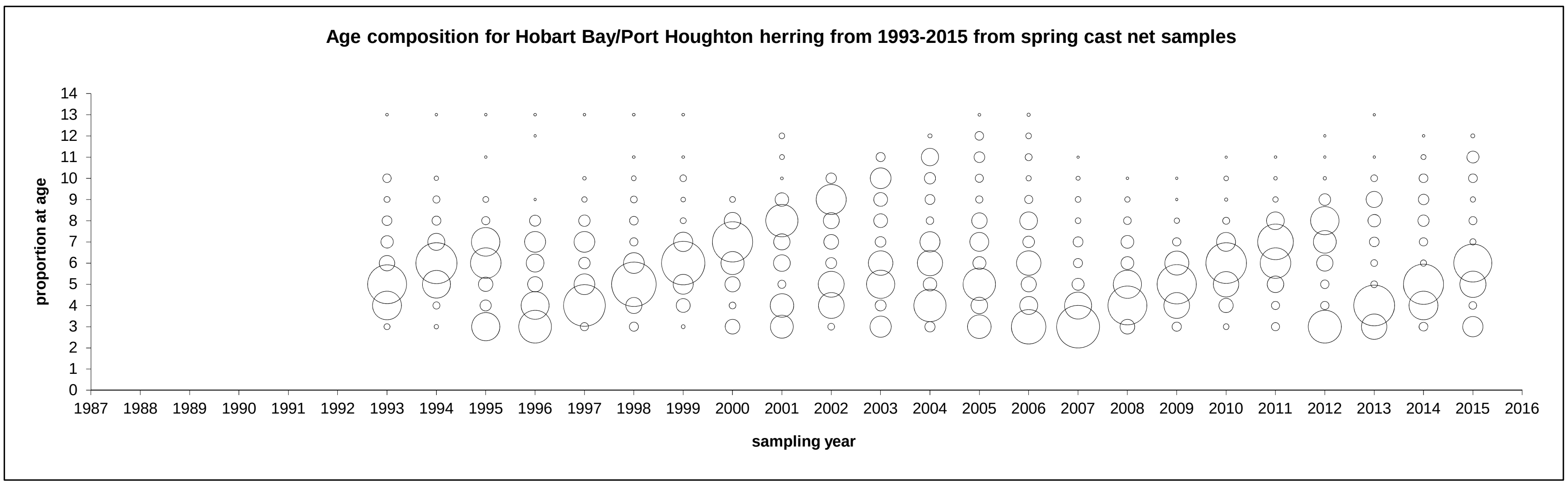

Figure 31–Age composition from sampling data for the Hobart Bay/Port Houghton herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

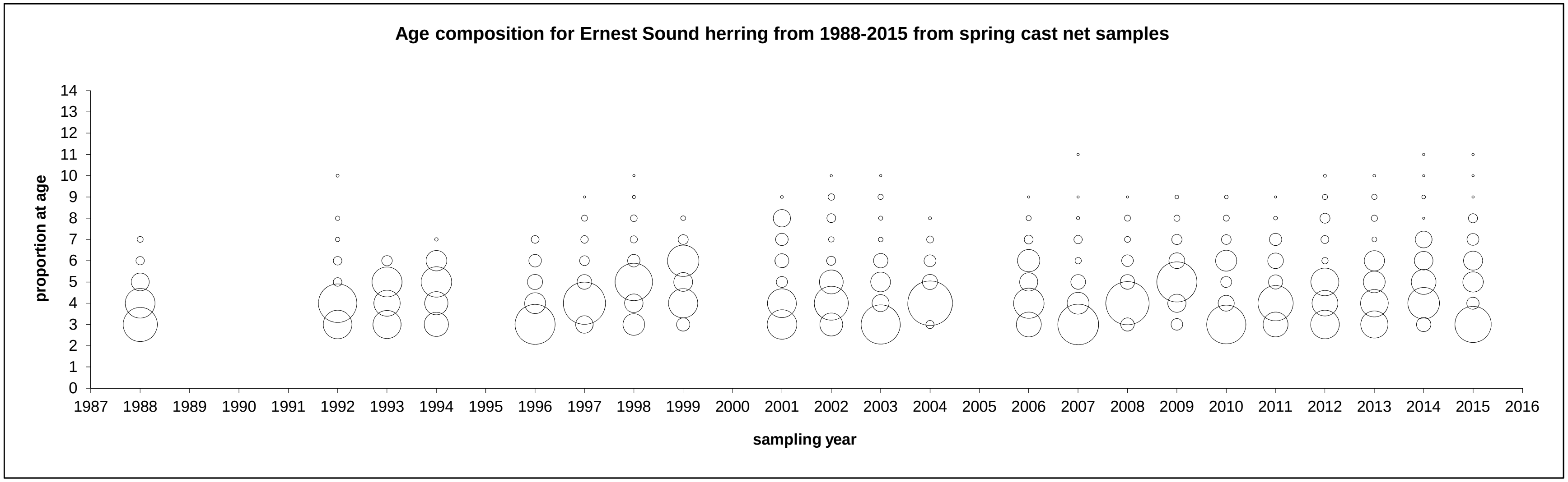

Figure 32.–Age composition from sampling data for the Ernest Sound herring stock.

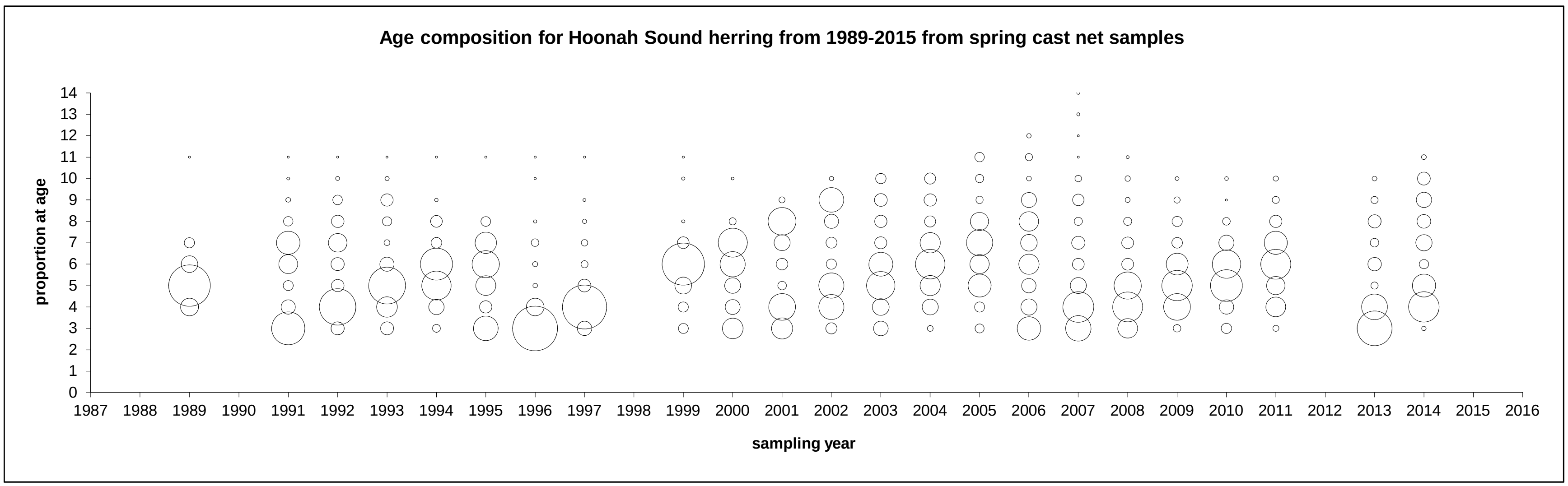

Figure 33.–Age composition from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

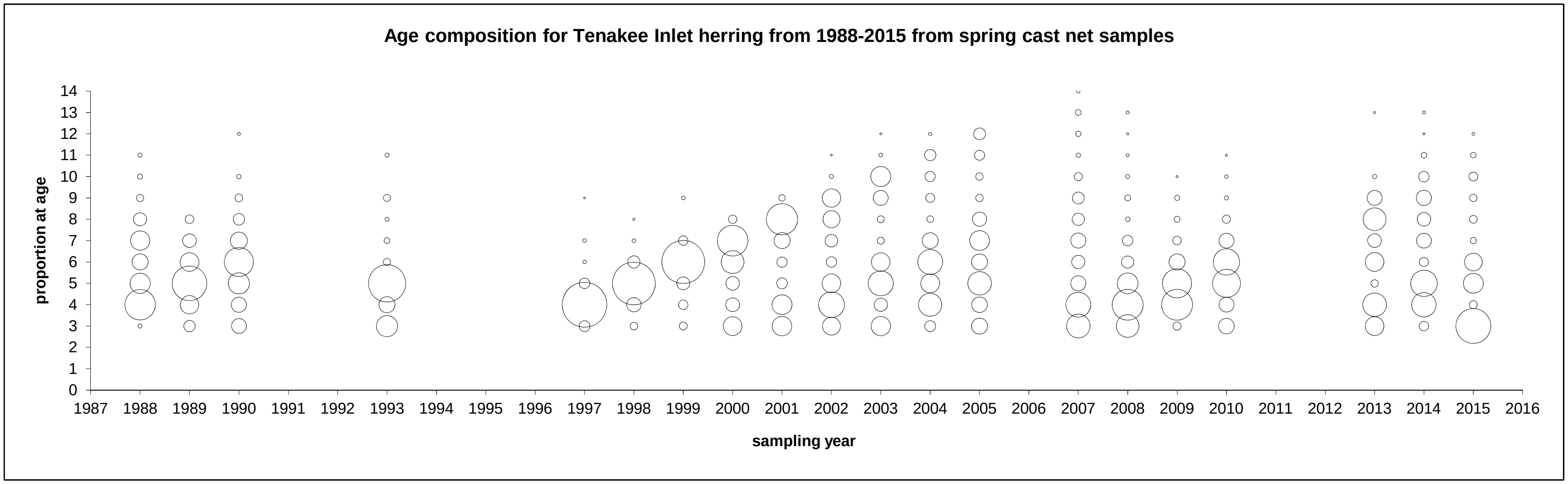

Figure 34.–Age composition from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

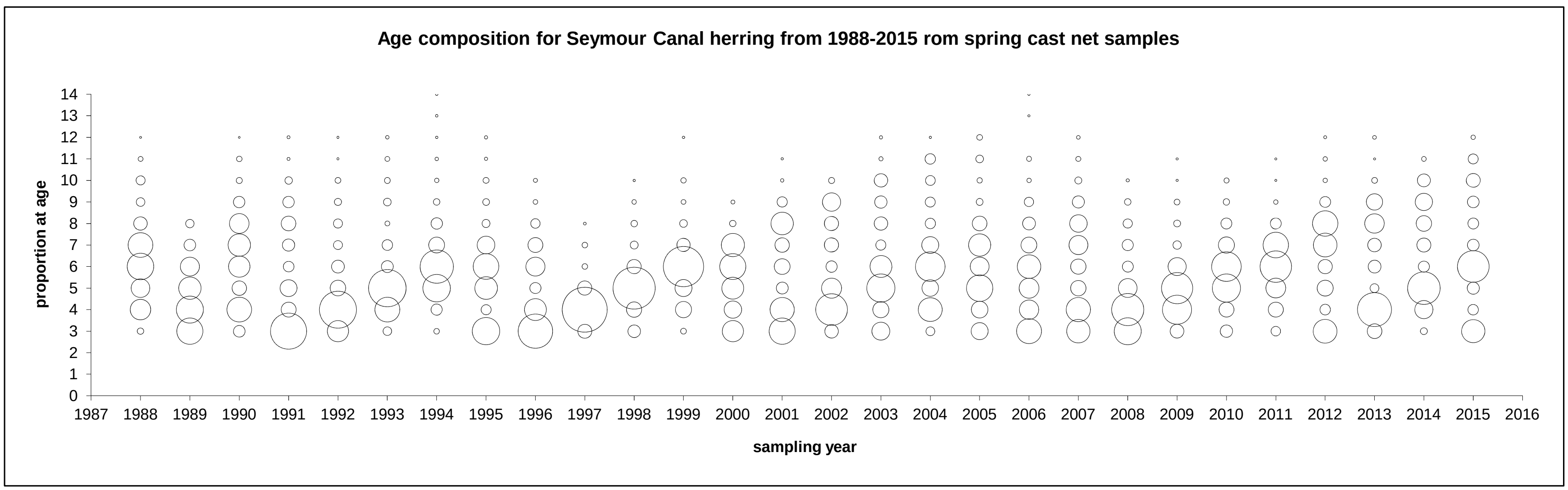

Figure 35.–Age composition from sampling data for the Seymour Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

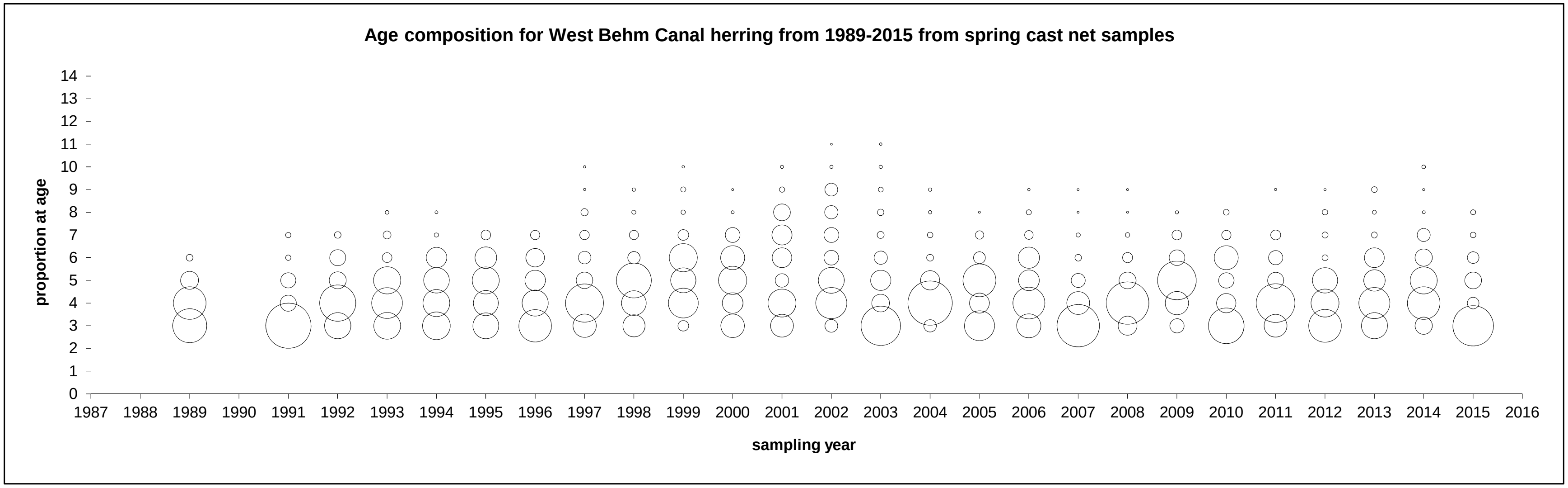

Figure 36.–Age composition from sampling data for the West Behm Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

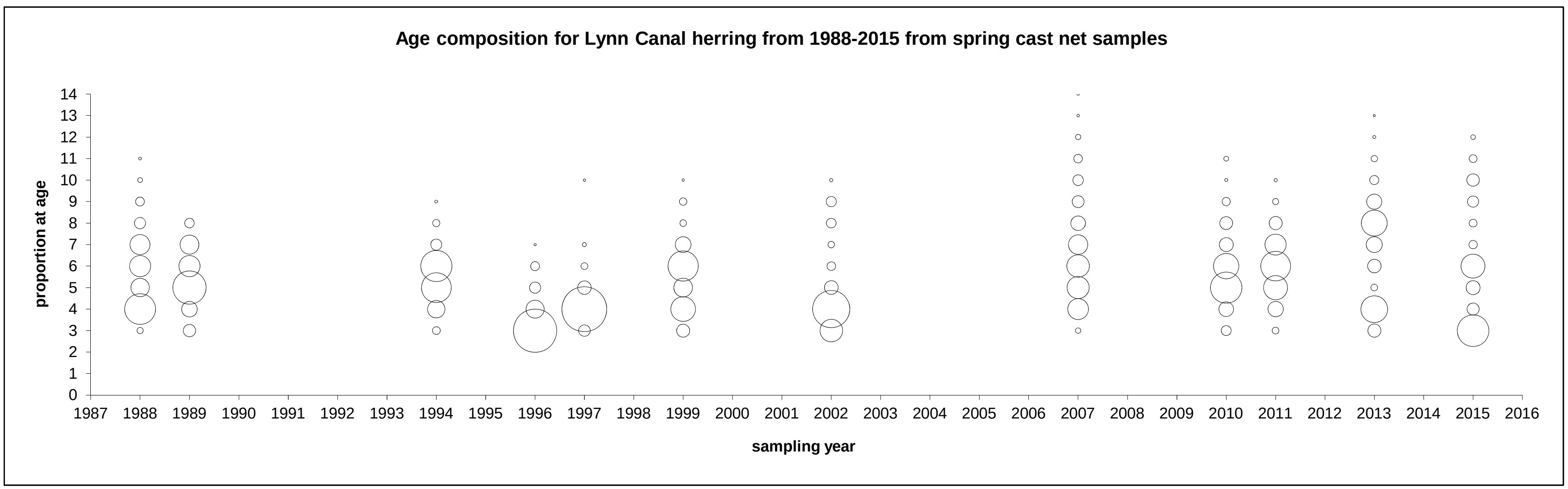

Figure 37.–Age composition from sampling data for the Lynn Canal herring stock.

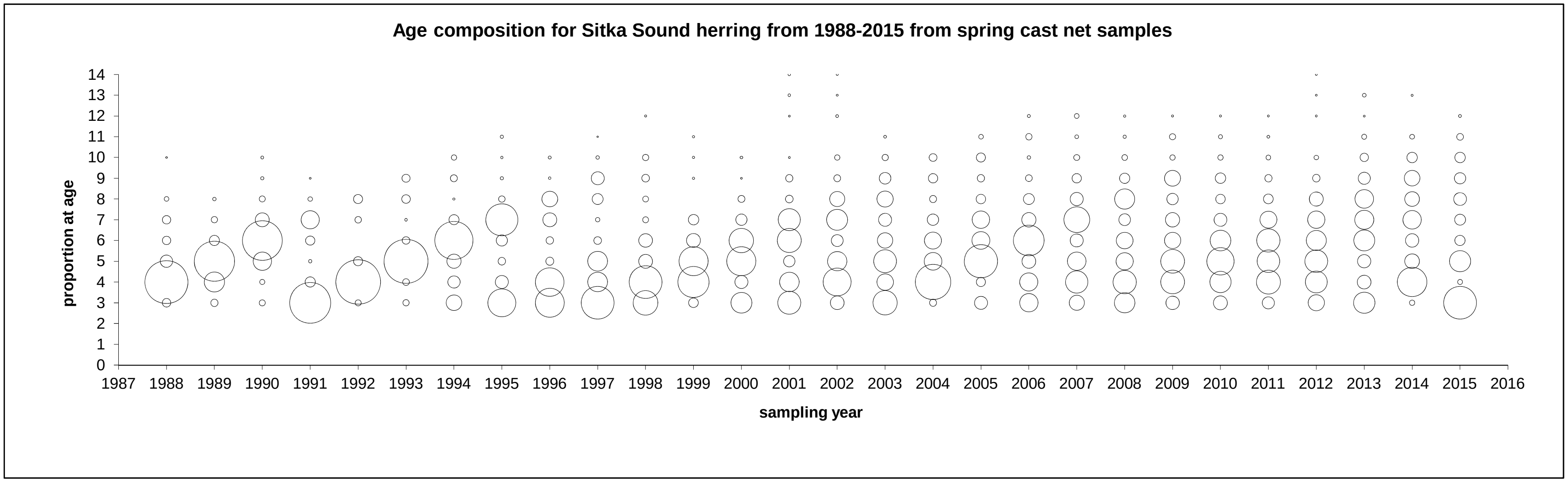

Figure 38.–Age composition from sampling data for the Sitka Sound herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

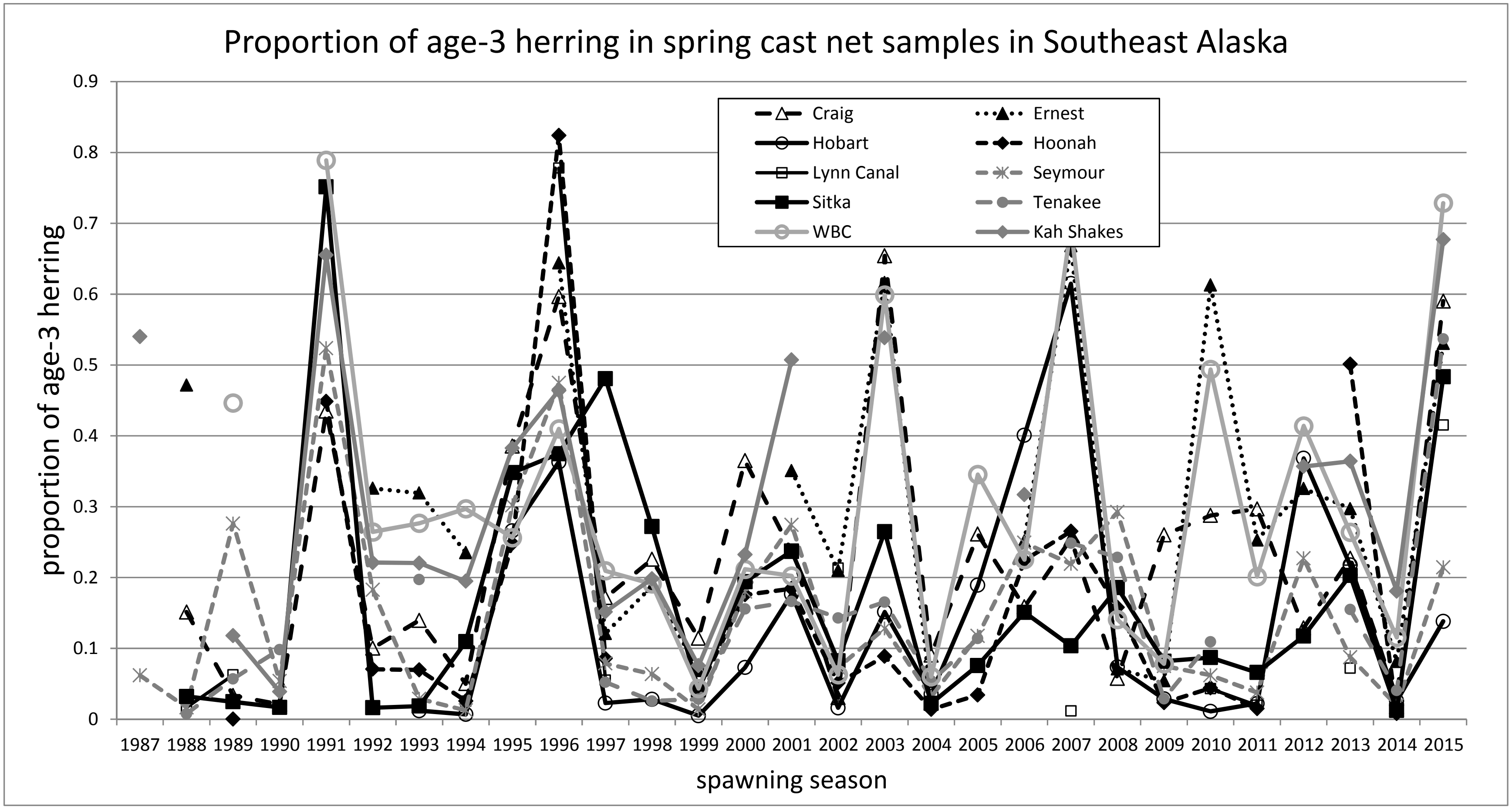

Figure 39.–Proportion of age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

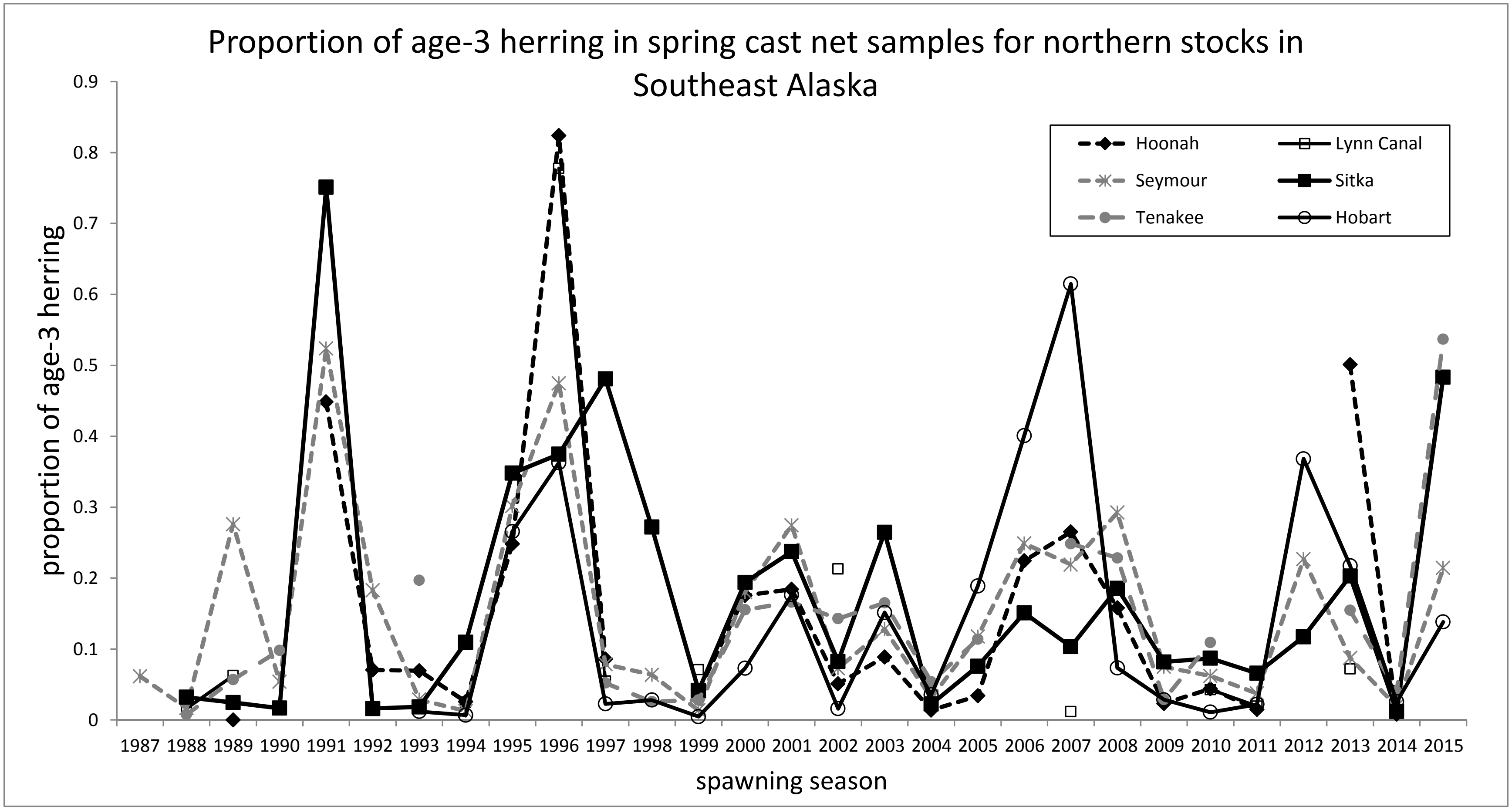

Figure 40.–Proportion of age-3 herring in spring cast nest samples of spawning populations for northern stocks in Southeast Alaska.

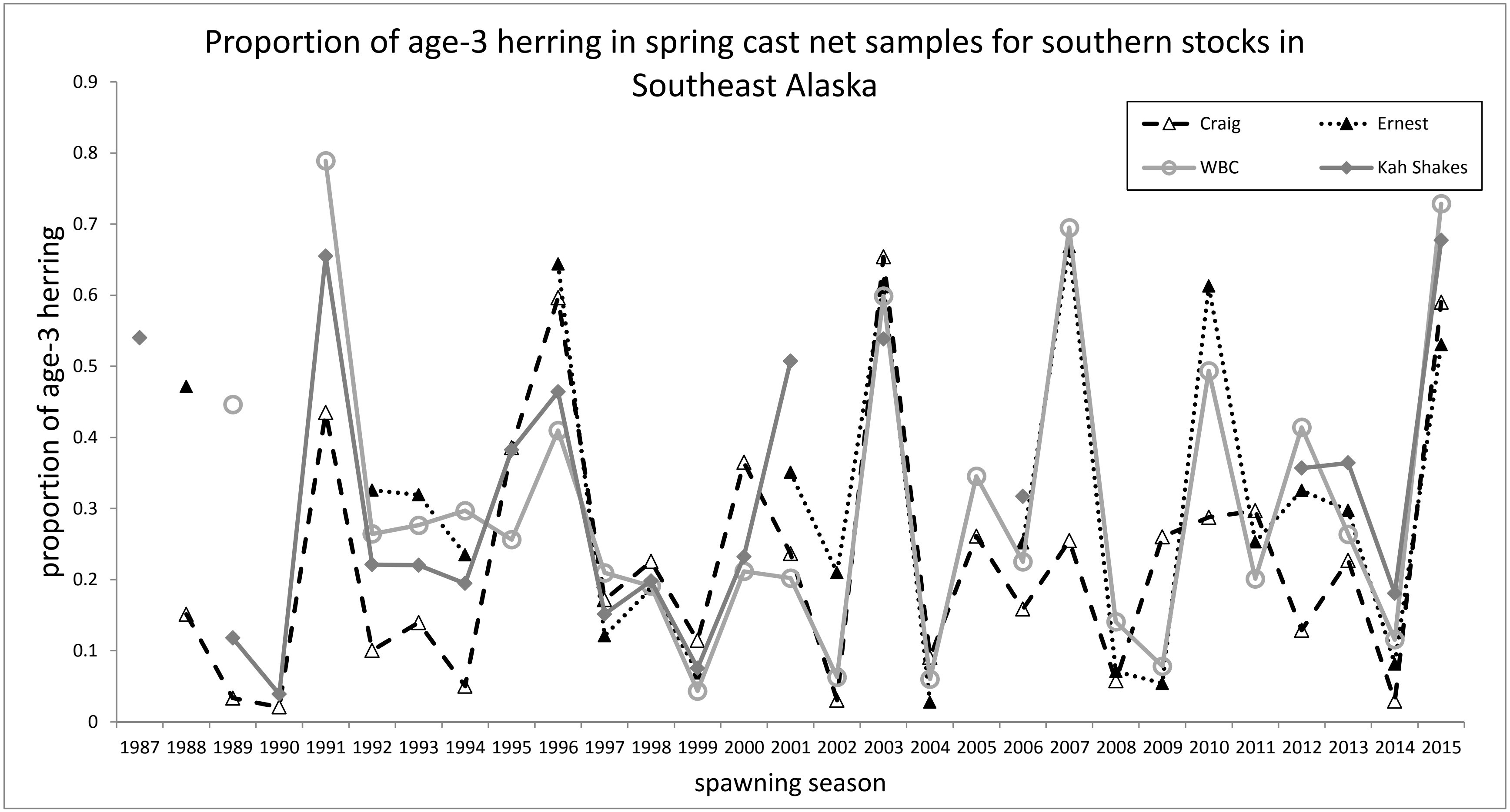

Figure 41.–Proportion of age-3 herring in spring cast nest samples of spawning populations for southern stocks in Southeast Alaska.

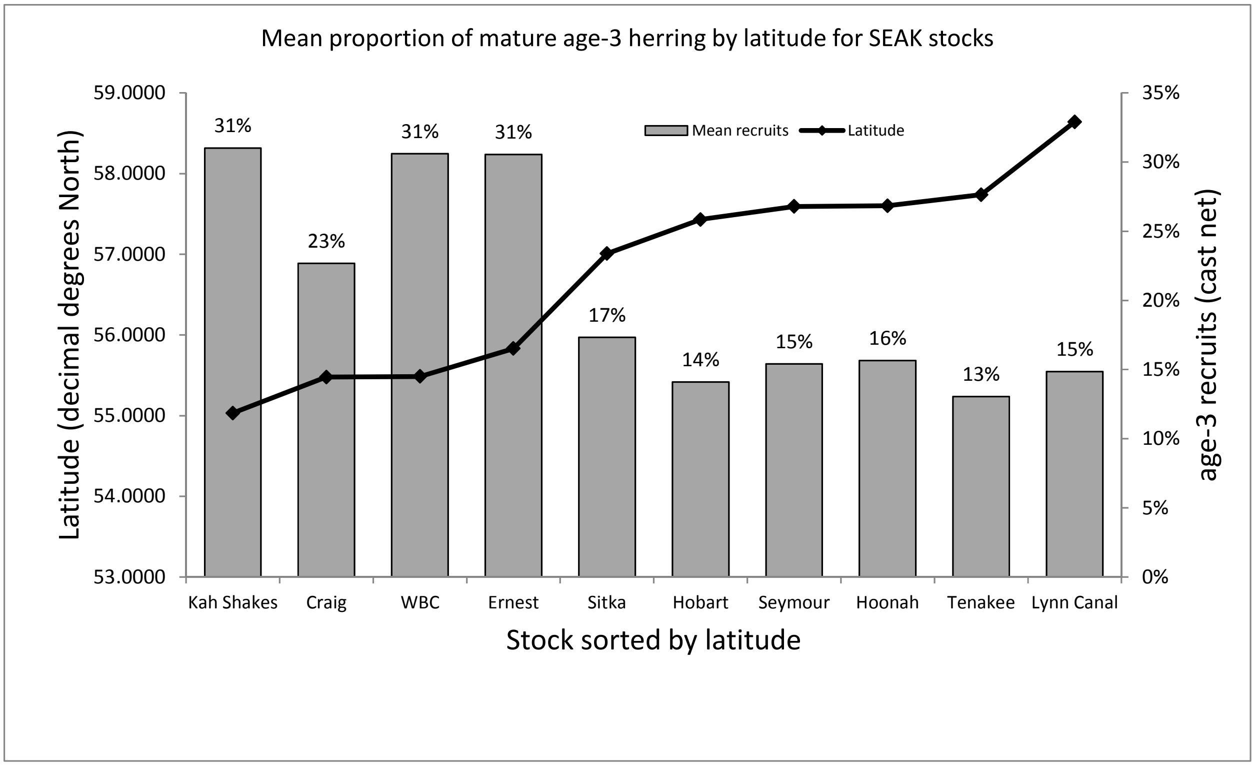

Figure 42.–Mean proportion of age-3 herring in spring cast nest samples (1988–2015) and latitude of spawning populations for stocks in Southeast Alaska.

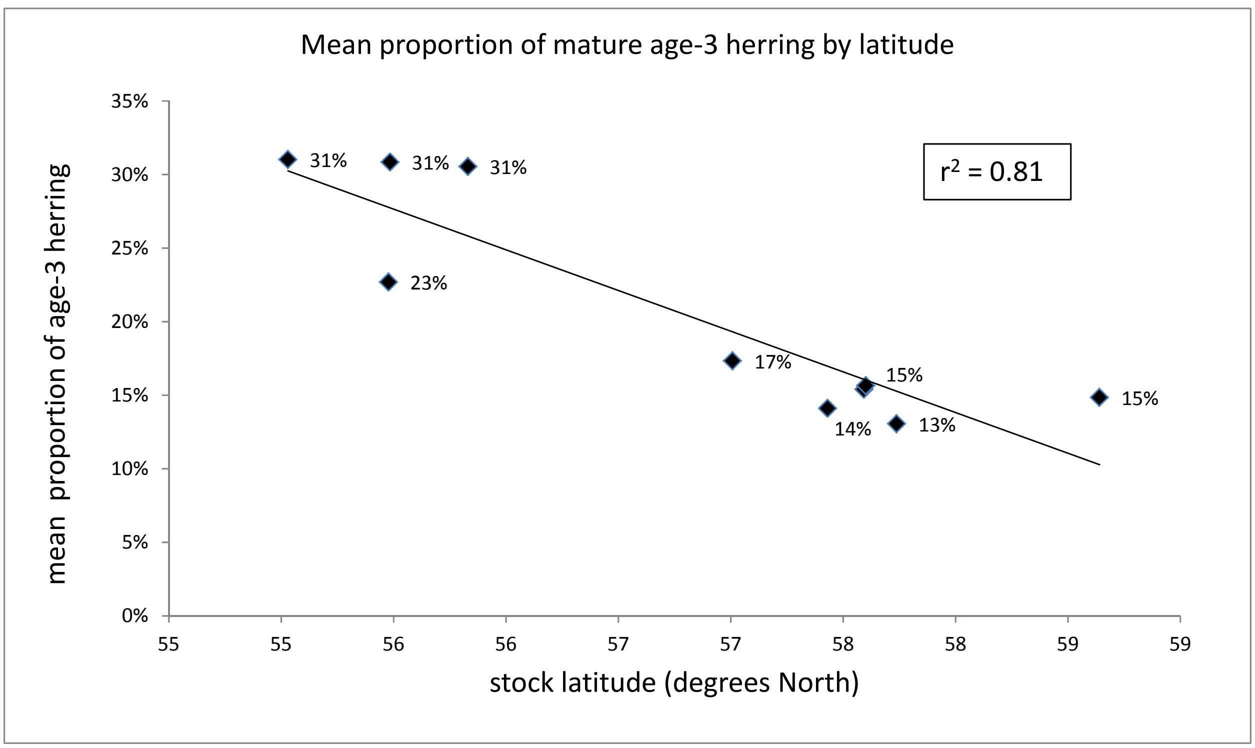

Figure 43.–Mean proportion of age-3 herring in spring cast nest samples versus stock latitude of spawning stocks in Southeast Alaska.

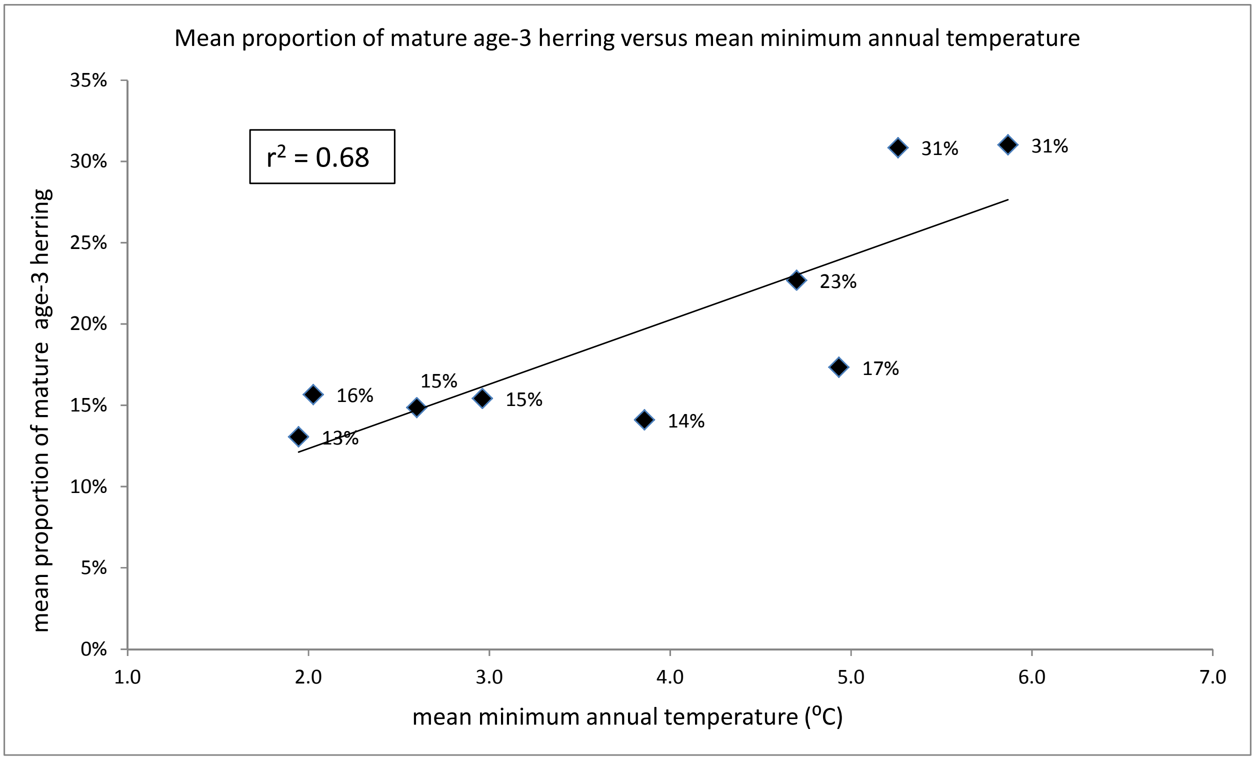

Figure 44.–Mean proportion of age-3 herring in spring cast nest samples versus mean minimum annual sea water temperature at location of spawning stocks in Southeast Alaska.

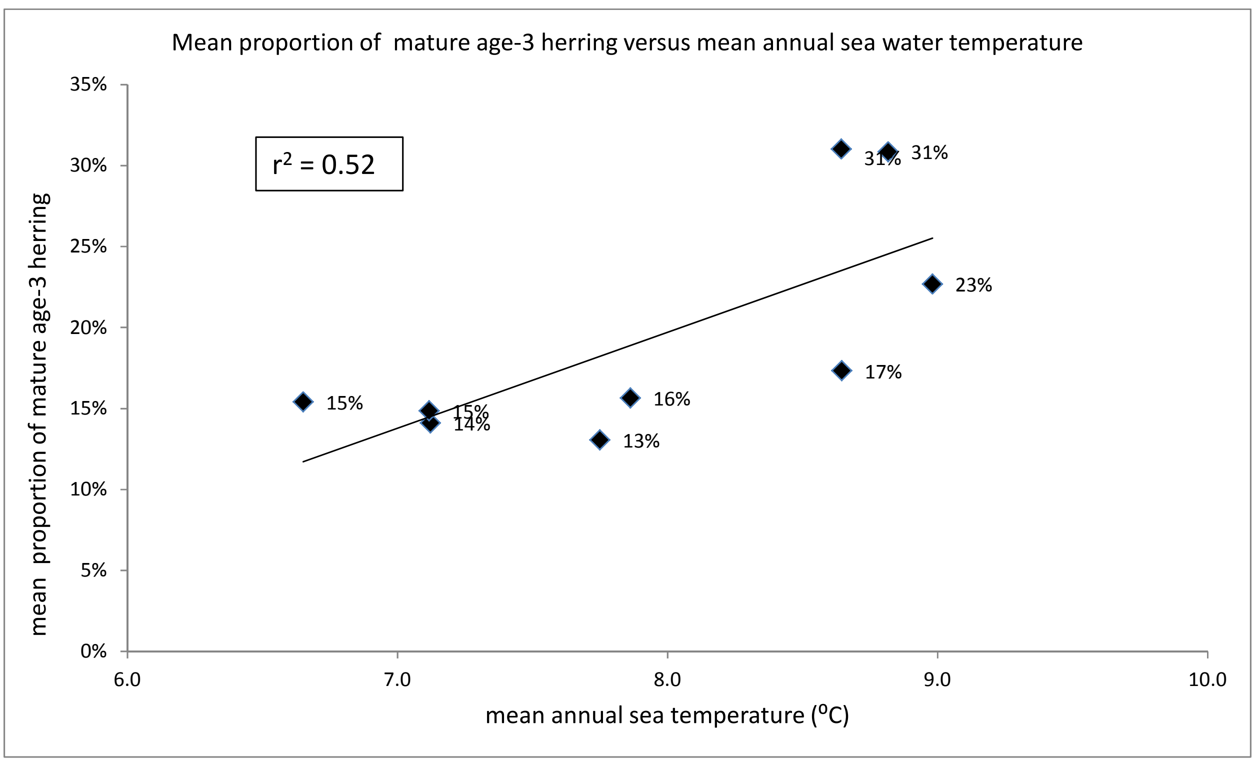

Figure 45.–Mean proportion of age-3 herring in spring cast nest samples versus mean annual sea water temperature at location of spawning stocks in Southeast Alaska.

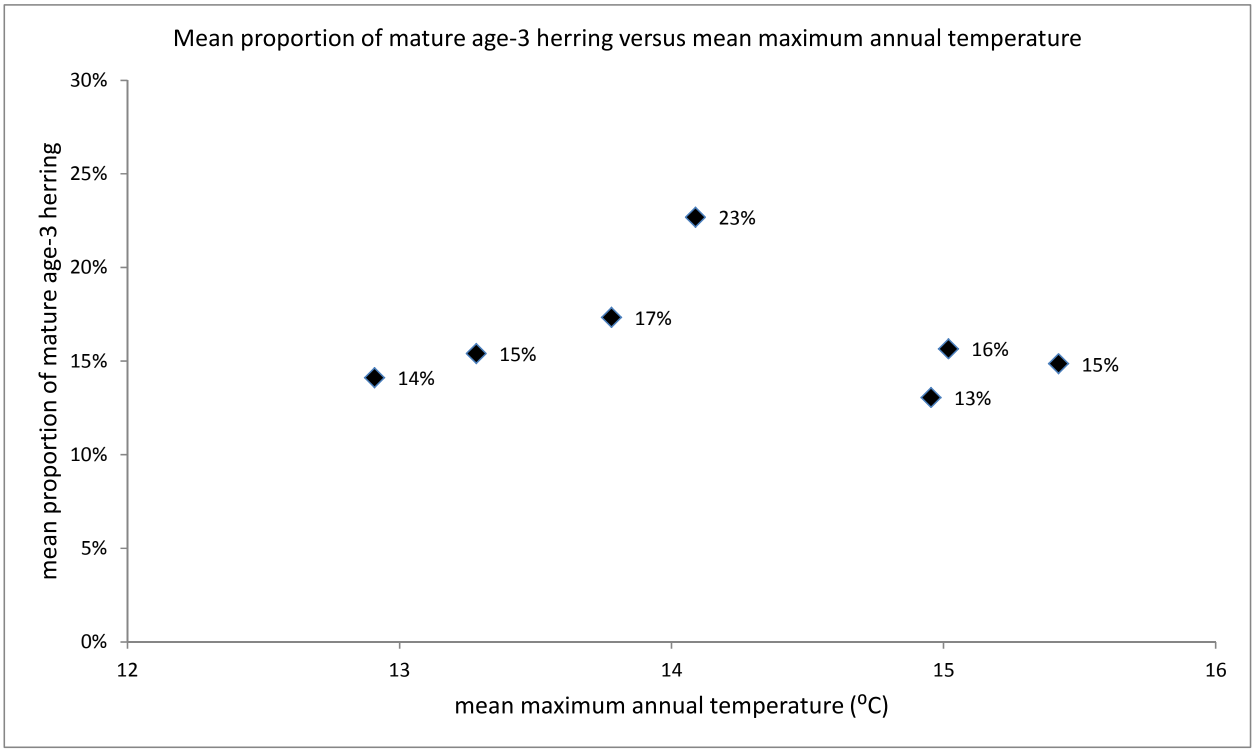

Figure 46.–Mean proportion of age-3 herring in spring cast nest samples versus mean maximum annual sea water temperature at location of spawning stocks in Southeast Alaska.

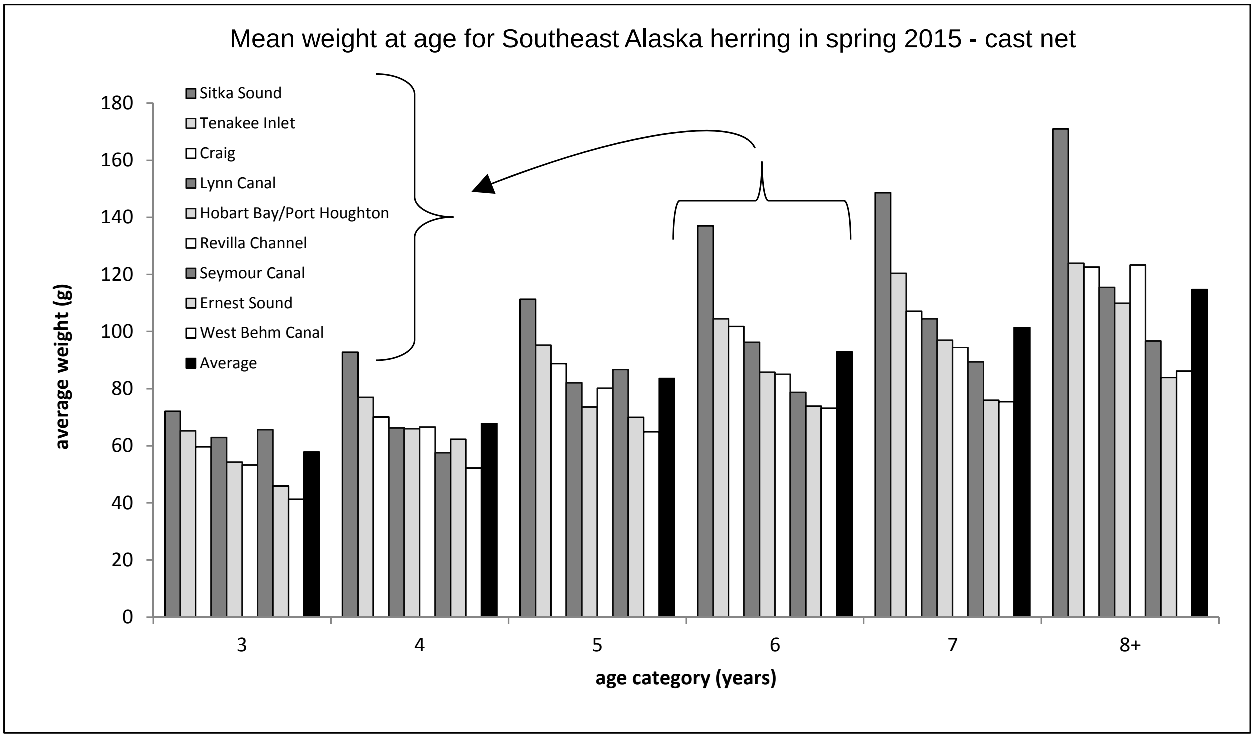

Figure 47.–Mean weight-at-age for Southeast Alaska herring stocks in spring 2015, sorted by age-6.

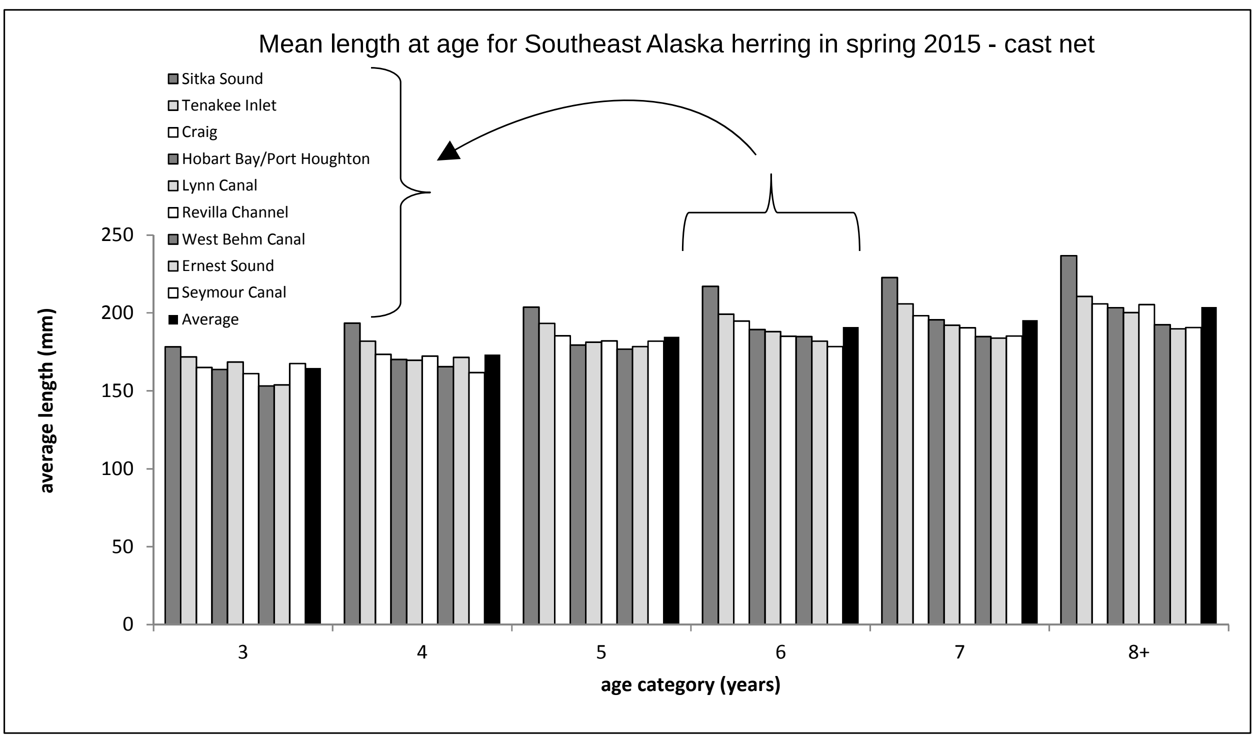

Figure 48.–Mean length at age for Southeast Alaska herring stocks in spring 2015, sorted by age-6.

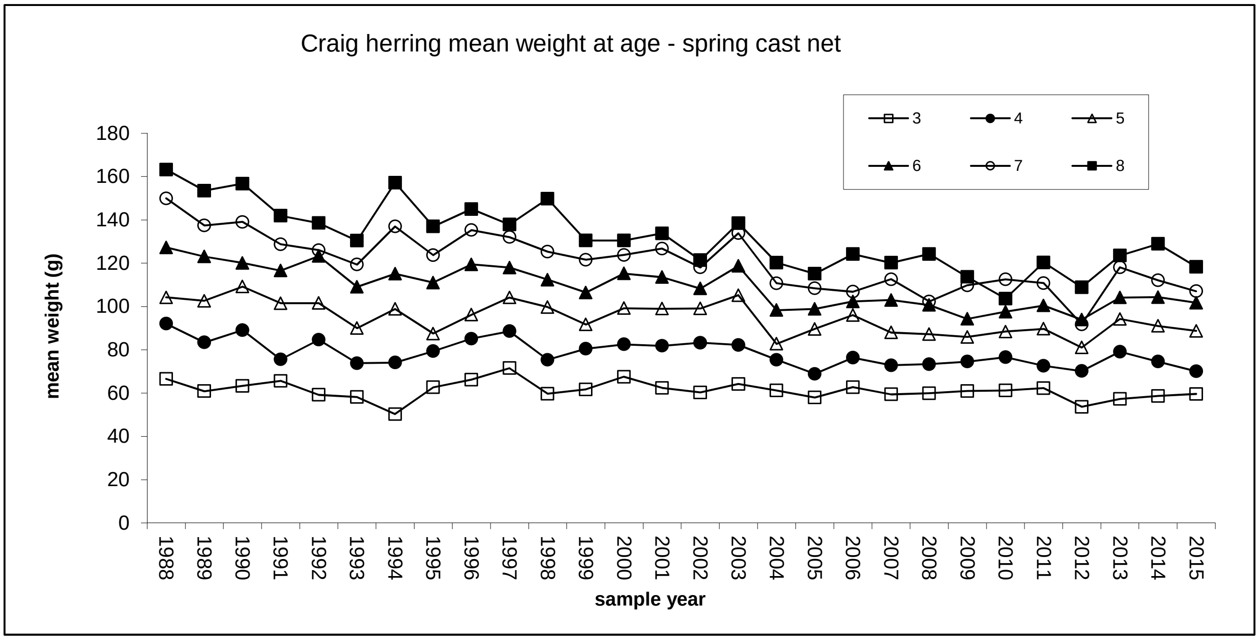

Figure 49.–Mean weight-at-age of the Craig herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

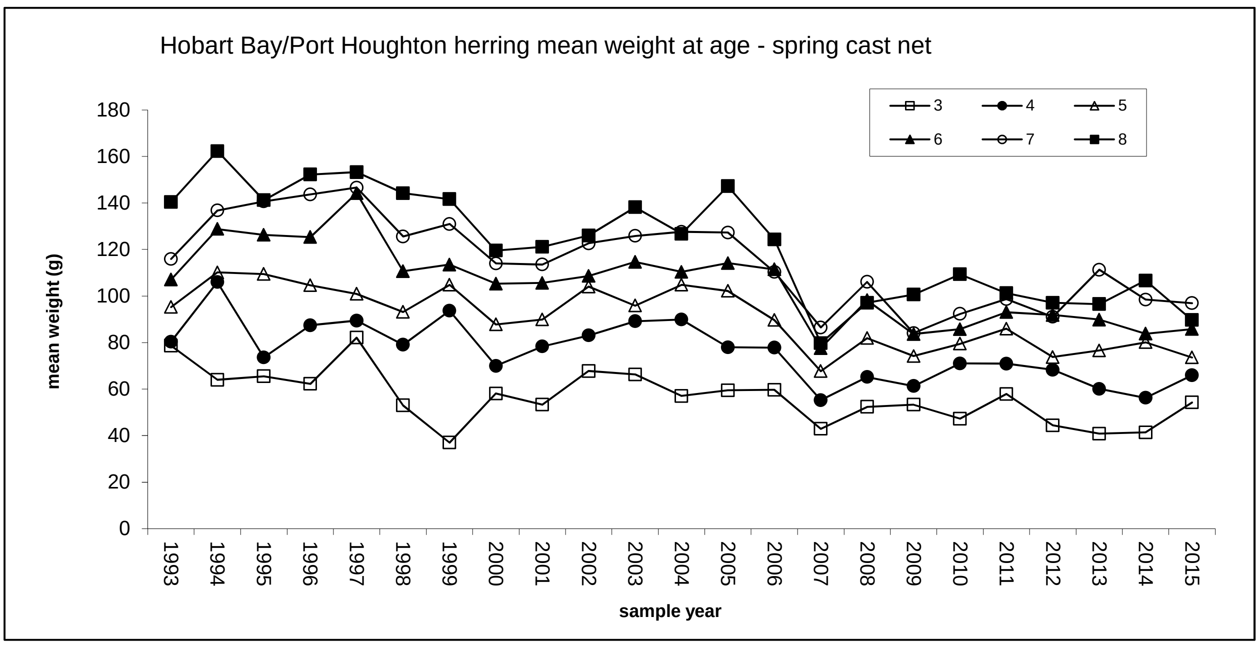

Figure 50.–Mean weight at age of the Hobart Bay/Port Houghton herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

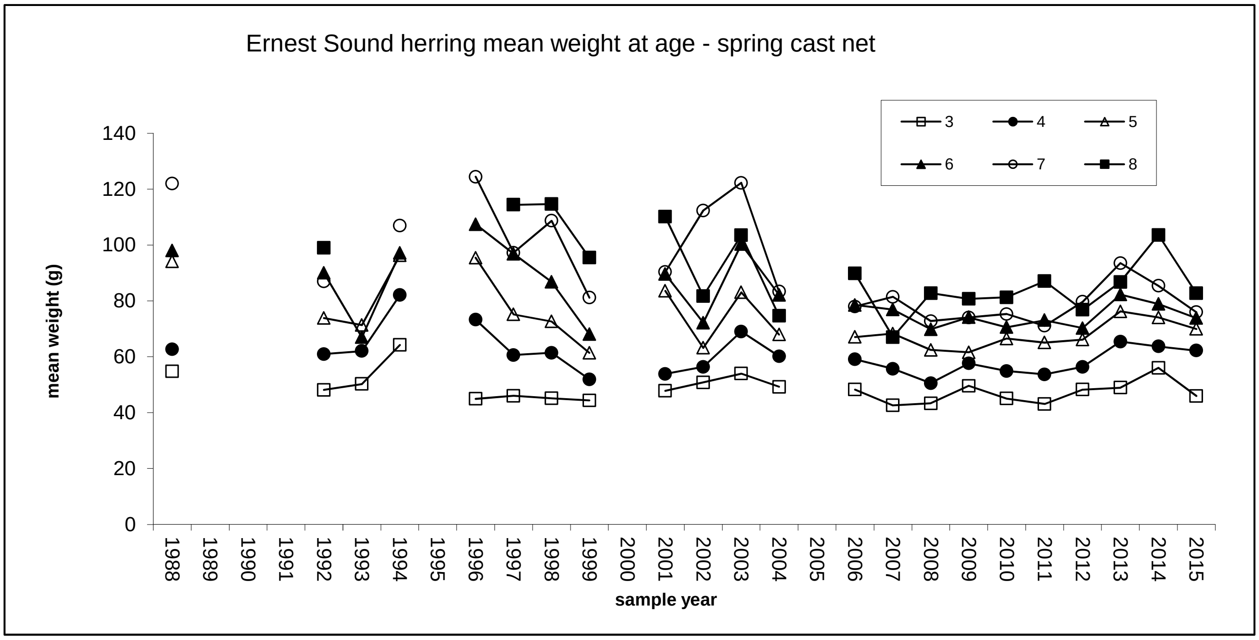

Figure 51.–Mean weight at age for the Ernest Sound herring spawning population.

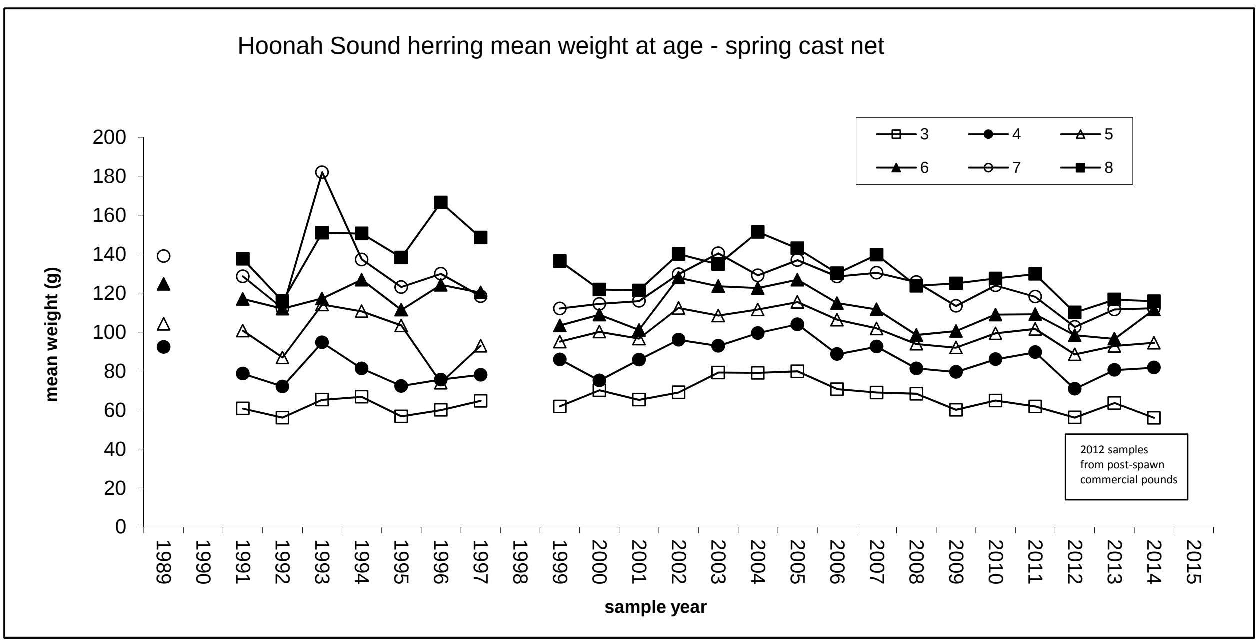

Figure 52.–Mean weight at age for the Hoonah Sound herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

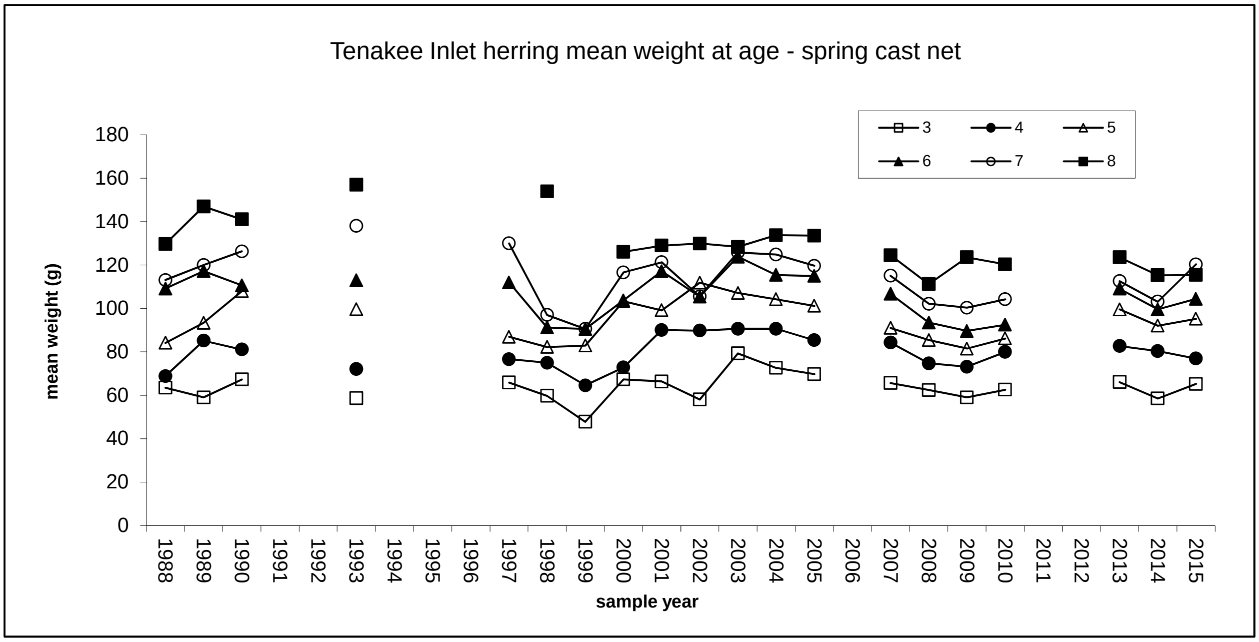

Figure 53.–Mean weight at age for the Tenakee Inlet herring stock. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

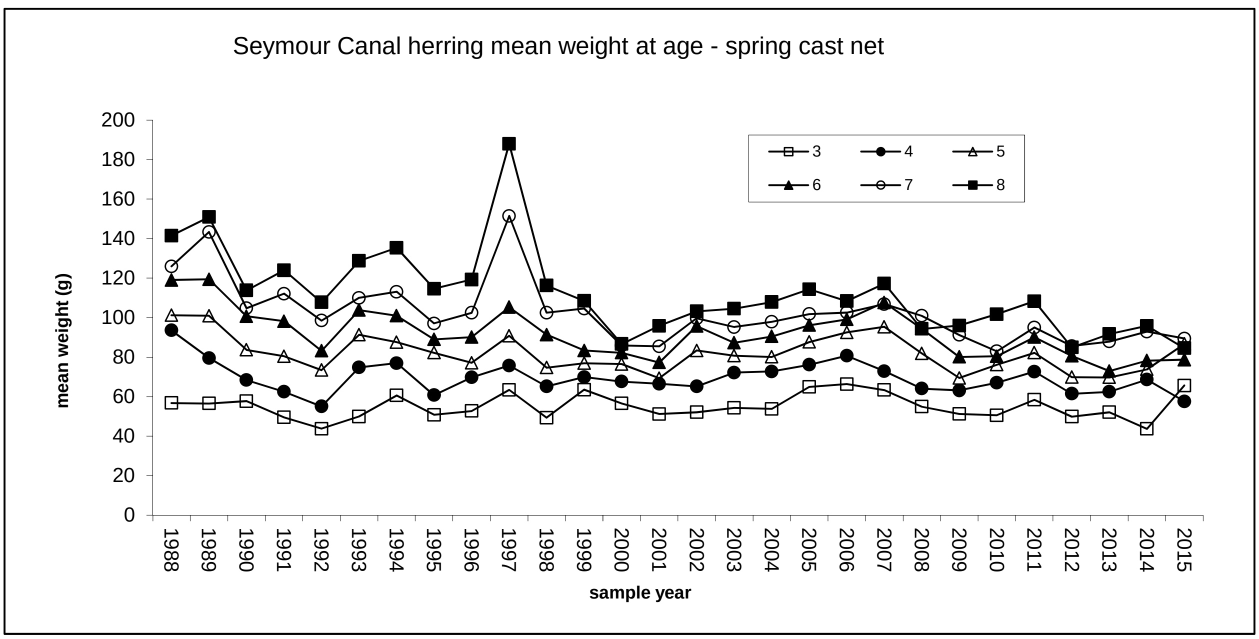

Figure 54.–Mean weight at age for the Seymour Canal herring stock. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

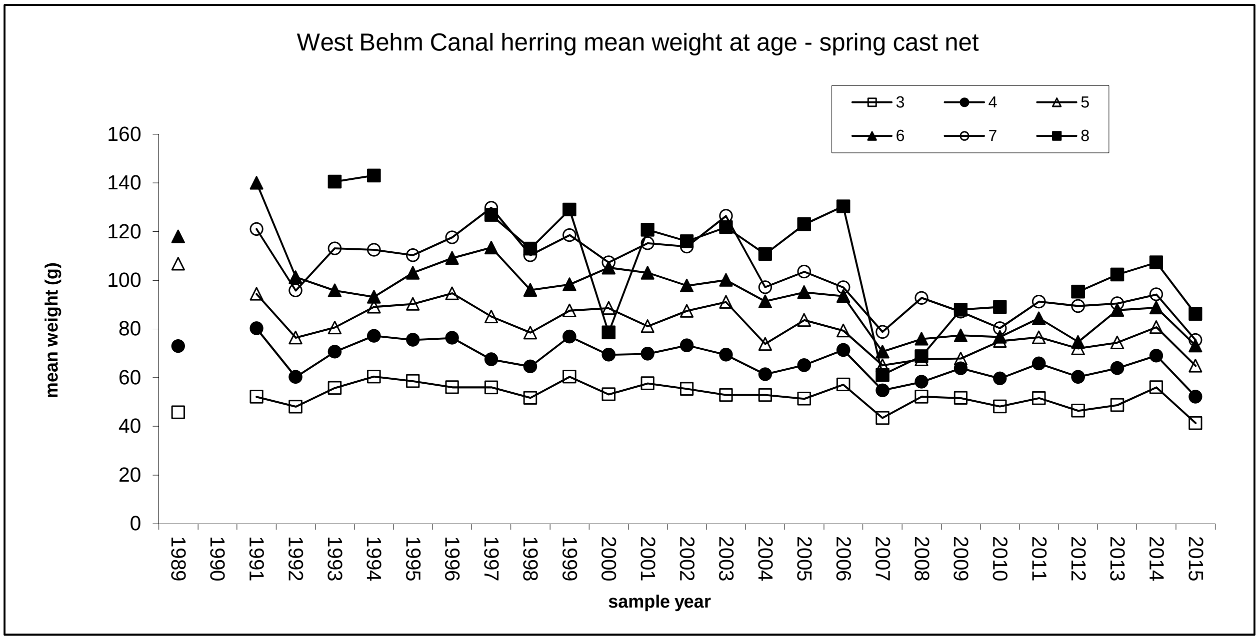

Figure 55.–Mean weight at age for the West Behm Canal herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. 2015 weights are likely biased low due to required additional sample handling that resulted in loss of weight.

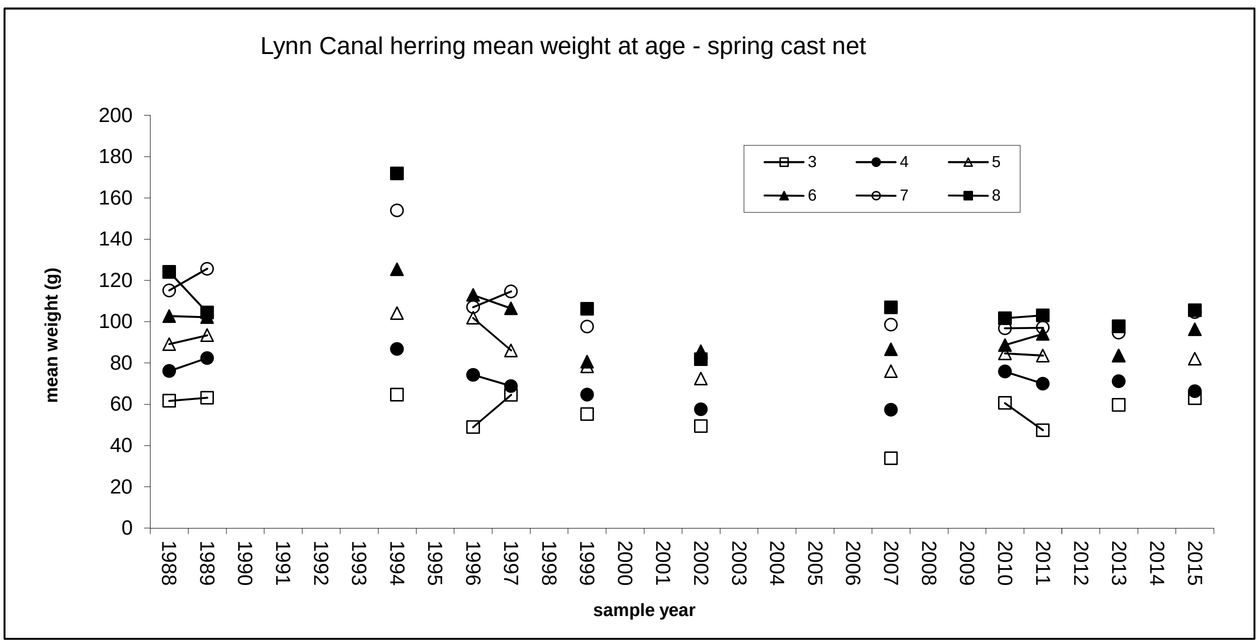

Figure 56.–Mean weight at age for the Lynn Canal herring spawning population.

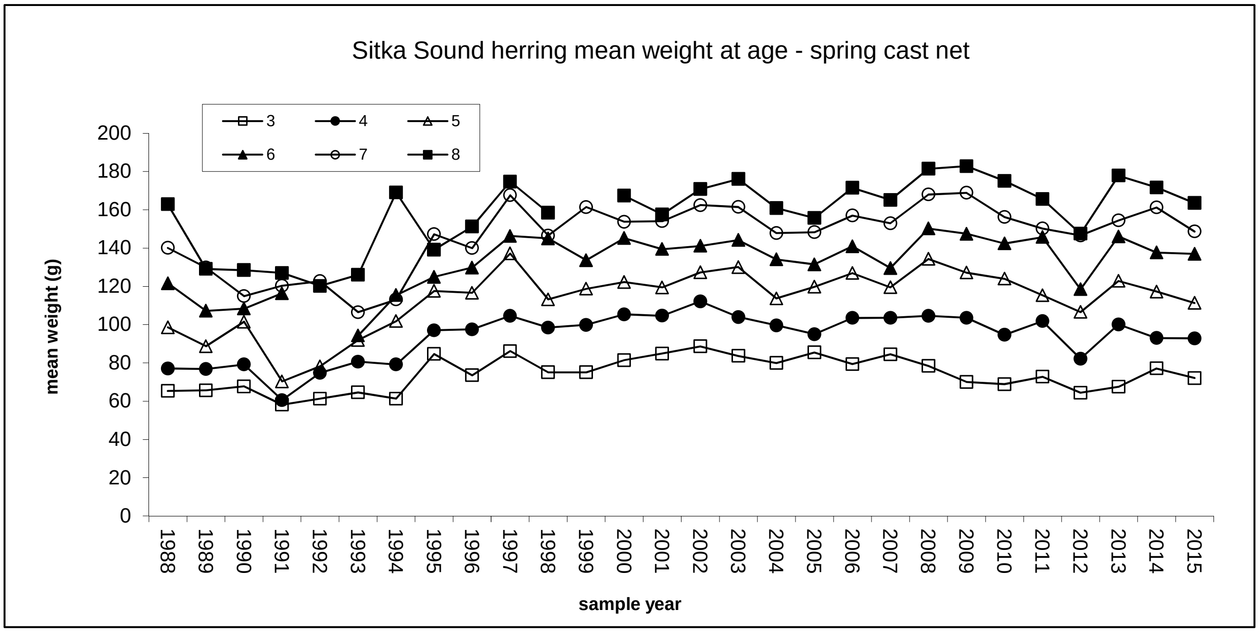

Figure 57.–Mean weight at age for the Sitka Sound herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

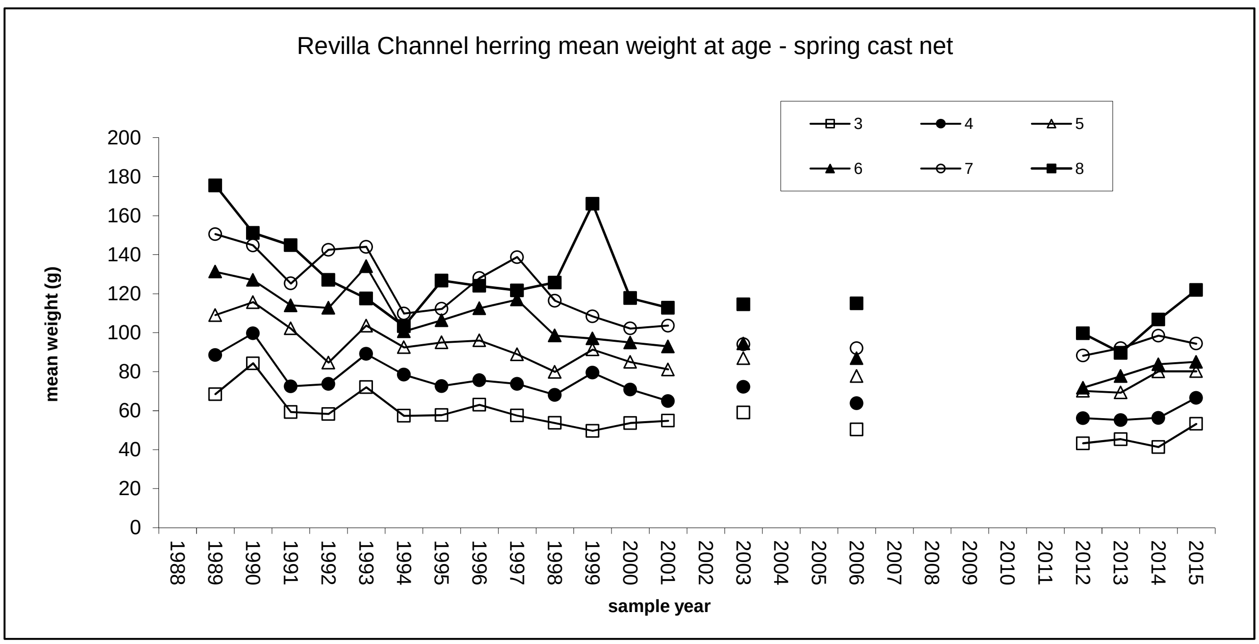

Figure 58.–Mean weight at age for the Revilla Channel herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

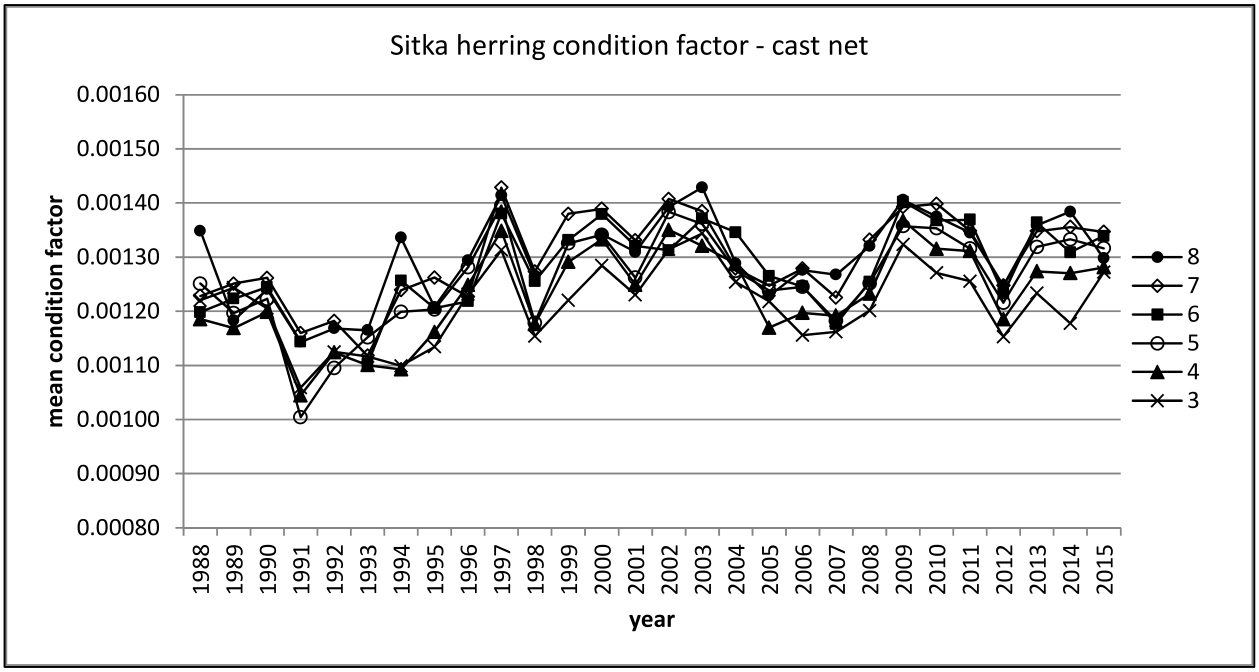

Figure 59.–Mean condition factors of age-3 through age-8 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning.

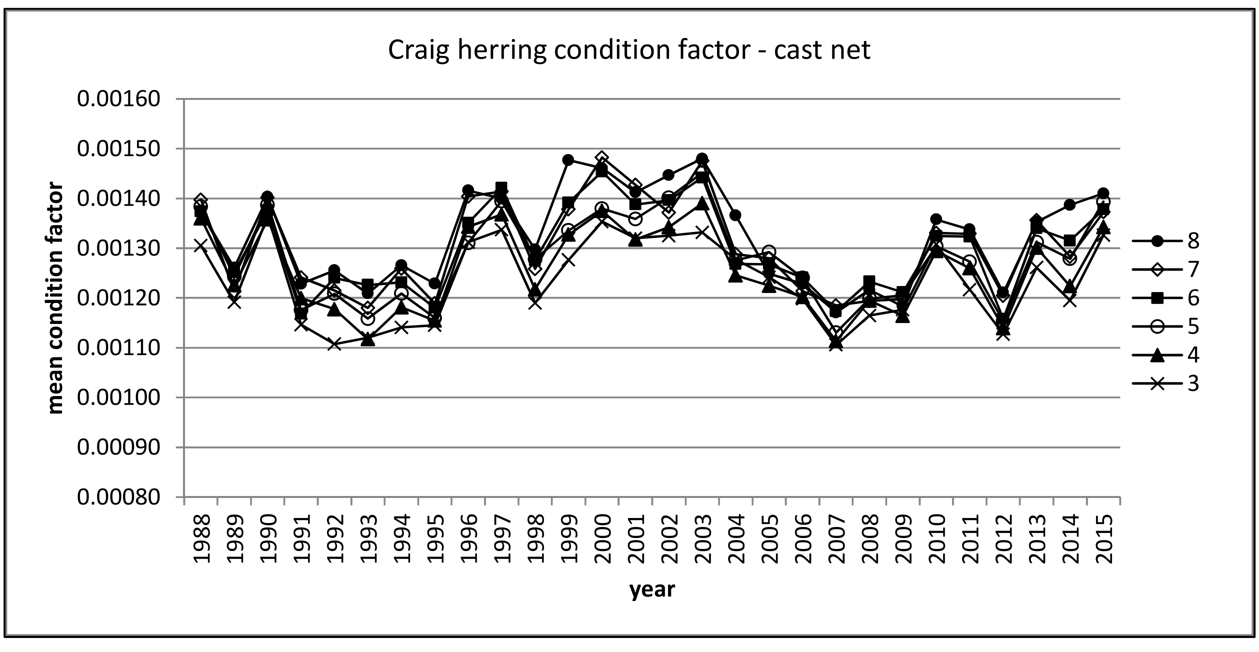

Figure 60.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

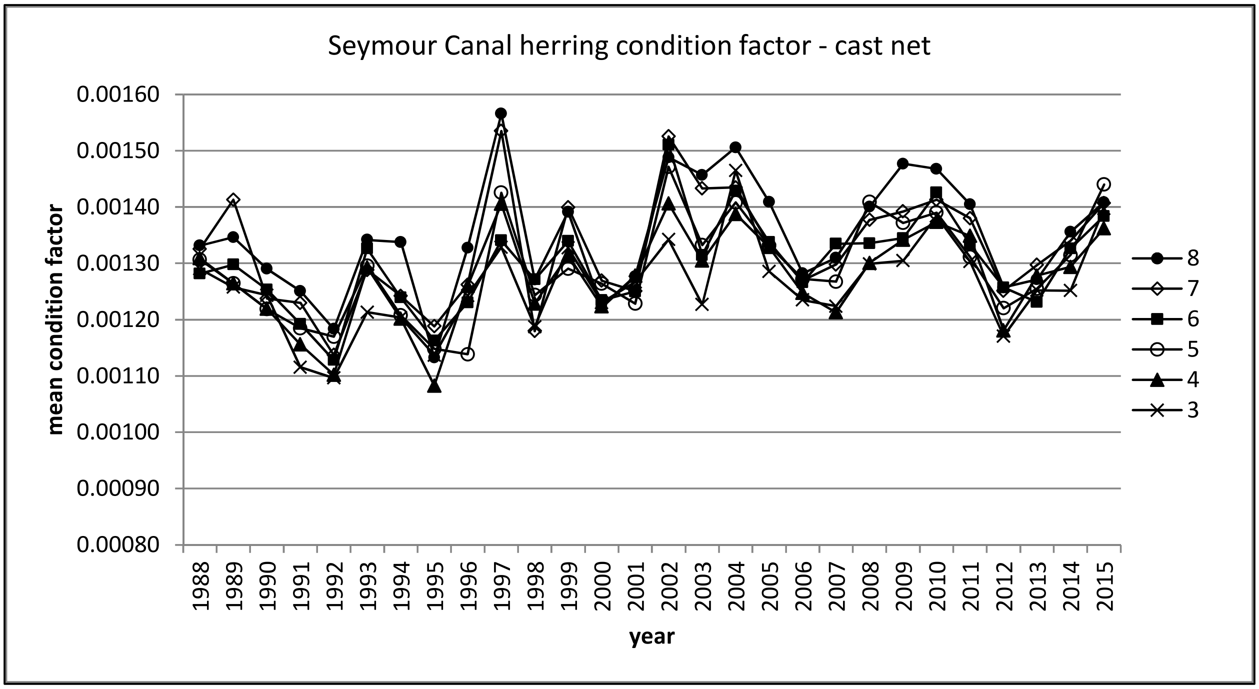

Figure 61.–Mean condition factors of age-3 through age-8 herring for the Seymour Canal spawning population, based on spring cast net samples taken during active spawning.

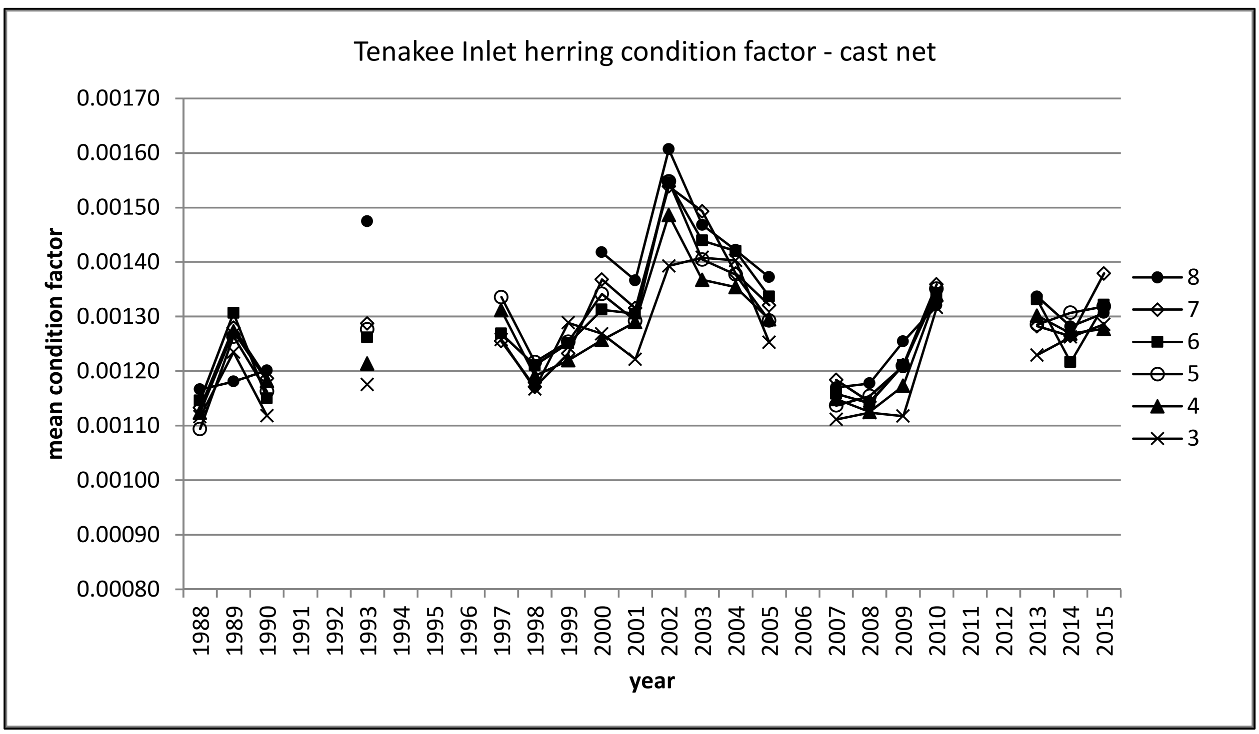

Figure 62.–Mean condition factors of age-3 through age-8 herring for the Tenakee Inlet spawning population, based on spring cast net samples taken during active spawning.

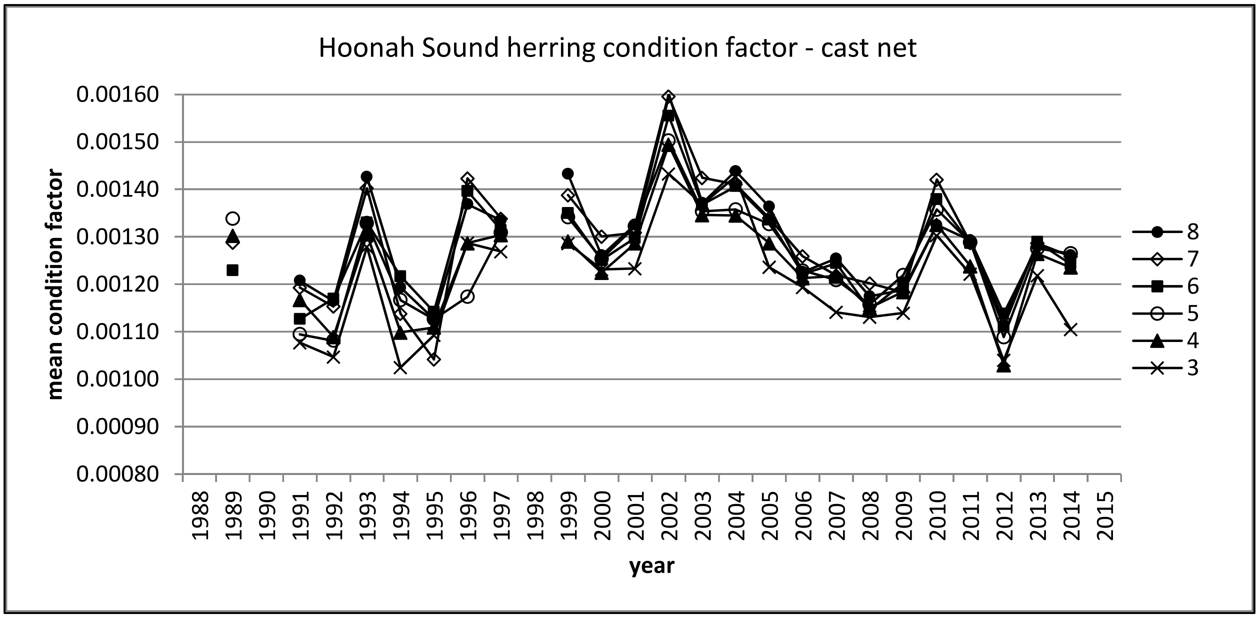

Figure 63.–Mean condition factors of age-3 through age-8 herring for the Hoonah Sound spawning population, based on spring cast net samples taken during active spawning.

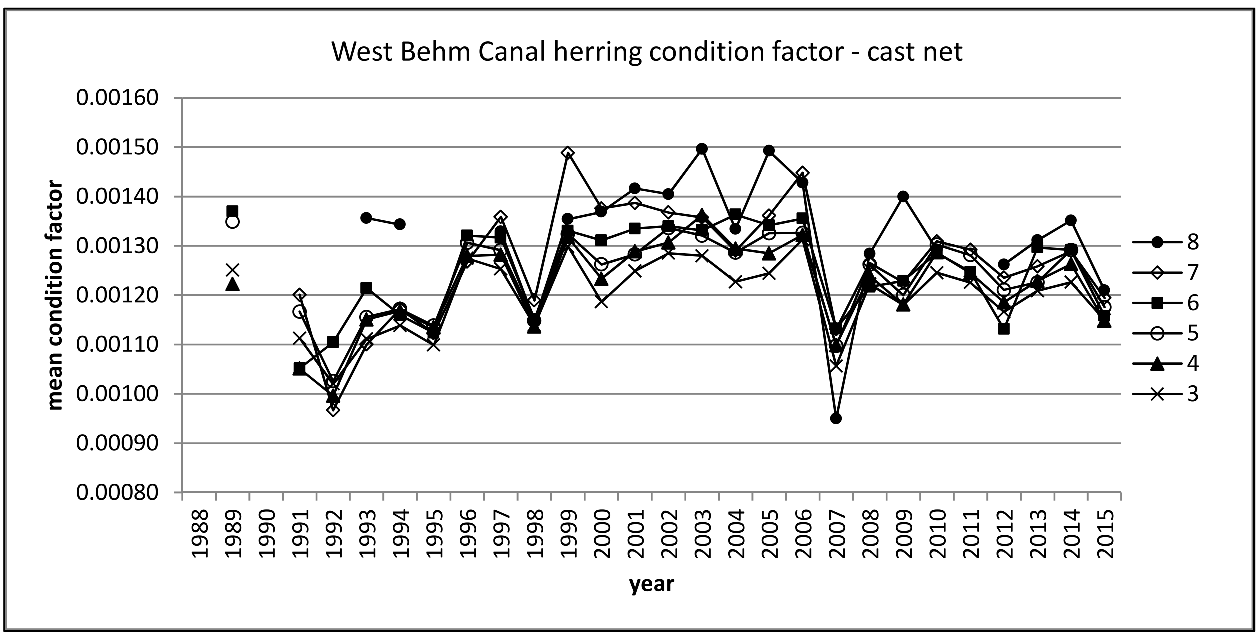

Figure 64.–Mean condition factors of age-3 through age-8 herring for the West Behm Canal spawning population, based on spring cast net samples taken during active spawning. 2015 condition factors are likely biased low due to required additional sample handling that resulted in loss of weight.

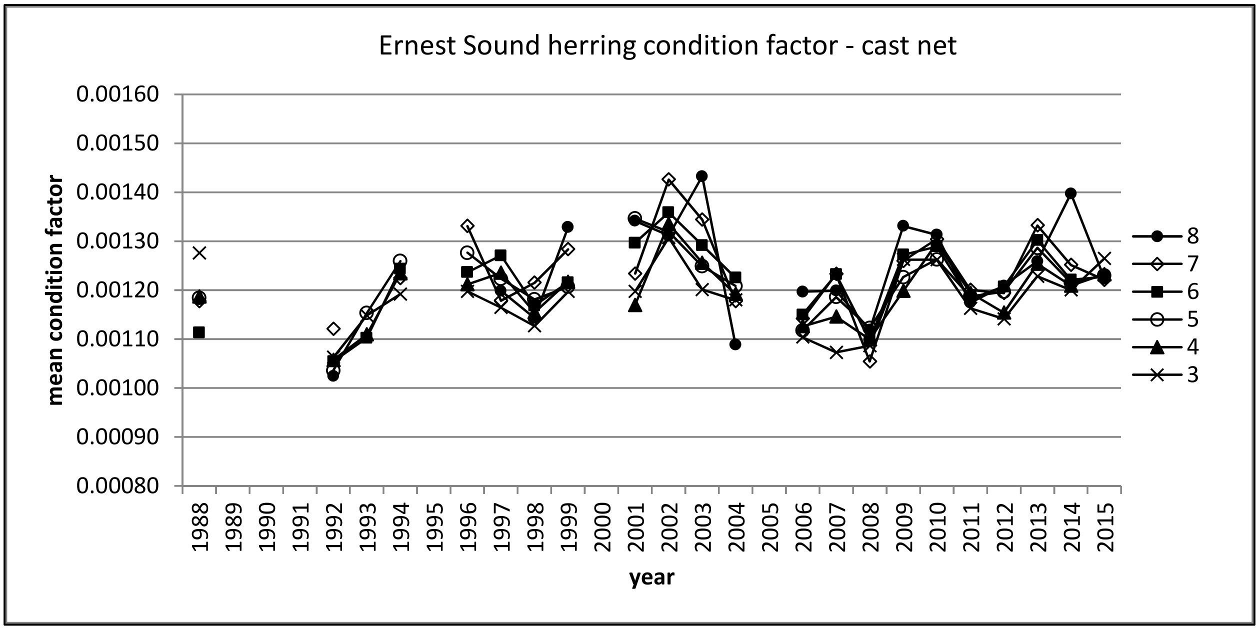

Figure 65.–Mean condition factors of age-3 through age-8 herring for the Ernest Sound spawning population, based on spring cast net samples taken during active spawning.

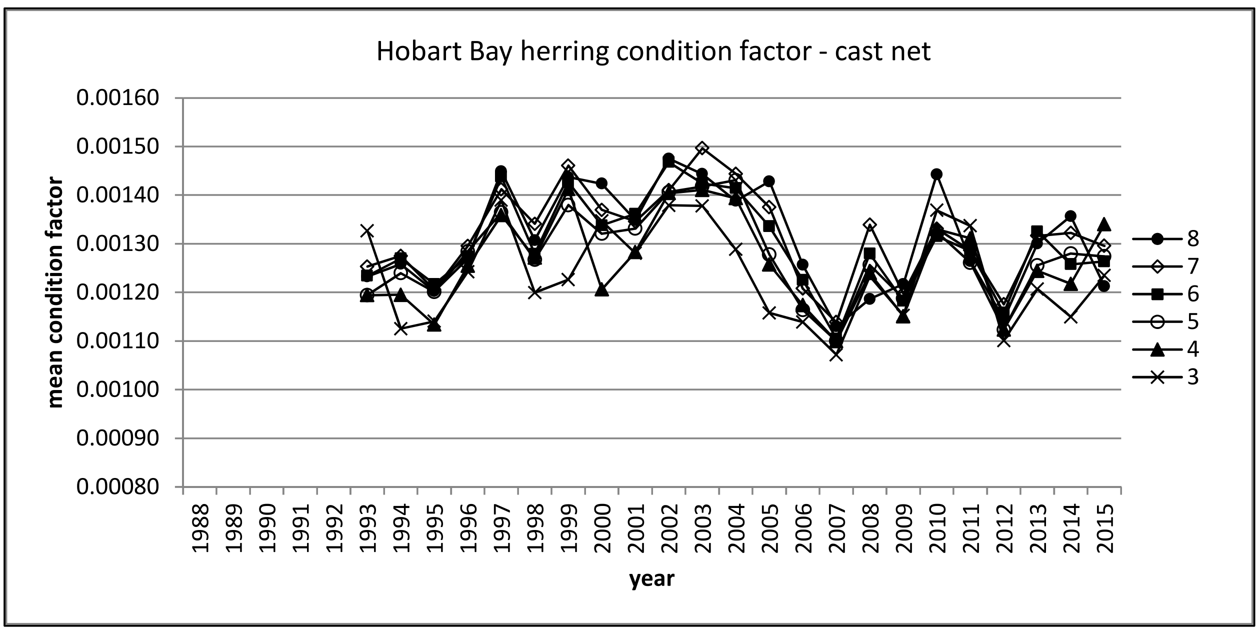

Figure 66.–Mean condition factors of age-3 through age-8 herring for the Hobart Bay spawning population, based on spring cast net samples taken during active spawning.

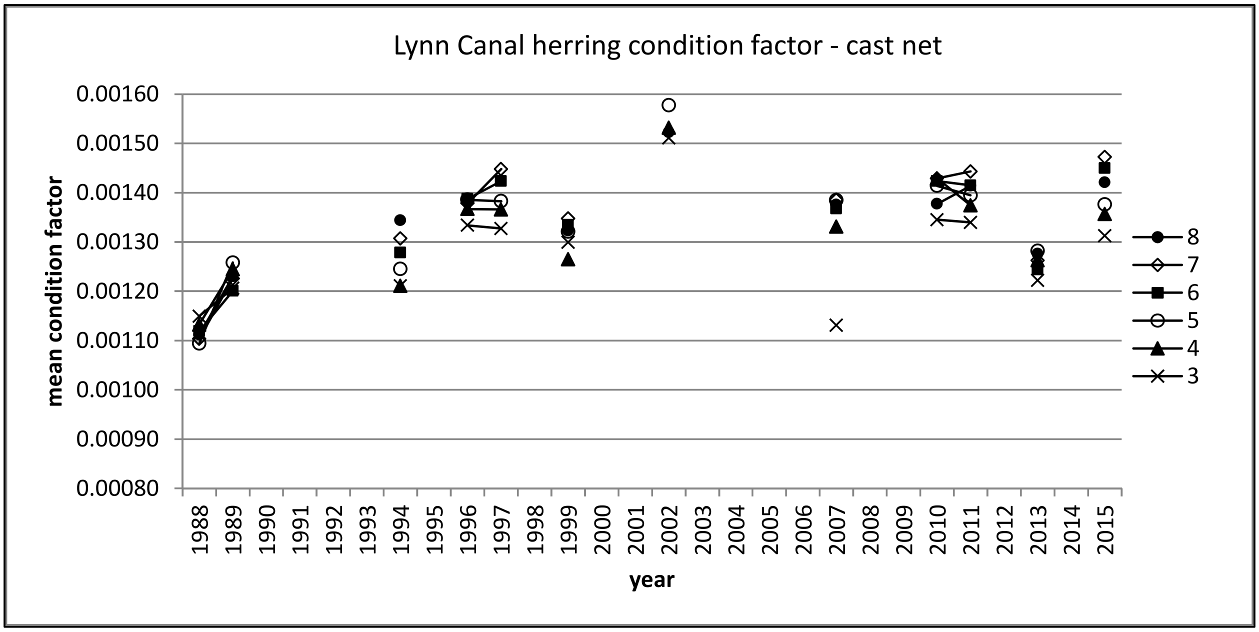

Figure 67.–Mean condition factors of age-3 through age-8 herring for the Lynn Canal spawning population, based on spring cast net samples taken during active spawning.

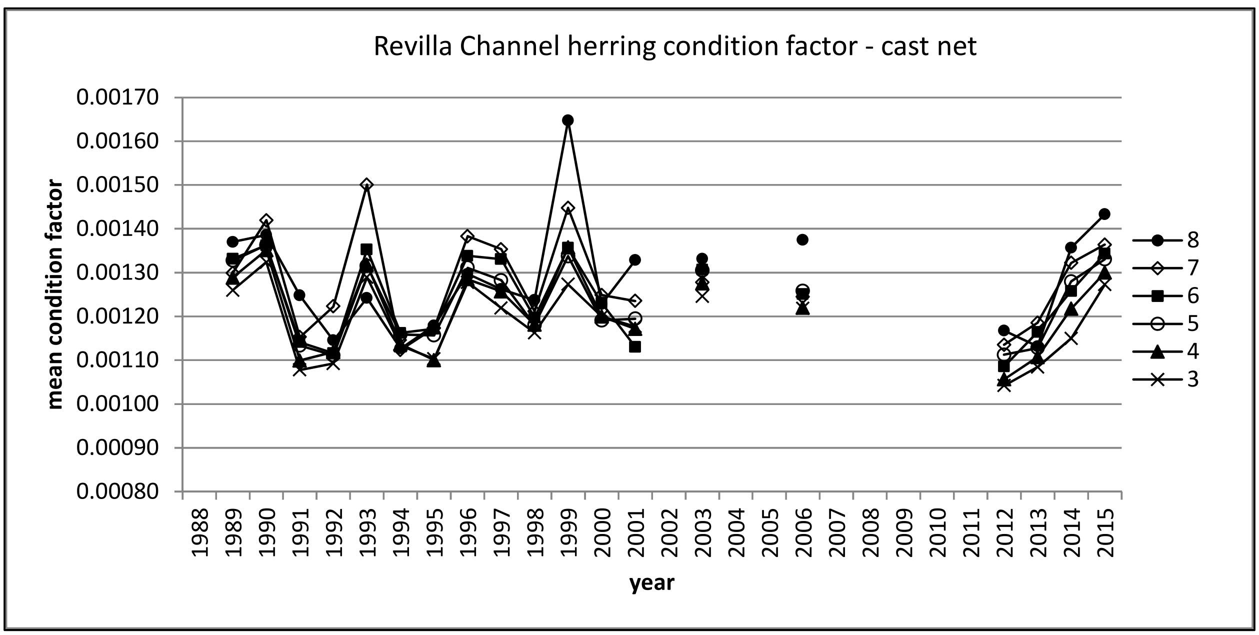

Figure 68.–Mean condition factors of age-3 through age-8 herring for the Revilla Channel spawning population, based on spring cast net samples taken during active spawning.

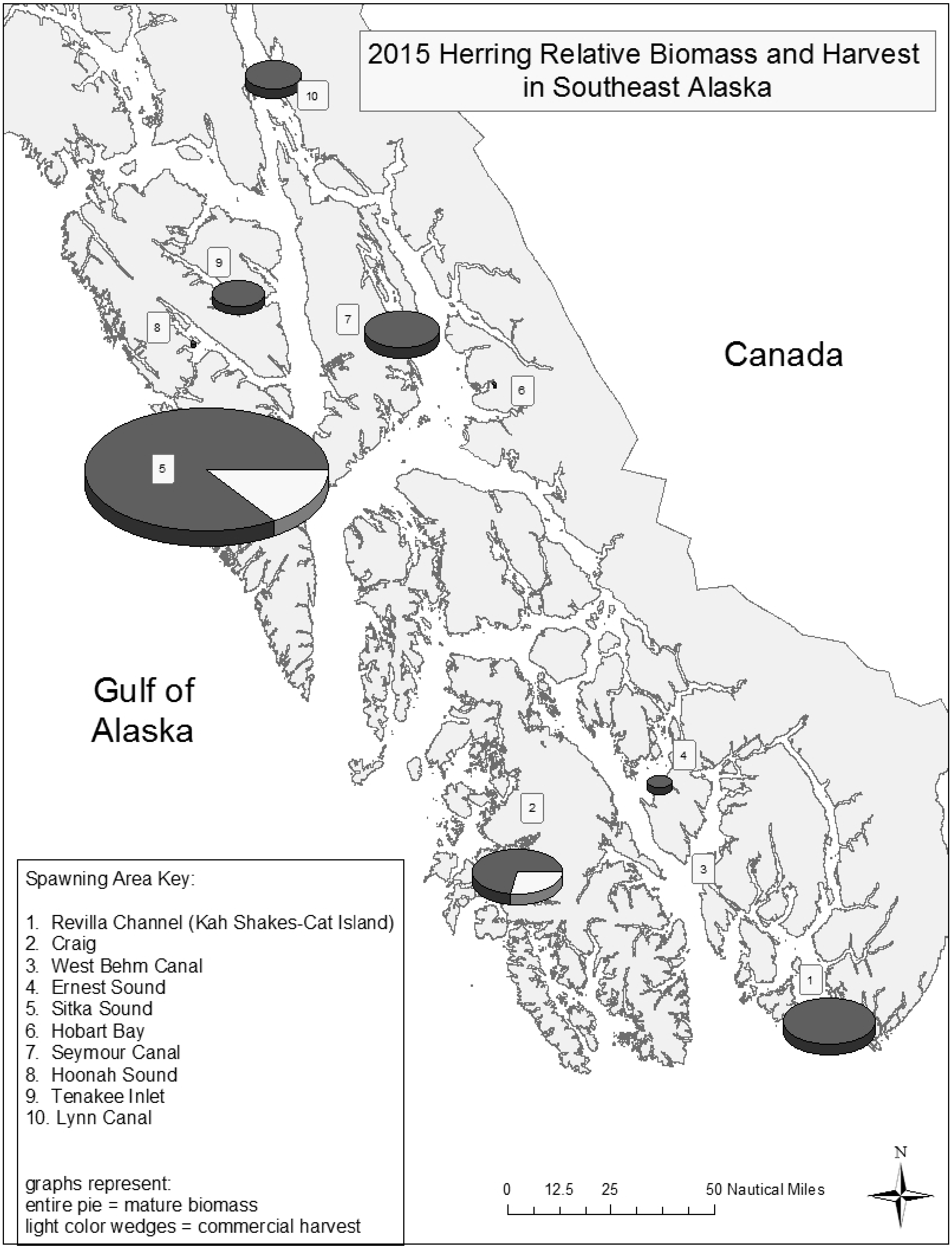

Figure 69.–Relative magnitude of herring spawning stocks and harvest levels in Southeast Alaska, based on biomass estimates converted from spawn deposition estimates. White wedges are intended to provide approximate indication of relative harvest, but do not represent actual exploitation rate.

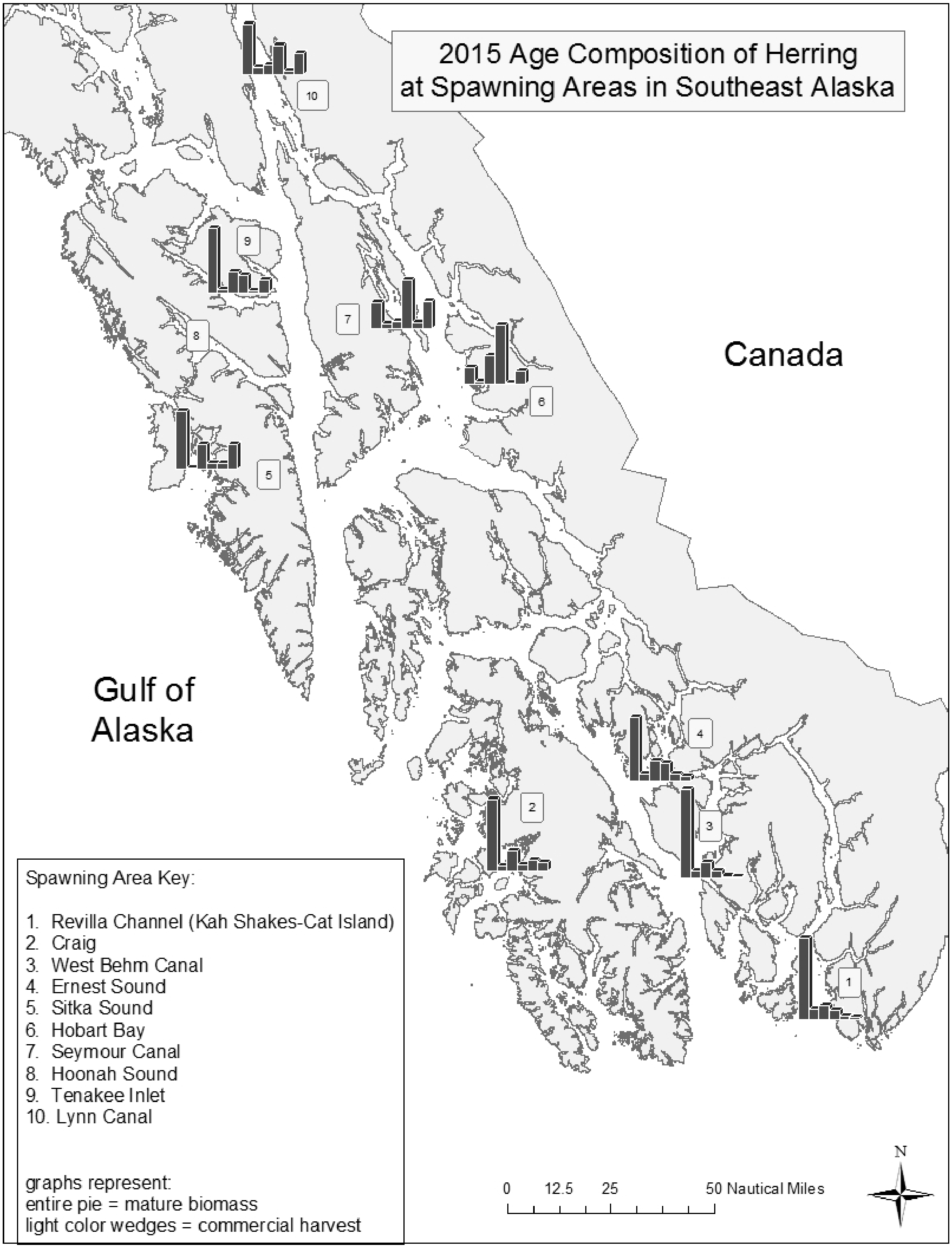

Figure 70.–Summary of age composition of herring spawning stocks in Southeast Alaska from cast net sampling.

APPENDIX A: KEY TO VEGETATIVE SUBSTRATE TYPES USED FOR HERRING SPAWN DEPOSITION SURVEY

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 B: KEY TO BOTTOM TYPES USED FOR HERRING SPAWN DEPOSITION SURVEY

Appendix B.1–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 C: SPAWN SURVEYS BY DATE

Appendix C.1–Aerial and skiff herring spawn surveys by date, in Revilla Channel, Craig, and West Behm Canal (Ketchikan Management Area), Southeast Alaska in 2015.

Total spawn documented by ADFG in Revilla Channel for 2015 is 11.9 nautical miles. This was all in state waters, no spawn was documented on Annette Island.

Total spawn documented by ADFG in Craig for 2015 was 11.5 nautical miles.

Total spawn documented by ADFG in West Behm Canal for 2015 is 1.7 nautical miles.

In addition there was 2.0 nautical miles of spawn along the Mountain Point shoreline and 2.5 nautical miles of spawn on the backside of Gravina in Nehenta Bay.

Revilla Channel

March 19, 2015	No herring activity observed. Very little predator activity.
March 26, 2015	**3.5 nmi spawn**.
March 27, 2015	**3.5 nmi spawn.**
March 28, 2015	**2 nmi spawn.**
March 29, 2015	**2 nmi spawn.**
March 30, 2015	**3 nmi spawn.**
March 31, 2015	**0.5 nmi spawn.**
April 1, 2015	**2 nmi spawn.**
April 2, 2015	No herring activity observed. Final survey.

Craig

March 19, 2015	No herring activity. Large numbers of predators observed.
March 26, 2015	No Spawn. Numerous of predators in the Craig area. 72 pounds.
March 27, 2015	**0.5 nmi spawn**.
March 28, 2015	**2.5 nmi spawn.**
March 29, 2015	**2 nmi spawn.**
March 30, 2015	**Skiff survey indicated active spawn Active spawn approximately 7 nmi.**
March 31, 2015	**3 nmi spawn.**
April 1, 2015	**0.5 nmi spawn.**
April 3, 2015	No herring activity observed. Final survey.

-continued-

Appendix C1.–continued (page 2 of 2).

March 28, 2015	No spawn. Few predators in Clover Pass.
March 29, 2015	**Spot spawn** observed.
March 31, 2015	No spawn. Few predators.
April 1, 2015	No spawn.
April 3, 2015	0.**75 nmi spawn at Vallenar Point**
April 4, 2015	No Spawn
April 5, 2015	No Spawn
April 6, 2015	No Spawn
April 7, 2015	**0.5 nmi spawn at Point Francis**
April 8, 2015	**0.5 nmi spawn at Point Francis**
April 10, 2015	**0.5 nmi spawn at Point Francis and Wadding Cove**
April 11, 2015	No herring activity observed. Final survey.

Appendix C.2–Aerial and skiff herring spawn surveys by date, in Sitka Sound and Hoonah Sound (Sitka Management Area), Southeast Alaska in 2015.

March 10: 2:00–3:30. Gordon/Coonradt. Today's aerial survey coved Sitka Sound north of Cape Burunof and Salisbury Sound. Spotting conditions were broken clouds with light winds. No herring or herring spawn was seen. There were approximately 300 sea lions near Inner Point and another 200 off Bieli Rock. A number of whales were active in the deeper waters between these large sea lion groups. Another 45 sea lions were seen off Mountain Point and 35 sea lions were near Guide Island. Smaller groups of sea lions were seen south of Siginaka Islands and off Lisianski Point. There was little activity in the waters between the island groups and the Halibut Point Road shoreline. South of Sitka there were several whales seen west of Eastern Channel and two whales were seen near the mouth of Silver Bay. In Salisbury Sound approximately 20 seas lions and one whale were seen at the mouth of St. John Baptist Bay. The observed distribution of herring predators was normal for this date.

March 16: 9:07–10:13. Gordon/Coonradt. Today's aerial survey coved Sitka Sound and south to Windy Pass. Spotting conditions were overcast skies and NW winds 10–20 knots. Herring predators were concentrated in the areas west and south of Crow Island and Bieli Rock. There was very little herring predator activity inside the island groups and along the Halibut Point Road shoreline. There was little activity noted in the areas south of Sitka to Windy Pass.

The Department announced today that the Sitka Sound sac roe herring fishery will be on 2-hour notice effective 10:00 a.m., Wednesday, March 18, 2015.

March 17: 09:00–09:50 Gordon. Today's aerial survey covered Sitka Sound north of Redoubt Bay. No herring were visible from the air. Spotting conditions were generally good with east wind 15–20 knots, and overcast skies. Herring predators continued to be concentrated in the areas west and south of the Middle, Crow and Gagarin Islands. Several whales and scattered sea lions were seen in the Long Island area south of Sitka.

March 18: 08:35–0926 Gordon/Coonradt/Vaughn. Today's aerial survey coved Sitka Sound and south to Frosty Reef. Spotting conditions were generally good with southeast wind 15–20 knots, and overcast skies. No herring spawn was seen. Herring predators were concentrated in the areas west and south of Crow Island and Bieli Rock. There was very little herring predator activity inside the island groups and along the Halibut Point Road shoreline. There was little activity noted in the areas south of Sitka to Windy Pass. The *R/V Kestrel* arrived in Sitka today and reported 2 whales in Salisbury Sound.

March 19: 08:30–09:55 Gordon. Today's aerial survey covered Sitka Sound north of Eastern Channel. Spotting conditions were clear skies with light winds. No herring or herring spawn observed during today's aerial survey. Herring predator activity was as follows: Dorthy Narrows – 4 sea lions and 3 whales; Eastern Channel – 4 sea lions; Bieli Rock –3 whales; Inner Point -100 sea lions and 12 whales; Guide Island – 2 whales; north Crow and Middle Islands – 2 whales; Chaichei and Parker Group – 14 sea lions and 3 whales: No herring were observed.

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March 20: 08:36–09:10 Coonradt. Today's aerial survey covered Sitka Sound north of Cape Burunof. Spotting conditions were overcast skies with southeast winds at 30 knots. No herring or herring spawn

observed during today's aerial survey. Herring predators continued to be concentrated in the areas west and south of the Middle, Crow and Gagarin Islands.

March 21: 13:30–14:30 Gordon. Today's aerial survey covered Sitka Sound north of Frosty Reef. Spotting conditions were overcast skies with intermittent rain showers. No herring or herring spawn observed during today's aerial survey. Herring predators continued to be concentrated in the areas west and south of the Middle, Crow and Gagarin Islands.

March 22: 08:30–10:12 Gordon/Coonradt. Today's aerial survey covered Sitka Sound north of West Crawfish Inlet and south of Salisbury Sound. Spotting conditions were clear skies and calm winds. No herring spawn observed during today's aerial survey. Herring schools were seen in Sitka Channel, Crescent Bay and Middle Channel, south of Kasiana Island and Middle Island and a large school was seen in St. John Baptist Bay. Whales were concentrated on the Kruzof Island shoreline north of Inner Point and west of Gagarin Island. Six whales were seen off Cape Burunof. Additional whales were seen widely scattered throughout Sitka Sound.

March 23: 08:30–09:15 Coonradt/Gray. Today's aerial survey covered Sitka Sound north of Redoubt Bay and south of Salisbury Sound. Spotting conditions were clear skies and calm winds. No herring spawn observed during today's aerial survey. Herring schools were seen in Sitka Channel, Crescent Bay and Middle Channel, south of Kasiana Island and Middle Island and several large schools were seen in St. John Baptist Bay. Whales were concentrated on the Kruzof Island shoreline north of Inner Point and west of Gagarin Island. Six whales were seen off Cape Burunof. Additional whales were seen widely scattered throughout Sitka Sound.

March 24: 08:40–09:25 Gordon/Coonradt/Bayne. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Krestof Sound. Spotting conditions were clear skies and calm winds. No herring spawn observed during today's aerial survey. Herring schools were seen in Sitka Channel, Crescent Bay and Eastern Channel. Numerous whales were seen scattered around the northwest portion of Sitka Sound with the highest concentration seen west of Crow and Gagarin Islands where a large biomass of herring continues to be seen on sonar surveys. In the afternoon a number of whales were seen moving into the pass between Middle Island and Kasiana Island.

March 25: 08:30–09:00 Coonradt. Today's aerial survey covered Sitka Sound from Cape Burunof to Hayward Strait. Spotting conditions were overcast skies and southeast winds 30 knots. Approximately **0.3 nmi of light herring spawn** was observed in the vicinity of Hayward Strait. Numerous whales and sea lions continue to be scattered around the northwest portion of Sitka Sound with the highest concentrations seen west of Crow and Gagarin Islands, and east of Inner Point on Kruzof Island.

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<u>March 26:</u> 13:00–13:50 Coonradt/Gordon/Davidson. Today's aerial survey covered Sitka Sound from Cape Burunof to Salisbury Sound. Spotting conditions were overcast skies and southwest winds 15–25 knots. Approximately **0.3 nmi of light herring spawn** was observed in the vicinity of Hayward Strait. Numerous whales and sea lions were seen scattered around the northwest portion of Sitka Sound with the highest concentrations seen west of Crow and Gagarin Islands, and east of Inner Point on Kruzof Island.

<u>March 27:</u> 09:00–10:00 Gordon/Coonradt. Today's aerial survey covered Sitka Sound from Windy Pass to Hayward Strait. Spotting conditions were overcast skies and southeast winds 20 knots, with rain and hail. Herring spawn had expanded in the Hayward Strait area **totaling 0.8 nmi**. Additionally, two spot spawns were observed on the Siginaka Islands. Herring predators continue to be concentrated in the northwest portion of Sitka Sound with the highest concentrations seen west of Crow and Gagarin Islands, and east of Inner Point on Kruzof Island.

<u>March 28:</u> 07:00–11:00 Gordon/Coltharp. No aerial survey was conducted today. A skiff survey was conducted covering areas of northern Sitka Sound. Approximately **3.8 nmi of old spawn** was recorded mostly in the Hayward Strait area. Spawn was also recorded in the Siginaka Islands. During the survey whales were seen in the islands to the south of Middle Island, west of the Gavanski Islands and scattered in areas west of Crow Island and west of the Gavanski Islands. A whale was also seen in Crescent Bay. Sizable schools of herring were seen on the sounder off of the spawn in Hayward Strait.

<u>March 29:</u> 07:00–11:00 Coonradt/Coltharp. No aerial survey was conducted today. A skiff survey was conducted covering areas of northern Sitka Sound. Approximately **7.6 nmi of old spawn** was recorded; in the Hayward Strait area, in the Siginaka Islands and on the Halibut Point Road system south of Old Sitka Rocks. During the survey whales were seen in the islands to the south of Middle Island, west of the Gavanski Islands and scattered in areas west of Crow Island and west of the Gavanski Islands. Sizable schools of herring were seen on the sounder off of the spawn in Hayward Strait.

<u>March 30:</u> 09:00–10:10 Coonradt. Today an aerial survey was conducted of Sitka Sound from Cape Burunof to Salisbury Sound. Spotting conditions were overcast skies and southeast winds 10–15 knots. Approximately **19.0 nmi of active spawn** was recorded; in the Hayward Strait area, in the Siginaka Islands and on the Halibut Point Road system south of Old Sitka Rocks. A small spot spawn was also observed on the west side of Middle Island and on the Lisianski Peninsula. During the survey whales were seen in the islands to the south of Middle Island, west of the Gavanski Islands and scattered in areas west of Crow Island and west of the Gavanski Islands.

<u>March 31:</u> 08:00–09:20 Gordon/Coonradt/Coltharp. Today an aerial survey was conducted of Sitka Sound from Windy Pass to Salisbury Sound. Spotting conditions were overcast skies and southeast winds 10–15 knots with snow squalls. Approximately **32.3 nmi of active spawn** was recorded; Hayward Strait, Krestof Sound, Siginaka Islands and on the Halibut Point Road system. Spawn was also observed on the west side of Middle Island, Kasiana Island, Eastern Bay, Apple Islands and on the Lisianski Peninsula. During the survey whales were seen in the islands to the north of the Makhnati Island causeway, several whales and sea lions were also observed east of Biorka Island.

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The cumulative spawn mileage for the season so far is approximately 35 nmi.

April 1: **08:30–09:50** Coonradt/Jensen. Today an aerial survey was conducted of Sitka Sound north of Cape Burunof and Salisbury Sound. Spotting conditions were overcast skies and southwest winds 25 knots with rain and hail.

10:00–11:05 Gordon. Today's aerial survey covered Sitka Sound north of Windy Pass and south of Hayward Strait. Spotting conditions were overcast skies and southwest winds 25 knots with rain and hail. Approximately **29.3 nmi of active spawn** was recorded in the northern Sitka Sound and Krestof Sound areas.

April 2: **08:30–09:50** Coonradt/Jensen. Today an aerial survey was conducted of Sitka Sound north of Cape Burunof and Salisbury Sound. Spotting conditions were overcast skies and southwest winds 25 knots with rain and hail. Approximately **24.5 nmi of active spawn** was recorded. Active spawn was observed in Krestof Sound along the west shoreline and on the Partofshikof Island shoreline, in Promisla and Eastern Bays, the Lisianski Peninsula, the Harbor Point and Starrigavan Bay area, the Gavanski Islands, the south end of Middle Island, most of the Kasiana shoreline. Spawn was also seen in Whiting Harbor, along the Breakwater, the Apple and Parker Island groups, and in Crescent Bay.

April 3: **08:30–09:49** Coonradt. Today an aerial survey was conducted of Sitka Sound north of Crawfish Inlet to Salisbury Sound, including Shelikof Bay. Spotting conditions were mostly overcast skies and northwest winds 15 knots. Approximately **9.5 nmi of active spawn** was recorded. Active spawn was observed in Krestof Sound, Promisla Bay, Middle Island, Whiting Harbor, The Channel, Crow and Gagarin Islands. Spawn was also seen in Crescent Bay and Jamestown Bay.

The total shoreline receiving spawn to date is 63.7 nautical miles.

April 4: **08:00–09:00** Gordon. Today an aerial survey was conducted of Sitka Sound north of West Crawfish Inlet to Salisbury Sound. Spotting conditions were clear skies and calm winds. Approximately **6.2 nmi of active spawn** was observed in Promisla Bay, on East Gagarin Island, South Middle Island, the north side of the Causeway and Japonski Island, Crescent Bay and Jamestown Bay.

April 5: **08:00–08:45** Gordon/Coonradt. Today an aerial survey was conducted of Sitka Sound north of Cape Burunof to Krestof Sound. Spotting conditions were clear skies and calm winds. Approximately **2.8 nmi total active spawn** was observed on West Crow Island, the Causeway, Crescent Bay and Jamestown Bay.

April 6: **08:30–09:25** Gordon/Jensen. Today an aerial survey was conducted of Sitka Sound north of West Crawfish Inlet to Salisbury Sound. Spotting conditions were partly cloudy skies and calm winds. Approximately **2.9 nmi total active spawn** was observed on West Crow Island, East Gagarin Island, and the Causeway. Small areas of spawn were also observed on Whale Island, between Guertin Island and Harris Island and north of Goddard.

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<u>April 7:</u> 08:30–09:30 Coonradt. Today an aerial survey was conducted of Sitka Sound north of West Crawfish Inlet to Salisbury Sound. Spotting conditions were clear skies and calm winds. Approximately **3.3 nmi of active spawn** was recorded. Most of this spawn was seen on West Crow Island, East Gagarin Island, South Middle Island and on the south side of the Causeway (see attached map). Small areas of spawn were also recorded in Krestof Sound and in two locations north of Goddard.

Skiff surveys were conducted April 6–7 to look for herring eggs on the beach at low tide in areas adjacent to but outside where milt was previously recorded during aerial surveys. This added 6.8 nm of shoreline with herring spawn. To date, a total length of shoreline where herring spawn has been recorded is 76.2 nm.

<u>April 8:</u> Today no aerial survey is planned due to weather.

<u>April 9:</u> Today no aerial survey is planned due to weather.

<u>April 10:</u> Today no aerial survey due to mechanical.

<u>April 11:</u> Today no aerial survey was planned.

<u>April 12:</u> Today no aerial survey was planned.

<u>April 13:</u> 10:00–10:40 Jensen. Today's aerial survey covered Sitka Sound north of Windy Pass. Approximately **0.9 nmi of active spawn** was observed, south of Frosty Reef and east of Chaichei Islands.

<u>April 14:</u> 08:30–09:30 Gordon/Coonradt. Today's aerial survey covered Sitka Sound north of Crawfish Inlet and south of Salisbury Sound. Spotting conditions were good with mostly clear skies with light winds. Approximately **0.8 nmi of active spawn** was observed, south of Frosty Reef and east of Chaichei Islands.

<u>April 15:</u> 08:30–09:00 Jensen. Today's aerial survey covered Sitka Sound north of Windy Pass. Spotting conditions were good with partly cloudy skies with north winds 15 kts. No herring or herring spawn was observed.

<u>April 17:</u> 08:40–09:55 Gordon/Coonradt. Today's aerial survey covered Hoonah Sound. Spotting conditions were overcast skies with southeast winds 15–20 knots and snow squalls. No herring or herring spawn was observed. Herring predators were observed as follows: Patterson Bay - 2 sea lions; White Cliff – 10 sea lions and Ushk Point - 2 whales.

-continued-

<u>April 20:</u> **08:30–09:50** Gordon. Today's survey covered Hoonah Sound. Spotting conditions were overcast skies with calm winds. No herring or herring spawn was observed. However herring spawn was observed in Suloia Bay. Herring predators were distributed as follows: Dead Man's Reach – 2 whales, Pederson Point – 4 sea lions, White Cliff Point **-** 6 sea lions.

<u>April 21:</u> Gordon/Gray. No Aerial Survey was conducted today. A skiff survey was conducted to determine if additional spawn occurred in Nakwasina Sound. Approximately **1.9 nmi of old spawn** was observed in Nakwasina.

<u>April 22:</u> **12:30–13:30** Jensen. The department conducted an aerial survey of Sitka Sound north of Eastern Channel. Spotting conditions were good with clear skies and light winds. In Sitka Sound approximately **5.7 nmi of active spawn** was observed mostly in Katlian Bay.

<u>April 23:</u> **9:45–11:15** Gordon/Coonradt. The department conducted an aerial survey of Sitka Sound north of Redoubt Bay, Hoonah Sound, and the Slocum Arm areas. In Sitka Sound approximately **1.2 nmi of active spawn** was observed in Katlian Bay and St. John Bay.

In Hoonah Sound and Slocum Arm no herring or herring spawn was observed. A few small groups of sea lions were seen scattered in the South Arm. There was no predator activity around either Vixen Island or Emmons Island. Six whales were actively feeding near Point Marie in Ushk Bay.

<u>April 24:</u> **8:30–10:00** Coonradt/Jensen. The department conducted an aerial survey of the Hoonah Sound area. Spotting conditions were good with clear skies and light winds. Approximately **0.4 nmi** of herring spawn was observed along the Chichigof Island shore between Finger River and Broad Creek. A few small groups of sea lions were seen scattered in the South Arm. There was no predator activity around either Vixen Island or Emmons Island. Two whales were observed south of Broad Creek and another two whales were observed near Pogibshi Point.

<u>April 25:</u> **08:00–09:30** Gordon. The department conducted an aerial survey of Sitka Sound north of Cape Burunof, and Hoonah Sound. In Sitka Sound approximately **1.2 nmi of active spawn** was observed in Katlian Bay and St. John Bay.

In Hoonah Sound **0.4 nmi of light herring spawn** was observed along the Chichigof Island shore south of Finger River.

<u>April 30:</u> **8:30–9:40** Gordon/Coonradt. The department conducted an aerial survey of Sitka Sound North of Cape Burunof and the Hoonah Sound area. Spotting conditions were good with clear skies and light winds.

-continued-

In Hoonah Sound no herring or herring spawn was observed. One whale was seen NE of Emmons Island and 5 whales south of Rodgers Point.

May 4: **10:45–11:30** Coonradt. The department conducted an aerial survey of the Hoonah Sound area. Approximately **0.3 nmi of herring spawn** was observed along Moser Island between White Cliff Point and Pedersen Point. No sea lions were observed during this survey, likely due to weather conditions in Hoonah Sound. There was no predator activity around either Vixen Island or Emmons Island. Two whales were observed in Ushk Bay, and another four whales were observed along the Chichigof Island Shore south of Finger River.

May 5: **09:00–09:45** Gray. The department conducted an aerial survey of the Hoonah Sound area. Spotting conditions were good with clear skies and calm wind. No herring or herring spawn was observed.

The department also conducted a brief skiff survey on the department's 25' Attack Whaler and no herring or herring predators were observed.

May 6: **10:45–11:45** Coonradt. The department conducted an aerial survey of the Hoonah Sound area. Spotting conditions were good with clear skies and calm wind. No herring were observed. Approximately **1.0 nmi of spawn** was observed mostly along the Duffield Peninsula between Goose cove and Rodman Bay.

May 7: **9:00–10:10** Coonradt. The department conducted an aerial survey of the Hoonah Sound area. Spotting conditions were good with clear skies and calm wind. No herring or herring spawn was observed.

Appendix C.3–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, 2015.

BRADFIELD CANAL

Total miles of spawn: unknown

Spawning dates: unknown

Peak spawning: unknown

4/7 No active spawn or herring observed, 4 sea lions, 850 scoters.

VIXEN INLET/ UNION BAY/EMERALD BAY

Total miles of spawn: ~5.35 nm

Spawning dates: 4/7 through 4/11

Peak spawning: 4/8

4/3 No active spawn, one school of herring observed, 16 Sea Lions, 1 whale.

4/7 1 active **spot spawn** and several areas of older milt, 10 herring schools, 60 sea lions.

4/8 **1.8 nm of active spawn,** 2 herring schools, 94 sea lions, 1 whale.

4/9 **0.75 nm of active spawn**, 35 sea lions.

4/10 1 **spot spawn**, 67 sea lions.

4/11 **0.75 nm of active spawn**, 30 sea lions.

4/12 No herring spawn or schools observed, 18 sea lions

4/13 No herring spawn or schools observed, 19 sea lions.

4/16 No herring spawn or schools observed, 43 sea lions.

ONSLOW/STONE/BROWNSON ISLAND/CANOE PASS

Total miles of spawn: 0.0 nm

4/3 No herring activity.

4/7 No herring activity.

4/8 No herring activity.

-continued-

4/10 No herring activity.

4/11 No herring activity.

4/12 No herring activity.

4/16 No herring activity.

ZIMOVIA ST. AND EASTERN PASSAGE

Total miles of spawn: ~7.5 nm

Spawning dates: 4/14 through 4/17

Peak spawning: 4/12 and 4/13

3/29 Report of several schools of herring at 8 mile beach by local pilot.

4/3 No active spawn or herring observed, 1,100 Scoters.

4/7 Spot spawn and drift with 1 herring school observed, 6 Sea Lions; and 300 Scoters.

4/8 **1.0 nm of active spawn** with herring schools, 1 sea lions, 200 gulls.

4/9 No herring spawn or schools observed 18 sea lions, 1,100 gulls, 700 scoters.

4/10 1.5 nm of active spawn, 24 sea lions, 1,000's gulls, 1,200 scoters.

4/12 4.5 nm of active spawn with herring schools, 103 sea lions, 200 gulls, 500 scoters.

4/13 4.0 nm of active spawn with herring schools, 49 sea lions, 900 scoters.

4/14 Report of small active at 8 mile

4/16 No herring spawn or schools observed, 7 sea lions, 1,000's of gulls, 1,000's of scoters.

BEAR CREEK

Not Surveyed in 2015.

FARRAGUT BAY

Total miles of spawn: ~2.0 nm

Spawning dates: 4/24 and 4/25

Peak spawning: 4/24

-continued-

April 13	No herring activity, 50 sea gulls.
April 20	No herring activity, 8 sea gulls.
April 24	**2.0 nm of active spawn,** 4 herring schools**,** 74 sea lions, 4,000 scoters.
April 25	**1.0 nm of active spawn,** 30 sea lions, 4,000 scoters.
April 26	No active spawn, 3 herring schools, 36 sea lions, 4,000 scoters.
April 27	No herring activity, 48 sea lions, 4,500 scoters, 2,000 gulls.

HOBART BAY

Total miles of spawn: ~2.3 nm

Spawning dates: 4/24 through 5/2

Peak spawning: 4/24 and 4/25

April 13	No herring activity, 1 whale, 7 sea lions.
April 17	No herring activity, 1 whale, 12 sea lions.
April 20	No herring activity, 40 sea lions.
April 21	No herring activity, 11 sea lions.
April 24	**2.5 nm of active spawn,** 3 herring schools**,** 3 whales, 108 sea lions, 15,500 scoters.
April 25	**1.0 nm of active spawn,** 3 whales, 77 sea lions, 39,000 scoters.
April 26	**0.25 nm of active spawn,** 4 whales, 11 sea lions, 50,500 scoters.
April 27	No herring activity, 1 whale, 23 sea lions, 68,000 scoters.
May 2	**0.25 nm of active spawn**, 1 whale, 10 sea lions, 1,000 scoters.
May 4	No herring activity, 2 whales, 9 sea lions, 3,000 scoters.

PORT HOUGHTON

Total miles of spawn: 0.0 nm

April 13	No herring activity, 6 sea lions.

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April 20	No herring activity, 17 sea lions.
April 24	No herring activity.
April 25	No herring activity, 3 sea lions.
April 26	No herring activity, 10 sea lions.
April 27	No herring activity, 22 sea lions.
May 2	No herring activity.
May 4	No herring activity.

SUNSET COVE/WINDHAM BAY

Total miles of spawn: 0.0 nm

April 13	No herring activity.
April 20	No herring activity, 1 whale, 28 sea lions.
April 24	No herring activity, 12 sea lions.
April 25	No herring activity, 20 sea lions.
April 26	No herring activity, 25 sea lions.
April 27	No herring activity, 25 sea lions.
May 2	No herring activity, 1 whale, 20 sea lions.
May 4	No herring activity.

GAMBIER BAY/PYBUS BAY

No survey was done in 2015.

PORT CAMDEN

No survey was done in 2015.

Tebenkof Bay

No survey was done in 2015.

Appendix C.4–Aerial and skiff herring spawn surveys by date, in Seymour Canal (Juneau Management Area), in Southeast Alaska, 2015.

Number of times surveyed: 20; 17 by Juneau mgmt. staff, 2 by P–burg mgmt. staff, 1 by divers returning from Seymour.

Total miles of spawn:

Spawning dates: 5/3–5/10

Peak spawn: 5/7–5/8

4/13: No herring or herring spawn observed; 7 SL at Pt Hugh, 4 whales. Poor vis.

4/17: No herring or herring spawn observed; 70 sea lions and 9 whales. Good vis.

4/21: No herring or herring spawn observed; 91 sea lions and 6 whales. Excellent vis.

4/22: No herring or herring spawn observed; 77 sea lions and 7 whales. Excellent vis.

4/24: No herring or herring spawn observed; 87 sea lions and 15 whales observed. Excellent vis.

4/25: No herring or herring spawn observed; 128 sea lions and 16 whales observed. Good vis. Survey conducted by P-burg staff.

4/26: No herring or herring spawn observed; 140 sea lions and 8 whales observed. Good vis.

4/27: 3 schools inside Sorethumb, one by Cloverleaf Rocks no spawn. 122 sealions and 1 whale observed. Survey conducted by P-burg staff.

4/28: 1 small school off Pt. Hugh Light, no spawn observed. 91 sea lions and 1 whale. Fair vis.

4/29: No herring or herring spawn observed; 119 sea lions and 10 whales observed. Vis good.

5/1: No herring or herring spawn observed; 100 sea lions and 4 whales observed. Vis good.

5/3: Small active spawn at W Pt Hugh, several schools tight to beach in Pt Hugh area. 121 sea lions and 5 whales observed. Vis good to fair.

5/4: spot spawns on west Glass, by Twin Is, Swimming Pool to Blackjack, and active spawn at Pt Hugh, total approximately 0.5 nm; 99 sea lions and 2 whales observed. Vis excellent.

5/5: Active spawn on west side of Pt Hugh, diminishing spawn on NE Swan Island, and a spot spawn in Pleasant Bay. Schools of herring observed on beach at Pt. Hugh. 76 sea lions and 10 whales observed.

5/6: Small spawn observed just south of Fools Inlet. Schools observed on eastern side of Point Hugh, with one school just below Cloverleaf rocks. 139 sea lions and 3 whales observed.

5/7: Active spawning at E Pt Hugh, small active spawn in Sorethumb Cove, a light spot at the S end of N Twin Island, spot spawns on the Glass Peninsula north of Faust Is, just south of Dorn Island, and in Sore Finger Cove were observed. Several schools observed between Point Hugh and Cloverleaf Rocks, with one school just south of Pt Hugh Light. 85 sea lions and 3 whales observed.

-continued-

Appendix C.4–continued (page 2 of 2).

5/8: 1.5 nm spawn observed, at Sorethumb Cove and from Pt Hugh to Cloverleaf Rocks. Schools observed on the beach at cloverleaf, Pt Hugh Light and north of the Dogleg.

5/9: light spawn north of Pt Hugh on the inside, a few spots on the Point, and more south of the Cloverleaf Rocks. Additional spots on either side of the Point Hugh light.

5/10: 0.8 nm spawn between 10/11 Boundary and Pt Hugh, and 3 very small spots N of the Dogleg.

5/11: Returning divers surveyed south Glass Peninsula on charter flight from Kestrel in Mole Harbor and reported no spawn.

Appendix C.5–Aerial and skiff herring spawn surveys by date, in Tenakee Inlet (Juneau Management Area), in Southeast Alaska, 2015.

Number of times surveyed: 12

Total miles of spawn: 2.3

Spawning dates: 4/22–4/25; 5/7

Peak spawn: 4/23–4/24

4/13: No herring no spawn observed; 7 sea lions at Corner Point

4/17: No herring or herring spawn observed. 44 sea lions and 0 whales observed.

4/20: No herring or herring spawn observed. 7 sea lions and 2 whales observed.

4/22: Two schools of herring on W Kadashan, two spot spawns in Trap Bay. 14 sea lions and 4 whales observed.

4/23 am: Spawns on either side of Trap Bay, same place as yesterday, an additional spawn near S. Passage Point. 15 sea lions observed west of Corner Point. Obtained 3 buckets of samples.

4/23 pm: Additional spawns developing from Finn Cove to South Passage point. Total of 1.1 nm spawn observed.

4/24: 1.6 nm of discontinuous spawn between Finn Cove and Trap Bay. 60 sea lions and 4 whales observed.

4/25: .67nm of spawn just west of Trap Bay, and the small spot just east. Several schools of herring, 5 whales and 40 sea lions right in Trap Bay.

4/26: no herring, no active spawning; a little drifting milt.

4/28: no herring or spawn, 22 sea lions between Basket Bay and S Passage Pt, 39 sea lions observed.

4/29: no herring or spawn, 42 sea lions scattered in small groups from White Rock to Saltery Bay, no whales observed.

5/7: Several spot spawns in Basket Bay, and another just south of Passage Point Creek; few predators observed.

Appendix C.6–Aerial and skiff herring spawn surveys by date, in Lynn Canal (Juneau Management Area), in Southeast Alaska, 2015.

Number of times surveyed:

Total miles of spawn:

Spawning dates:

Peak spawn:

4/13: No herring no spawn observed; 2 whale in S Berners, 100 SL in tight raft by Slate Point.

4/17: No herring or herring spawn observed. 49 sea lions and 8 whales observed. Predator concentrations near Slate Cove and Pt. St. Mary suggest eulachon have begun to enter Berners Bay.

4/20: No herring or herring spawn observed. 97 sea lions and 5 whales observed. Concentrations of birds at the mouths of streams at the edge of the flats and well over 100 seals suggest eulachon are beginning to enter the rivers.

4/22: No herring or herring spawn observed; 73 sea lions and 3 whales observed.

4/24: No herring or herring spawn observed; 25 sea lions and 3 whales observed.

4/26: No herring or herring spawn observed; 5 sea lions and 6 whales observed.

4/28: No herring or herring spawn observed; 2 sea lions and 1 whales observed.

5/1: Numerous schools of herring from Sunshine Cove up through Bridget Cove, at Pt Bridget and towards Cowee Creek and one school in side Tee Harbor. No spawn observed; 22 sea lions and 9 wales observed.

5/2: Small schools in north Bridget Cove, on the eastern shore of Berners Bay near Cascade Point and north of Sawmill Creek, and several more on the outside north of Pt St Mary. 15 sea lions and 8 whales observed.

5/3: 2 schools inside Mabb Island, 3 spot spawns on Lynn Canal shore within 3 nm of Point Sherman; 29 sea lions and 3 whales observed.

5/4: Spawns on Pt St Mary shore observed active by Haines staff on scheduled commercial flight to Juneau to join Medeia for Seymour sample trip.

5/5: Spot spawn at Pt Louisa, spawn on SE corner of Benjamin Island, and multiple spots along the Pt. St Mary shoreline, with some school still in evidence. Schools of herring observed inside Bridget Cove. 67 sea lions and 6 whales observed.

5/6: Small spawn on N side of Pt Louisa, three small spawns at S Shelter Is., and about 1.0 nm of active spawn north of Pt St Mary was observed. One school of herring observed just east of Pt Bridget, and another in Bridget Cove. 48 sea lions and 7 whales observed.

-continued-

5/7: Spawn was observed at South Shelter Island and the south tip of Aaron Island. Approximately 2.25 nm of discontinuous active spawn was observed along the Pt St Mary shoreline and two schools of herring were observed in S Bridget Cove. 34 sea lions and 4 whales were observed.

5/8: 0.5nm of spawn on Pt St Mary shoreline, schools of herring in Bridget Cove, east of Pt Bridget, Sunshine and Yankee Coves, and in N Tee Harbor.

5/9: school in N Tee Harbor, and around south Pt Bridget. Good numbers of predators between Bridget Cove and Cowee Creek; 95 sea lions and 7 whales observed.

5/10: Many schools in Bridget Cove (sampled yesterday by Kestrel crew and confirmed pre-spawning fish. 83 sea lions and 6 whales observed between Sunshine Cove and Echo Cove, sea lions concentrated near Bridget Cove.

5/11: A small amount of active spawn in S Bridget Cove and E of Pt Bridget; herring lining the beach in Bridget Cove, and numerous schools between Bridget Cove and Sunshine Cove. Predators concentrated near Bridget Cove.

5/12: 1.3 nautical miles of active spawn in Bridget Cove and east of Pt Bridget. Active schools observed in Bridget Cove. Few predators observed.

5/13: 3.7 nm of spawn in Bridget Cove and east of Pt Bridget, with only a few spots appearing active; no schools of herring associated with the spawn were observed, several schools of non-spawning fish observed in Auke Bay.. Few predators were in evidence.

Appendix C.7–Aerial and skiff herring spawn surveys by date, in Port Frederick, Oliver Inlet, Taku Harbor, and Stephens Passage (Juneau Management Area), in Southeast Alaska, 2015.

Port Frederick

Number of times surveyed: 7

Total miles of spawn: none observed

4/13: No herring no spawn observed; 3 SL.

4/17: No herring no spawn observed; 2 whale just north of Cannery Point.

4/20: No herring no spawn observed; 4 SL and 2 whales just south of Cannery Point.

4/22: No herring or herring spawn observed; 0 sea lions and 4 whales – 2 whales in 8 Fathom Bight.

4/24: 3 small schools of herring; in the harbor, near Game Creek, and north of Burnt Point. 12 sea lions and 1 whale observed.

4/26: A few small schools ouseide the Harbor, one north of Burnt Point. One whale.

4/28: No herring or herring spawn observed. 10 sea lions and 1 whale observed.

Oliver Inlet

Number of times surveyed: numerous

Total miles of spawn: 0

4/13: No herring no herring spawn no predators observed.

4/17: No herring no herring spawn; 1 sea lion observed.

4/21: No herring no herring spawn; no predators observed.

4/22: No herring no herring spawn; no predators observed.

4/24: No herring no herring spawn; no predators observed.

4/26: No herring no herring spawn; no predators observed.

4/28: No herring no herring spawn; no predators observed.

4/29: No herring no herring spawn; no predators observed.

5/1: No herring no herring spawn; no predators observed.

5/3: No herring no herring spawn; no predators observed.

5/4: No herring no herring spawn; no predators observed.

5/5: Six small schools of herring observed; no spawn or predators.

-continued-

5/6: No herring no herring spawn; no predators observed.

5/7: No herring no herring spawn; no predators observed.

Port Snetisham

4/21: no herring or herring spawn; sea lions hauled out on N shore of throat.

Freshwater Bay

4/23: No herring or spawn, no predators.

5/11: 0.8 nm spawn observed in Iyoukeen Cove. 2sea lions observed.

Hobart

4/17: No herring or herring spawn; 13 sea lions one whale

4/21: No herring or herring spawn; 45 sea lions

Stephens Passage

5/1: No herring, few predators. Spot spawns on eastern shore of Greens Cove.

5/5: Three spawns at south Horse Island.

Hawk Inlet

5/11: Three spot spawns observed just south of Greens Creek mine.

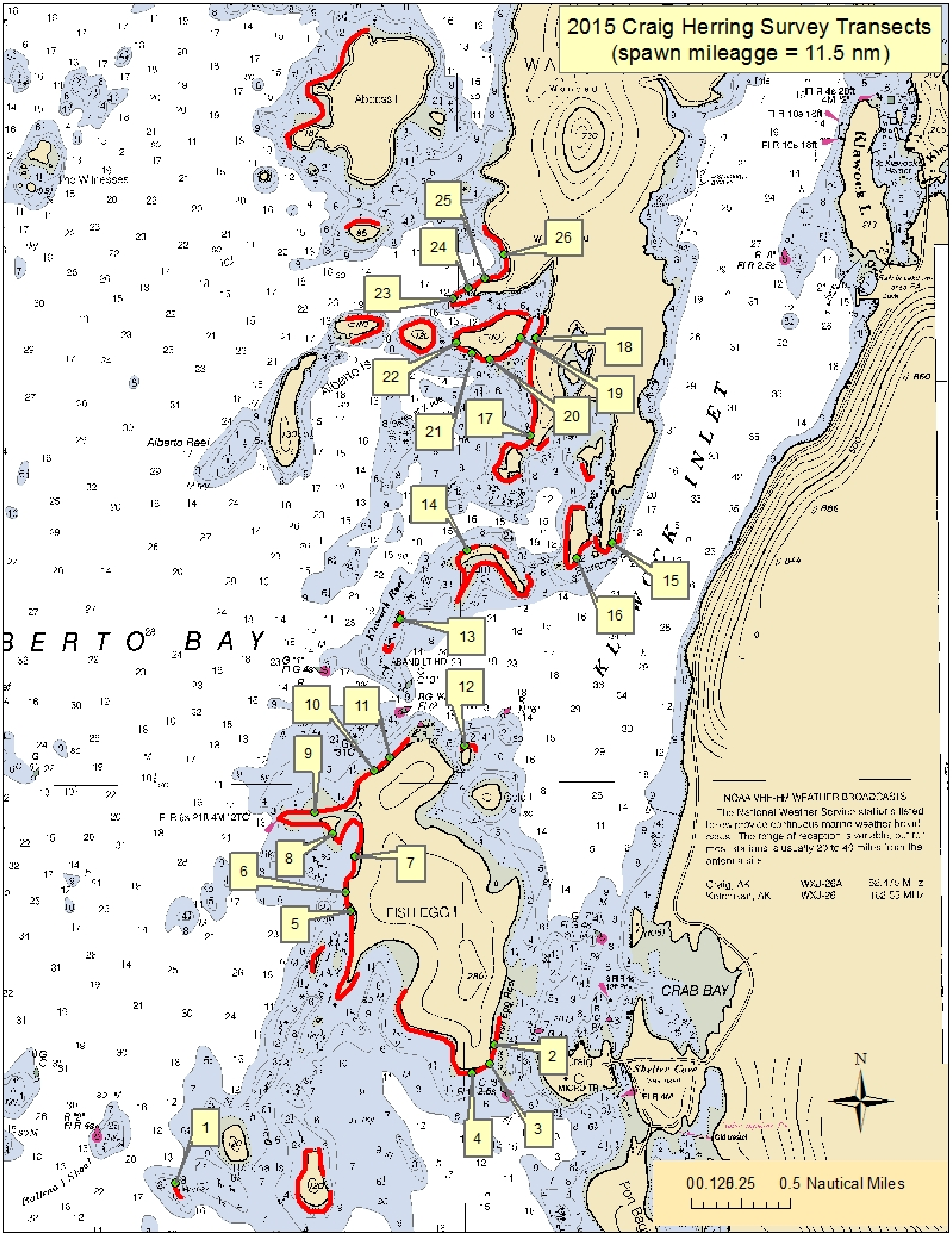
Appendix C.8–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2015.

Yakutat Bay

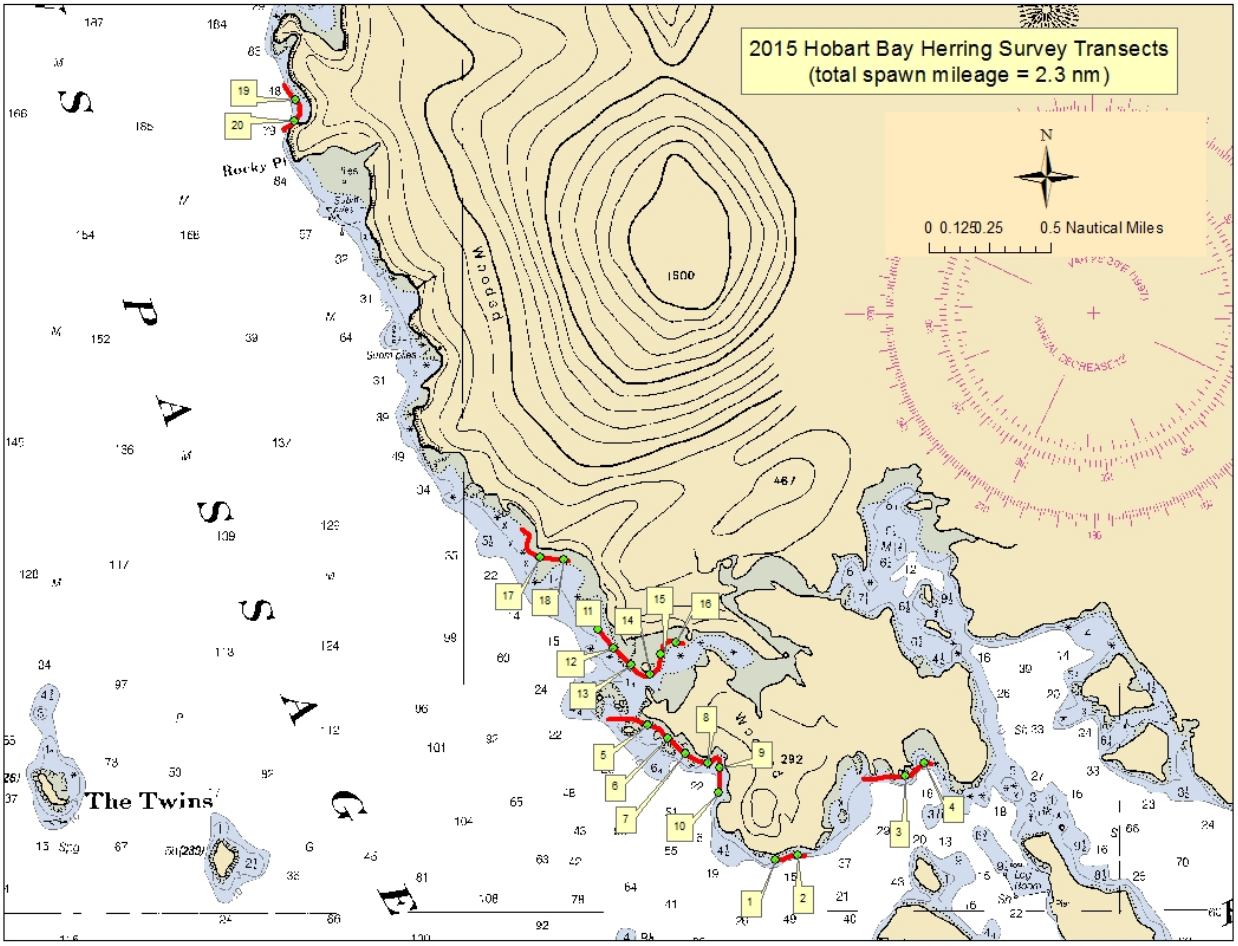
There was one aerial survey flight conducted in 2015. Approximately 12 nautical miles of active herring spawn were observed during that flight on April 23, 2105. Total miles of spawn for the season are unknown.

APPENDIX D: SPAWN AND SPAWN DEPOSITION SURVEY TRANSECT LOCATIONS

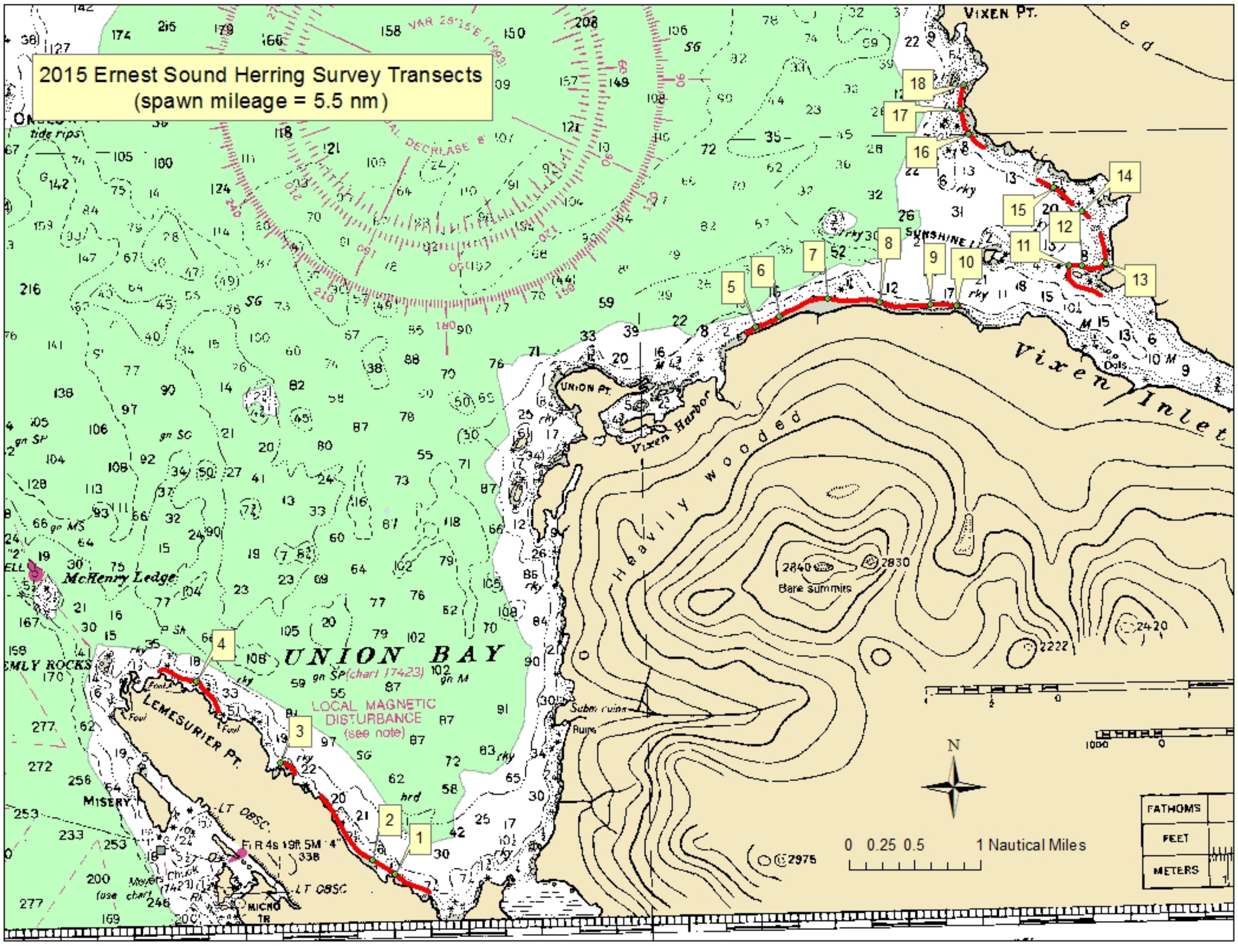
Appendix D.1–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Craig herring stock in 2015.



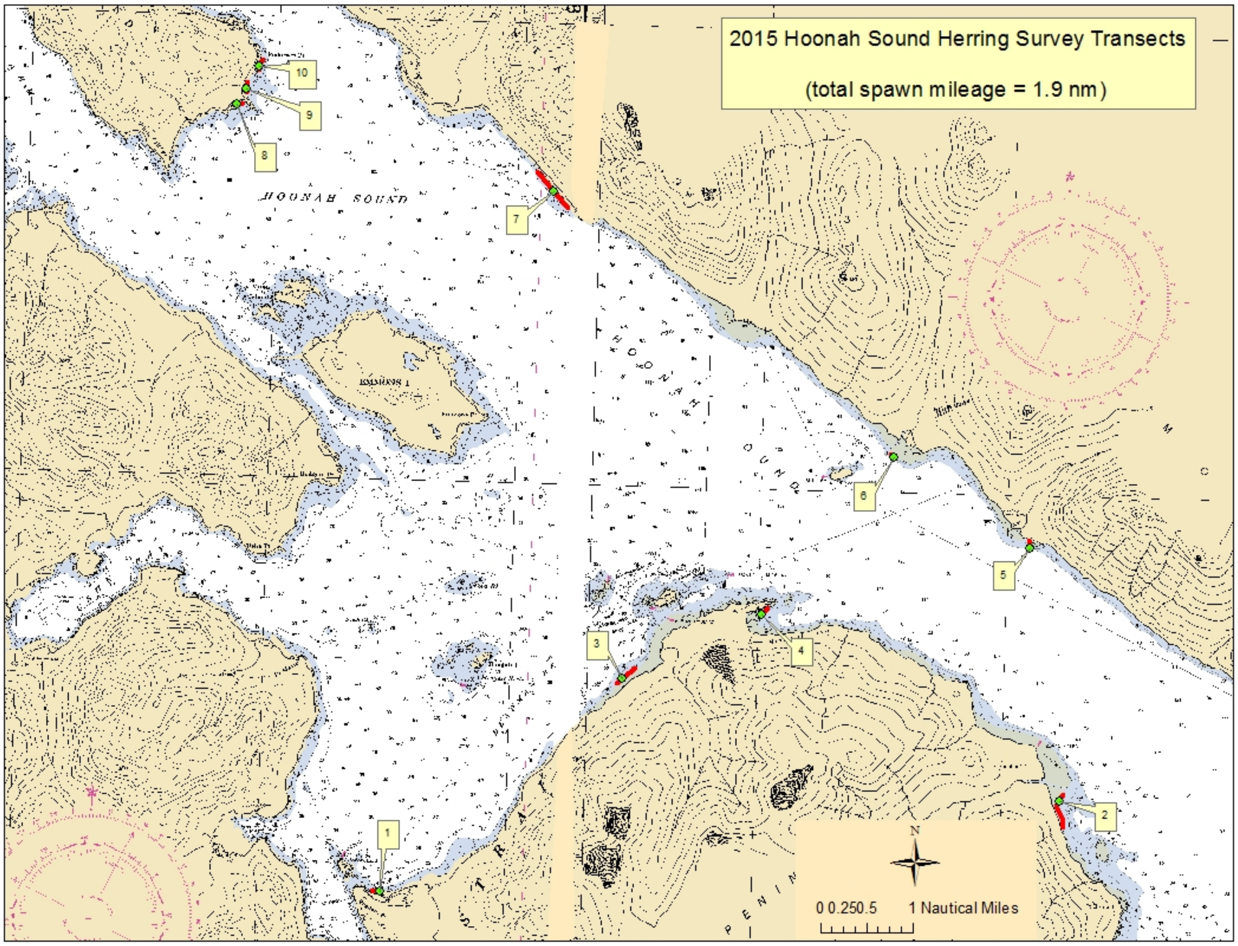
Appendix D.2–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hobart Bay/Port Houghton herring stock in 2015.



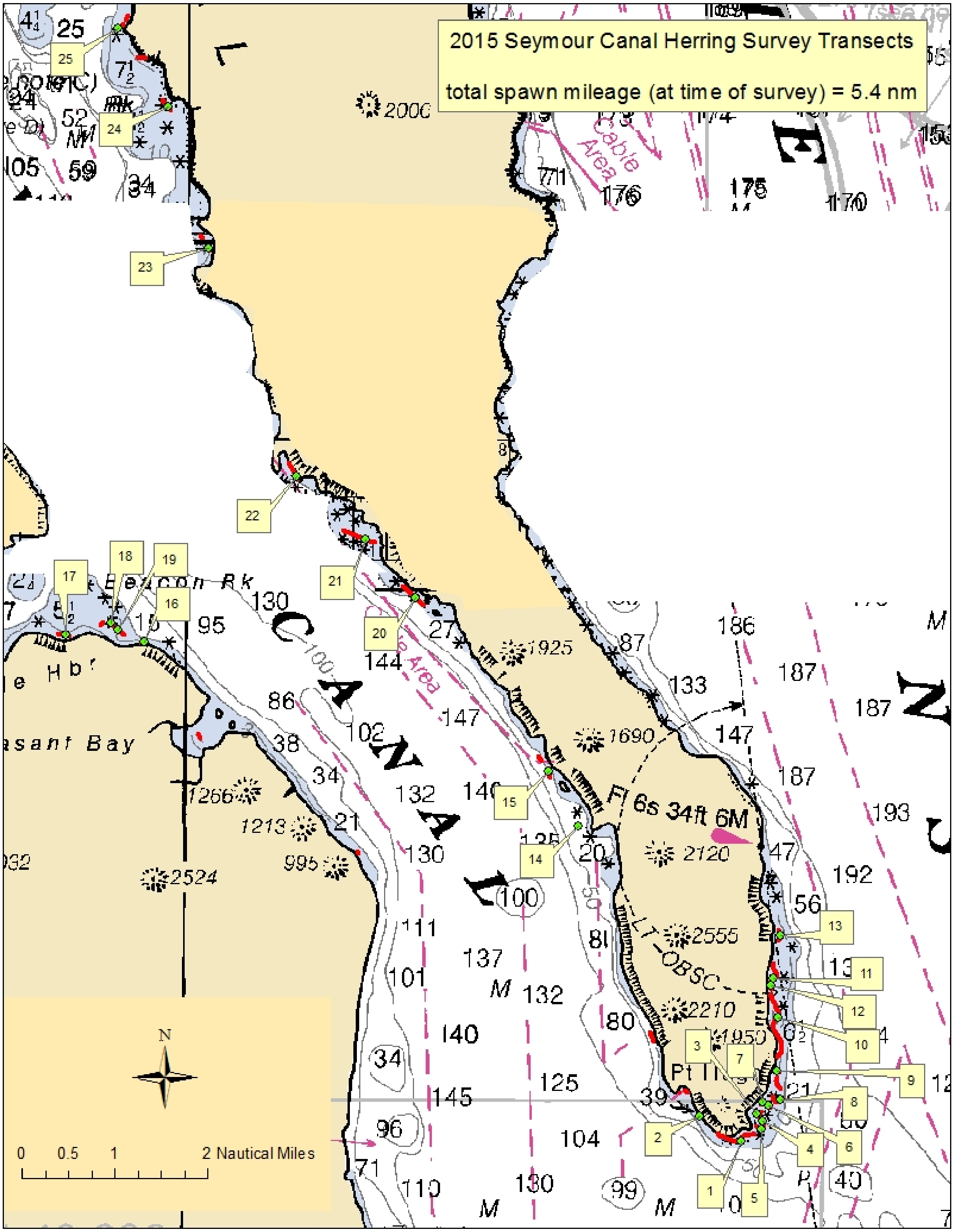
Appendix D.3–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Ernest Sound herring stock in 2015.



Appendix D.4–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hoonah Sound herring stock in 2015.



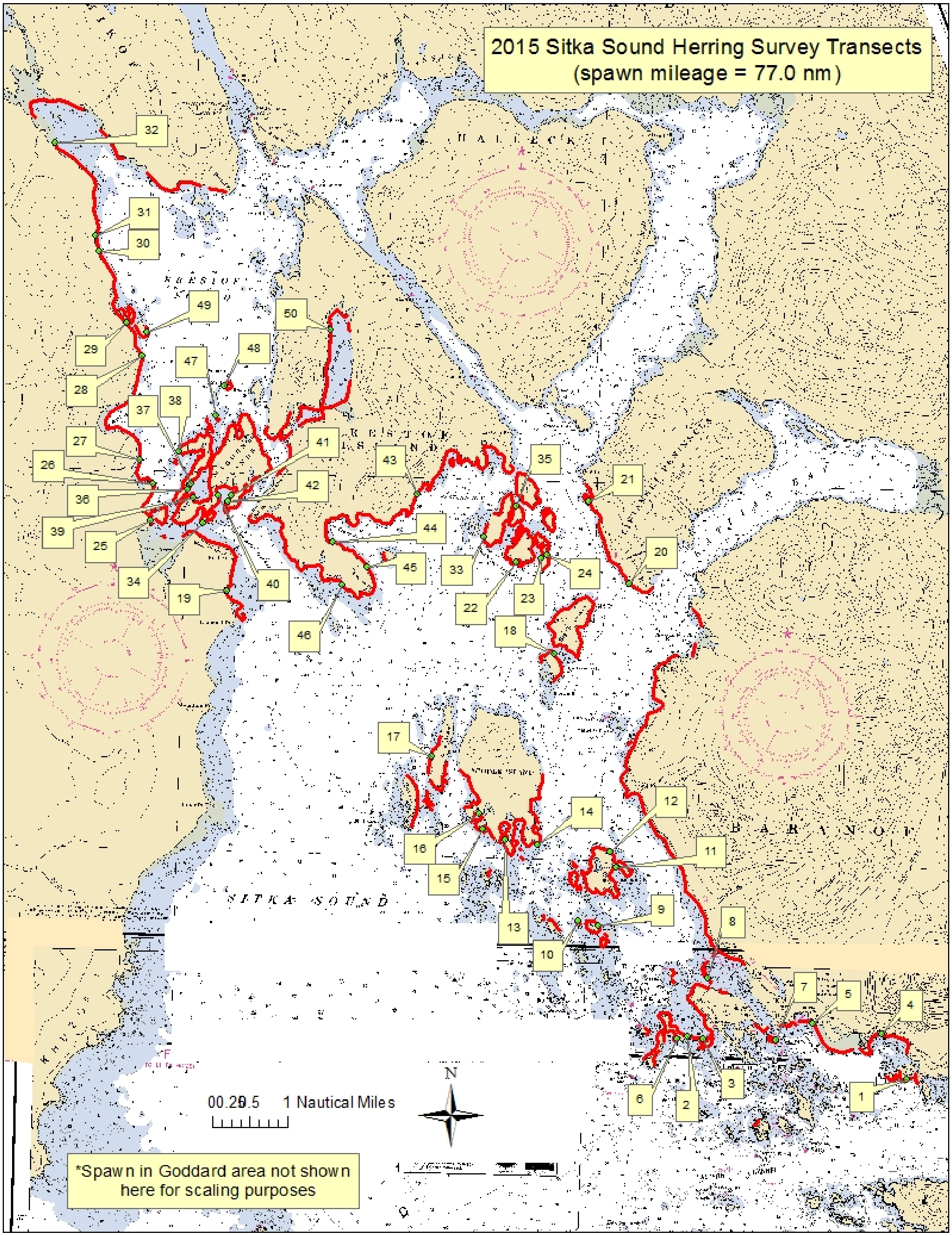
Appendix D.5–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Seymour Canal herring stock in 2015.



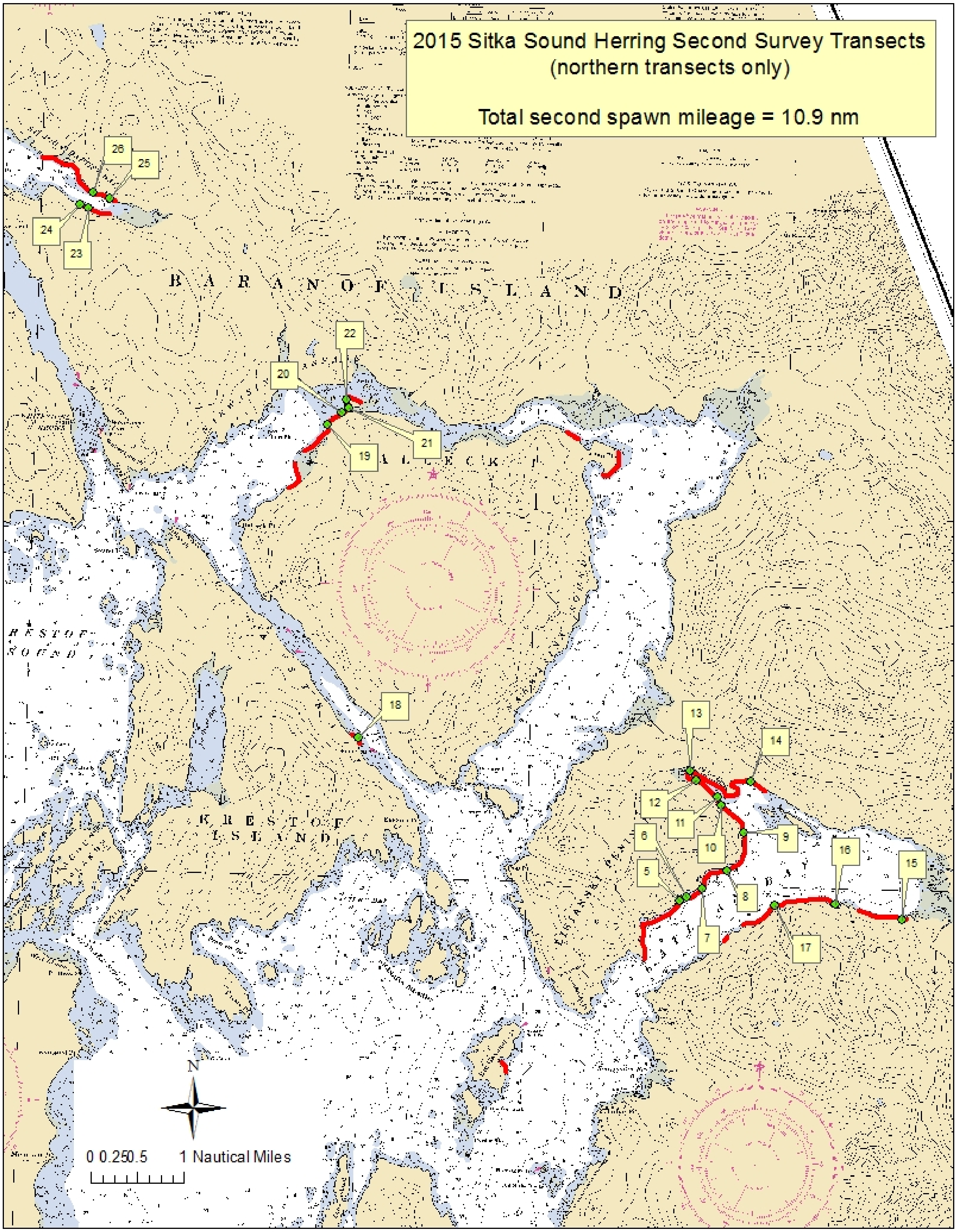
Appendix D.6–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2015.

No survey was conducted in West Behm Canal in 2015 due to a very low level of spawn mapped during aerial surveys.

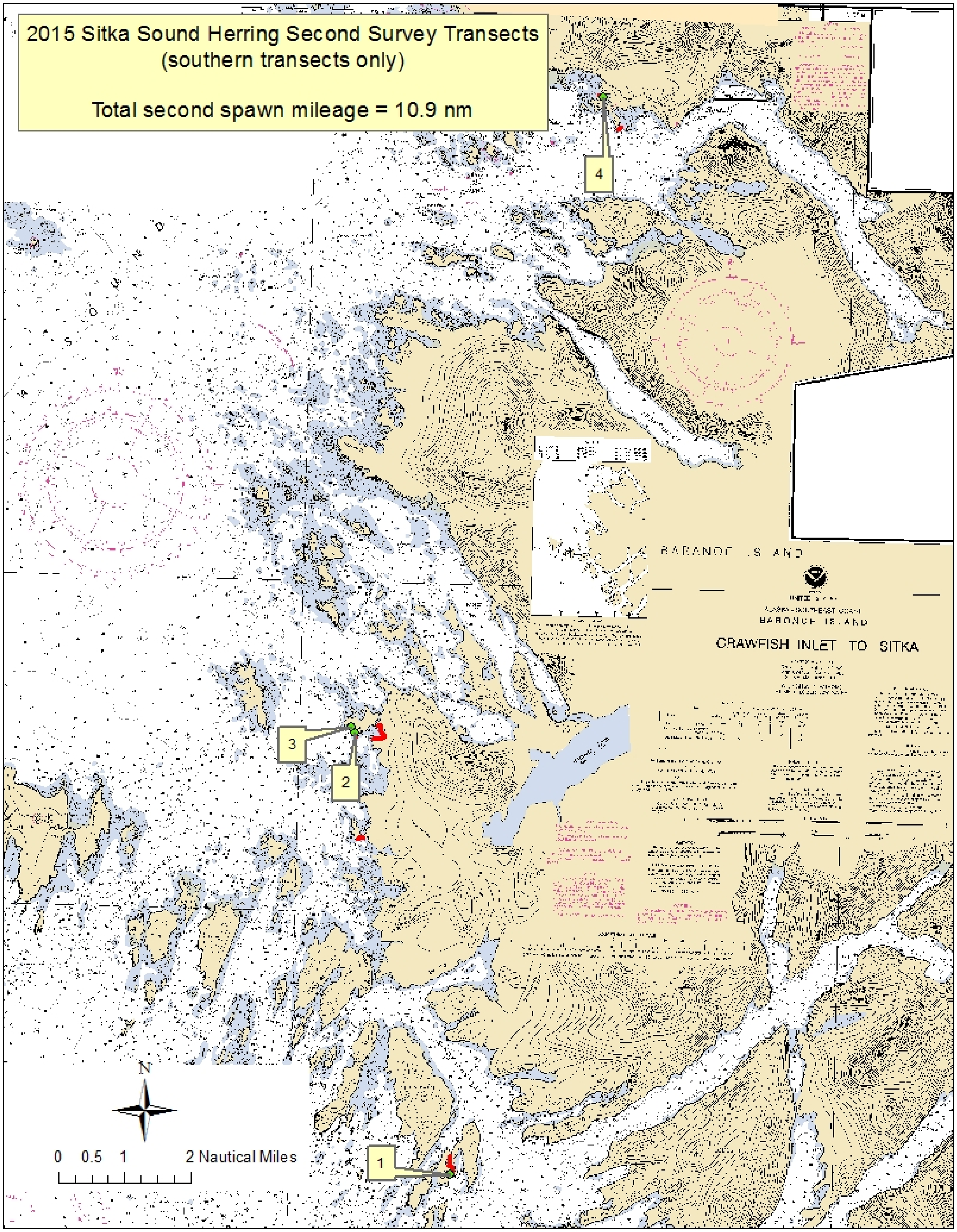
Appendix D.7–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock first survey in 2015.



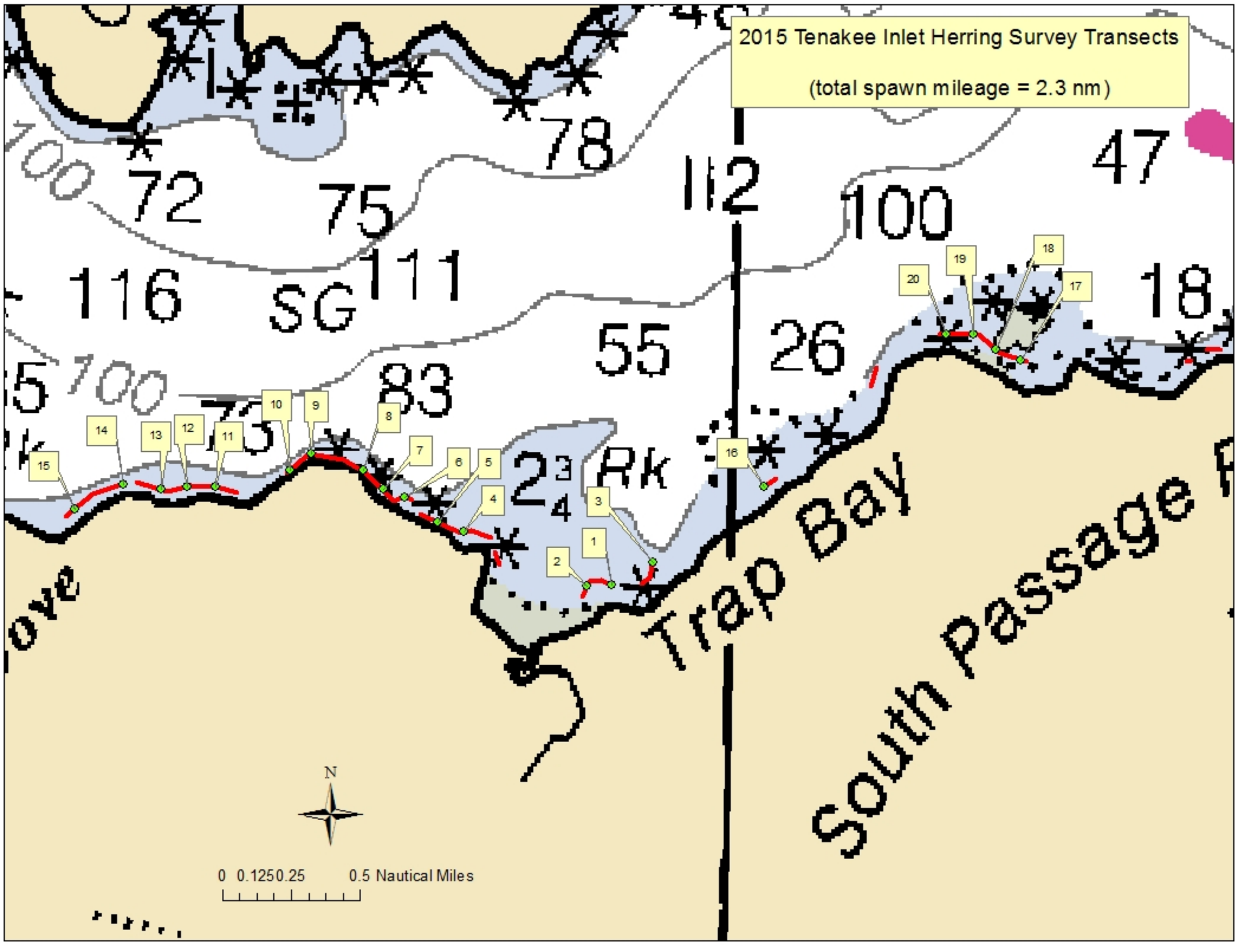
Appendix D.8–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock second survey in 2015 (northern Sitka Sound transects only).



Appendix D.9–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock second survey in 2015 (southern Sitka Sound transects only).



Appendix D.10–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Tenakee Inlet herring stock in 2015.



Appendix D.11–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Lynn Canal herring stock in 2015. Figure denotes only the spawn documented at the time of dive survey, and does not show all spawn mapped in 2015. For a complete depiction of spawn in 2015, see Figure 13.