Fishery Data Series No. 14-13

Southeast Alaska 2013 Herring Stock Assessment Surveys

by

Kyle Hebert

February 2014

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. 14-13

SOUTHEAST ALASKA 2013 HERRING STOCK ASSESSMENT SURVEYS

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

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

February 2014

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.

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

This document should be cited as:
Hebert, K. 2014. Southeast Alaska 2013 herring stock assessment surveys. Alaska Department of Fish and Game, Fishery Data Series No. 14-13, Anchorage.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

TABLE OF FIGURES (Continued)

LIST OF APPENDICES

ABSTRACT

Pacific herring, *Clupea pallasii*, is important to many marine species found in Southeast Alaska and is also harvested in fisheries for commercial bait, commercial sac roe, commercial spawn-on-kelp, subsistence spawn-on-branches, subsistence spawn-on-kelp, personal use, and research/cost-recovery purposes. The Southeast Alaska Herring Management plan (5 AAC 27.190.(3)) requires the Alaska Department of Fish and Game to assess the abundance of mature herring for each stock before allowing commercial harvest. Included here are results of stock assessment surveys completed primarily during 2013, including summaries of herring spawn deposition surveys and age-weight-length sampling, which are the principle model inputs used to forecast herring abundance. Spawn deposition surveys were conducted in Sitka Sound, Craig, West Behm Canal, Ernest Sound, Hobart Bay-Port Houghton, Hoonah Sound, Tenakee Inlet, and Lynn Canal. The combined total cumulative shoreline where spawn was documented in 2013 for surveyed areas was 111.1 nautical miles. In 2013, post-fishery spawn deposition biomass estimates, combined for all surveyed stocks, totaled 160,253 tons.

During the 2012–13 season, winter bait fisheries were opened in Craig and Ernest Sound with guideline harvest levels totaling 2,777 tons. A gillnet sac-roe fishery was opened in Seymour Canal with a guideline harvest level of 1,014 tons. A purse seine sac-roe fishery was opened in Sitka Sound with a guideline harvest level of 11,549 tons. Spawn-on-kelp fisheries were open in Craig, Ernest Sound, and Hoonah Sound; however Hoonah Sound was limited to open-pound structures only. No commercial fisheries were opened in Hobart Bay-Port Houghton, Tenakee Inlet, West Behm Canal, Kah Shakes/Cat Island, or Lynn Canal. Herring harvested commercially during the 2012–13 season totaled just over 6,800 tons, not including herring pounded for spawn-on-kelp fisheries.

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

INTRODUCTION

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

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

Historically biomass estimates and abundance forecasts of mature herring in Southeast Alaska were based on either hydroacoustic surveys or the product of estimates of egg density and area of spawn deposition (called "spawn deposition" method). Currently the ASA model is used for herring populations with longer (i.e., generally a minimum of 10 years) time series of stock assessment data and the biomass accounting model may be used for all other stocks where fisheries occur. These two models are not mutually exclusive of the spawn deposition method. Spawn deposition data is an important element of ASA and biomass accounting models. A primary difference between the two approaches is the amount of data required to conduct the respective analyses. Biomass estimates derived from the spawn deposition method use only the most recent spawn deposition data, and do not factor in trends in age composition or weight at age. A conversion factor based on an estimate of the number of eggs per ton of herring, is applied to the total egg estimate to compute spawning biomass. In contrast, the ASA model uses a time series of age compositions and weight at age in conjunction with estimates of spawn deposition to estimate biomass. Biomass accounting, which does not require a data time series, is based on spawn deposition estimates adjusted for natural mortality, age-specific growth, and recruitment. A more detailed explanation of the ASA and biomass accounting models and how the objective estimates are used in these models are provided by Carlile et al. (1996).

Since 1993, the ASA model has been used to estimate and forecast the abundance of herring for four major Southeast Alaskan herring stocks: Sitka, Seymour Canal, Revillagigedo Channel (also called "Revilla Channel," or the Kah Shakes/Cat Island/Annette Island area), 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 2012 through spring 2013 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 9.3)[1] over raster images of nautical charts published by the National Oceanic and Atmospheric Administration. Spawn was drawn to conform to the shoreline so that any given segment of shoreline that received spawn had an approximately equal chance of being sampled during the dive survey. This required that shoreline features be smoothed without adhering closely to the shore on a small scale, but also without drawing sweeping straight lines that did not adequately capture enough detail to design a meaningful survey.

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

Although the same procedure and patterns of drawing spawn were followed as in past years, the process requires that judgment be used based on knowledge and experience of the local spawning areas. The intent of drawing a smoothed spawn line is to produce a survey area that is oriented along the spawn and is such that transects laid perpendicularly to the spawn line will sample 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

---

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

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:

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

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%);
$\overline{d}$	=	overall estimated mean egg density;
t_a	=	critical t value for a one-sided, 90% confidence interval; and
N	=	estimated total number of transects possible within the spawning area.

Field Sampling

Transect direction was determined by comparing the dive location to a chart with the spawn shoreline, and setting a compass bearing perpendicular to the spawn shoreline. Transects began at the highest point of the beach where eggs were observed and continued down to a depth in the sub tidal zone until no further egg deposition was observed, or to a maximum of 21 m (70 fsw) of depth. The portion of transects above the waterline were surveyed by walking until the water reached diving depth (usually 2 to 3 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 2011, 2012, and 2013 were used if there were at least a total of six samples for each estimator and kelp type, with at least three samples in at least two of the three years. If this was not satisfied, then samples from prior years were added until the minimum sampling guideline was met. The intent of these sampling guidelines was to achieve a reasonably adequate sample size to minimize variation, but also to develop correction coefficients that reflected an estimator's tendency to estimate high or low in the most recent years.

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

ESTIMATES OF TOTAL EGG DEPOSITION

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

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

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

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

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

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

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

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

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

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

SPAWNING BIOMASS ESTIMATION

The total number of eggs per spawning area is a key element used in forecasting herring spawning biomass. Although estimated spawning biomass is not an input for the ASA or biomass accounting models, it does provide a static value in a given year (unlike ASA-derived estimates which 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:

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

where

b = estimated total spawning biomass;

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

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

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

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

where

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

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

AGE AND SIZE

Herring samples were collected from a combination of skiff surveys, aerial surveys, research surveys, commercial fisheries, and test fisheries from major stocks located throughout Southeast Alaska. Collection gear varied with location and 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, two 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:

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

where

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

Sea Temperature

Daily sea surface temperature was recorded in spawning areas for most stocks using submerged Onset Stowaway Tidbit™ temperature loggers. Depth of temperature recorders ranged from about 5 ft MLLW to 10 ft MLLW. Temperature was recorded daily at six-hour intervals for a minimum of one year and up to ten 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 2012–13 season, several commercial herring fisheries were conducted in Southeast Alaska. Products resulting from these fisheries included food and bait, sac roe, and spawn on kelp. Threshold biomass levels have been established 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 2012–13 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 2012–13 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 14, 2013, in Sitka Sound and ending on May 12, 2013, in Seymour Canal. Notes of activity related to herring or herring spawning were recorded in logs, which are presented in Appendix C. Surveys were conducted by staff in each area office (Ketchikan, Petersburg, Sitka, Juneau, Yakutat) and covered major and traditional herring spawning locations within each management area. 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 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). The department also documented a total of 10.0 nmi of herring spawn on Annette Island in 2013.

Spawn Deposition Surveys

In 2013, spawn deposition surveys were conducted in Sitka Sound, Craig, West Behm Canal, Ernest Sound, Hobart Bay, Hoonah Sound, Tenakee Inlet, Lynn Canal, and Seymour Canal. Surveys began in Sitka Sound on April 8, and were completed in Seymour Canal on May 14

(Table 3). Survey site locations, spawn, and transect locations are presented in Appendix D. Egg estimates by transect for each spawning area are presented in Table 4.

A summary of the 2013 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 2013 spawning stock abundance to prior years, estimates of spawning biomass are presented in Figures 3–8.

The total documented spawn for major spawning areas in Southeast Alaska in 2013 was 111.1 nmi (Table 5). This did not include spawning in several minor spawning areas, around Kah Shakes-Cat Island (0.7 nmi), Annette Island (10.0 nmi), or near Yakutat (6.1 nmi) (see Appendix C for a detailed accounting of minor spawn areas throughout Southeast Alaska).

Visual Estimate Correction

Minimum sample size guidelines (at least three samples per kelp type for the most recent three years) were met using data from 2011 through 2013 for most (8 of 9) estimators. Correction coefficients applied to 2013 spawn deposition visual estimates ranged from 0.681 to 2.376 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 9,389 herring were sampled from all stocks and gear types (cast net, purse seine, and pound) during the 2012–13 season. Of those, 9,365 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 data 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 Cana, Hoonah Sound, Tenakee Inlet, Lynn Canal, and Revilla Channel. Spawning herring samples were obtained from the Yakutat are using a beach seine. 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 2012-13, except for Hoonah Sound. Fisheries sampled included Craig winter bait and spawn on kelp, Sitka sac roe and winter test fishery, Ernest Sound winter bait and spawn on kelp, and Seymour Canal gillnet sac roe. The Hoonah Sound spawn-on-kelp fishery was limited to open pounds only, which prevented sampling of herring during the commercial 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 nearly all cases (Tables 7 and 8). The sampling goal was not met in two instances: Sitka commercial sac roe (429 samples obtained), and Revilla Channel / Kah Shakes-Cat Island (401 samples obtained).

Age Composition

Age composition data was obtained for all major stocks in the region. Frequency distributions of ages for all stocks are presented in Tables 9–18 and Figures 20–29.

Distributions of ages were very similar among most southern stocks. Ernest Sound, West Behm Canal, and Revilla Channel all had very similar age distributions, with relatively high proportions of younger ages (age 3 and 4) and low proportions of older ages (age 5+). The age distribution of the only other southern stock, Craig, had similarities to other southern stocks, but was not as closely aligned. Like other southern stocks, age composition was comprised of relatively high proportions of age-3 and age-4 herring; however the highest proportion was age-5. Proportions of age 6+ were relatively low in Craig.

Age distributions varied among northern stocks, but similarities were observed among several stocks. Most notably, stocks in Seymour Canal, Hobart Bay/Port Houghton, Tenakee Inlet, and Lynn Canal were all comprised of relatively high proportions of age-4 and age-8+ herring and low proportions of other ages. The similarity between Seymour Canal and Hobart Bay/Port Houghton was particularly striking. Age distributions in Sitka Sound, Hoonah Sound, and Yakutat did not match those of other stocks. In Hoonah Sound young herring were most prevalent (ages 3, 4), whereas in Yakutat older herring were most prevalent (age 8+). In Sitka Sound, herring tended to be older, although several age classes were prominent.

The proportions of age-3 herring entering the mature population each year seem to fluctuate similarly 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). Although there have been many years in the past when the proportion of age-3 herring has followed the same trajectory among stocks (i.e. clear increase or decrease from previous year), in 2013 a mix was observed, with the proportion increasing for some stocks, but decreasing for others. The picture was unclear for several stocks (Tenakee Inlet, Hoonah Sound, Lynn Canal), as no samples were obtained in 2012.

There appears to be a relationship between the latitude of spawning stocks and the proportion of mature age-3 herring (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 $r^2=0.83$ (Figure 43). There is also a moderate correlation between the mean proportion of age-3 mature herring and the mean minimum annual sea temperature ($r^2=0.69$) (Figure 44). A weak correlation exists between the mean proportion of age-3 herring and the mean annual sea surface temperature ($r^2=0.50$) (Figure 45). Although there is no linear correlation between the mean proportion of age-3 herring and the mean maximum annual sea temperature, there appears to be a curvilinear relationship (dome-shaped), where the highest mean proportion of age-3 fish occurred around 14.5º C, but proportions declined progressively as they approached higher or lower mean maximum temperatures (Figure 46).

Size-at-Age

Based on cast net samples in 2013, 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. There also appears to be a difference in weight-at-age among major Southeast Alaska stocks other than Sitka Sound. Herring from some stocks appear to have consistently higher mean weights-at-age, across all ages, than others. For example, in 2013 Tenakee Inlet, Craig, and Hoonah Sound herring generally have higher weight-at-age across age groups than other stocks, with Ernest Sound, Seymour Canal, and Revilla Channel 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 2013 data with general observations of trends and characterization of stocks. Herring samples were obtained from Yakutat in 2013, which revealed that Yakutat herring rivaled Sitka herring for highest weight at age in the region. In fact, Yakutat herring were heavier than Sitka herring at age 3 and the same weight at ages 4 and 5. However, beginning at age 6, Sitka herring were progressively heavier with age.

Length-at-age has a similar pattern among stocks as weight-at-age. Although the distinction between Sitka Sound herring mean length-at-age and other Southeast Alaska stocks is clear, it is not as great as observed for mean weight-at-age (Figure 48). The ranking of stocks for both mean length-at-age, and mean weight-at-age is very similar. This is not surprising as weight is 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. The pattern of length at age for Yakutat herring was very similar to that of weight at age, and was comparable to Sitka herring.

Trends in weight-at-age are variable among stocks (Figures 49–58). For most stocks, a common pattern is evident: weight-at-age of age-3 herring has been stable, while older ages appear to have steadily declined. The decline appears to be more pronounced for older herring. The exception is Sitka Sound, where weight-at-age appears to have increased over the past 20 years. Another apparent pattern is that weight-at-age of age-4+ herring has declined more in the southernmost stocks (e.g., Craig, West Behm Canal, Revilla Channel) than in northernmost stocks (e.g. Tenakee Inlet, Lynn Canal, Hoonah Sound).

Between 2012 and 2013 weight at age increased for most stocks. For two stocks, Hobart Bay and Revilla Channel, weight at age did not change appreciably, or was variable among age classes.

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 prespawning 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 more complete and consistent time series are available 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 2013 are considerably higher than those for 2012, which appears to have reversed the declines observed over the prior two or three years for most stocks.

Sitka Sound Winter Test Fishery

Winter sampling was conducted in Sitka Sound by the department between January 26 and March 1, 2013 using a purse seine. 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. The preliminary forecast for 2013 was 74,894 tons, and following the updated weight at age estimates from the winter test fishery, the final forecast was increased to 76,988 tons.

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

Commercial sac roe fisheries were announced for the Sitka Sound and Seymour Canal in 2013. There were no sac roe fisheries announced for West Behm Canal, Hobart Bay-Port Houghton, Kah Shakes/Cat Island, or Lynn Canal areas because spawning biomass was estimated to be below threshold.

Seymour Canal

The Seymour Canal commercial gillnet fishery was placed on two-hour notice at 9:00pm on May 6. The fishery was opened at 7:00 p.m. on May 8 and continued until the fishery was closed at 4:00 p.m. on May 11. The guideline harvest level (GHL) was 1,014 tons, of which 649 tons were harvested.

Sitka Sound

The sac roe fishery was placed on two-hour notice on March 25 at 11:00am. The GHL was 11,549 tons. Three competitive openings were held during the 2013. The first opening was on March 27 from 3:00 p.m. until 6:05 p.m. in the main part of Sitka Sound south of Bieli Rock. Approximately 2,100 tons were harvested during the first opening. The second opening occurred on March 28 from 2:00 p.m. until 5:30 p.m. in a large area in northern Sitka Sound and Katlian Bay. Approximately 3,600 tons were harvested during the second opening. The third and final competitive opening occurred on March 30 from 4:10 p.m. until 5:25 p.m. in the waters northwest of Crow Island, south of the Siginaka Islands and Kresta Point, and in lower Hayward Strait. Approximately 175 tons were harvested during this opening. A cooperative agreement fishery opening occurred on April 3 from 8:0 a.m. until 6:00 p.m. during which about 250 tons of herring were harvested.

On April 4 the fishery was announced closed for the season. The total harvest for the season was 5,688 tons, leaving 5,771 tons remaining of the GHL. The fishery was closed due to inadequate availability of marketable herring, as a large amount of spawning that had occurred by the closing date (about 44 nmi).

West Behm Canal

There were no commercial fisheries announced in the West Behm Canal area in 2013, as the stock was below threshold.

Hobart Bay-Port Houghton

There were no commercial fisheries announced in the Hobart Bay-Port Houghton area in 2013, as the stock was below threshold.

Winter Bait Fisheries

During the 2012-13 season, winter food and bait fisheries were opened near Craig and Ernest Sound on November 30, 2012. The Ernest Sound fishery was closed by emergency order on January 28, 2013, and the Craig fishery closed by regulation on February 28, 2013. Harvest information is confidential as there were fewer than three participants in the fishery.

Spawn-on-Kelp Pound Fisheries

Three areas were open to the commercial harvest of spawn on kelp (SOK) during the 2012–13 season: Craig, Ernest Sound, and Hoonah Sound. The other SOK area in the region, Tenakee Inlet was not opened during the 2012-13 season as the forecasted spawning biomass was below threshold.

Craig

A total of 80 closed pounds were actively fished, of which 32 were single-permit pounds, 45 were double-permit pounds, and three were triple-permit pounds. A total of 131 permits registered and participated in the fishery. A total of 138 tons of SOK were harvested.

Ernest Sound

A total of 30 closed pounds were actively fished, of which one was a single-permit pound, five were double-permit pounds, 22 were triple-permit pounds, and one was a combined double-permit pound (size of two regular pounds). A total of 65 tons of SOK were harvested.

Hoonah Sound

In Hoonah Sound the GHL of 130 tons permitted an open-pound fishery only, meaning by regulation no seining of herring was allowed. Only three vessels participated in the fishery; however no SOK was harvested.

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2012–13 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 2012–13 season was in Sitka Sound, for bait, using purse seine gear during January 26 to March 1, 2013. A total of 60 tons of herring were harvested from the Salisbury Sound area, near the Siginaka Islands, and in Silver Bay.

DISCUSSION

Spawn Deposition

Spawning population biomass estimates, as calculated from spawn deposition estimates, increased between 2012 and 2013 for six of nine stocks that were surveyed in Southeast Alaska. For all six of these areas the increases were substantial (defined here as 20% change at least). For some stocks, biomass estimates in 2013 were greater than two-fold those of 2012. The spawning areas where increases were observed include Sitka, Craig, Ernest Sound, Tenakee Inlet, Lynn Canal, and Hobart Bay-Port Houghton. Although the error surrounding biomass estimates was not calculated, the magnitudes of the increases 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 three areas that were surveyed in 2013 where biomass apparently decreased since 2012 were Hoonah Sound, West Behm Canal, and Seymour Canal. The decrease in Hoonah Sound between 2012 and 2013 (46%) was substantial per the above definition; however, stock has been at such low levels for the past two years that the 2013 estimate may not be appreciably different than 2012, when considered in the context of biomass levels over the previous decade. Similarly, in West Behm Canal the change fits the definition of substantial (37% decrease), but because the stock has been at very low levels for the past two years, it is difficult to characterize the significance of the change. In Seymour Canal there appears to have been a clear decrease as estimated biomass in 2013 is about 31% of that in 2012.

The increase 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 increase 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 increase.

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 stock size but should not necessarily be considered the most accurate estimate of stock size in any given year. For all major herring stocks in Southeast Alaska, the results of ASA or biomass accounting models are considered to provide 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.

The trend for overall herring biomass in Southeast Alaska is increasing over the period 1980 to 2013 (Figure 8). This is true whether or not the largest stock in the region, Sitka Sound, is included. The regional spawning biomass estimated for 2013 is 47% greater than the long-term average (1980–2012), for all stocks combined, and 16% greater for all stocks combined except Sitka Sound. The long-term trend of spawning biomass for the majority of individual spawning areas where data is available in Southeast Alaska is increasing; however, the long-term trend is decreasing for a few areas (Figures 3–7). Biomass levels in some areas have fluctuated widely over the past few decades and are currently at low levels. This is true for Hoonah Sound and Hobart Bay-Port Houghton. Another exception to the general increasing biomass trend in the region is the Kah Shakes-Cat Island area, where significant spawn has not been observed since 2001. However, since stock assessment surveys are not conducted around the Annette Island Indian Reserve—an area where substantial herring spawning occurs that is adjacent to the Kah Shakes-Cat Island area—the trend in spawning stock size for this greater area is unclear.

Overall, spawn deposition estimates for 2013 suggest that herring spawning biomass in Southeast Alaska is at a moderate level relative to the period 1980–2012. In 2012, there appeared to have been a substantial drop in spawning biomass for several stocks (based on spawn deposition estimates only); however after another year of data, it appears that estimates from 2012 may be indicative of natural stock volatility as opposed to beginning of a serious downward trend. As is generally the case for herring, biomass estimates in coming years will help to interpret the likelihood that any given year in the recent past was a good reflection of the actual spawning biomass level.

Age Composition

For all stocks, estimates of age composition in 2013 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 2013 samples was consistent with those methods used in prior years, which has been a concern in recent years (see Hebert 2012a, 2012b).

The proportion of age-3 herring in the mature population 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 appears 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 22-31%), 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 11-17%). The latitudinal split is further supported by age compositions observed in 2013, which were remarkably similar among all southern stocks, and very similar among several northern stocks (Seymour Canal, Hobart Bay, Tenakee Inlet, and Lynn Canal). Two stocks where age compositions did not match either southern or northern stocks, or each other, were Sitka Sound and Hoonah Sound.

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.

ACKNOWLEDGMENTS

Dr. Sara Miller and Dr. Kray Van Kirk (Region I Biometricians) assisted with herring age and size data processing, and Dr. Sherri Dressel (Herring Fishery Scientist) advised on and reviewed calculation of spawn deposition estimates. Many department divers and boat officers contributed to the successful completion of the spawn deposition dive surveys. The dive team included Jeff Meucci, Bo Meredith, Sherri Dressel, Troy Thynes, Scott Kelley, Dave Gordon, Justin Breese, Eric Coonradt, and Kyle Hebert. Thanks to Captain Kevin Kivisto, Lito Skeek, and Erin Watkins for their safe and skillful operation of the dive support vessel, *R/V Kestrel*. Captain Kivisto's steady, calming, and capable presence in the region's herring program for many years was greatly appreciated, and he will be deeply missed.

REFERENCES CITED

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

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

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

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

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

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

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

Hebert, K. 2012a. Southeast Alaska 2011 herring stock assessment surveys. Alaska Department of Fish and Game, Fishery Data Series No. 12-53, Anchorage.

Hebert, K. 2012b. Southeast Alaska 2010 herring stock assessment surveys. Alaska Department of Fish and Game, Fishery Data Series No. 12-46, Anchorage.

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

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

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

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

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

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

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

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

TABLES AND FIGURES

Table 1.–Transect sampling rates used for 2013 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 2013 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 2013 herring spawn deposition surveys conducted in Southeast Alaska.

Survey area	Survey Leg	Survey Dates
Sitka Sound	I	April 8–12, May 2–5
Craig	I	April 14–15
West Behm Canal	I	April 16
Ernest Sound	I	April 17
Hobart Bay/Port Houghton	II	May 8
Lynn Canal	II	May 10
Tenakee Inlet	II	May 11
Hoonah Sound	II	May 12
Seymour Canal	II	May 13–14

Table 4.–Summary of herring egg estimates (in thousands) by transect for 2013 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	1,547	11	0	1
2	0	2	249	12
3	14	9	2,050	37
4	200	10	561	7
5	3,598	8	2,253	47
6	4,302	51	2,793	61
7	2,284	20	0	1
8	758	21	47	8
9	0	1	0	1
10	197	7	1,256	21
11	0	1	4,869	23
12	326	8	662	23
13	353	9	2,524	19
14	0	6	1,135	18
15	305	13	0	1
16	223	4	136	4
17	1,225	9	43	6
18	518	9	343	4
19	335	10	705	12
20	794	12	484	13
21	7	1	2,997	33
22	2,882	27	460	26
23	1,971	31	2,712	20
24	986	40	401	10
25	2,201	15	243	7
26	8,025	35	558	5
27	*	*	341	11
28	0	1	0	1
29	186	10	2,205	28
30	4,169	27	1,174	15
31	5,365	68	226	4
32	289	8	10	4
33	923	15	0	3
34	0	1	555	3
35	1,921	15	136	24
36	867	14	0	1
37	10,614	35	94	11
38	1,308	13	22	7
39	185	14	465	21
40	156	5	0	1
41	81	5	—	—
42	943	17	—	—
43	1,579	33	—	—
44	996	21	—	—
45	2,284	16	—	—
46	*	*	—	—
47	*	*	—	—
48	*	*	—	—
49	*	*	—	—
50	198	9	—	—

Data not collected due to weather
Em-dashes indicate no survey transects planned.

Table 5.–Summary of herring egg estimates (in thousands) by transect for 2013 spawn deposition surveys conducted in Southeast Alaska (excluding Sitka Sound).

	Craig		Ernest Sound		Hobart/Houghton		Hoonah Sound		Seymour Canal		Tenakee Inlet		West Behm		Lynn Canal	
Transect Number	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	frame count	frame count	egg estimate	frame count	egg estimate	frame count
1	463	12	0	2	2	4	—	—	1,694	19	1,307	34	0	5	708	13
2	204	16	807	9	0	1	3	5	0	1	111	15	37	9	872	9
3	917	9	1,805	17	51	6	4	6	409	24	857	11	81	10	660	8
4	1,245	24	2,398	53	490	24	75	8	1,059	8	582	9	1,821	38	279	3
5	0	1	1,558	32	250	13	11	7	305	8	206	9	423	13	1,633	17
6	311	10	3,049	22	225	13	—	—	615	20	427	13	1,515	24	15	6
7	413	9	2,556	14	0	2	108	13	2,443	13	213	3	1,686	24	257	19
8	972	17	1,012	9	294	3	49	9	247	3	777	12	518	8	1	3
9	380	8	4,452	20	34	11	14	9	1,673	14	379	11	646	10	2,396	15
10	3,306	19	2,022	19	316	5			1,094	7	0	1	497	13	992	15
11	2,281	29	83	6	266	4	23	15	274	7	27	5	1,295	19	1,787	7
12	2,820	24	163	8	1,386	18	51	13	603	10	2,494	46	106	9	2,407	9
13	12	6	134	9	956	15	0	1	809	11	2,479	28	5	4	345	7
14	1,422	30	0	1	497	19	—	—	792	17	4,839	48	289	21	469	9
15	639	16	0	1	50	7	133	9	323	8	820	20	0	1	274	1
16	2,656	38	3	4	659	7	0	1	288	5	758	17	466	5	642	6
17	4,530	20	370	9	158	14	—	—	971	8	1,396	12	396	7	908	12
18	1,240	12	129	10	38	5	503	14	55	6	383	16	359	4	731	10
19	0	2	217	24	—	—	—	—	788	9	1,170	17	0	1	974	12
20	3,065	33	220	4	—	—	765	13	369	7	1,648	55	26	7	1,642	12
21	802	20	1,139	9	—	—	877	10	815	14	977	11	—	—	921	9
22	182	6	812	6	—	—	95	4	359	9	196	4	—	—	797	22
23	793	1	259	7	—	—	46	5	62	5	—	—	—	—	422	27
24	4,606	41	685	7	—	—	0	1	165	4	—	—	—	—	159	7
25	2,658	19	127	11	—	—	—	—	—	—	—	—	—	—	—	—
26	4,320	30	5,090	40	—	—	—	—	—	—	—	—	—	—	—	—
27	614	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	2,751	24	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	295	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	310	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Em-dashes indicate no survey transects planned.

Table 6.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2013.

Spawning Stock	Number of Transects Completed	Average Length of Transects (m)	Nautical Miles of Spawn Observed	Area of Survey (m^2)	Average Egg Density ($eggs/m^2$)	Total eggs in survey area (trillions)	Mean weight (g) (weighted by age composition) of fish in spawning population	Estimated fecundity of fish of mean weight	Estimated number of fish	post-fishery mature biomass (tons)
Craig	30	89	15.3	2,517,146	829,434	2.320	88.9	17,621	263,296,055	25,802
Ernest Sound	26	68	5.4	678,900	824,046	0.622	64.4	12,463	99,751,874	7,081
Hobart/Houghton	24	48	2.4	211,128	331,738	0.078	65.9	13,075	11,904,034	864
Hoonah Sound	18	40	2.4	176,557	192,658	0.038	78.2	15,807	4,781,858	412
Seymour Canal	24	49	8.0	731,540	684,122	0.556	72.1	14,464	76,890,856	6,112
Sitka Sound total	85	—	61.3	8,629,698	879,545	8.434	161.8	29,137	578,900,014	103,267
[a]Sitka Sound – 1st	45	77	50.6	7,257,412	934,214	7.533	—	—	—	—
[a]Sitka Sound – 2nd	40	69	10.7	1,372,286	590,423	0.900	—	—	—	—
Tenakee Inlet	22	90	5.4	902,345	555,328	0.557	101.4	17,124	65,027,271	7,268
West Behm Canal	20	58	2.3	247,057	438,204	0.120	66.4	12,882	18,675,079	1,367
Lynn Canal	24	54	8.6	856,087	786,503	0.748	86.1	17,575	85,134,278	8,080
Total	273	—	111.1	14,950,458	—	13.472	—	—	1,204,361,320	160,253
Average	30	64	—	2,990,092	613,509	2.694	87.2	16,683	—	—

[a] Two separate surveys were conducted in 2013 because of two spawning events, so final estimates of egg deposition were calculated by summing estimates from each survey.

Table 7.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2013. Data was combined for years 2011 through 2013 unless otherwise noted.

	Estimator initials								
Kelp type	BM	DG	JB	JM	KH	SD	TT[a]	EC	SK
Eelgrass	1.233	0.988	1.399	1.338	1.002	0.681	1.691	2.021	1.065
n =	30	30	30	30	30	30	19	30	30
Fucus	1.532	1.244	1.580	1.014	1.186	0.772	1.869	2.376	1.396
n =	28	28	28	28	28	28	24	28	28
Fir kelp	1.761	0.991	1.246	1.280	0.995	0.908	1.514	2.262	1.47
n =	26	25	26	26	26	26	23	26	26
Hair kelp	1.573	1.061	1.897	1.361	1.978	0.956	1.572	2.320	1.630
n =	33	33	33	33	33	33	27	32	32
Large brown kelp[b]	1.061	1.108	1.287	1.034	1.143	0.744	2.341	1.699	1.308
n =	28	28	27	28	28	27	19	28	28
Average[c]	1.432	1.078	1.482	1.206	1.061	0.812	1.797	2.136	1.309

[a] Data from years 2010, 2011 and 2013.

[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 2012–13.

	Commercial Fishery			Survey	Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	528	525	530	–	1,583
Ernest Sound	–	525	525	528	–	1,578
Hobart/Houghton	–	–	–	530	–	530
Hoonah Sound	–	–	–	525	–	525
Lynn Canal	–	–	–	527	–	527
Seymour Canal	526	–	–	528	–	1,054
Sitka Sound	–	–	429	638	541	1,608
Tenakee Inlet	–	–	–	530	–	530
West Behm Canal	–	–	–	528	–	528
Revilla Channel	–	–	–	401	–	401
Yakutat[a]	–	–	–	525	–	525
Total	526	1,053	1,479	5,790	541	9,389

[a] Survey gear was beach seine.

Table 9.–Summary herring samples aged for Southeast Alaska stocks in 2012–13.

	Commercial Fishery			Survey	Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	528	520	529	–	1,577
Ernest Sound	–	522	517	527	–	1,566
Hobart/Houghton	–	–	–	529	–	529
Hoonah Sound	–	–	–	525	–	525
Lynn Canal	–	–	–	527	–	527
Seymour Canal	526	–	–	526	–	1,052
Sitka Sound	–	–	429	636	541	1,608
Tenakee Inlet	–	–	–	530	–	530
West Behm Canal	–	–	–	527	–	527
Revilla Channel	–	–	–	401	–	401
Yakutat[a]	–	–	–	525	–	525
Total	526	1,050	1,466	5,782	541	9,365

[a] Survey gear was beach seine.

Table 10.–Summary of age, weight, and length for the Sitka Sound herring stock in 2012–13.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	129	54	50	126	104	172	636
	Percent age composition	20%	8%	8%	20%	16%	27%	100%
	average weight (g)	67.5	100.1	122.8	146.0	154.5	185.9	–
	standard dev. of weight (g)	17.6	24.7	25.2	27.3	30.7	30.2	–
	average length (mm)	176	199	210	220	225	238	–
	variance of length (mm)	145	198	166	126	135	90	–
commercial purse seine–spring	number of fish	51	26	35	111	70	136	429
	percent age composition	12%	6%	8%	26%	16%	32%	100%
	average weight (g)	78.9	117.5	148.7	176.4	195.1	210.7	–
	standard dev. of weight (g)	20.4	36.3	31.7	25.6	28.5	25.2	–
	average length (mm)	180	200	215	226	232	238	–
	variance of length (mm)	183	294	159	89	108	76	–
test fishery purse seine–winter	number of fish	169	66	76	108	62	60	541
	percent age composition	31%	12%	14%	20%	11%	11%	100%
	average weight (g)	68.8	110.5	125.4	151.5	175.3	186.7	–
	standard dev. of weight (g)	14.6	24.3	26.8	31.0	25.2	30.1	–
	average length (mm)	174	200	208	218	228	232	–
	variance of length (mm)	106	141	182	176	98	138	–

Table 11.–Summary of age, weight, and length for the Craig herring stock in 2012–13.

		Age Category						
Gear type/season	Age category	3	4	5	6	7	8+	Total
survey cast net – spring	number of fish	110	115	144	93	34	33	529
	percent age composition	21%	22%	27%	18%	6%	6%	100%
	average weight (g)	56.6	72.7	90.5	98.0	115.2	120.3	84.0
	standard dev. of weight (g)	9.6	14.2	16.8	17.9	20.0	19.8	24.0
	average length (mm)	168	181	193	197	207	212	188
	variance of length (mm)	71	98	84	76	72	72	261
commercial pound – spring	number of fish	132	117	155	70	28	26	528
	percent age composition	25%	22%	29%	13%	5%	5%	100%
	average weight (g)	56.0	81.5	93.4	107.4	116.3	124.9	86.0
	standard dev. of weight (g)	10.3	14.3	15.3	19.9	20.6	21.7	25.0
	average length (mm)	165	184	193	199	204	209	186
	variance of length (mm)	68	65	65	103	81	75	258
commercial seine– winter	number of fish	116	108	144	81	40	31	520
	percent age composition	22%	21%	28%	16%	8%	6%	100%
	average weight (g)	59.6	83.4	99.0	108.4	121.8	129.4	91.0
	standard dev. of weight (g)	10.0	16.5	14.7	14.4	18.6	17.9	26.0
	average length (mm)	164	182	193	198	206	211	186
	variance of length (mm)	88	119	79	55	84	94	322

Table 12.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2012–13.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net– spring	number of fish	115	296	8	8	17	85	529
	percent age composition	22%	56%	2%	2%	3%	16%	100%
	average weight (g)	40.9	60.1	76.6	89.8	111.3	107.5	65.0
	standard dev. of weight (g)	12.9	14.3	17.2	22.0	21.9	25.7	28.0
	average length (mm)	150	169	183	189	204	202	171
	variance of length (mm)	140	143	157	137	99	159	434
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 13.–Summary of age, weight, and length for the Ernest Sound herring stock in 2012–13.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	149	170	93	89	7	19	527
	percent age composition	28%	32%	18%	17%	1%	4%	100%
	average weight (g)	47.7	62.9	73.2	79.3	91.3	86.3	64.0
	standard dev. of weight (g)	7.3	10.6	11.0	12.3	9.2	12.1	16.0
	average length (mm)	158	173	181	184	191	191	172
	variance of length (mm)	45	59	48	51	41	36	159
commercial pound–spring	number of fish	163	152	107	84	3	13	522
	percent age composition	31%	29%	20%	16%	1%	2%	100%
	average weight (g)	50.1	68.2	78.9	85.4	98.7	92.6	68.0
	standard dev. of weight (g)	8.0	10.5	12.1	12.8	9.8	16.4	17.0
	average length (mm)	159	174	181	186	193	192	173
	variance of length (mm)	58	55	51	45	37	82	168
commercial seine–winter	number of fish	216	153	80	54	7	7	517
	percent age composition	42%	30%	15%	10%	1%	1%	100%
	average weight (g)	51.5	72.1	81.2	83.6	92.1	96.2	66.0
	standard dev. of weight (g)	7.3	10.6	11.8	13.1	5.8	6.4	17.0
	average length (mm)	156	172	179	180	185	191	167
	variance of length (mm)	45	60	75	64	20	28	176

Table 14.–Summary of age, weight, and length for the Hoonah Sound herring stock in 2012–13.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	263	143	11	39	16	53	525
	percent age composition	50%	27%	2%	7%	3%	10%	100%
	average weight (g)	63.6	80.5	92.8	96.5	111.6	117.7	78.0
	standard dev. of weight (g)	9.5	13.9	11.7	18.5	13.3	18.1	22.0
	average length (mm)	173	185	194	196	206	210	183
	variance of length (mm)	49	90	62	139	81	83	220
commercial pound –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 15.–Summary of age, weight, and length for the Tenakee Inlet herring stock in 2012–13.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	82	131	13	82	44	178	530
	percent age composition	15%	25%	2%	15%	8%	34%	100%
	average weight (g)	66.1	82.7	99.6	109.1	112.6	125.4	–
	standard dev. of weight (g)	10.0	13.4	14.6	20.8	16.8	18.2	–
	average length (mm)	175	185	198	202	206	211	–
	variance of length (mm)	40	63	45	103	84	71	–
commercial – winter / 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 16.–Summary of age, weight, and length for the Seymour Canal herring stock in 2012–13.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	46	243	17	35	38	147	526
	percent age composition	9%	46%	3%	7%	7%	28%	100%
	average weight (g)	52.1	62.5	69.7	73.0	87.9	93.7	–
	standard dev. of weight (g)	14.7	14.8	14.5	13.1	20.5	20.3	–
	average length (mm)	161	170	177	181	189	194	–
	variance of length (mm)	188	160	158	146	133	131	–
commercial gillnet–spring	number of fish	0	30	25	31	55	385	526
	percent age composition	0%	6%	5%	6%	10%	73%	100%
	average weight (g)	–	103.7	102.7	112.1	109.0	115.9	–
	standard dev. of weight (g)	–	10.8	13.9	16.9	15.5	15.5	–
	average length (mm)	–	195	193	200	199	203	–
	variance of length (mm)	–	41	88	74	61	67	–

Table 17.–Summary of age, weight, and length for the West Behm Canal herring stock in 2012–13.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	139	198	94	79	7	10	527
	percent age composition	26%	38%	18%	15%	1%	2%	100%
	average weight (g)	48.7	63.9	74.4	87.7	90.5	103.0	66.0
	standard dev. of weight (g)	9.6	12.0	13.8	17.0	21.9	22.4	19.0
	average length (mm)	159	173	182	189	193	202	174
	variance of length (mm)	66	81	71	91	138	173	204
commercial gillnet–spring	number of fish							
	percent age composition							
	average weight (g)			NO FISHERY				
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 18.–Summary of age, weight, and length for the Lynn Canal herring stock in 2012–13.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	38	157	10	40	56	226	527
	percent age composition	7%	30%	2%	8%	11%	43%	100%
	average weight (g)	59.6	71.2	83.6	83.5	94.7	99.4	86.0
	standard dev. of weight (g)	12.4	15.5	18.8	17.8	17.4	19.9	22.0
	average length (mm)	170	178	187	189	196	198	188
	variance of length (mm)	133	102	140	132	95	110	212

Table 19.–Summary of age, weight, and length for the Revilla Channel herring stock in 2012–13.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	146	159	52	35	5	4	401
	percent age composition	36%	40%	13%	9%	1%	1%	100%
	average weight (g)	45.4	55.2	69.3	77.7	92.0	88.6	56.0
	standard dev. of weight (g)	7.8	10.7	12.8	20.3	9.7	12.4	16.0
	average length (mm)	161	171	183	188	198	199	171
	variance of length (mm)	51	84	108	133	49	35	174

Table 20.–Summary of age, weight, and length for the Yakutat herring stock in 2012–13.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	11	46	19	151	81	217	525
	percent age composition	2%	9%	4%	29%	15%	41%	100%
	average weight (g)	77.3	100.0	119.8	126.7	135.2	159.3	137.0
	standard dev. of weight (g)	12.8	17.1	24.3	20.5	23.1	25.6	31.0
	average length (mm)	183	199	209	213	217	227	217
	variance of length (mm)	74	117	124	79	92	120	199

Table 21.–Proportion of mature age-3 herring (cast net, 1988–2013), latitude and mean sea temperature of herring spawning stocks in Southeast Alaska.

Stock	Latitude (decimal degrees)	Median proportion of mature age-3 herring	Mean proportion of mature age-3 herring	Mean annual sea temperature (^{o}C)	Mean minimum annual sea temperature (^{o}C)	Mean maximum annual sea temperature (^{o}C)
Kah Shakes	55.0300	23%	30%	8.6	5.9	14.7
Craig	55.4770	20%	22%	9.0	4.7	14.1
WBC	55.4846	26%	30%	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%	15%	7.1	3.9	12.9
Seymour Canal	57.5923	10%	16%	6.7	3.0	13.3
Hoonah Sound	57.6001	8%	16%	7.9	2.0	15.0
Tenakee Inlet	57.7381	11%	11%	7.8	1.9	15.0
Lynn Canal	58.6402	10%	12%	7.1	2.6	15.4

Table 22.–Summary of Southeast Alaska herring target levels for the 2012–13 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target Exploitation Rate (%)	Guideline harvest level (tons)[a]
Craig	5,000	23,391	17.4	4,060
Ernest Sound	2,500	3,509	10.8	379
Hobart Bay/Port Houghton	2,000	149	—	—
Hoonah Sound	1,000	1,244	10.5	130
Seymour Canal	3,000	7,716	13.1	1,014
Sitka Sound	25,000	76,988	15.0	11,549
Tenakee Inlet	3,000	—	—	—
West Behm Canal	6,000	2,860	—	—
Lynn Canal	5,000	—	—	—
Kah Shakes	6,000	—	—	—

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

Table 23.–Summary of commercial herring harvest during the 2012–13 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	30-Nov-12	28-Feb-13	[redacted]
Winter food and bait	Purse seine	Tenakee Inlet	12	Not Open		—
Winter food and bait	Purse seine	Ernest Sound	7	30-Nov-12	28-Jan-13	[redacted]
Winter food and bait	Purse seine	Hobart Bay	10	Not Open		—
Sub-total						[redacted]
Sac roe	Purse seine	Sitka Sound	13	27-Mar-13	4-Apr-13	5,688
Sac roe	Purse seine	Lynn Canal	11	Not Open		—
Sac roe	Gillnet	Seymour Canal	11	8-May-13	11-May-13	649
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						6,337
Spawn on kelp	Pound	Hoonah Sound[d]	13	—	—	0
Spawn on kelp	Pound	Tenakee Inlet	12	Not Open		—
Spawn on kelp	Pound	Ernest Sound	7	1-Apr-13	18-Apr-13	65
Spawn on kelp	Pound	Craig	3	17-Mar-13	30-Apr-13	138
Sub-total						203
Test fishery - bait	Purse seine	Sitka	13	26-Jan-13	1-Mar-13	60

[a] For spawn-on-kelp fisheries, represents start of seining and transferring herring into pounds.
[b] For spawn-on-kelp fisheries, represents end of removing SOK from pounds.
[c] Values expressed in tons of whole herring, except for spawn-on-kelp fisheries, values are tons of eggs-on-kelp product.
[d] Area opened to open pound gear only, but there was no fishing effort.

Figure 1.–Locations of major herring spawning areas in Southeast Alaska, where surveys or sampling of herring was conducted during 2012–13.

Stock	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	13-Apr	14-Apr	15-Apr	16-Apr
Craig				6.0	11.5	7.0	2.0													
Sitka Sound	2.2	11.6	17.8	28.2	20.5	6.6	2.2	1.2	1.3	1.5	1.6	ns	ns	0.0						6.6
West Behm Canal							0.5	0.5	0.5	0.2										
Revilla Channel		0.5		1.3	1.3	1.5	2.0	4.0												
Ernest Sound																	1.5	1.5	0.3	1.0
Hoonah Sound																				
Tenakee Inlet																				
Hobart Bay/Port Houghton																				
Seymour Canal																				
Lynn Canal																				
Yakutat																				

Stock	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May	4-May	5-May	6-May
Craig																				
Sitka Sound	2.9	3.3	2.1	0.0	ns	0.5	0.5	ns	ns	ns	ns	ns								
West Behm Canal																				
Revilla Channel																				
Ernest Sound																				
Hoonah Sound																				
Tenakee Inlet																				
Hobart Bay/Port Houghton																0.3	1.2			
Seymour Canal																0.1				
Lynn Canal																			1.2	0.9
Yakutat				0.1	1.0	0.1	2.0	1.0	0.5	ns	ns	0.5	ns	1.0						

continued	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	22-May	23-May	24-May	25-May	26-May
Hoonah Sound	0.7	1.3	0.2																	
Hobart Bay/Port Houghton											1.9									
Seymour Canal	1.4	4.5	0.8	0.7	1.5	0.3														
Tenakee Inlet	1.0	1.2	4.0	0.3																
Lynn Canal	2.0	4.0	0.1															0.1		

continued	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	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun
Hoonah Sound																				
Hobart Bay/Port Houghton																				
Seymour Canal																				
Tenakee Inlet																				
Lynn Canal	0.1																			

Figure 2.–Spawn timing of herring stocks in Southeast Alaska during spring 2013. 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). Daily spawn mileage for Yakutat was approximated.

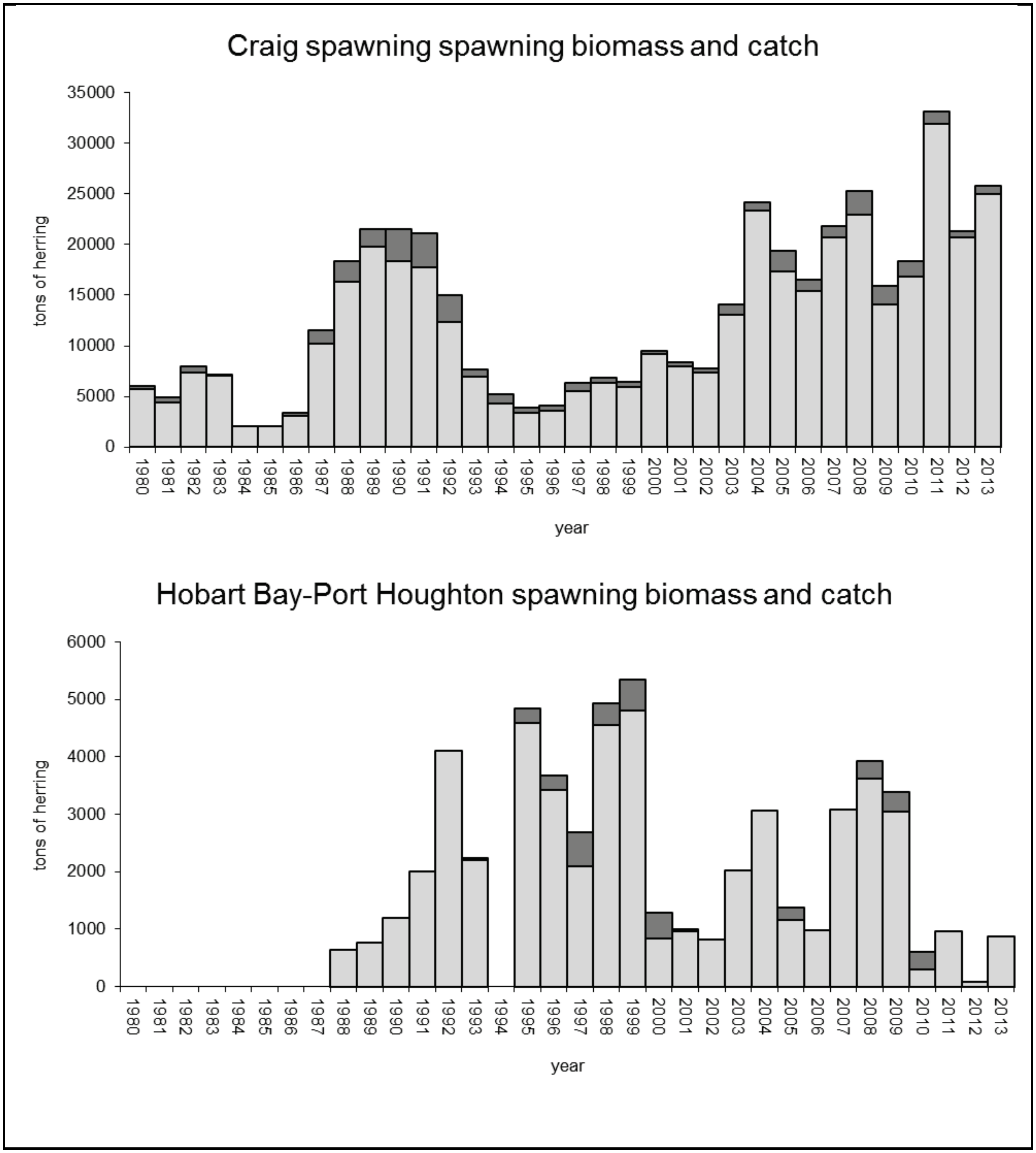


Figure 3.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Craig and Hobart Bay-Port Houghton areas, during 1980–2013.

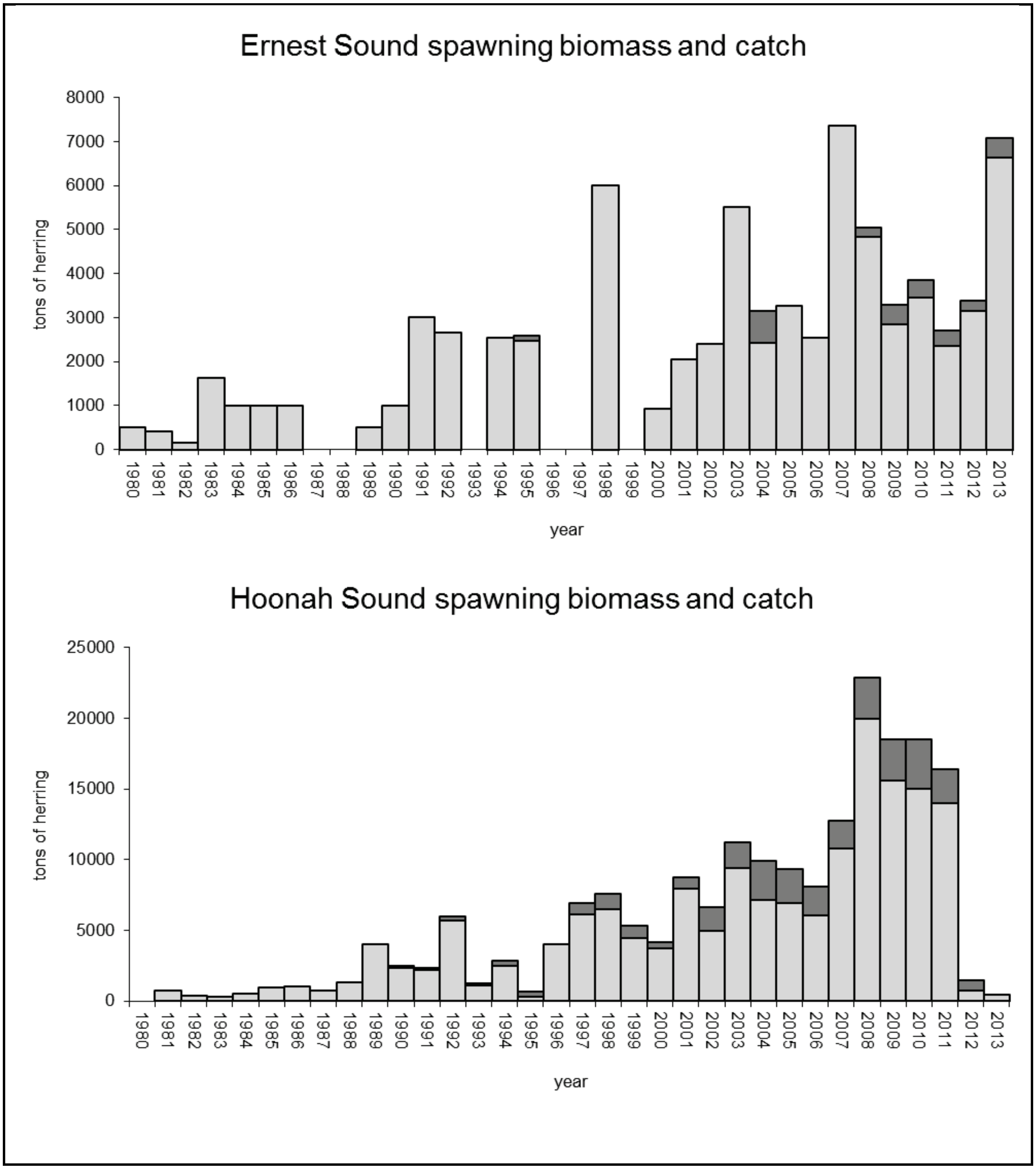


Figure 4.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2013.

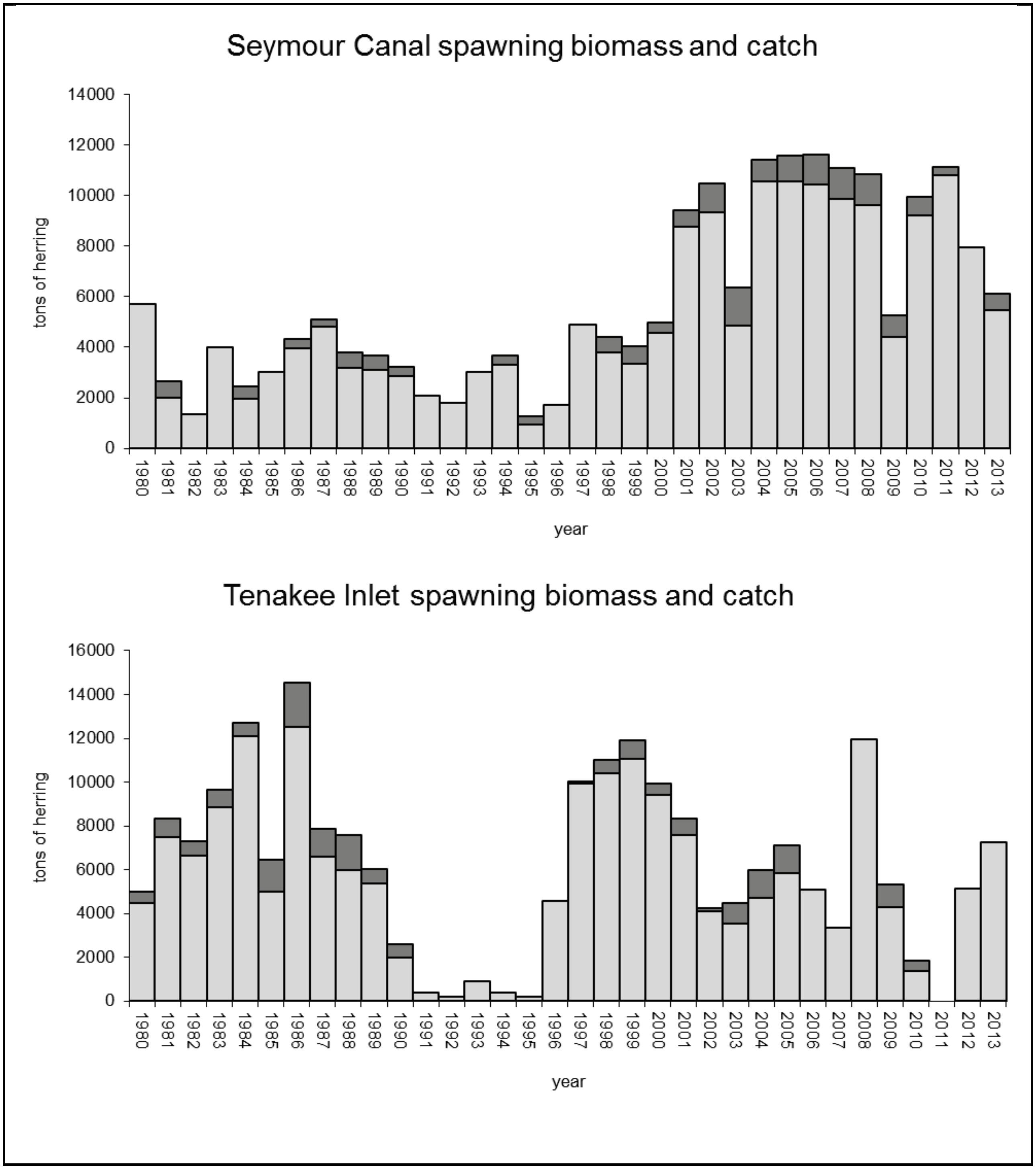


Figure 5.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Tenakee Inlet and Seymour Canal areas, during 1980–2013.

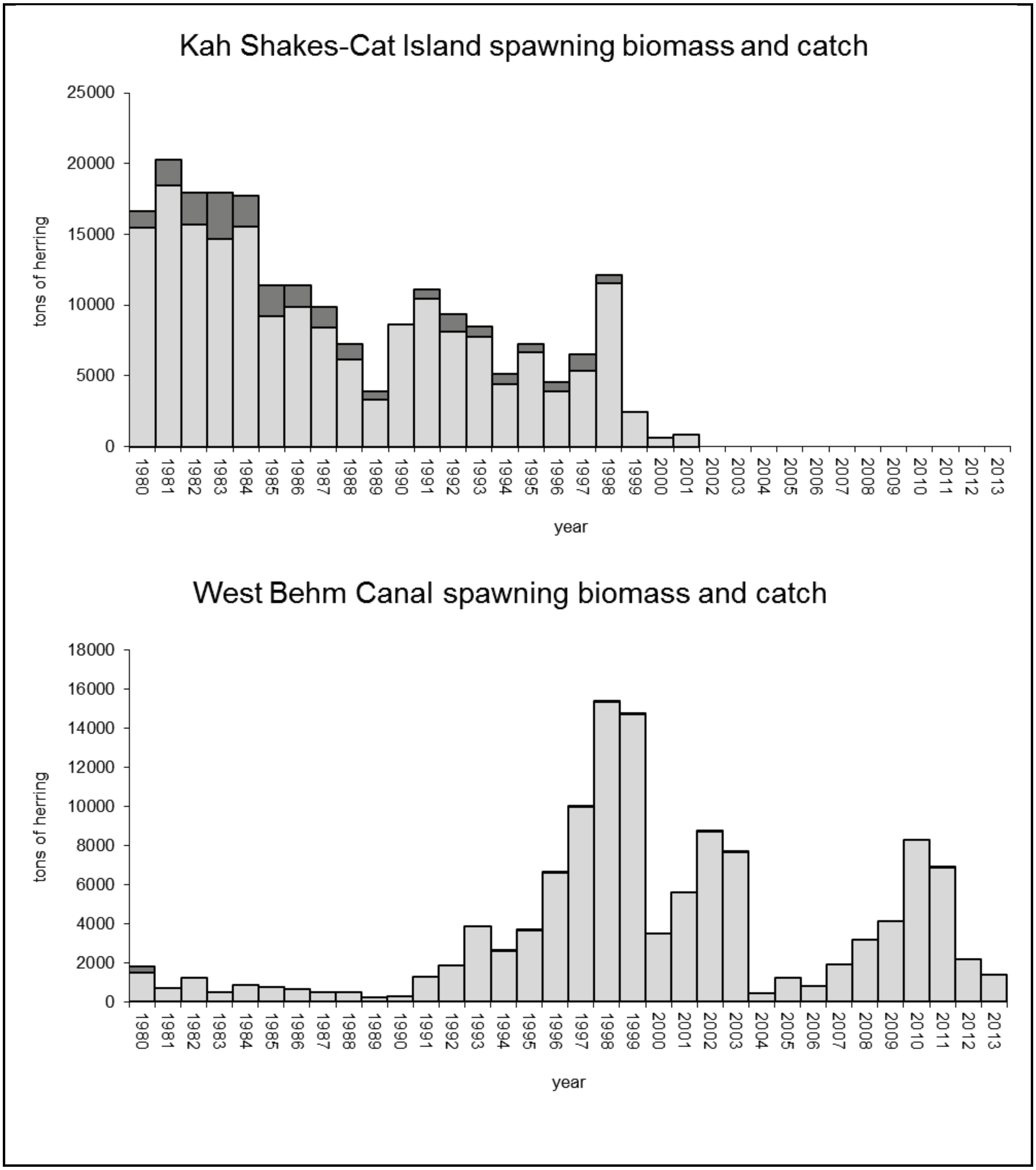


Figure 6.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the West Behm Canal and Kah Shakes-Cat Island areas, during 1980–2013.

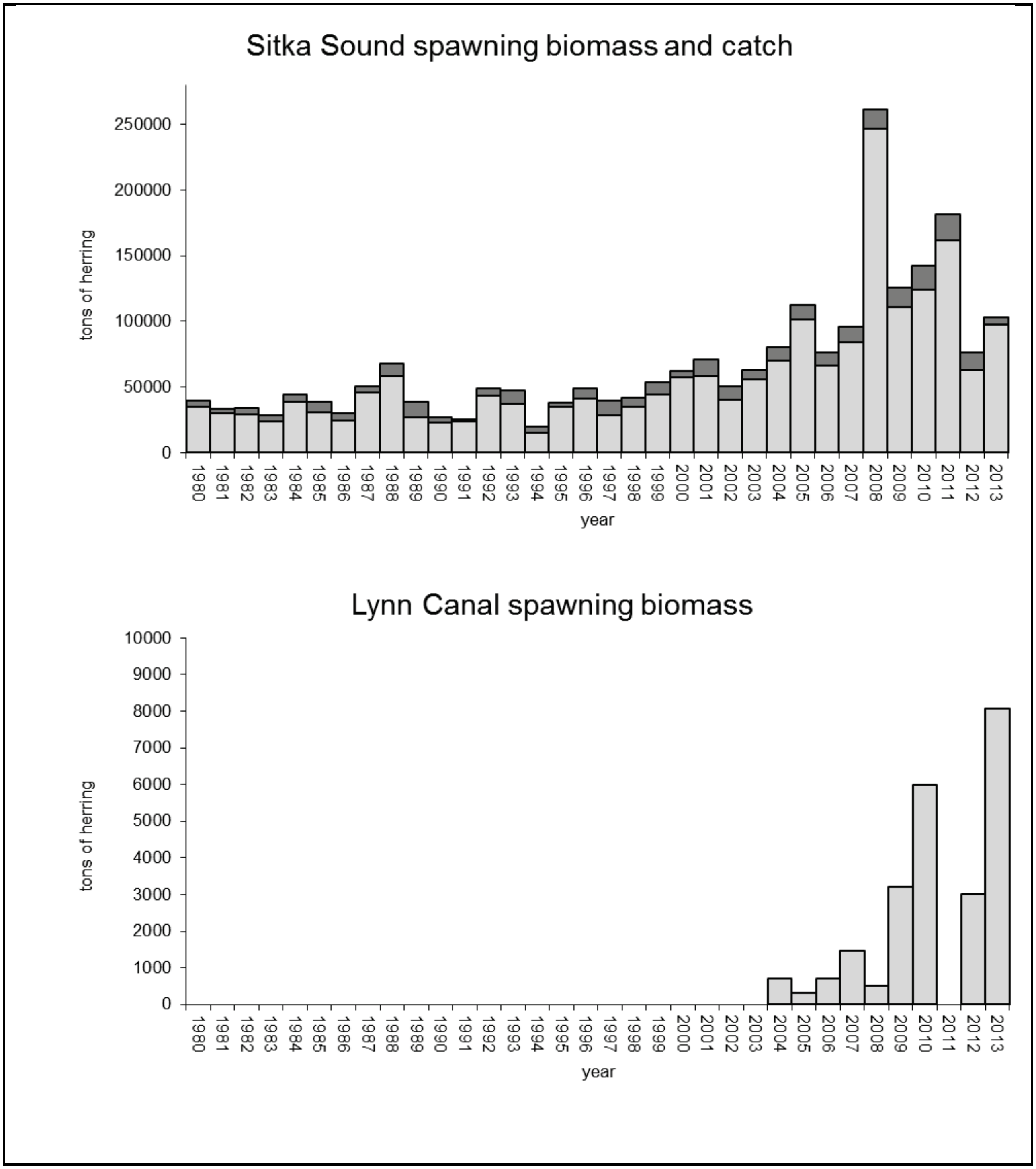


Figure 7.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2013. Estimates of spawning biomass for Lynn Canal prior to 2004 area not presented due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

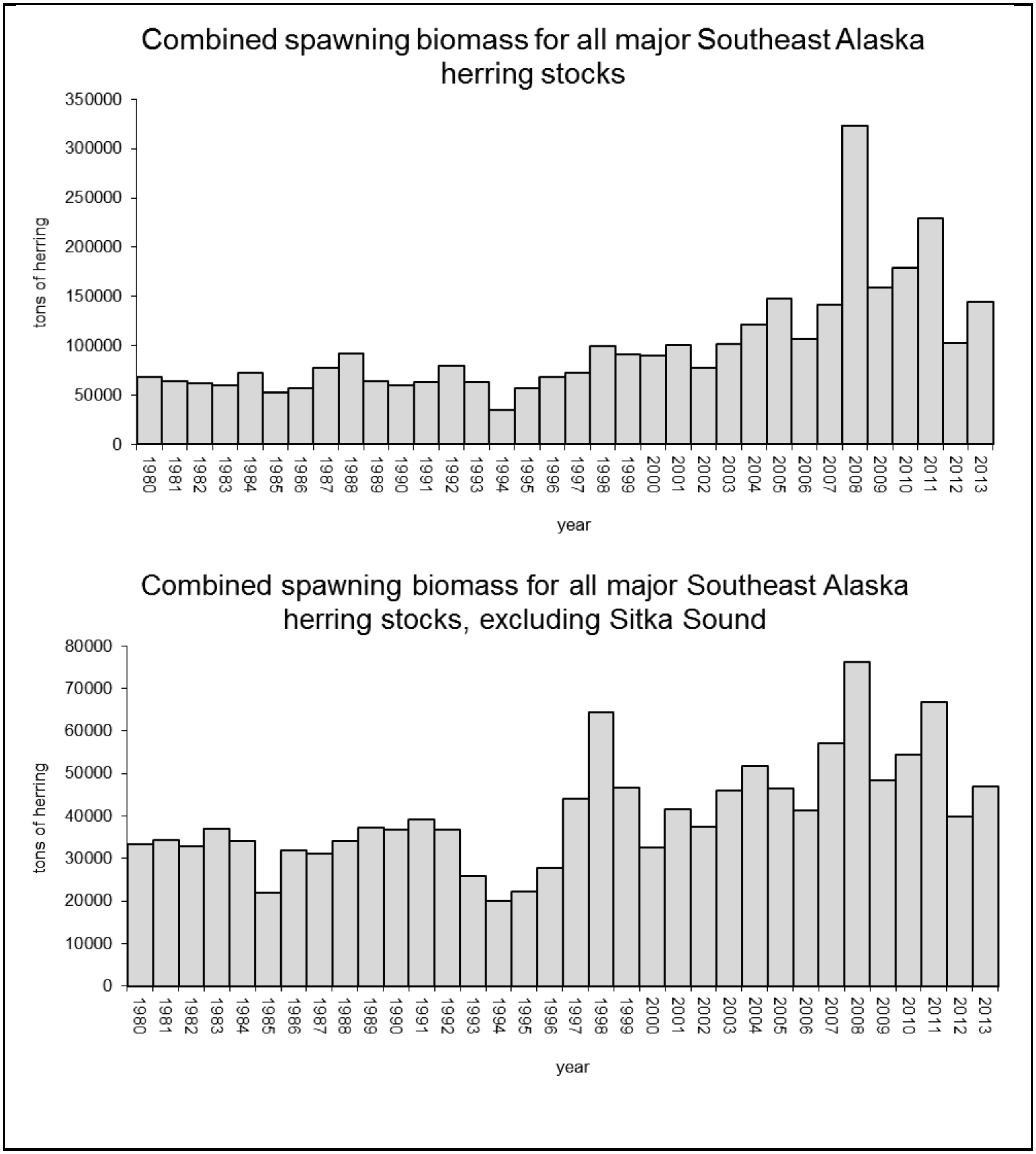


Figure 8.–Combined post-fishery spawning biomass, based on spawn deposition surveys, or hydro-acoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2013. Estimates of spawning biomass for Lynn Canal area not included due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

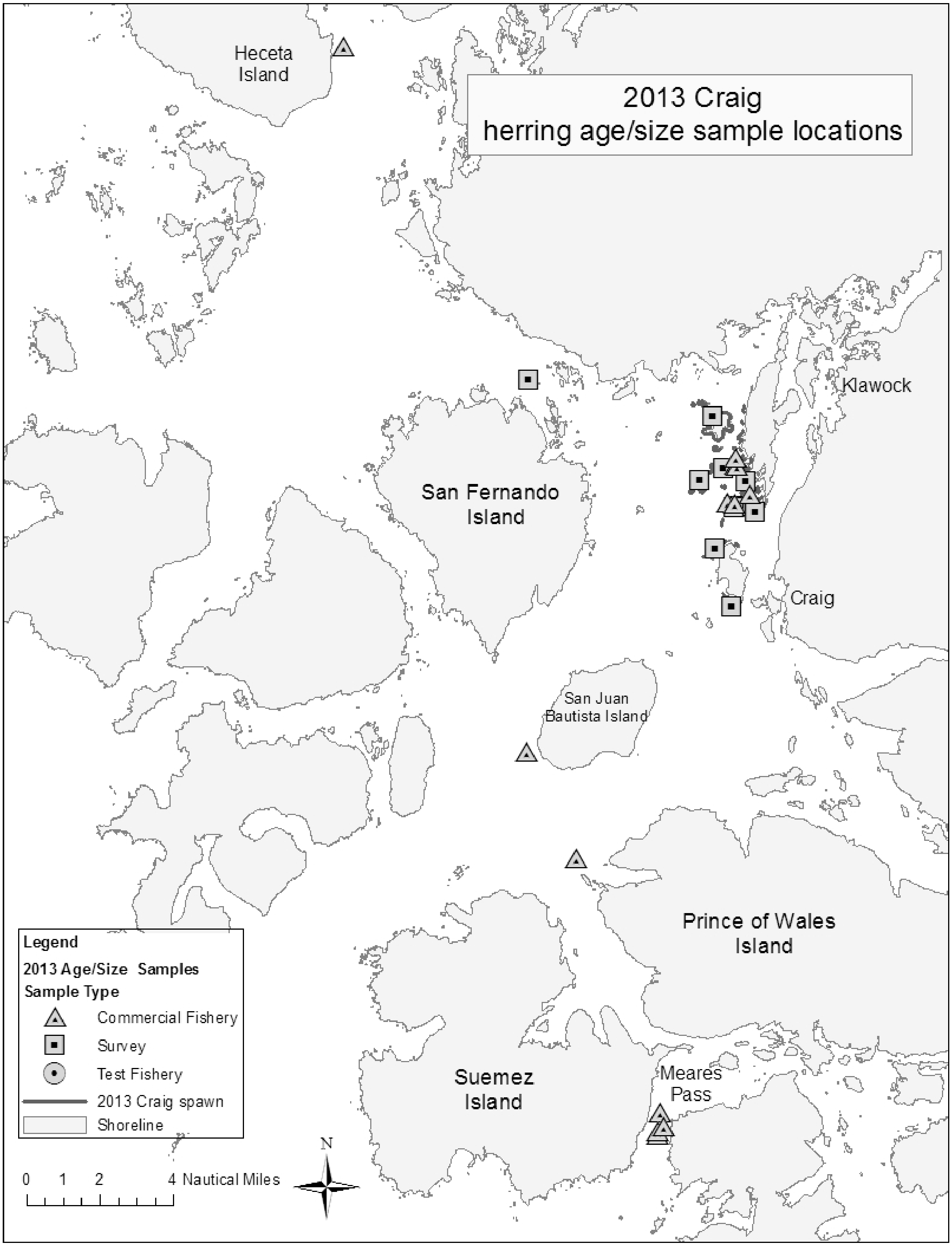


Figure 9.–Locations of herring samples collected for estimates of age and size for the Craig herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

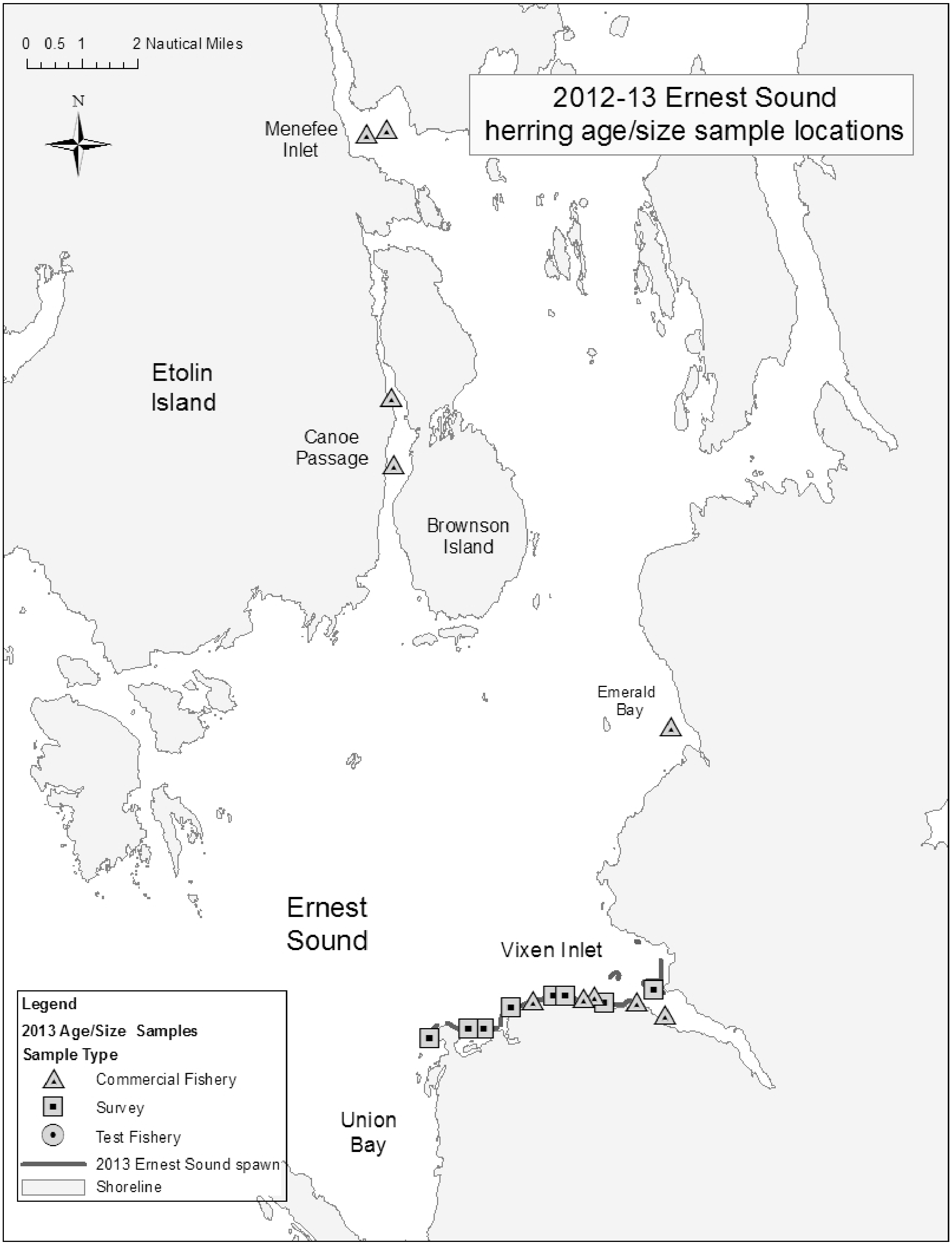


Figure 10.–Locations of herring samples collected for estimates of age and size for the Ernest Sound herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

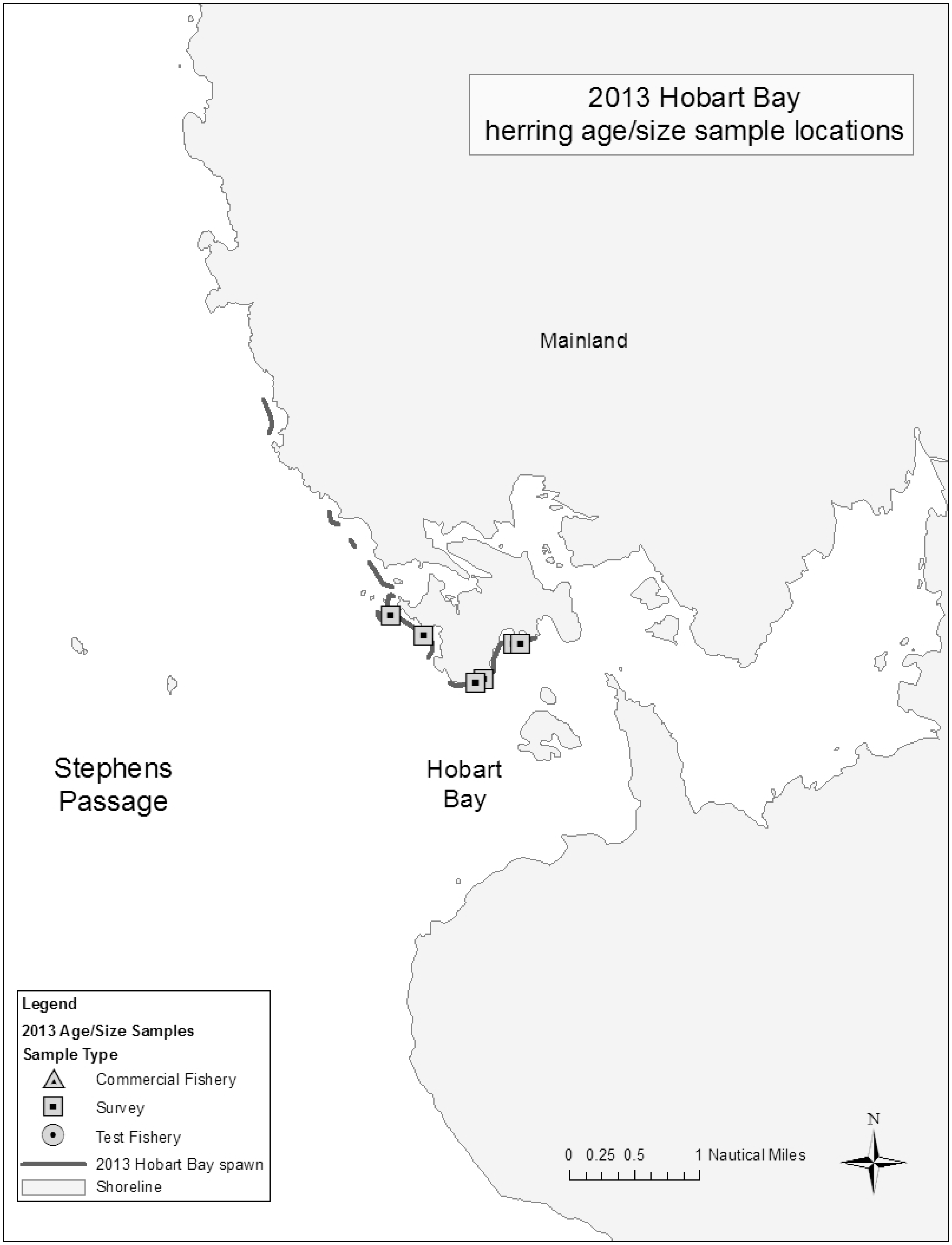


Figure 11.–Locations of herring samples collected for estimates of age and size for the Hobart bay-Port Houghton herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

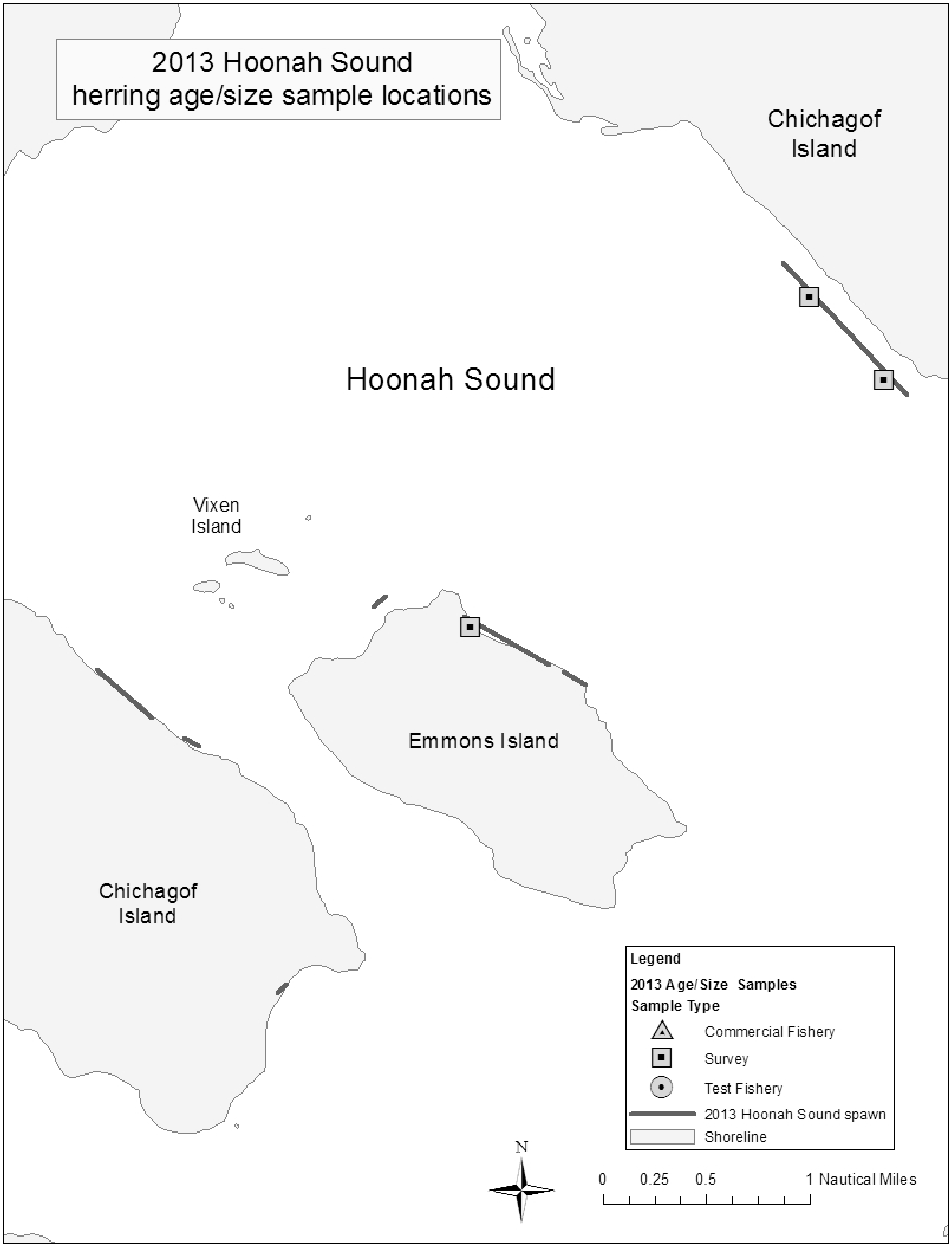


Figure 12.–Locations of herring samples collected for estimates of age and size for the Hoonah Sound herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

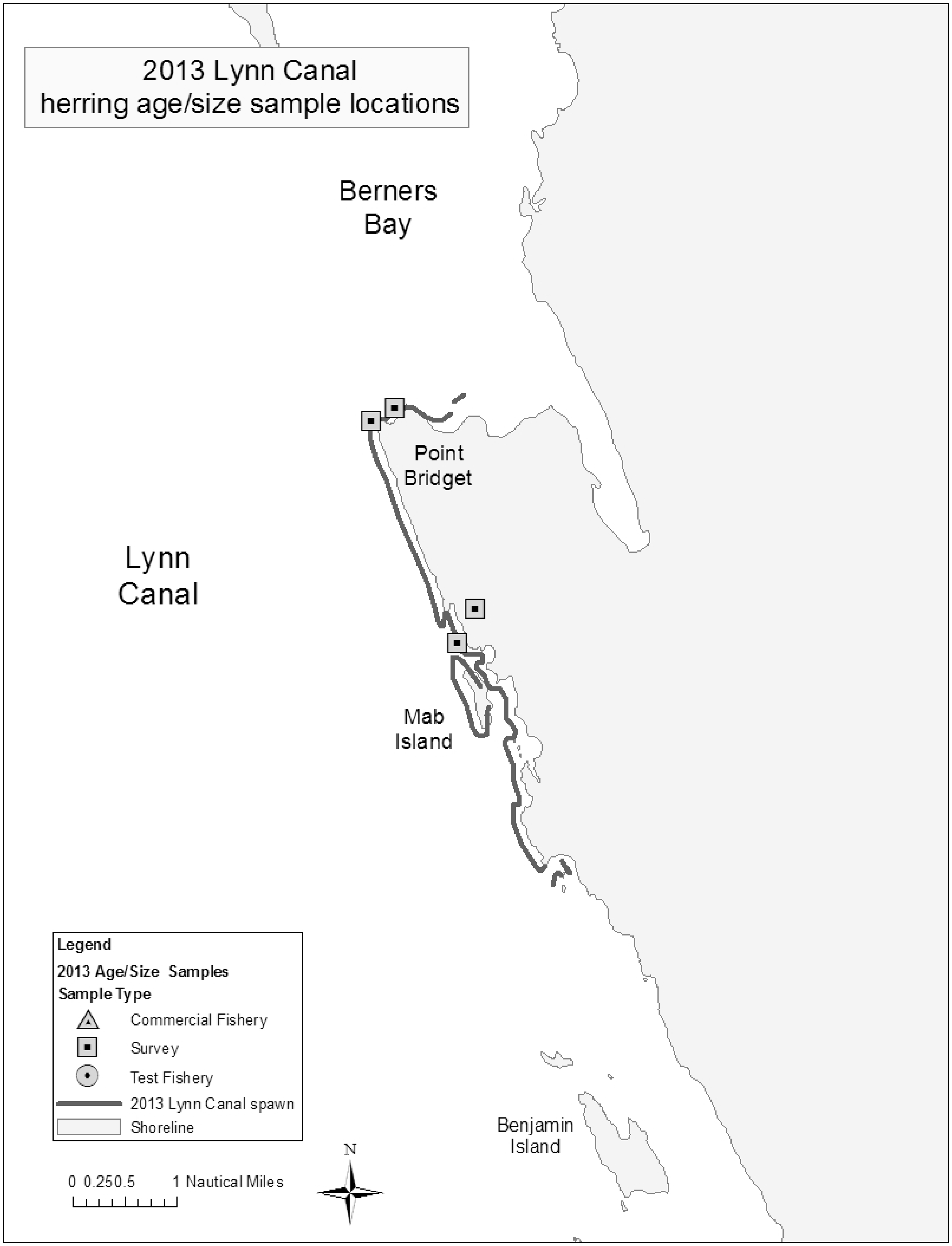


Figure 13.–Location of herring spawn for the Lynn Canal herring stock, 2013. No age/size samples were obtained during 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

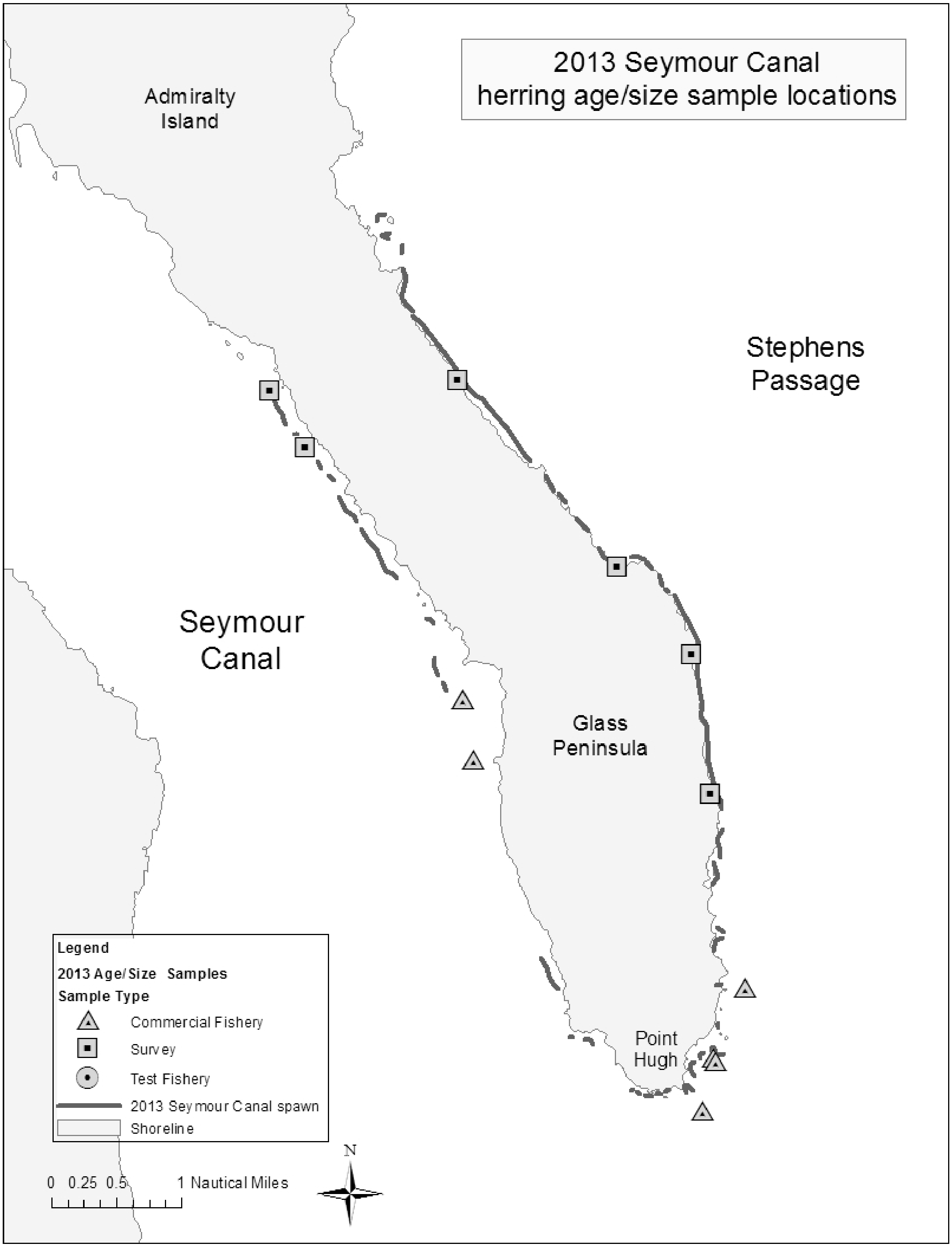


Figure 14.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

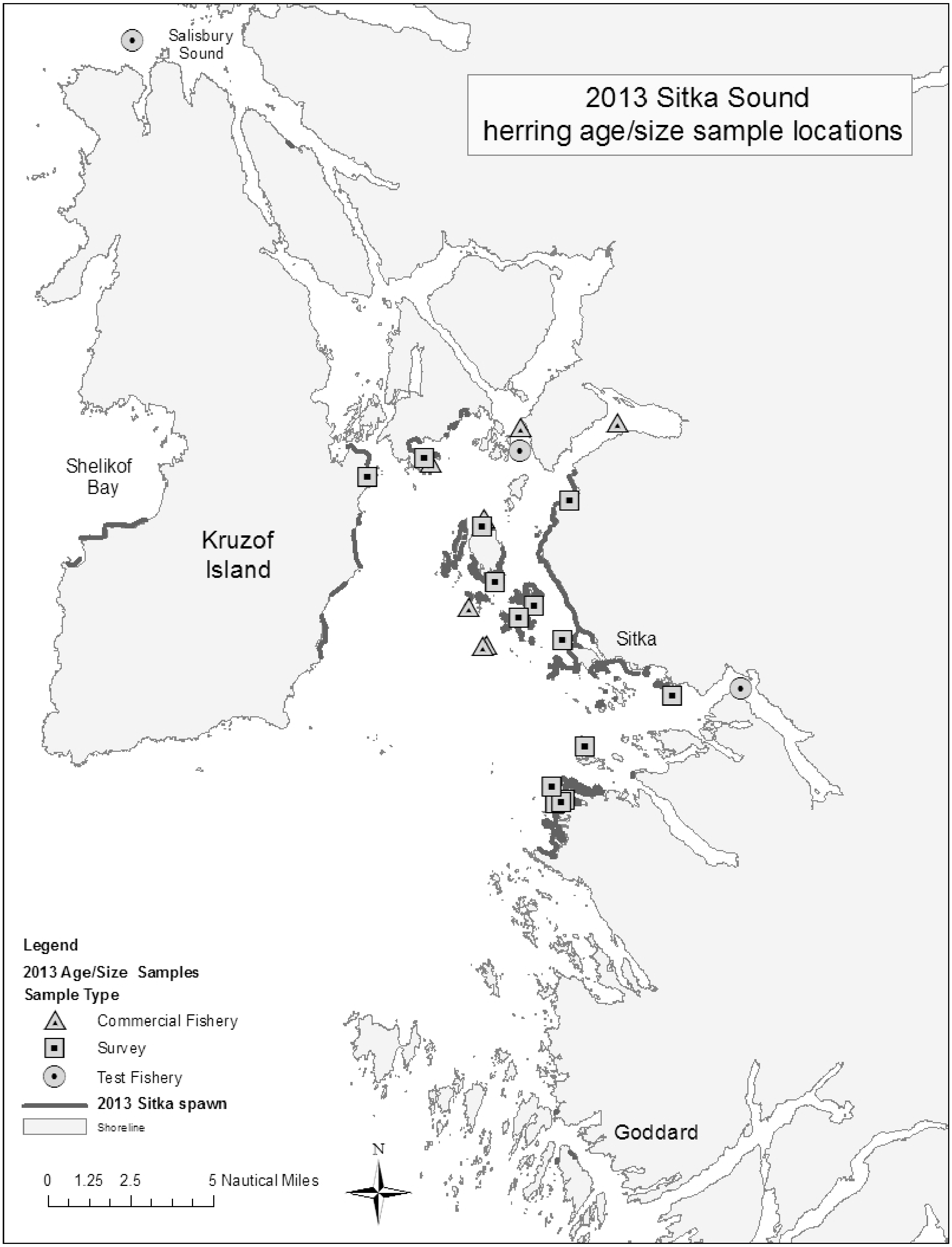


Figure 15.–Locations of herring samples collected for estimates of age and size for the Sitka Sound herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

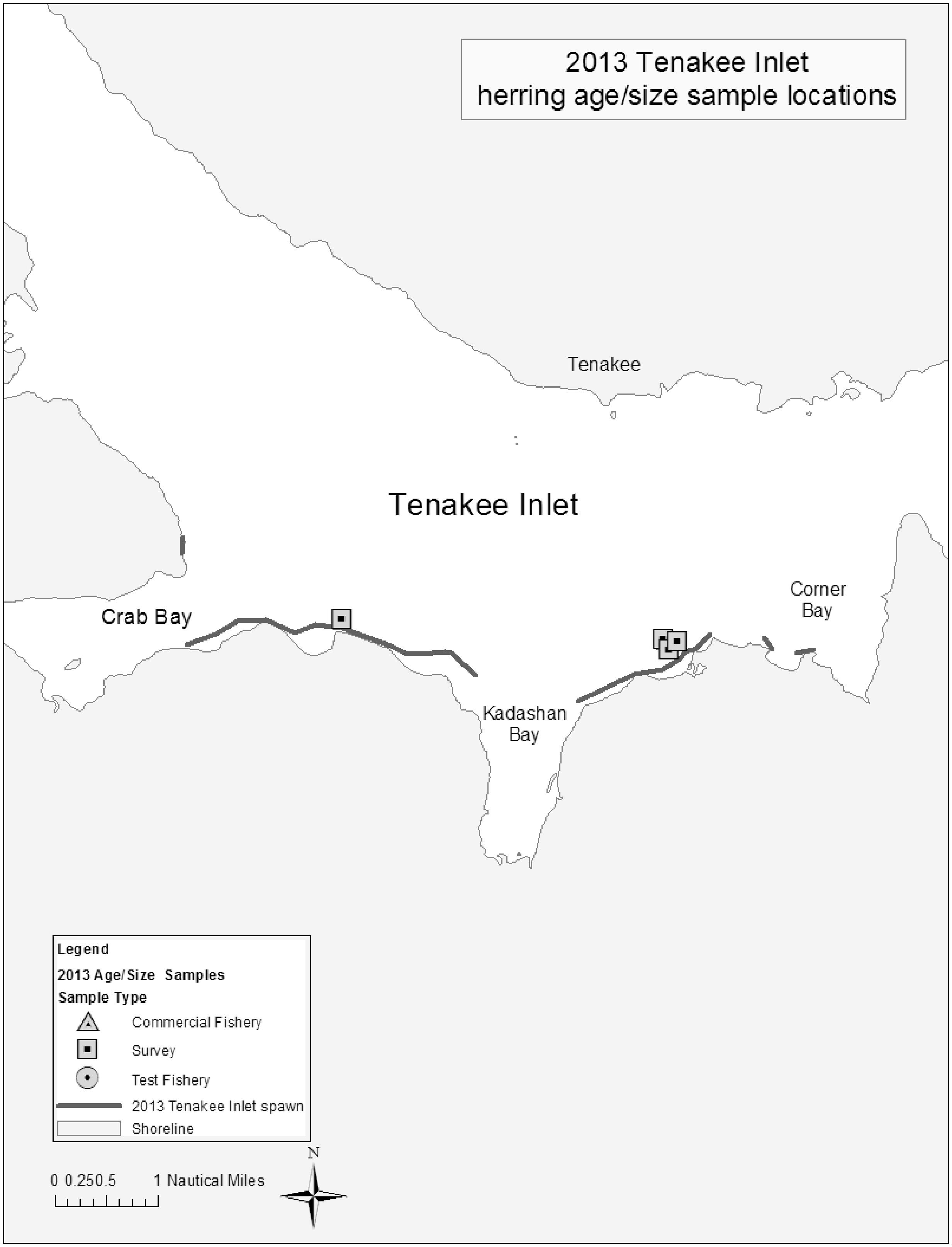


Figure 16.–Location of herring spawn for the Tenakee Inlet herring stock, 2013. No age/size samples were obtained during 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

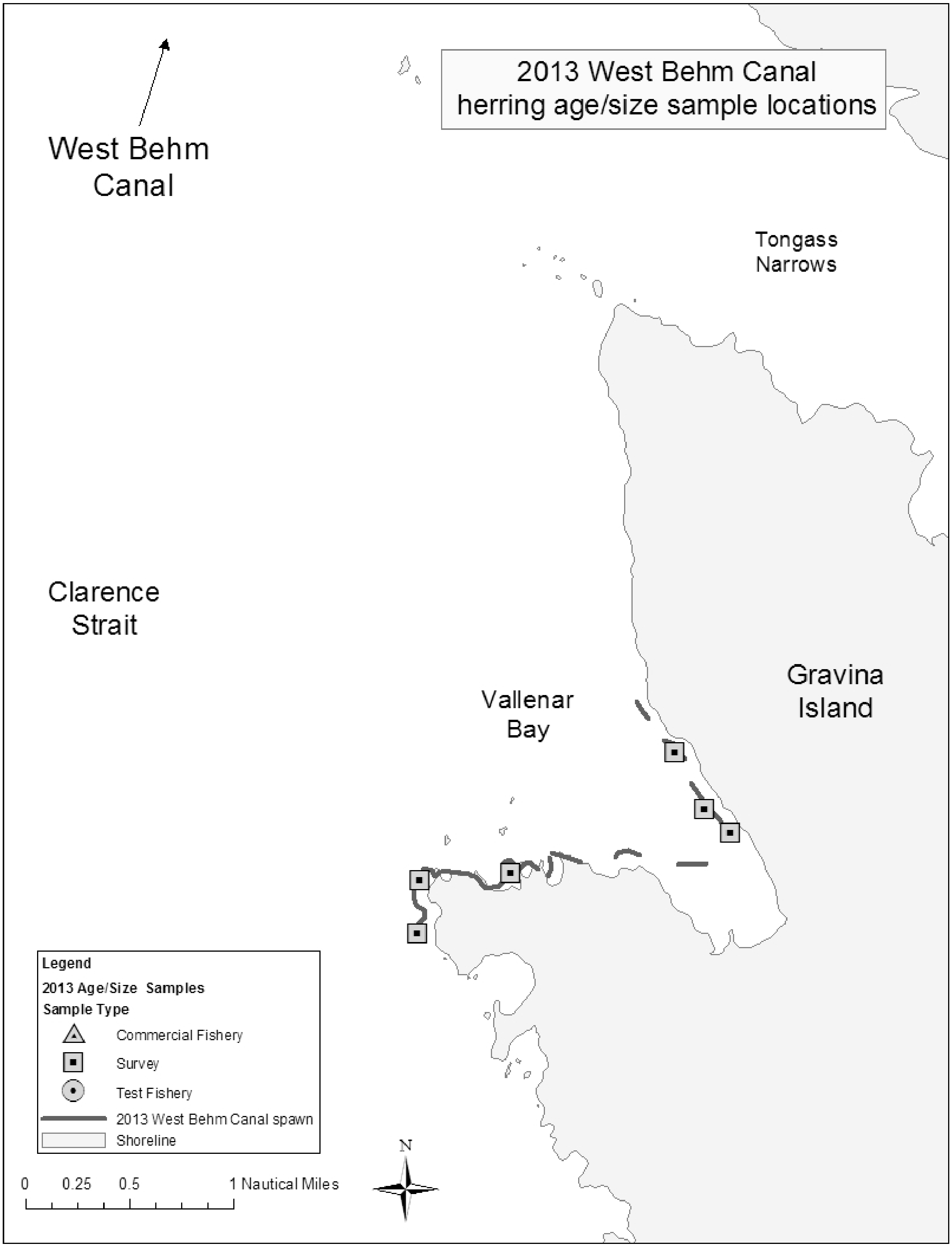


Figure 17.–Locations of herring samples collected for estimates of age and size for the West Behm Canal herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

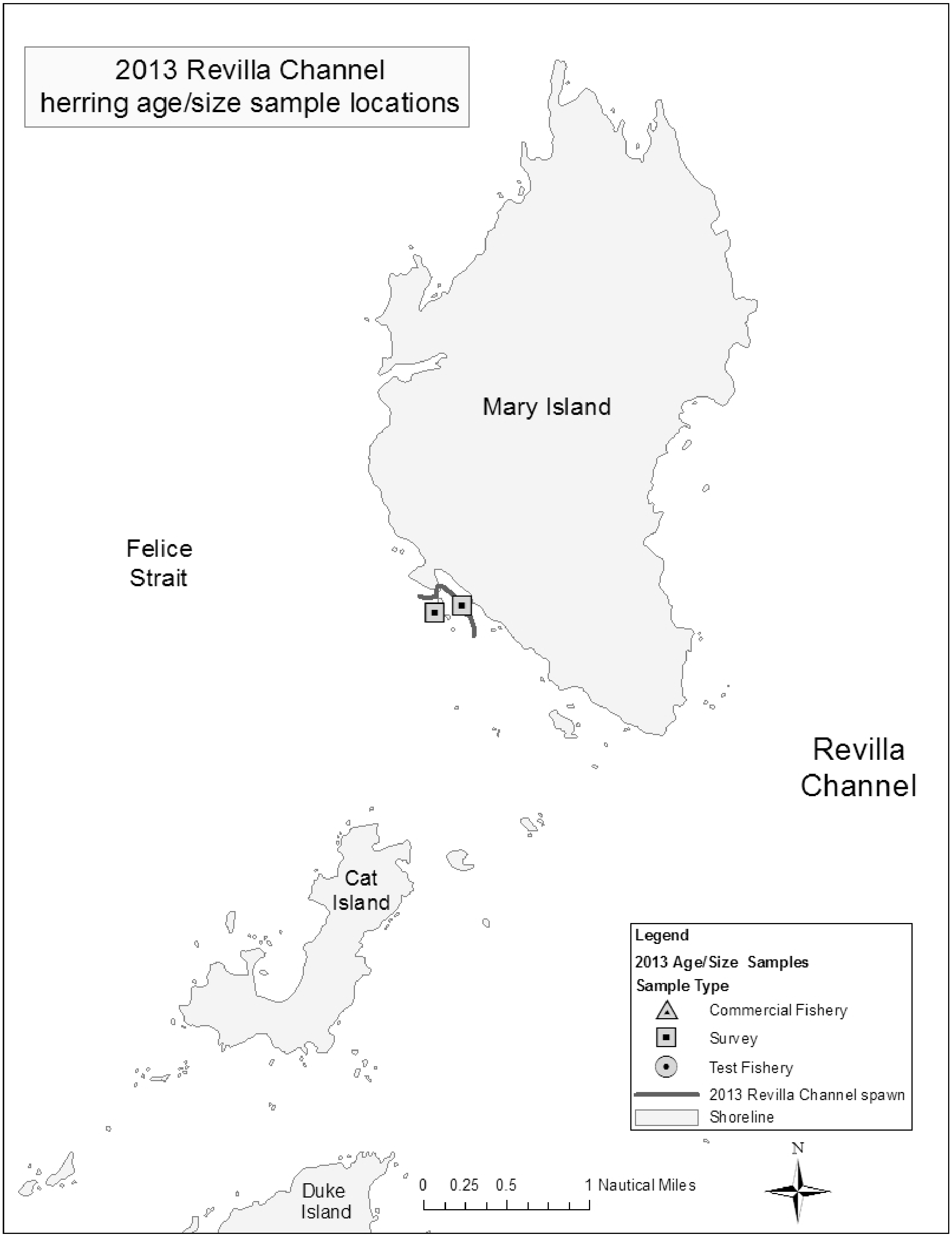


Figure 18.–Locations of herring samples collected for estimates of age and size for the Revilla Channel herring stock, 2013 (state waters only are shown). Cumulative herring spawn denoted by thick gray line along shoreline.

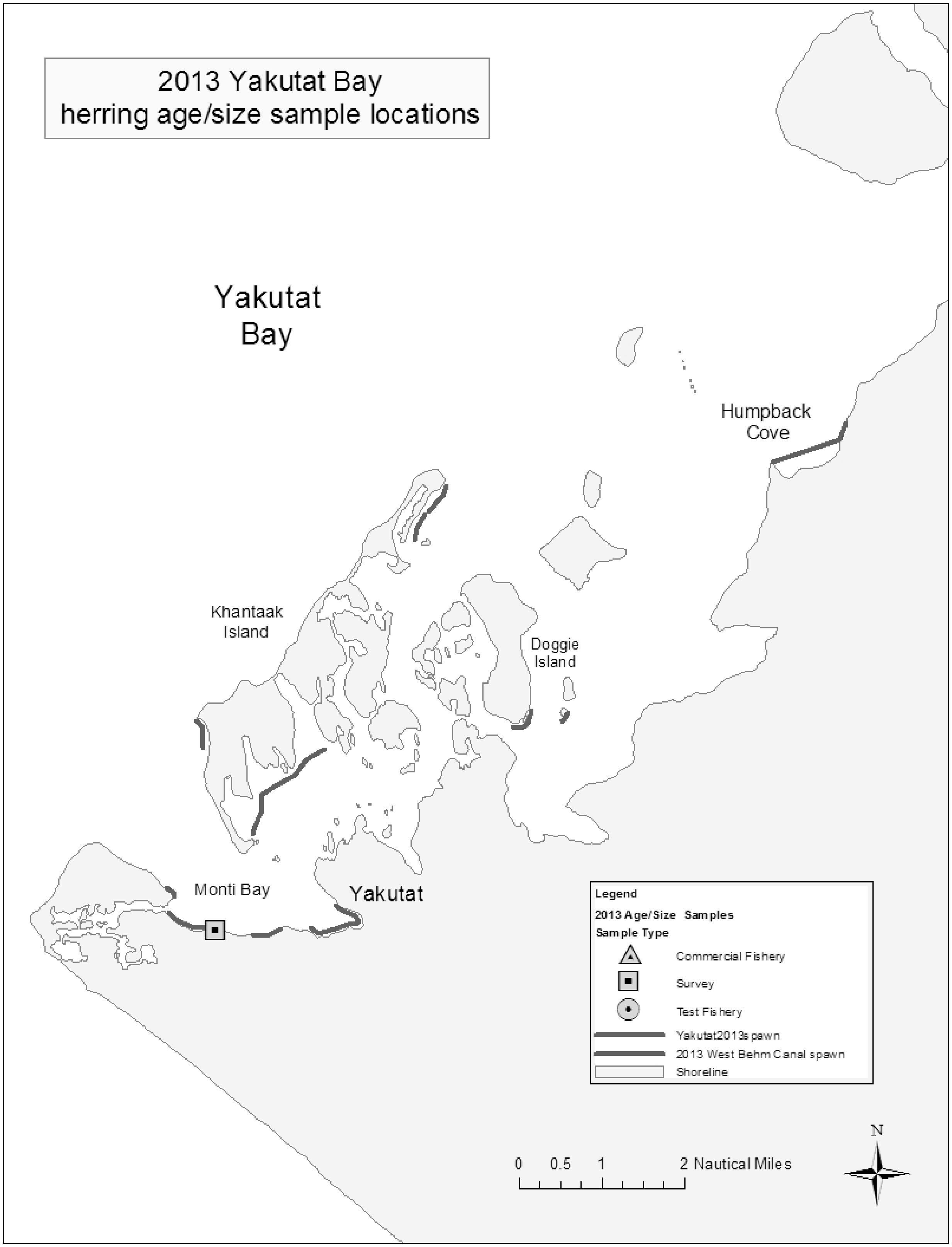


Figure 19.–Locations of herring for the Yakutat herring stock, 2013. Cumulative herring spawn denoted by thick gray line along shoreline.

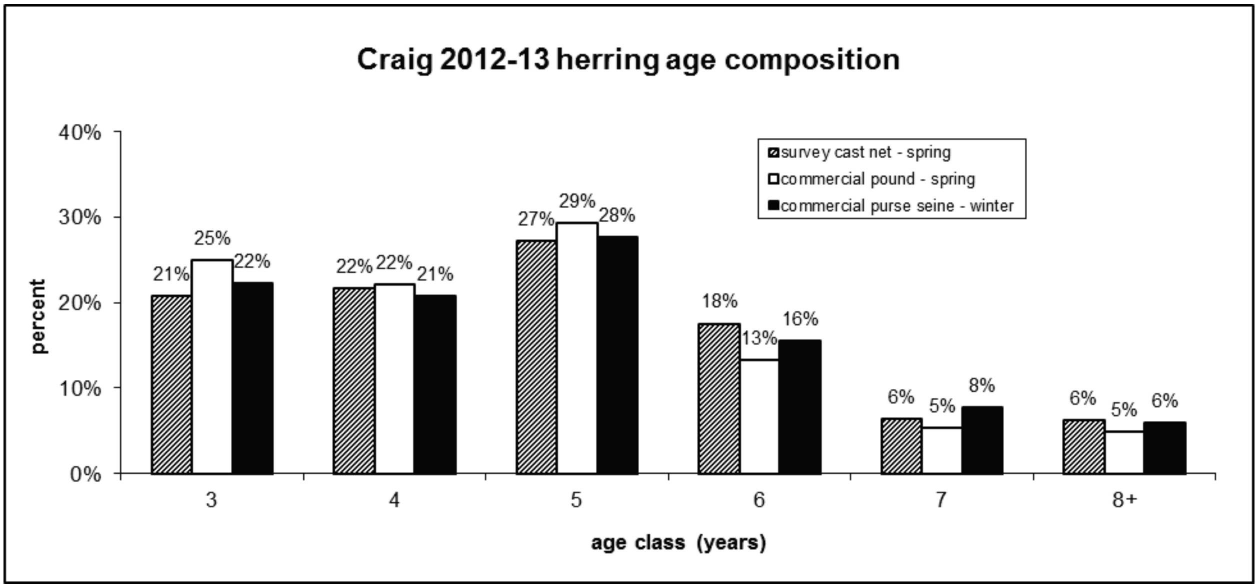


Figure 20.–Age composition for Craig herring stock in 2012–13.

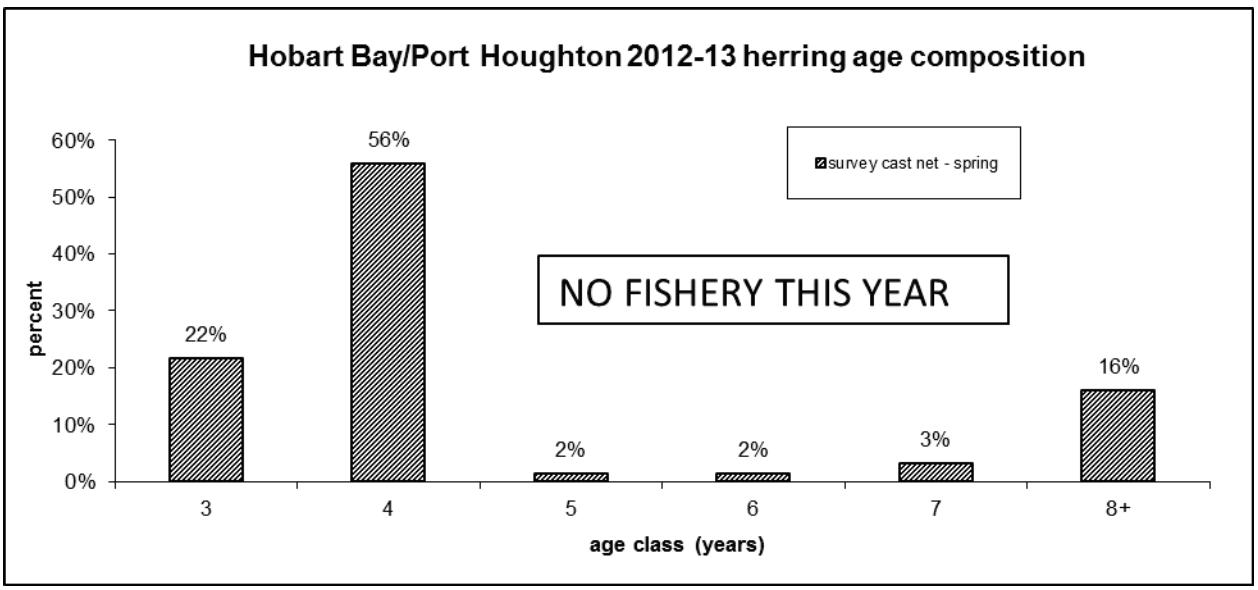


Figure 21.–Age composition for Hobart Bay/Port Houghton herring stock in 2012–13. No commercial fishery samples were obtained as no commercial fishery was opened in 2012–13.

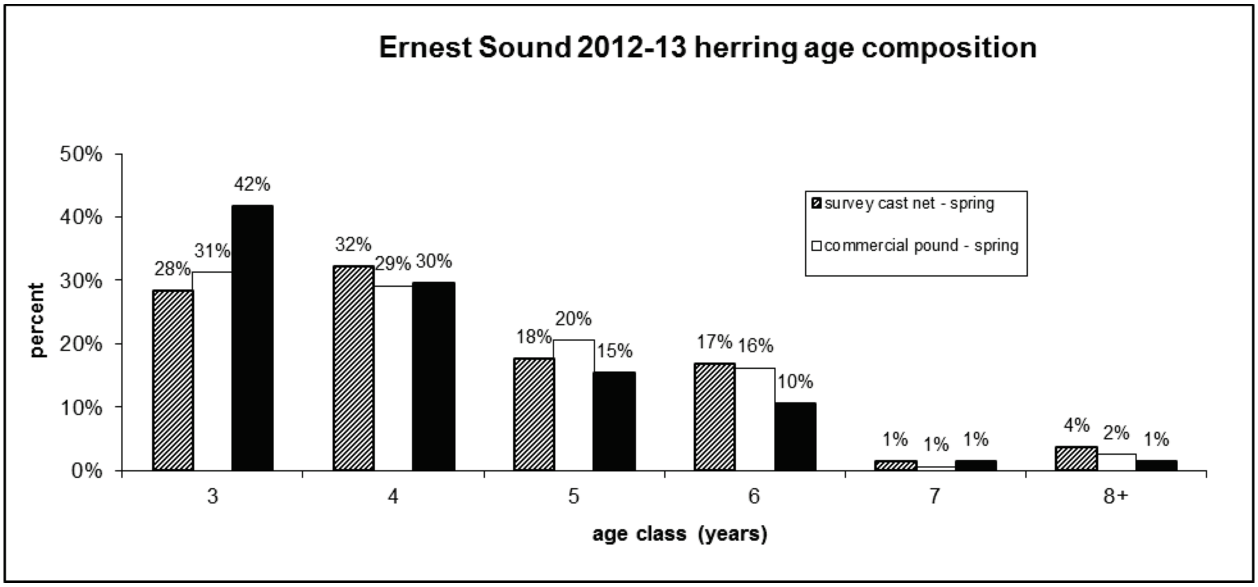


Figure 22.–Age composition for Ernest Sound herring stock in 2012–13.

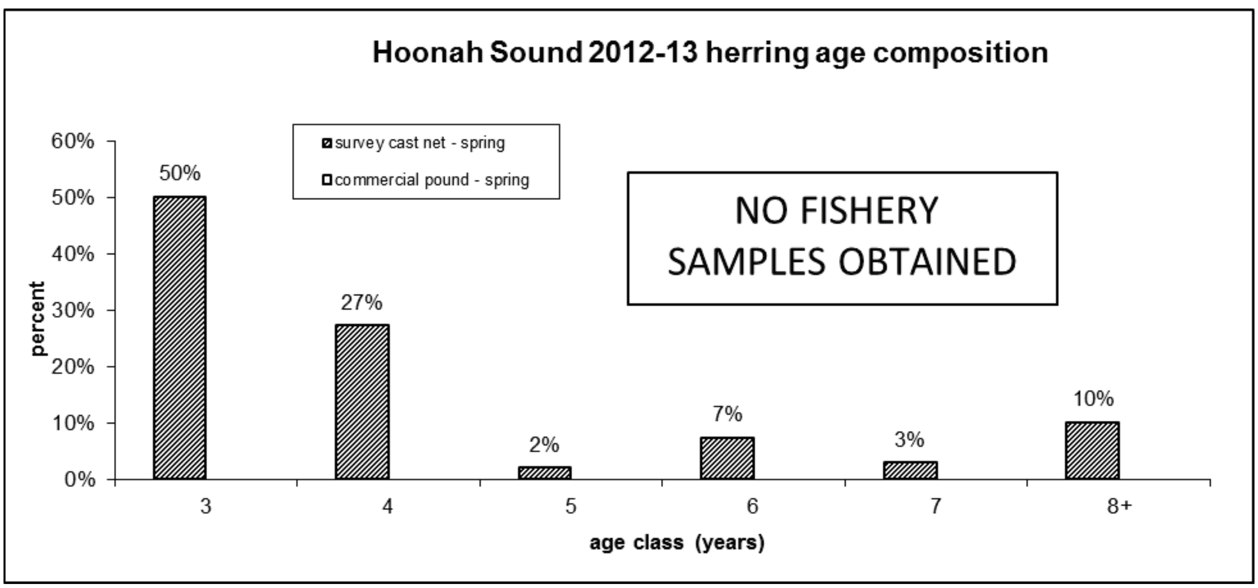


Figure 23.–Age composition for Hoonah Sound herring stock in 2012–13.

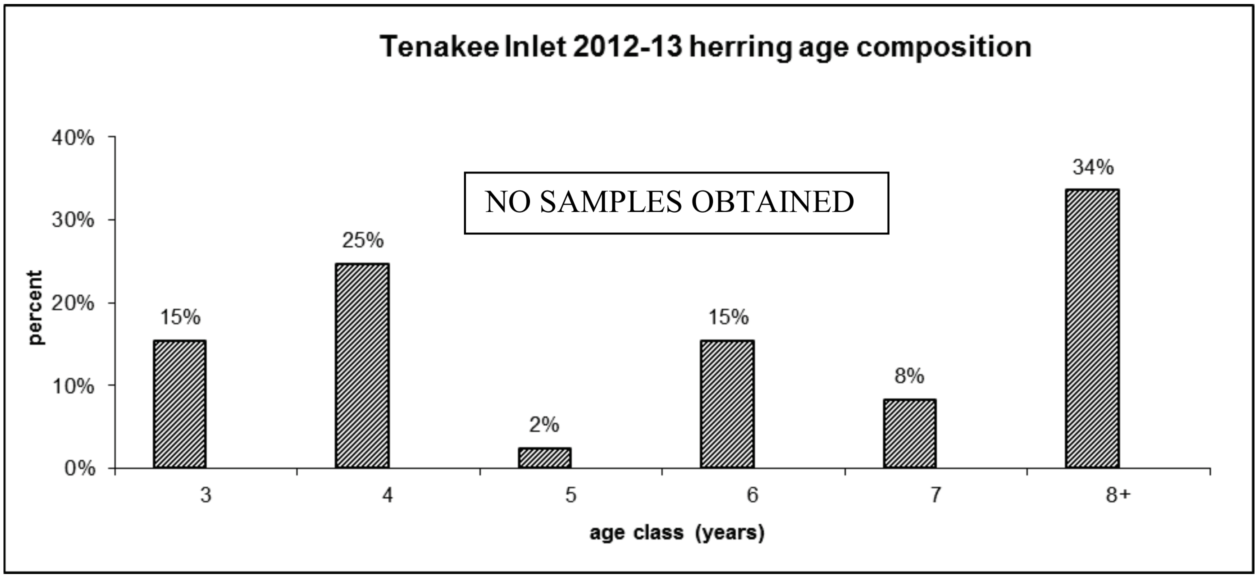


Figure 24.–Age composition for Tenakee Inlet herring stock in 2012–13. No commercial fishery samples were obtained as no commercial fishery was opened in 2012–13.

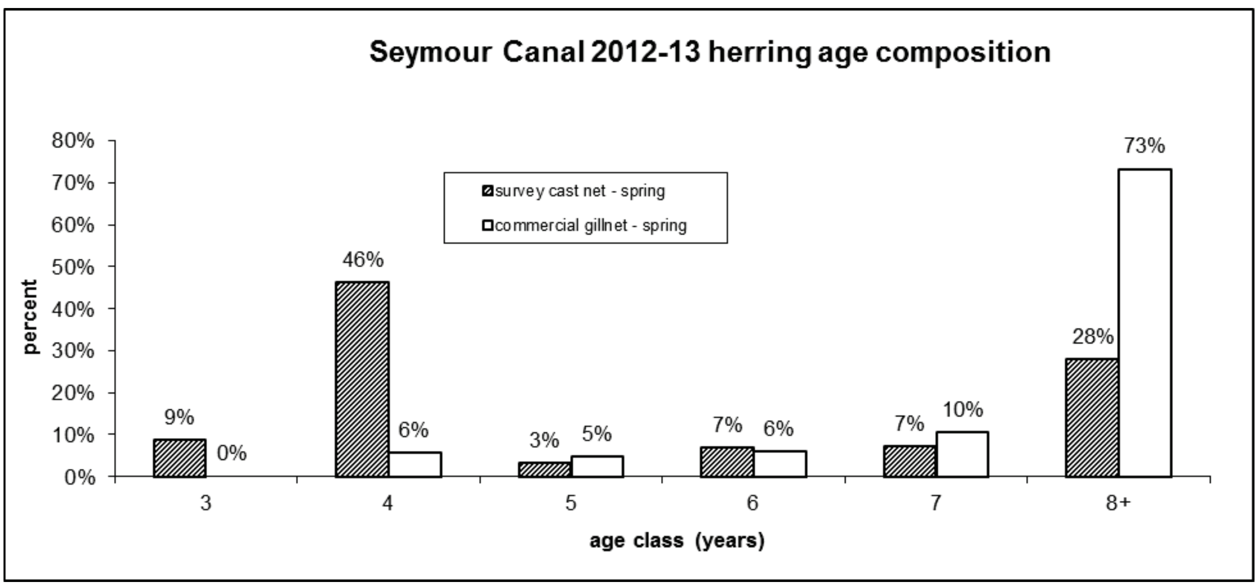


Figure 25.–Age composition for Seymour Canal herring stock in 2012–13.

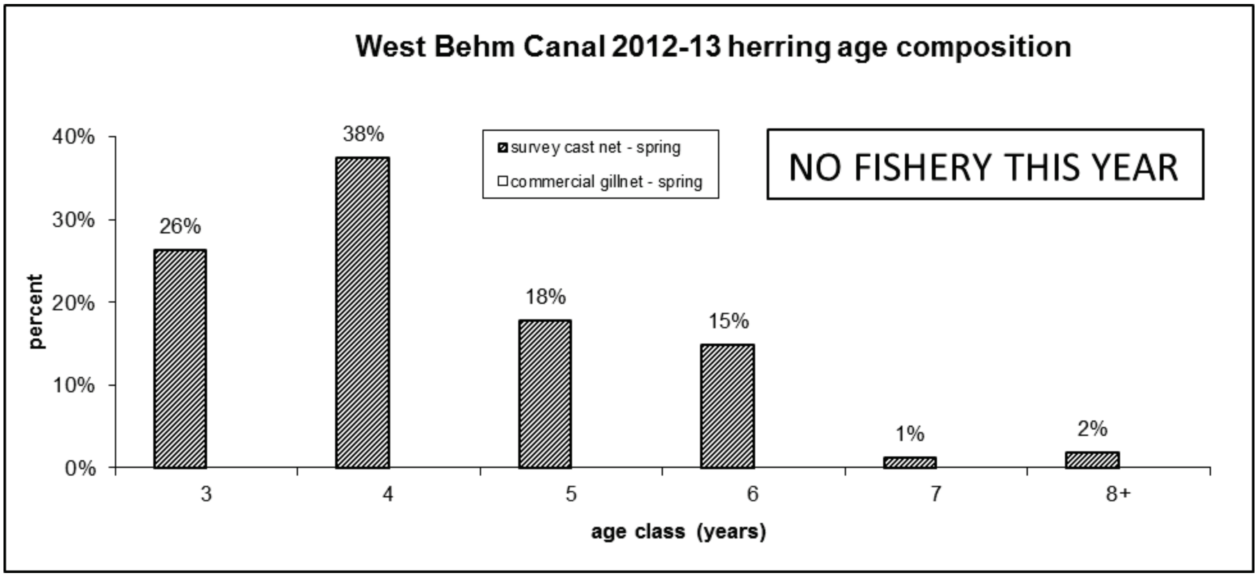


Figure 26.–Age composition for West Behm Canal herring stock in 2012–13. No commercial fishery samples were obtained as no commercial fishery was opened in 2012–13.

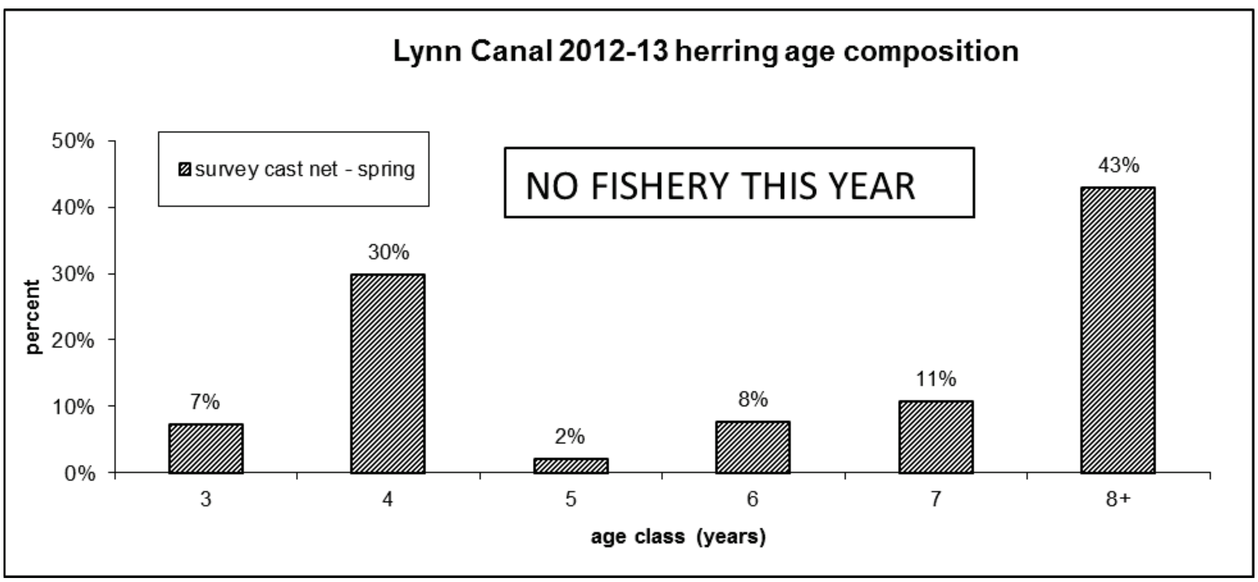


Figure 27.–Age composition for Lynn Canal herring stock in 2012–13. No commercial fishery samples were obtained as no commercial fishery was opened in 2012–13.

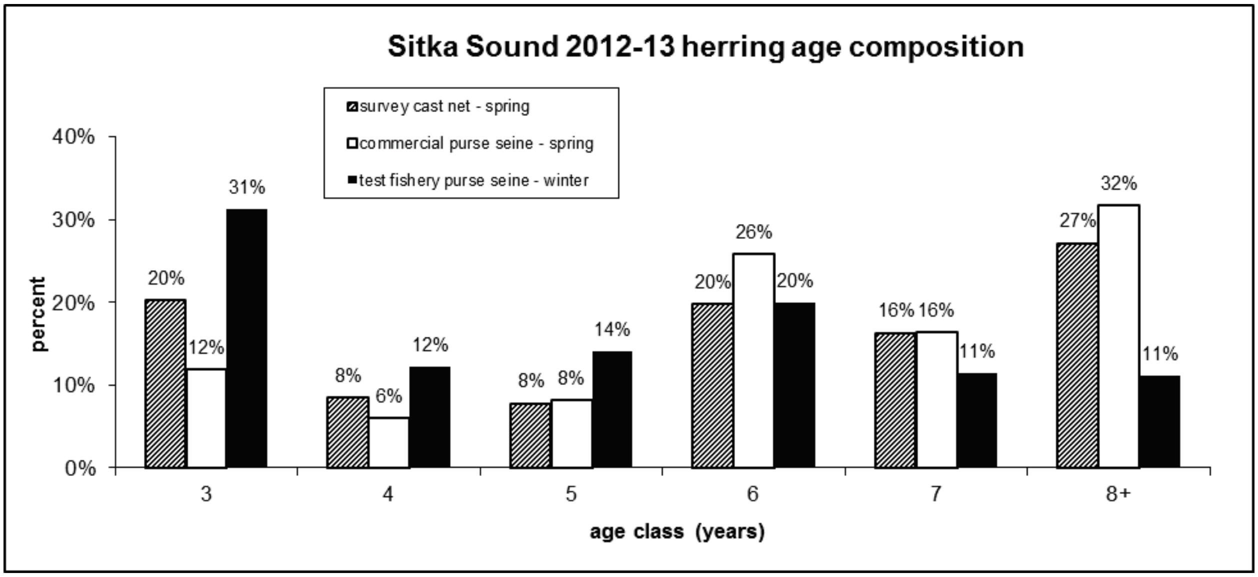


Figure 28.–Age composition for Sitka Sound herring stock in 2012–13.

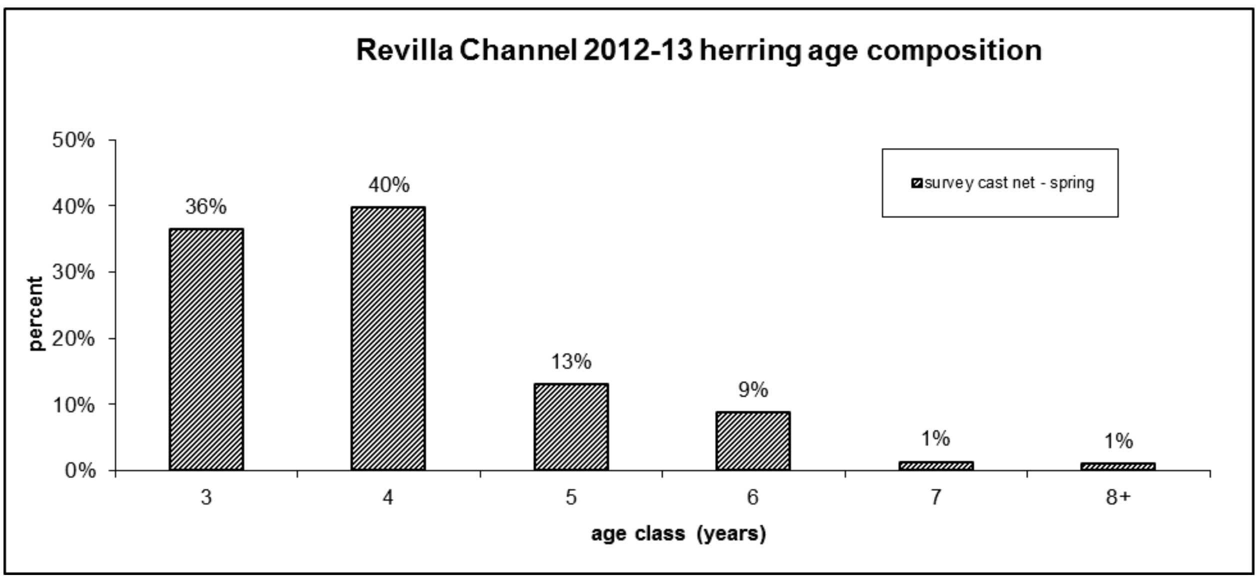


Figure 29.–Age composition for Revilla Channel herring stock in 2012–13.

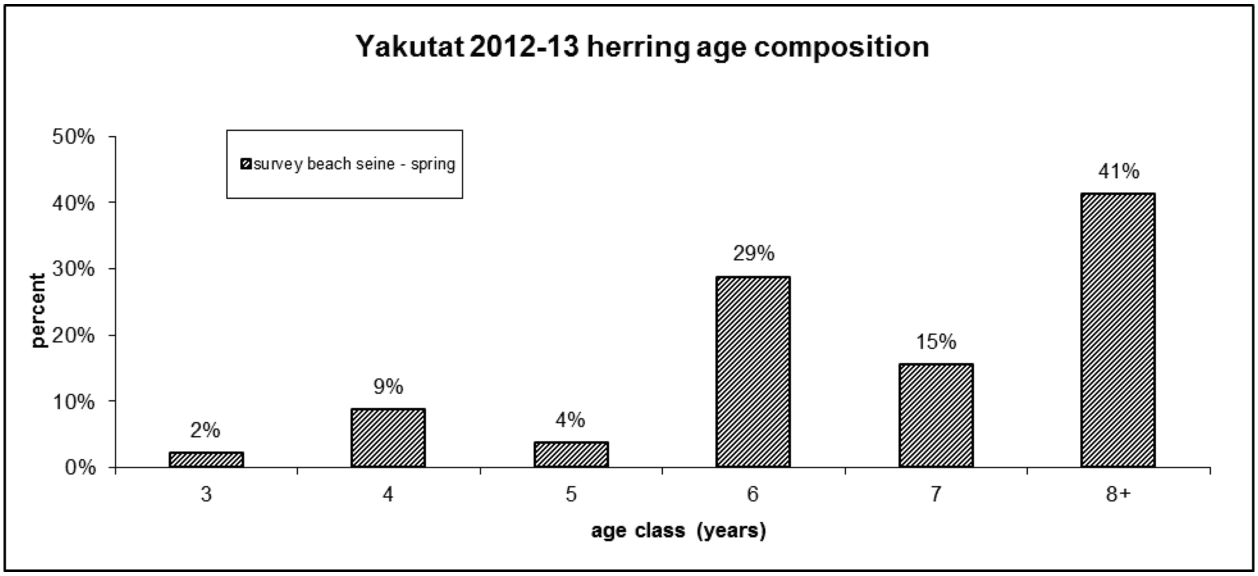


Figure 30.–Age composition for Yakutat Bay herring stock in 2012–13.

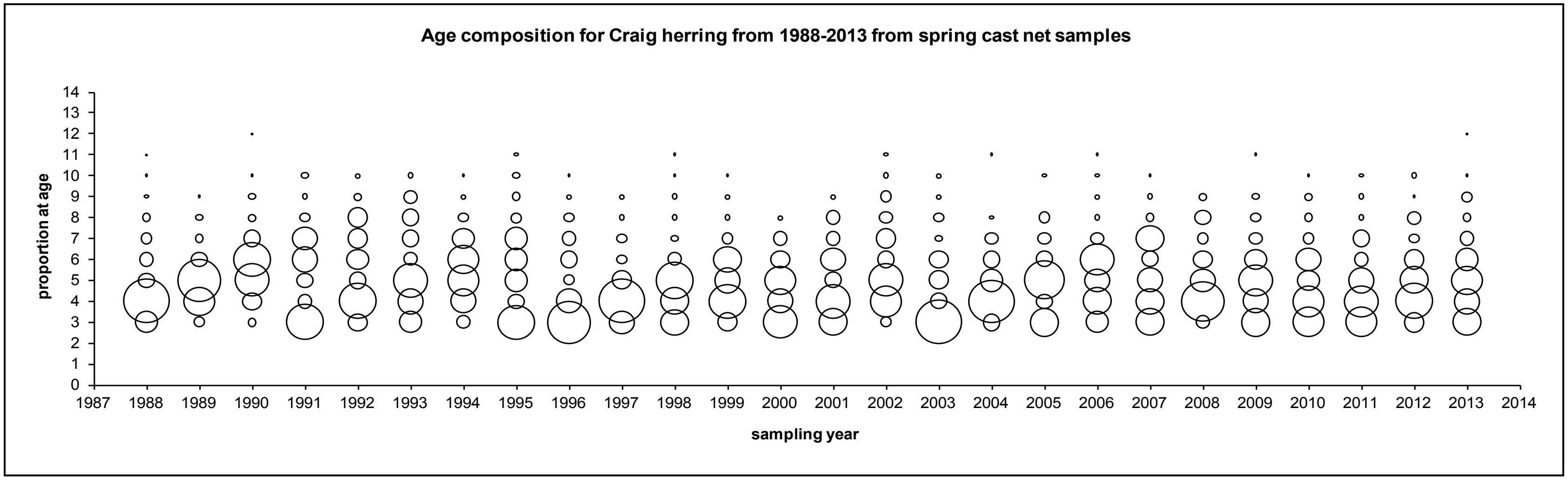


Figure 31.–Age composition from sampling data for the Craig herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

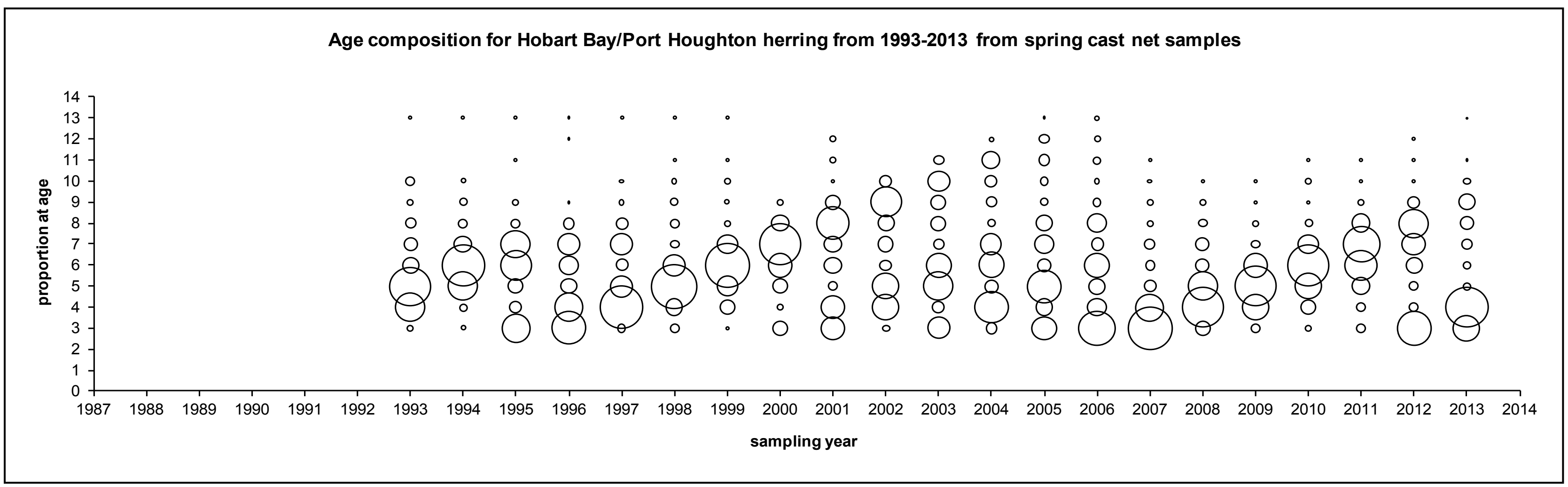


Figure 32–Age composition from sampling data for the Hobart Bay/Port Houghton herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

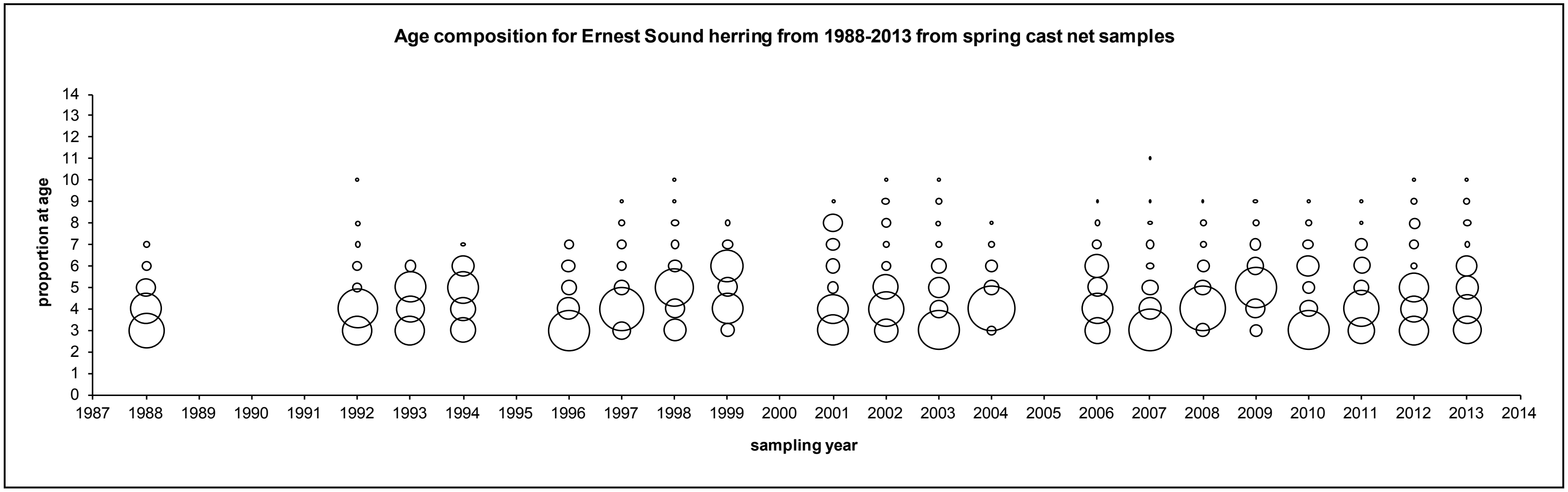


Figure 33.–Age composition from sampling data for the Ernest Sound herring stock.

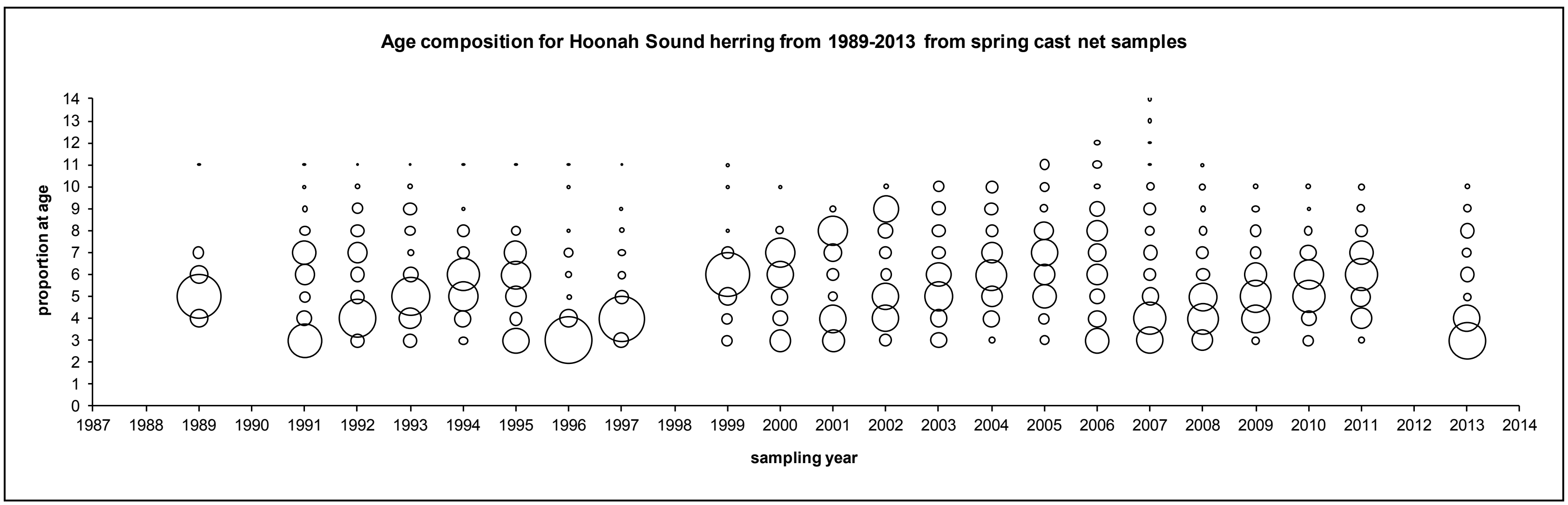


Figure 34.–Age composition from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

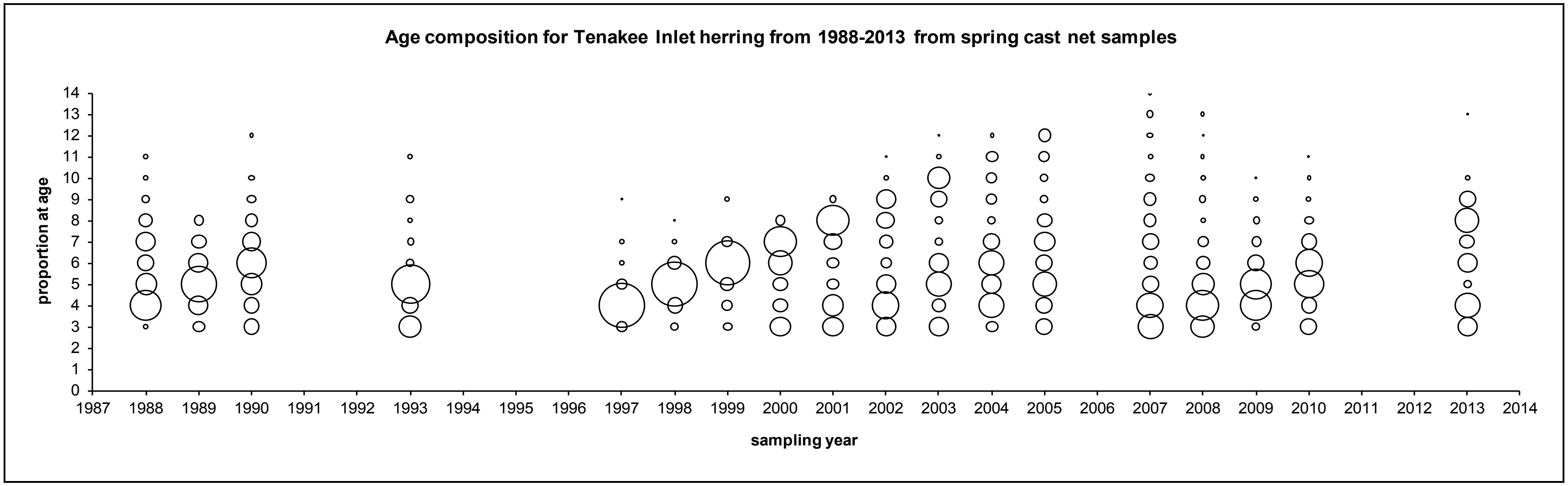


Figure 35.–Age composition from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

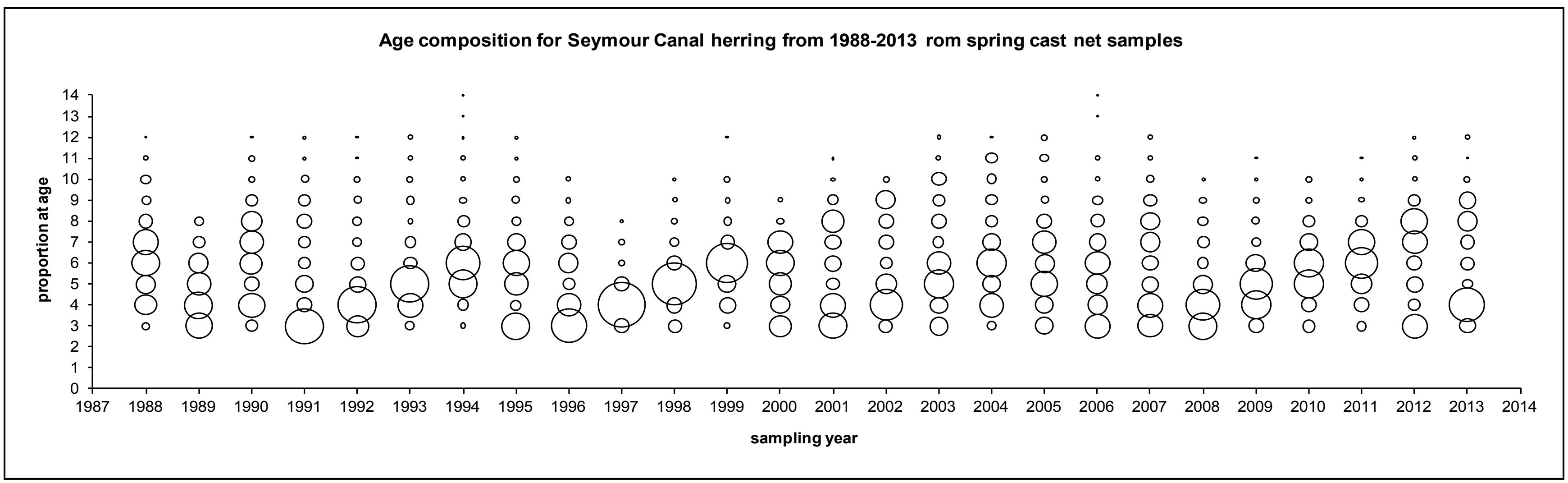


Figure 36.–Age composition from sampling data for the Seymour Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

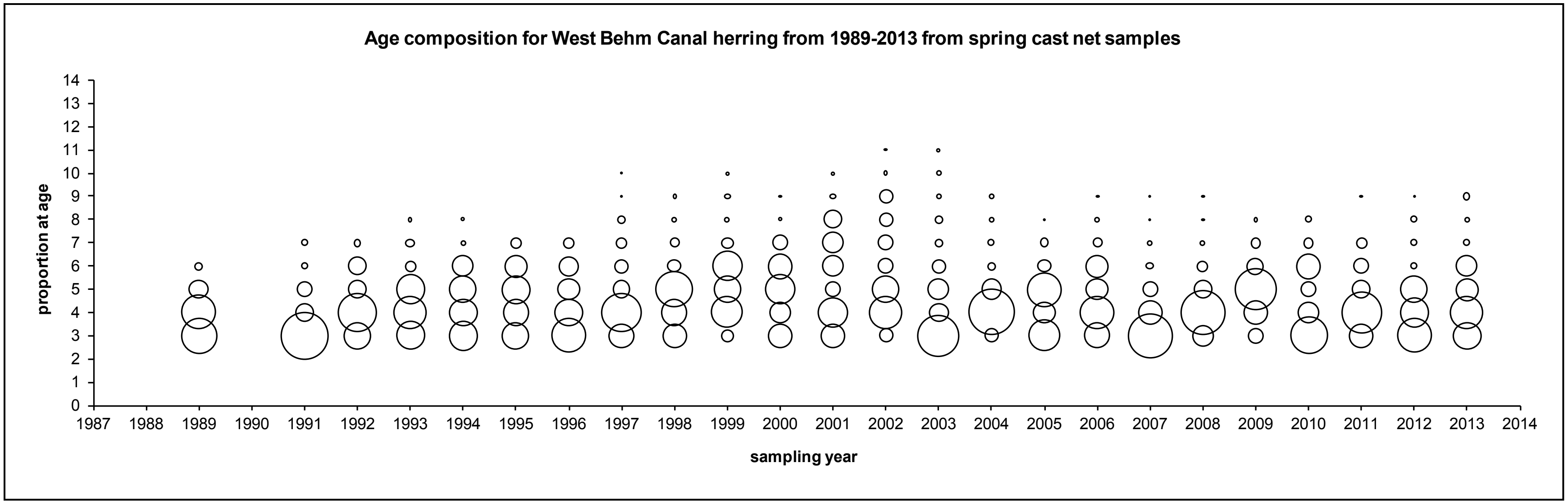


Figure 37.–Age composition from sampling data for the West Behm Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

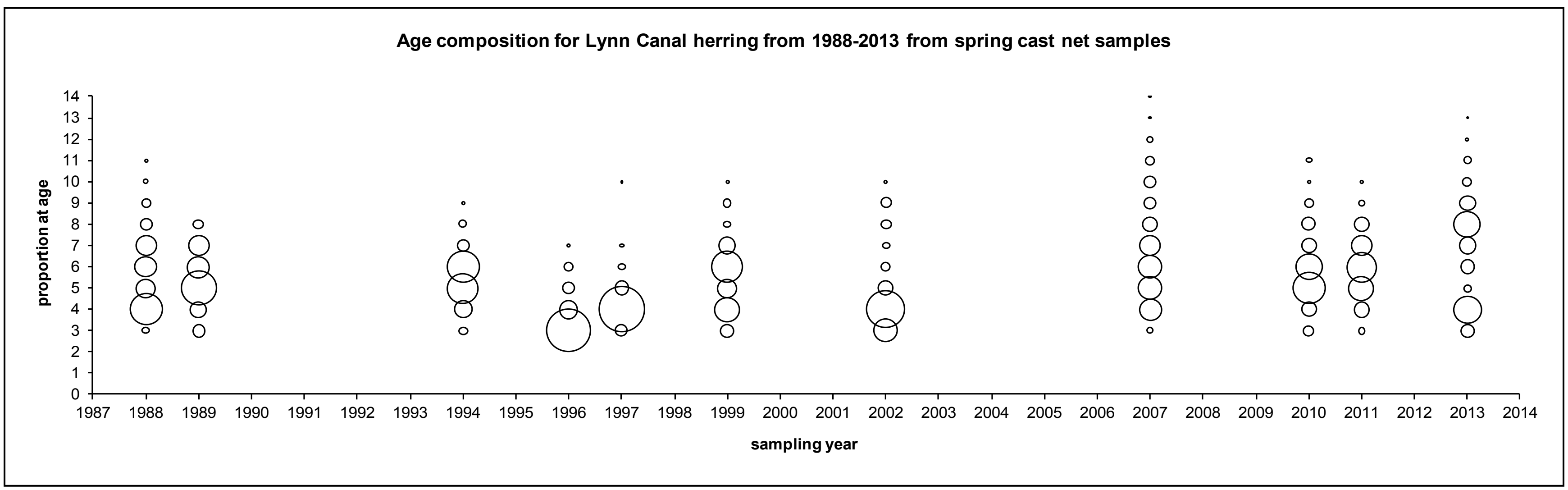


Figure 38.–Age composition from sampling data for the Lynn Canal herring stock.

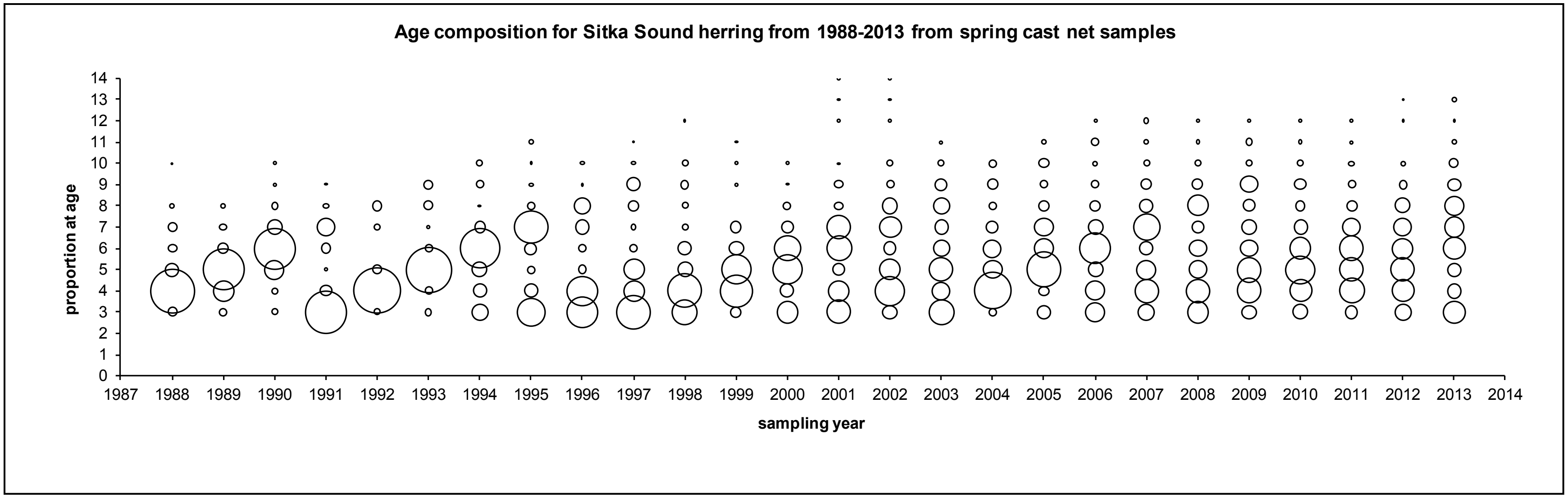


Figure 39.–Age composition from sampling data for the Sitka Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

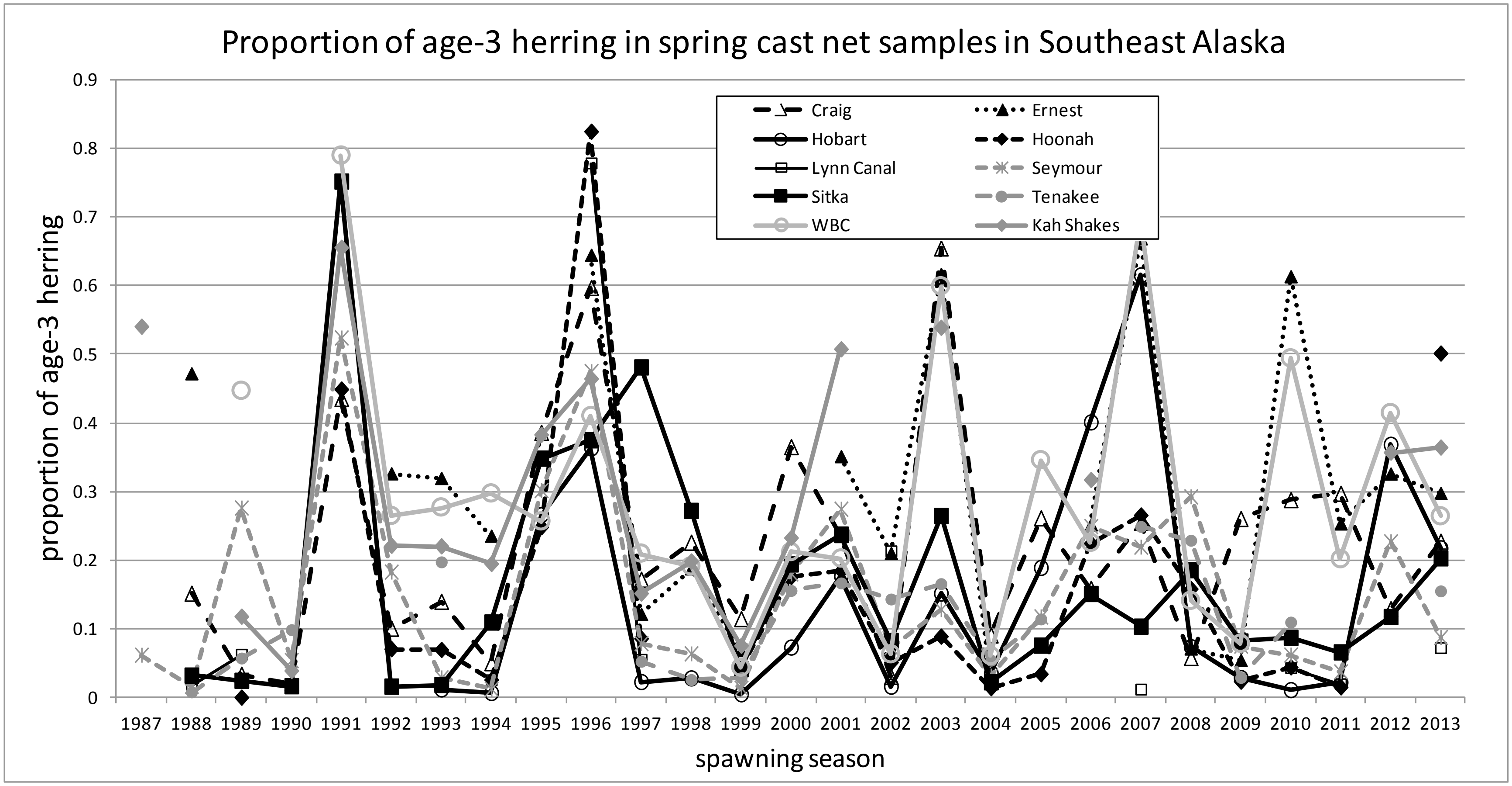


Figure 40.–Proportion of age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

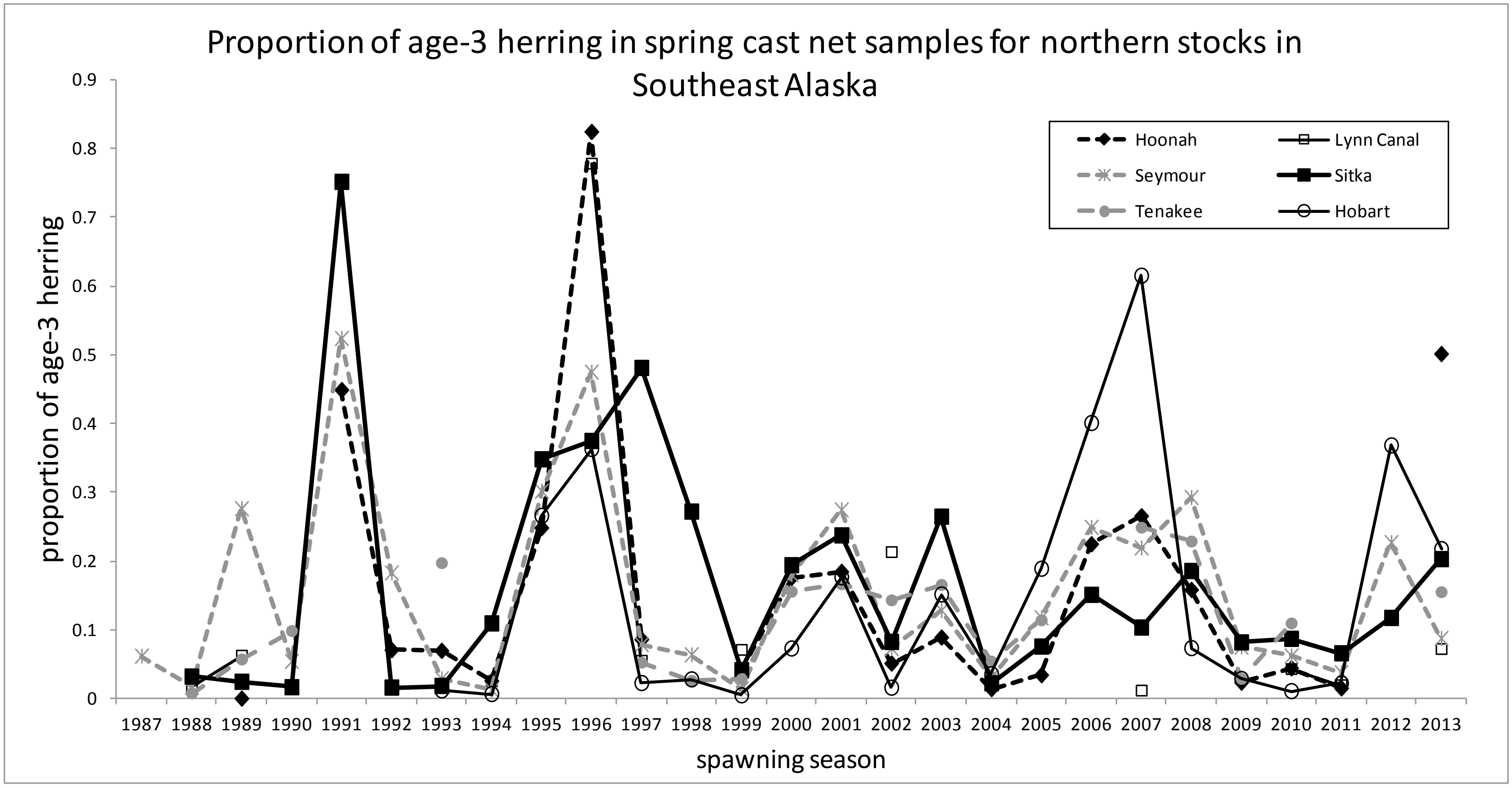


Figure 41.–Proportion of age-3 herring in spring cast nest samples of spawning populations for northern stocks in Southeast Alaska.

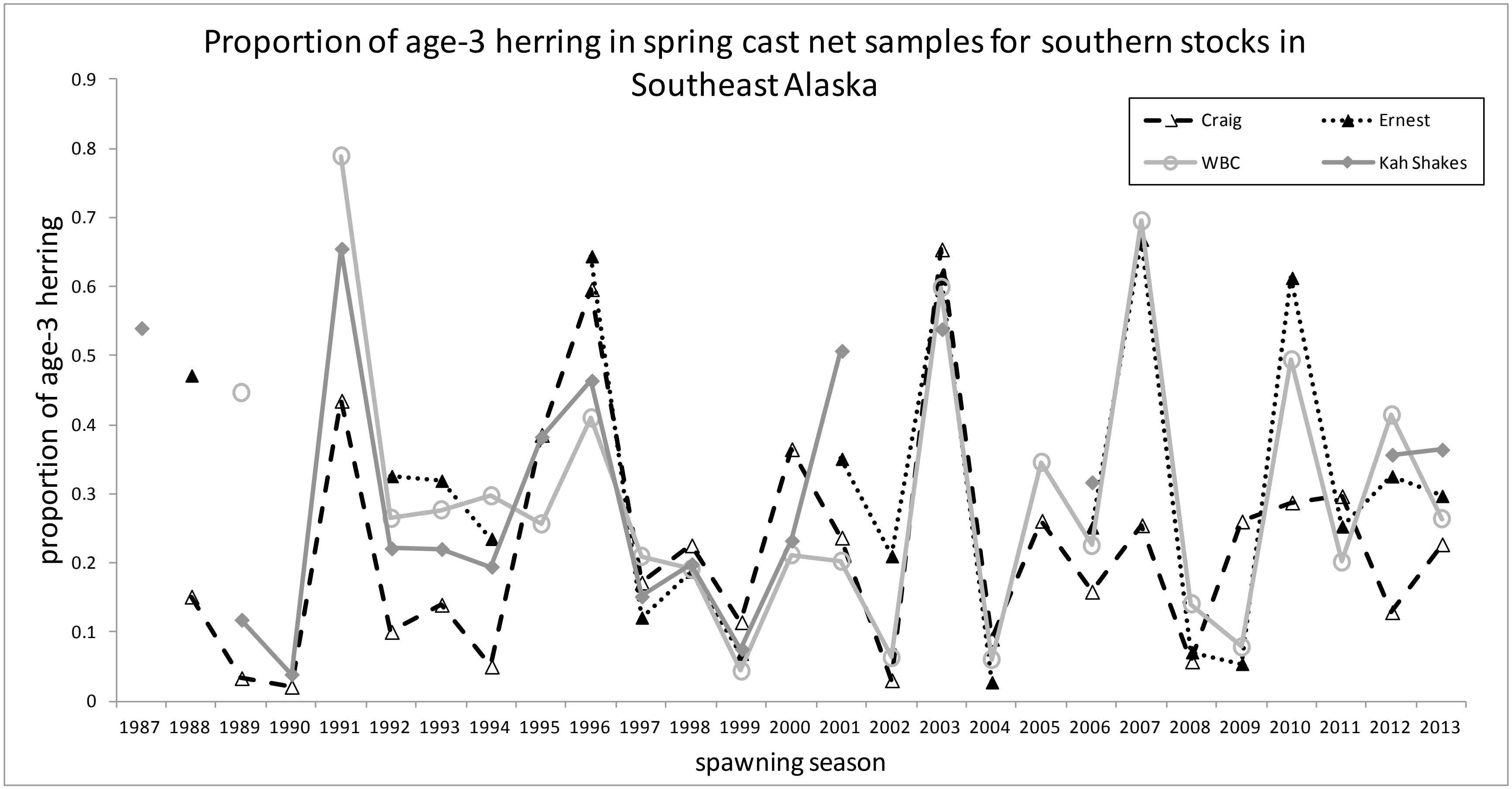


Figure 42.–Proportion of age-3 herring in spring cast nest samples of spawning populations for southern stocks in Southeast Alaska.

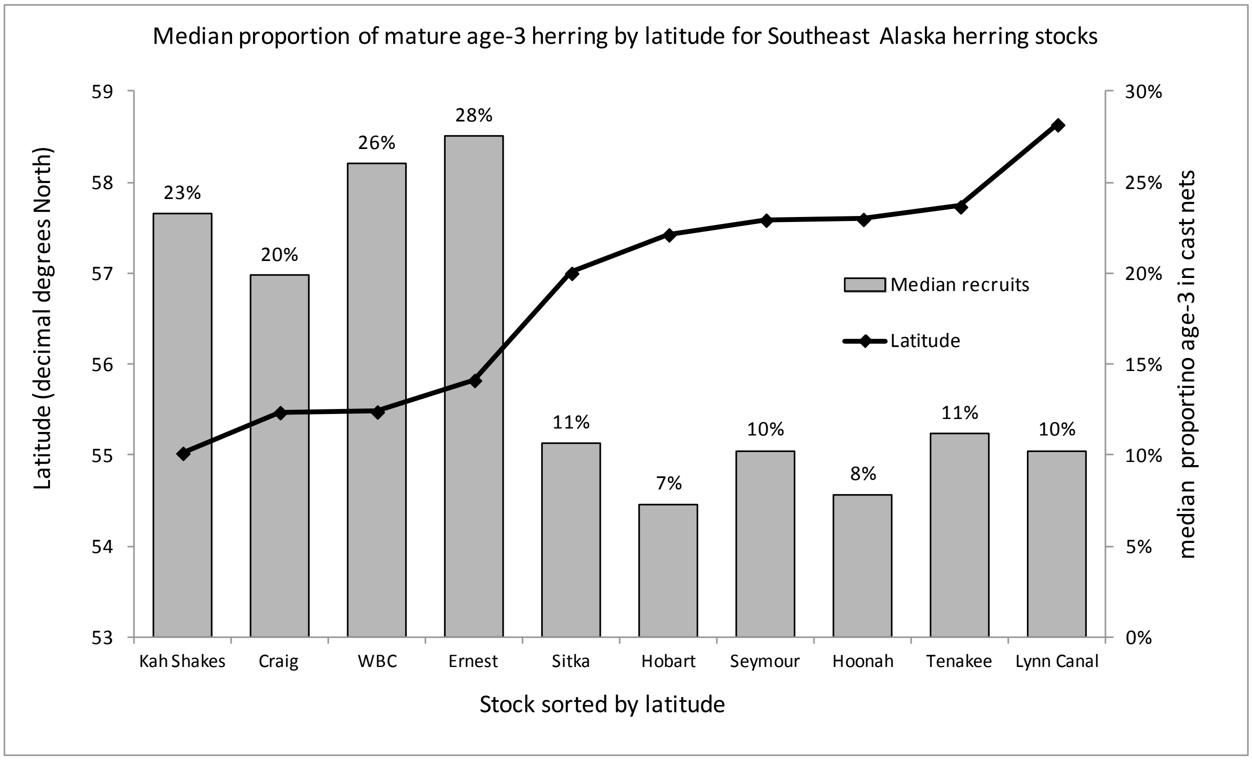


Figure 43.–Mean proportion of age-3 herring in spring cast nest samples (1988–2013) and latitude of spawning populations for stocks in Southeast Alaska.

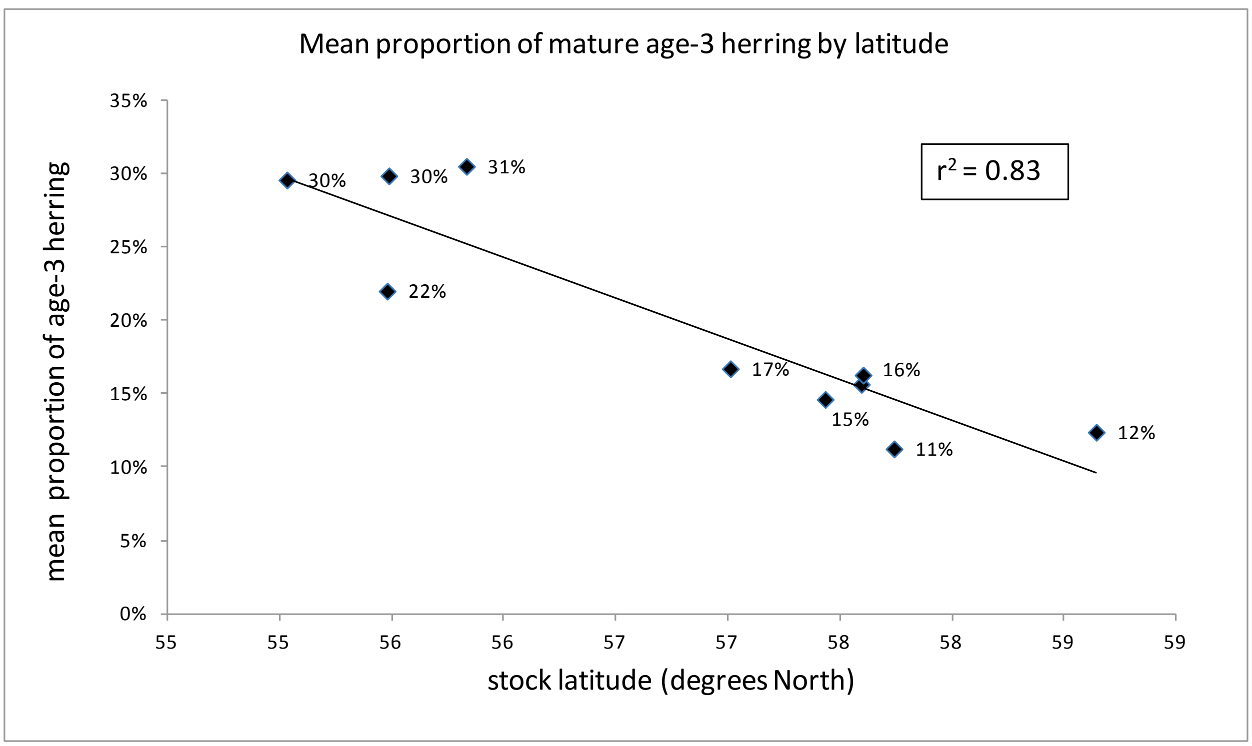


Figure 44.–Mean proportion of age-3 herring in spring cast nest samples versus stock latitude of spawning stocks in Southeast Alaska.

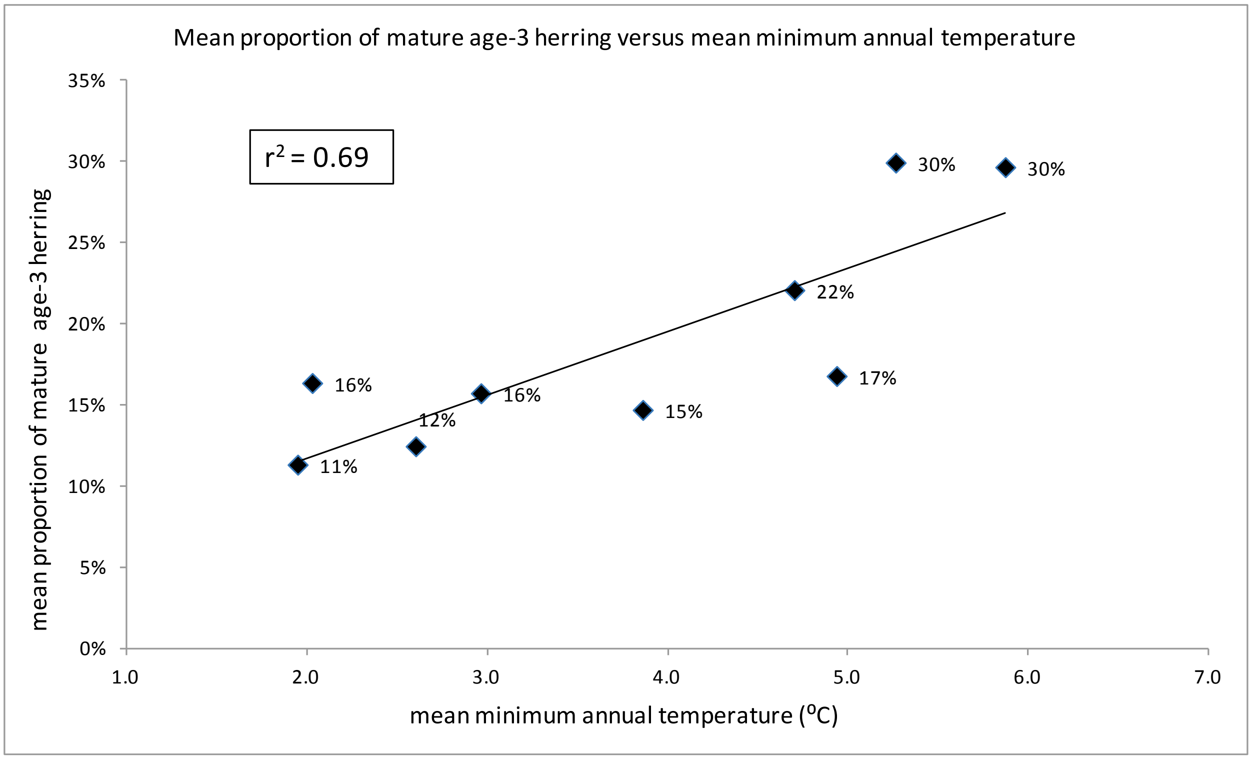


Figure 45.–Mean proportion of age-3 herring in spring cast nest samples versus mean minimum annual sea water temperature at location of spawning stocks in Southeast Alaska.

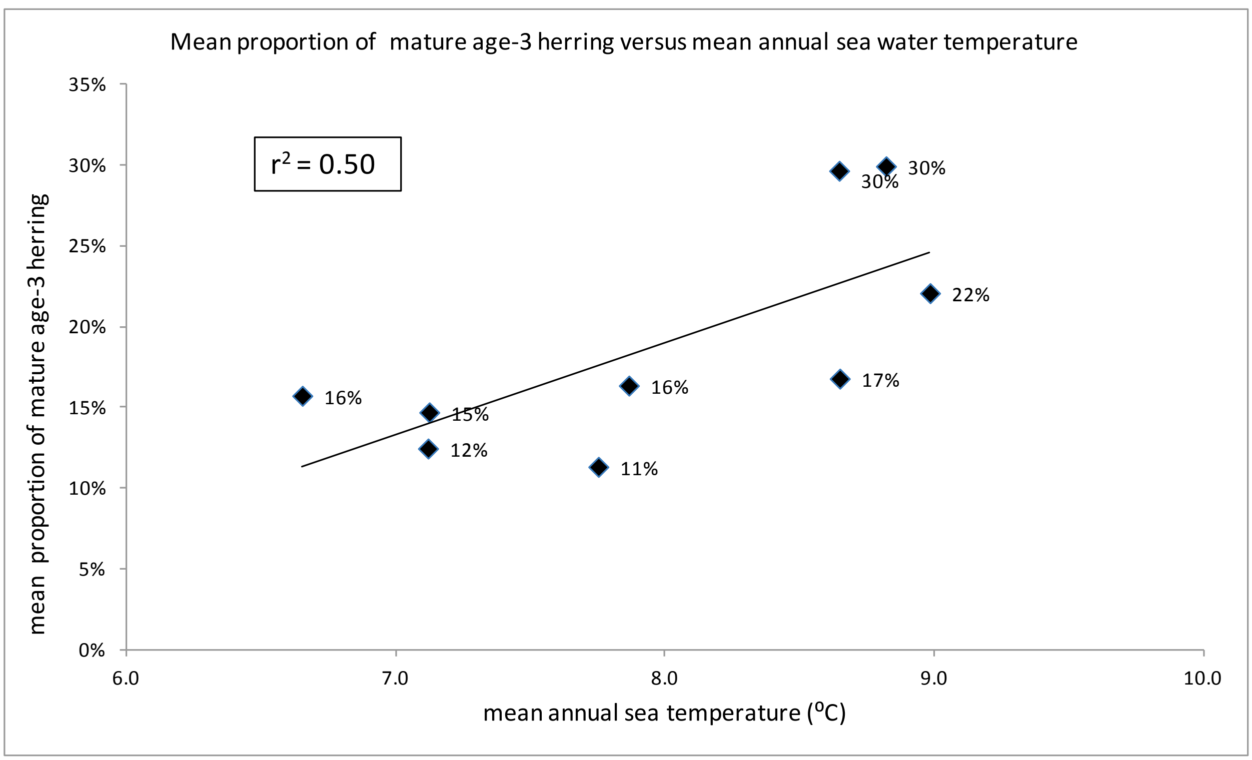


Figure 46.–Mean proportion of age-3 herring in spring cast nest samples versus mean annual sea water temperature at location of spawning stocks in Southeast Alaska.

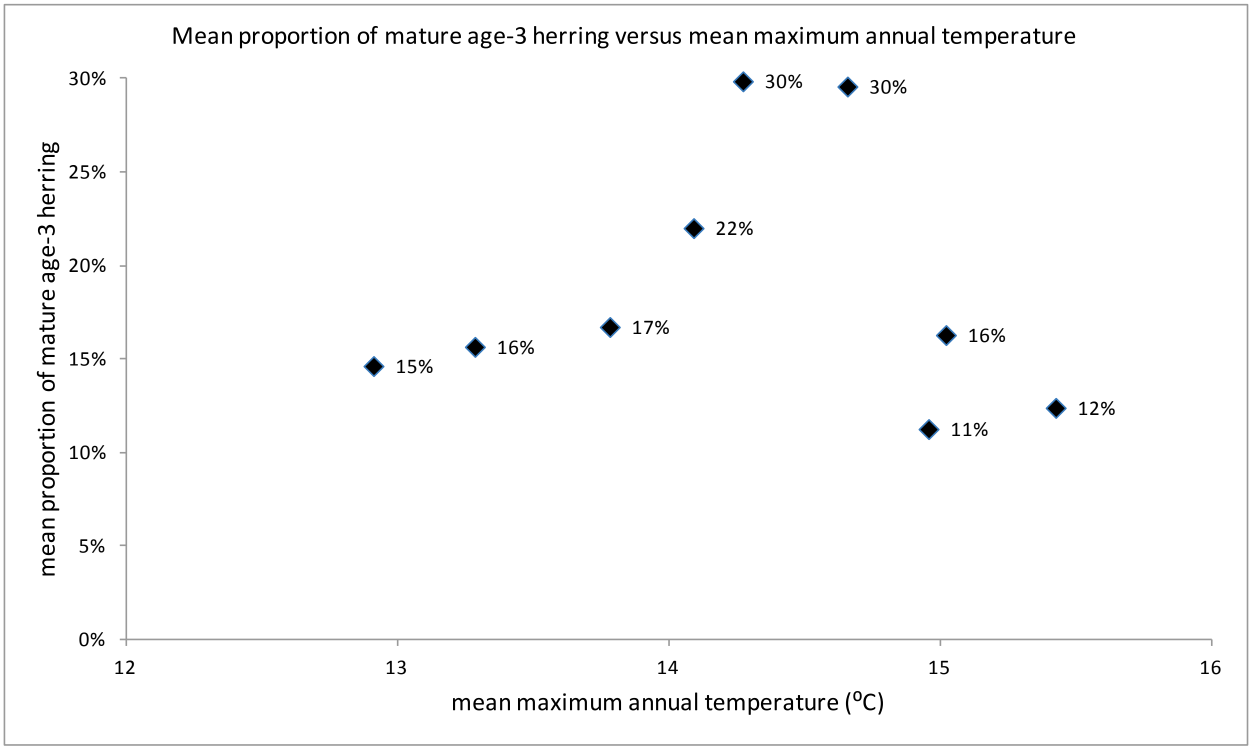


Figure 47.–Mean proportion of age-3 herring in spring cast nest samples versus mean maximum annual sea water temperature at location of spawning stocks in Southeast Alaska.

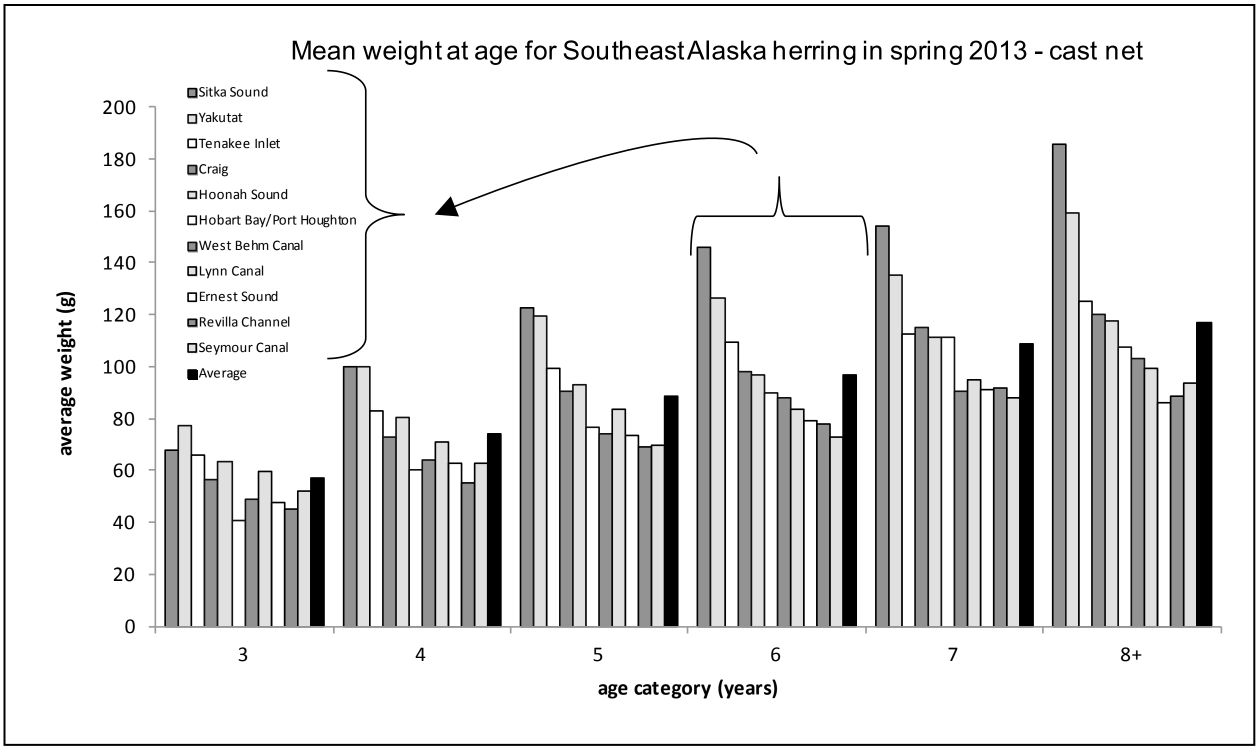


Figure 48.–Mean weight-at-age for Southeast Alaska herring stocks in spring 2013, sorted by age-6.

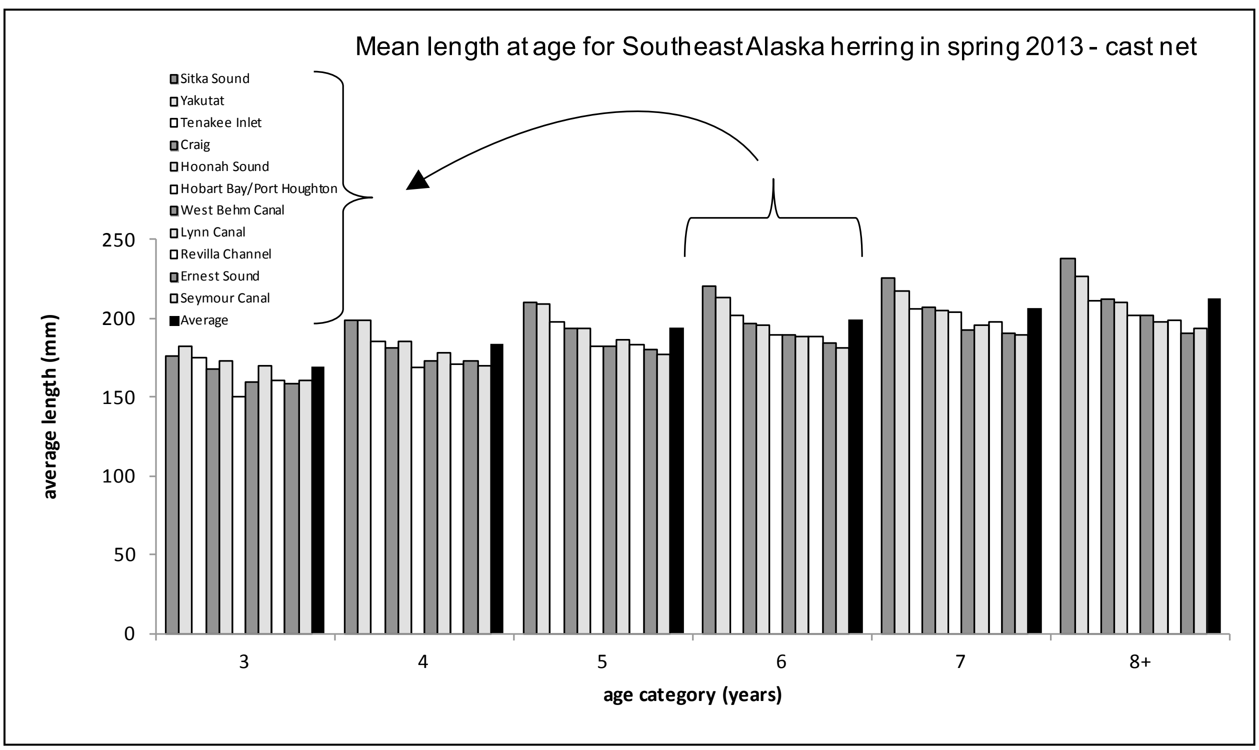


Figure 49.–Mean length at age for Southeast Alaska herring stocks in spring 2013, sorted by age-6.

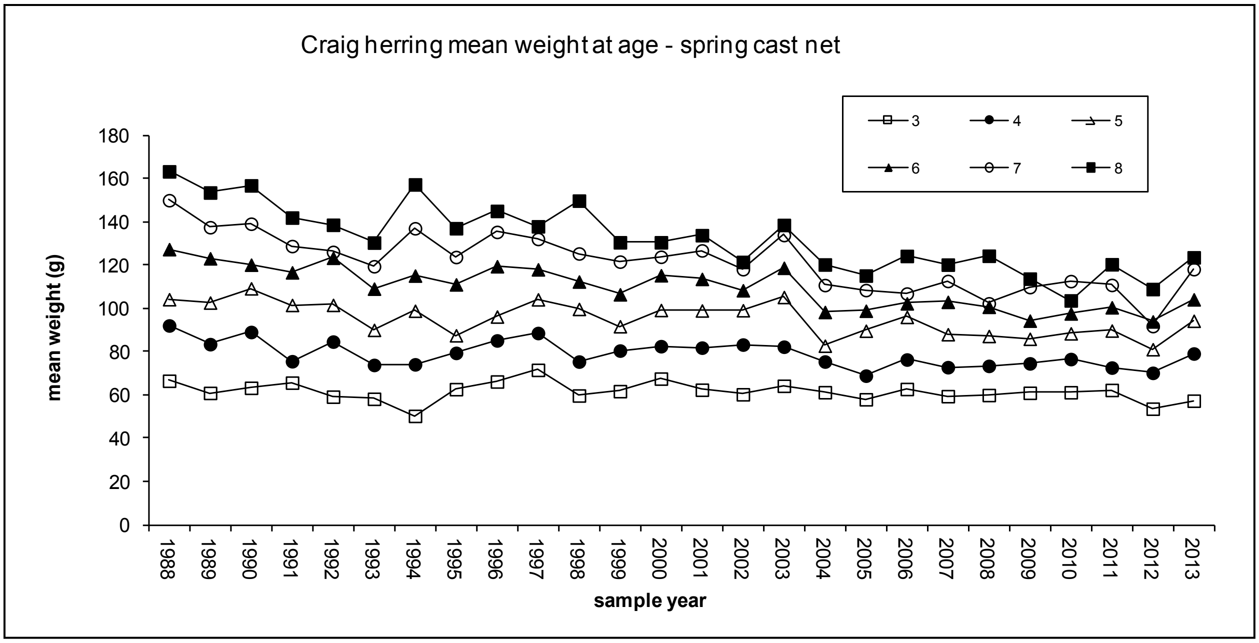


Figure 50.–Mean weight-at-age of the Craig herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

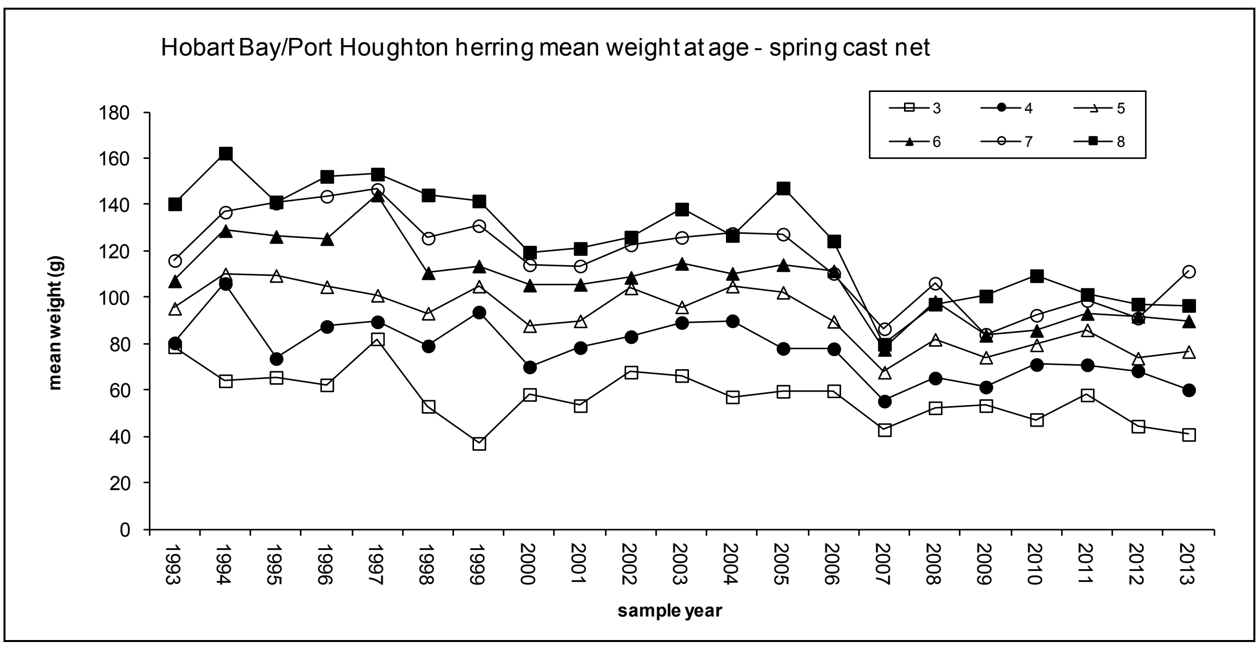


Figure 51.–Mean weight at age of the Hobart Bay/Port Houghton herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

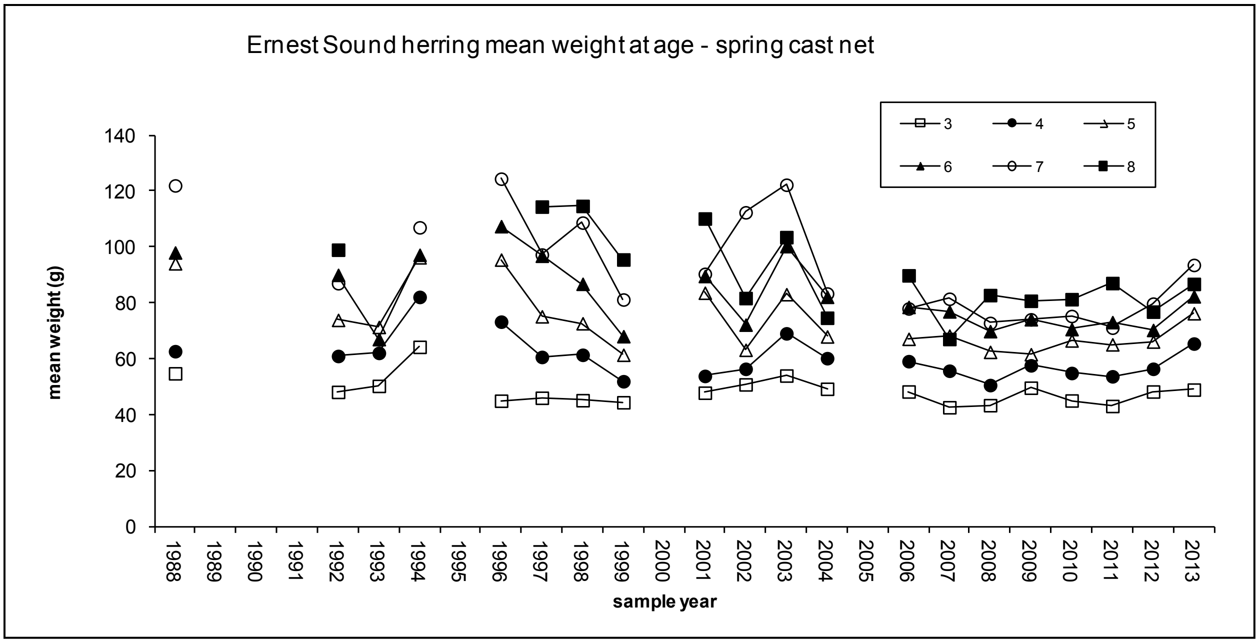


Figure 52.–Mean weight at age for the Ernest Sound herring spawning population.

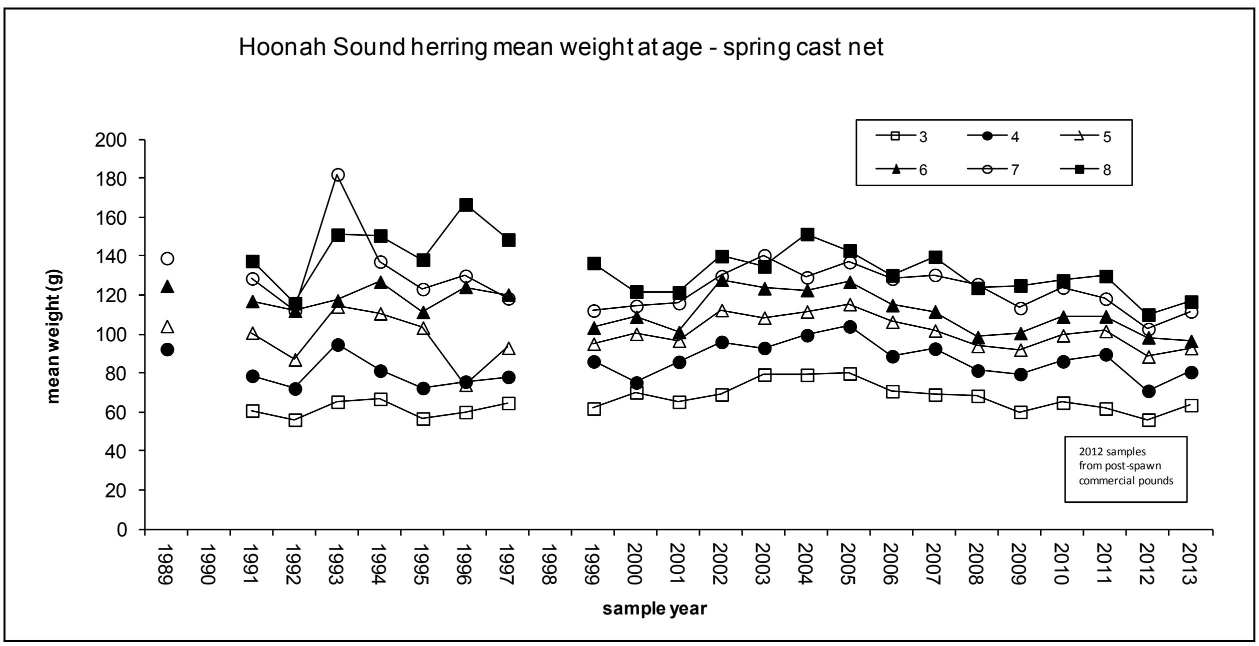


Figure 53.–Mean weight at age for the Hoonah Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

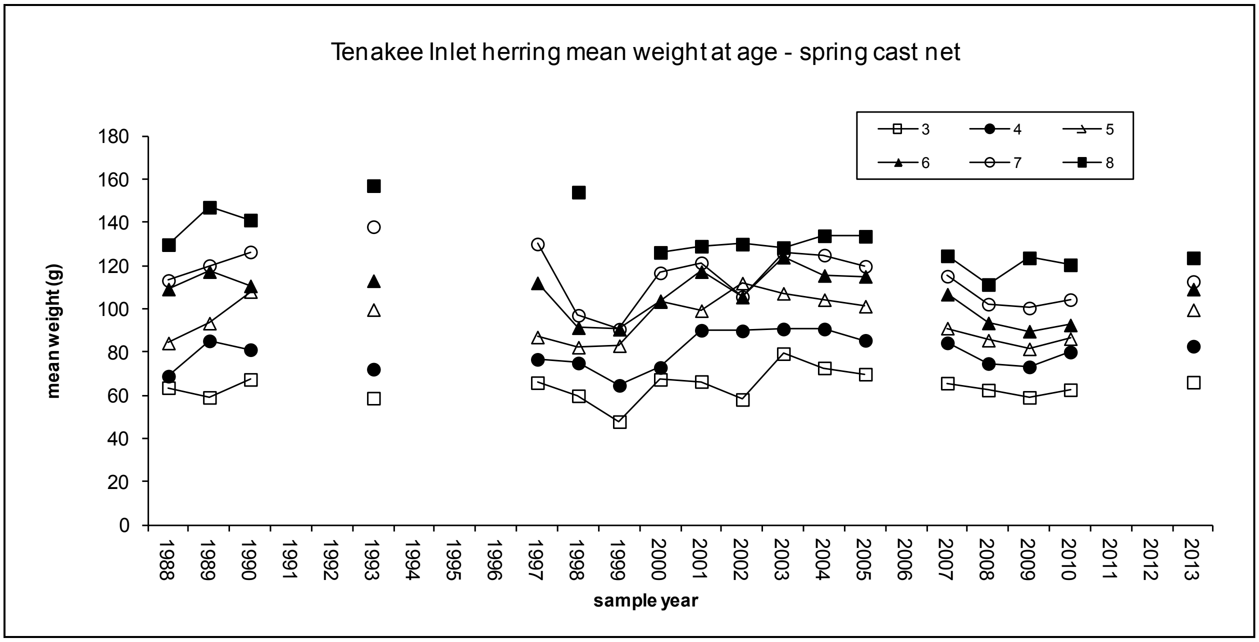


Figure 54.–Mean weight at age for the Tenakee Inlet herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

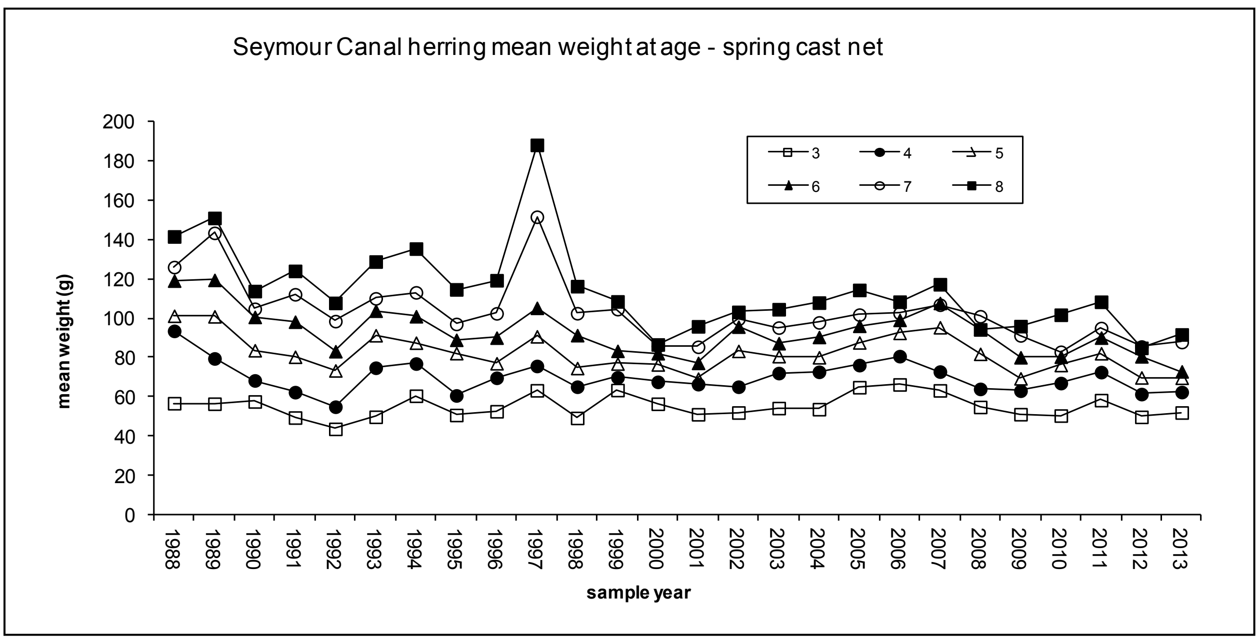


Figure 55.–Mean weight at age for the Seymour Canal herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

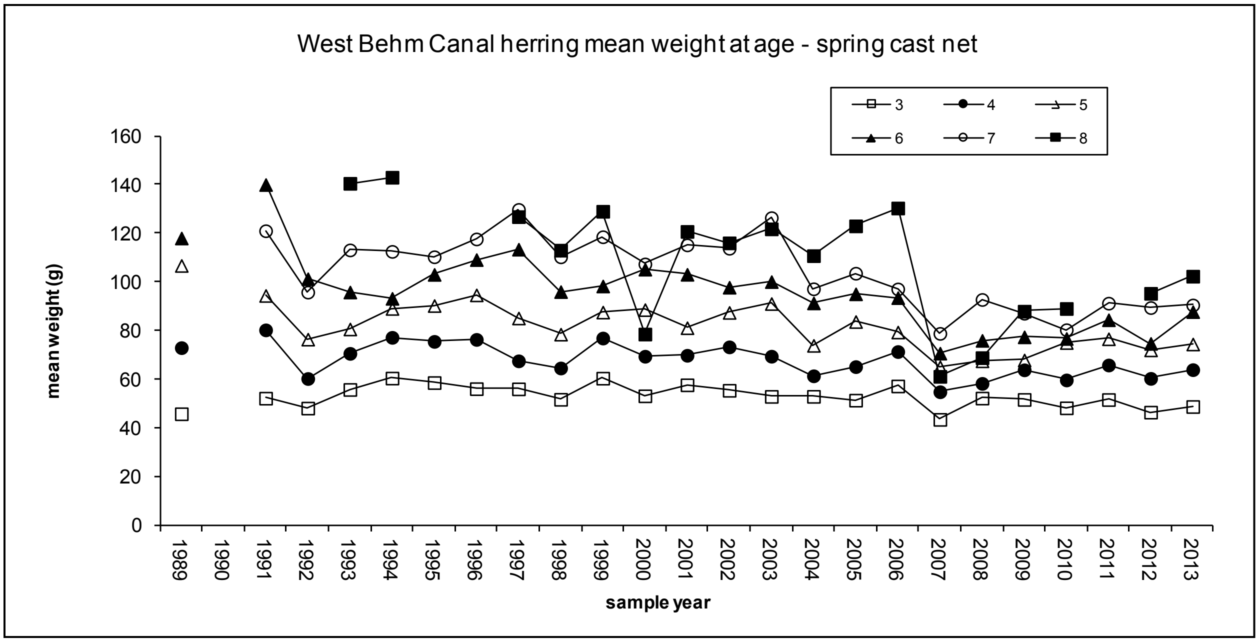


Figure 56.–Mean weight at age for the West Behm Canal herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

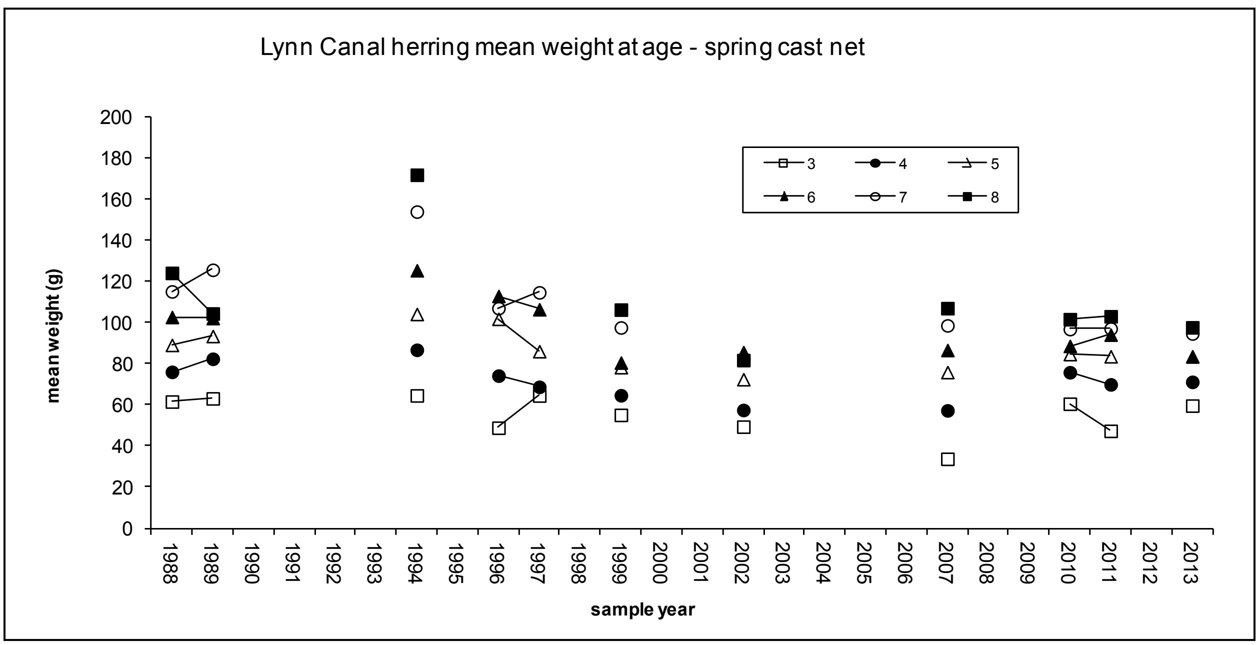


Figure 57.–Mean weight at age for the Lynn Canal herring spawning population.

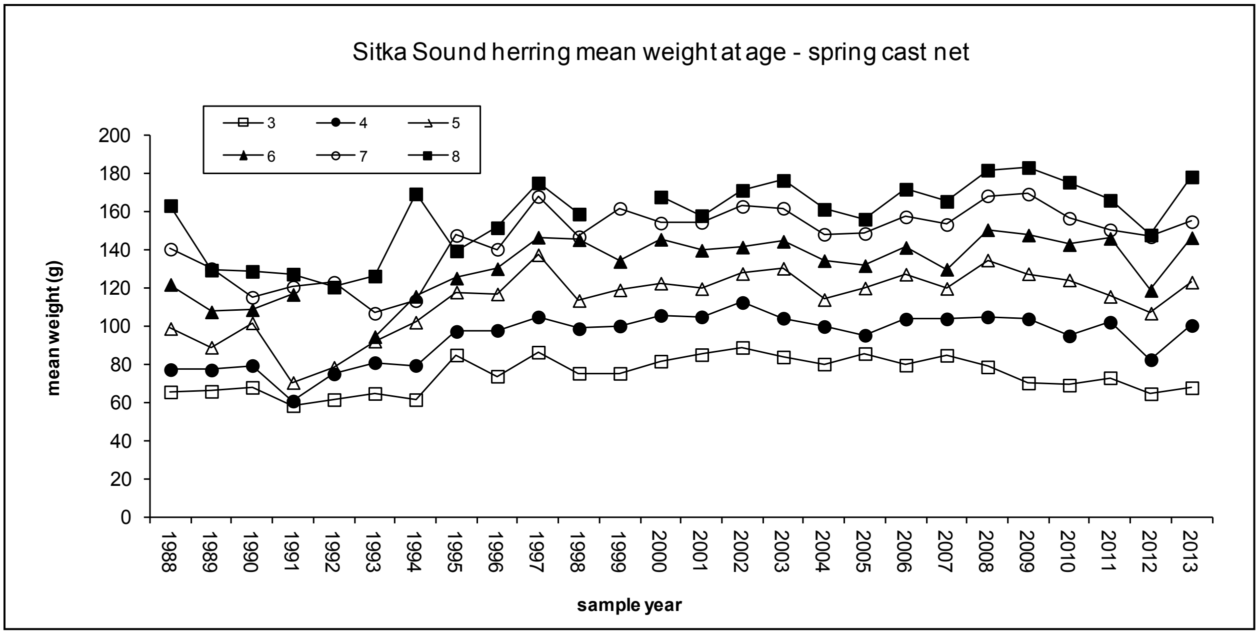


Figure 58.–Mean weight at age for the Sitka Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

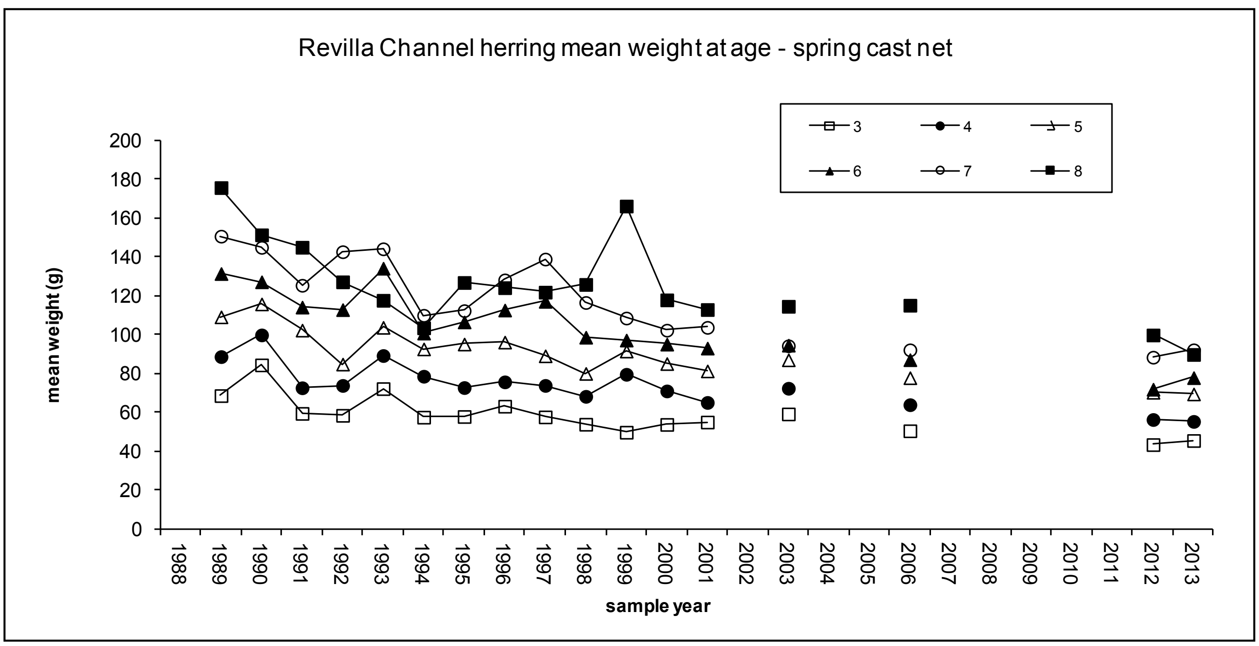


Figure 59.–Mean weight at age for the Revilla Channel herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

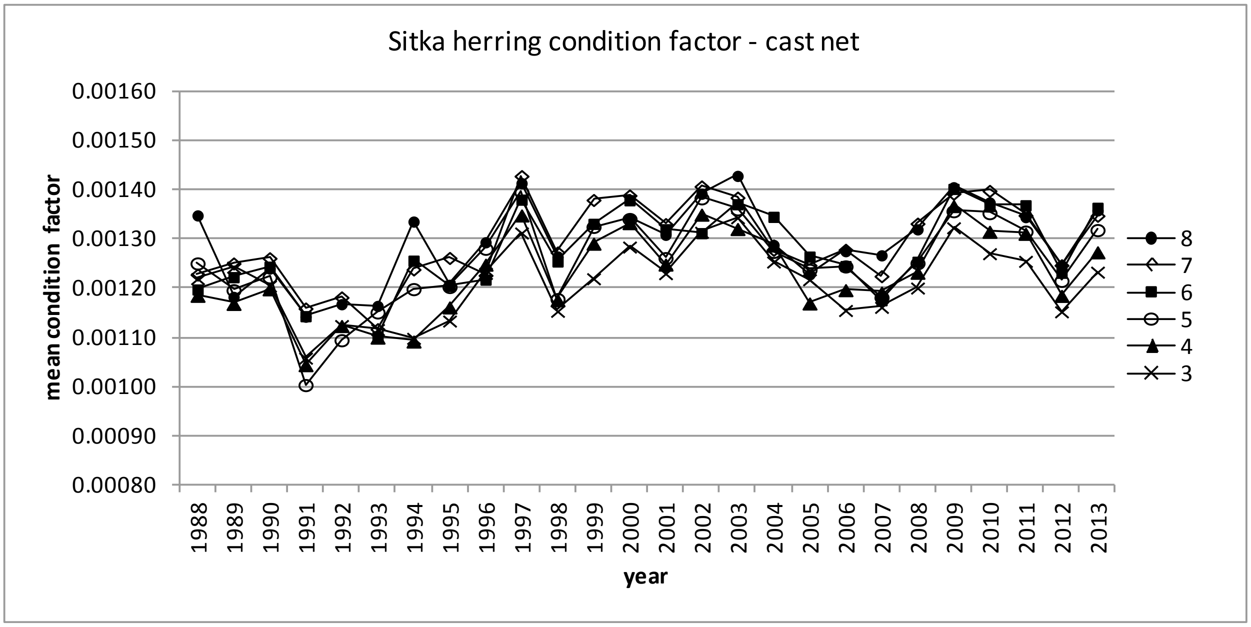


Figure 60.–Mean condition factors of age-3 through age-8 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning.

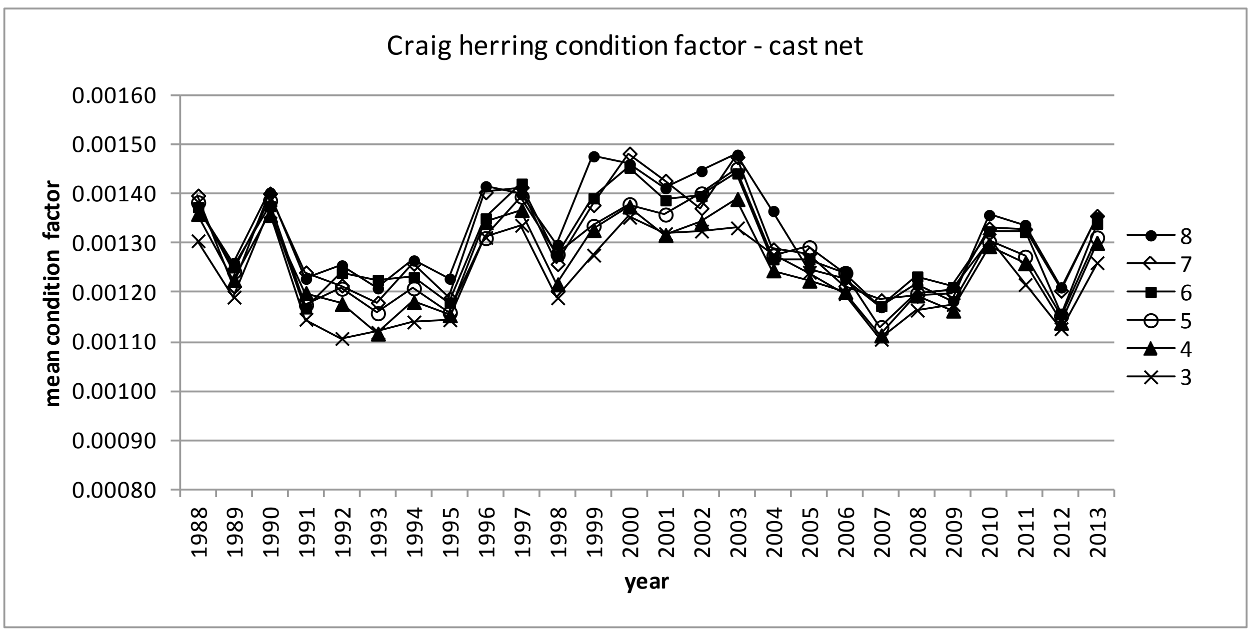


Figure 61.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

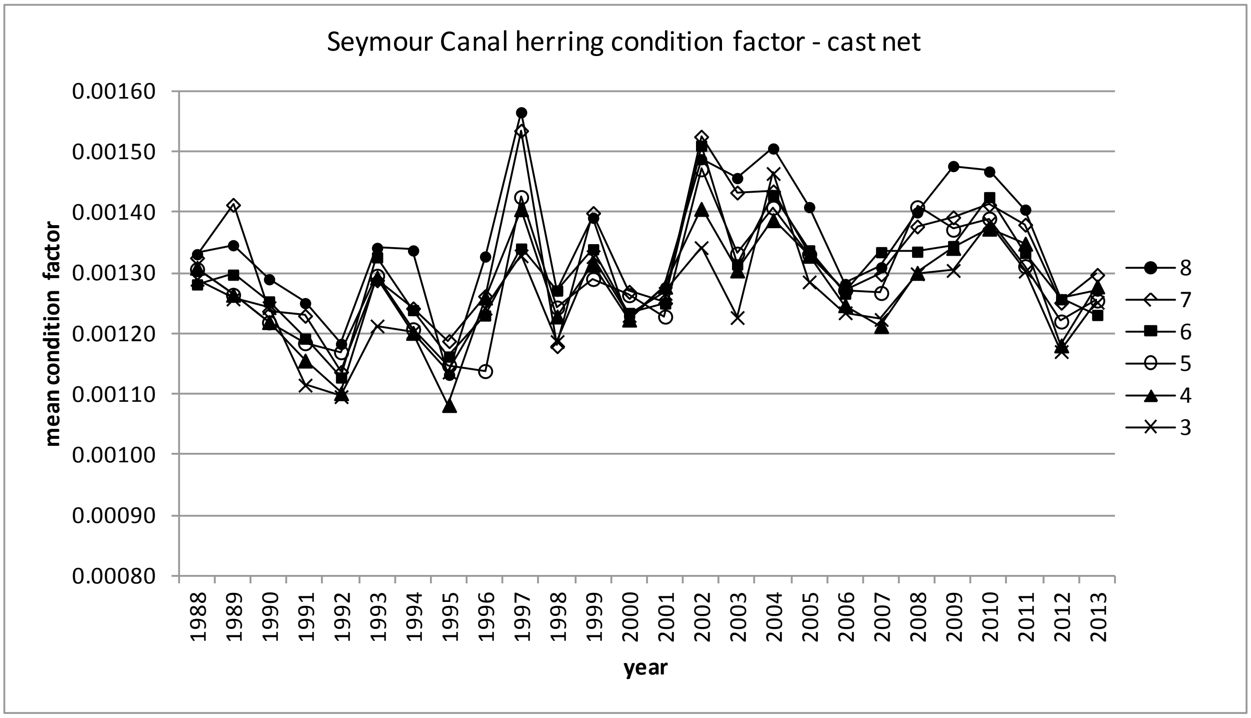


Figure 62.–Mean condition factors of age-3 through age-8 herring for the Seymour Canal spawning population, based on spring cast net samples taken during active spawning.

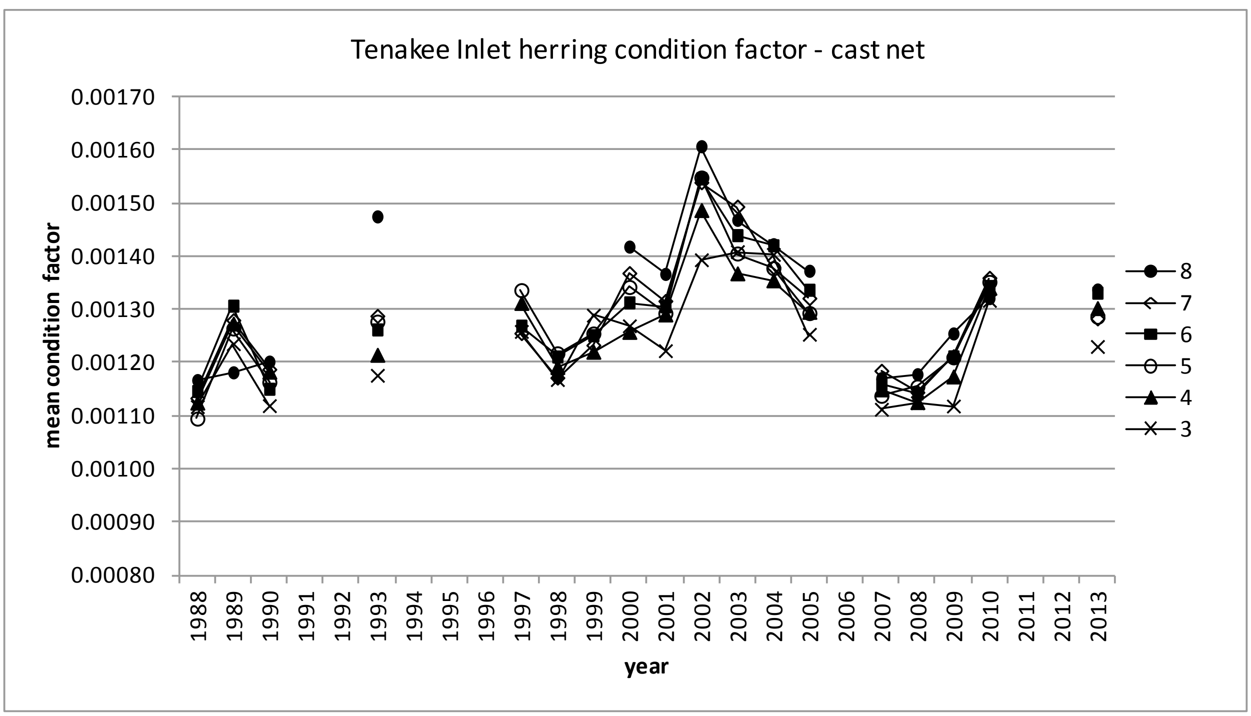


Figure 63.–Mean condition factors of age-3 through age-8 herring for the Tenakee Inlet spawning population, based on spring cast net samples taken during active spawning.

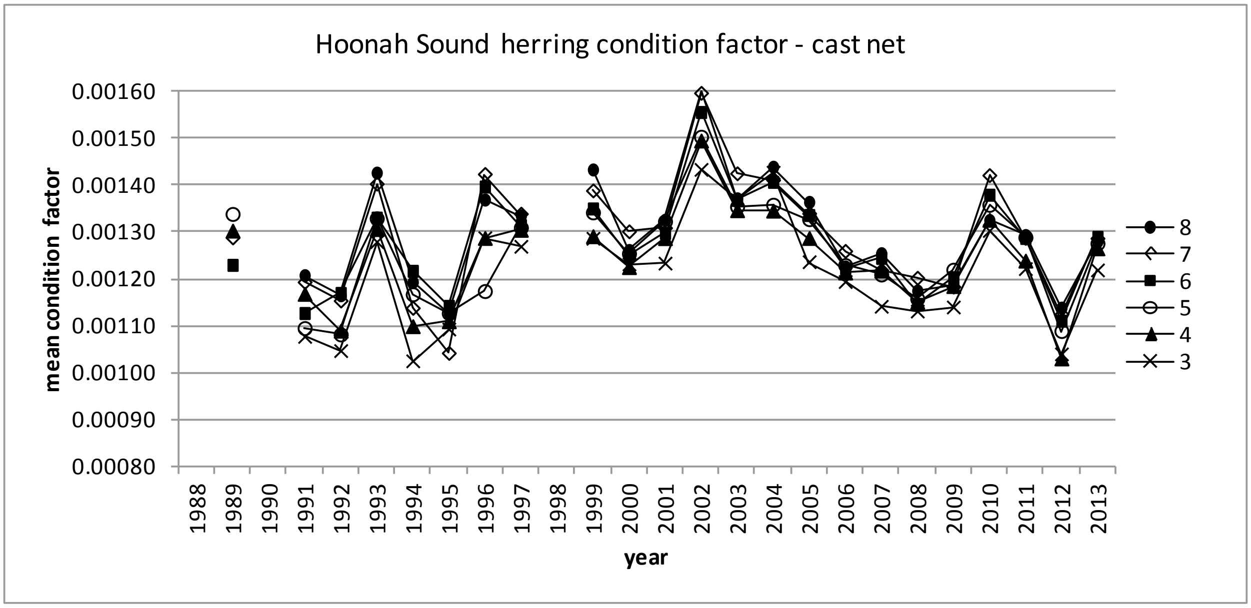


Figure 64.–Mean condition factors of age-3 through age-8 herring for the Hoonah Sound spawning population, based on spring cast net samples taken during active spawning.

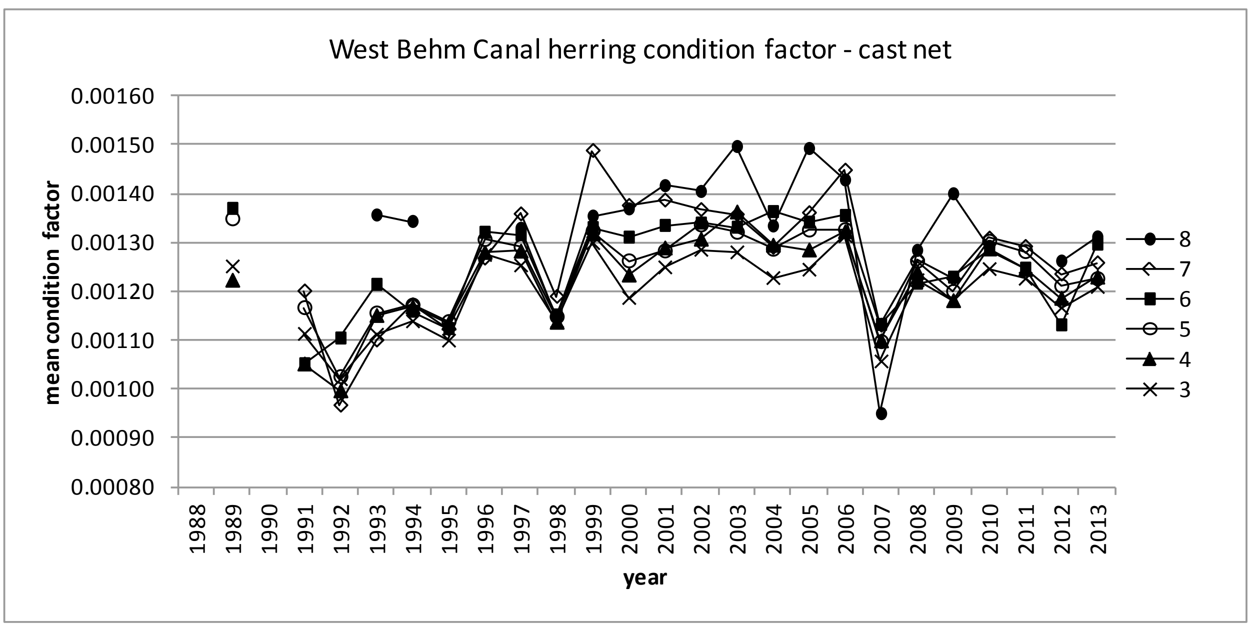


Figure 65.–Mean condition factors of age-3 through age-8 herring for the West Behm Canal spawning population, based on spring cast net samples taken during active spawning.

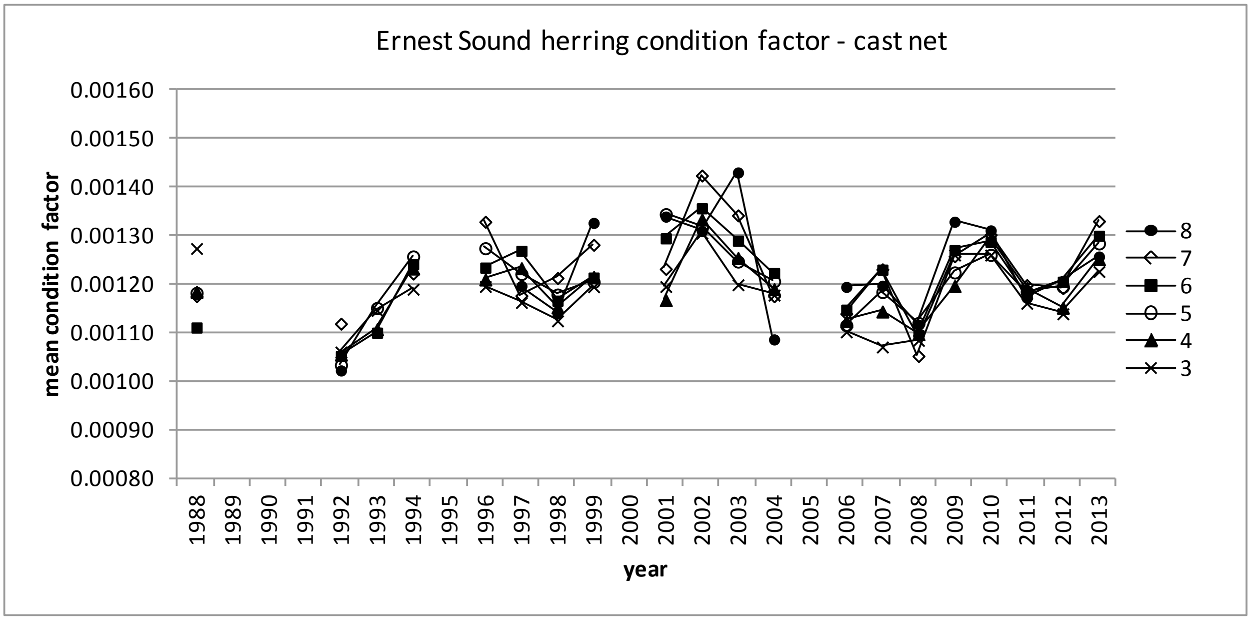


Figure 66.–Mean condition factors of age-3 through age-8 herring for the Ernest Sound spawning population, based on spring cast net samples taken during active spawning.

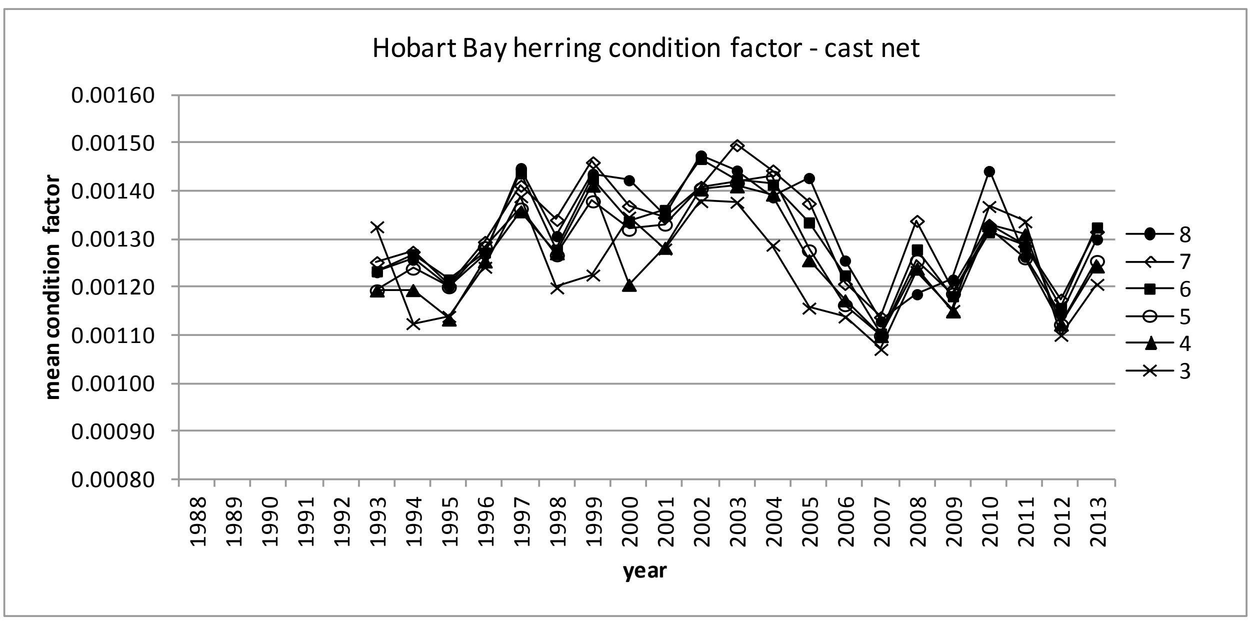


Figure 67.–Mean condition factors of age-3 through age-8 herring for the Hobart Bay spawning population, based on spring cast net samples taken during active spawning.

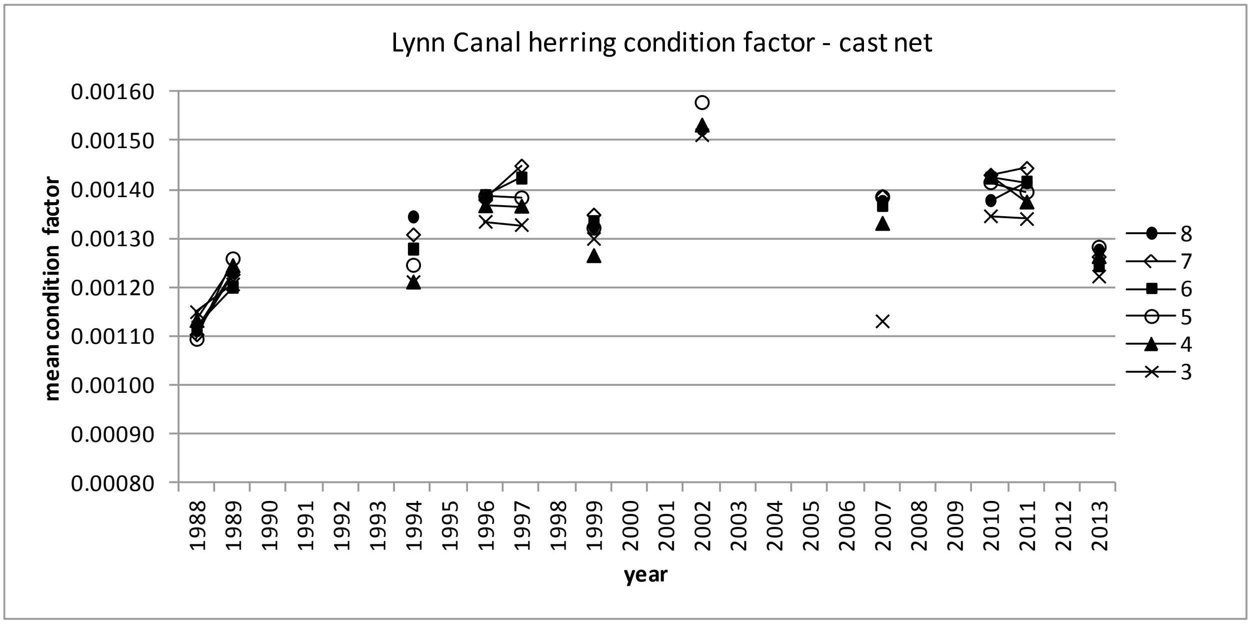


Figure 68.–Mean condition factors of age-3 through age-8 herring for the Lynn Canal spawning population, based on spring cast net samples taken during active spawning.

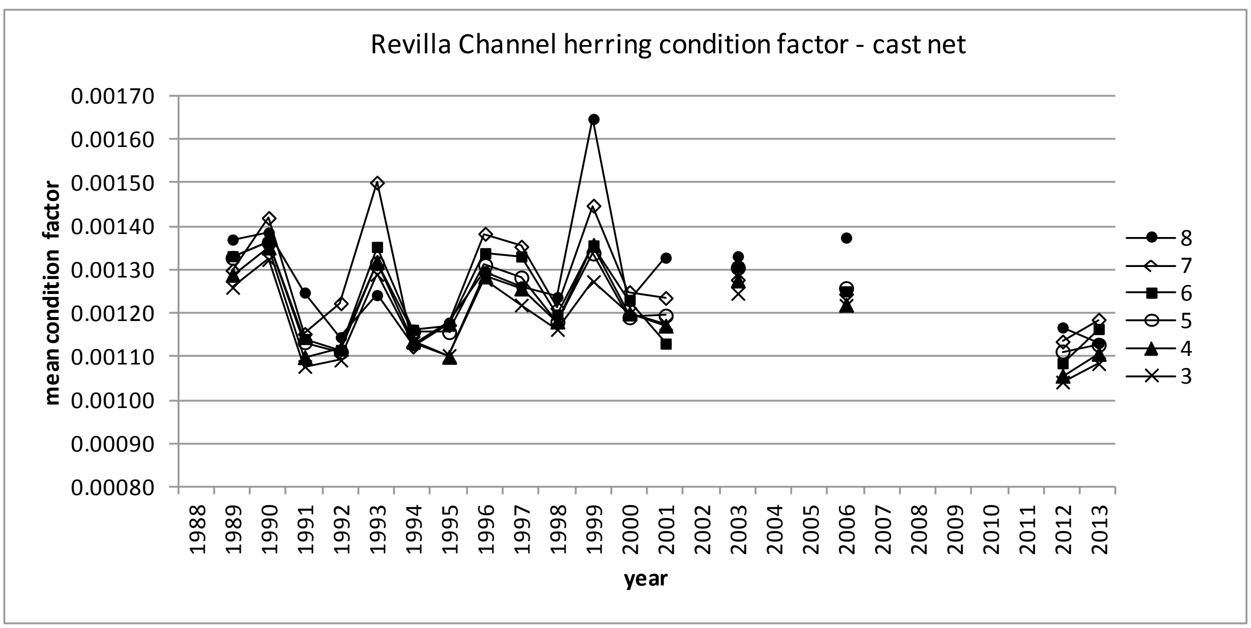


Figure 69.–Mean condition factors of age-3 through age-8 herring for the Revilla Channel spawning population, based on spring cast net samples taken during active spawning.

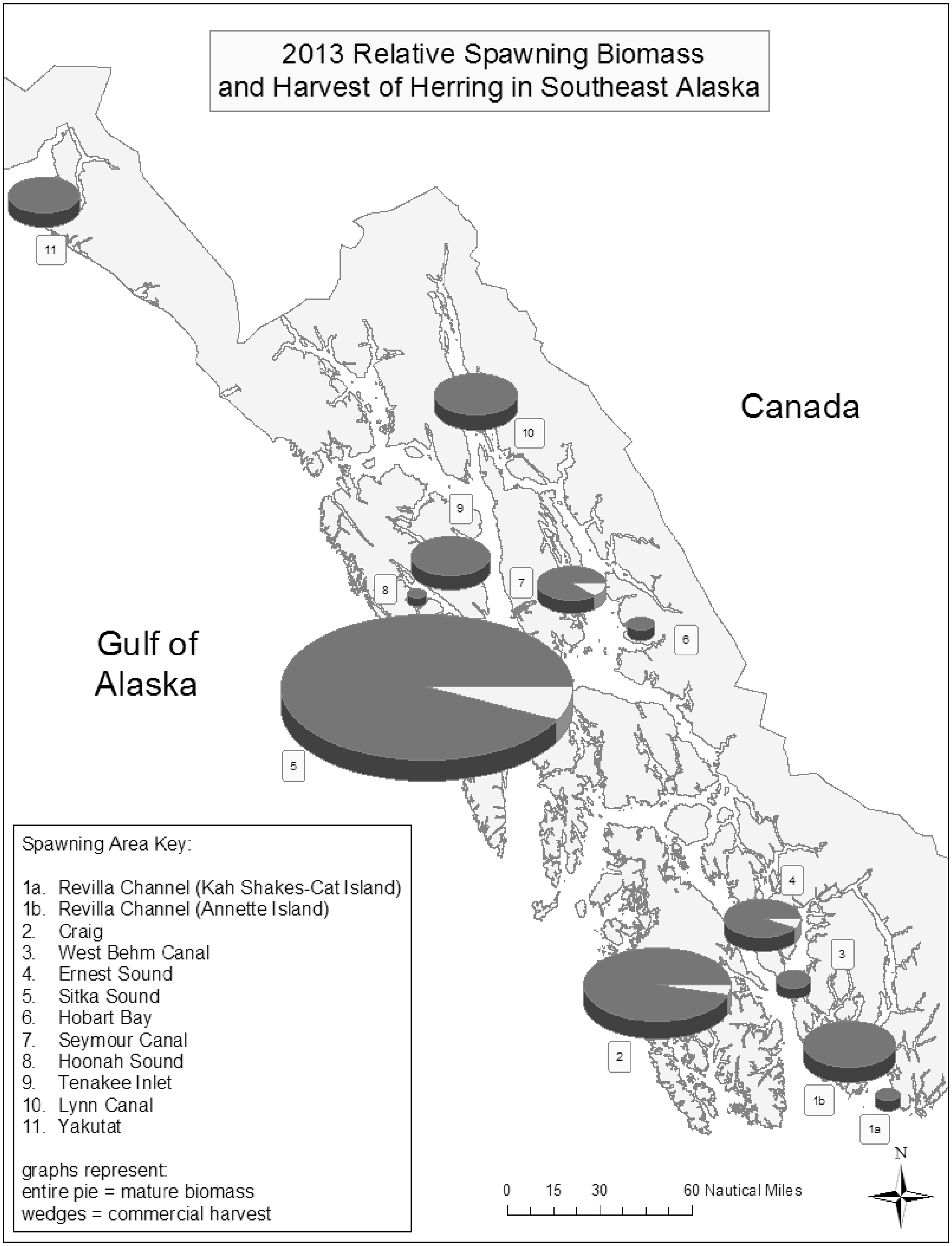


Figure 70.–Relative magnitude of herring spawning stocks and harvest levels in Southeast Alaska, based on biomass estimates converted from spawn deposition estimates.

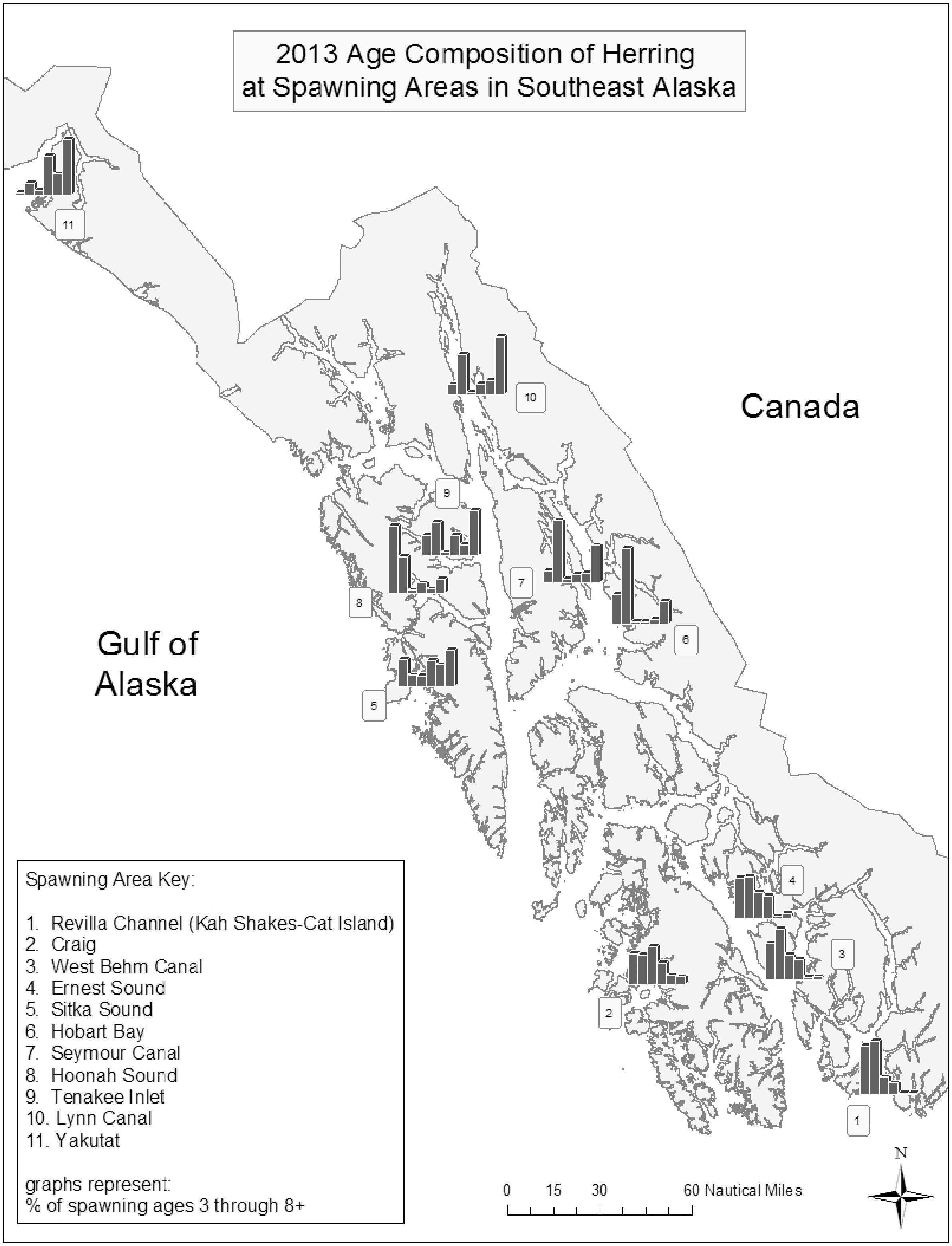


Figure 71.–Summary of age composition of herring spawning stocks in Southeast Alaska from cast net sampling.

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

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

APPENDIX C: SPAWN SURVEYS BY DATE

Appendix C1.–Aerial and skiff herring spawn surveys by date, in Revilla Channel (Ketchikan Management Area), Southeast Alaska in 2013.

March 18, 2013

Today a herring aerial survey was conducted in the Revilla Channel area. No activity was observed except for a few sea lions on the eastern shore of Annette Island. The weather was poor with numerous snow squalls.

March 22, 2013

Today a herring aerial survey was conducted in Craig and Revilla Channel area. The weather was light winds and clear skies. The survey was conducted between 10:00 am and 11:45 am. No herring spawn was observed. Minimal sea lion activity observed on the east side of Annette Island.

March 27, 2013

Today a herring aerial survey was conducted in the Revilla Channel area. The weather was moderate winds and clear skies. The survey was conducted around 8:00 am. No herring activity was observed in Annette Island waters or in State waters. The survey in state waters was expanded to ensure that no activity was missed.

March 29, 2013

An aerial survey was conducted today in Revilla Channel and West Behm Canal. A skiff survey was conducted in the Craig area yesterday and today. The weather was light winds and clear skies. **½ mile of herring spawn** was observed in State waters on the south end of Mary Island. No other herring activity was observed in State waters. Sea lions and birds were seen in large numbers in Cascade Inlet on the eastern shore of Annette Island. No herring spawn was seen. Numerous vessels were seen heading to the grounds during the afternoon skiff survey indicating that preparation for fishing has begun.

March 30, 2013

An aerial survey was conducted today in Revilla Channel. The weather was light winds, rain and fog. No spawn or herring activity was observed in State waters. Sea lions were observed south and east of Cascade Inlet on the eastern shore of Annette Island. No herring spawn was seen. Annette Island was actively gillnet fishing. Additional sea lions were observed on the Southeast tip of Annette Island.

March 31, 2013

An aerial survey was conducted in Revilla Channel today. The weather was light winds, clear skies with some morning fog. No spawn or herring activity was observed in State waters during today's survey. **1.25 miles of herring spawn** observed on the eastern shore of Annette Island near Crab Bay. Sea lions were also observed in the area.

-continued-

April 1, 2013

An aerial survey was conducted in Revilla Channel today. The weather was moderate to high winds, overcast skies with some morning fog in Revilla Channel and rain in Craig. No spawn or herring activity was observed in State waters. **1.25 miles of herring spawn** observed on the eastern shore of Annette Island near Crab Bay. Sea lions were also observed in the area. Fishing was actively taking place in Annette Island waters near Crab Bay.

April 2, 2013

An aerial survey was conducted in Revilla Channel today. The weather was moderate winds, overcast skies with some rain squalls in Craig. No spawn or herring activity was observed in State waters. **1.5 miles of herring spawn** was observed on the eastern shore of Annette Island from the southern end of Cascade Inlet to Crab Bay. Numerous sea lions were scattered along the shoreline. The Annette Island herring gillnet fishery appeared to be over as no vessels were observed in the Crab Bay area. There was no predator activity on the southern or eastern shore of Annette Island.

April 3, 2013

An aerial survey was conducted in Revilla Channel today. The weather was light winds and overcast skies. No spawn or herring activity was observed in State waters. **2 miles of herring spawn** was observed on the eastern shore of Annette Island from Ham Island to Crab Bay. Numerous sea lions were scattered along the shoreline.

April 4, 2013

An aerial survey was conducted in Revilla Channel today. The weather was light winds and overcast skies in the morning and windy conditions in the afternoon. No spawn or herring activity was observed in State waters. **4 miles of herring spawn** was observed on the eastern shore of Annette Island from Ham Island to Crab Bay. Numerous sea lions were scattered along the shoreline.

April 5, 2013

An aerial survey was conducted in Revilla Channel today. The weather was light winds, overcast skies and light rain. No spawn was observed in Revilla Channel. Sea lions and birds were observed on the eastern shore of Annette Island.

-continued-

April 6, 2013

Aerial surveys were conducted in the West Behm and Revilla Channel areas today. The weather was high winds, overcast skies, rain and fog. No spawn was observed in Revilla Channel. Survey conditions were poor with high winds. The department estimates that the spawning is done for 2013.

Total spawn in Revilla Channel for 2013 is 10.7 nautical miles, with 10.0 on Annette Island and 0.7 nautical miles in state waters.

Appendix C2.–Aerial and skiff herring spawn surveys by date, Craig (Ketchikan Management Area), Southeast Alaska in 2013.

March 20, 2013

Today a herring aerial survey was conducted in Craig area. No activity was observed except for a few sea lions and whales south of Point Ildefonso. The weather was light winds with squalls. 30 herring pounds were seen on the grounds.

March, 22, 2013

Today a herring aerial survey was conducted in Craig and Revilla Channel area. The weather was light winds and clear skies. The survey was conducted between 10:00 am and 11:45 am. No herring spawn was observed. Sea lion and bird activity has greatly increased in the pounding area with 100+ sea lions from Clam Island to Abbess Island. 53 herring pound structures were seen on the grounds.

March 26, 2013

Today a herring aerial survey was conducted in the Craig area. The weather was moderate winds and clear skies. The survey was conducted around noon. No herring spawn was observed. Sea lion and bird activity has greatly increased in the pounding area with numerous sea lions from Fish Egg Island to Abbess Island.

March 27, 2013

Today a skiff survey was conducted in the Craig area. The weather was moderate winds and clear skies. No spawn. Bird and sea lion activity continues with large numbers of sea lions around Fish Egg Island. Herring pound staging activity has increased in the herring pounding areas with 101 total pound structures. Fish have not yet been introduced into any of the pounds.

March 28, 2013

A skiff survey was conducted in the Craig area today. The weather was light winds and clear skies. No spawn. Birds, whales and sea lion activity continues around Fish Egg Island and the herring pounding areas. Herring have been moving through the herring pound area today. Information from the fishermen on the grounds indicate a mix of immature fish.

March 30, 2013

An extensive skiff survey of the Fish Egg Island and Pounding area was conducted, some fresh fish has moved into the pounding area and most groups have harvested some fish overnight and today and placed them in their pounds. No herring spawn was observed. Herring densities have increased in the herring pounding area and several herring pounds have been filled with herring in the last 24 hours. Large numbers of sea lions have also moved into the waters west of Wadleigh Island.

-continued-

March 31, 2013

Skiff and aerial surveys were conducted in the Craig, West Behm and Revilla Channel areas today. The weather was light winds, clear skies with some morning fog. **6 miles of herring spawn** were observed in the Craig area today. Intense spawn is located around Alberto Islands, the eastern shore of Wadleigh Island and covered a large portion of Abbess Island. There is also a spot spawn on the north end of San Christoval Channel. Sea lions are concentrated on the north end of Abbess Island with numerous whales in the San Christoval area. No spawn has yet to be observed around Fish Egg Island. A large portion of the herring pounds now have fish.

April 1, 2013

Skiff and aerial surveys were conducted in the Craig, West Behm and Revilla Channel areas today. The weather was moderate to high winds, overcast skies with some morning fog in Revilla Channel and rain in Craig. **11.5 miles of herring spawn** was observed in the Craig area today. Intense spawn is located around Alberto Islands, the eastern shore of Wadleigh Island and covered a large portion of Abbess Island. There is also a spot spawn on the small Island near the north end of Fish Egg Island. Sea lions are concentrated on the north end of Abbess Island. A large portion of the herring pounds now have fish. Purse seining was observed throughout the area. Fishermen are advised that today is most likely the peak day of herring spawn in the Craig area. Fish available for pounds will become more difficult to find in the coming days. It is strongly advised to harvest fish as soon as possible if you are planning to participate in the 2013 herring pound fishery. Yesterday's **6.1 nmi** of spawn along with today's **11.5 nmi** spawn makes a total of approximately **12.5 total** nmi of very intense herring spawn in the Craig area.

April 2, 2013

An aerial survey was conducted in the Craig today. The weather was moderate winds, overcast skies with some rain squalls in Craig.**7.0 miles of herring spawn** was observed in the Craig area today. The spawn has decreased in intensity from yesterday. New spawn was observed on the south end of Fish Egg Island. Other spawn areas include Clam Island, Entrance Point, the outer Alberto Islands and Abbess Island. There are numerous predators throughout the area with the biggest concentration of sea lions around the Klawock Reef and the north end of Abbess Island. Fishermen are advised that yesterday was most likely the peak day of herring spawn in the Craig area. Fish available for pounds will become more difficult to find in the coming days. It is strongly advised to harvest fish as soon as possible if you are planning to participate in the 2013 herring pound fishery. Total spawn is estimated to be around 14 nautical miles.

-continued-

April 4, 2013

An aerial survey was conducted in the Craig today. The weather was light winds and overcast skies in the morning and windy conditions in the afternoon. No spawn was observed in the Craig area today. All indications suggest that the spawning is done for 2013. Total miles of spawn will be announced in a future update. Department staff will be departing Craig tomorrow.

April 5, 2013

No survey. The department estimates that the spawning is done for 2013.

Total spawn documented by ADFG in Craig for 2013 was 15.3 nautical miles.

Appendix C3.–Aerial and skiff herring spawn surveys by date, in West Behm Canal (Ketchikan Management Area), Southeast Alaska in 2013.

March 29, 2013

An aerial survey was conducted today in West Behm Canal. The weather was light winds and clear skies. No herring or herring activity was observed except for a few sea lions at Vallenar Point.

March 31, 2013

An aerial survey was conducted today in West Behm Canal. The weather was light winds and clear skies with some morning fog. No herring or predator activity was observed.

April 1, 2013

An aerial survey was conducted today in West Behm Canal. The weather was light winds and clear skies with some morning fog. No herring or predator activity was observed.

April 2, 2013

An aerial survey was conducted today in West Behm Canal. The weather was moderate winds, overcast skies with rain squalls. No herring activity was observed. 8 sea lions were seen off Pt. Higgins and another 8 sea lions were seen at the north end of Bond Bay.

April 3, 2013

An aerial survey was conducted today in West Behm Canal. The weather was light winds and overcast skies. **.5 nmi of spawn** was observed in Vallenar Bay. Sea lions and schools of herring were observed in the South Vallenar Bay area. Sea lions were observed around Survey Point and on the Cleveland Peninsula.

April 4, 2013

Skiff and aerial surveys were conducted in West Behm today. The weather was light winds and overcast skies in the morning and windy conditions in the afternoon. **1/2 nmi of spawn** was observed in Vallenar Bay. Sea lions and schools of herring were observed in the South Vallenar Bay area. A few sea lions were observed around Survey Point. Very little activity was seen on the Cleveland Peninsula.

April 5, 2013

Skiff and aerial surveys were conducted in West Behm today. The weather was light winds, overcast skies and light rain. **1/2 nmi of spawn** was observed in the Vallenar Bay area. Sea lions and schools of herring were observed in the South Vallenar Bay area. A few sea lions were observed around Survey Point. No activity was seen on the Cleveland Peninsula.

April 6, 2013

Aerial surveys were conducted in West Behm Canal today. The weather was high winds, overcast skies, rain and fog. **Two spot spawns** were observed. One small spawn was observed in Vallenar Bay and one at Survey Point. Sea lions were observed in Vallenar Bay and around Survey Point. No activity was seen on the Cleveland Peninsula.

-continued-

April 7, 2013

An aerial survey was conducted in West Behm Canal today. The weather was light winds and clear skies. No spawn was observed. Herring activity has diminished throughout the area. One more survey will be done this week to determine if the spawn in over for the season.

April 10, 2013

An aerial survey was conducted in West Behm today. The weather was light winds and clear skies. No activity was observed. It is estimated that all herring spawning is over in the Ketchikan area. No more aerial surveys will be completed unless new information if received.

Total spawn documented by ADFG in West Behm Canal for 2013 is 2.3 nautical miles.

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Sitka Sound and Hoonah Sound (Sitka Management Area), Southeast Alaska in 2013.

<u>March 14:</u> 08:20–09:55

Gordon/Coonradt/Case. Spotting conditions were good with a light east wind and partly cloudy skies. This survey covered Sitka Sound, south to Crawfish Inlet and north to Salisbury Sound. No herring were seen during the survey. In Sitka Sound a total of 24 whales were observed. Whales were concentrated in waters offshore between Kruzof Island and Crow Island, and offshore north of Middle Island. Two whales were seen west of the Gavanski Islands and one whale was seen north of Vitskari Rocks. In Salisbury Sound, one whale was seen near Sinitsin Island. Areas to the south of Sitka were generally quiet though bird activity was observed in the Eastern Channel area. Conditions were marginal for obtaining a detailed assessment of sea lion distribution in the survey area. The highest concentration of sea lions was observed off Mountain Point and Inner Point. Otherwise only scattered smaller sea lion groups were seen during the survey. Based on the distribution of whales and sea lions, it appears that herring are most concentrated in the deepwater trenches west and north of Middle Island. The results of this survey are considered normal for this date.

<u>March 18:</u> 08:30–10:10.

Gordon/Coonradt/Jensen. Spotting conditions were good at times with snow squalls, light wind and cloudy skies. This survey covered Sitka Sound, south to Cape Burnof and north to Salisbury Sound. Whales were concentrated in waters offshore between Kruzof Island and Crow Island, and offshore north of Middle Island. Two whales were seen east of the Gavanski Islands. In Salisbury Sound, seven whales were seen between Scraggy Islands and Kane Islands. Areas to the south of Sitka were generally quiet though bird activity was observed in the Eastern Channel area. The highest concentration of sea lions was observed off Kresta Point and the northern tip of Crow Island. Otherwise only scattered smaller sea lion groups were seen during the survey. Based on the distribution of whales and sea lions, it appears that herring are most concentrated in the deepwater trenches west and north of Middle Island.

<u>March 20:</u> 08:00–09:30

Gordon/Coonradt/Zeitzer. Spotting conditions were generally good with a light wind, breezy in places and clear skies. Today’s aerial survey covered Sitka Sound north of Cape Burunof and Salisbury Sound. No herring were visible from the air. Whales and sea lions continue to be concentrated in the offshore areas west and north of Crow Island showing little change in distribution from the previous survey. Seine vessels surveying the area report that a large biomass of herring can be seen on the sonar holding in the deep water trench between Crow Island and Kruzof Island.

<u>March 21</u>: 09:30–10:45

Gordon/Case. Spotting conditions were good with overcast skies and light winds. Today’s aerial survey covered Sitka Sound north of Cape Burunof and Salisbury Sound. No herring were visible from the air. Whales and sea lions continue to be concentrated in the offshore areas west and north of Crow Island. An increase in sea lions was noted near Lisianski Point and Harbor Point.

-continued-

<u>March 22</u>: 10:00–11:05

Gordon/Case/Brandi. Spotting conditions were good with broken clouds and light winds. Today's aerial survey covered Sitka Sound south of Cape Burunof and north to Hayward Strait. Whale and sea lion concentrations have shifted to the area just west of Bieli Rock to Parker Islands. Herring schools were observed in the shallower water west of the Chaichei Islands. Additionally, a concentration of herring was still in the deeper water east of Middle Island.

<u>March 23:</u> 09:05–10:25

Coonradt/Gordon. Spotting conditions were good. Today's aerial survey covered Sitka Sound south to West Crawfish Inlet and north to Hayward Strait. No herring were visible from the air. Whales and sea lions continue to be mostly concentrated in the offshore areas west and north of Crow Island. Three whales and approximately 35 sea lions were seen north of Kasiana Island and three whales and 12 sea lions were seen west of the Parker Group. South of Sitka, three whales were seen near shore off Cape Burunof, with approximately 30 sea lions off Three Entrance Bay south of Cape Burunof. No other notable concentrations of herring predators were observed in areas further to the south.

<u>March 24:</u> No Aerial survey was conducted today.

<u>March 26:</u> 08:10–09:17

Jensen/Coonradt. Spotting conditions were poor with overcast skies and west winds 15–25 knots. Today's aerial survey covered Sitka Sound north of Frosty Reef and north to Hayward Strait. Sea lions continue to be concentrated off of Inner Point (250) and Bieli Rock (200), with whales in the deeper water between. Additionally, sea lions were spotted around the parker Island group and two whales were observed north of Watson Point.

<u>March 27:</u> 08:00–09:15

Kelley/Davidson, Gordon. Spotting conditions were good with high overcast and light winds. Today's aerial survey covered Sitka Sound south to Cape Burunof and north to Salisbury Sound. No herring spawn was observed. Herring were seen in shallow waters on the southeast side of Kasiana Island. In Sitka Sound herring predators are concentrated in the islands south of Crow and Middle Island (13 whales and 356 Sea lions). Additionally, 70 sea lions were observed off of Inner Point and north of Crow Island there was two whales and 8 sea lions. In Salisbury Sound five whales were observed bubble net feeding by Scraggy Islands, additionally there were 7 sea lions in St. John Bay and 4 off of Hayward Point.

<u>March 28:</u> 08:10–09:20

Kelley/Coonradt, Gordon. Spotting conditions were good with scattered overcast and light winds. Today's aerial survey covered Sitka Sound south to Cape Burunof and north to Hayward Strait. The first spawn was recorded during today's aerial survey with a total of **2.2 nm** of intense spawning mostly on the south and east sides on Kasiana Island with spawn also starting on the Apple Islands. Large numbers of sea lions and whales were seen among the rocks and smaller islands south of Kasiana and Middle Islands (13 whales and 200 sea lions). Whales were

-continued-

also seen widely dispersed around northern Sitka Sound. During the aerial survey herring schools could be seen south of Sitka in Crescent Bay and Jamestown Bay and north of Sitka schools were seen in Eastern Bay and Katlian Bay.

<u>March 29:</u> 08:10–09:50

Coonradt/Gordon, Fowler. Spotting conditions were good clear skies and light winds. Today's aerial survey covered Sitka Sound south to Cape Burunof and north to Hayward Strait. During today's aerial survey a total of **11.6 nm** of spawn was observed along the HPR Road system, on Kasiana Island, on the Apple Islands and on the Parker Islands; with spawn starting on the Makhnati Islands Causeway and on Battery Island.

<u>March 30:</u> 08:00–09:30

Davidson. Spotting conditions were good clear skies and light winds. Today's aerial survey covered Sitka Sound south to Windy Pass and north to Hayward Strait. During today's aerial survey a total of **17.8 nm** of spawn was observed along the HPR Road system, on Kasiana Island, on the Apple Islands, on the Parker Islands, on the Chaichei Islands and on south Middle Island. South of Sitka herring spawn was observed between Povorotni Point and Pirates Cove. Herring predators were observed off of Inner Point (2 whales), in Hayward Strait (5 whales and 30 sea lions), and off of Kresta Point (1 whale and 6 sea lions).

<u>March 31:</u> 08:30–10:00

Coonradt/Gordon. Spotting conditions were good overcast skies and light winds. Today's aerial survey covered Sitka Sound south to Windy Pass and north to Hayward Strait. During today's aerial survey a total of **28.2 nm** of spawn was observed along the HPR Road system, on Kasiana Island, on the Apple Islands, on the Parker Islands, on the Chaichei Islands, on Crow Island, on Gagarin Island and on south Middle Island. South of Sitka herring spawn was observed between Povorotni Point and Samsing Cove.

<u>April 1:</u> 08:30–09:00

Coonradt. Spotting conditions were good overcast skies and light winds. Today's aerial survey covered Sitka Sound south to Windy Pass and north to Hayward Strait. During today's aerial survey a total of **20.5 nm** of active spawn was mapped.

<u>April 2:</u> 08:15–09:30

Davidson/Gordon. Spotting conditions were good with overcast skies and light winds. Today's aerial survey covered Sitka Sound south to Windy Pass and north to Hayward Strait. Today's active spawn included **6.6 nm** of shoreline including the area between Povorotni Point and Samsing Cove, south Middle Island and the Makhnati Island Causeway.

<u>April 3:</u> 08:30–09:30

Case. Spotting conditions were good with overcast skies and light winds. Today's aerial survey covered Sitka Sound south to Cape Burunof and north to Hayward Strait. Only 0.1 nm of active spawn was observed along the north entrance to Deep Inlet, an additional 2.1 nm of spawn was mapped by skiff for a total of **2.2 nm** for the day.

-continued-

April 4: 08:30–10:30

Coonradt/Jensen, Gordon. Spotting conditions were very poor with overcast skies and winds 20–25 knots. Today’s aerial survey covered Sitka Sound south to Cape Burunof, including Shelikof Bay and north to Slocum Arm. In Sitka Sound **1.2 nm** of spawn was observed on the southern shore of Shelikof Bay.

In Slocum Arm no herring, herring spawn or herring predators were observed.

April 5: 08:30–10:00

Gordon/Coonradt/Jensen. Spotting conditions were good with overcast skies and light winds. Today’s aerial survey covered Sitka Sound south to Cape Burunof, including Shelikof Bay. In Sitka Sound **1.3 nm** of spawn was observed on the southern shore of Shelikof Bay.

April 6: 08:30–10:00

Gordon. Spotting conditions were good with mostly cloudy skies and northeast winds at 10 knots. Today’s aerial survey covered north Sitka Sound including Shelikof Bay and Slocum Arm. In Shelikof Bay **1.5 n**m of herring spawn was observed on the south shore.

In Slocum, no herring or herring spawn was observed. Herring predators included only 4 whales in the area.

April 7:

Today **1.3 nm** of active spawn was observed on the southern shore of Shalekof Bay.

April 7:

Today **1.3 nm** of active spawn was observed on the southern shore of Shalekof Bay.

April 10: 08:30–10:30

Case/Davidson. Spotting conditions are unknown. Today’s aerial survey covered Sitka Sound north of Sitka, including Shelikof Bay and Slocum Arm. No herring or herring spawn was observed. Herring predator sightings were minimal with only one whale and four sea lions observed off of Scraggy Island, and one whale in Slocum Arm.

April 12: 14:00–15:00

Case/ Davidson. Spotting conditions were very poor with overcast skies and winds 20–25 knots. Today’s aerial survey covered Sitka Sound north of Sitka, including Shelikof Bay and Salisbury Sound. No herring or herring spawn was observed. Herring predator sightings were minimal with only ten sea lions observed off of Inner Point.

April 15: 10:20–12:20

Gordon/Jensen. Spotting conditions were good with partly cloudy skies and light winds. The department conducted an aerial survey of Sitka Sound south to West Crawfish Inlet, Slocum Arm and Hoonah Sound south to Ostoia Island. In Sitka Sound spawning began again with **1.9 nm** of discontinuous spawn observed along the Kruzof Island shore north of Kamenoi Point, in Promisla/Eastern Bay and in Starrigavan Bay.

-continued-

In Hoonah Sound no herring or herring spawn was seen during the survey. A total of 38 sea lions were seen scattered in the Hoonah Sound area including 8 north of Fick Cove, 14 north of Vixen Island, 13 off Moser Island between White Cliff Point and Pederson Point and 3 off north Emmons Island. Two whales were seen north of Vixen Island.

<u>April 16:</u> 08:30–09:45

Coonradt/Gordon/Case. Spotting conditions were good with overcast skies and light winds. The department conducted an aerial survey of Sitka Sound, south to Cape Burunof and north to Salisbury Sound. In Sitka Sound **6.6 nm** of discontinuous spawn was observed along the Kruzof Island shore north of Fred's Creek, in Promisla/Eastern Bay, in Starrigavan Bay and on north Middle Island.

<u>April 17:</u> 13:10–15:00

Coonradt/Gordon. Spotting conditions were good with partly overcast skies and light winds. The department conducted an aerial survey of Sitka Sound, south to Windy Pass and Hoonah Sound, south to Rodman Bay. In Sitka Sound **2.9 nm** of discontinuous spawn was observed along the Kruzof Island shore north of Fred's Creek, in Starrigavan Bay and on north Middle Island

In Hoonah Sound no herring or herring spawn was seen during the survey. A total of 30 sea lions were seen scattered in the Hoonah Sound area including 10 north of Vixen Island, 8 off Moser Island between White Cliff Point and Pederson Point and 9 near Emmons Point. Two whales were seen north of Hoggatt Reef.

<u>April 18:</u> 08:00–08:55

Gordo/Case. Spotting conditions were good with overcast skies and light winds. Today's aerial survey covered Sitka Sound south to Windy Pass and north to Salisbury Sound. Approximately 2.9 nm of discontinuous spawn was observed along the Kruzof Island shore north of Fred's Creek and in Promisla Bay and on north Middle Island. In addition 0.4 nm of spawn was mapped by skiff for a total of **3.3 nm** of spawn mapped today.

<u>April 19:</u> 08:50–10:00

Coonradt/Case. Spotting conditions were good with sunny skies and light winds. Today's aerial survey covered north Sitka Sound, Slocum Arm and the Hoonah Sound area north of Ostoia Island. In Sitka Sound **2.1 nm** of spawn was observed north of Inner Point and Promisla Bay, with a couple spot spawns on north Middle Island.

In Slocum Arm, herring schools were observed along the Takeena Peninsula. Dissipating herring spawn was observed along Ramp Island and on the Takeena Peninsula. One whale and 30 sea lions were also observed in the area.

In Hoonah Sound no herring or herring spawn was observed during the survey. A total of 18 sea lions were seen on the northwest shoreline of Vixen Island. One whale was seen near Broad Island.

-continued-

<u>April 20:</u> 08:30–10:00

Coonradt. Spotting conditions were good with partly cloudy skies and light winds. Today's aerial survey covered north Sitka Sound, north to Slocum Arm. No herring or herring spawn was observed on today's flight.

<u>April 22:</u> 10:40–12:30 Gordon. Spotting conditions were good with overcast skies and light winds. Today the department conducted an aerial survey of Sitka Sound north of West Crawfish Inlet and Hoonah Sound/Peril Strait out to Rodman Bay. In Sitka Sound **spot spawns** were observed in Dorothy Narrows, Crescent Harbor Breakwater, the mouth of Katlian Bay and North of Gilmer Cove in Salisbury Sound.

In Hoonah Sound: No herring or herring spawn was seen during the survey. There were 12 sea lions in South Arm and 8 sea lions between White Cliff Point and Pederson Point. No whales were seen during the survey.

<u>April 23:</u> 10:10–11:05

Gordon/Coonradt. Spotting conditions were good with overcast skies and light winds. Today's aerial survey covered Sitka Sound north of Windy Pass and south of Salisbury Sound. Herring continue to spawn is Sitka Sound, although along very small sections of shoreline. **Spot spawns** were observed in Salisbury Sound, Katlian Bay, Big Gavanski Island, Crescent Harbor Breakwater, Samsing Cove, Redoubt Bay and on Gornoi Island.

<u>April 24:</u>

Miscommunication with pilot and no aerial survey was conducted.

<u>April 25:</u>

Weather was too poor to fly; therefore no aerial survey was conducted today.

<u>April 26:</u>

Weather was too poor to fly; therefore no aerial survey was conducted today.

<u>April 27:</u> 08:30–10:00

Coonradt. Spotting conditions were generally good with sunny skies and variable winds. Today's aerial survey covered of Hoonah Sound and Peril Strait. No herring or herring spawn was seen during the survey. There were 15 sea lions north of Emmons Island and 3 sea lions off White Cliff Point and 2 sea lions off of Rodgers Point. No whales were seen during today's survey.

<u>April 28:</u>

No aerial survey was scheduled for today

<u>April 29:</u> 10:00–11:15

Coonradt. Spotting conditions were generally good with sunny skies and variable winds. Today's aerial survey covered of Hoonah Sound and Peril Strait. Herring schools were observed in the pound area between Emmons and Vixen Islands. No herring spawn was seen during the survey. There were 12 sea lions north of Emmons Island and 5 sea lions between White Cliff Point and Pederson Point. No whales were seen during today's survey.

-continued-

<u>April 30:</u> 09:45–11:05

Coonradt. Survey conditions were fair with overcast skies, snow and variable wind. The department conducted an aerial survey of Hoonah Sound and Peril Strait north of Nismeni Point. Herring schools were observed along the northeast Emmons Island shoreline, and on the Chichigof Island shoreline due east of Vixen Islands. No herring spawn was observed. There were 10 sea lions east of Emmons Island and 6 sea lions south of White Cliff Point. One whale was observed south of Emmons Island on today's survey.

<u>May 1:</u>

Weather was too poor to fly; therefore no aerial survey was conducted today.

<u>May 2:</u> 12:00–13:15 Coonradt. Survey conditions were good with overcast skies and light wind. No herring or herring spawn was observed on today's flight. Today's aerial survey covered Hoonah Sound and Peril Strait north of Rodman Bay There were 10 sea lions south of Finger River, 4 sea lions south of White Cliff Point and 2 sea lions in the pound area.

<u>May 3:</u> No aerial survey was scheduled today.

<u>May 4:</u> Weather was too poor to fly; therefore no aerial survey was conducted today.

<u>May 5:</u> Weather was too poor to fly; therefore no aerial survey was conducted today.

<u>May 6:</u> 06:45–08:45

Coonradt. Survey conditions were good with overcast skies and light wind. Today's aerial survey covered Hoonah Sound and Peril Strait north of Rodman Bay. No herring or herring spawn was observed on today's flight. There were 3 sea lions north of Emmons Island and 2 sea lions south of Emmons Island. One whale was observed north of Emmons Island on today's survey.

<u>May 7:</u> 10:45–12:15

Coonradt. Survey conditions were good with clear skies and light wind. Today's aerial survey covered Hoonah Sound and Peril Strait north of Rodman Bay. Herring spawn was observed on Emmons Island, on the Chichagof Island shore north of Rodgers Point, and on the Chichagof Island shore south of Finger River. **Total spawn mileage was 0.7 nm**. In addition, herring schools were observed along Emmons Island, on the Chichagof Island shore north of Rodgers Point and on the Chichagof Island shore south of Finger River. There were 3 sea lions north of Emmons Island and 9 sea lions south of Emmons Island. One whale was observed north of Emmons Island on today's survey.

<u>May 8:</u> 09:00–10:30

Case. Survey conditions were good with clear skies and light wind. Today's aerial survey covered Hoonah Sound and Peril Strait north of Rodman Bay. On today's aerial survey **1.3 nautical miles of spawn** was recorded on Emmons Island and on the Chichagof Island shore between Finger River and Broad Island.

-continued-

<u>May 9:</u> 07:25–08:35

Coonradt. Survey conditions were good with partly overcast skies and light wind. Today's aerial survey covered Hoonah Sound and Peril Strait north of Ostoia Island. Herring spawn was observed on the Chichagof Island shore south of Rodgers Point, and on the Chichagof Island shore south of Finger River. Total spawn mileage for today was **0.2 nautical miles**. In addition, herring schools were observed along Emmons Island, and on the Chichagof Island shore north of Rodgers Point.

<u>May 10:</u> 06:30–09:30

Coonradt. Survey conditions were good with clear skies and light wind. Today's aerial survey covered Hoonah Sound and Peril Strait north of Hanus Bay. No herring or herring spawn was seen during the survey. Based on the absence of predators in the area, the spawning event in Hoonah Sound appears to be complete. The department will not be conducting further aerial surveys of Hoonah Sound unless the department receives reports of additional spawning.

Appendix C5.–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, 2013.

Bradfield Canal

Total miles of spawn: ~14.9 nm

Spawning dates: between 4/05 & 4/8

Peak spawning: unknown

4/5 ~14.9 nm of active spawn and scattered schools; 3 Sea Lions; 75 Scoters.

4/18 No active spawn, marine mammals, or herring observed. Skiff survey.

Vixen Inlet/ Union Bay/Emerald Bay

Total miles of spawn: ~5.6 nm

Spawning dates: 4/13 through 4/19

Peak spawning: 4/14

4/3 No active spawn or herring observed; 45 Sea Lions; 100 Gulls; 150 Scoters.

4/5 No active spawn or herring observed, 19 Sea Lions; 50 Gulls; 50 Scoters.

4/8 No active spawn or herring observed, 17 Sea Lions, 20 Gulls.

4/12 No active spawn or herring observed, 123 Sea Lions; 1 Whale; 300 Gulls.

4/13 ~1.5 nm of active spawn, 22 herring schools observed; 180 Sea Lions; 1 Whale; 500 Gulls.

4/14 ~1.5 nm of active spawn, 4 herring schools observed; 268 Seas Lions; 2 Whales; 20 Scoters.

4/15 ~0.25 nm of active spawn, 1 herring school observed; 172 sea lions, 500 Gulls.

4/16 ~1.0 nm of active spawn; 83 Sea Lions; 1 whale; 500 Scoters.

4/17 No active spawn or herring observed; 40 Sea Lions; 1,000 Scoters; 1,000 Gulls.

4/19 No active spawn or herring observed, 4 Sea Lions; 1,000 Scoters.

-continued-

Onslow/Stone/Brownson Island/Canoe Pass

Total miles of spawn: 0.0 nm

4/13 No active spawn or herring observed; 1 Sea Lions.

4/14 No active spawn or herring observed; 2 Sea Lions.

4/19 No active spawn or herring observed; 100 Scoters.

Zimovia St. and Eastern Passage

Total miles of spawn: ~2.0 nm

Spawning dates: 4/26

Peak spawning: 4/26

4/3 No active spawn or herring observed; 200 Scoters.

4/5 One spot spawn and 1 herring school observed; 4 Sea Lions; 1,000 Scoters.

4/14 No active spawn or herring observed; 16 Sea Lions.

4/19 No active spawn or herring observed; 1,000 Scoters

4/26 ~2.0 nm active spawn and no herring schools observed; 2,000 Scoters.

Bear Creek

Not Surveyed in 2013

Farragut Bay

Total miles of spawn: ~2.0 nm

Spawning dates: 5/17

Peak spawning: 5/17

-continued-

4/16 No active spawn or herring observed; 25 Sea Lions.

4/19 No active spawn or herring observed; 43 Sea Lions; 2 whales.

4/22 No active spawn or herring observed; 13 Sea Lions.

4/24 No active spawn or herring observed; 25 Sea Lions.

4/27 No active spawn or herring observed; 2 Sea Lions; 100 Scoters.

4/30 No active spawn, 2 herring schools observed; 10 Sea Lions.

5/2 No active spawn, 6 herring schools observed; 11 Sea Lions.

5/3 No active spawn, 5 herring schools observed; 17 Sea Lions.

5/5 No active spawn, 9 herring schools observed; 1 Sea Lion.

5/6 No active spawn or herring observed; 7 Sea Lions.

5/8 No active spawn or herring observed; 13 Sea Lions.

5/13 No active spawn, 3 herring schools observed; 79 Sea Lions.

5/17 ~1.8 nm of active spawn; 2 Sea Lions.

5/18 No active spawn or herring observed; 4 Sea Lions; 2,000 Scoters.

Hobart Bay

Total miles of spawn: ~2.4 nm

Spawning dates: 5/2 through 5/3

Peak spawning: 5/3

4/16 No active spawn or herring observed; 71 Sea Lions; 2 Whales.

4/19 No active spawn or herring observed; 102 Sea Lions.

4/22 No active spawn or herring observed; 69 Sea Lions.

4/24 No active spawn or herring observed; 25 Sea Lions.

4/27 No active spawn or herring observed; 29 Sea Lions; 1,075 Scoters.

4/30 No active spawn or herring observed; 41 Sea Lions; 500 Scoters.

5/2 ~0.25 nm of active spawn; 15 herring schools observed; 85 Sea Lions; 1,650 Scoters.

5/3 ~1.2 nm of active spawn; 3 herring schools observed; 117 Sea Lions; 2 Whales; 2,250 Scoters.

-continued-

5/4 No active spawn or herring observed; 27 Sea Lions, 5,500 Scoters.

5/5 No active spawn or herring observed; 32 Sea Lions, 500 Gulls; 5,500 Scoters.

5/6 No active spawn or herring observed; 28 Sea Lions; 1 Whale; 700 Gulls; 5,500 Scoters.

5/8 No active spawn or herring observed; 13 Sea Lions, 11,200 Scoters.

5/13 No active spawn or herring observed; 1 Sea Lions, 1,500 Scoters.

5/17 No active spawn, 2 herring schools observed.

5/18 No active spawn or herring observed; 500 Scoters.

Port Houghton

Total miles of spawn: 1.0 nm

Spawning dates: 5/17

Peak spawning: 5/17

4/16 No active spawn or herring observed.

4/19 No active spawn or herring observed; 16 Sea Lions; 800 Scoters.

4/22 No active spawn or herring observed; 10 Sea Lions; 1,500 Scoters.

4/24 No active spawn or herring observed; 1 Sea Lion.

4/27 No active spawn or herring observed; 29 Sea Lions; 1,075 Scoters.

4/30 No active spawn or herring observed; 4 Sea Lions; 500 Scoters.

5/2 No active spawn or herring observed; 50 Scoters.

5/3 No active spawn or herring observed.

5/8 No active spawn or herring observed.

5/13 No active spawn or herring observed; 2 Sea Lions.

5/17 ~1.9 nm of active spawn; 16 Sea Lions; 1,100 Scoters.

5/18 No active spawn or herring observed; 1 Sea Lion; 1,500 Scoters.

5/28 Skiff survey found ~1.0 nm of spawn on the beach.

-continued-

Sunset Cove/Windham Bay

Total miles of spawn: 0.0 nm

4/19 No active spawn or herring observed.

4/22 No active spawn or herring observed; 3 Sea Lions.

4/24 No active spawn or herring observed; 5 Sea Lions.

4/27 No active spawn, 1 school of herring.

4/30 No active spawn or herring observed.

5/3 No active spawn or herring observed; 2 Sea Lions.

5/8 No active spawn or herring observed; 15 Sea Lions.

5/13 No active spawn or herring observed.

Gambier Bay/Pybus Bay

No survey was done in 2013

Port Camden

Total miles of spawn: 0

5/13 No active spawn, 2 herring schools observed.

5/8 No active spawn or herring observed.

Tebenkof Bay

Total miles of spawn: 0.5 nm

Spawning dates: 5/7

Peak spawning: 5/7

5/7 ~0.4 nm active spawn and 5 herring schools observed. (Elena Bay)

5/7 ~.01 nm active spawn and 4 herring schools observed. (Petrof Bay)

Appendix C6.–Aerial and skiff herring spawn surveys by date, in Seymour Canal (Juneau Management Area), in Southeast Alaska, 2013.

Seymour Canal

Number of times surveyed: 27 total (includes 2 flights by Petersburg staff, does **not** include flights by industry only).

Total nautical miles of spawn: 8.0 nm

Spawning dates: 5/7–5/12

Peak spawn: 5/8

4/15 First aerial survey of season in Ward Air C-185. No herring or herring spawn observed. 59 sea lions and 0 whales observed. Vast majority of sea lions on outside of Glass Peninsula with very little activity on inside.

4/17 C-185 survey. No herring or herring spawn observed. 68 sea lions and 0 whales. Most sea lion activity from Point Hugh around outside of Glass Peninsula with increased activity from Dorn Island to Sore Finger on inside.

4/19 C-185 survey. No herring or herring spawn observed. 63 sea lions and 1 whale observed. Nearly all sea lions observed on inside of Glass Peninsula. Whale seen in deep water off of Sore Thumb.

4/21 C-185 survey. No herring or herring spawn observed. 104 sea lions and 2 whales observed with sea lion concentration most significant on the outside of the Glass Peninsula from the lone island northeast across the peninsula from Twin Islands down to Point Hugh.

4/22 C-206 survey (Petersburg staff). No herring or herring spawn observed. 112 sea lions and 1 whale observed with sea lion concentrations north of Sorethumb and around Point Hugh.

4/23 C-185 survey. No herring or herring spawn observed. 67 sea lions and 1 whale observed with the majority of sea lions between the Rock Garden and #9 Rock. The whale was observed near Pleasant Bay on the other side of the canal.

4/25 61Z survey (first survey in the revamped cub). No herring or herring spawn observed. 54 sea lions and 1 whale observed with majority of sea lions spread out along the inside of the peninsula from Sore Finger to Point Hugh.

4/27 61Z survey – 8:45am. No herring or herring spawn observed. 93 sea lions and 6 whales observed with concentration of activity between #9 Rock and Sorethumb. Canoe and bundle of life jackets observed from One People Canoe Society mishap.

-continued-

4/29 61Z survey. No herring or herring spawn observed. 115 sea lions and 2 whales observed with half the sea lions between Sorefinger and the Rock Garden and the other half from Point Hugh north to just past the Dogleg. The entire Big Bend shoreline was included on this survey and was very quiet. Hobart was also surveyed for the Petersburg office and a couple groups of sea lions were observed just off the Sanctuary.

4/30 Ward Air C-206 survey—11:30am. No herring or herring spawn observed. 77 sea lions and 5 whales observed mainly between #9 Rock and Blackjack.

4/30 C185 survey (Petersburg staff)—12:10pm. No herring or herring spawn observed. 47 sea lions and 2 whales observed.

5/2 61Z survey. One small school of herring north of Pleasant Bay was observed. No herring spawn observed. 147 sea lions and 3 whales observed with majority of activity between Blackjack and Sorefinger. This was the first survey of the season that herring were seen in Seymour. Hobart was included in this survey and a **spot spawn** and herring school were observed inside Entrance Island.

5/3 61Z survey. No herring or herring spawn observed. 101 sea lions and 6 whales observed with activity spread from #9 Rock to Point Hugh and the largest concentration between Blackjack and Point Hugh.

5/4 61Z survey. No herring or herring spawn observed. 47 sea lions and 4 whales observed with most sea lions spread from #9 Rock to Twin Islands. Lowest count of sea lions yet (possibly related to spawning in Hobart).

5/5 61Z survey–8:20am. One school of herring observed north of Winning Cove. No herring spawn observed. 112 sea lions and 5 whales observed with most activity between #9 Rock and Twin Islands. Four larger boats (packers and/or hotel boats) associated with fishery now on grounds combined with several gillnetters.

5/5 61Z survey–6:00pm. One small school of herring observed north of the Swimming Pool. No herring spawn observed. 118 sea lions and 10 whales observed with sea lions spread out all along the inside of the peninsula and most whale activity in the Blackjack Cove vicinity. More boats associated with the fishery were observed heading towards Seymour in Stephens Passage.

5/6 61Z survey–7:30am. No herring or herring spawn observed. 168 sea lions and 3 whales observed with the majority of activity from just north of the Swimming Pool to Point Hugh. Sea lions were observed to be generally much more active on this survey.

-continued-

5/6 61Z survey–5:45pm. Herring schools observed on the outside of Glass Peninsula in the region of the lone island across the peninsula from Twin Islands and also between Point Hugh light and Cloverleaf Rocks. No herring spawn observed. Approximately 130 sea lions and 5 whales observed with activity spread out on both sides of the peninsula and significantly more sea lions remaining on the inside.

5/7 61Z survey–8:15am. Several light **spot spawns** observed just north of Point Hugh light. Numerous schools observed on outside of Glass Peninsula from Lone Island in the north to just north of Point Hugh in the south. This was the first herring spawn of the season observed in the Seymour area.

5/7 61Z survey–4:15pm. **Active spawn expanding** slightly to the north. Numerous herring schools observed on outside of Glass Peninsula scattered from north of Midway Point in the north to just north of Point Hugh in the south. One school also observed in the Cypress Rock area on the inside of the peninsula.

5/7 15V survey–7:50pm. **Active spawn expanding** south of Point Hugh light to Cloverleaf Rocks. **1.4 nm of active spawn** observed by end of day. Numerous schools of fish observed starting from Point Hugh light, south to Point Hugh, and around the corner on the inside of the peninsula to the District 10/11 boundary.

5/8 61Z survey–7:10am. **Active spawn** on the outside of the Glass peninsula starting just south of Lone Island and extending south to the Dogleg with dissipating patches continuing south to Cloverleaf Rocks.

5/8 61Z survey–4:45pm. **Active spawn** just south Lone Island on outside of Glass Peninsula with areas of patchy spawn and drift extending south to the Dogleg, small spot spawns also observed in Cloverleaf Rocks area and slightly to south. Herring schools observed north of Lone Island on the outside, at Point Hugh, and south of Twin Islands on the inside.

5/8 61Z survey–5:15pm. Active spawn in same locations as previous survey for a total of **4.5 nm of spawn for the day**. Many schools observed from Cloverleaf Rocks to Point Hugh on outside and in the Blackjack Cove area north to Twin Islands. This was the peak spawning day of the season. Observations of spawn and schools were also reported to us throughout the day from industry pilots.

5/9 61Z survey. Small spots of active spawn observed on and near Lone Island on outside of Glass Peninsula, and from Cloverleaf Rocks to Point Hugh. Numerous schools observed offshore north of Midway Point, as well as smaller schools scattered from the Swimming Pool area to Sorethumb Cove. **0.8 nm of active spawn** observed today.

5/10 61Z survey. One small section of active spawn south of Lone Island on the outside of the Glass Peninsula, a few small spots at Point Hugh, and two small spots north of Point Hugh along the inside of the peninsula were observed. Schools were observed offshore north of Midway Point and one tiny school was observed inside Sorethumb Cove. **0.7 nm of active spawn** observed today.

-continued-

5/11 61Z survey. Two small sections of active spawn observed just northwest of Point Hugh on the inside of the Glass Peninsula, and more extensive spawn observed north of Blackjack Cove to just south of the Twin Islands. One school of herring observed north of the active spawn occurring south of Twin Islands. **1.5 nm of active spawn** observed today.

5/12 skiff survey. Approximately **0.3 nm of active spawn** observed just south of Twin Islands.

Appendix C7.–Aerial and skiff herring spawn surveys by date, in Tenakee Inlet (Juneau Management Area), in Southeast Alaska, 2013.

Tenakee Inlet

Number of times surveyed: 17 total (includes 2 flights by Sitka staff, and 1 flight by SK/DG).

Total nautical miles of spawn: 5.4 nm

Spawning dates: 5/7–5/10

Peak spawn: 5/9

4/15 First aerial survey of season in Ward Air C-185. No herring or herring spawn observed. 32 sea lions and 5 whales in deep water observed in general vicinity of Kadashan flats area.

4/17 C-185 survey. No herring or herring spawn observed. 84 sea lions along south shore and 5 whales in deep water. Most activity between Corner Bay and Crab Bay.

4/19 C-185 survey. Herring schools observed pressed up against Kadashan flats and just to the west of the flats. No herring spawn observed. 60 sea lions and 19 whales were observed concentrated between Crab Bay and Kadashan flats. Many of the whales were actively feeding in shallow water.

4/20 C-185 survey. Herring schools observed just off of Kadashan flats. No herring spawn observed. 67 sea lions and 10 whales observed between Crab Bay and Kadashan flats. The herring schools were in tight balls and predators were less actively feeding than on the previous survey with most of the sea lions in two large groups outside of Crab Bay. Freshwater Bay was also surveyed and was very quiet.

4/21 C-185 survey. No herring or herring spawn observed. 71 sea lions and 16 whales observed along south shoreline with most of the whales having moved off to deeper water. Sea lions were mostly in large groups and were inactive.

4/23 C-185 survey. No herring or herring spawn observed. 97 sea lions and 7 whales observed along south shoreline with most sea lions in large groups outside of Crab Bay and whales much more spread out in the inlet.

4/25 61Z survey (first survey in the revamped cub). No herring or herring spawn observed. 93 sea lions and 2 whales observed along south shoreline with a large group of sea lions between Crab Bay and Kadashan flats and others spread north of Crab Bay to Corner Bay.

4/27 61Z survey. No herring or herring spawn observed. 73 sea lions and 7 whales observed on south shoreline with sea lions extending out to South Passage Point. The majority of whale and sea lion activity had shifted between Crab Bay and Saltery Bay.

-continued-

4/29 61Z survey. No herring or herring spawn observed. 60 sea lions and 0 whales observed on south shoreline with most of the sea lions grouped together outside of Crab Bay. This was the first survey of Tenakee for the season with no whales observed.

5/2 61Z survey. No herring or herring spawn observed. 57 sea lions and 1 whale observed on south shoreline with most activity between Kadashan and Crab Bay.

5/4 61Z survey. No herring or herring spawn observed. 36 sea lions and 2 whales observed on south shoreline with most activity between Crab Bay and Kadashan.

5/6 61Z survey. No herring or herring spawn observed. 40 sea lions and 5 whales observed on south shoreline with most sea lion activity shifted north and west of Crab Bay.

5/7 Sitka staff survey – am. **Spot spawns** observed between Crab Bay and Kadashan. Schools of herring observed associated with the spawn.

5/7 61Z survey–5:40pm. **1.0 nm of light density spawn** observed between Crab Bay and Kadashan. Herring schools observed associated with active spawn and just to the west of the spawn towards Crab Bay.

5/8 61Z survey. **1.2 nm of active spawn** observed between Crab Bay and Kadashan flats. Herring schools observed associated with spawn and just west of active spawn towards Crab Bay.

5/9 Ward Air survey (Juneau staff – SK/DG). Active spawn observed from LTF outside of Crab Bay east to Corner Bay. Over **4 nm of active spawn** was observed making this the peak day of spawning inside Tenakee.

5/10 Sitka staff survey. Small section of active spawn observed just outside of Crab Bay on the northern shoreline and small spots observed between Kadashan flats and Corner Bay. **0.25 nm of active spawn** observed today.

Appendix C8.–Aerial and skiff herring spawn surveys by date, in Lynn Canal (Juneau Management Area), in Southeast Alaska, 2013.

Lynn Canal

Number of times surveyed: 11 total (includes one flight by SK/KH).

Total nautical miles of spawn: 8.6 nm

Spawning dates: 5/5–5/9

Peak spawn: 5/8

4/15 First aerial survey of season in Ward Air C-185. No herring or herring spawn observed. 49 sea lions and 3 whales observed in Berners Bay with most activity on Cascade Point shoreline.

4/19 C-185 survey. No herring or herring spawn observed. 90 sea lions and 1 whale were observed with most activity just off the Berners flats. Sea lion haul-out at Benjamin Island was mostly full. Predators appear to be targeting staging eulachon off of flats. No eulachon activity seen on the flats.

4/23 C-185 survey. No herring or herring spawn observed. Around 100 sea lions and 4 whales were observed in Berners Bay. Large groups of sea lions were observed just off the Berners flats with one actively swimming and diving group of at least 25 sea lions closer to Point St. Mary. No eulachon activity seen on the flats. The Benjamin Island haul-out appeared less full than on the previous survey.

4/27 61Z survey. No herring or herring spawn observed. 115 sea lions and 6 whales observed in Berners Bay with majority of sea lions actively feeding inside Slate Cove.

4/29 61Z survey. No herring or herring spawn observed. 149 sea lions and 5 whales observed in the Berners Bay area with huge groups of sea lions rafted together just off the Berners flats. One school of fish was observed near the flats in shallow water on the east side of the bay. They were likely eulachon as they did not shimmer. No eulachon activity was seen on the flats.

5/2 61Z survey. No herring or herring spawn observed. 92 sea lions and 4 whales observed in Berners Bay with far less activity off the edge of the Berners flats. No eulachon activity was seen on the flats.

5/5 61Z survey. Approximately **1.2 nm of active spawn** observed extending from Point Bridget east towards Echo Cove. Schools of herring also observed immediately south of the active spawn on Point Bridget and in the Bridget Cove vicinity. The number of predators associated with this spawning event was minimal. The northern section of Berners Bay was not surveyed due to runoff from the Berners drainage allowing no visibility into the water.

-continued-

5/6 61Z survey. Approximately **0.9 nm of active spawn** observed extending from Point Bridget south towards Mabb Island. Numerous schools of herring were observed around Cascade Point, east of Point Bridget, and in and around Bridget Cove. 47 sea lions and 5 whales were observed with most predators associated with fish east of Point Bridget. Birds and seals were observed on the Berners flats which may suggest eulachon activity.

5/7 61Z survey. **2.0 nm of active spawn** observed south of Point Bridget, inside Bridget Cove, and just south of Bridget Cove. No herring schools observed on this survey.

5/8 61Z survey. **4.0 nm of active spawn** observed south of Point Bridget, inside and outside of Mabb Island, inside Bridget Cove, and south of Bridget Cove to just north of Sunshine Cove. Small schools of herring observed north of Point St. Mary, north of Sunshine Cove, along road system inside of Benjamin Island, and in the northern portion of Tee Harbor. This was the peak day of spawning in Lynn Canal.

5/9 Ward Air survey (Juneau staff – SK/KH). **Small amount of active spawning** observed. Appeared that Lynn Canal spawning event was wrapping up.

5/24 Local resident (Mark) called to report **spawn in Tee Harbor**.

5/27 Local resident (Jim Andel) reported small amount of **spawn in Auke Bay** in front of Spaulding Condos. Herring were trapped in a pool by the falling tide. Good sized fish, ravens had to sort through for the smaller ones. 1st time in 12 years he's been here he's observed spawn here.

Appendix C9.–Aerial and skiff herring spawn surveys by date, in Port Frederick, Oliver Inlet, Taku Harbor, and Stephens Passage (Juneau Management Area), in Southeast Alaska, 2013.

Port Frederick

Number of times surveyed: 9 total.

Total nautical miles of spawn: none observed

4/15 First aerial survey of season in Ward Air C-185. No herring or herring spawn observed. 5 sea lions observed. Very quiet.

4/19 C-185 survey. No herring or herring spawn observed. No predators.

4/23 C-185 survey. One school of herring observed inside Hoonah harbor. No herring spawn observed. 3 sea lions observed between The Narrows and Burnt Point.

4/25 61Z survey (first survey in the revamped cub). No herring or herring spawn observed. 2 sea lions observed around Cannery Point.

4/27 61Z survey. 3 schools of herring observed (one west of The Narrows, one near Game Point, and one inside Hoonah harbor). No herring spawn observed.

4/29 61Z survey. No herring or herring spawn observed. No predators.

5/2 61Z survey. Possible school of herring observed off of Seagull Creek flats. No herring spawn observed. 7 sea lions observed with most of them around small ball of fish.

5/6 61Z survey. Numerous schools of fish extending from The Narrows north and east along the shoreline to Burnt Point. No herring spawn observed. 3 sea lions observed around fish south of Burnt Point, 2 whales observed northwest of Hoonah.

5/8 61Z survey. Numerous schools observed scattered from The Narrows north and east to Game Point with the concentration of schools from Seagull Creek to north of Burnt Point. No herring spawn observed. One whale observed near school south of Game Point.

Oliver Inlet

Number of times surveyed: 16 total.

Total nautical miles of spawn: none observed

4/15 First aerial survey of season in Ward Air C-185. No herring or herring spawn observed. 12 sea lions observed outside on NW spit.

4/17 C-185 survey. No herring or herring spawn observed. 15 sea lions observed outside.\

4/19 C-185 survey. No herring or herring spawn observed. 8 sea lions observed on outside.

-continued-

4/21 C-185 survey. No herring or herring spawn observed. No predators.

4/23 C-185 survey. No herring or herring spawn observed. 6 sea lions observed outside.

4/25 61Z survey (first survey in the revamped cub). No herring or herring spawn observed. 7 sea lions observed outside.

4/27 61Z survey. No herring or herring spawn observed. 2 sea lions observed outside.

4/29 61Z survey. No herring or herring spawn observed. No predators.

4/30 Ward Air C-206 survey. No herring or herring spawn observed. No predators.

5/2 61Z survey. No herring or herring spawn observed. No predators.

5/3 61Z survey. No herring or herring spawn observed. Two small balls of fish observed just west of spit outside inlet. No predators.

5/4 61Z survey. No herring or herring spawn observed. No predators.

5/5 61Z survey – 8:00am. No herring or herring spawn observed. No predators.

5/5 61Z survey – 5:20pm. No herring or herring spawn observed. One whale on outside.

5/6 61Z survey – 7:20am. No herring or herring spawn observed. One whale outside, offshore.

5/6 61Z survey – 5:30pm. No herring or herring spawn observed. No predators.

Taku Harbor

Number of times surveyed: 2

5/5 61Z survey. No herring or herring spawn observed. 8 sea lions observed south of Stockade Point.

5/8 61Z survey. No herring or herring spawn observed. No predators.

Stephens Passage

4/15 First aerial survey of season in Ward Air C-185. No herring or herring spawn observed. Very quiet from Grand Island to Midway Point.

5/5 61Z survey. No herring or herring spawn observed.

5/8 61Z survey. Numerous schools of herring seen mostly in deeper water along the shoreline south of Twin Points nearly to Point Glass on the outside of the Glass Peninsula. One school also observed between Point Glass and Midway Point.

Appendix C 10.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2013.

Yakutat Bay

4-19: Schools of herring seen in Monti Bay, near boat harbor. Locals jigging up herring off the docks in the harbor. Herring look huge, ~200gms.

4-20: Schools of herring still at the harbor. Water a bit milky but no heavy spawn was apparent. Took the skiff out to assess the Bay. Went to Canoe Pass, Redfield Bay, and around Kantack Islands (north and south end). Heavy bird activity near the south end but no herring observed. No spawn was seen. Local reports of a small spot spawn in the Bay but unsure of exact location.

4-21: Heavy spawn in Monti Bay, and up in Yakutat Bay near Khantaak Island. Reports on lots of herring caught in subsistence nets in the Bay.

4-22: Spot spawn in Monti Bay near fuel dock. Several miles of spawn on east side of Khantaak Island. More bird activity and sea lions. Several whales in Monti Bay.

4-23: Heavy spawn seen around Ankua. Collected 7 buckets of herring samples for lab. ~500 herring collected with smolt seine near mouth of Ankau Creek.

4-24: Surveyed in skiff. Saw about a mile of spawn near Humpy Creek. Checked out Redfield Cove, Humpback Cove, Eleanor Cove, Chicago Harbor and Knight Island where spawn was heavy in 2013 but no spawn was seen. 6 sealions seen off north end of Khantaak Island. Lots of bird activity as well. Spawn was present for several miles off the north end of Khantaak Island.

4-25: Spawn present along the shore by processing plant in Monti Bay, lots of bird activity and sea lions on south end of Khantaak Island.

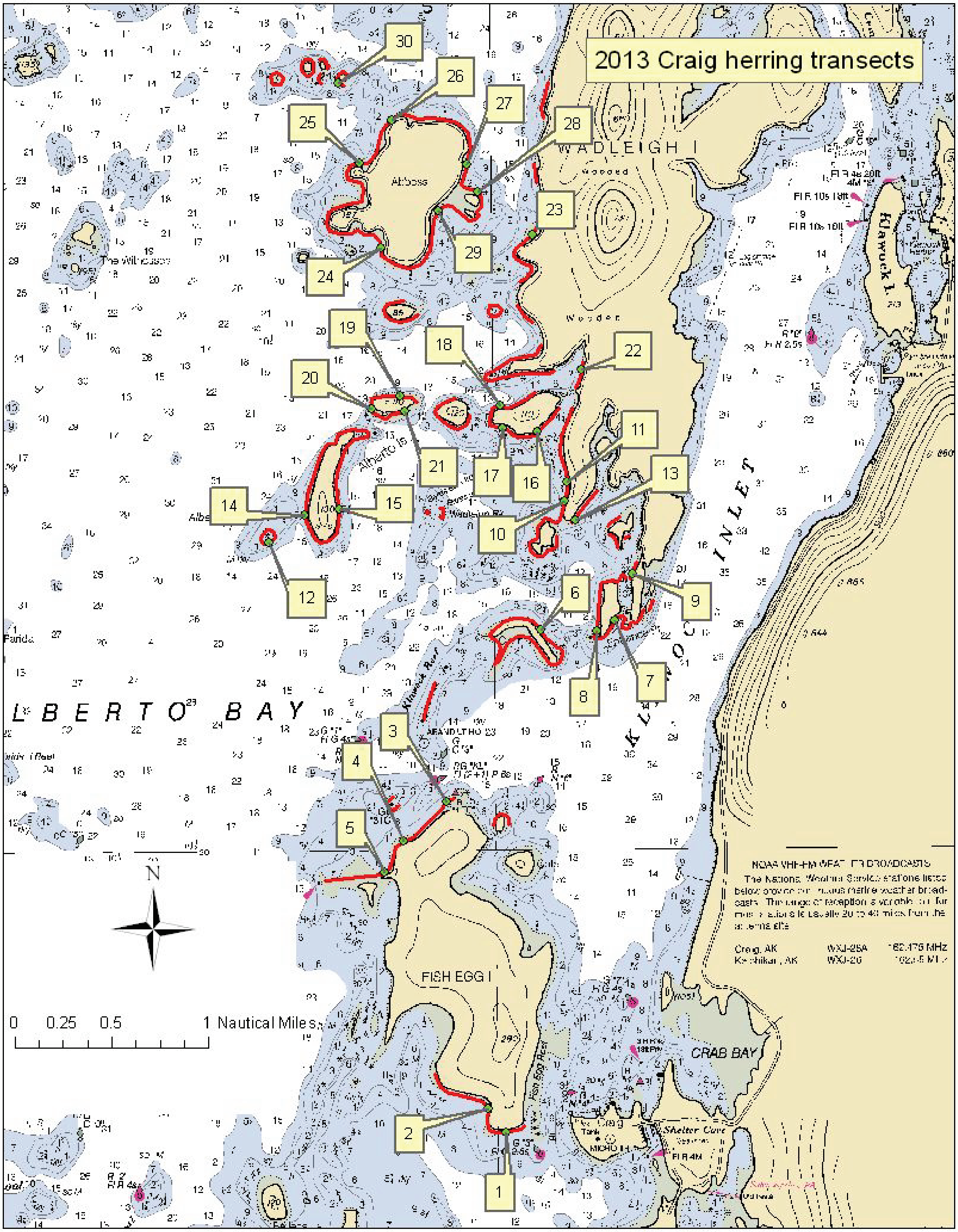
4-28: spawn around Doggie Island

4-30: Flew with USFS conducting an aerial survey for Eulachon. Focused on areas south of town toward Dry Bay. Flew a partial survey over Monti Bay on the way back. Clear, sunny skies with good visibility. Observed old spawn around Yakutat Seafood's plant shoreline and new spawn (~1 mile) on SW tip of Khantaak Island off Point Munoz. Saw several 100 ton balls of herring off shore near Dangerous River.

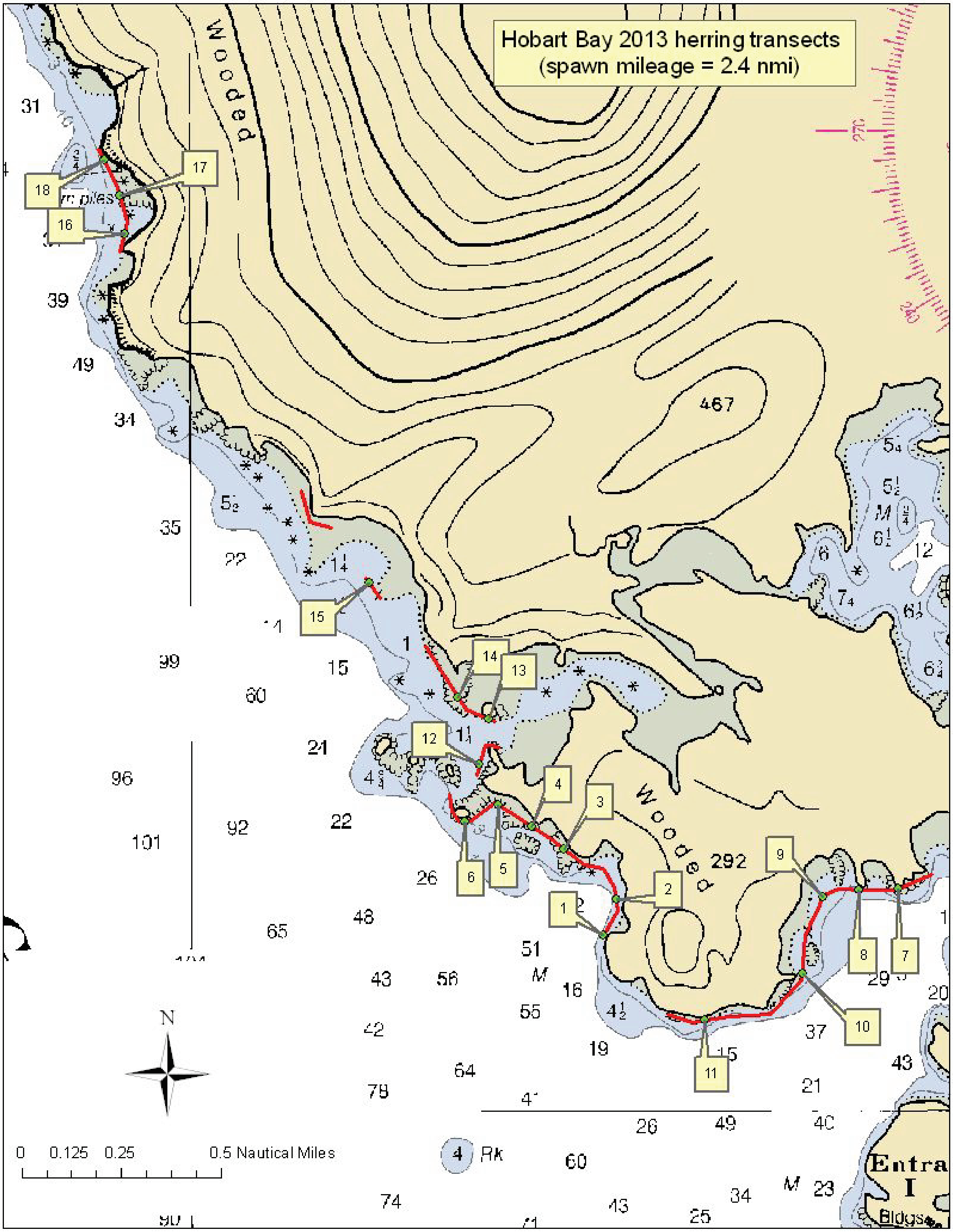
In summary: The first spawn began on April 20, peaked on April 22 and concluded on April 30. A cumulative total of 6.1 nautical miles of spawn were recorded in 2013.

APPENDIX D: SPAWN AND SPAWN DEPOSITION SURVEY TRANSECT LOCATIONS

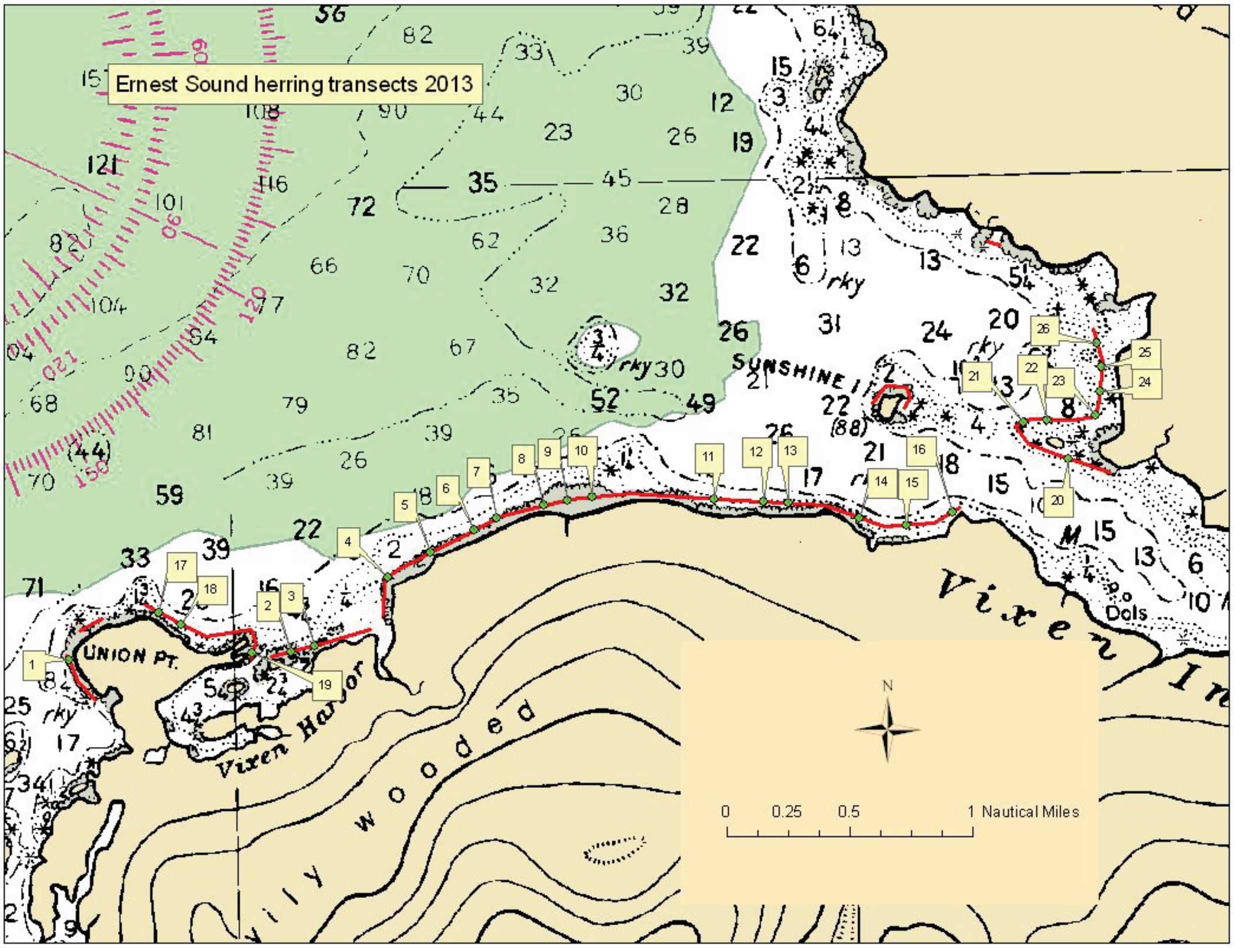
Appendix D1.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Craig herring stock in 2013.



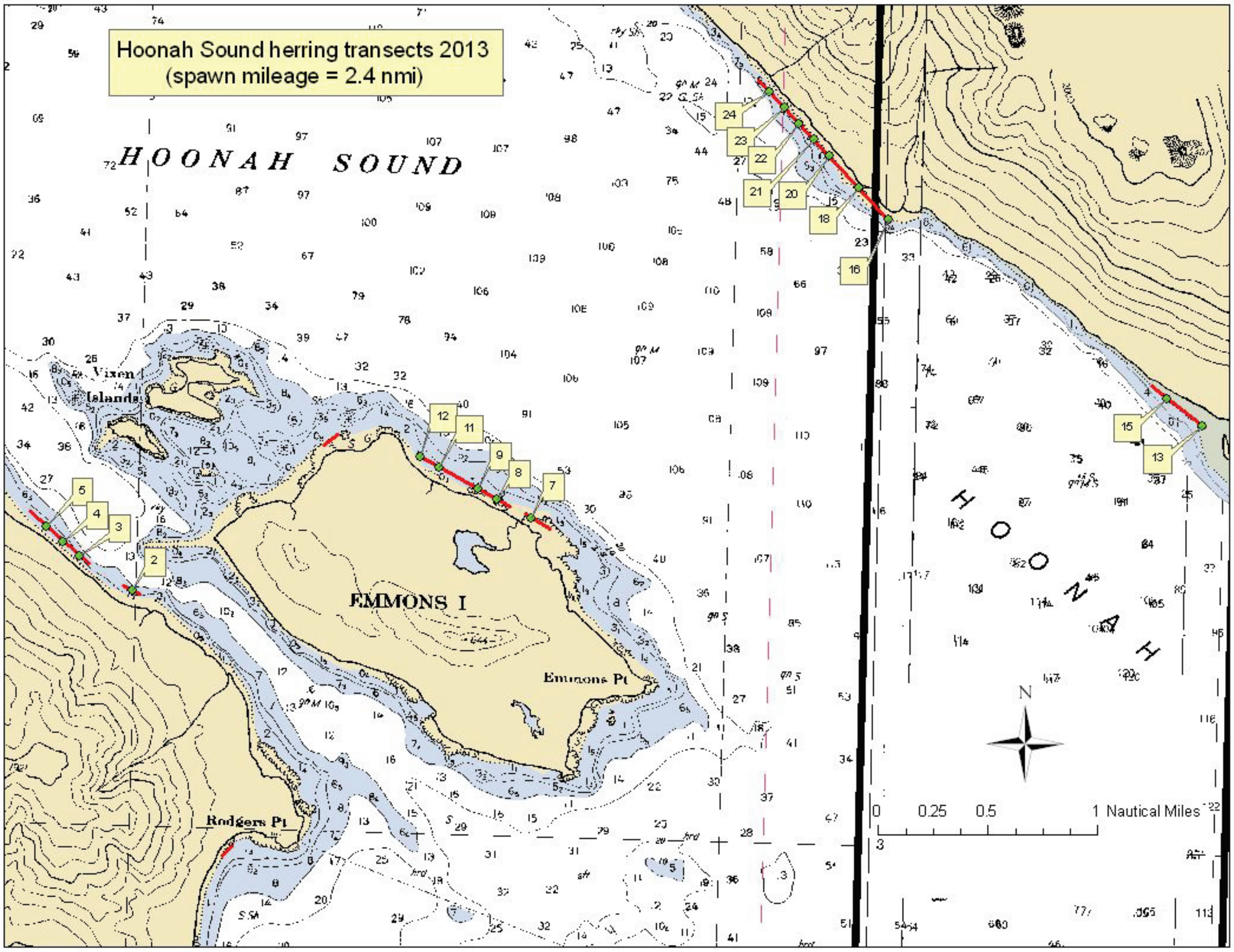
Appendix D2.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hobart Bay/Port Houghton herring stock in 2013.



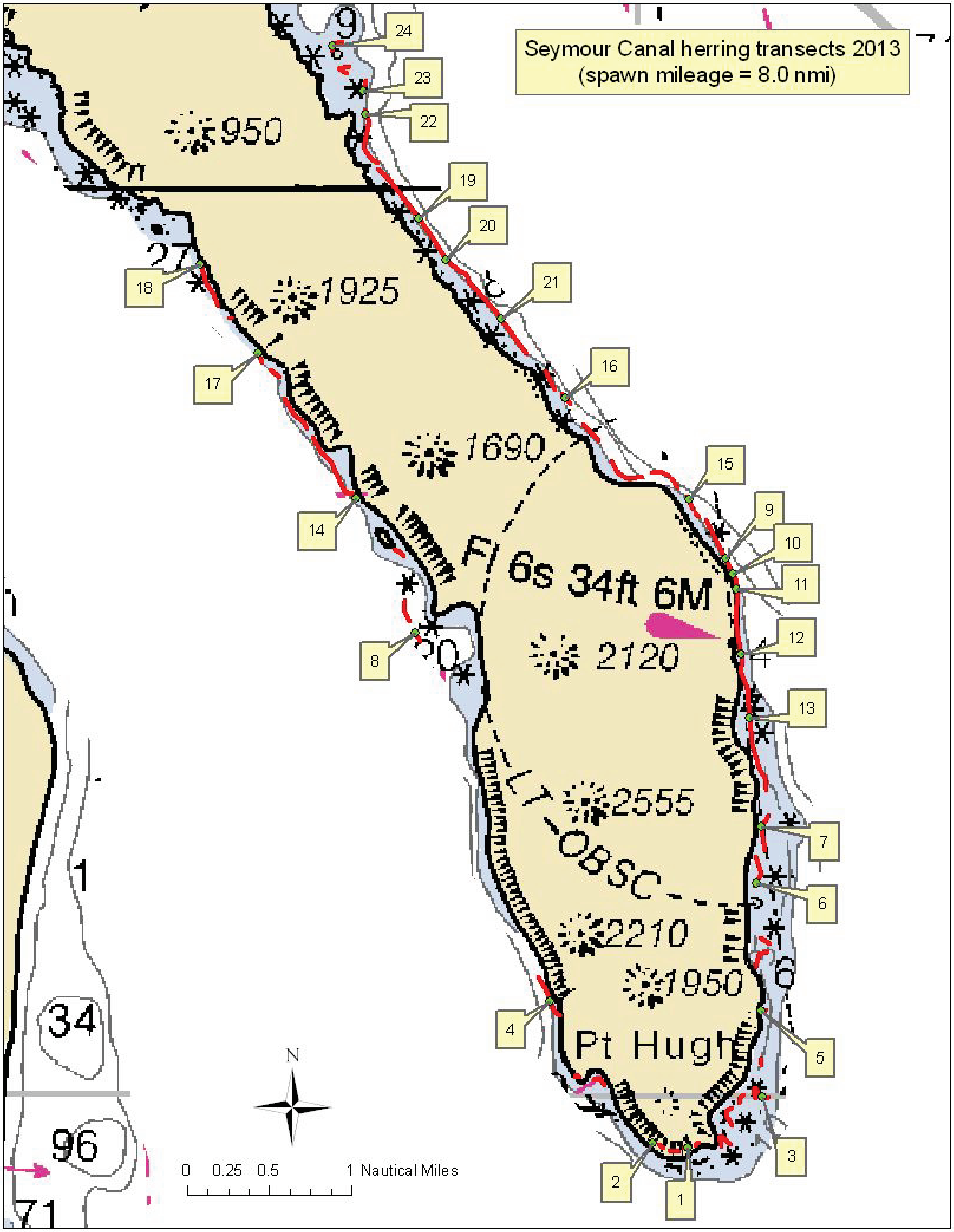
Appendix D3.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Ernest Sound herring stock in 2013.



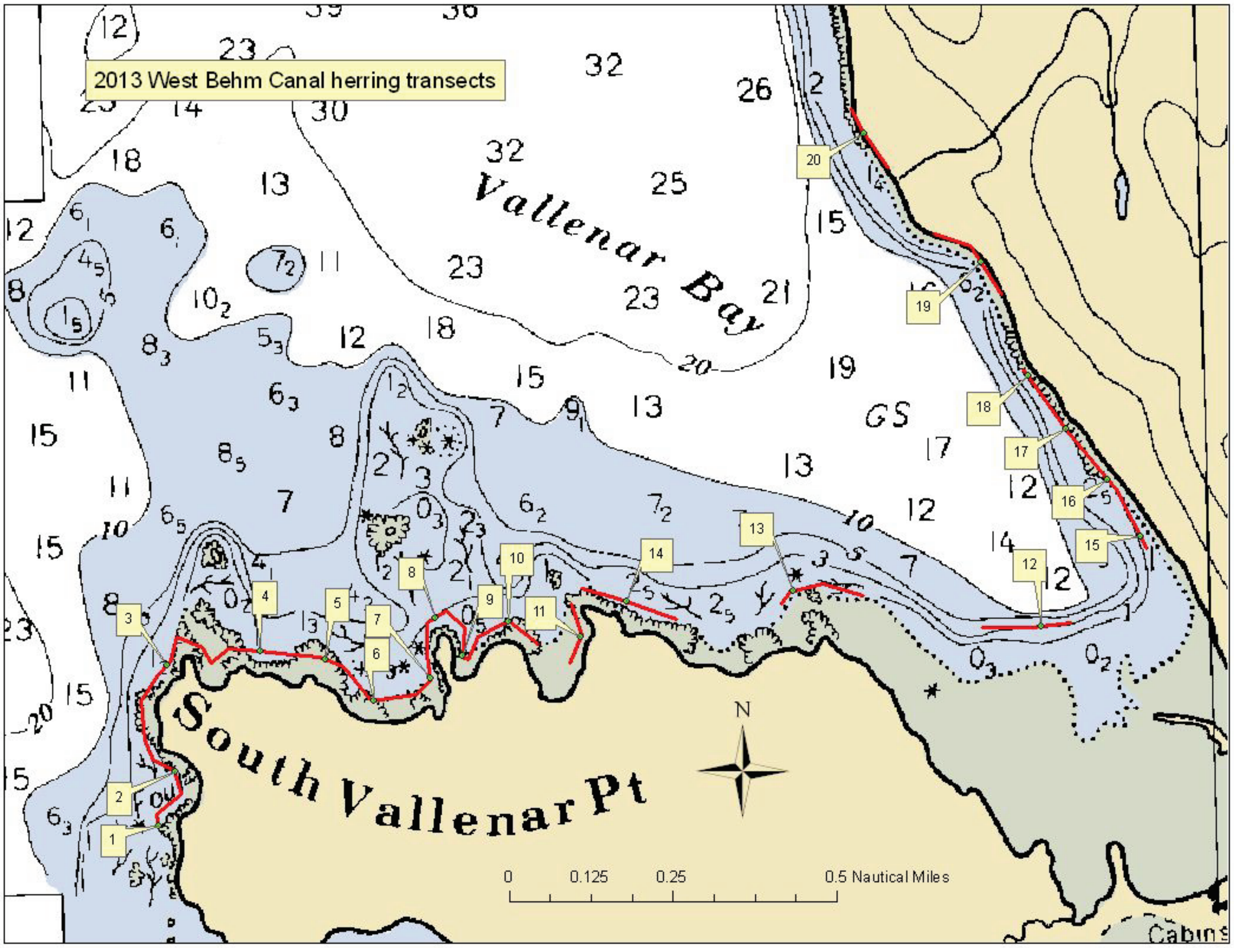
Appendix D4.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hoonah Sound herring stock in 2013.



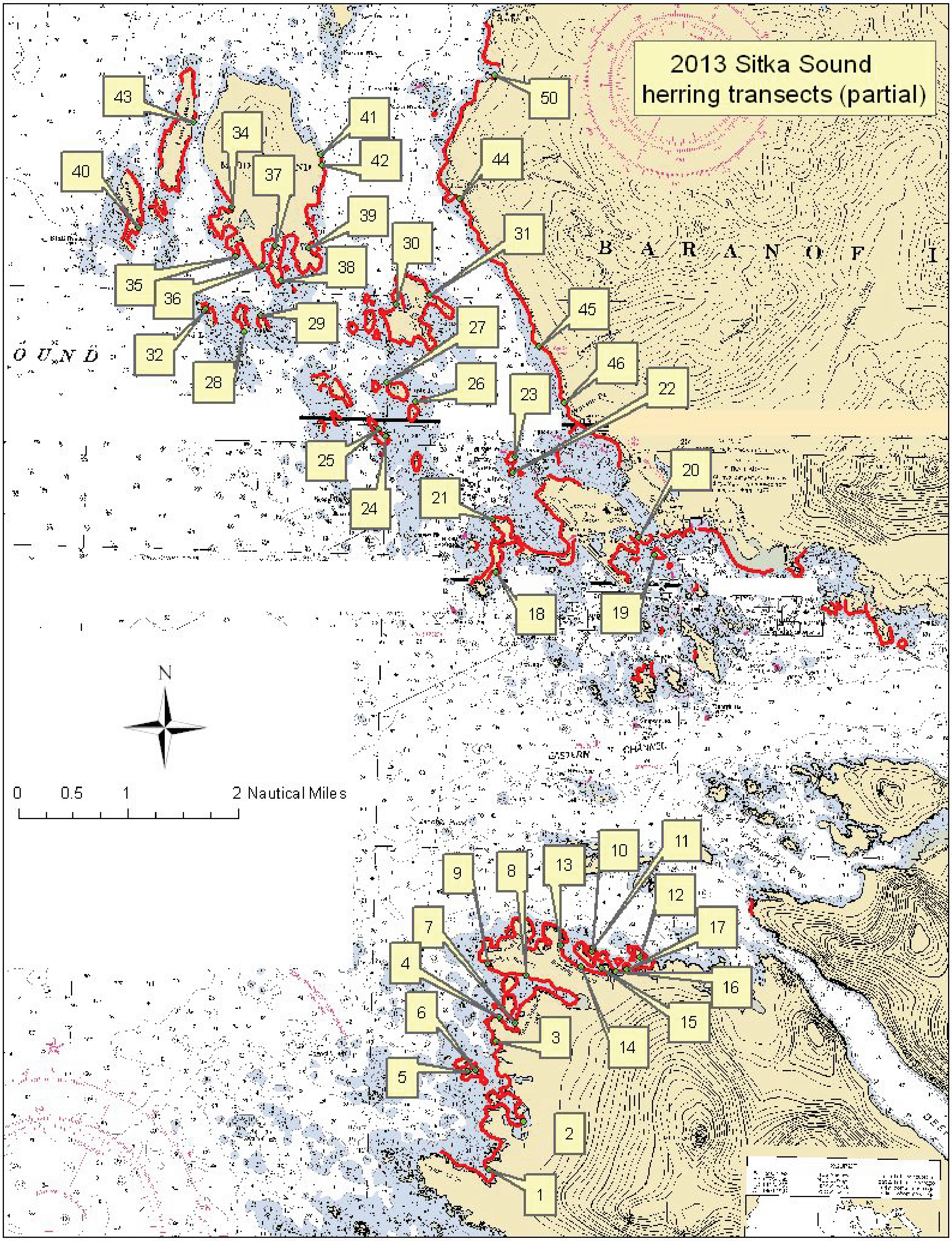
Appendix D5.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Seymour Canal herring stock in 2013.



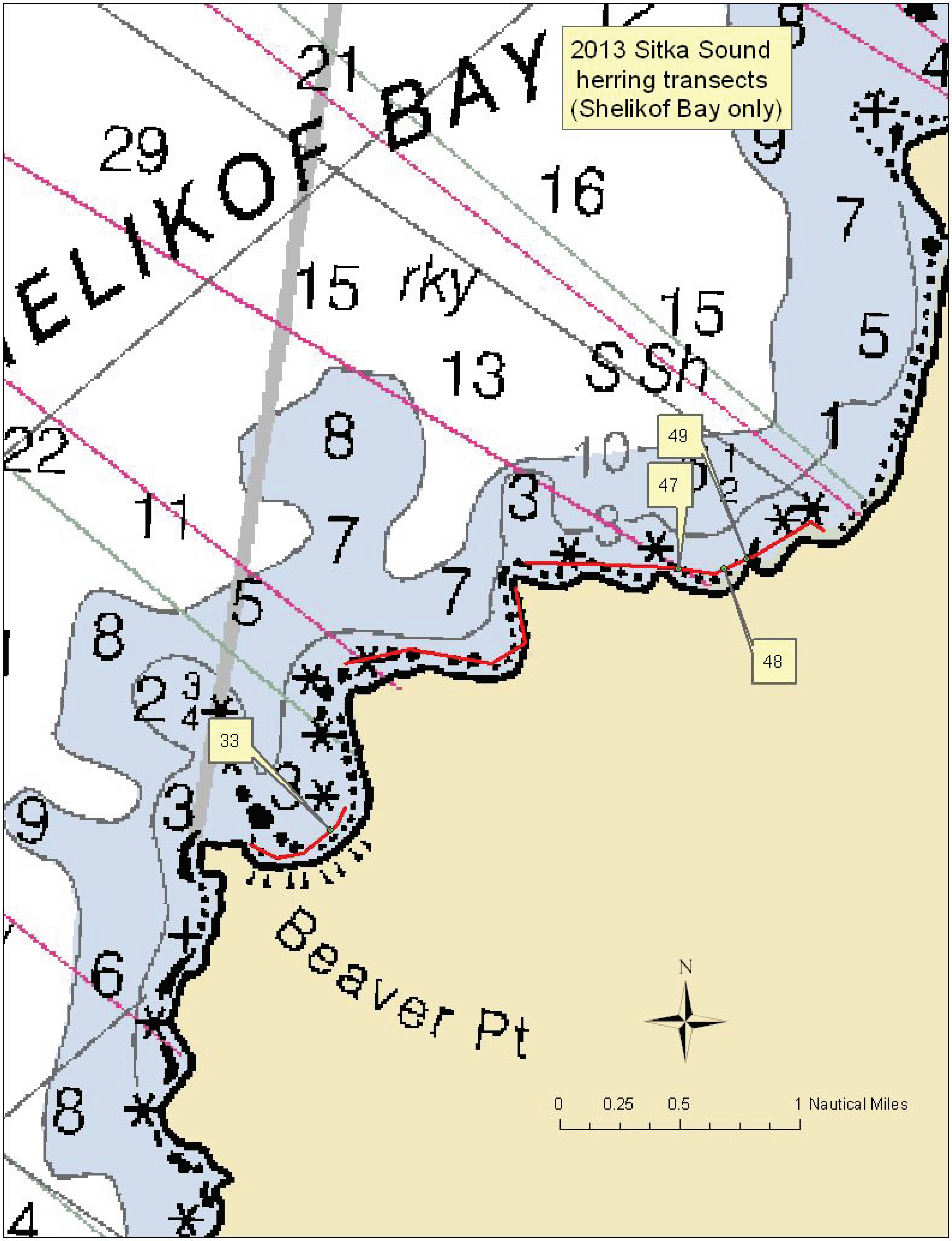
Appendix D6.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2013.



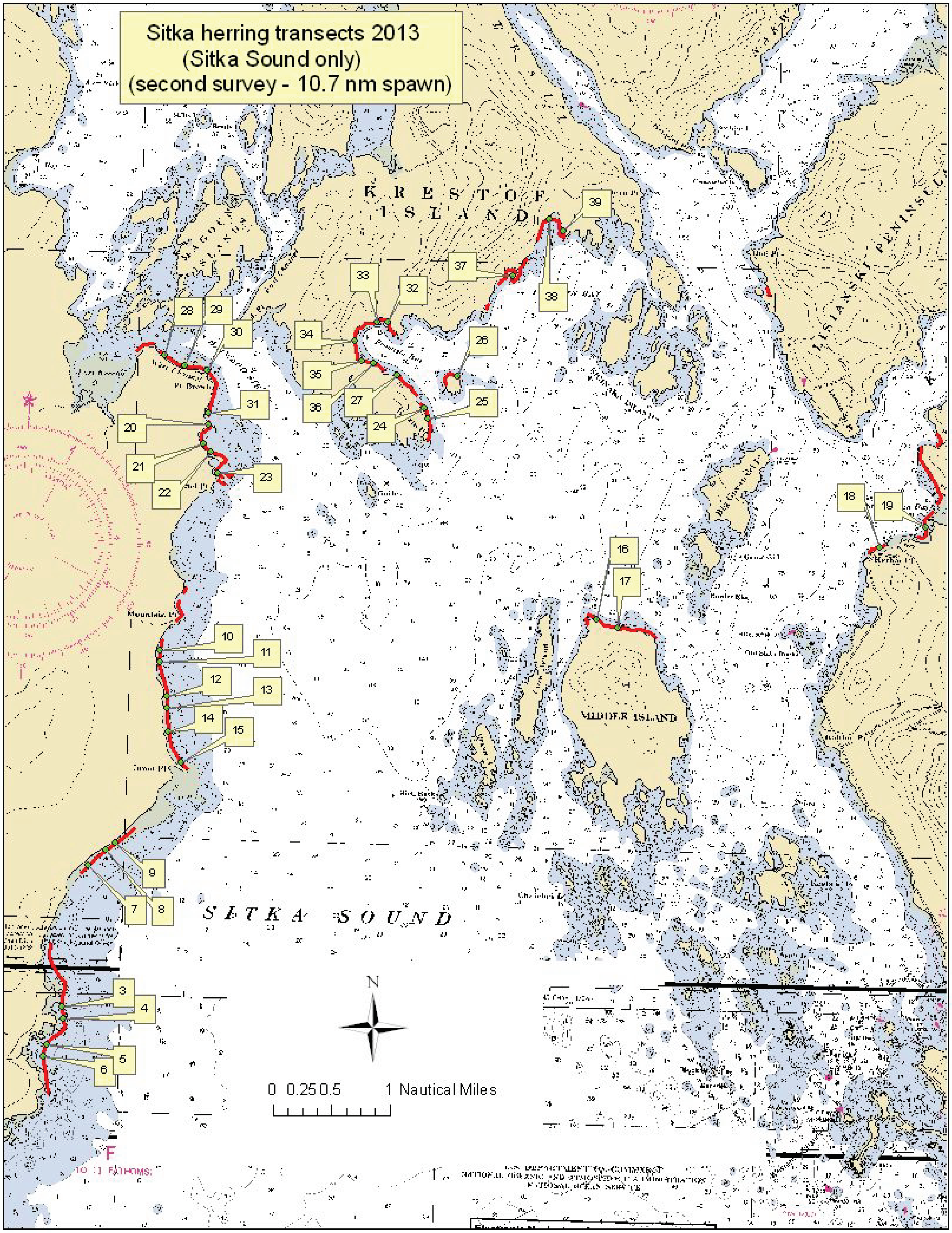
Appendix D7.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock first survey in 2013 (transects within Sound only).



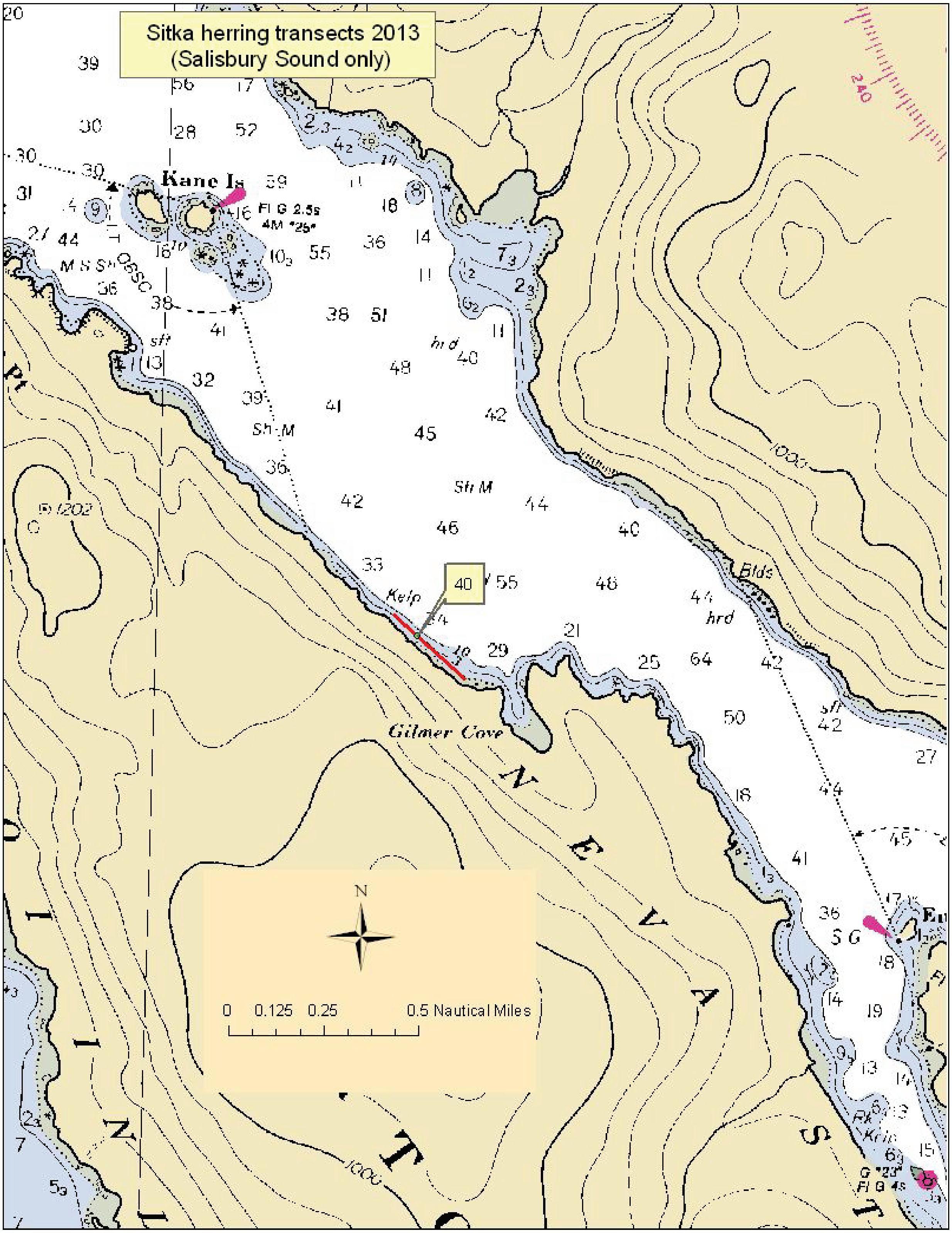
Appendix D8.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock first survey in 2013 (Shelikof Bay transects only).



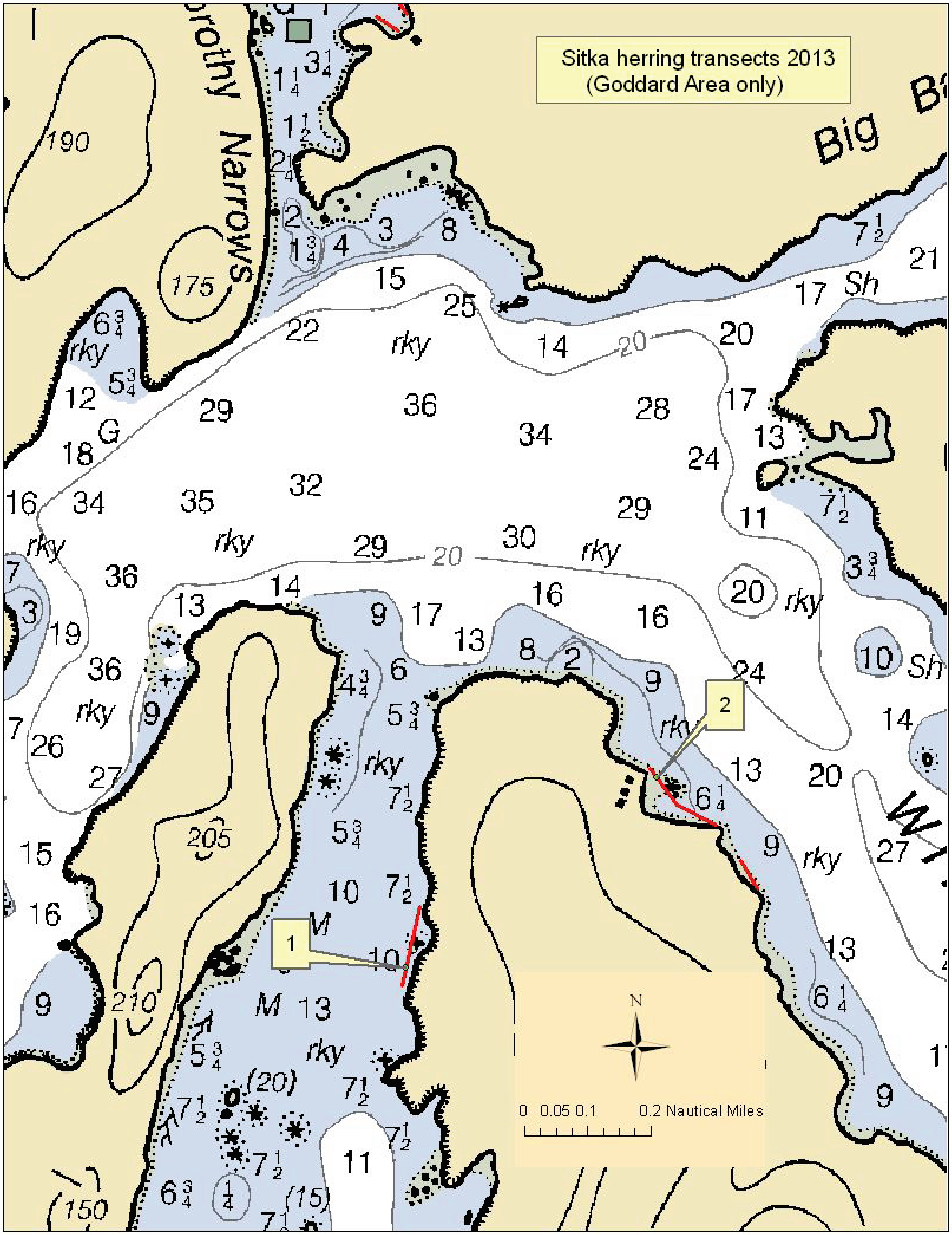
Appendix D9.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock second survey in 2013 (transects in Sound only).



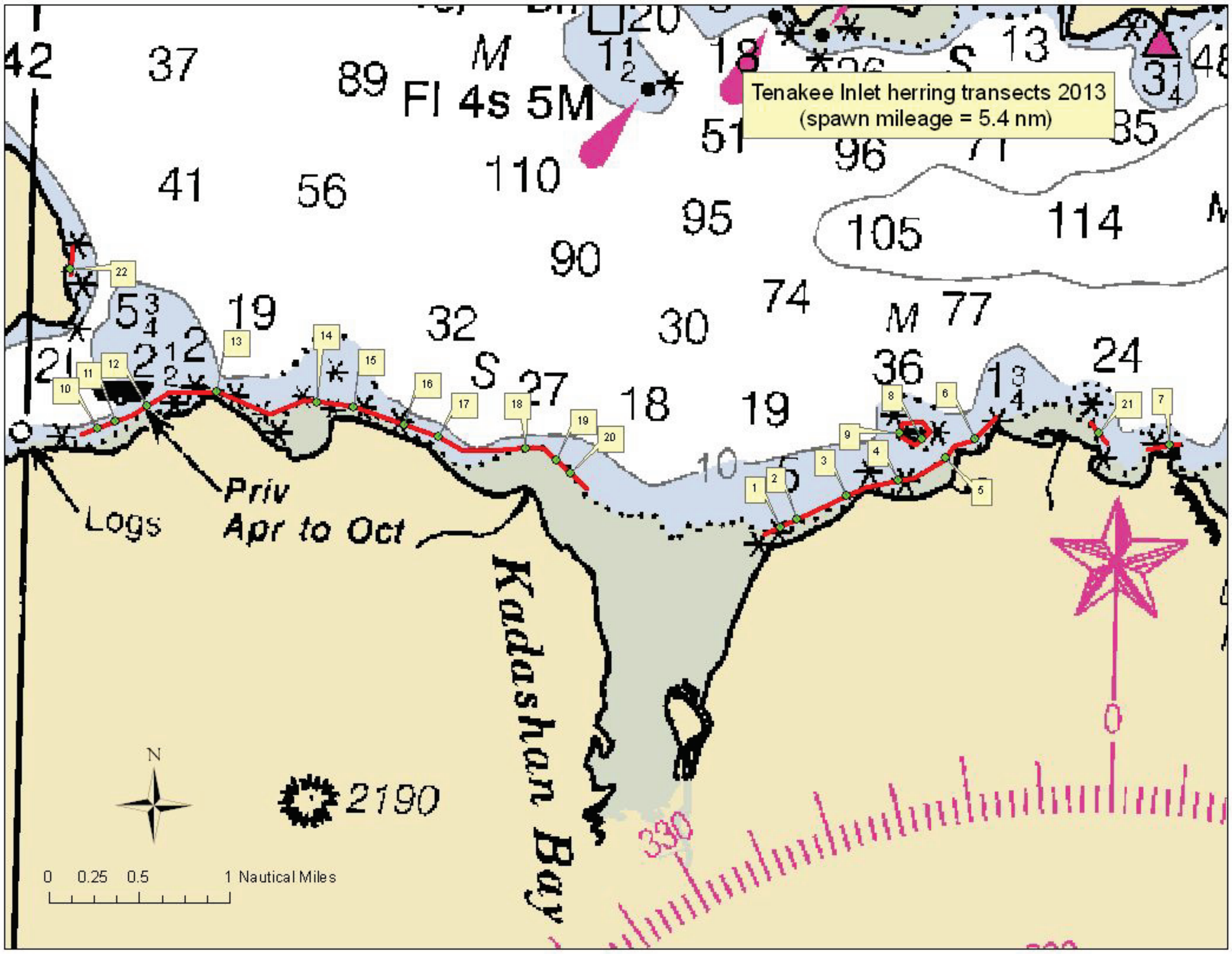
Appendix D10.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock second survey in 2013 (transects in Neva Strait only).



Appendix D11.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock second survey in 2013 (transects in Goddard area only).



Appendix D12.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Tenakee Inlet herring stock in 2013.



Appendix D13.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Lynn Canal herring stock in 2013.