Fishery Data Series No. 13-08

Southeast Alaska 2012 Herring Stock Assessment Surveys

by

Kyle Hebert

March 2013

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. 13-08

SOUTHEAST ALASKA 2012 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

March 2013

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. 2013. Southeast Alaska 2012 herring stock assessment surveys. Alaska Department of Fish and Game, Fishery Data Series No. 13-08, Anchorage.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

LIST 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 2012, 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, Lynn Canal, Slocum Arm, and Farragut Bay. The combined total cumulative shoreline where spawn was documented in 2012 for surveyed areas was 122.8 nautical miles. In 2012, post-fishery biomass estimates, combined for all surveyed stocks, totaled 115,744 tons. Excluding Slocum Arm and Farragut Bay, which have not been surveyed historically, the combined total post-fishery biomass was estimated at 102,955 tons, which was the lowest documented since 2003.

During the 2011–12 season, winter bait fisheries were opened in Craig and Ernest Sound with guideline harvest levels totaling 4,353 tons. A gillnet sac-roe fishery was announced for Seymour Canal and purse seine sac-roe fisheries were announced for Sitka Sound and West Behm Canal; however, these fisheries were not opened or fell short of the guideline harvest level due to lack of acceptable fishing opportunity. Spawn-on-kelp fisheries were open in Craig and Hoonah Sound. No commercial fisheries were opened in Hobart Bay-Port Houghton, Tenakee Inlet, Kah Shakes/Cat Island, or Lynn Canal. Herring harvested commercially during the 2011–12 season totaled over 13,000 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 2011 through spring 2012 and provide historical perspective by presenting general trends in Southeast Alaska herring populations.

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

METHODS AND PROCEDURES

AERIAL AND SKIFF SURVEYS

A combination of aerial and skiff surveys were used to record spawning activities during the spring, to document spawn timing, and estimate the distance of shoreline that received herring spawn for all major spawning areas (Figure 1), and for many minor spawning areas in Southeast Alaska. Aerial surveys 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 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

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

oriented along the spawn and is such that transects laid perpendicularly to the spawn line will sample egg density throughout the entire width of the spawn, without biasing the estimate. A second objective of measuring the spawn observed along shorelines is to obtain an estimate of spawn length, which factors into the estimate of overall spawn area, and is discussed more below.

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

Sample Size

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

The desirable number of transects is estimated as follows:

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

where

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

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

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

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

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

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

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

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

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

Field Sampling

Transect direction was determined by comparing the dive location to a chart with the spawn shoreline, and setting a compass bearing perpendicular to the spawn shoreline. Transects began at the highest point of the beach where eggs were observed and continued down to a depth in the sub tidal zone until no further egg deposition was observed, or to a maximum of 21 m (70 fsw) of depth. The portion of transects above the waterline were surveyed by walking until the water reached diving depth (usually 2 to 3 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 2010, 2011, and 2012 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 $\overline{d_i}$ 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

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

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* ($\overline{d_i}$) 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 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 2010 and was collected in the fall of 2011, two growing seasons had occurred (age-2). If the herring had been collected in the spring of 2012 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 2011–12 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 2011–12 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 2011–12 Southeast Alaska commercial herring fisheries. It was adopted by the Alaska Board of Fisheries at its January 1994 meeting.

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

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

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

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

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

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

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

RESULTS

AERIAL AND SKIFF SURVEYS

Aerial and skiff surveys of herring activity, herring spawn, and marine mammal/bird activity were conducted at major stock locations beginning on March 13, 2012, in Sitka Sound and ending on June 6, 2012, in Lynn Canal. Notes of activity related to herring or herring spawning were recorded in logs, which are presented in Appendix C. Surveys were conducted by staff in each area office (Ketchikan, Petersburg, Sitka, Juneau, Yakutat) and covered major and traditional herring spawning locations within each management area. 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 2.6 nmi of herring spawn on Annette Island in 2012.

SPAWN DEPOSITION SURVEYS

In 2012, spawn deposition surveys were conducted in the Sitka Sound, Craig, West Behm Canal, Ernest Sound, Hobart Bay/Port Houghton, Hoonah Sound, Tenakee Inlet, Lynn Canal, Seymour Canal, Slocum Arm, and Farragut Bay. Surveys began in Sitka Sound on April 13, and were completed in Seymour Canal on May 13 (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 2012 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 2012 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 2012 was 122.8 nmi (Table 5). This did not include spawning in several minor spawning areas, around Annette Island, or near Yakutat (see Appendix C for a detailed accounting of minor spawn areas throughout Southeast Alaska).

Visual Estimate Correction

Minimum sample size guidelines (at least three samples per kelp type for the most recent three years) were met using data from 2010 through 2012 for most (9 of 10) estimators. Correction coefficients applied to 2012 spawn deposition visual estimates ranged from 0.756 to 2.575 and are presented in Table 6.

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

AGE AND SIZE

A combined total of 6,923 herring were sampled from all stocks and gear types (cast net, purse seine, and pound) during the 2011–12 season. Of these, 6,856 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 Canal and Revilla Channel. Samples of the spawning population were collected throughout the geographic extent of the active spawn in most spawning areas (Figures 9-17). For most spawning areas, collection of samples from the spawning population was also distributed throughout the duration of spawning, or was focused on the most intense spawning events (Figure 2). Two areas where herring samples could not be collected due to spawn timing and time constraints in 2012 are Tenakee Inlet and Lynn Canal.

Samples were obtained from commercial and test fisheries for all areas where fisheries were conducted in 2011-12. Fisheries sampled included Craig winter bait, Craig spawn on kelp, Sitka sac roe, Sitka winter test fishery, Ernest Sound winter bait, and Hoonah Sound spawn on kelp. Samples were obtained opportunistically from vessels or tenders, during or shortly after the fisheries. 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). In one case, Craig winter bait purse seine, the sample size of 491 was just below the sample goal.

Age Composition

Age composition data was obtained for most major stocks in the region, although the spawn timing precluded cast net sampling in some areas, including Tenakee Inlet, Lynn Canal, and Hoonah Sound. Frequency distributions of ages for all stocks are presented in Tables 9–18 and Figures 20–29.

Distributions of ages were markedly similar among most southern stocks. Ernest Sound, West Behm Canal, and Revilla Channel all had very similar age distributions, with high proportions of age 3, 4, and 5 herring and low proportions of age 6, 7, and 8+ herring. 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 3, 4, and 5 herring had the highest proportions and age 6, 7, and 8+ had the lowest, however the differences in magnitude between those age groupings were not as great as for other southern stocks.

Among northern stocks, age distributions had strong similarities as well. Most notably, stocks in Seymour Canal, Hobart Bay/Port Houghton, and Hoonah Sound shared high proportions of age 3, 7, and 8 herring, and lower proportions of age 4, 5, and 6 herring. The similarity between Seymour Canal and Hobart Bay/Port Houghton was particularly striking. Although proportions at age in Hoonah Sound were similar, the age-3 proportion was not as high as observed in Seymour Canal and Hobart Bay/Port Houghton. The Sitka Sound stock age distribution was an exception in the region in that there was no close similarity to other stocks, although there was a general similarity to Hoonah Sound with lower proportions of age 3 and 4 herring and higher proportions of age 5 through 8+ herring. Although age samples were not obtained from Tenakee Inlet or Lynn Canal, age compositions from prior years suggest that the 2012 age distributions were probably similar to other northern stocks (see Figures 30–38 for age distribution time series for all stocks). By projecting forward age classes from previous years, it is apparent that there would be relatively high proportions of age 7 and 8 herring and low proportions of age 5 herring present in Lynn Canal and Tenakee Inlet during 2012. This age composition is also consistent with other northern stocks. Because no age data exists for 2012, age 3 proportions cannot be deduced for Tenakee Inlet or Lynn Canal, other than speculation that they may be high if they follow the pattern of other northern stocks. Likewise, age 4 proportions cannot be surmised for Tenakee Inlet in 2012 since age data does not exist for 2011.

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).

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=0.81 (Figure 43). There is also a strong correlation between the mean proportion of age-3 mature herring and the mean minimum annual sea temperature (r^2=0.71) (Figure 44). A weak correlation exists between the mean proportion of age-3 herring and the mean annual sea surface temperature (r^2=0.47)

(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 2012, 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). 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, Hoonah Sound herring have the second highest weight-at-age across age groups and Ernest Sound herring consistently have 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 2012 data with general observations of trends and characterization of stocks.

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.

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 greater as age increases. 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).

To determine whether changes in weight-at-age were due to corresponding changes in length-at-age, condition factors were calculated. Condition factors were calculated to index the physical dimensions of herring (i.e., weight-to-length ratio) over time, to roughly gauge herring health. Condition factors were calculated for all major stocks, which are presented in Figures 59–68. Data obtained from cast net samples during active spawn events were used to calculate condition factors. Weight estimates derived from samples taking from actively spawning herring probably produce lower average values that contain more variability than would be expected from pre-spawning fish sampled during the commercial fishery; however, the overall trends in condition factor are expected to be the same. Other benefits of using data from cast net samples are that 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 factor for most stocks increased sharply, peaking in 2010 and then declined sharply to 2012. The condition factors calculated for 2012 are among the lowest observed over the last two decades, although they are not the lowest ever observed

Sitka Sound Winter Test Fishery

Winter sampling was conducted in Sitka Sound by the department during February 15-16, 2012 using a purse seine. The purpose of the Sitka winter sampling is to provide data to update weight-at-age used in a 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 weight-at-age is 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 final forecast and guideline harvest level of mature herring in Sitka Sound for 2012 was 144,143 tons and 28,829 tons, respectively.

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. 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, Seymour Canal, and West Behm Canal areas during 2012, however no fisheries were opened in Seymour Canal or West Behm Canal because conditions for fisheries were not optimal due to spawn timing and fish quality in the case of Seymour Canal, or lack of adequate fish volume in the cast of West Behm Canal. There were no sac roe fisheries announced in the Hobart Bay-Port Houghton, Kah Shakes/Cat Island, or Lynn Canal areas because spawning biomass was estimated to be below threshold.

Seymour Canal

The Seymour Canal commercial gillnet fishery placed on two-hour notice on April 23. The fishery was not opened for the 2012 season due to a lack of a concentration of adequate quality herring within fishable water depths.

Sitka Sound

The sac roe fishery was placed on two-hour notice on March 27 at 11:00am. The guideline harvest level (GHL) was 28,829 tons. Three competitive openings were held during the 2012 season on the following dates: March 31, April 2, and April 7. The first opening was held in the northwest portion of Sitka Sound in the waters of Hayward Strait, Promisla Bay, and Eastern Bay, and lasted 3 hours, 26 minutes. The second opening was also held in northwestern Sitka Sound, in the waters of Hayward Strait and Krestof Sound, south to northern Crow Island, and lasted 5 hours, 10 minutes. The third and final opening was held in Salisbury Sound and south to Krestof Sound and lasted 3 hours, 15 minutes.

The cumulative harvest during the three opens was 13,232 tons. On April 12 the fishery was announced closed, leaving 15,597 tons remaining of the GHL. The fishery was closed due to the large amount of spawning that had occurred by this date (about 54 nmi) and lack of an identifiable biomass of pre-spawning herring the area.

West Behm Canal

The fishery was placed on 12-hour notice on April 4 at 12:00pm. By regulation, the 2012 fishery was allocated to the purse seine fleet, and was structured as an equal quota share fishery with the GHL of 748 tons to be divided equally between the number of eligible purse seine fishermen registered for the fishery at the time of two-hour notice. However, on April 12, 2012, an announcement was made that the fishery would not open due to a lack of herring abundance on the fishery grounds.

Hobart Bay-Port Houghton

There were no commercial fisheries announced in the Hobart Bay-Port Houghton area in 2012, as the stock was below threshold.

Winter Bait Fisheries

During the 2011-12 season, winter food and bait fisheries were opened near Craig and Ernest Sound on November 25, 2011. The Ernest Sound fishery was closed by emergency order on January 25, 2012, and the Ernest Sound fishery closed by regulation on February 28, 2012. The harvest amount in Craig was 309 tons; however, the harvest from Ernest Sound is confidential due to fewer than three participants in the fishery.

Spawn-on-Kelp Pound Fisheries

Two areas were open to the commercial harvest of spawn on kelp (SOK) during the 2011–12 season: Craig and Hoonah Sound. The two other SOK areas in the region, Ernest Sound and Tenakee Inlet were not opened during the 2011-12 season.

Hoonah Sound

A total of 75 closed pounds were actively fished, of which 72 were single-permit pounds and three were experimental double-sized pounds. About 187 tons of SOK was harvested.

Craig

A total of 35 closed pounds were actively fished, of which seven were single-permit, 27 were double-permit pounds, and one was a triple-permit pound. About 98 tons of SOK were harvested.

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2011–12 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 2011–12 season was in Sitka Sound, for bait, using purse seine gear during February 15-16, 2012. A total of 60 tons of herring were harvested from areas near the mouth of Nakwasina Sound and the mouth of Silver Bay.

DISCUSSION

Spawn Deposition

Spawning population biomass estimates, as calculated from spawn deposition estimates, decreased between 2011 and 2012 for six of eight stocks that were surveyed in Southeast Alaska. For all six of these areas the decreases were substantial (defined here as 20% change at least). For several stocks, biomass estimates in 2012 were less than half of 2011 estimates. The spawning areas where decreases were observed include Sitka, Craig, Hoonah Sound, West Behm Canal, Seymour Canal, and Hobart Bay-Port Houghton. Although the error surrounding biomass estimates was not calculated, the magnitudes of the decreases were large enough that they probably reflect actual changes in the spawning population levels.

The only areas that were surveyed in 2012 where biomass apparently increased since 2011 were Ernest Sound and Tenakee Inlet. The increase in Ernest Sound between 2011 and 2012 was substantial; however, the 2012 estimate was similar to two of the last three years, with 2011 being the least similar. Based on the last few years of estimates for Ernest Sound, that stock appears more stable than most others in the region. In Tenakee Inlet a survey was conducted in 2012, but not in 2011, therefore it is difficult to gauge the relative change in biomass. In 2012, the shoreline receiving spawn in Tenakee Inlet was recorded to be about 4.6 nmi, which is considerably more than the 0.5 nmi recorded in 2011. Thus, it is highly probably that the Tenakee Inlet spawning biomass increased between 2011 and 2012, though the magnitude is unknown.

The large declines in spawning biomass observed at several spawning areas around the region suggest that a common factor affected herring populations between spring 2011 and spring 2012, but the mechanism is unclear. There did not appear to be an obvious failure of age-3 recruitment into the mature population in 2012, suggesting that survival of the adult/mature population was impacted.

The decline in estimated spawning biomass 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 large declines observed for estimated biomass were due, at least in part, to estimate error. However, the consistency of the declines 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 decline.

Estimates of spawning biomass presented in this report are based primarily on egg deposition estimates (as opposed to model-derived results), which are useful for providing a general view of trends in stock size but should not necessarily be considered the most accurate estimate of stock size in any given year. For all major herring stocks in Southeast Alaska, the results of ASA or biomass accounting models are considered to provide 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.

Despite the large drop in herring spawning biomass over the last year, the general trend for herring biomass in Southeast Alaska, is increasing over the period 1980 to 2012 (Figure 8). This is true whether or not the largest stock in the region, Sitka Sound, is included. Biomass estimates from 2012 are very close to the long-term average (1980–2011), for all stocks combined, and for all stocks combined except Sitka Sound: 106% and 93% respectively, of the long term average. The long-term trend of spawning stock size for the majority of 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 Tenakee Inlet 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 2012 suggest that herring spawning biomass in Southeast Alaska is at a moderate level relative to the period 1980–2011. Although a substantial decline in spawning biomass was apparent over the last year for several stocks (based on spawn deposition estimates only), it is too soon to tell if the decline signifies a downward trend or simply represents stock volatility, which has been commonly observed in the past. Biomass estimates for 2013 spawning populations may help determine whether the 2012 estimates accurately gauged stock levels.

Age Composition

For all stocks, estimates of age composition in 2012 continued to follow patterns that are generally expected, which is 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 2012 samples was consistent with those methods used in prior years, which was 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, commonly the direction of change from year to year is the same. In other words, in years when the proportion of age-3 fish is high or low for one stock, it is usually relatively high or low for all or most stocks. This suggests that age-3 recruitment into the mature segment of each stock is influenced by a common factor (e.g., biological or physical conditions in the marine environment). The scale of influence may be greater than Southeast Alaska, as 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-3 herring proportions 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. 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 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 2012, which were remarkably similar among stocks within each of the two areas. Not surprisingly, there is an inverse relationship between latitude and sea temperature. 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

Sherri Dressel (Region I Biometrics Supervisor) advised on calculation of spawn deposition estimates. Jan Rumble (Region I Herring-Dive Fisheries Research Assistant Biologist) assisted with spawn deposition survey design.

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

REFERENCES CITED

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

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

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

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

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

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

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

Hebert, K. 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 2012 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 2012 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 2012 herring spawn deposition surveys conducted in Southeast Alaska.

Survey area	Survey Leg	Survey Dates
Sitka Sound	I	April 13–16
Slocum Arm	I	April 18–19
Craig	I	April 21–22
West Behm Canal	I	April 23
Ernest Sound	I	April 24
Farragut Bay	II	May 4
Hobart Bay/Port Houghton	II	May 5
Hoonah Sound	II	May 7
Tenakee Inlet	II	May 8
Lynn Canal	II	May 10–11
Seymour Canal	II	May 12–13

Table 4.–Summary of herring egg estimates (in thousands) by transect for 2011 spawn deposition surveys conducted in Southeast Alaska.

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

-continued-

Table 4.–Page 2 of 2.

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

Table 5.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2012.

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	65	14.9	1,802,860	952,811	1.855	84.1	16,604	223,383,551	20,701
Ernest Sound	30	32	8.9	532,944	433,614	0.257	58.8	10,573	48,571,282	3,148
Hobart/Houghton	18	38	2.1	147,561	44,370	0.007	74.8	15,073	965,285	80
Hoonah Sound	22	56	4.9	505,301	107,563	0.060	125.1	21,842	5,529,886	763
Seymour Canal	24	57	6.9	724,132	900,664	0.725	74.8	15,062	96,226,470	7,934
Sitka Sound	50	61	55.9	6,325,487	714,283	5.020	130.8	22,974	437,042,841	63,026
Tenakee Inlet[a]	22	107	4.6	908,069	378,198	0.382	88.1	14,472	52,735,820	5,119
West Behm Canal	24	36	7.3	492,902	325,177	0.178	58.4	10,494	33,940,346	2,185
Lynn Canal[a]	30	37	8.3	568,749	441,512	0.279	89.8	18,403	30,323,041	3,002
Slocum Arm[a]	18	69	7.1	905,834	772,785	0.778	130.8	22,974	67,712,202	9,765
Farrugut Bay[a]	12	15	1.9	52,782	33,838	0.002	74.8	15,073	263,320	22
Total	280	—	122.8	12,966,622	—	9.542	—	—	996,694,044	115,774
Average	25	52	—	1,178,784	461,619	0.867	90.0	16,686	—	—

[a] Herring samples not obtained in 2012, so mean weight estimated using data from nearest stock or from previous years within the same stock.

Table 6.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2012. Data was combined for years 2010 through 2012 unless otherwise noted.

	Estimator initials									
Kelp type	BM	DG	JB	JM	KH	SD	TT[a]	SW	EC	JR
Eelgrass	1.203	0.956	1.382	1.307	0.955	0.756	1.314	1.566	1.746	1.258
n =	20	27	22	26	30	30	9	23	27	26
Fucus	1.625	1.257	1.620	1.021	1.166	0.827	1.787	2.437	2.169	1.108
n =	22	23	22	22	23	23	15	22	23	22
Fir kelp	1.863	1.447	1.271	1.323	1.067	1.023	1.299	1.746	2.341	1.474
n =	21	22	21	24	23	23	15	21	23	24
Hair kelp	1.604	1.106	1.768	1.400	1.036	0.957	1.453	2.146	2.575	1.226
n =	22	25	26	29	28	28	14	25	24	29
Large brown kelp[b]	1.044	1.171	1.343	1.124	1.296	0.803	2.505	1.882	1.699	0.888
n =	20	24	23	26	28	27	11	24	24	24
Average[c]	1.468	1.187	1.477	1.235	1.104	0.873	1.672	1.955	2.106	1.191

[a] Data from years 2010 and 2011.

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

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

Table 7.–Summary of samples collected from Southeast Alaska herring stocks in 2011–12.

	Commercial Fishery			Survey	Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	532	525	530	–	1,587
Ernest Sound	–	–	525	554	–	1,079
Hobart/Houghton	–	–	–	528	–	528
Hoonah Sound	–	528	–	–	–	528
Lynn Canal	–	–	–	–	–	0
Seymour Canal	–	–	–	532	–	532
Sitka Sound	–	–	524	574	525	1,623
Tenakee Inlet	–	–	–	–	–	0
West Behm Canal	–	–	–	532	–	532
Revilla Channel	–	–	–	514	–	514
Total	0	1,060	1,574	3,764	525	6,923

Table 8.–Summary herring samples aged for Southeast Alaska stocks in 2011–12.

	Commercial Fishery			Survey	Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	531	491	528	–	1,550
Ernest Sound	–	–	518	553	–	1,071
Hobart/Houghton	–	–	–	517	–	517
Hoonah Sound	–	527	–	–	–	527
Lynn Canal	–	–	–	–	–	0
Seymour Canal	–	–	–	529	–	529
Sitka Sound	–	–	524	571	524	1,619
Tenakee Inlet	–	–	–	–	–	0
West Behm Canal	–	–	–	529	–	529
Revilla Channel	–	–	–	514	–	514
Total	0	1,058	1,533	3,764	524	6,923

Table 9.–Summary of age, weight, and length for the Sitka Sound herring stock in 2011–12.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	67	121	131	102	77	73	571
	percent age composition	12%	21%	23%	18%	13%	13%	100%
	average weight (g)	64.4	82.2	106.6	118.5	146.5	151.6	109.0
	standard dev. of weight (g)	14.0	19.6	20.7	21.8	30.6	29.7	36.0
	average length (mm)	177.4	191	206	213	227	230	206
	variance of length (mm)	122.8	143	110	136	112	160	418
commercial purse seine–spring	number of fish	45	44	114	104	126	91	524
	percent age composition	9%	8%	22%	20%	24%	17%	100%
	average weight (g)	80.0	106.5	125.5	141.2	163.5	178.7	141.0
	standard dev. of weight (g)	14.0	14.6	20.5	23.0	24.9	27.8	36.0
	average length (mm)	182.0	199	208	216	225	232	214
	variance of length (mm)	98.7	78	99	89	81	90	288
test fishery purse seine–winter	number of fish	23	66	132	116	107	80	524
	percent age composition	4%	13%	25%	22%	20%	15%	100%
	average weight (g)	80.7	105.5	127.2	143.0	162.9	176.7	140.0
	standard dev. of weight (g)	9.6	19.5	21.4	24.1	21.8	24.9	34.0
	average length (mm)	185	201	212	219	229	234	217
	variance of length (mm)	60	125	104	109	102	119	272

Table 10.–Summary of age, weight, and length for the Craig herring stock in 2011–12.

		Age Category						
Gear type/season	Age category	3	4	5	6	7	8+	Total
survey cast net – spring	number of fish	68	222	125	62	16	35	528
	percent age composition	13%	42%	24%	12%	3%	7%	100%
	average weight (g)	53.7	70.2	81.1	93.9	91.8	111.0	76.0
	standard dev. of weight (g)	10.1	11.7	13.1	15.6	15.9	20.8	19.0
	average length (mm)	168.2	183	192	201	197	209	187
	variance of length (mm)	94.0	67	63	72	60	91	191
commercial pound – spring	number of fish	66	214	133	69	16	33	531
	percent age composition	12%	40%	25%	13%	3%	6%	100%
	average weight (g)	57.3	76.0	89.3	105.2	105.3	122.0	84.0
	standard dev. of weight (g)	13.0	12.5	15.2	17.9	10.7	23.5	22.0
	average length (mm)	170.0	185	193	202	204	211	189
	variance of length (mm)	83.4	64	68	60	61	114	188
commercial seine– winter	number of fish	107	218	100	41	8	17	491
	percent age composition	22%	44%	20%	8%	2%	3%	100%
	average weight (g)	58.2	77.9	90.7	102.0	107.8	112.0	76.0
	standard dev. of weight (g)	10.9	14.8	15.3	14.3	8.2	16.6	23.0
	average length (mm)	168.4	184	191	199	203	205	181
	variance of length (mm)	72.1	103	106	42	70	55	310

Table 11.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2011–12.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net– spring	number of fish	194	12	13	46	91	171	527
	percent age composition	37%	2%	2%	9%	17%	32%	100%
	average weight (g)	44.4	68.3	73.7	91.8	91.0	96.8	74.0
	standard dev. of weight (g)	10.5	15.9	16.4	16.6	18.7	16.4	28.0
	average length (mm)	159.2	183	187	199	198	204	185
	variance of length (mm)	111.1	145	154	79	127	101	517
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 12.–Summary of age, weight, and length for the Ernest Sound herring stock in 2011–12.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	180	147	173	9	14	30	553
	percent age composition	33%	27%	31%	2%	3%	5%	100%
	average weight (g)	48.3	56.4	66.1	70.3	79.7	78.8	58.0
	standard dev. of weight (g)	8.0	8.9	10.9	9.9	13.7	13.0	13.0
	average length (mm)	161.7	170	177	180	188	187	170
	variance of length (mm)	56.0	40	66	65	106	65	119
commercial seine–winter	number of fish	190	148	147	14	11	8	518
	percent age composition	37%	29%	28%	3%	2%	2%	100%
	average weight (g)	54.7	68.6	75.1	75.2	85.3	95.5	66.0
	standard dev. of weight (g)	9.8	13.0	13.7	13.2	15.4	12.4	15.0
	average length (mm)	161.2	172	176	178	183	192	169
	variance of length (mm)	72.3	100	92	101	122	34	146

Table 13.–Summary of age, weight, and length for the Hoonah Sound herring stock in 2011–12.

Gear type/season	Parameter	Age Category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	NO SAMPLES OBTAINED						
	percent age composition							
	average weight (g)							
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							
commercial pound –spring	number of fish	55	16	94	66	181	115	527
	percent age composition	10%	3%	18%	13%	34%	22%	100%
	average weight (g)	56.1	70.9	88.5	98.4	102.6	110.0	95.0
	standard dev. of weight (g)	11.8	13.1	15.2	16.0	19.1	21.6	23.0
	average length (mm)	175.4	190	201	207	209	213	204
	variance of length (mm)	91.3	93	71	61	43	70	181

Table 14.–Summary of age, weight, and length for the Tenakee Inlet herring stock in 2011–12.

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

Table 15.–Summary of age, weight, and length for the Seymour Canal herring stock in 2011–12.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	120	24	54	42	119	170	529
	percent age composition	23%	5%	10%	8%	22%	32%	100%
	average weight (g)	49.9	61.5	69.9	80.6	85.6	86.9	74.0
	standard dev. of weight (g)	12.1	10.8	13.4	17.5	18.0	18.8	22.0
	average length (mm)	162.1	173	179	186	190	190	181
	variance of length (mm)	142.6	104	128	112	112	105	255
commercial gillnet–spring	number of fish	NO FISHERY						
	percent age composition							
	average weight (g)							
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 16.–Summary of age, weight, and length for the West Behm Canal herring stock in 2011–12.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	219	158	131	7	7	7	529
	percent age composition	41%	30%	25%	1%	1%	1%	100%
	average weight (g)	46.4	60.3	72.0	74.7	89.4	92.9	58.0
	standard dev. of weight (g)	10.0	11.1	13.3	13.1	15.3	11.8	16.0
	average length (mm)	158.4	172	181	188	193	195	169
	variance of length (mm)	96.4	69	92	72	28	110	197
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 17.–Summary of age, weight, and length for the Lynn Canal herring stock in 2011–12.

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

Table 18.–Summary of age, weight, and length for the Revilla Channel herring stock in 2011–12.

Gear type/season	Parameter	Age category 3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	185	151	146	9	12	12	514
	percent age composition	36%	29%	28%	2%	2%	2%	100%
	average weight (g)	43.1	56.2	70.2	71.7	88.2	97.7	57.5
	standard dev. of weight (g)	9.0	12.1	14.2	9.6	11.4	23.9	18.1
	average length (mm)	160.7	175	185	188	198	204	174
	variance of length (mm)	87.1	108	117	85	62	141	236

Table 19.–Proportion of mature age-3 herring (cast net, 1988–2012), latitude and mean sea temperature of herring spawning stocks in Southeast Alaska.

Stock	Latitude (decimal degrees)	Median proportion of mature age-3 herring	Mean proportion of mature age-3 herring	Mean annual sea temperature (^{0}C)	Mean minimum annual sea temperature (^{0}C)	Mean maximum annual sea temperature (^{0}C)
Kah Shakes	55.0300	23%	29%	8.6	5.9	14.7
Craig	55.4770	17%	22%	9.0	4.7	14.1
WBC	55.4846	26%	30%	8.8	5.3	14.3
Ernest Sound	55.8307	25%	31%	—	—	—
Sitka	57.0079	10%	17%	8.6	4.9	13.8
Hobart Bay	57.4308	5%	14%	7.1	3.9	12.9
Seymour Canal	57.5923	12%	16%	6.7	3.0	13.3
Hoonah Sound	57.6001	7%	15%	7.9	2.0	15.0
Tenakee Inlet	57.7381	11%	11%	7.8	1.9	15.0
Lynn Canal	58.6402	12%	13%	7.1	2.6	15.4

Table 20.–Summary of Southeast Alaska herring target levels for the 2011–12 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target Exploitation Rate (%)	Guideline harvest level (tons)[a]
Craig	5,000	34,235	20.0	6,847
Ernest Sound	2,500	2,682	10.1	272
Hobart Bay/Port Houghton	2,000	599	—	—
Hoonah Sound	1,000	10,696	20.0	2,139
Seymour Canal	3,000	9,135	14.1	1,287
Sitka Sound	25,000	144,143	20.0	28,829
Tenakee Inlet	3,000	—	—	—
West Behm Canal	6,000	7,915	10.6	842
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 21.–Summary of commercial herring harvest during the 2011–12 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)[e]
Winter food and bait	Purse seine	Craig	3/4	25-Nov-11	28-Feb-12	309
Winter food and bait	Purse seine	Tenakee Inlet	12	Not Open		--
Winter food and bait	Purse seine	Ernest Sound	7	25-Nov-11	25-Jan-12	[redacted]
Winter food and bait	Purse seine	Hobart Bay	10	Not Open		--
Sub-total						[redacted]
Sac roe	Purse seine	Sitka Sound	13	31-Mar-12	12-Apr-12	13,232
Sac roe	Purse seine	Lynn Canal	11	Not Open		--
Sac roe	Gillnet	Seymour Canal	11	No Fishery		0
Sac roe	Gillnet	Hobart Bay	10	Not Open		--
Sac roe	Gillnet	Kah Shakes	1	Not Open		--
Sac roe	Gillnet	West Behm Canal	1	No Fishery		0
Sub-total						13,232
Spawn on kelp	Pound	Hoonah Sound	13	6-Apr-12	27-Apr-12	187
Spawn on kelp	Pound	Tenakee Inlet	12	Not Open		--
Spawn on kelp	Pound	Ernest Sound	7	Not Open		--
Spawn on kelp	Pound	Craig	3	17-Mar-12	30-Apr-12	98
Sub-total						285
Test fishery - bait	Purse seine	Sitka	13	15-Feb-12	16-Feb-12	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.

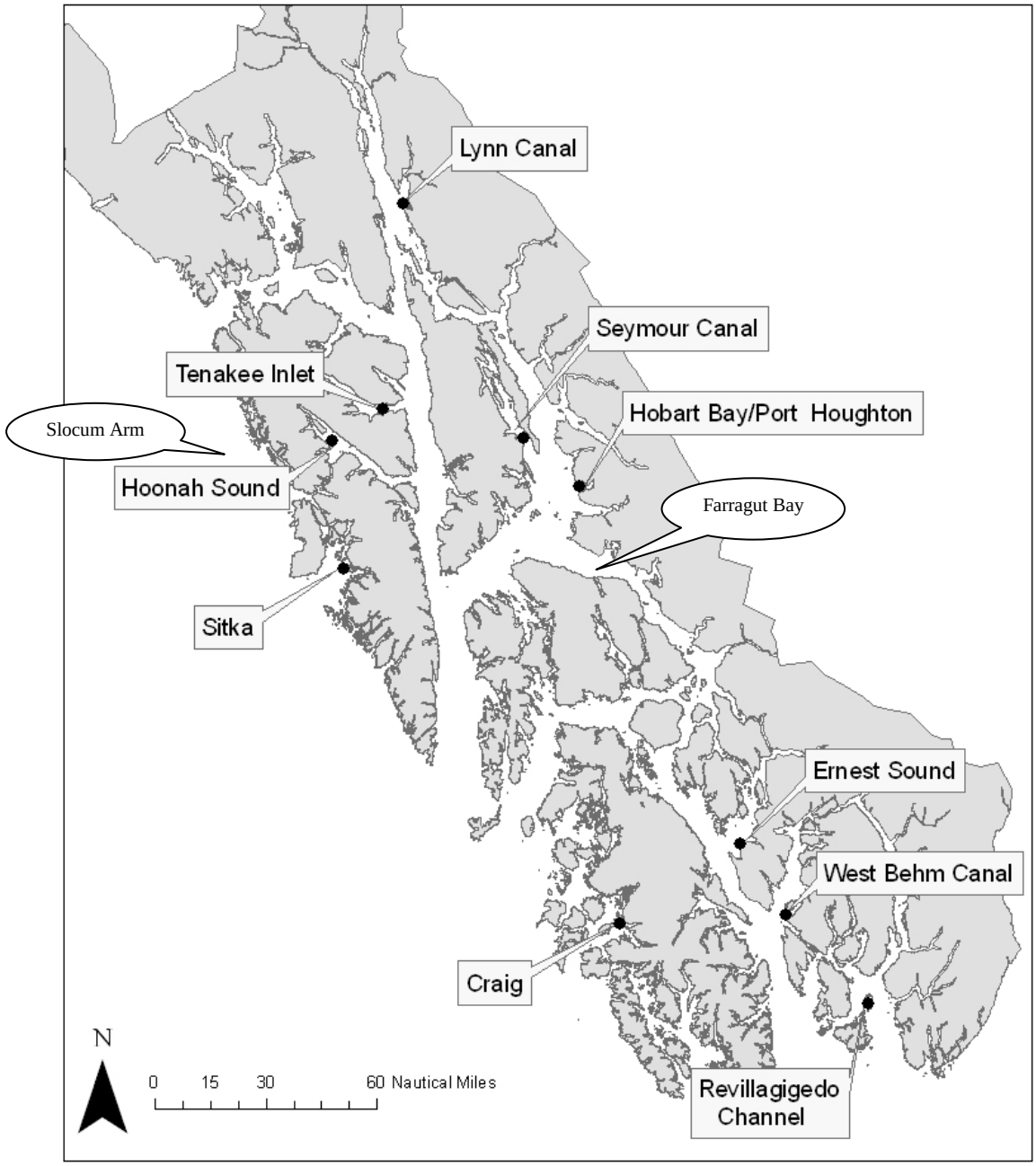
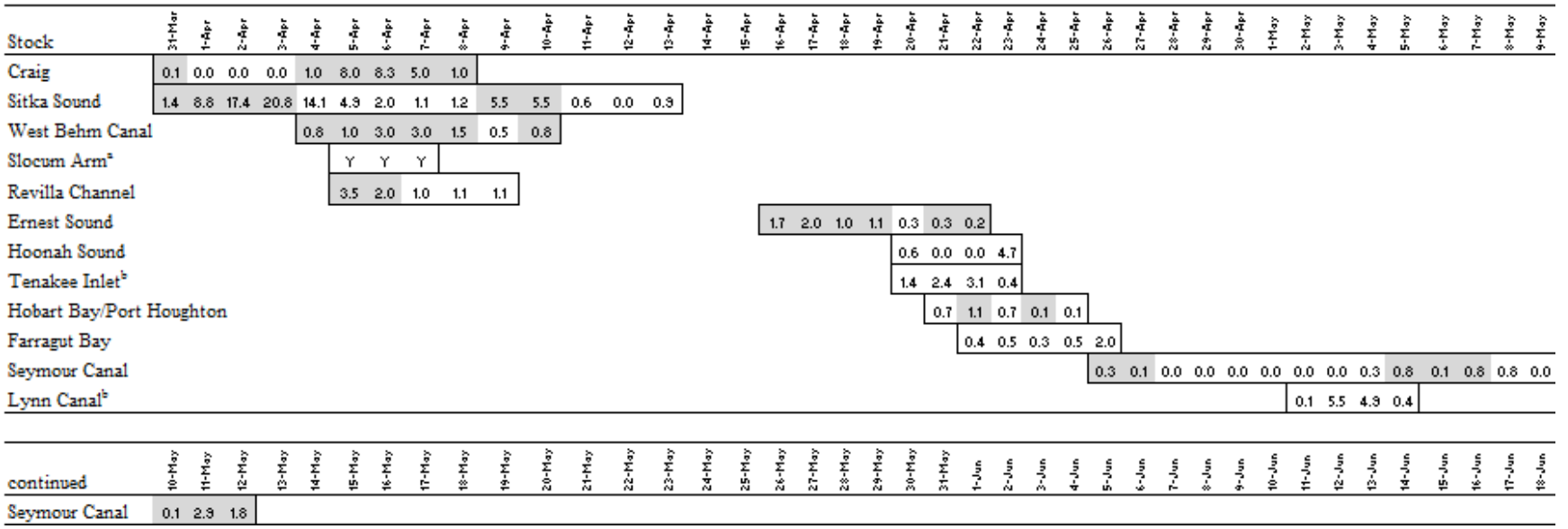


Figure 1.–Locations of major herring spawning areas in Southeast Alaska (rectangular labels). Areas with oval labels are not historically major spawning areas, but were surveyed in 2012.



[a] Spawn event reported by private pilot, but no estimates of daily active spawning were made.

[b] Samples not collected due to no opportunity.

Figure 2.–Spawn timing of herring stocks in Southeast Alaska during spring 2012. 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). Dates with "Y" indicate spawning occurred, but no estimates of magnitude available.

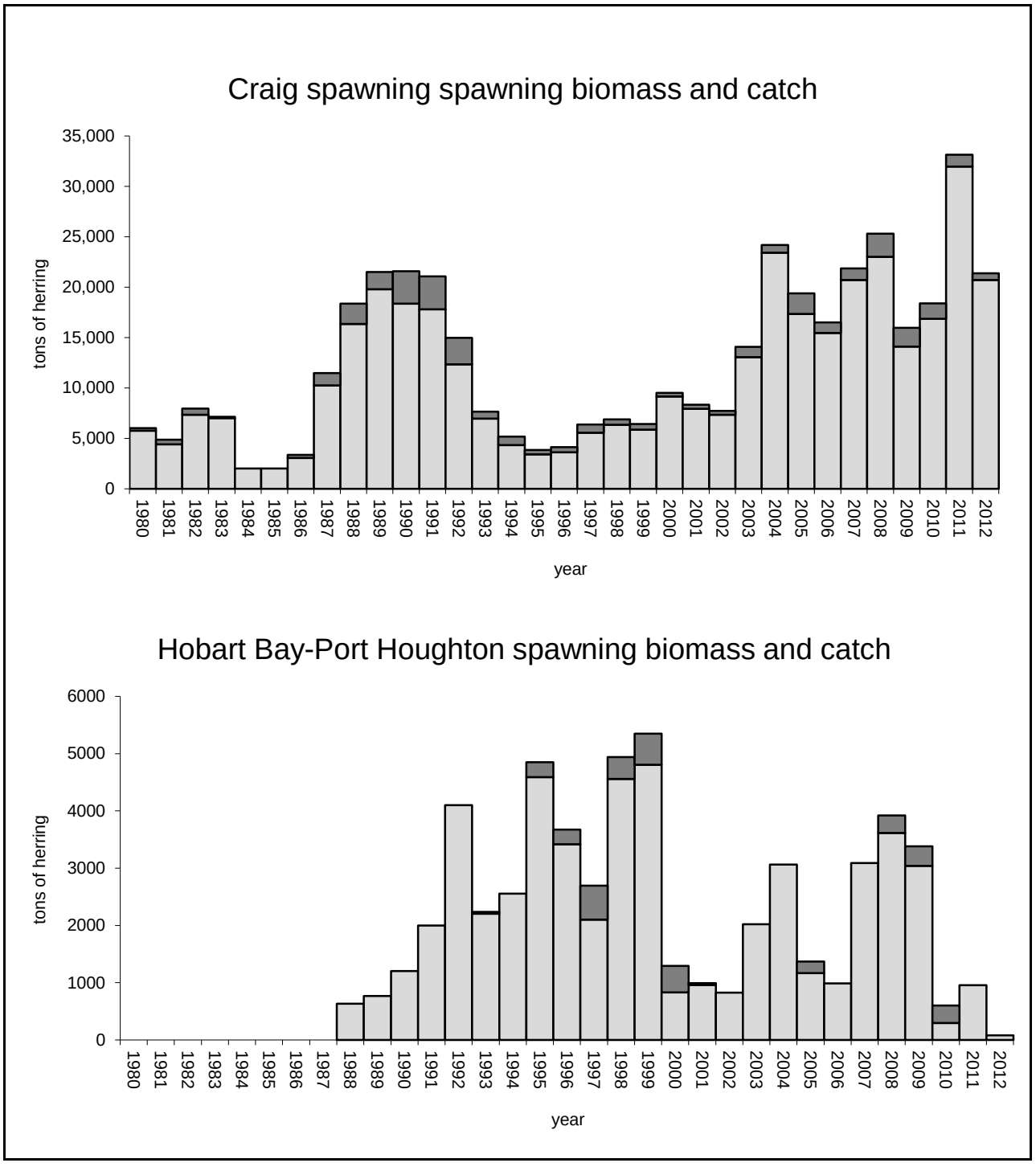


Figure 3.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Craig and Hobart Bay-Port Houghton areas, during 1980–2012.

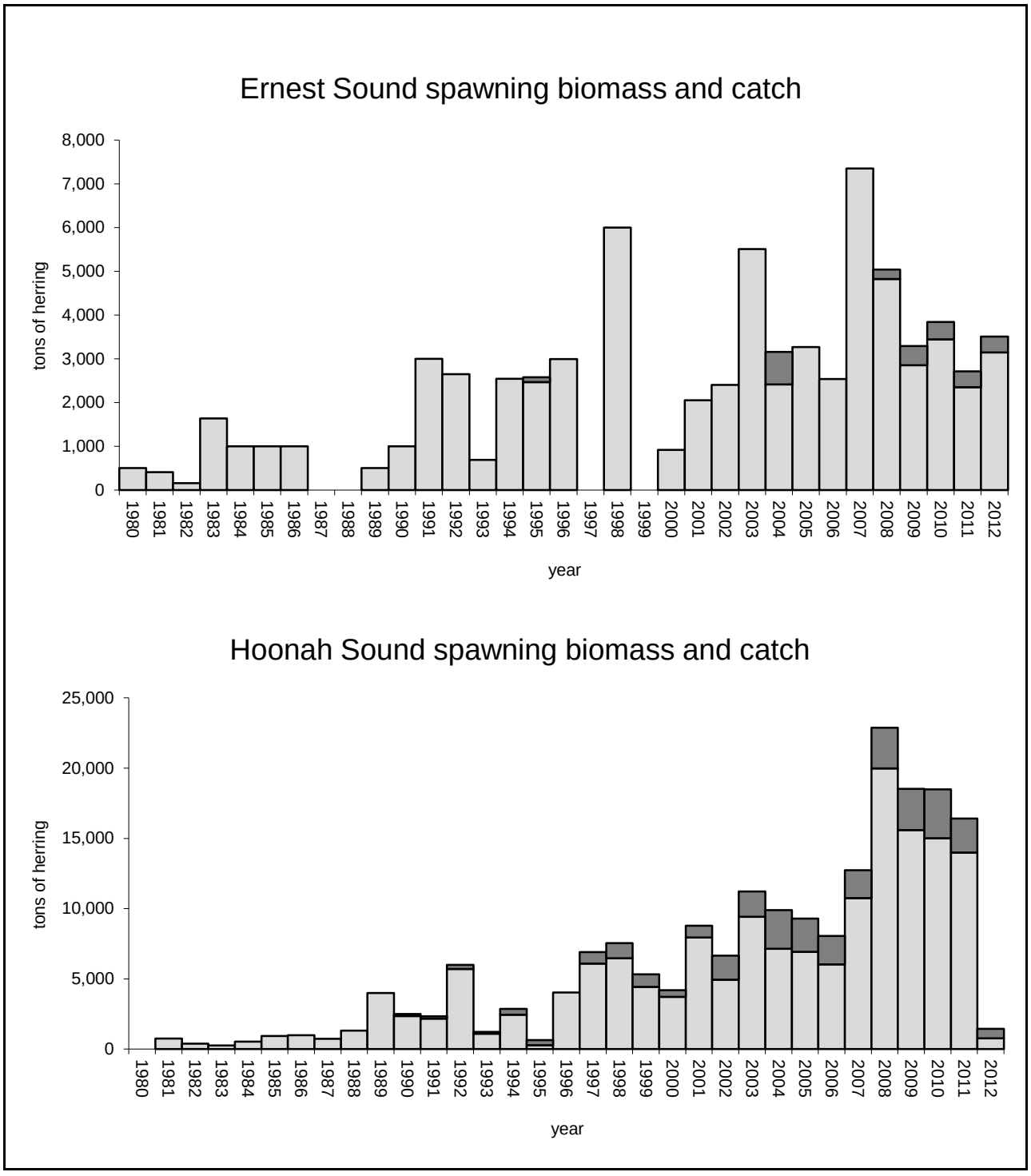


Figure 4.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2012.

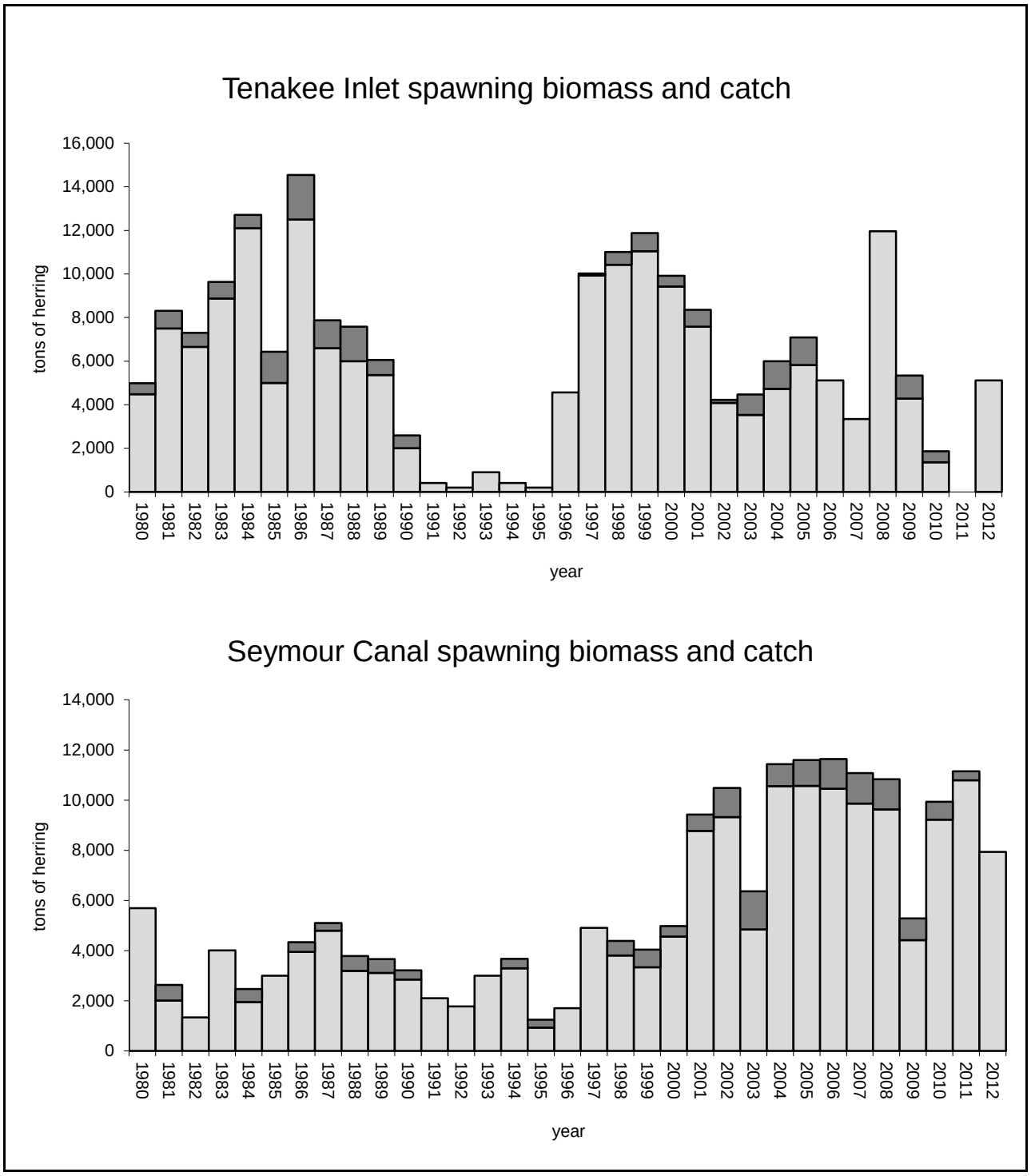


Figure 5.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Tenakee Inlet and Seymour Canal areas, during 1980–2012.

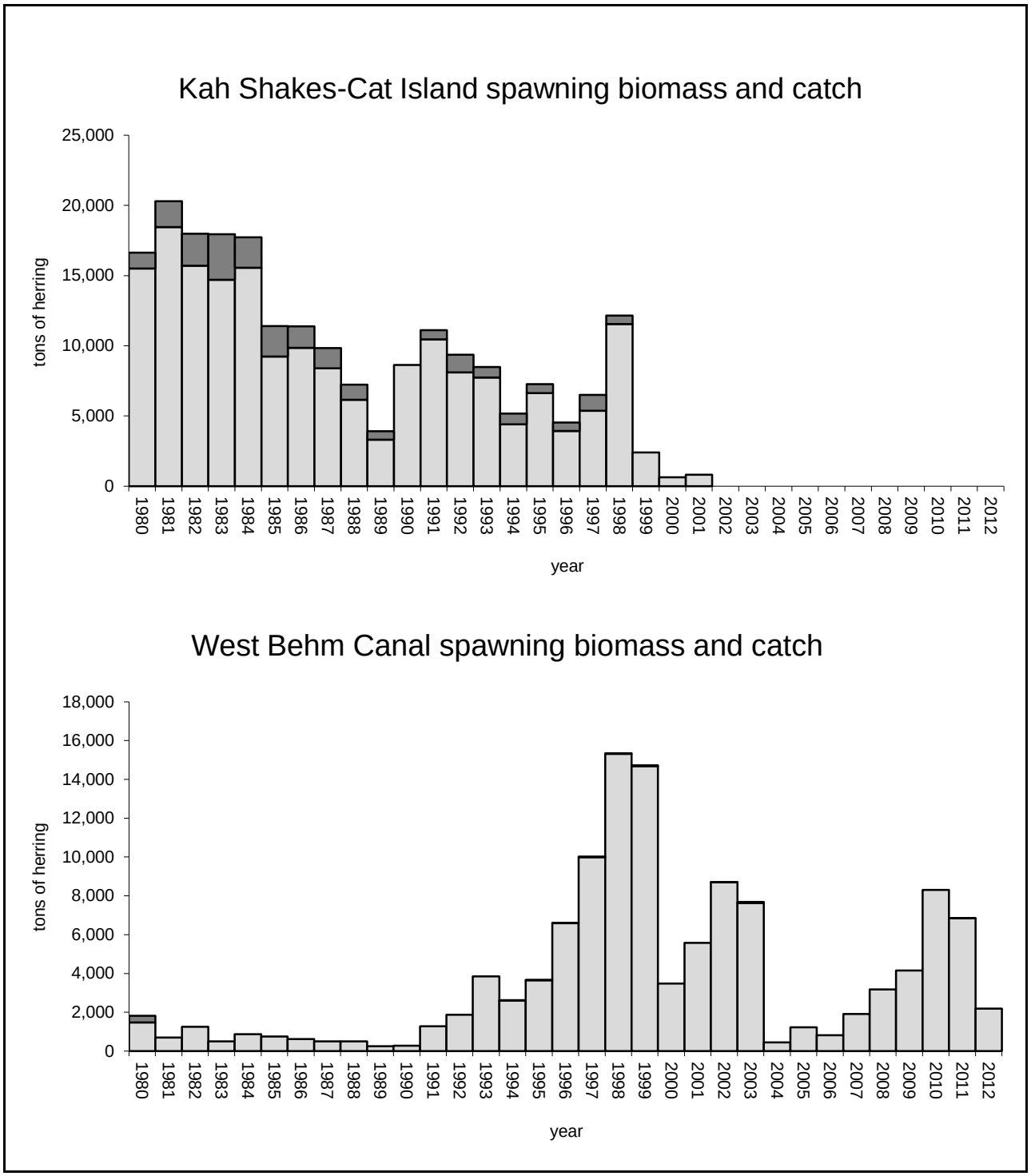


Figure 6.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the West Behm Canal and Kah Shakes-Cat Island areas, during 1980–2012.

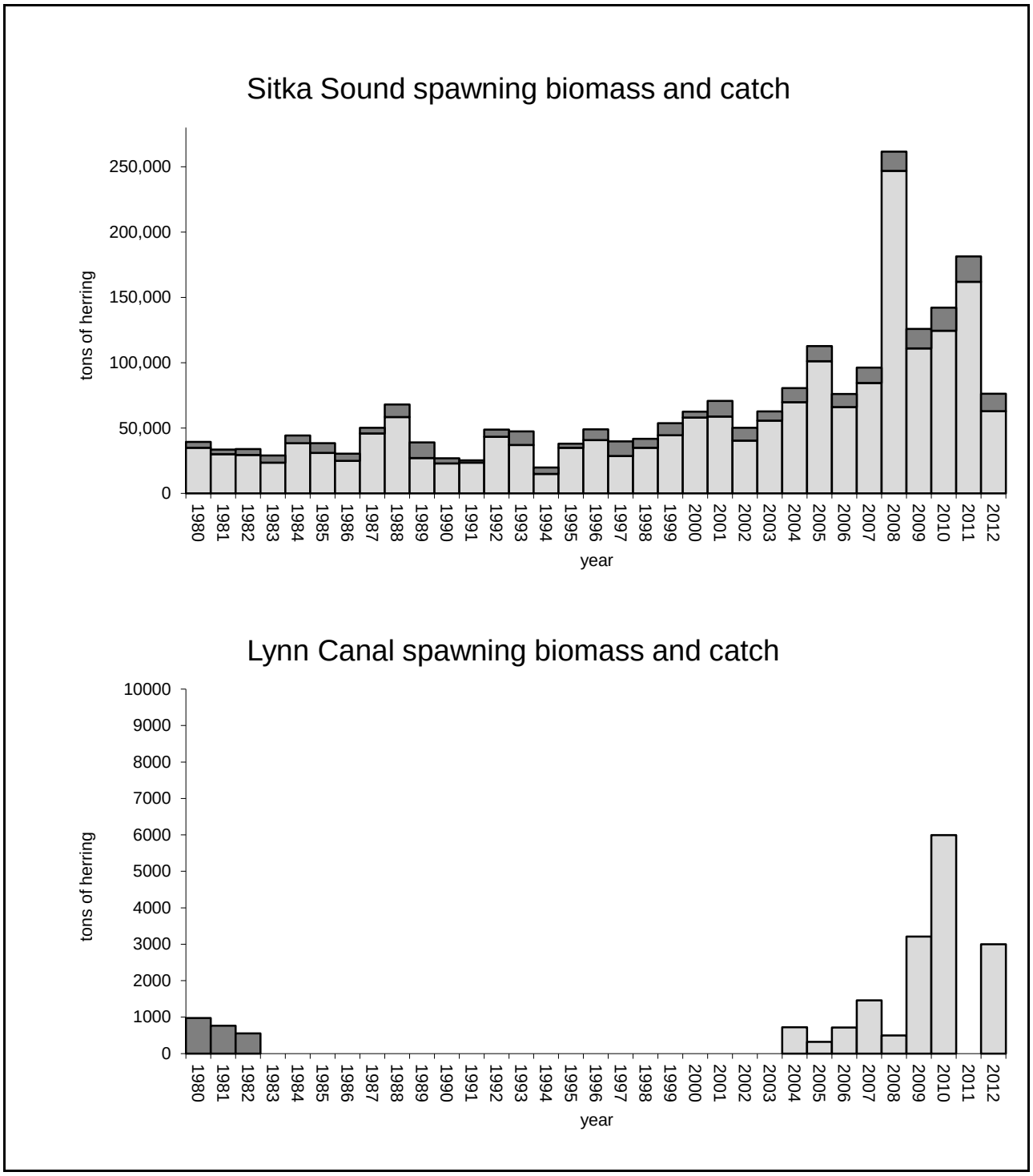


Figure 7.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2012. Estimates of spawning biomass for Lynn Canal prior to 2004 area not presented due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

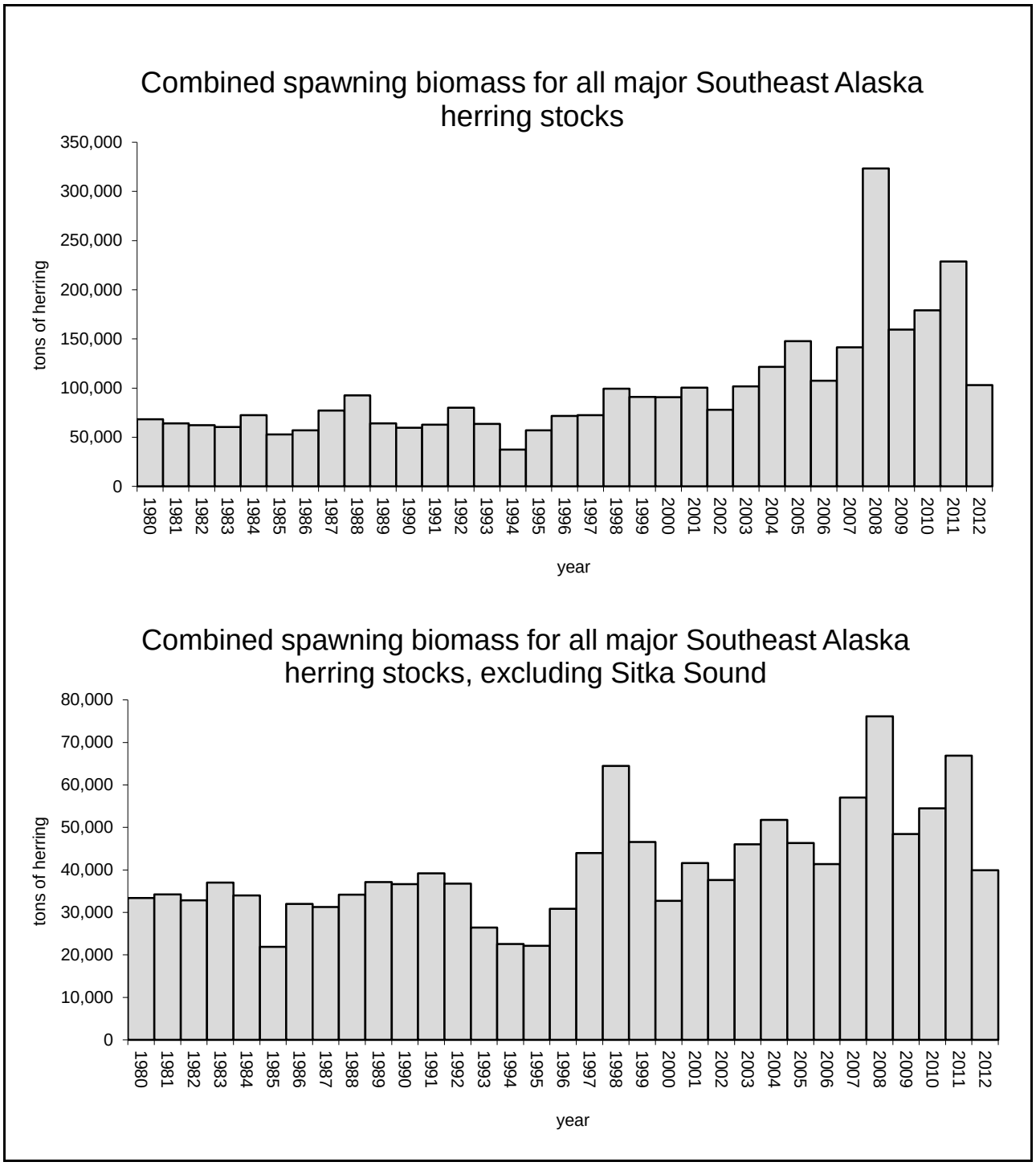


Figure 8.–Combined post-fishery spawning biomass, based on spawn deposition surveys, or hydro-acoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2012. Estimates of spawning biomass for Lynn Canal area not included due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

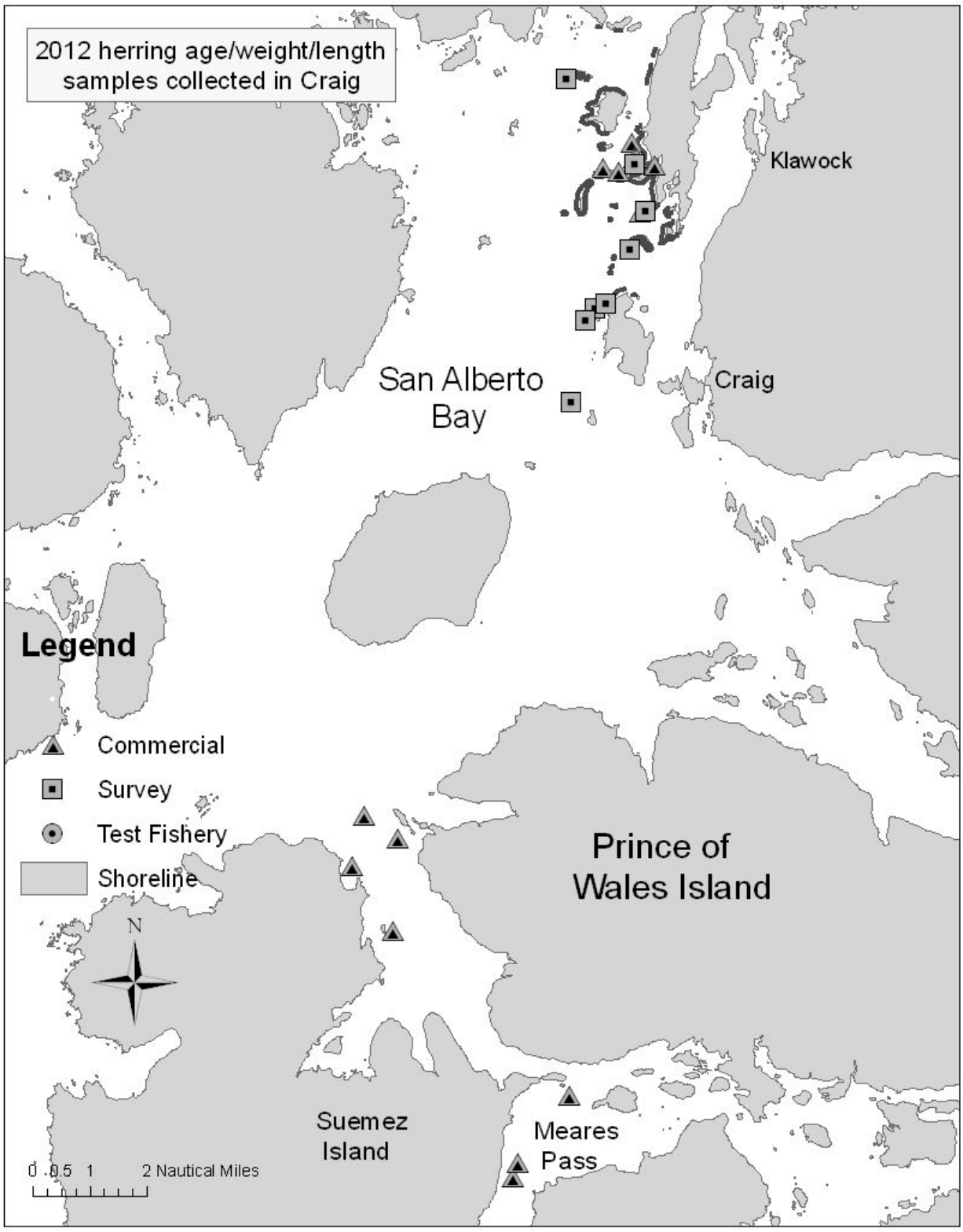


Figure 9.–Locations of herring samples collected for estimates of age and size for the Craig herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

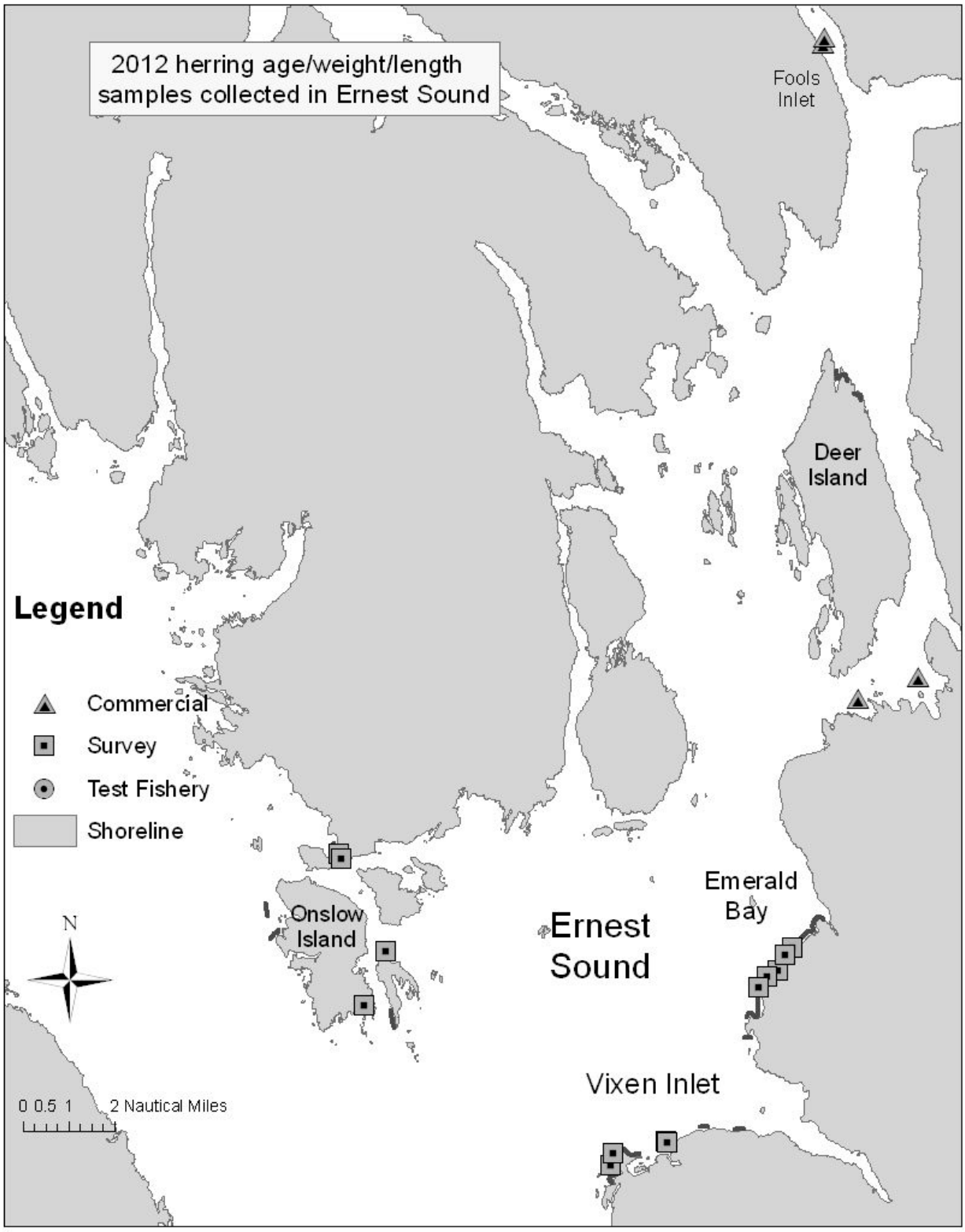


Figure 10.–Locations of herring samples collected for estimates of age and size for the Ernest Sound herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

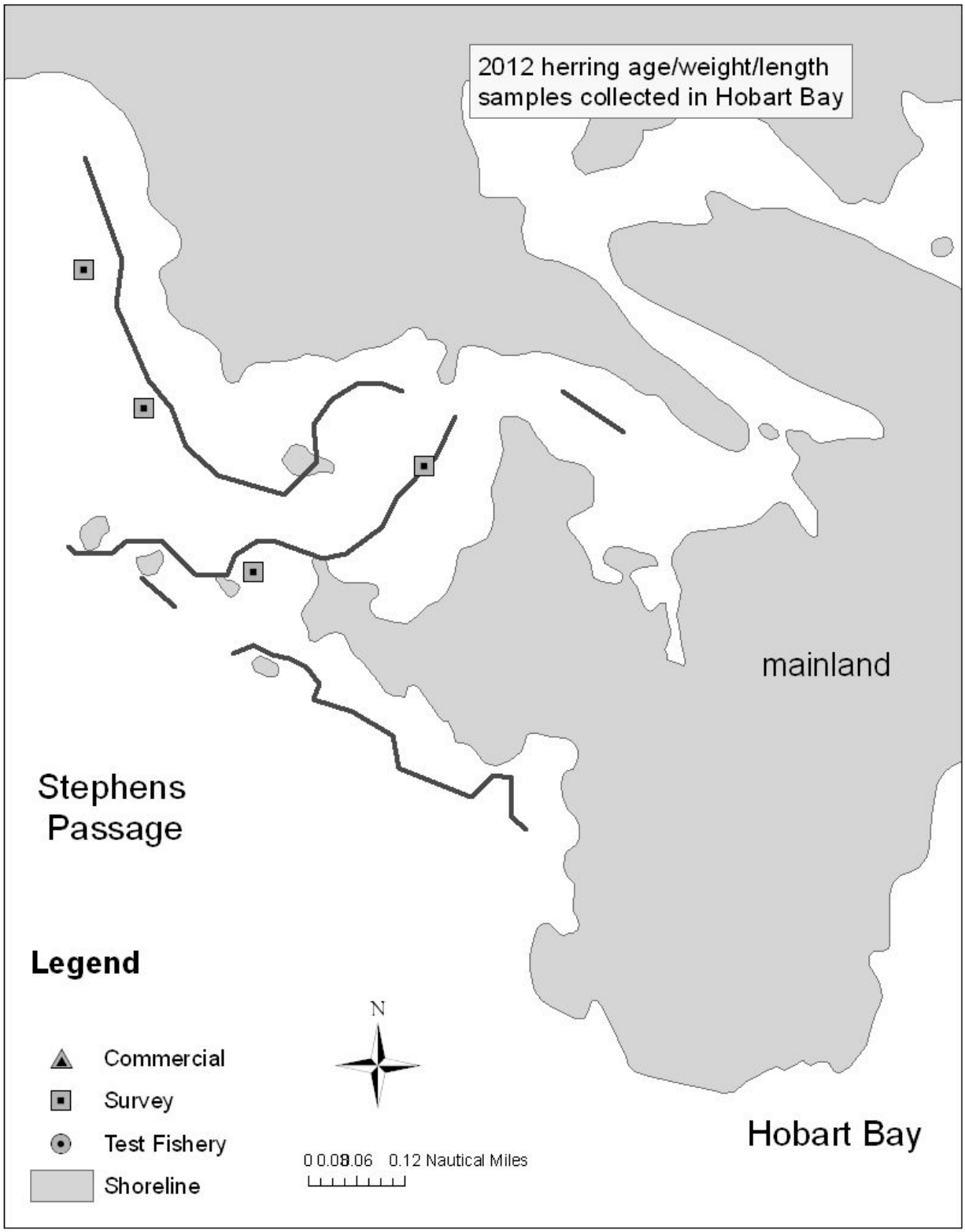


Figure 11.–Locations of herring samples collected for estimates of age and size for the Hobart bay-Port Houghton herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

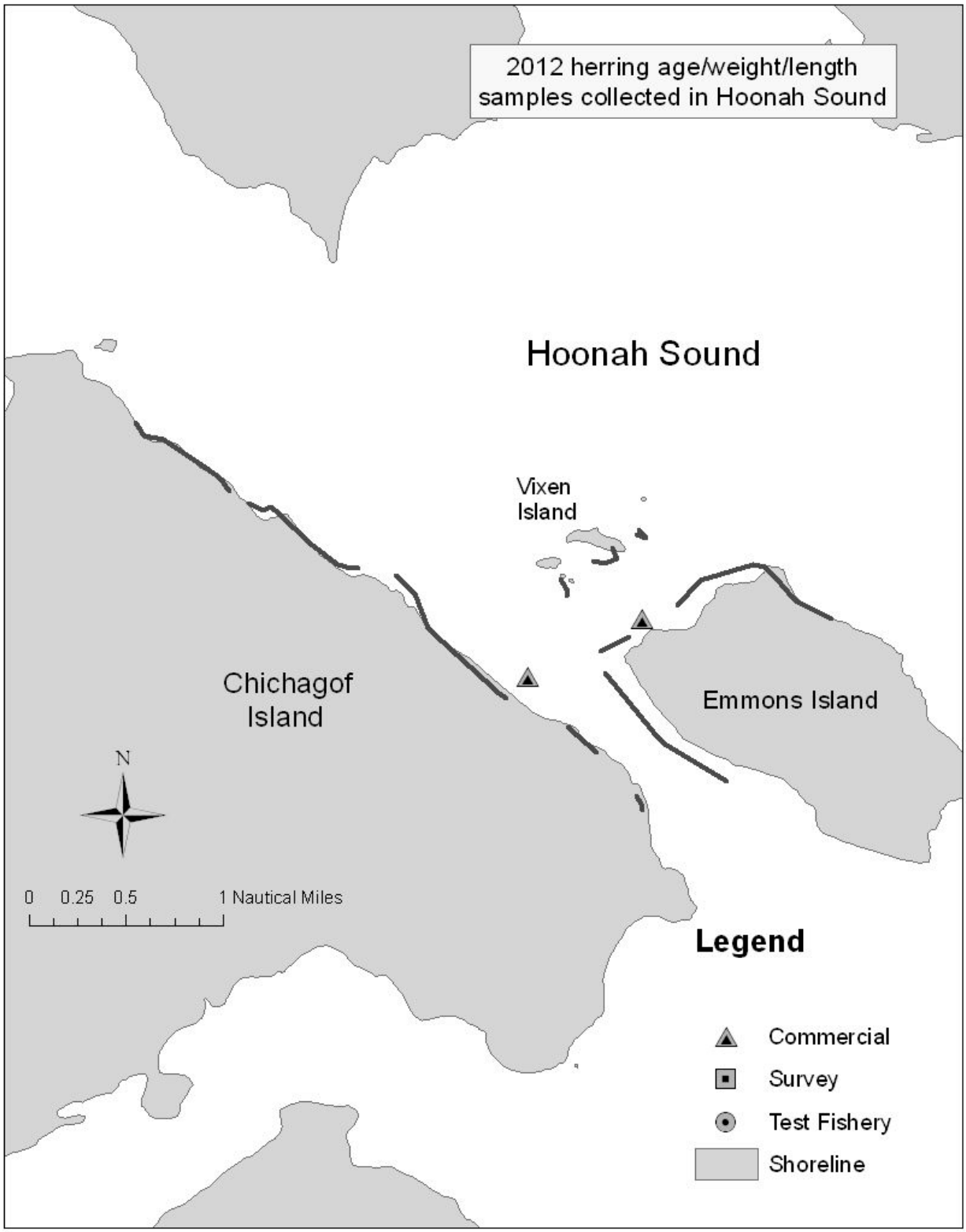


Figure 12.–Locations of herring samples collected for estimates of age and size for the Hoonah Sound herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

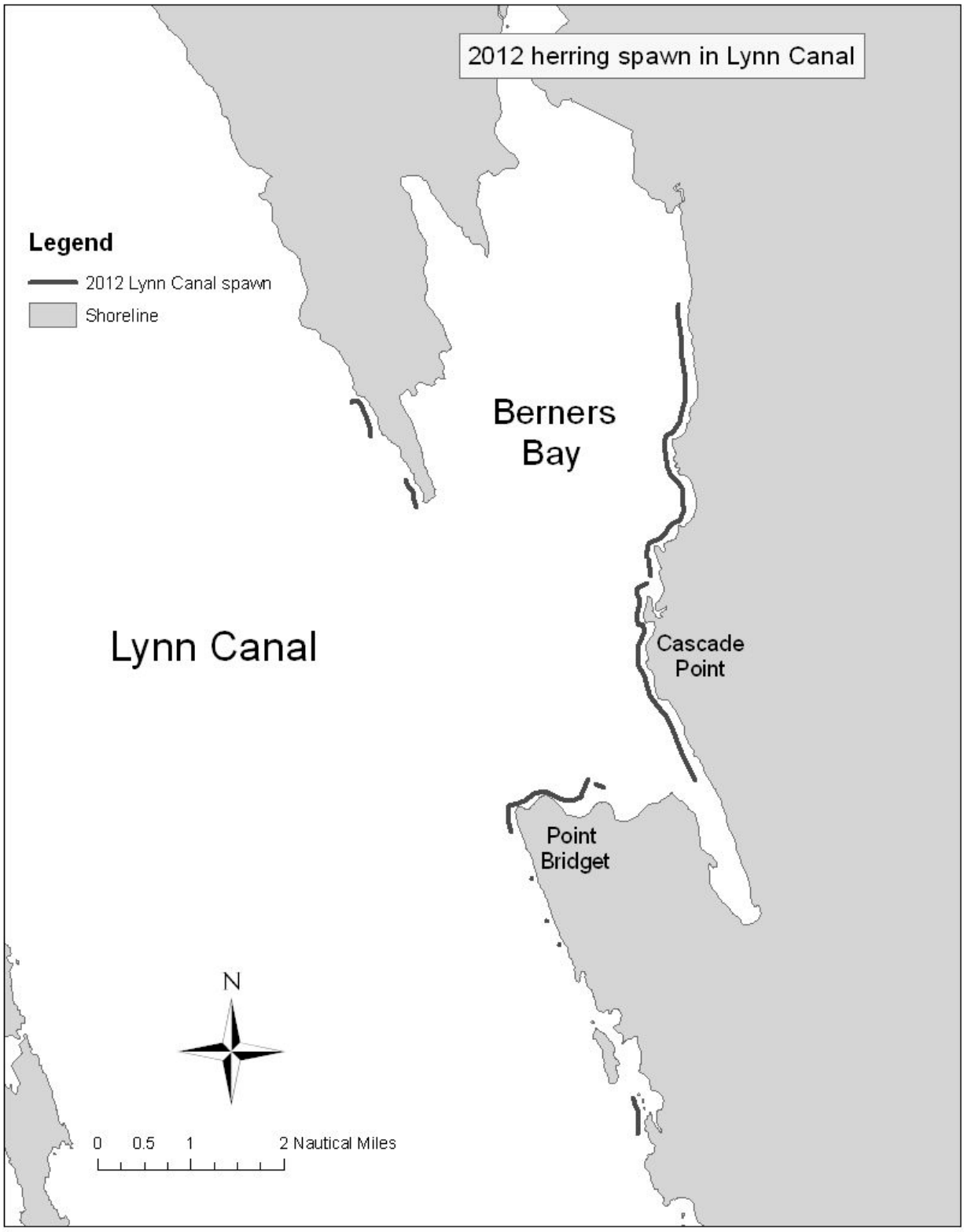


Figure 13 .– Location of herring spawn for the Lynn Canal herring stock, 2012. No age/size samples were obtained during 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

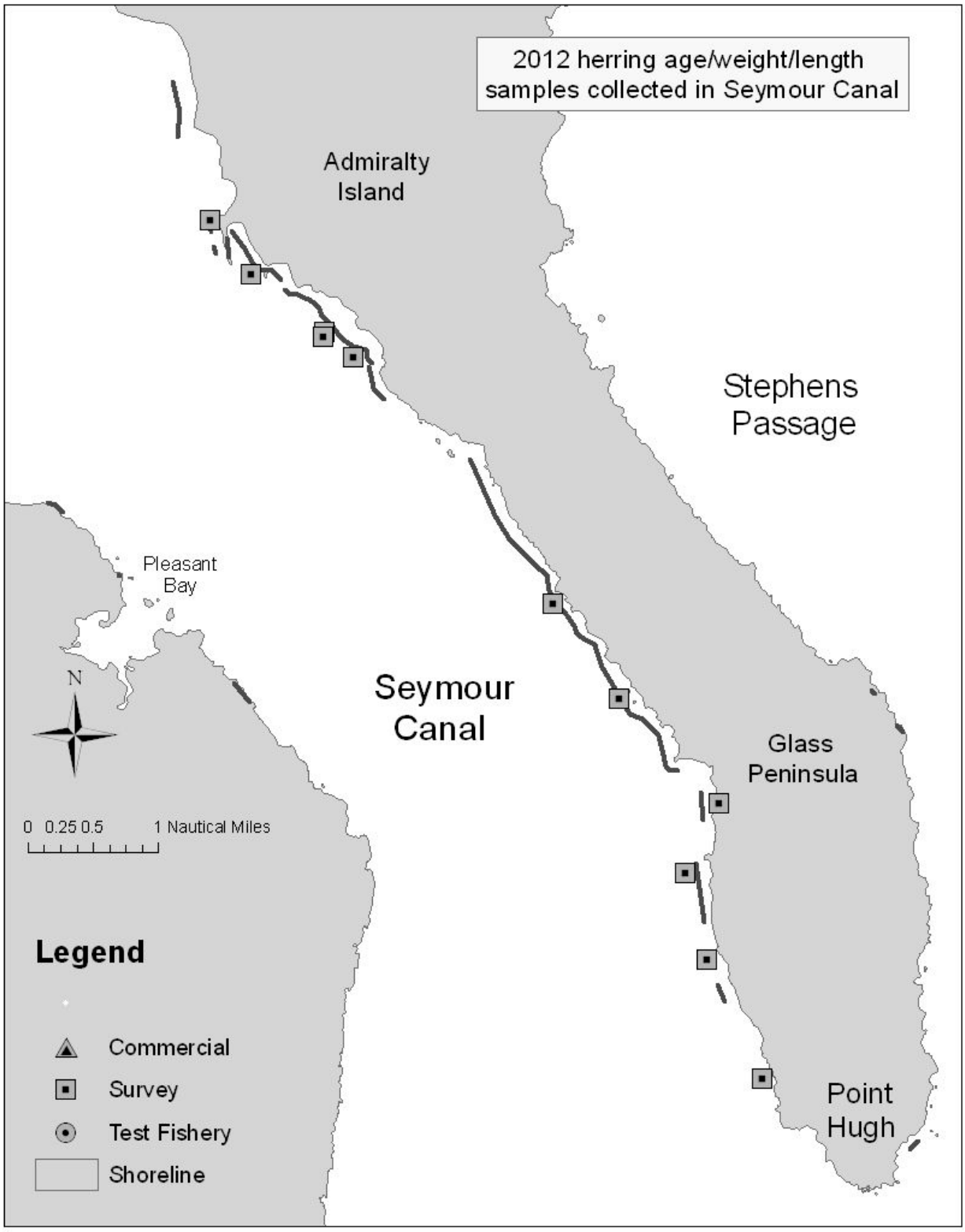


Figure 14.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

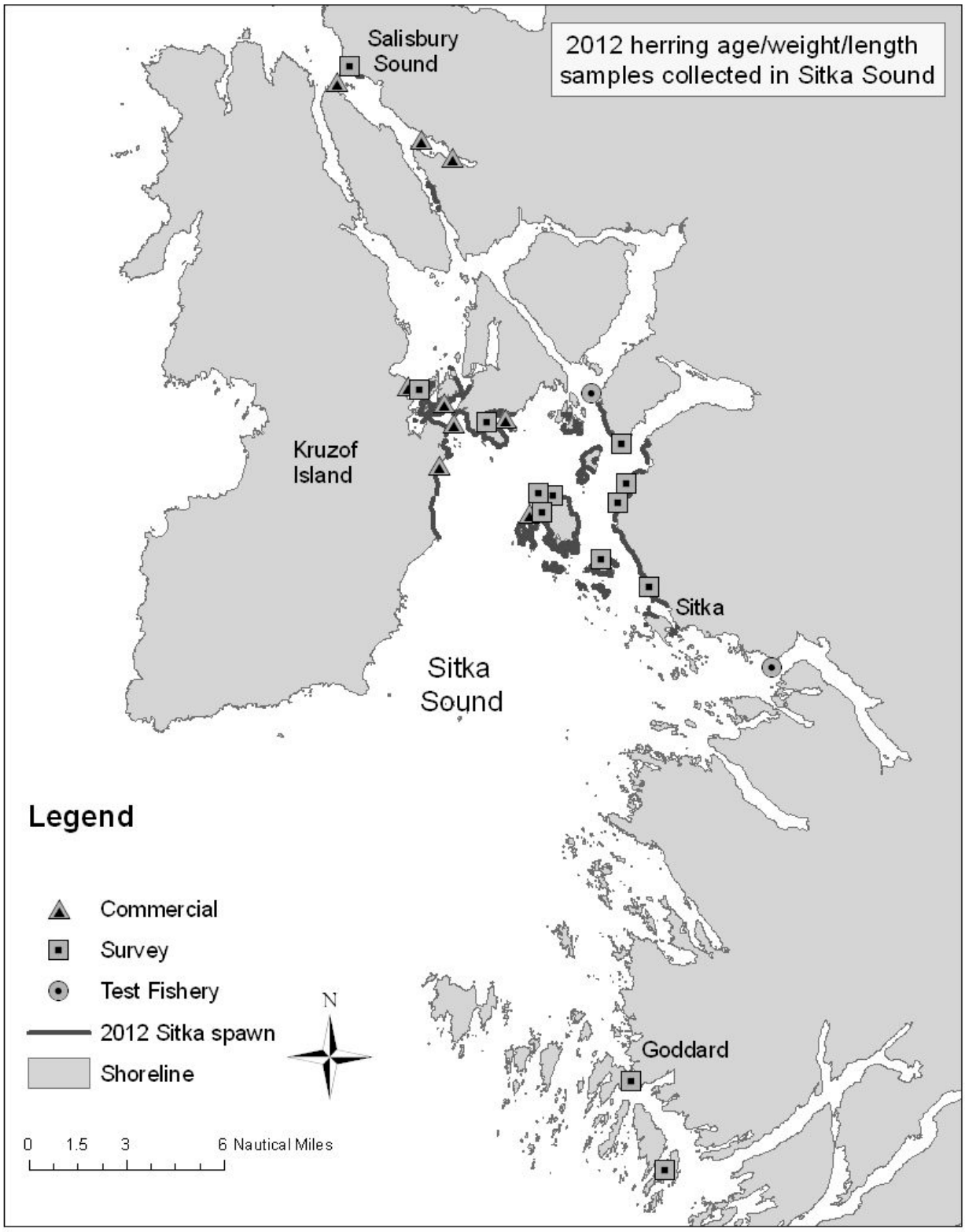


Figure 15.–Locations of herring samples collected for estimates of age and size for the Sitka Sound herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

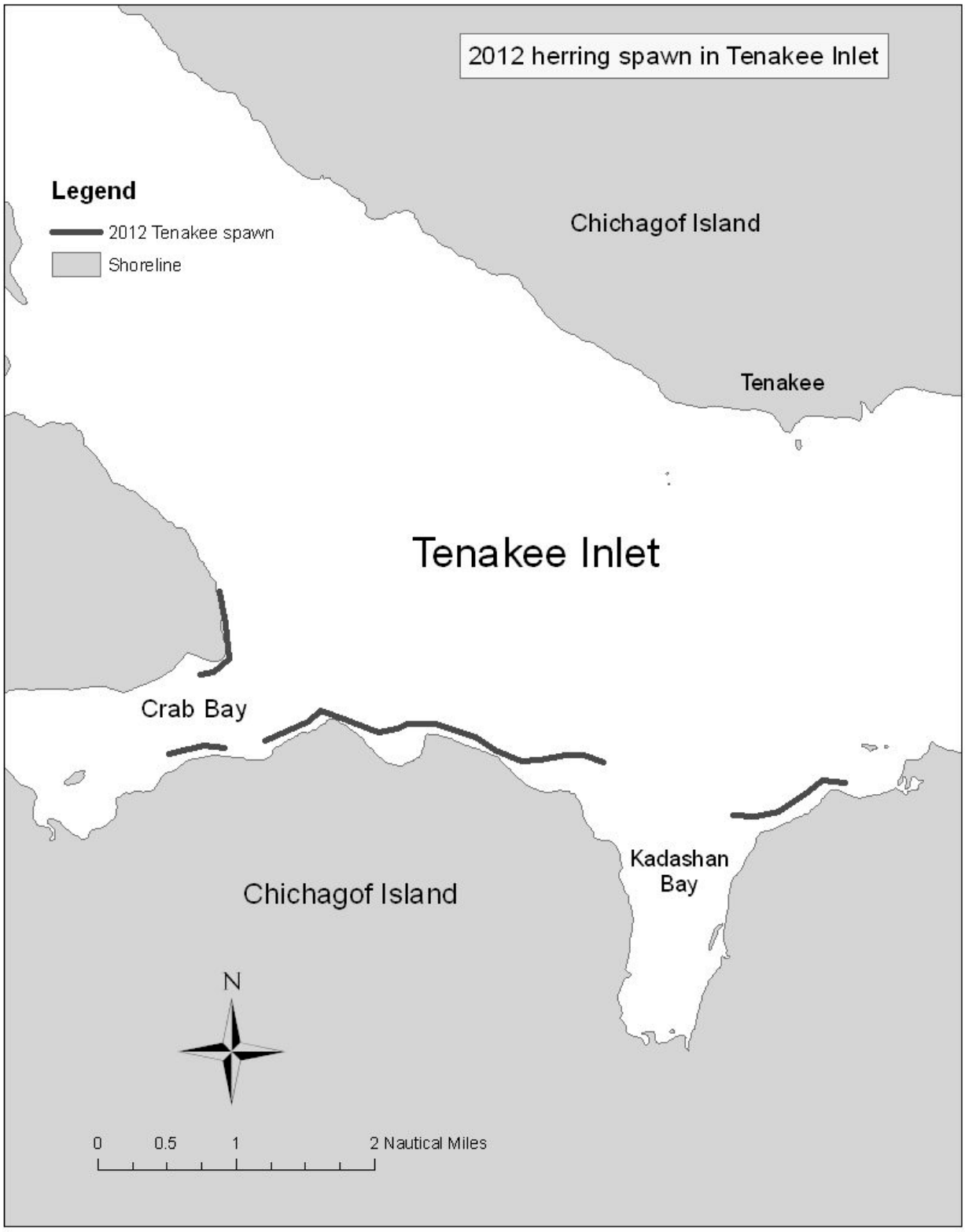


Figure 16.–Location of herring spawn for the Tenakee Inlet herring stock, 2012. No age/size samples were obtained during 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

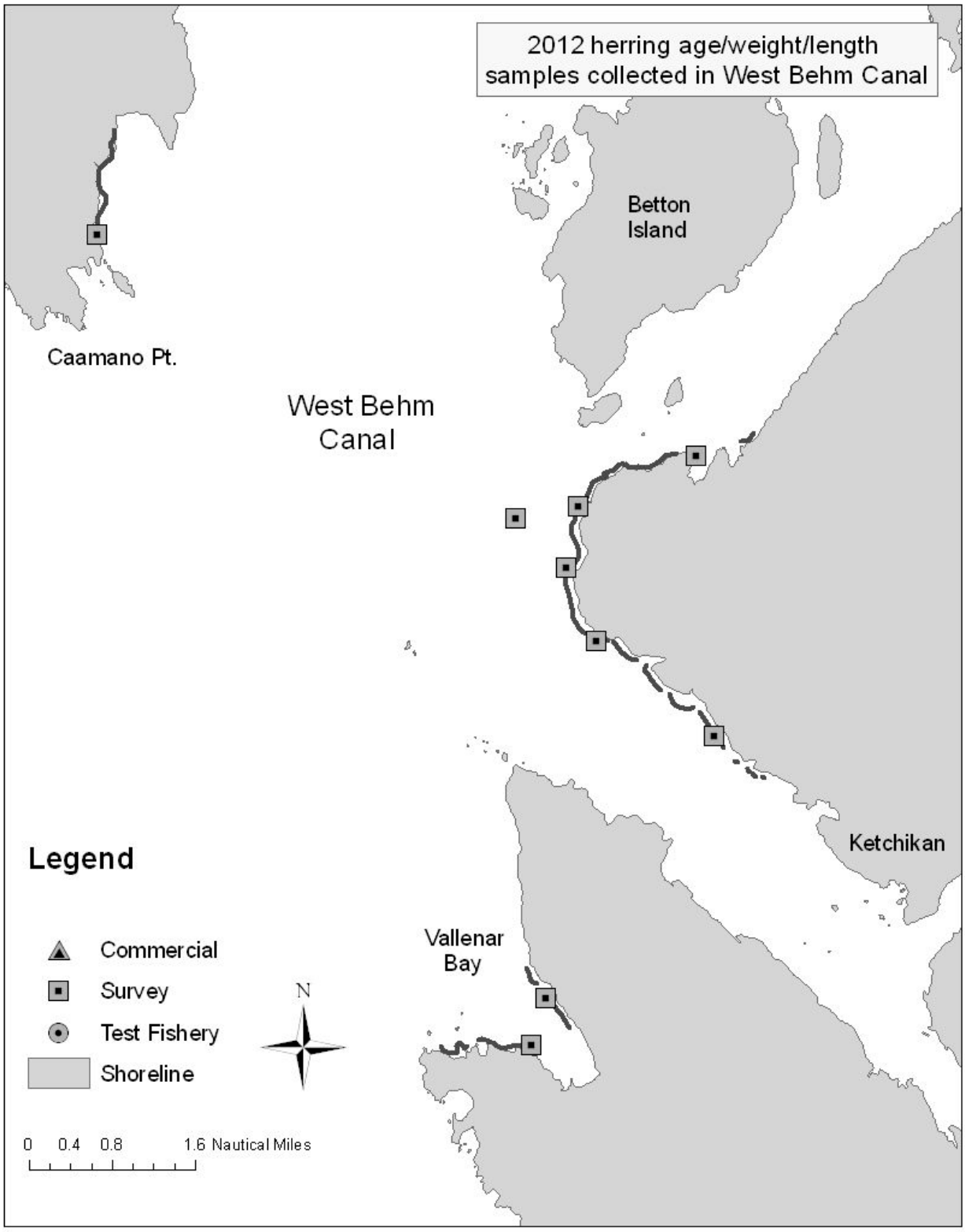


Figure 17.–Locations of herring samples collected for estimates of age and size for the West Behm Canal herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

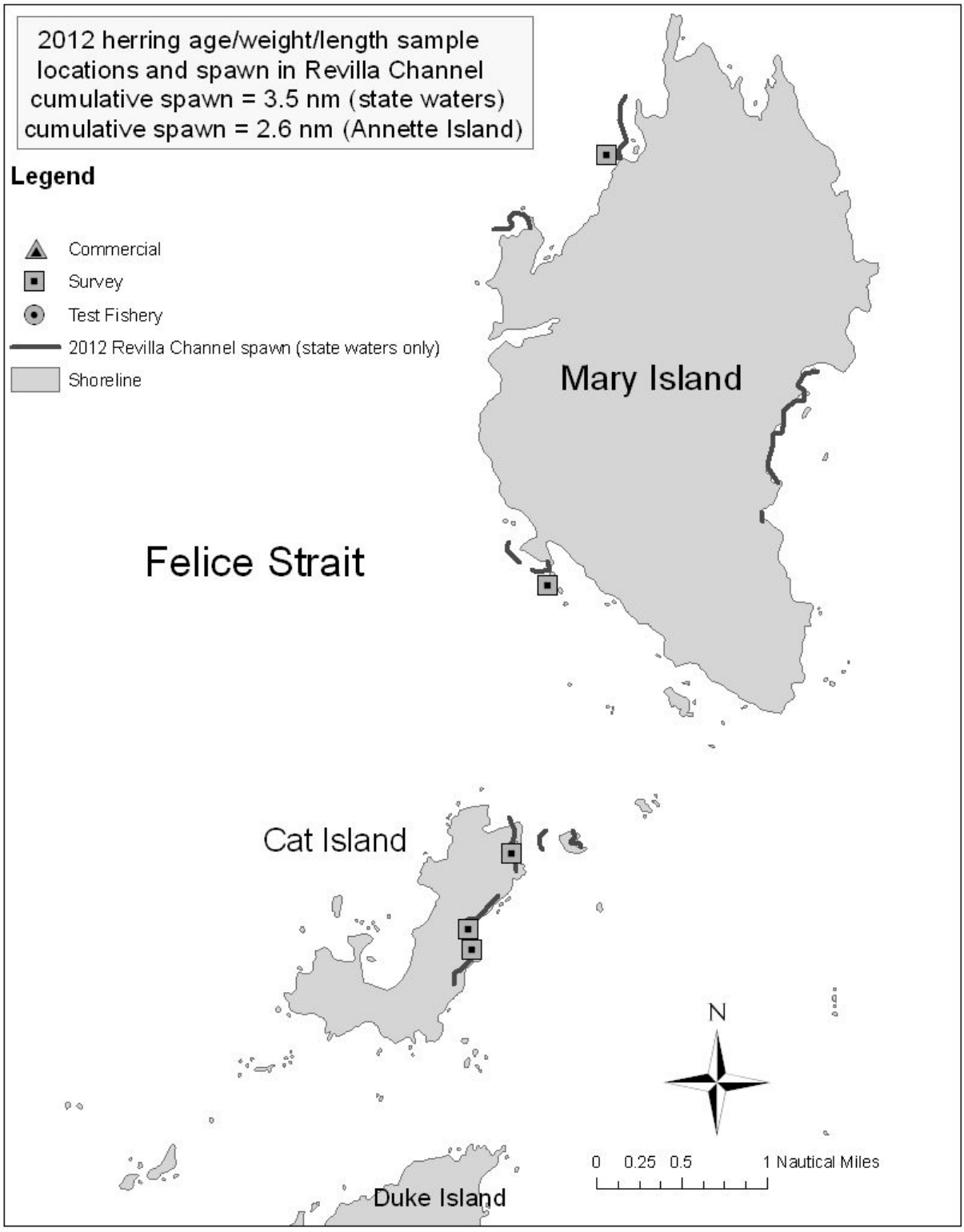


Figure 18.–Locations of herring samples collected for estimates of age and size for the Revilla Channel herring stock, 2012 (state waters only are shown). Cumulative herring spawn denoted by thick gray line along shoreline.

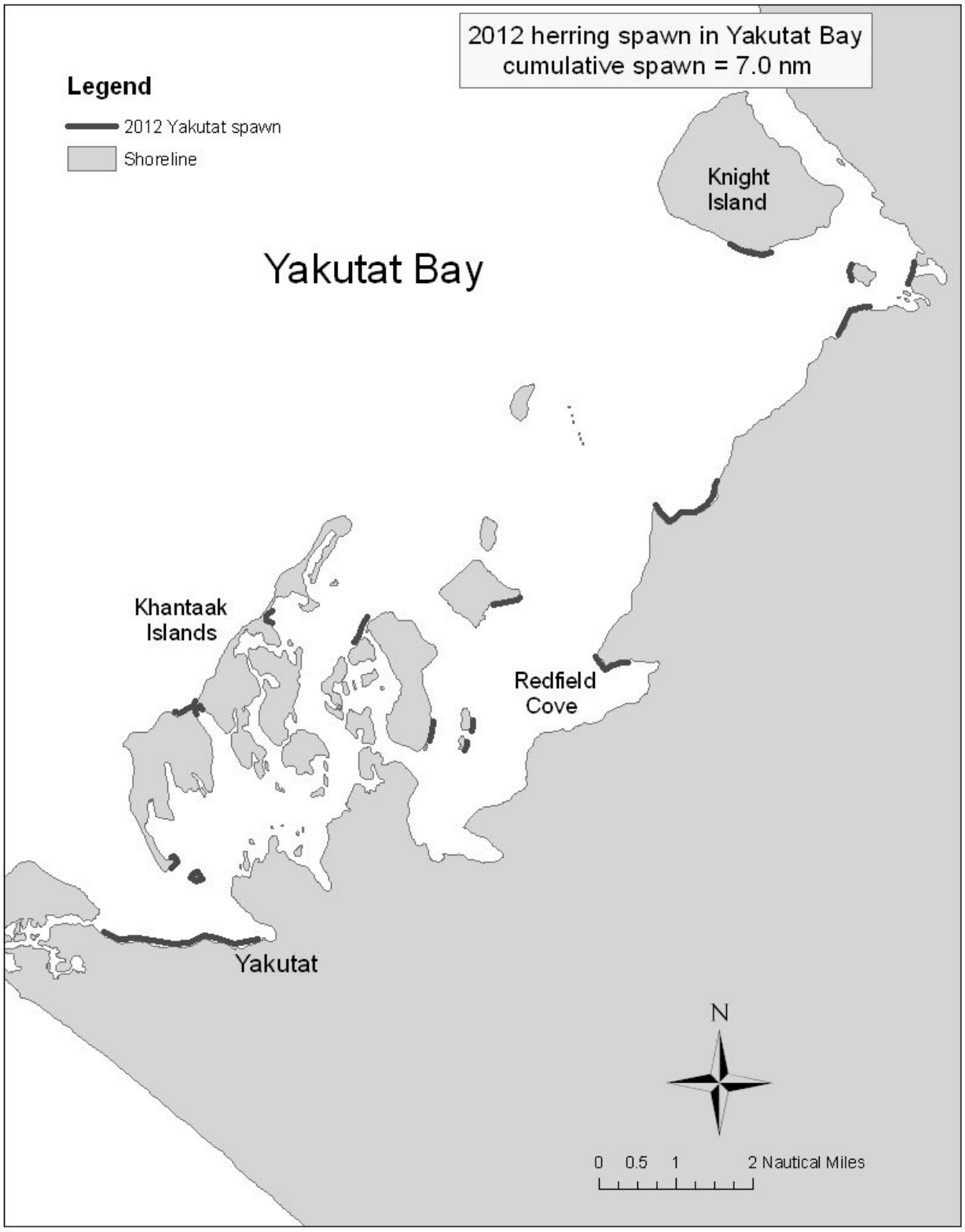


Figure 19.–Locations of herring for the Yakutat herring stock, 2012. Cumulative herring spawn denoted by thick gray line along shoreline.

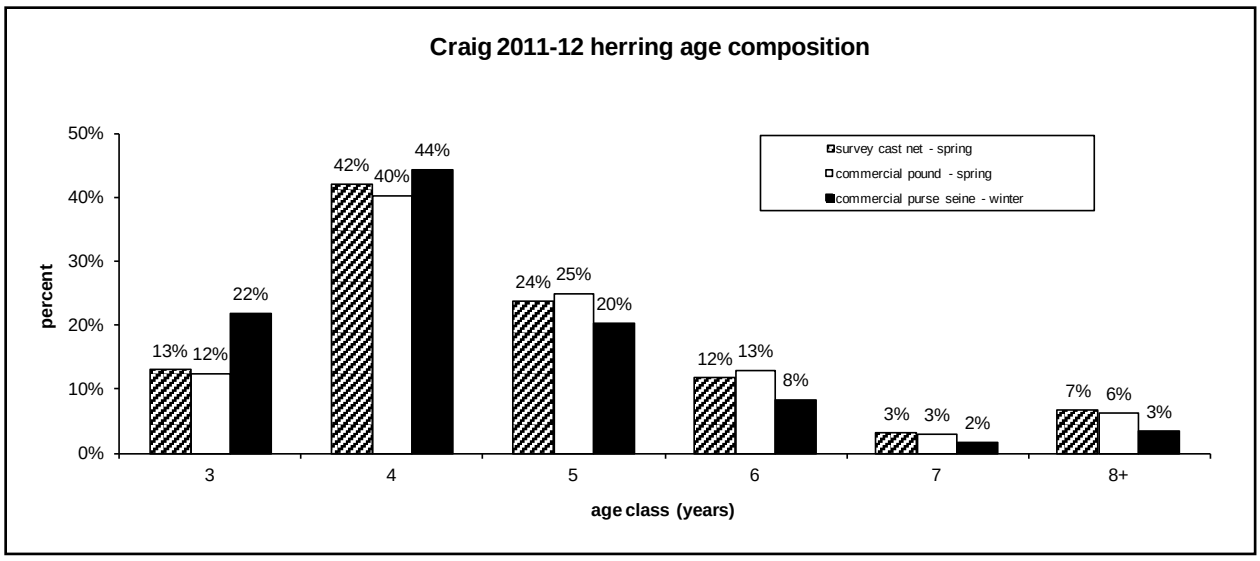


Figure 20.–Age composition for Craig herring stock in 2011–12.

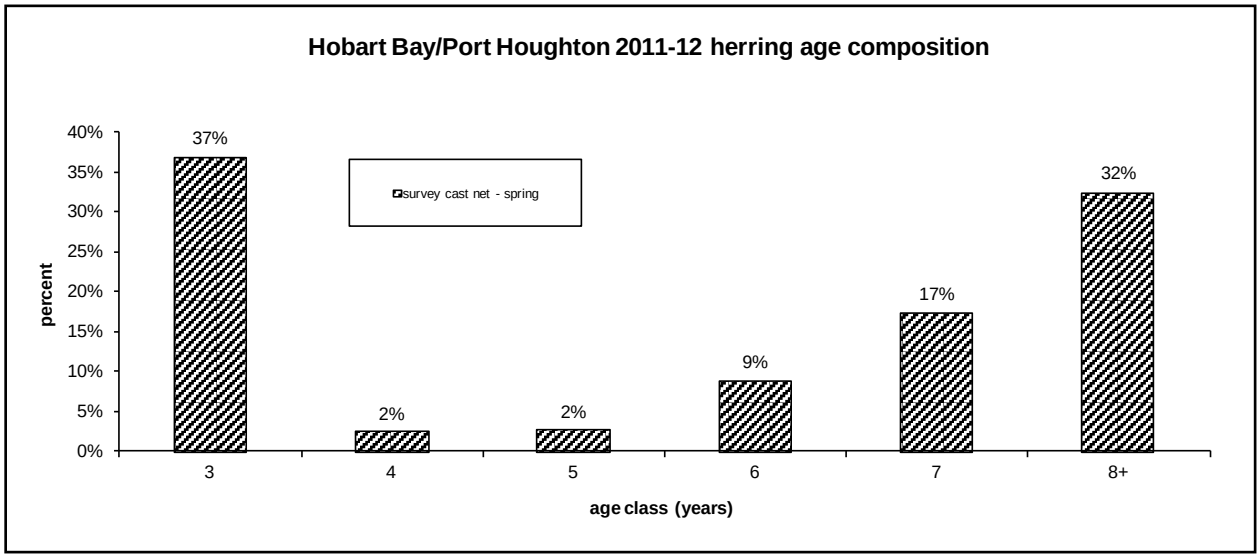


Figure 21.–Age composition for Hobart Bay/Port Houghton herring stock in 2011–12.

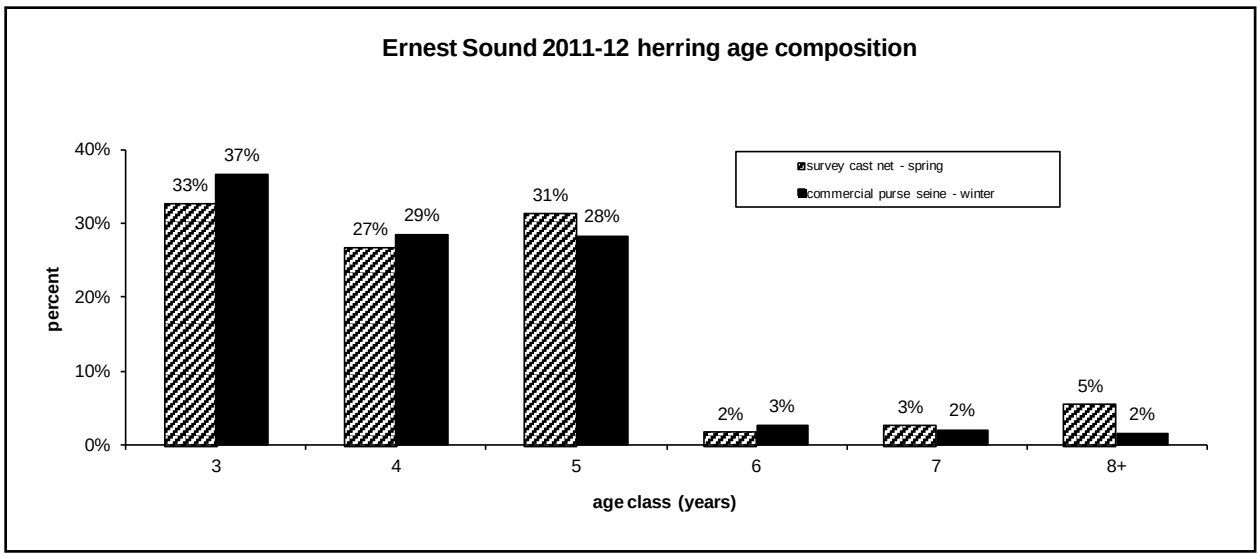


Figure 22.–Age composition for Ernest Sound herring stock in 2011–12.

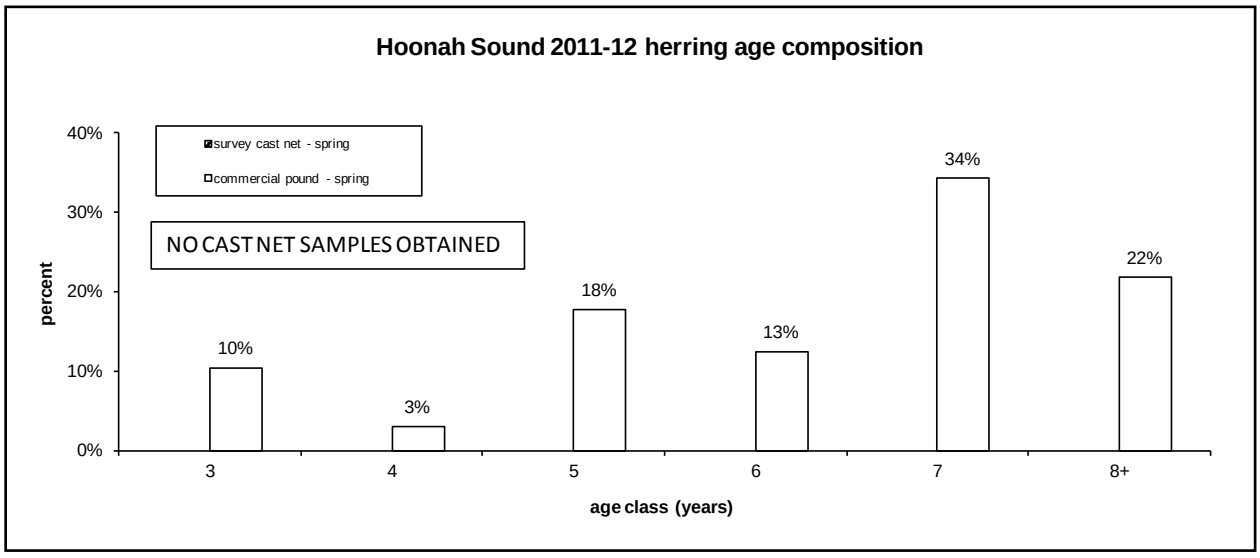


Figure 23.–Age composition for Hoonah Sound herring stock in 2011–12.

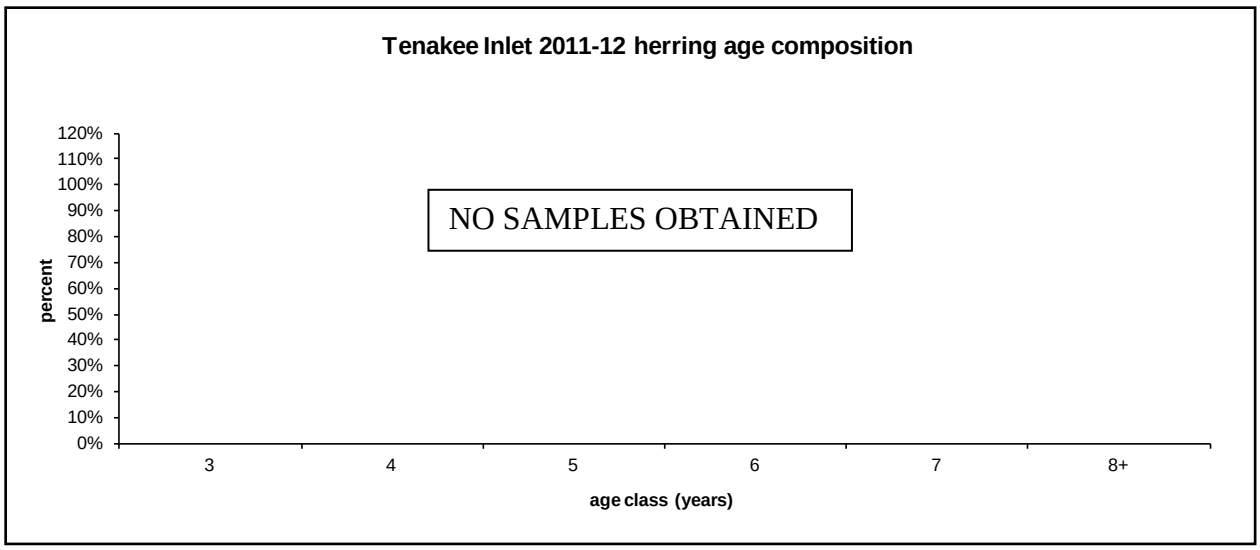


Figure 24.–Age composition for Tenakee Inlet herring stock in 2011–12. No samples were obtained and no commercial fishery was opened in 2011-12.

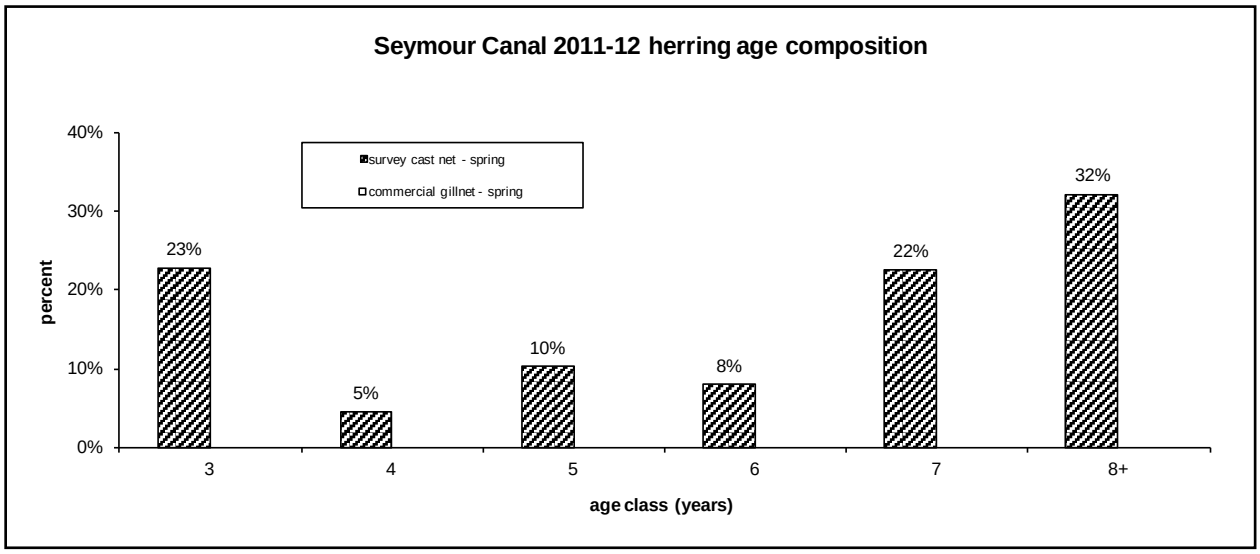


Figure 25.–Age composition for Seymour Canal herring stock in 2010–11.

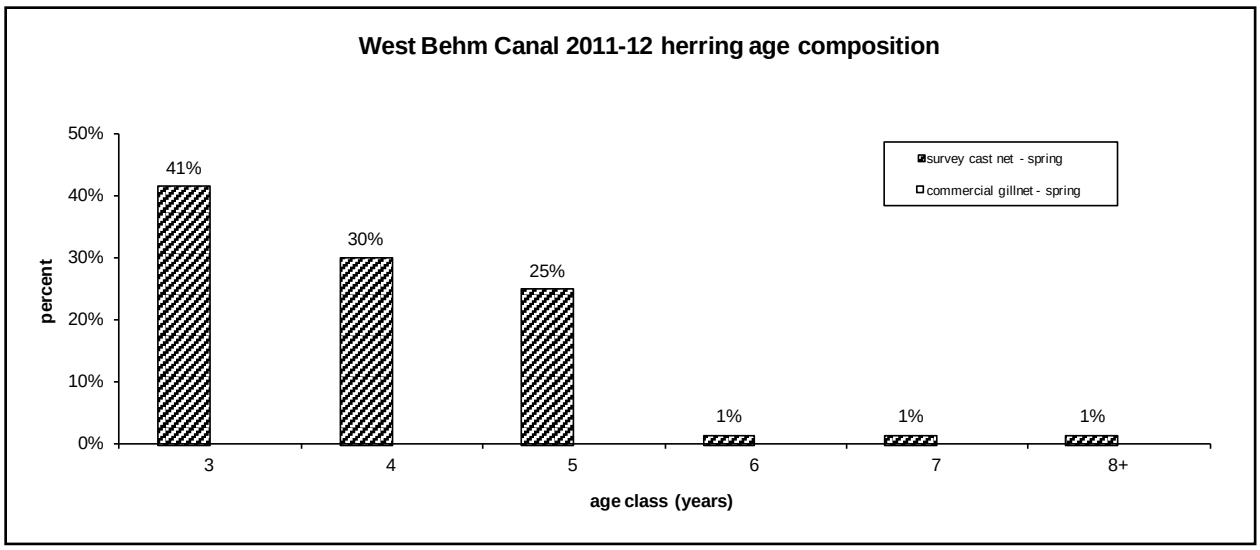


Figure 26.–Age composition for West Behm Canal herring stock in 2011–12.

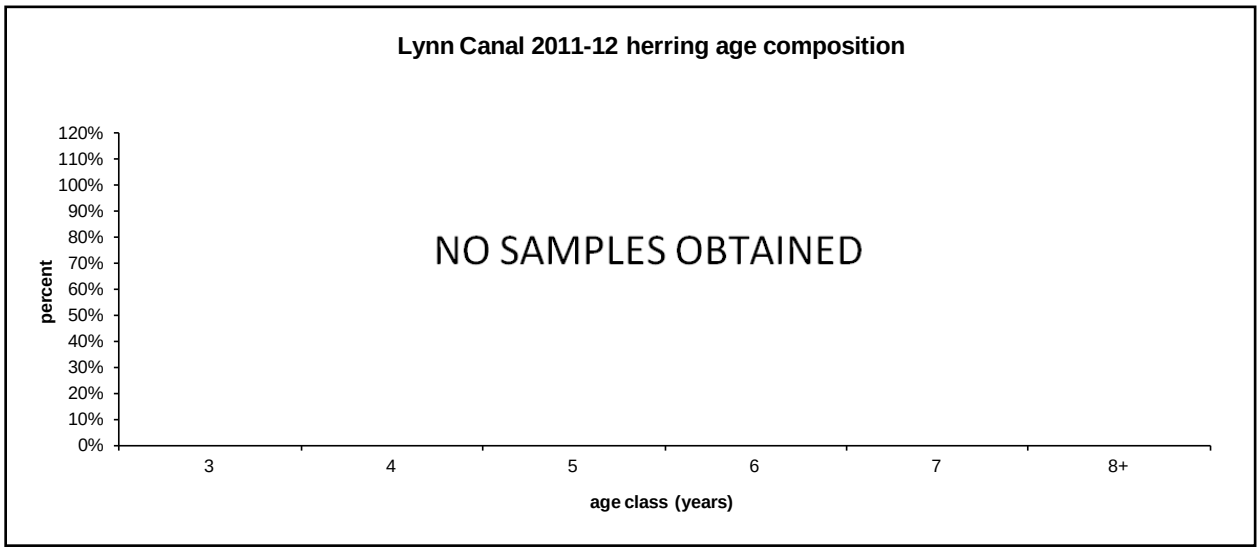


Figure 27.–Age composition for Lynn Canal herring stock in 2011–12. No samples were obtained and no commercial fishery was opened in 2011-12.

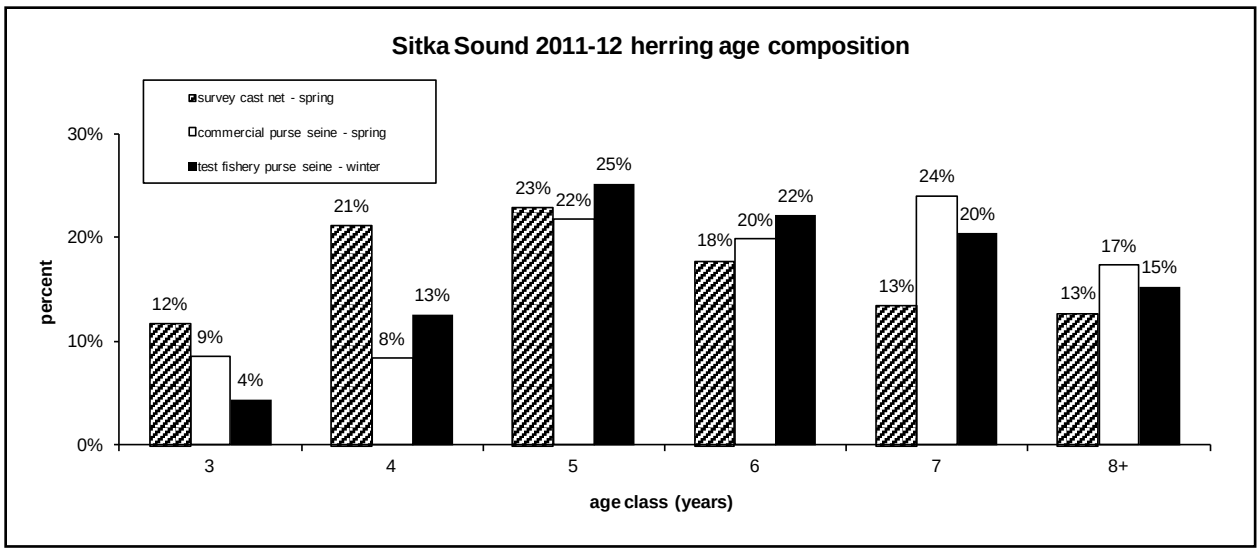


Figure 28.–Age composition for Sitka Sound herring stock in 2011–12.

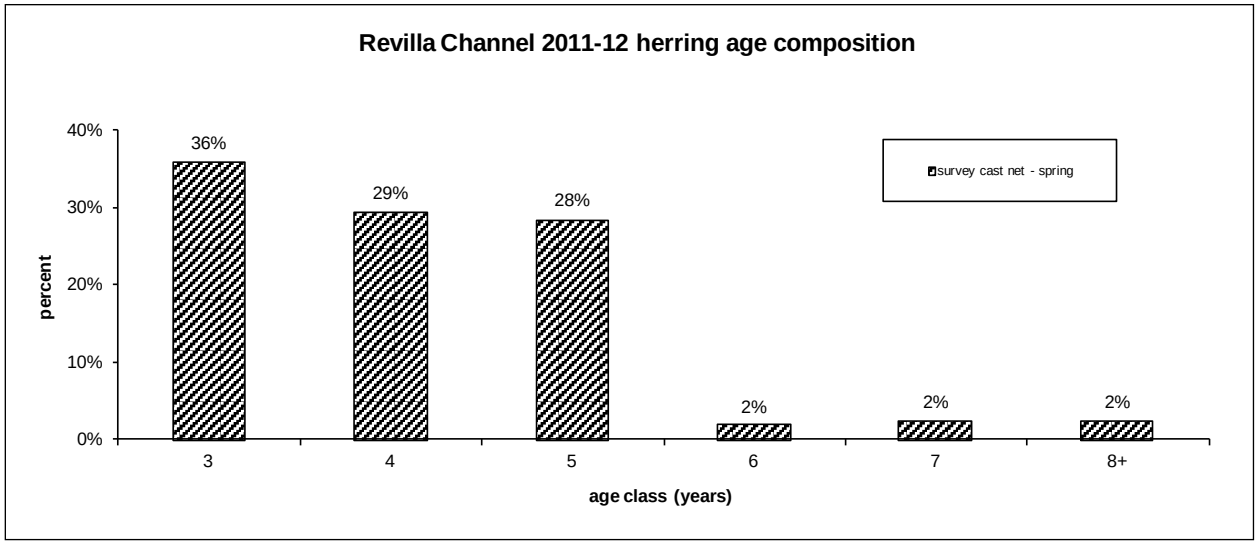


Figure 29.–Age composition for Revilla Channel herring stock in 2011–12.

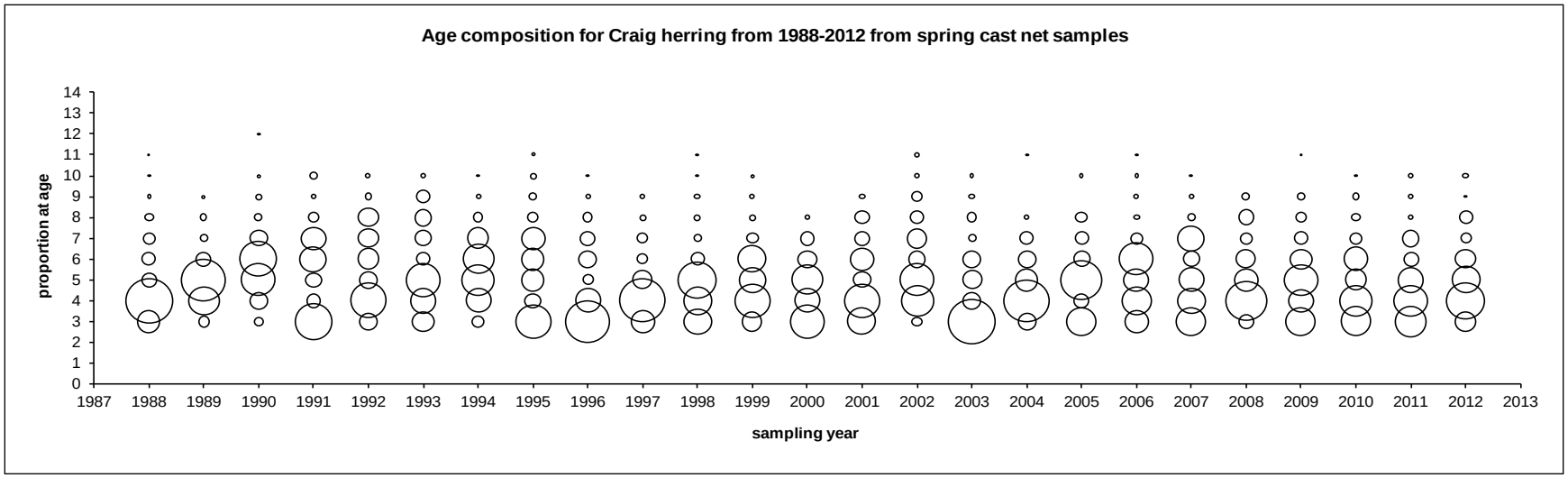


Figure 30.–Age composition from sampling data for the Craig herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

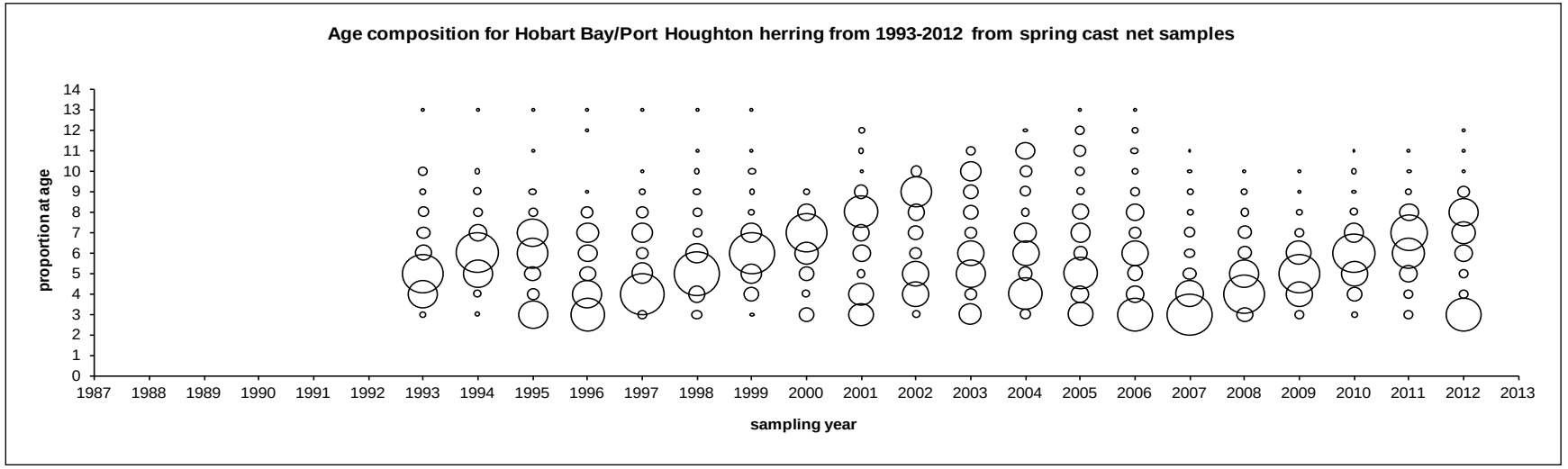


Figure 31.–Age composition from sampling data for the Hobart Bay/Port Houghton herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

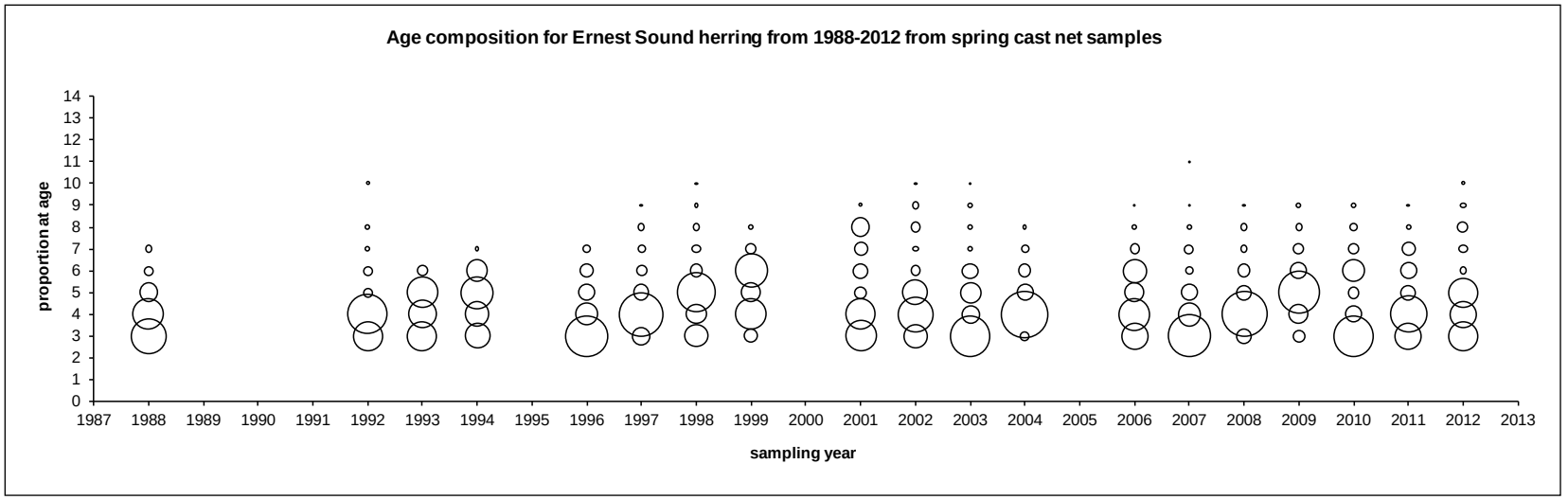


Figure 32.–Age composition from sampling data for the Ernest Sound herring stock.

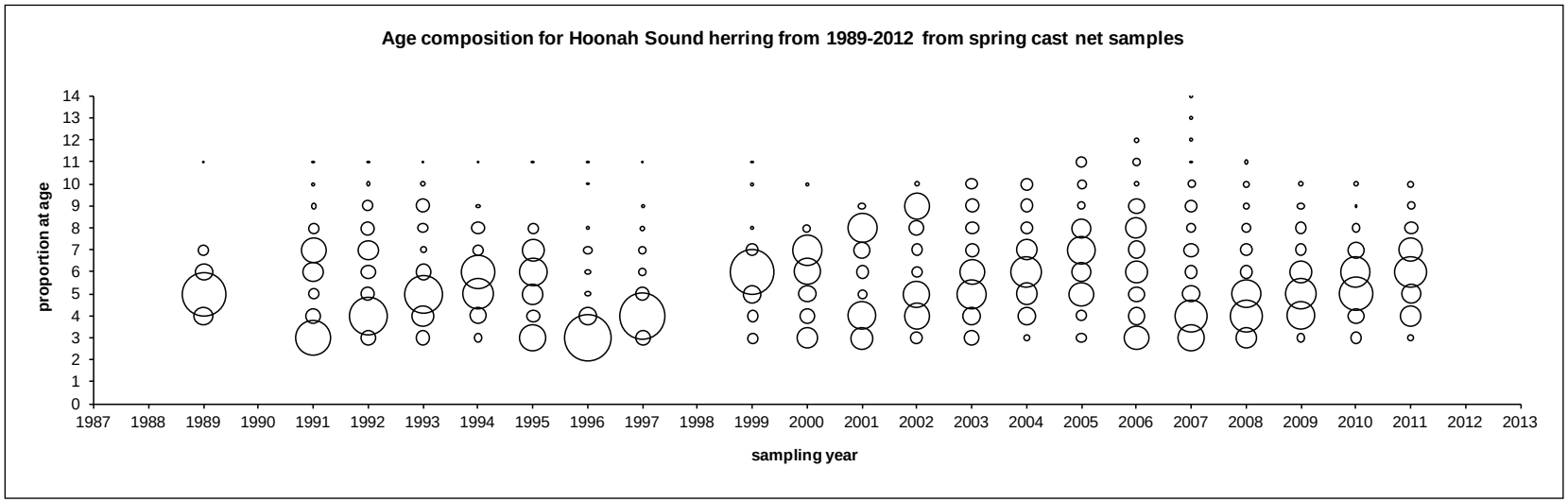


Figure 33.–Age composition from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

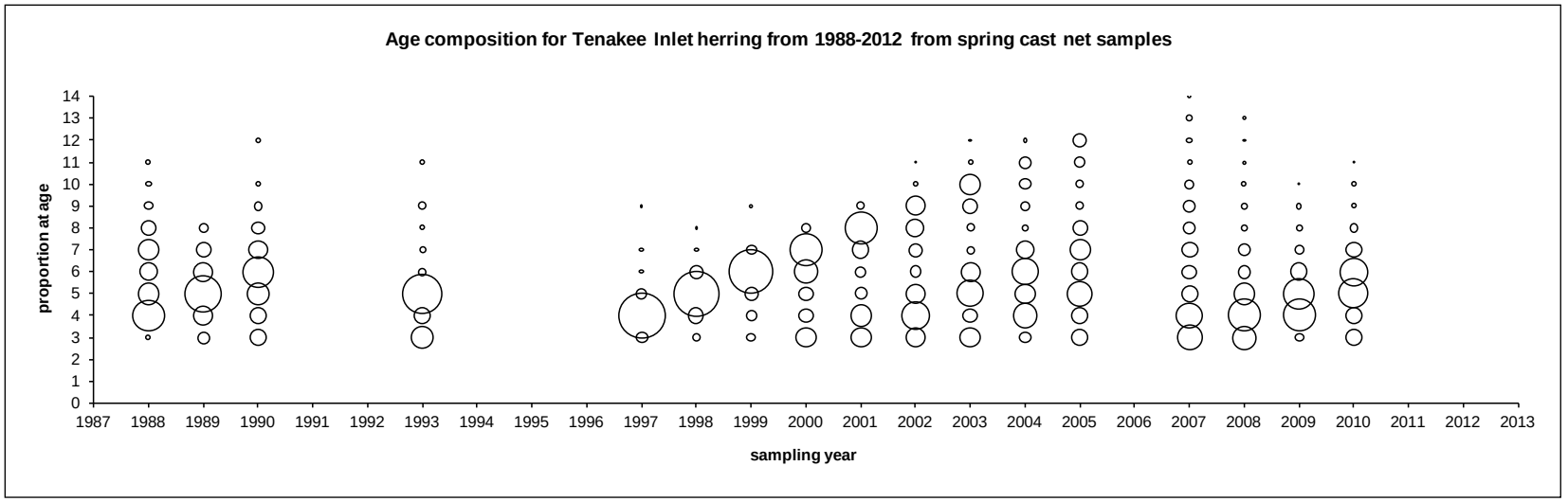


Figure 34.–Age composition from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

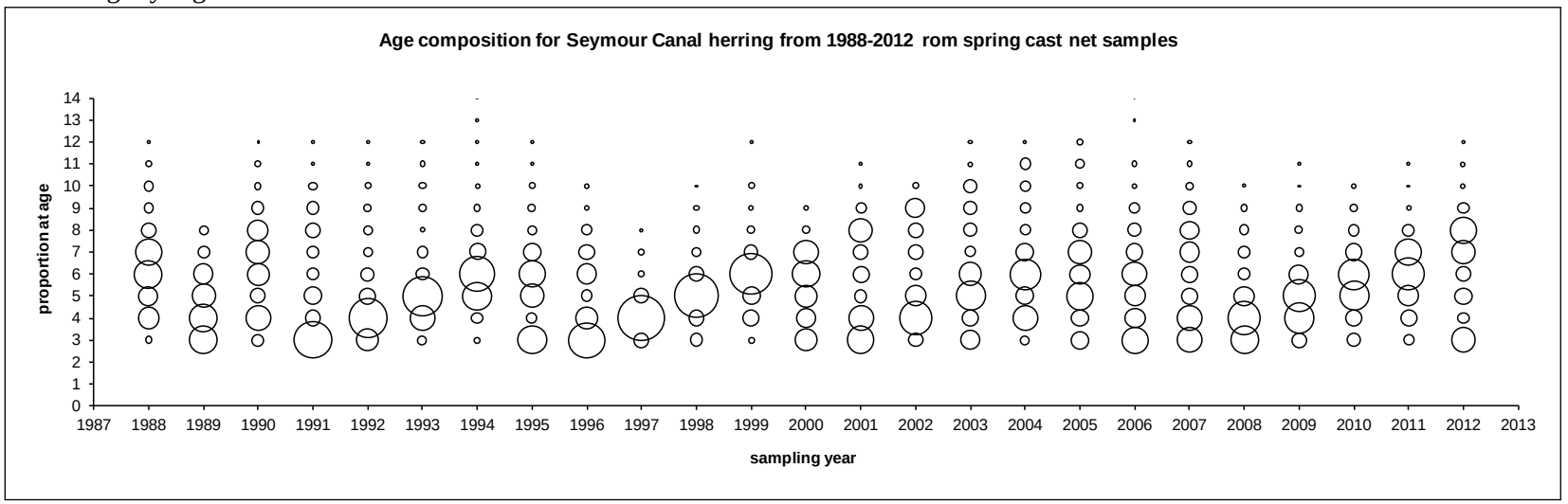


Figure 35.–Age composition from sampling data for the Seymour Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

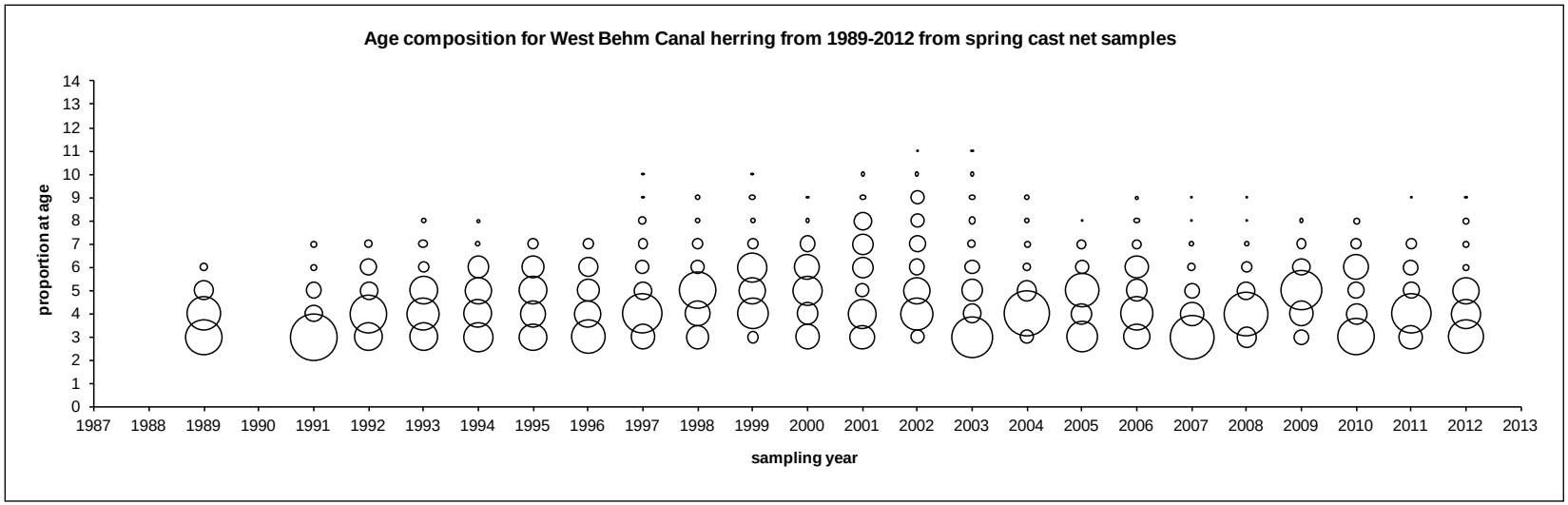


Figure 36.–Age composition from sampling data for the West Behm Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

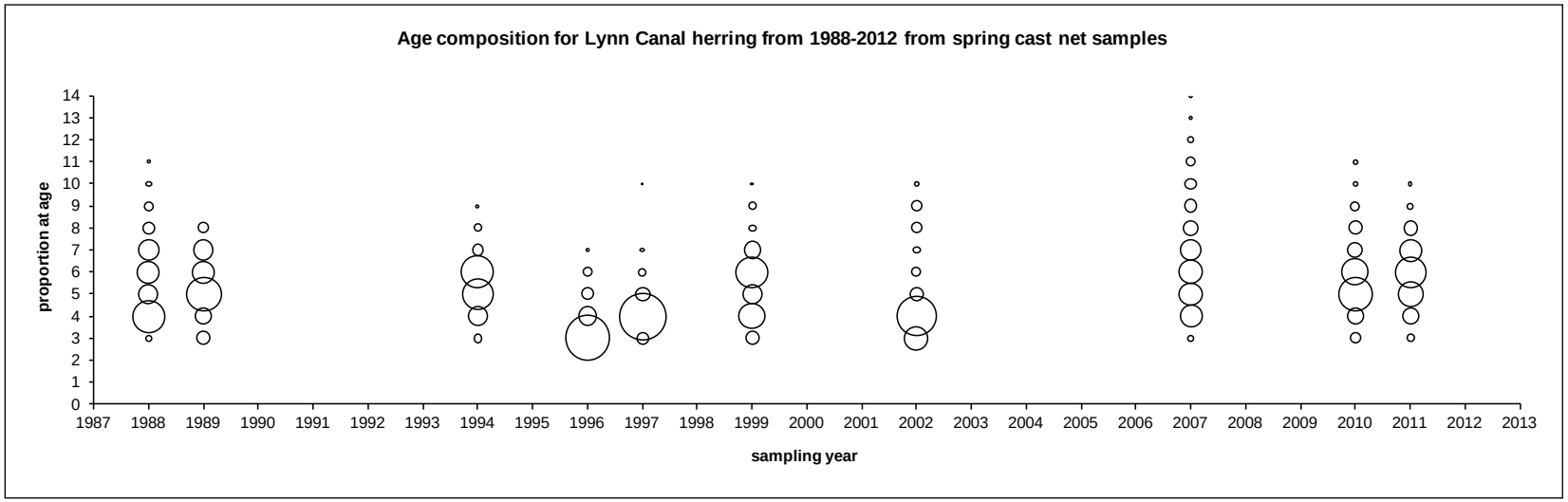


Figure 37.–Age composition from sampling data for the Lynn Canal herring stock.

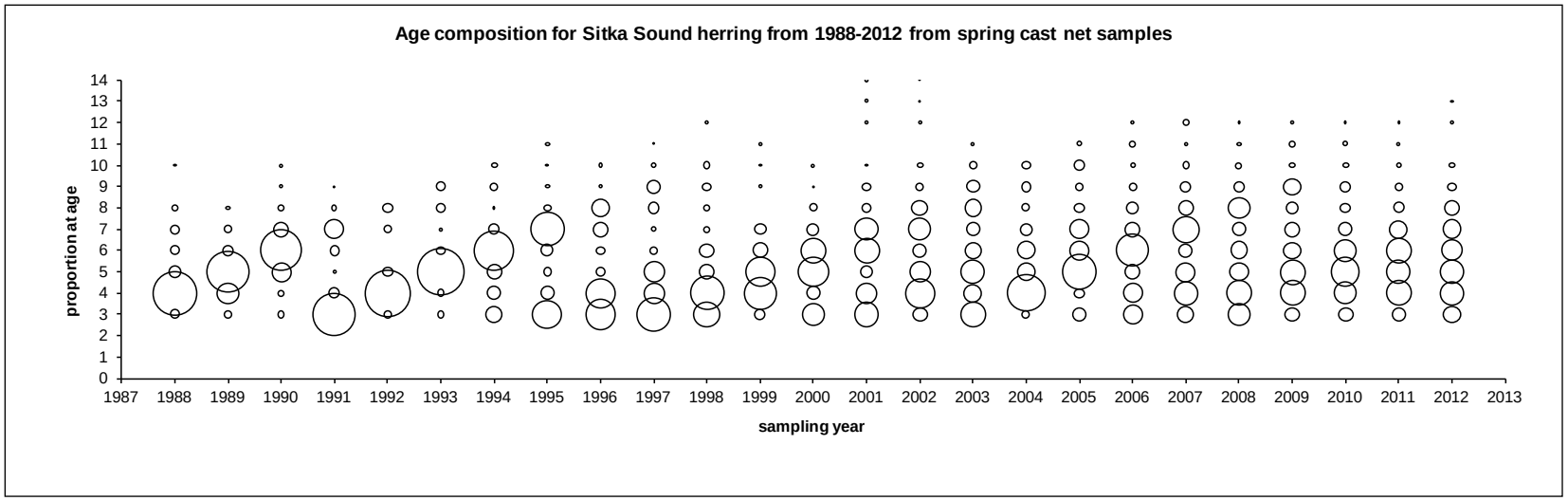


Figure 38.–Age composition from sampling data for the Sitka Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

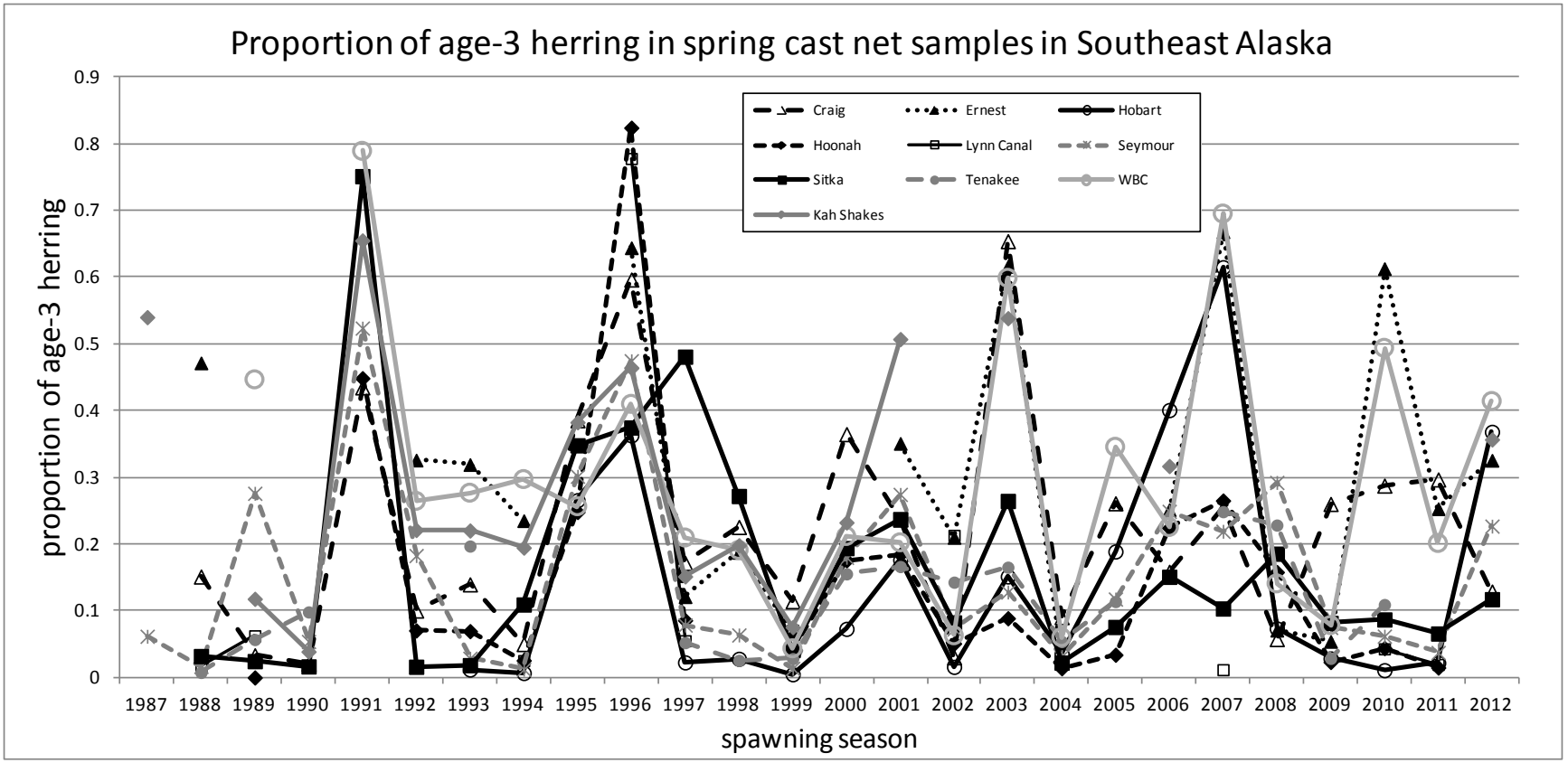


Figure 39.–Proportion of age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

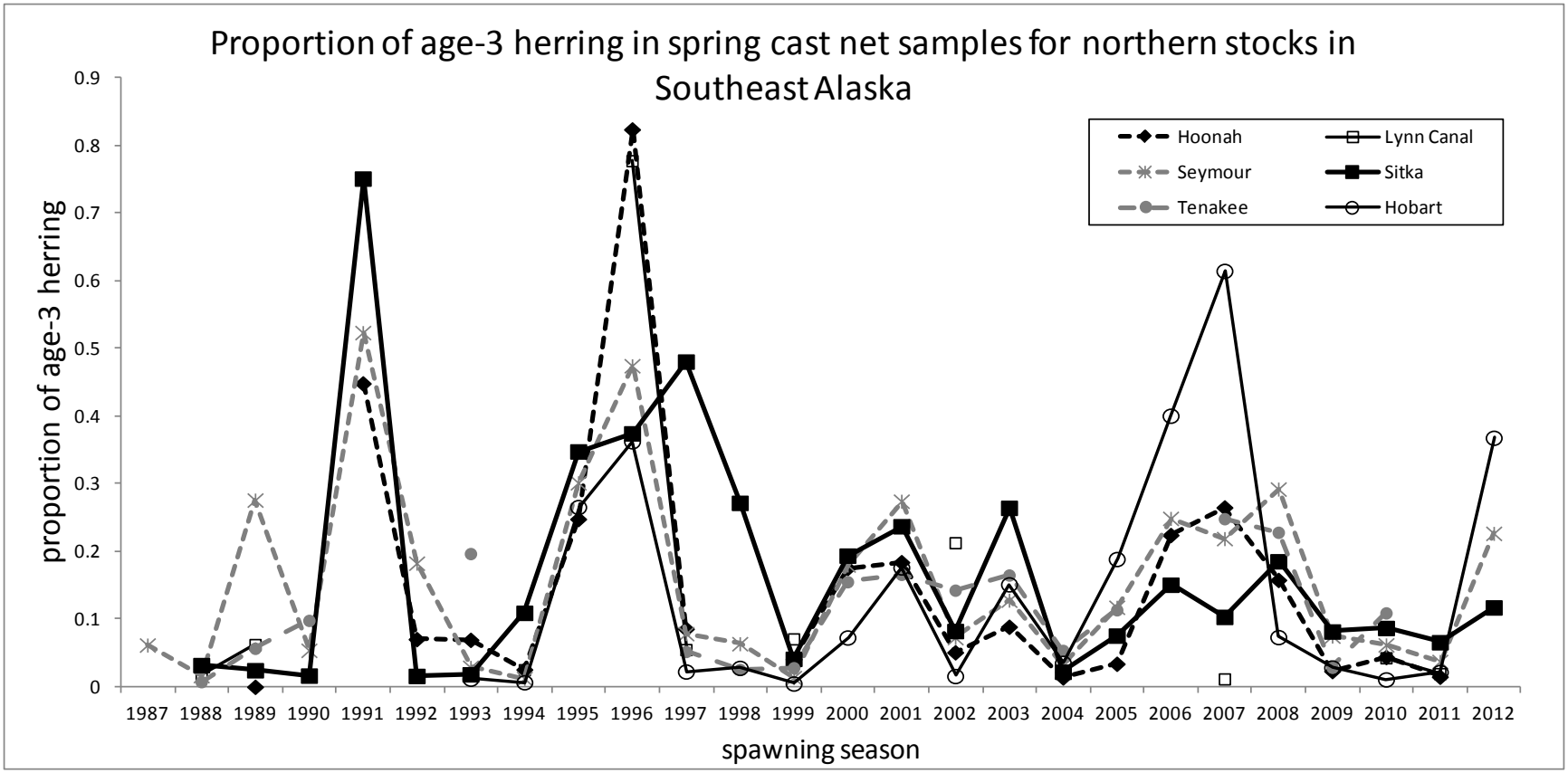


Figure 40.–Proportion of age-3 herring in spring cast nest samples of spawning populations for northern stocks in Southeast Alaska.

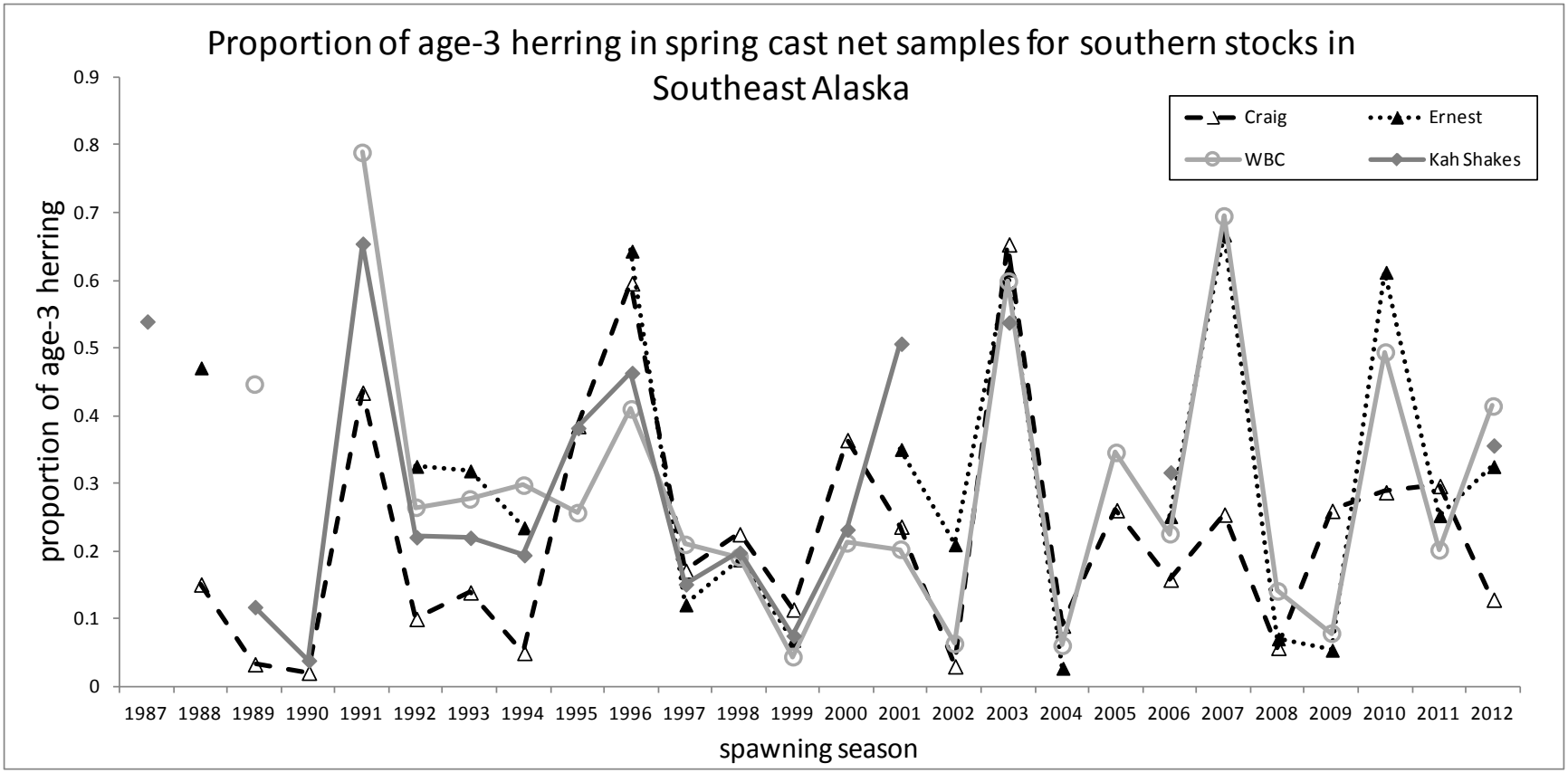


Figure 41.–Proportion of age-3 herring in spring cast nest samples of spawning populations for southern stocks in Southeast Alaska.

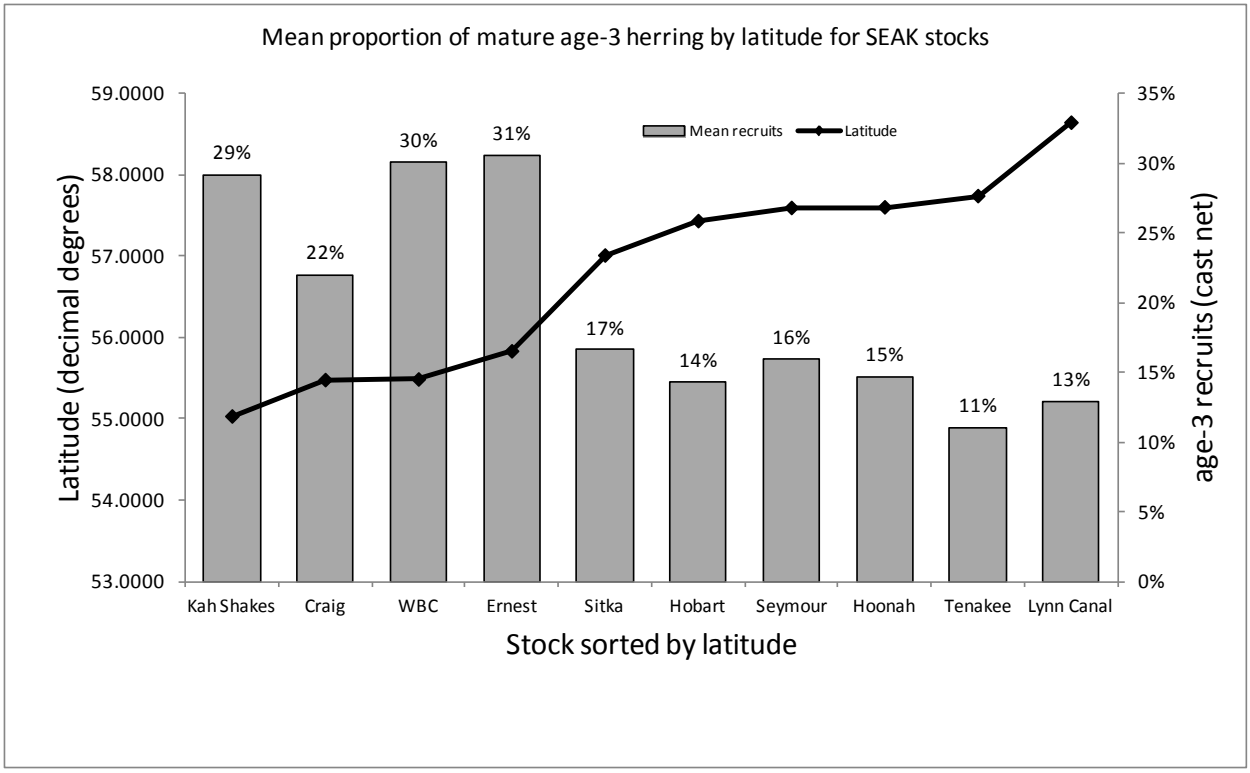


Figure 42.–Mean proportion of age-3 herring in spring cast nest samples (1988–2012) and latitude of spawning populations for stocks in Southeast Alaska.

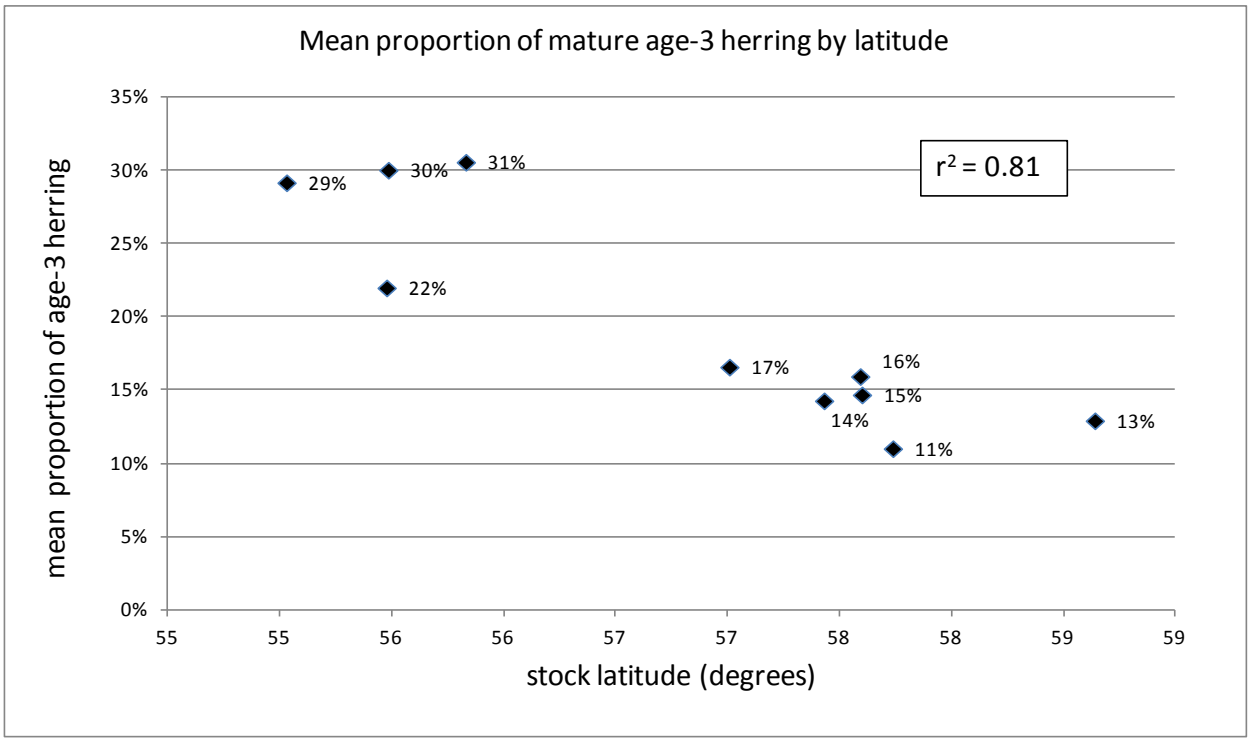


Figure 43.–Mean proportion of age-3 herring in spring cast nest samples versus stock latitude of spawning stocks in Southeast Alaska.

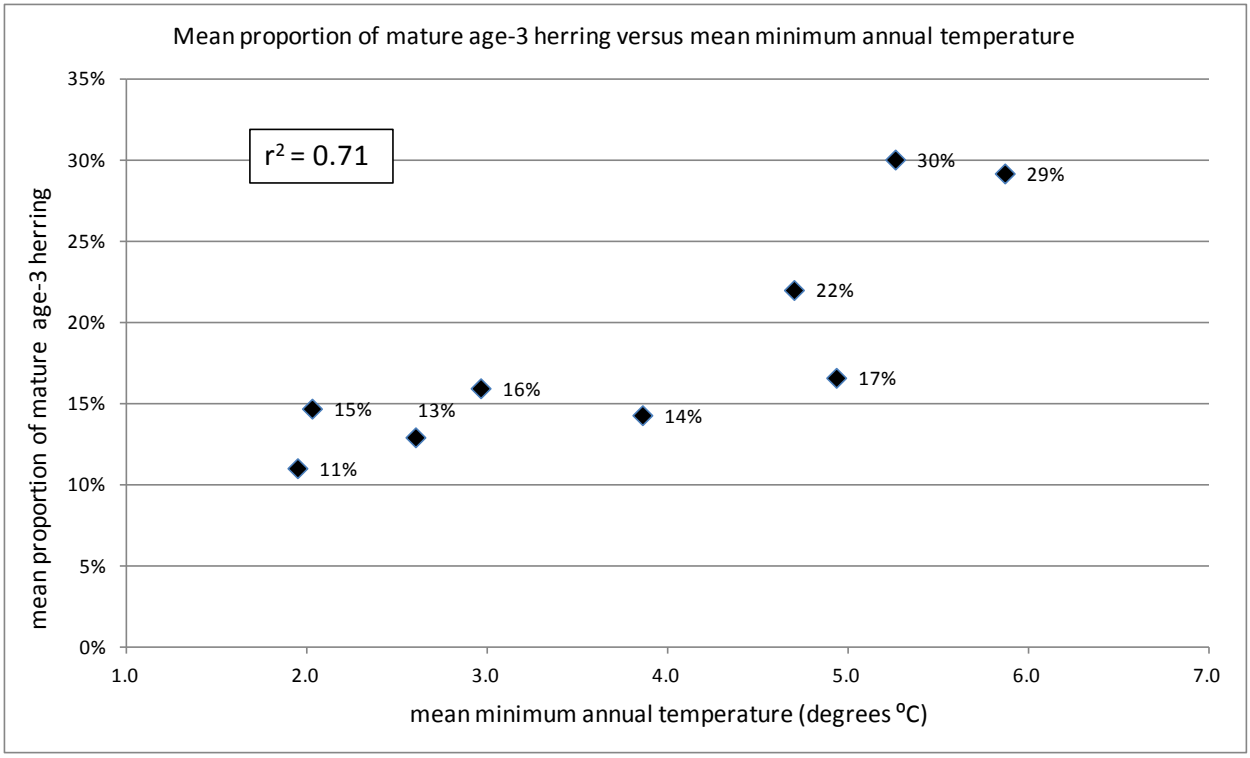


Figure 44.–Mean proportion of age-3 herring in spring cast nest samples versus mean minimum annual sea water temperature at location of spawning stocks in Southeast Alaska.

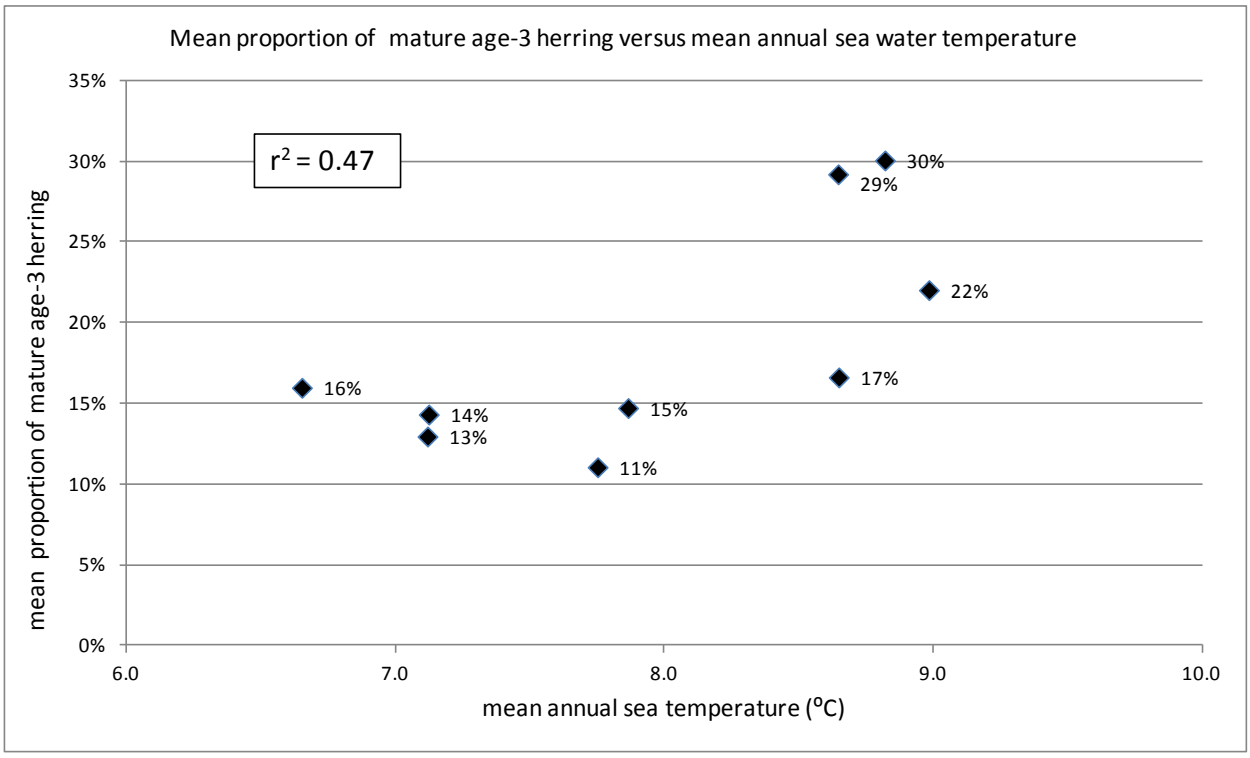


Figure 45.–Mean proportion of age-3 herring in spring cast nest samples versus mean annual sea water temperature at location of spawning stocks in Southeast Alaska.

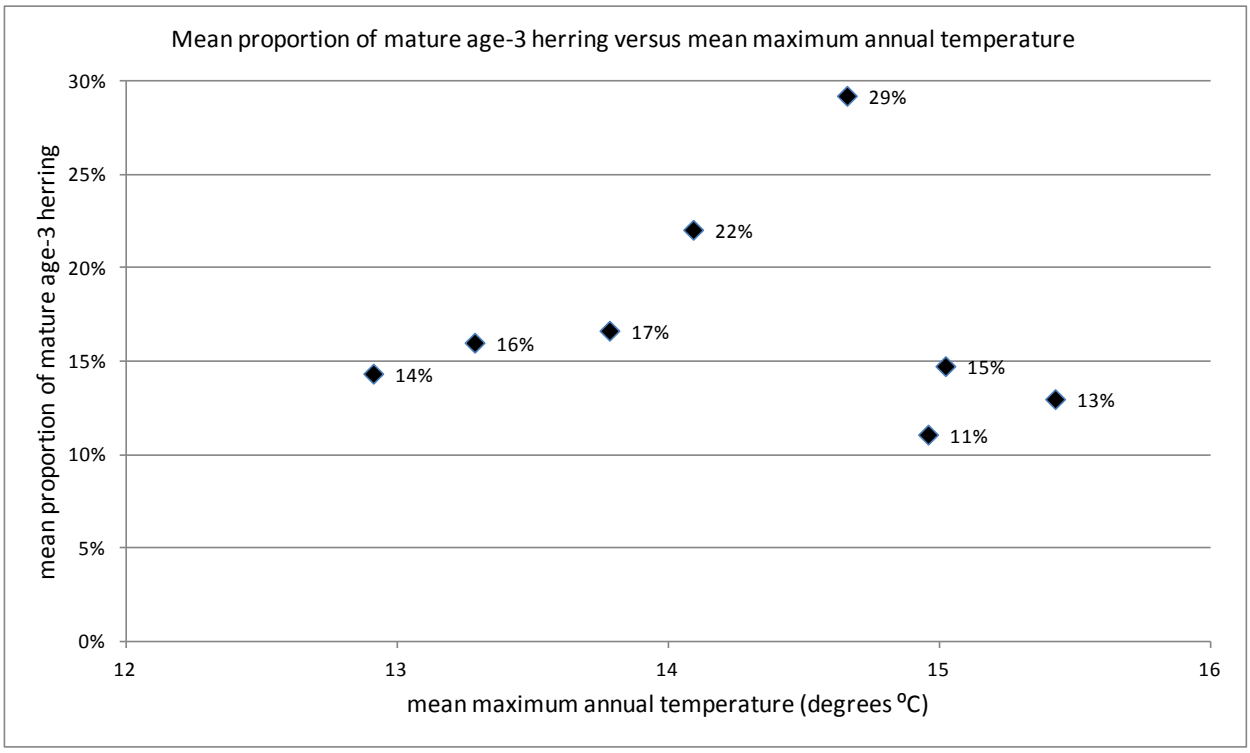


Figure 46.–Mean proportion of age-3 herring in spring cast nest samples versus mean maximum annual sea water temperature at location of spawning stocks in Southeast Alaska.

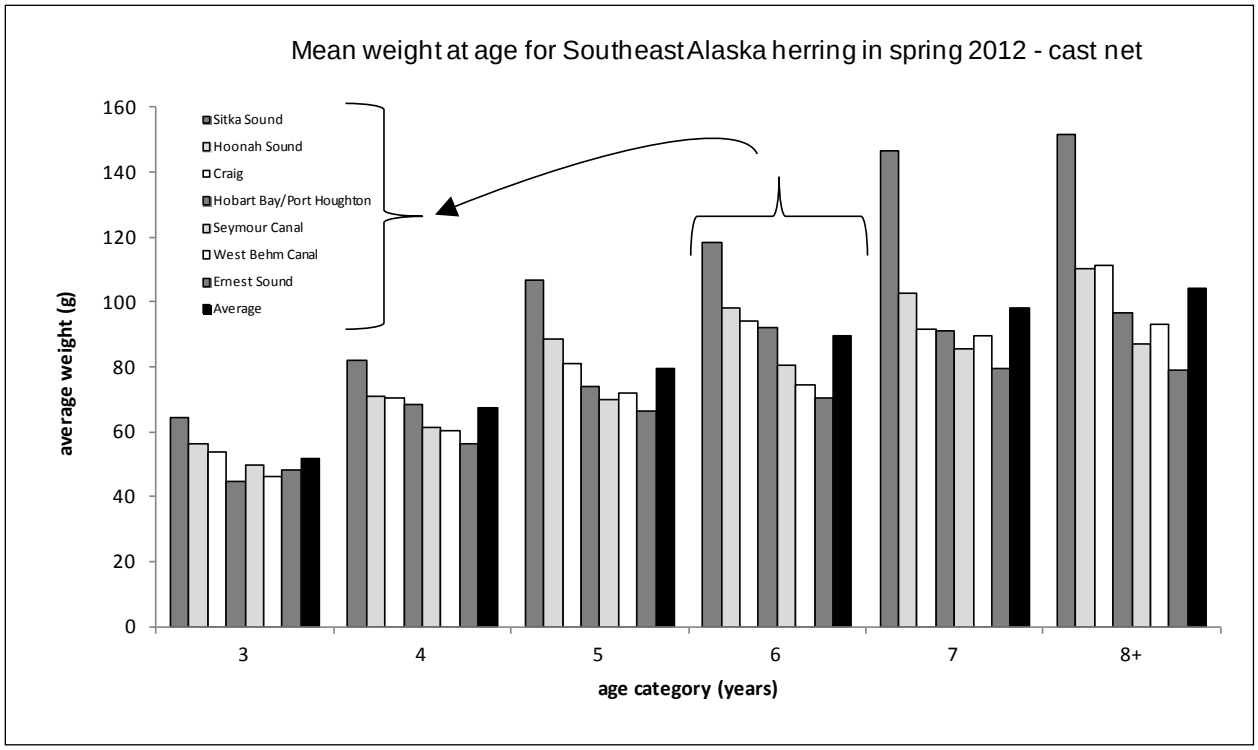


Figure 47.–Mean weight-at-age for Southeast Alaska herring stocks in spring 2012.

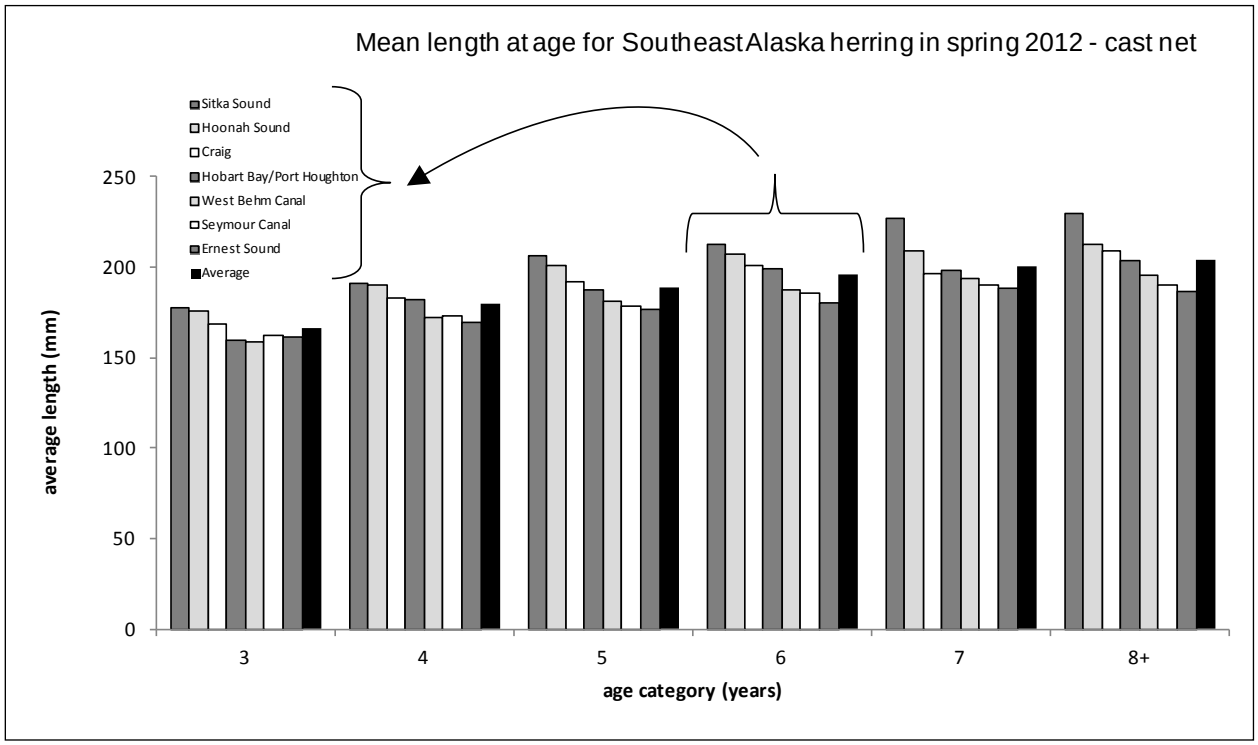


Figure 48.–Mean length at age for Southeast Alaska herring stocks in spring 2012.

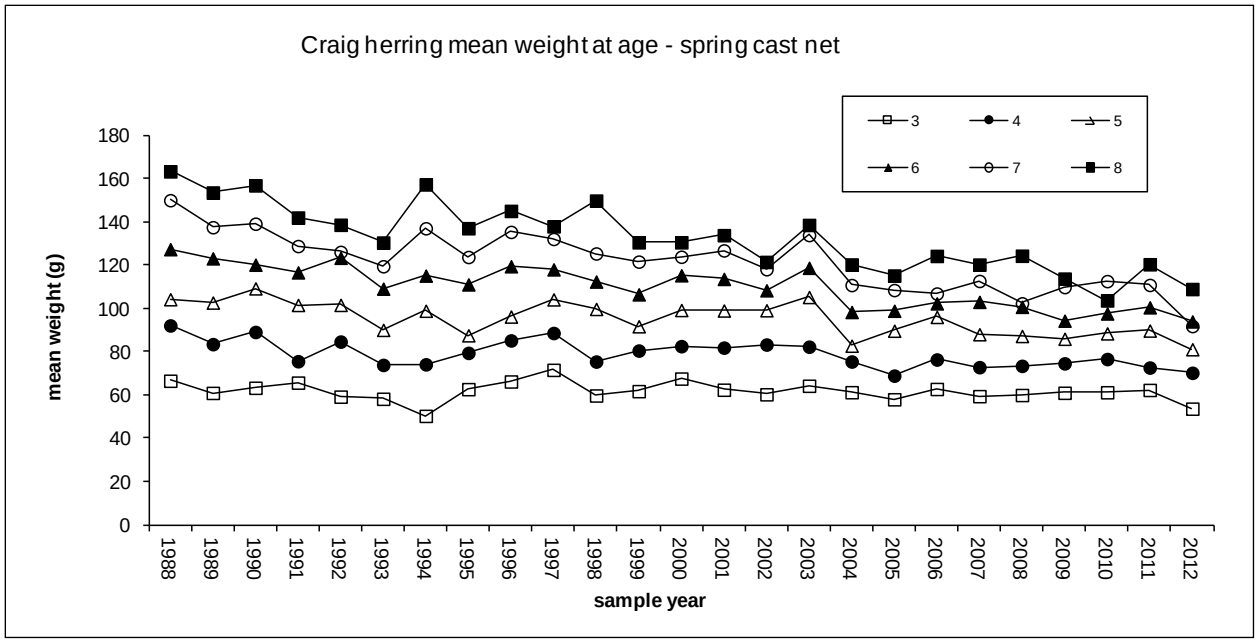


Figure 49.–Mean weight-at-age of the Craig herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

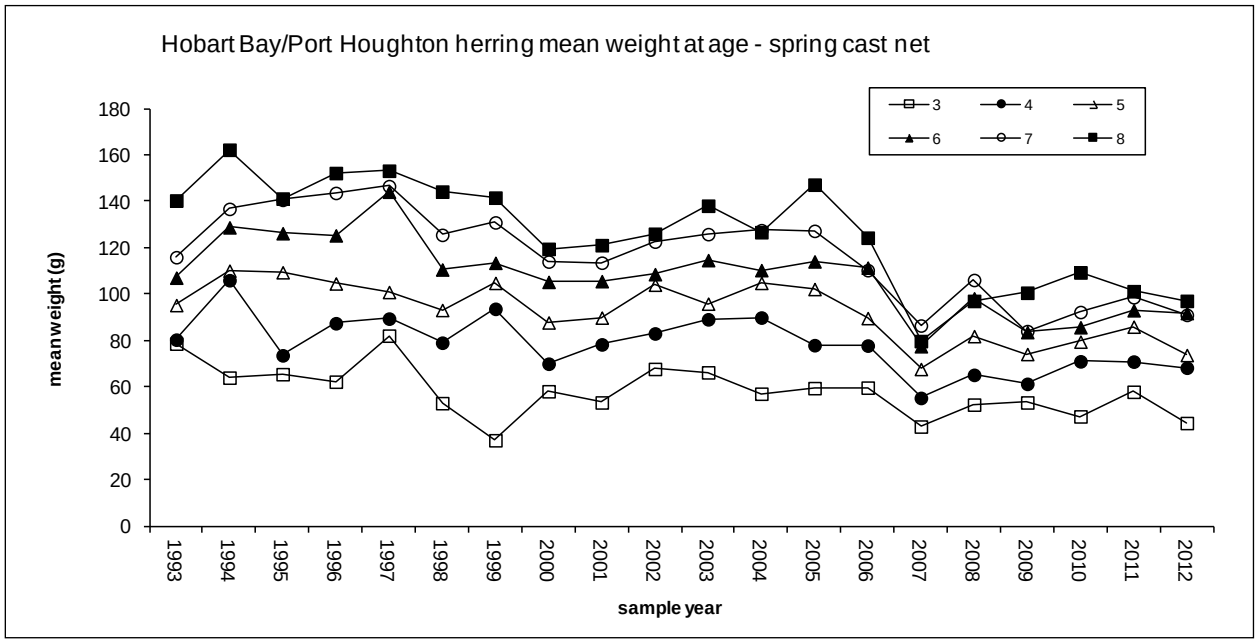


Figure 50.–Mean weight at age of the Hobart Bay/Port Houghton herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

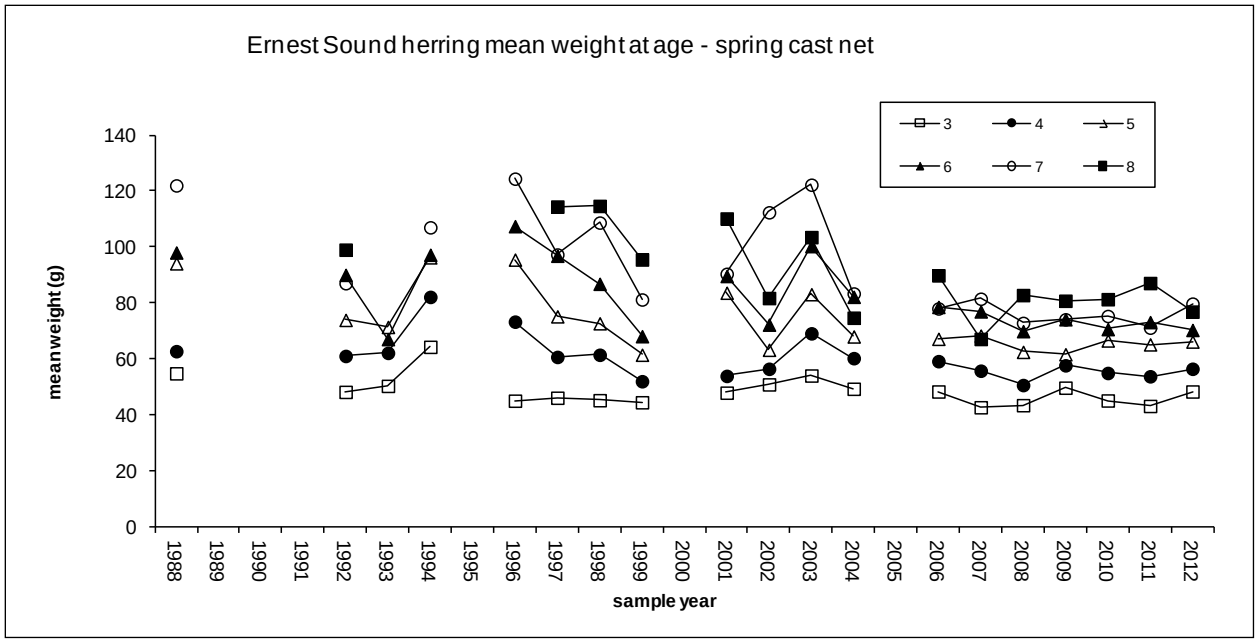


Figure 51.–Mean weight at age for the Ernest Sound herring spawning population.

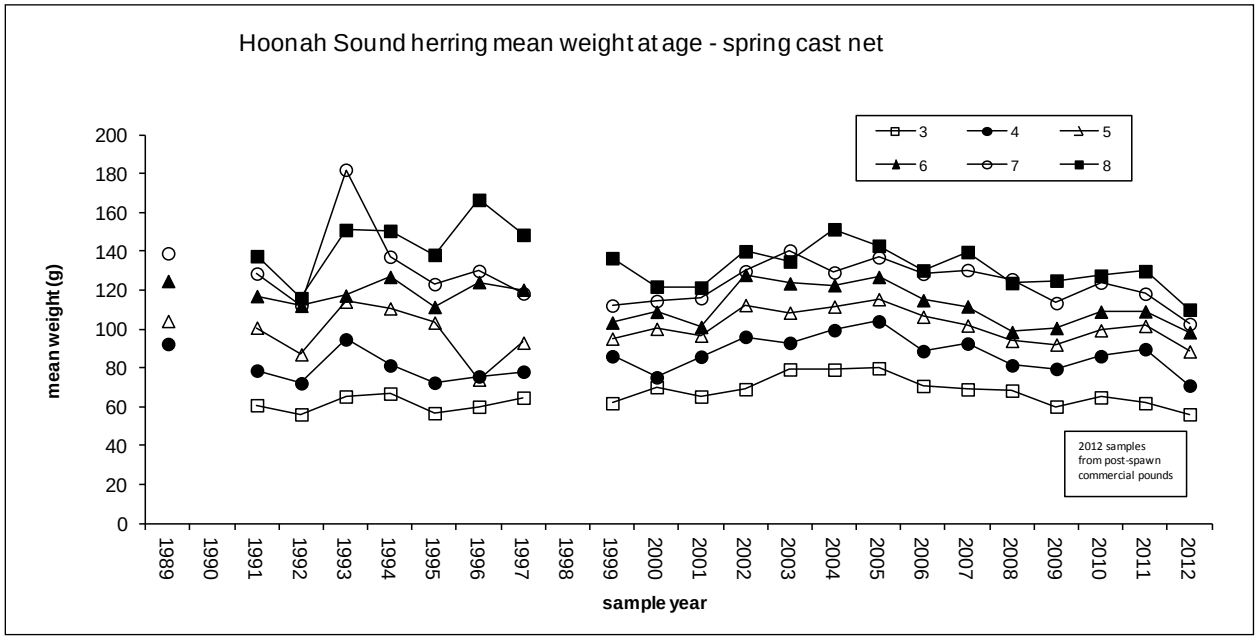


Figure 52.–Mean weight at age for the Hoonah Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

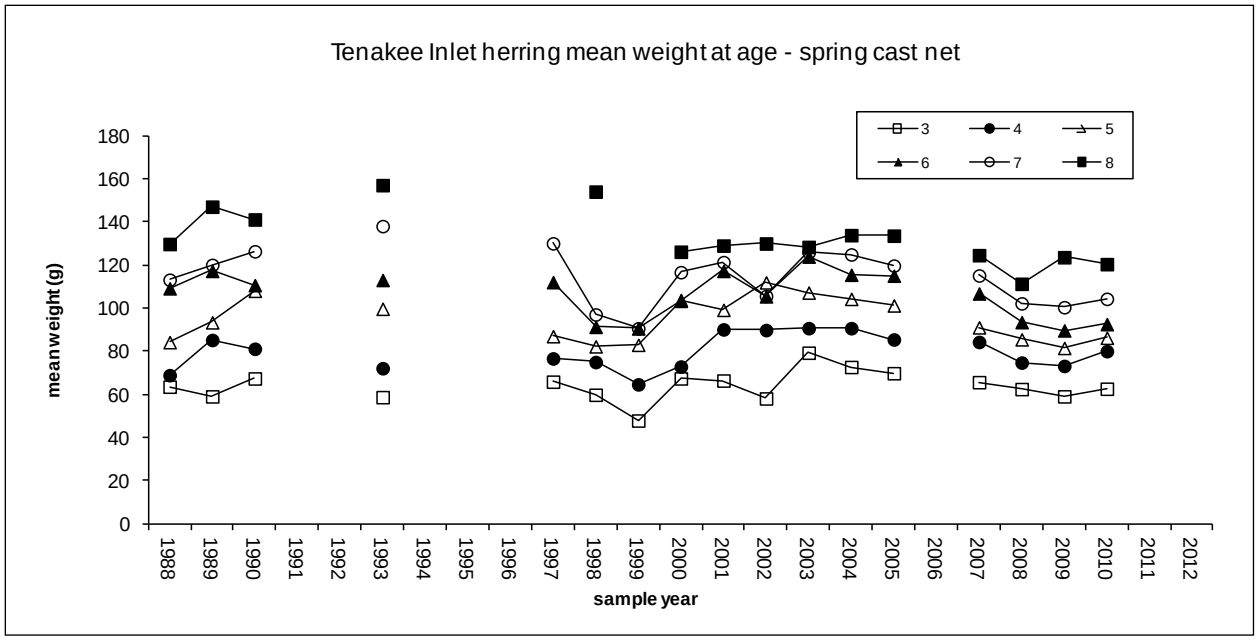


Figure 53.–Mean weight at age for the Tenakee Inlet herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

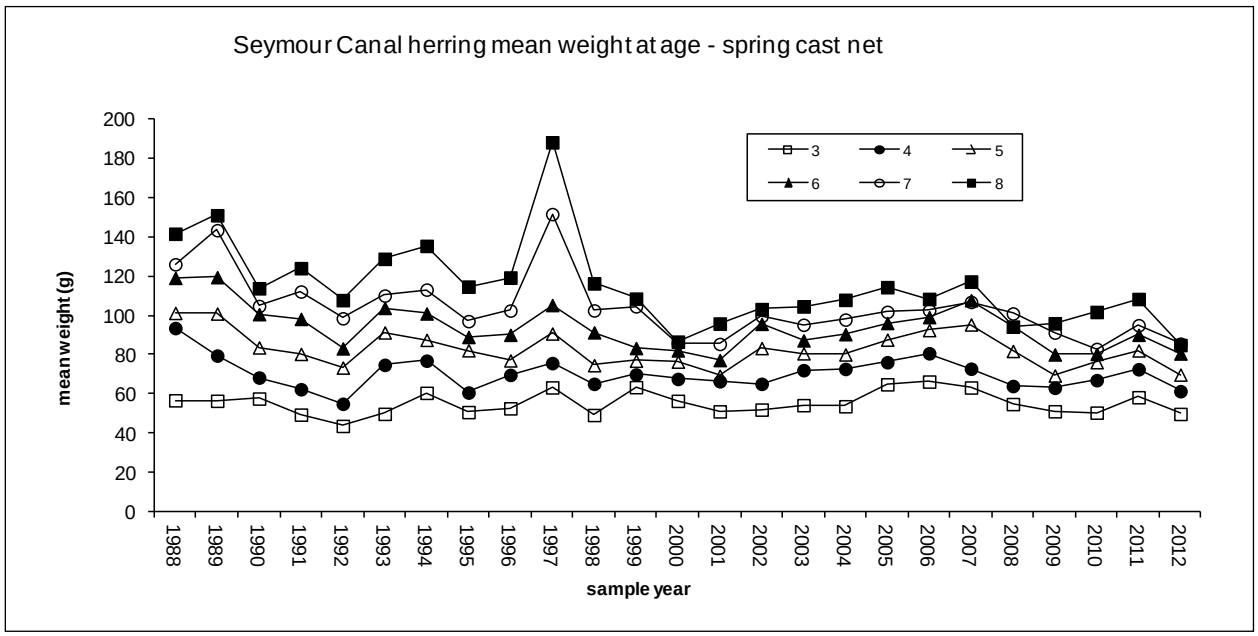


Figure 54.–Mean weight at age for the Seymour Canal herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

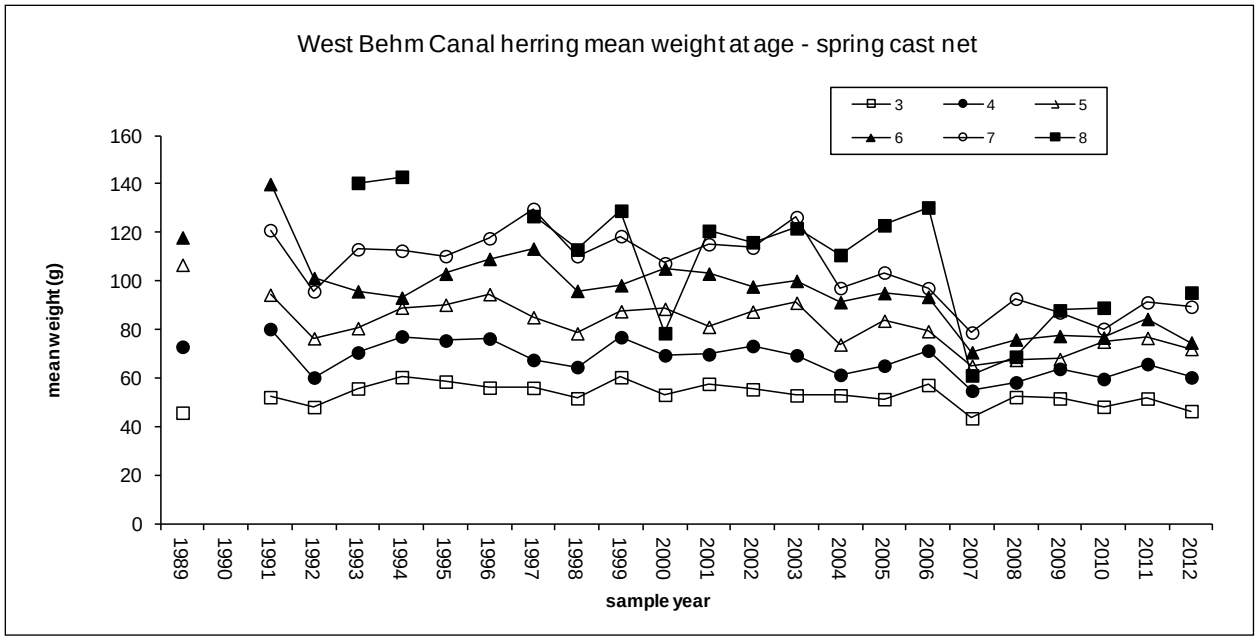


Figure 55.–Mean weight at age for the West Behm Canal herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

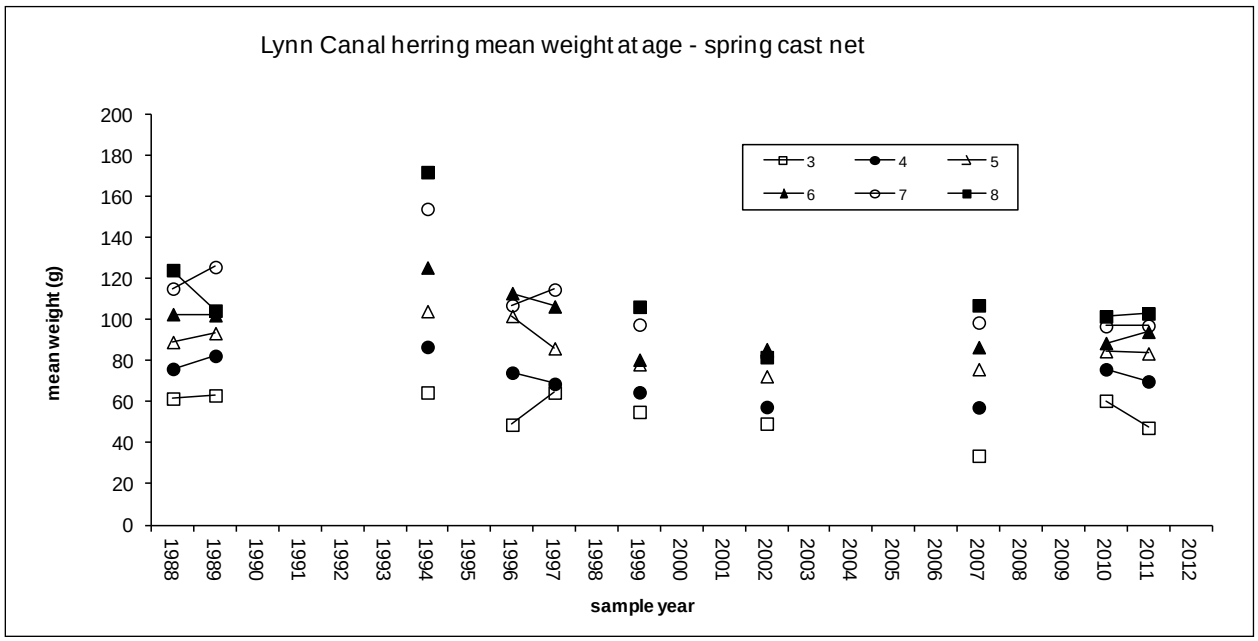


Figure 56.–Mean weight at age for the Lynn Canal herring spawning population.

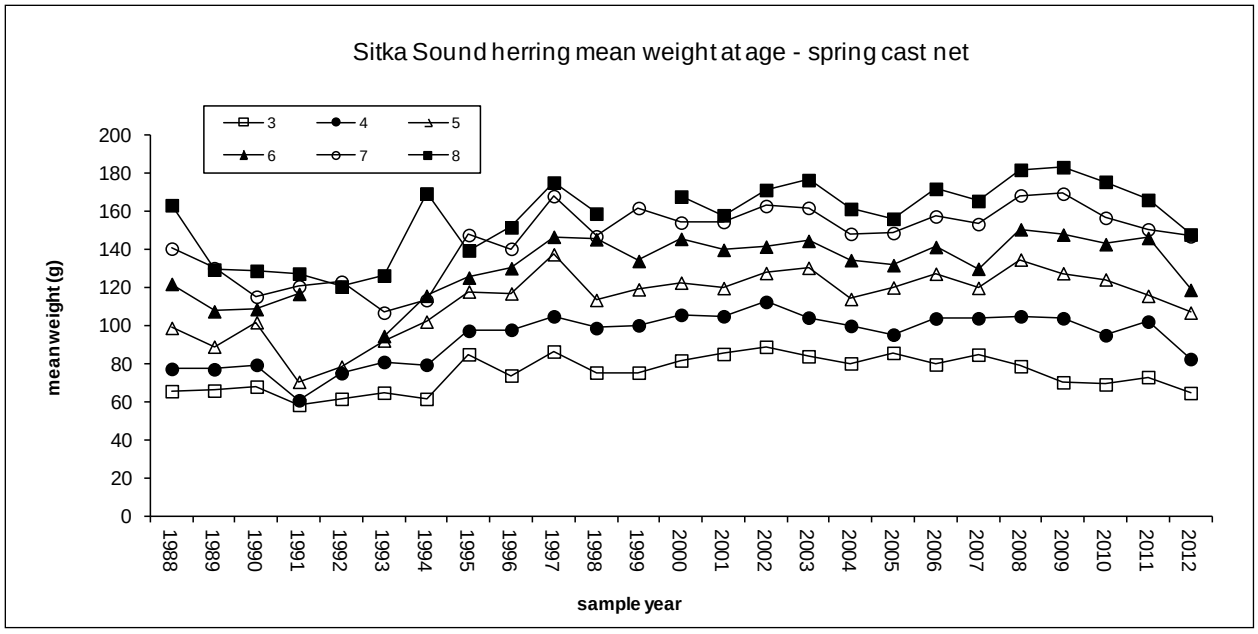


Figure 57.–Mean weight at age for the Sitka Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

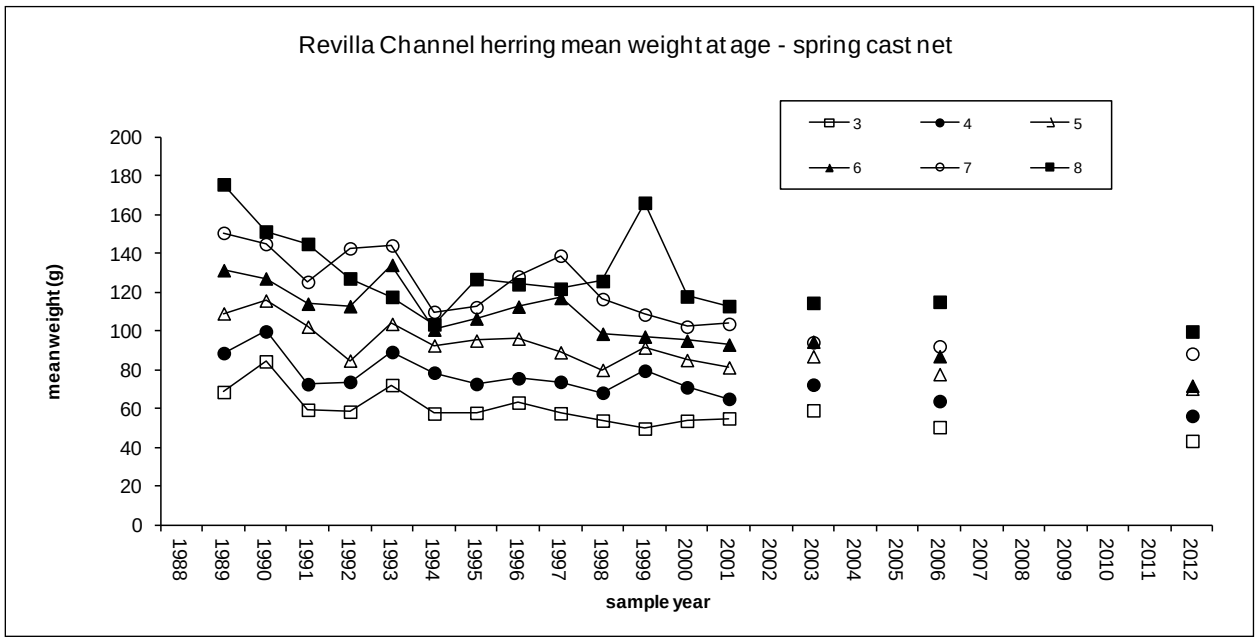


Figure 58.–Mean weight at age for the Revilla Channel herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

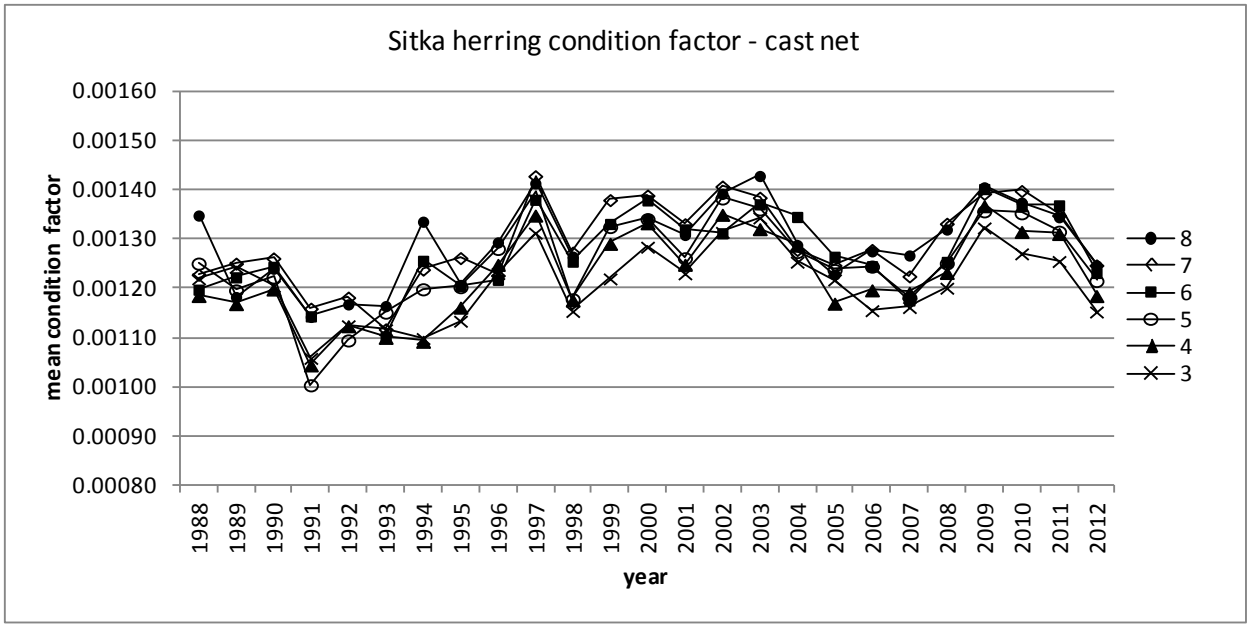


Figure 59.–Mean condition factors of age-3 through age-8 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning.

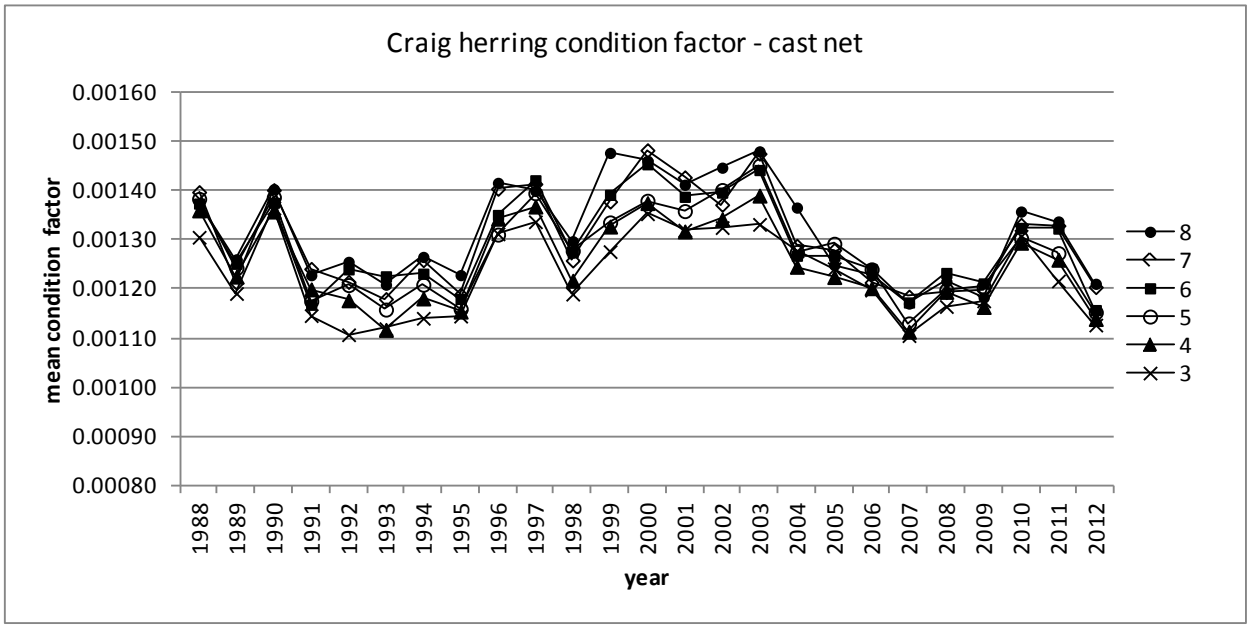


Figure 60.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

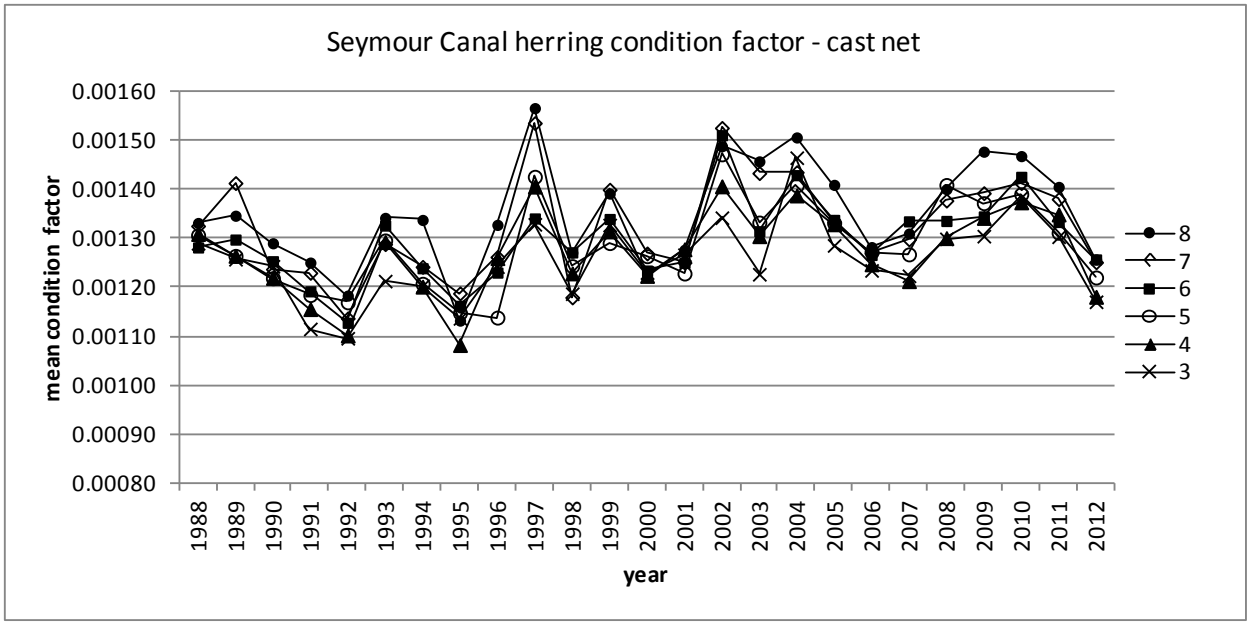


Figure 61.–Mean condition factors of age-3 through age-8 herring for the Seymour Canal spawning population, based on spring cast net samples taken during active spawning.

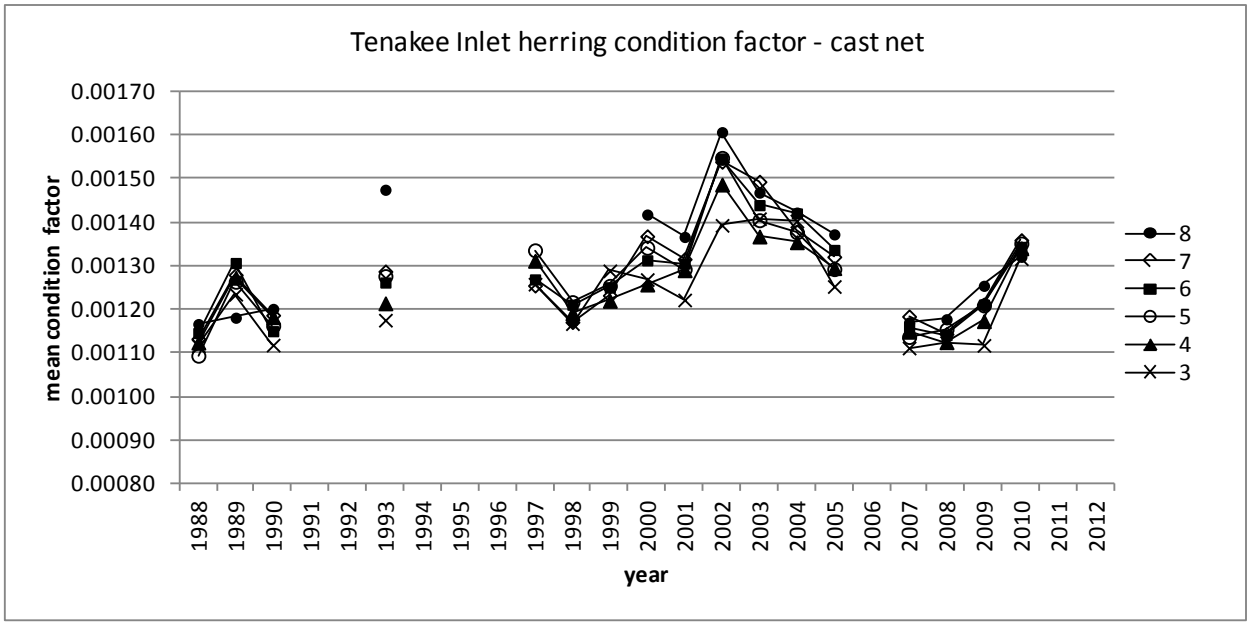


Figure 62.–Mean condition factors of age-3 through age-8 herring for the Tenakee Inlet spawning population, based on spring cast net samples taken during active spawning.

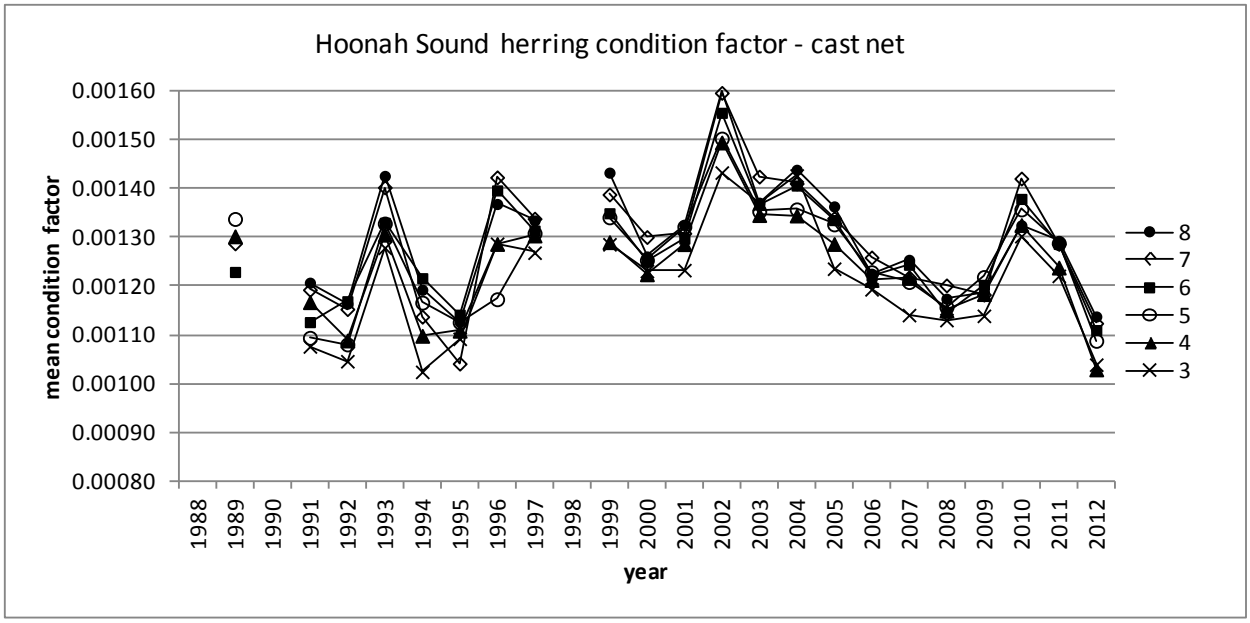


Figure 63.–Mean condition factors of age-3 through age-8 herring for the Hoonah Sound spawning population, based on spring cast net samples taken during active spawning.

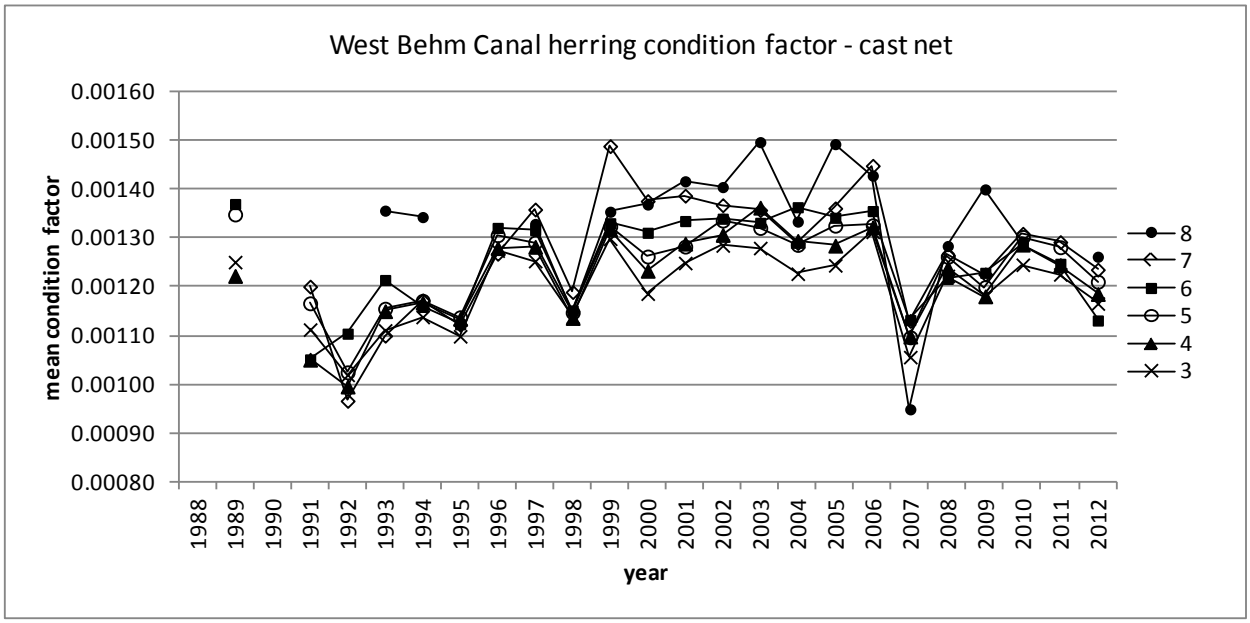


Figure 64.–Mean condition factors of age-3 through age-8 herring for the West Behm Canal spawning population, based on spring cast net samples taken during active spawning.

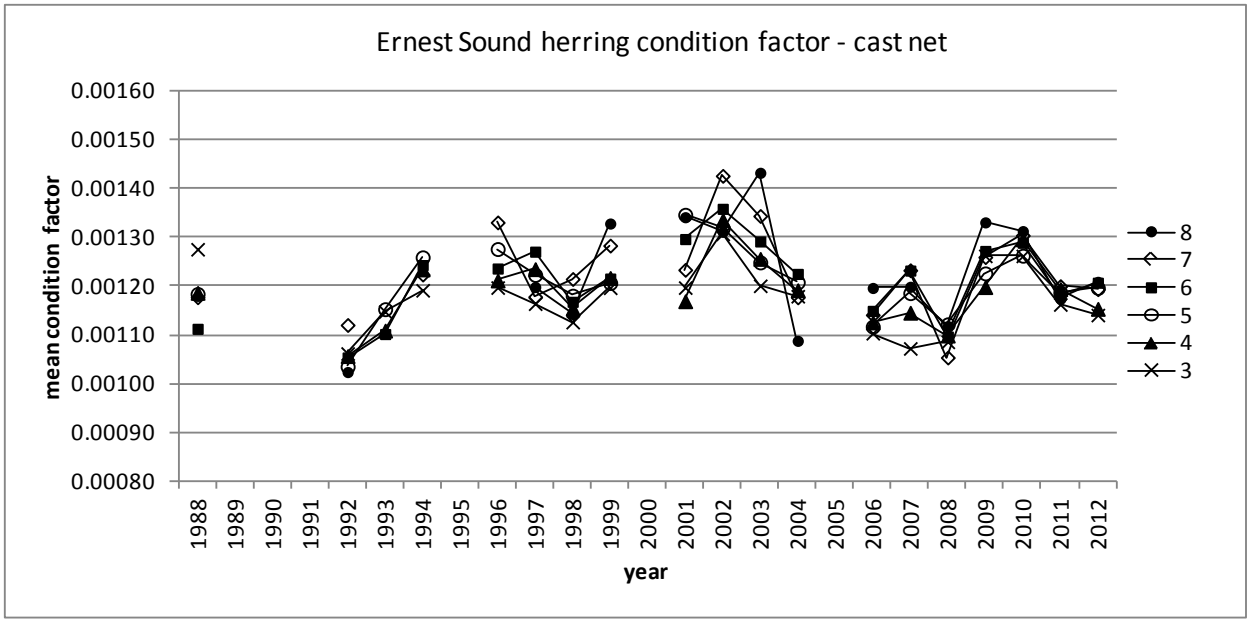


Figure 65.–Mean condition factors of age-3 through age-8 herring for the Ernest Sound spawning population, based on spring cast net samples taken during active spawning.

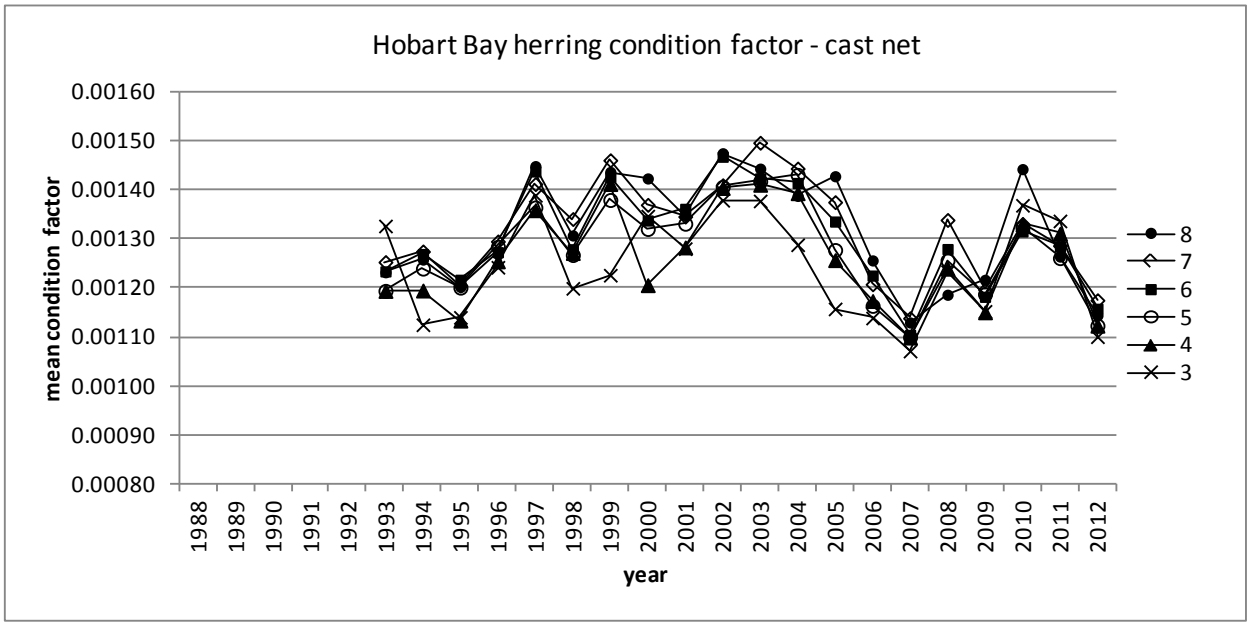


Figure 66.–Mean condition factors of age-3 through age-8 herring for the Hobart Bay spawning population, based on spring cast net samples taken during active spawning.

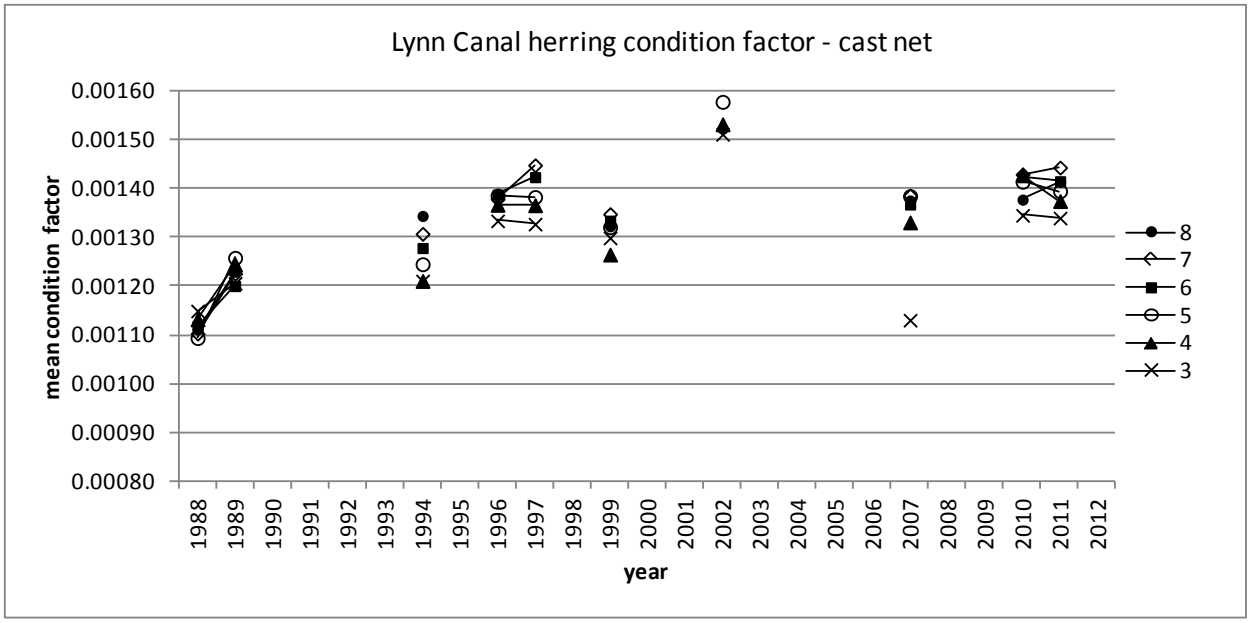


Figure 67.–Mean condition factors of age-3 through age-8 herring for the Lynn Canal spawning population, based on spring cast net samples taken during active spawning.

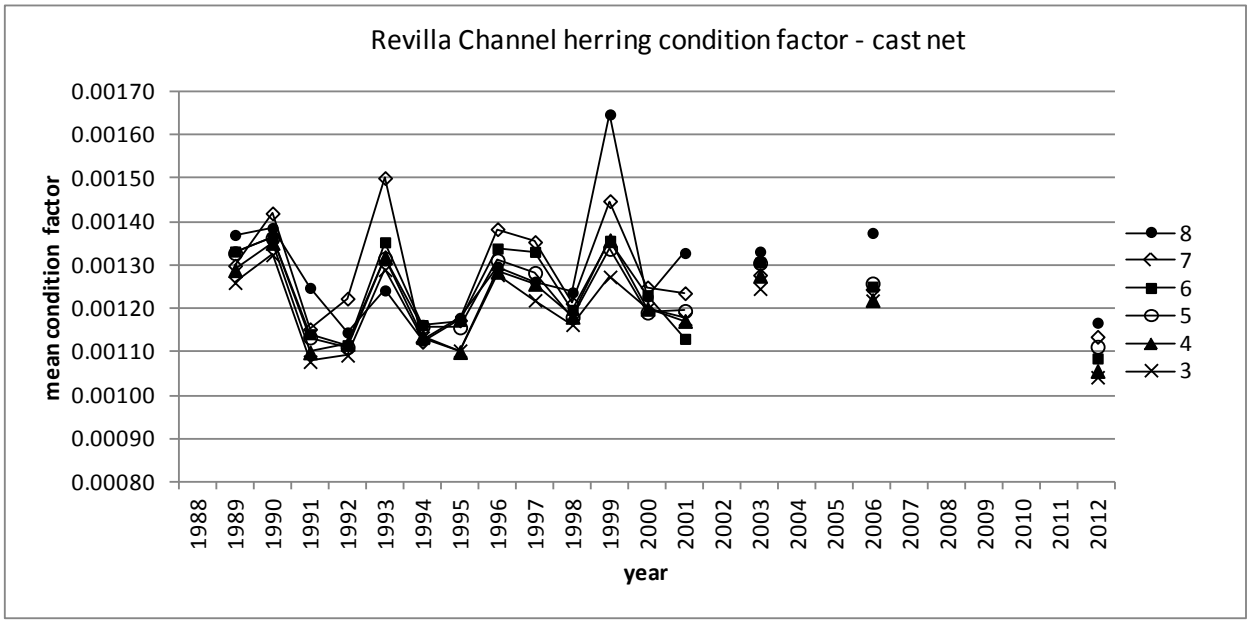


Figure 68.–Mean condition factors of age-3 through age-8 herring for the Revilla Channel spawning population, based on spring cast net samples taken during active spawning.

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, near Craig (Ketchikan Management Area), Southeast Alaska in 2012.

March 19

The weather was good with passing snow showers and a small amount of freezing rain. No spawn. Herring predator activity was seen between the Coronados and Madre de Dios Islands in Trocadero Bay. Approximately 25 sea lions were seen in this area and between 5 and 10 whales were seen in the deep water off shore. No other predator activity was seen. There were 7 lbs on the grounds.

March 23

Skiff surveys were conducted in the Craig area yesterday and this morning Craig weather overcast with light winds. No spawn. A few sea lions and whales were seen in the Craig area but very little herring predator activity was seen.

March 27

The weather was overcast with light winds. No spawn. Herring activity has increased. Herring, bird and sea lion activity was observed on the west and east shore of Fish Egg Island. One hundred fifty sea lions and six whales were observed SW of Fish Egg Island. Seventy sea lions were seen on the west side of Fish Egg Island. Thirty-five lbs are on the grounds. ADF&G personnel are on the grounds and will be conducting daily skiff surveys.

March 28

A skiff survey was conducted in the Craig area. The weather was very windy and rainy in Craig. No spawn. Herring and predator activity has diminished some around Fish Egg Island but large amounts of Sea Lions remain in the Craig area. ADF&G personnel are on the grounds and will be conducting daily skiff surveys.

March 29

A skiff survey was conducted in the Craig area today. The weather was rain squalls with moderate winds turning to very windy conditions. No spawn. There is significant predator activity on the eastern side of Fish Egg Island and the southern portion of Klawock Inlet, with ten whales and close to 100 sea lions in the area. A large volume of herring was also observed in the southern end of Klawock Inlet. There are scattered schools of sea lions and whales throughout the Craig/Klawock area, including the western side of Fish Egg Island, Clam Island, Klawock Reef and the outer Alberto Island.

March 30

A skiff survey was conducted in the Craig area today. The weather was rain with moderate winds. No spawn. There continues to be significant predator activity on the western side of Fish Egg Island and in Klawock Inlet, with ten whales and close to 100 sea lions in the area. There are scattered schools of sea lions and whales throughout the Craig/Klawock area, including the western side of Fish Egg Island, Clam Island, Klawock Reef and the outer Alberto Island.

-continued-

March 31

A skiff survey was conducted in the Craig area today. The weather was partly cloudy with light winds. **Spot spawns observed**. A small spot spawn was observed on the inside of the outer Ballenas Island. There were nine whales in the area between Fish Egg Island and the Ballenas. Most of the predator activity is still concentrated on the north side of Fish Egg Island where a large volume of herring is staged between Clam Island and Fish Egg Island. There were also some fish starting to push up on the beach on the south west side of Fish Egg, directly across from the Ballenas.

April 1

A skiff survey was conducted in the Craig area. No herring spawn was seen today. Weather was moderate winds and intermittent rain squalls. There were numerous schools of herring throughout the Craig/Klawock area and schools are starting to break off from the main body of fish which is still holding in the deeper water between the southern tip of Wadleigh Island and Fish Egg Island. The predator activity has also dispersed throughout the area.

April 3

A skiff survey was conducted in the Craig area today. The weather was rain with heavy winds. There were numerous schools of herring throughout the Craig/Klawock area concentrating around Fish Egg, Clam and the Alberto Islands. Whales and sea lions can be seen throughout the area and are actively feeding on large concentrations of herring. Herring have moved up into the herring pounding area and the pound fishery is proceeding nicely. Most of the fishermen have successfully introduced fish into their pounds.

April 4

Approximately 1 mi of herring spawn observed. Weather was clear with light winds. Numerous schools of herring were observed throughout the Craig/Klawock area concentrating around Fish Egg, Clam, Abbess, western Wadleigh and the Alberto Islands. Twenty-thirty whales and nearly 500 sea lions can be seen throughout the area and are actively feeding on large concentrations of herring. Active spawn was located on the western shore of Wadleigh Island. Herring have moved up into the herring pounding area and are spawning in several areas. We now have 36 lbs on the grounds with 66 permit holder participating in the fishery.

April 5

Weather was morning fog until 10:00 a.m. then clear with light winds. **Approximately 8 mi of herring spawn observed**. Numerous schools of herring were observed throughout the Craig/Klawock area concentrating around Clam, Abbess, western Wadleigh and the Alberto Islands. Twenty–thirty Whales and nearly 500 sea lions can be seen throughout the area. Active spawn was concentrated on the western shore of Wadleigh Island, the Alberto Islands and Abbess Island. We now have 36 lbs on the grounds with 65 permit holder participating in the fishery.

-continued-

April 6

Weather was clear with light winds. **Approximately 8.3 mi of herring spawn observed**. Numerous schools of herring were observed throughout the Craig/Klawock area concentrating around Clam, Abbess, western Wadleigh and the Alberto Islands. Numerous whales and nearly 500 sea lions can be seen throughout the area. Active spawn was concentrated on the western southwestern shore of Wadleigh Island, the Alberto Islands, Abbess Island and the small Islands north of Abbess Island. We now have 36 lbs on the grounds with 65 permit holder participating in the fishery. Spawn intensity has diminished some from yesterday.

April 7

Weather clear with light winds. **Approximately 5 mi of herring spawn observed**. Numerous schools of herring were observed throughout the Craig/Klawock area concentrating around Clam, Abbess, western Wadleigh, north end of Fish Egg Island, the Alberto Islands and the northern section of San Alberto Bay. Numerous whales and nearly 500 sea lions can be seen throughout the area. Active spawn was concentrated on the western southwestern shore of Wadleigh Island, the Alberto Islands, Abbess Island, the small Islands north of Abbess Island and north of Abbess Island on POW Island. We now have 36 lbs on the grounds with 65 permit holder participating in the fishery.

April 8

Weather clear with light winds. **Approximately 1 mi of herring spawn observed**. Spawn was seen on the northern end of Fish Egg Island. Herring activity has diminished in the Craig area.

April 9

Weather clear with light winds. No spawn was observed. The Craig spawning event appears to be over.

April 10

No spawn was observed. The Craig spawning event appears to be over. A total of **14.9** nmi of spawn was observed in Craig this year.

Appendix C2.–Aerial and skiff herring spawn surveys by date, in Revilla Channel (Ketchikan Management Area), Southeast Alaska in 2012.

March 19

The weather was marginal with passing snow showers and a small amount of freezing rain. No spawn. No herring activity was seen around Annette Island. Three sea lions were seen on the eastern tip of Ham Island. Slightly north of Kah Shakes Cove, near White Reef there was quite a bit of bird activity, and some eagles were seen diving on a small ball of small fish.

March 23

The weather was poor with large snow squalls and accompanying wind. No spawn. No herring activity was seen around Annette Island. Sea lions were seen near Ham Island and near Crab Bay. Mary Island was surveyed while waiting for a passing squall, but no activity was seen. The survey was not completed due to adverse weather.

March 27

The weather was overcast with light winds. No spawn. Herring activity has increased on the eastern shore of Annette Island. Thirty-forty sea lions and two whales were seen in the area. No survey was done on Mary Island or Kah Shakes

April 1

The weather was cloudy and snow squalls with moderate to heavy winds. No spawn. Herring activity continues on the eastern shore of Annette Island. Forty–fifty sea lions were seen in the area. No activity was observed on or around Mary Island or the Kah Shakes area.

April 5

Weather was morning fog until 10:00 a.m. then clear with light winds. **Approximately 1 mi of herring spawn observed.** Spawn was seen on eastern Annette Island, north of Crab Bay. Fishing was occurring throughout the day on the eastern shore of Annette Island near Crab Bay. **Approximately 2.5 mi of herring spawn observed in State waters.** Spawn was observed on Cat, Fripo and Mary Islands. No other spawn was seen in state waters.

April 6

Approximately 1 mi of herring spawn observed. Spawn was seen on eastern Annette Island, north of Crab Bay. Fishing was occurring this morning on the eastern shore of Annette Island near Crab Bay. **Approximately 1 mi of herring spawn was observed in State waters.** Spawn was observed on Cat and Mary Islands in seven small locations. No other spawn was seen in state waters.

-continued-

April 7

Approximately 1 mi of herring spawn observed. Spawn was seen on eastern Annette Island, north of Crab Bay. Fishing was occurring this morning on the eastern shore of Annette Island near Crab Bay. No spawn was observed in State waters**.**

April 8

Approximately 1 mi of herring spawn observed. Spawn was on eastern Annette Island, north of Crab Bay. Fishing was occurring this morning on the eastern shore of Annette Island near Crab Bay. **Approximately 1/8 mi of herring spawn observed in state waters.**

April 9

Weather clear with light winds. **Approximately 1 mi of herring spawn observed.** Light spawn was observed on eastern Annette Island, near Crab Bay. **Spot spawn was observed on Cat Island in state waters.**

April 10

Weather clear with light winds. No spawn was observed. The Revilla spawning event appears to be over.

April 11

Weather—rain with fog and light winds. No spawn observed.

The Revilla spawning event appears to be over. **2.6 nmi** of spawn occurred on Annette Island and **3.5 nmi** of spawn occurred in state waters on Mary and Cat Island for a total of 6.1 nmi of spawn in the Revilla Channel.

Appendix C3.–Aerial and skiff herring spawn surveys by date, in West Behm Canal (Ketchikan Management Area), Southeast Alaska in 2012.

March 28

The weather was overcast with strong winds. No spawn. An increase in sea lion activity was observed in the northern end of Tongass narrows and Clover Pass. Individual sea lions were seen throughout Cleveland Peninsula shore and in Vallenar Bay.

April 1

The weather was cloudy and snow squalls with moderate to heavy winds. No spawn. Very little predator activity was observed in the area. Most of the area showed no herring or predator activity.

April 4

Weather was overcast clouds and light winds. **Approximately ¾ mi of herring spawn was observed.** Weather was clear with light winds. Herring spawn and herring were seen in Vallenar Bay. Fish were also observed in the northern half of Tongass Narrows concentrating on the eastern shore from Ward Cove to Survey Point.

The West Behm Canal purse seine herring fishery has been given a 12-hr notice. This means that the fishery will be on a 2-hr notice as of 12:00 noon tomorrow, Thursday April 5. Therefore, a fishery could occur as early as 2:00 p.m. tomorrow afternoon. This notice also gives the last warning for fishermen to register to participate in the fishery. So far there are no fishermen registered to participate in the West Behm Canal purse seine fishery. At present, there are not enough fish observed in the area to allow for a commercial fishery, but herring and predator activity are building rapidly and notice is required to ensure that the industry is prepared if herring levels continue to build.

April 5

Approximately 1 mi of herring spawn was observed. Herring spawn and herring were seen on the shoreline in Tongass Narrows from Ward Cove to Survey Point. Fish were also observed in Clover Pass. Limited sea lion and bird activity was seen in Bond Bay. There is no evidence of herring anywhere else in the area.

The West Behm Canal purse seine herring fishery is now on a 2-hr notice. So far there are no fishermen registered to participate in the West Behm Canal purse seine fishery. At present, there are not enough fish observed in the area to open a fishery. There is also not enough fish in the area open to commercial fishing to allow for a commercial fishery, but herring and predator activity has been building. A total of 2 mi of spawn have been observed.

-continued-

April 6

Approximately 3 mi of herring spawn was observed. Herring spawn and herring were seen on the shoreline in Tongass Narrows from Whipple Creek to Survey Point. Spawn was also seen in Vallenar Bay just east of South Vallenar Point. About 1 mi of spawn is actively occurring in the area. Increased sea lion activity was observed in Bond Bay but no fish are seen. There is no evidence of herring anywhere else in the area.

The West Behm Canal purse seine herring fishery is on a 2-hr notice. No fishermen have registered to participate in the West Behm Canal purse seine fishery. At present, there are not enough fish observed in the West Behm area to open a fishery. There is also not enough fish in the area open to commercial fishing to allow for a commercial fishery.

Activity in the area open for commercial harvest is as follows:

- 1 mi of active spawn in Vallenar Bay.
- Small amount of fish seen in Vallenar Bay
- 50 sea lions in Bond Bay
- The department will be collecting samples today from Vallenar Bay to be tested.

A total of 5 mi of spawn have been documented in West Behm Canal.

April 7

Approximately 3 mi of herring spawn was observed. Herring spawn and herring were seen on the shoreline in Tongass Narrows from Whipple Creek to Clover Pass Resort. Spawn was also seen in Vallenar Bay just east of South Vallenar Point. About 1 mi of spawn was observed in Vallenar Bay and was dissipating by early afternoon. Increased sea lion activity was observed in Bond Bay in the morning aerial survey, but no fish was seen in the area during a detailed skiff survey. There is no evidence of herring anywhere else in the area that is open for commercial fishing. A skiff survey in the early evening showed spawn building on Survey Point with fish leading into Clover Pass.

The West Behm Canal purse seine herring fishery is on a 2-hr notice. No fishermen have registered to participate in the West Behm Canal purse seine fishery. At present, there are not enough fish observed in the West Behm area to open a fishery, but if concentrations continue to increase we will be at a level that will allow a fishery. There is currently very little fish in the area open to commercial fishing.

Activity in the area open for commercial harvest is as follows:

- 1/4 mi of active spawn in Vallenar Bay.
- 10 sea lions in Bond Bay with small amount of fish in the area.

Samples were taken and results will be announced later today.

A total of 5-6 mi of spawn have been documented in West Behm Canal.

-continued-

April 8

Weather was clear with light winds. **Approximately 1.5 mi of herring spawn was observed.** Herring spawn and herring were seen on the shoreline in Tongass Narrows from Pond Reef to Knudson Cove. Half a mile of spawn was observed in Vallenar Bay along with some schools of herring. There is no evidence of herring anywhere else in the area that is open for commercial fishing. No herring activity was seen on the Cleveland Peninsula. There continues to be good schools of herring in Tongass Narrows and Clover Passage.

April 9

Weather was clear with light winds. **Approximately 1/2 mi of herring spawn was observed.** Herring spawn was seen on the shoreline in Tongass Narrows from Coast Guard Beach to Knudson Cove. There is no evidence of herring anywhere in the area that is open for commercial fishing. No herring activity was seen on the Cleveland Peninsula. Indications are that the spawning event in West Behm Canal is nearing completion.

The West Behm Canal purse seine herring fishery continues to be on a 2-hr notice. No fishermen have registered to participate in the West Behm Canal purse seine fishery. At present, there are no fish observed in the area open for fishing in West Behm Canal. Indications are that the spawn is nearly completed. The department will continue to monitor the area until the spawning event is over.

April 10

Weather clear with light winds. **Approximately 3/4 mi of herring spawn was observed.** Herring spawn was seen in Bond Bay on the Cleveland Peninsula. There is no evidence of herring anywhere else in the West Behm Canal area. Indications are that the spawning event in West Behm Canal is nearing completion.

April 11

No spawn was observed. The West Behm spawning event appears to be over. **7.3 nmi of spawn** occurred in West Behm Canal.

No commercial fishery was prosecuted in 2012.

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Sitka Sound (Sitka Management Area), Southeast Alaska in 2012.

March 13: 08:30 – 10:15 Gordon/Jensen/Coonradt. Spotting conditions were good with northwest winds 5-10 knots and clear skies. This extensive survey covered all areas of Sitka Sound, south to Crawfish Inlet and north to Salisbury Sound. Spotting conditions were good with light winds. No herring were seen. All areas to the south of Sitka were quiet with minimal bird and sea lion activity. North of Sitka there were 130 sea lions inside of Katlian Bay, 20 sea lions off Harbor Point, 7 sea lions off the eastern side of Big Gavanski Island, 8 sea lions on east Middle Island, 15 sea lions in Eastern Bay, and 25 sea lions in Hayward Strait. Eight whales were seen scattered in the area from Halibut Point to the mouth of Katlian Bay and two whales were seen in Eastern Bay. In Salisbury Sound there were 25 sea lions scattered between Kane Island and St. John Baptist Bay and two whales were seen north of Kane Island.

March 19: 9:30 – 10:45 Gordon/Coonradt/Case. Spotting conditions were good with clear skies and calm winds. No herring were seen. Today's aerial survey covered Sitka Sound, and areas south to Redoubt Bay and north to Salisbury Sound. Spotting conditions were good with light winds. No herring were seen during the survey. Herring predators continue to be scattered throughout the northern areas of Sitka Sound. Approximately 280 sea lions and 23 whales where seen during the survey with the highest concentrations seen near Old Sitka Rocks and to the north along the Lisianski Peninsula. Ten whales were seen scattered in the area from Guide Island to Vitskari Rocks and one whale was seen near Makhnati Island. Approximately 30 sea lions were seen between Kasiana Island and the Parker Group. South of Sitka there were few herring predators observed except for approximately 40 sea lions seen in Silver Bay.

- *F/V Karine Brit*; tried to take a test sample in the afternoon but all herring schools observed were holding deep.

March 21: 10:00 – 11:35 Gordon/Jensen. Spotting conditions were excellent with clear skies and light winds. Today's aerial survey this covered areas south to Windy Pass and north to Salisbury Sound. Spotting conditions were excellent with light winds. No herring were seen during the survey. North of Sitka sea lions and whales continue to be concentrated in the area between Old Sitka Rocks and Dog Point with few herring predators seen outside of this area. In Salisbury Sound there were scattered small groups of sea lions from Kane Islands to St John Baptist Bay. South of Sitka there was 30 sea lions and one whale in Silver Bay. No other notable concentration of herring predators was observed south of Sitka.

- *F/V Confidence*, 11:00 a.m., N. Old Sitka Rocks, 200 tons, 2.5% mature roe; 10.8% immature roe, 161 gm, 59% female.

March 23: 9:45 – 11:35 Gordon/Case/Davidson. Spotting conditions were good with southwest winds 10-15 knots and mostly clear skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and Salisbury Sound out to Klokachef Island. North of Sitka, sea lions and whales continue to be concentrated in the area between the islands and Baranof Island shoreline from Halibut Point to Dog Point. Additionally, there were 30 sea lions in South Crow Pass, 15 sea lions and one whale south of the Chaichie Islands, 16 sea lions south of Bieli Rock, 5 sea lions off Inner Point, and a total of 27 sea lions in small groups in Nakwasina Sound from the entrance to near Allan Point. South of Sitka in Silver Bay there were 55 sea lions scattered along the south

-continued-

shoreline from the entrance to Bear Cove and 7 sea lions were near Entry Point. Three whales were seen near the mouth of Silver Bay. There were 8 sea lions and one whale between the islands south of Middle Channel. In the middle of Sitka Sound there were six whales observed between Bieli Rock and Guide Island and one whale was north of Vitskari Rocks. There was little activity in the southern reaches of Salisbury Sound, though several whales were seen offshore south of Klokachef Island. One large school of herring was seen on the surface between St. Lazaria Island and Shoals Point.

- *F/V Karine Brit*, 11:20 a.m., Halibut Point, 200 tons, 8.2% mature roe; 4.9% immature roe, 165 gm, 54% female.

March 24: 10:00-11:20 Gordon/Coonradt/Davidson. Spotting conditions were good under overcast skies and winds southeast 10-15 knots. Today's aerial survey covered Sitka Sound from Redoubt Bay to Nakwasina Sound. North of Sitka concentrations of sea lions and whales continue to be seen in the area between the islands and the Baranof Island shoreline distributed from the north end of Kasiana Island to the entrance of Nakwasina Sound. South of Sitka, approximately 30 sea lions were seen in Silver Bay.

- *F/V Aleutian Spirit*, 12:35 a.m., S. Old Sitka Rocks, 30 tons, 6.4% mature roe; 5.7% immature roe, 154 gm, 52% female.

March 25: 8:30-9:50 Gordon/Davidson. Spotting conditions were fair under overcast skies and winds southeast 15-20 knots. Today's aerial survey covered Sitka Sound from Cape Burunof to Salisbury Sound. The aerial survey today showed a similar distribution of sea lions and whales as has been seen during the past several days. No herring or spawn was seen.

It was announced today that the Sitka Sound sac roe herring fishery will be on two-hour notice effective 11:00 a.m., Tuesday, March 27, 2012.

March 26: 8:35 – 9:45 Gordon/Davidson/Case. Spotting conditions were good under overcast skies and light winds. Today's aerial survey covered Sitka Sound north of Cape Burunof. North of Sitka concentrations of sea lions and whales continue to be seen in the area between the islands and the Baranof Island shoreline distributed from the north end of Kasiana Island to the entrance of Nakwasina Sound. Scattered small groups of sea lions were also seen in the outer half of Katlian Bay. At Inner Point there were 70 sea lions with an additional 30 sea lions scattered along the Kruzof Island shoreline north to Kamenoi Point. South of Sitka, a few sea lions were seen scattered in the Aleutkina Bay and near Silver Point. Approximately 35 sea lions were seen in Silver Bay.

- *F/V Agave*, 9:30 a.m., Aleutkina Bay, 120 tons, 7.9% mature roe; 4.7% immature roe, 155 gm, 51% female.
- *F/V Pillar Bay*, 9:40 a.m., Halibut Point, 30 tons, 8.9% mature roe; 3.0% immature roe, 159 gm, 50% female.

March 27: 8:30 – 10:00 Gordon/Coonradt/Davidson. Spotting conditions were good under partly overcast skies and northwest winds 10-15 knots. Today's aerial survey covered Sitka Sound north of Windy Passage. Herring predators were well distributed throughout the sound

-continued-

with significant concentrations observed east of Middle and Kasiana Islands, north of Inner Point, Nakwasina Sound, Katlian Bay and south of town in Silver Bay.

- *No test samples were taken today.*

The R/V Kestrel arrived today and a vessel survey in the afternoon showed significant concentrations of herring off Mountain Point and between Halibut Point and Lisianski Point. Smaller concentrations were also noted in the Eastern Bay area and around Kasiana Island.

March 28: 8:40 – 9:45 Gordon/Coonradt. Spotting conditions were good under partly overcast skies and east winds 10-15 knots. Today's aerial survey covered Sitka Sound north of Cape Burunof. Spotting conditions were good under overcast skies and light winds. North of Sitka concentrations of sea lions and whales continue to be seen in the area between the islands and the Baranof Island shoreline distributed from the north end of Kasiana Island to the entrance of Nakwasina Sound. Within this area the higher numbers of sea lions and whales were seen between Halibut Point and Middle Island. At Inner Point there were 40 sea lions and two whales with smaller groups of sea lions and a number of whales distributed around northern Sitka Sound. South of Sitka, there were a few sea lions scattered in the Eastern Channel area and approximately 40 sea lions were seen in Silver Bay.

- *F/V Agghileen*, 10:30 a.m., Promisila Bay, 100 tons, 9.2% mature roe; 3.5% immature roe, 155 gm, 50% female.
- *F/V Invincible*, 12:00 a.m., N. Inner Point, 100 tons, 9.9% mature roe; 2.6% immature roe, 154 gm, 48% female.
- *F/V Confidence*, 12:15 a.m., Dog Point, 100 tons, 8.1% mature roe; 3.8% immature roe, 146 gm, 51% female.
- *F/V Anika*, 12:30 a.m., Inner Point, 200 tons, 10.9% mature roe; 3.1% immature roe, 152 gm, 60% female.

The *R/V Kestrel* surveyed the northern Sitka Sound area. A very large volume of herring was observed in the area between Halibut Point and Middle Island. Most of this volume is holding in deeper waters with scattered large schools breaking off toward the surface. Another large volume of herring was observed on the bottom in deep waters in the middle of Sitka Sound west of Gagarin Island. A number of large schools were observed in waters 25-40 fathoms deep just north of Inner Point and there were a number of scattered moderate size schools observed along the Lisianski Peninsula.

March 29: 9:30-10:15 Davidson. Conditions were poor for flying so an abbreviated survey was conducted, no spawn of herring were observed.

- *F/V Karine Brit*, 1:00 p.m., E. Middle Island, 100 tons, 8.4% mature roe; 2.3% immature roe, 157 gm, 45% female.
- *F/V Rose Lee*, 1:00 p.m., Inner Point, 100 tons, 5.9% mature roe; 3.6% immature roe, 135 gm, 44% female.

The *R/V Kestrel* surveyed north Sitka Sound today, and found significant concentrations of herring east of Middle Island, off Dog Point, and just north of Inner Point.

-continued-

March 30: 8:30 – 10:00 Gordon/Coonradt/Davidson. Spotting conditions were poor with southwest winds 20-25 knots, mostly cloudy skies, and snow squalls. Today's aerial survey covered Sitka Sound north of Cape Burunof and Salisbury Sound. North of Sitka concentrations of sea lions and whales continue to be seen in the area between the islands and the Baranof Island shoreline distributed from the north end of Kasiana Island to the entrance of Nakwasina Sound. Within this area the higher numbers of sea lions and whales were seen between Halibut Point and Middle Island. At Inner Point there were 160 sea lions and six whales with smaller groups of sea lions and a number of whales distributed around between Bieli Rocks and Hayward Strait. South of Sitka, there were a few sea lions scattered in the Eastern Channel area and approximately 40 sea lions were seen in Silver Bay.

- *F/V Pillar Bay*, 12:15 p.m., N. of St. John Bay, 150 tons, 8.0% mature roe; 3.0% immature roe, 134 gm, 49% female.
- *F/V Pillar Bay*, 1:30 p.m., St. John Bay, 200 tons, 7.2% mature roe; 1.6% immature roe, 136 gm, 38% female.

The *R/V Kestrel* surveyed portions of northern Sitka Sound and Salisbury Sound. A very large volume of herring continues to reside in the area between Halibut Point and Middle Island. Most of this volume is holding in deeper waters with scattered large schools breaking off toward the surface. In Salisbury Sound there were a number of large schools scattered throughout the area from St John Baptist Bay to Kane Island. Waters north of Kane Island were not surveyed.

March 31: 8:30 – 9:40 Gordon/Coonradt. Today's aerial survey covered Sitka Sound north of Cape Burunof and Salisbury Sound. Spotting conditions were good under overcast skies and light winds. North of Sitka concentrations of sea lions and whales continue to be seen in the area between the islands and the Baranof Island shoreline distributed from the north end of Kasiana Island to the entrance of Nakwasina Sound. Within this area the higher numbers of sea lions and whales were seen between Halibut Point and Middle Island. At Inner Point there were 150 sea lions, a significant increase since yesterday's count. There were a number of whales scattered throughout the open waters between Inner Point and Crow Island, and three whales were seen near the Chaichie Islands. In Salisbury Sound there was a significant increase in sea lions and whale activity from Kane Islands into St John Baptist Bay with nine whales and approximately 70 sea lions counted in that area. South of Sitka, there were a few sea lions scattered in the Eastern Channel area and approximately 35 sea lions were seen in Silver Bay. During today's aerial survey the first spawn of the season was observed, **1.4 nmi of active spawn** was mapped, primarily around Middle and Crow Islands.

- *F/V Ace*, 8:30 a.m., Promisila Bay, 75 tons, 13.6% mature roe; 1.0% immature roe, 178 gm, 59% female.
- *F/V Pacific Fisher*, 7:30 a.m., N. Crow Pass, 100 tons, 11.9% mature roe; 2.1% immature roe, 159 gm, 54% female.

-continued-

- *F/V Defiant*, 9:00 a.m., W. of Gavanski Island, 100 tons, 8.2% mature roe; 5.2% immature roe, 133 gm, 56% female.
- *F/V North Cape*, 12:30 a.m., N. Guide Island, 100 tons, this sample was worked up on the grounds and it was determined these were acceptable quality fish.

Today **the Sitka Sound herring sac roe fishery was opened** in the northwest portion of Sitka Sound that included waters of Hayward Strait, Promisla Bay, and Eastern Bay north of 57°06.02' N. latitude, south of 57°10.01' N. latitude, and west of a line from the northernmost tip of Crow Island to the northernmost tip of the Siginaka Island group to the Krestof Island shoreline. The fishery opened at 2:30 p.m. and closed at 5:56 p.m. The preliminary harvest estimate is 4,730 tons.

In the afternoon the department received reports of spot spawns developing on north Middle Island and the Gavanski Islands. Observations from the *R/V Kestrel* showed limited spawning with little volume of herring off the beach where the spawns were occurring.

April 1: 9:00 – 10:40 Gordon/Film Crew. Today's aerial survey covered Sitka Sound north of Dorothy Narrows to Hayward Strait. Spotting conditions were fair with mostly overcast skies, and winds east 10-15 knots. Concentrations of herring predators were observed along the Kruzof Island shore south of Mountain Point, along the south shore of Gagarin Island, and north of the Eliason Harbor Breakwater. During today's aerial survey **8.8 nmi of active spawn** was mapped, primarily around Middle, Crow and Gagarin Islands.

No fishery is planned for today.

- *No test samples were taken today.*

April 2: 8:00 – 9:00 Gordon/Coonradt/Botz. Today's aerial survey covered Sitka Sound north of Cape Burunof to Krestof Sound. Spotting conditions were poor with overcast skies, intermittent rain and winds east 25-30 knots. During today's brief aerial survey a total of **17.4 nmi of active spawn** was recorded broadly distributed throughout northern Sitka Sound. Predator activity was not noted due to the poor flying conditions.

- *F/V Jean C*, 8:30 a.m., Hayward Strait, 100 tons, 11.4% mature roe; 2.9% immature roe, 147 gm, 57% female.

Today the Sitka Sound herring sac roe fishery was opened in the northwest portion of Sitka Sound that included the waters of Hayward Strait and Krestof Sound north of 57°06.02' N. latitude, south of 57°13.00' N. latitude, and west of a line from the northernmost tip of Crow Island to Kresta Point. The fishery opened at 11:30 a.m. and closed at 4:40 p.m. The preliminary harvest estimate is 5,610 tons for a total harvest this season of 10,340 tons.

April 3: 09:15 – 11:00 Gordon/Monagle. Today's aerial survey covered Sitka Sound north of Cape Burunof to Salisbury Sound. Spotting conditions were good with mostly overcast skies and winds east 15-20 knots. During today's aerial survey a total of **20.8 nmi of active spawn** was recorded broadly distributed throughout northern Sitka Sound. Predator concentrations were noted in Salisbury Sound, east of Inner Point, and south of the bridge. Herring Schools were also observed in Hayward Strait.

No Vessel Survey was conducted today.

-continued-

April 4: 09:55 – 11:25 Coonradt/Case/Davidson. Today's aerial survey covered Sitka Sound north of Cape Burunof to Salisbury Sound. Spotting conditions were excellent with mostly clear skies and calm winds. During today's aerial survey a total of **14.1 nmi of active spawn** was recorded broadly distributed throughout northern Sitka Sound. Predator concentrations were noted in Salisbury Sound, south of Fred's Creek, and south of the bridge. Herring Schools were also observed in Hayward Strait.

- *F/V Ace*, 10:00 a.m., St. John Bay, 30 tons, 9.5% mature roe; 1.0% immature roe, 135 gm, 43% female.
- *F/V Ace*, 10:45 a.m., N. St. John Bay, 40 tons, 6.5% mature roe; 0.7% immature roe, 122 gm, 33% female.

The *R/V Kestrel* surveyed Salisbury Sound and portions of northern Sitka Sound. No significant volume of herring was found in Sitka Sound during today's survey. In Salisbury Sound there were a number of large schools scattered throughout the area from St John Baptist Bay to Kane Island. Waters north of Kane Island were not surveyed.

April 5: 10:00-12:00 Gordon. Today's aerial survey covered Sitka Sound north of Cape Burunof to Krestof Sound. Spotting conditions were excellent with mostly clear skies and calm winds. During today's aerial survey a total of **4.9 nmi of active spawn** was recorded broadly distributed throughout northern Sitka Sound. Predator concentrations were not noted on today's flight.

- *F/V Pacific Fisher*, 9:00 a.m., St. John Bay, 200 tons, 9.5% mature roe; 1.9% immature roe, 131 gm, 49% female.
- *F/V Alaskan Rose*, 9:30 a.m., N. St. John Bay, 200 tons, 7.7% mature roe; 0.7% immature roe, 133 gm, 38% female.

April 6: **8:00-10:15** Gordon Davidson, Coonradt. Today's aerial survey covered Sitka Sound north of Cape Burunof to Krestof Sound. Today's aerial survey **showed 2.0 nmi of active spawn** mostly along the Halibut Point Road and in Hayward Strait. Predator concentrations were noted south of the Magoun Islands, east of Middle Island and South of Dorothy Narrows. Herring schools were observed near Inner Point and Shoals Point.

- *F/V Ace*, 9:00 a.m., NE Middle Island, 100 tons, 2.7% mature roe; 7.3% immature roe, 92 gm, 5% female.

April 7: 7:20-8:30 Gordon. Today's aerial survey covered Sitka Sound north of Cape Burunof to Salisbury Sound. Spotting conditions were good with clear skies and calm winds. Today's aerial survey found only isolated areas of **active spawn totaling 1.1 nmi** in the Hayward Strait area. Predator concentrations were not noted on today's flight.

- *F/V Karine Britt*, 7:30 a.m., St. John Bay, 100 tons, 10.4% mature roe; 0.6% immature roe, 131 gm, 48% female.
- *F/V Karine Britt*, 10:00 a.m., Kane Island, 200 tons, 11.1% mature roe; 0.3% immature roe, 140 gm, 50% female.

-continued-

A detailed vessel survey was not conducted today. While transiting to Salisbury Sound the *R/V Kestrel* continued to see a substantial volume of herring in deeper waters east of Middle Island. An extensive mid-water layer of herring was also seen north of Middle Island.

Today, the Sitka Sound sac roe herring fishery was opened in the Salisbury Sound and Krestof Sound area from 2:15 p.m. to 5:30 p.m., harvesting approximately 3,700 tons. The area opened included the waters of Krestof Sound north of 57°10.00' N. latitude, Neva Strait, and Salisbury Sound south of 57°10.00' N. latitude and east of 135°43.81 W. longitude.

April 8: 8:30-10:10 Gordon/Coonradt. Today's aerial survey covered Sitka Sound north of West Crawfish Inlet to Salisbury Sound. Spotting conditions were good with clear skies and calm winds. Total **active spawn was 1.2 nmi** mapped in Starrigavan Bay and Hayward Strait. Herring Schools were observed in Windy Passage and in Hayward Strait. Herring predators continue to be broadly distributed in Sitka Sound, Windy Passage and in Salisbury Sound.

April 9: 8:05-9:35 Davidson/Coonradt. Today's aerial survey covered Sitka Sound north of West Crawfish Inlet to Salisbury Sound. Spotting conditions were good with mostly clear skies and winds NW 10 knots. Total **active spawn was 5.5 nmi** mapped in Starrigavan Bay, Hayward Strait and Windy Pass. Herring Schools were observed in Windy Passage and in Hayward Strait. Herring predators continue to be broadly distributed in Sitka Sound, Windy Passage and in Salisbury Sound.

- *F/V Jean C*, 2:00 p.m., Presidents Bay, 200 tons, all immature fish.

April 10: Davidson/Case. Today's aerial survey covered Sitka Sound north of West Crawfish Inlet to Salisbury Sound. Total **active spawn was 5.5 nmi** mapped in Starrigavan Bay, Hayward Strait and Windy Pass. Herring schools and herring predators were not noted on today's survey.

- *F/V Pillar Bay*, 10:00 p.m., E. Middle Island, 20 tons, all spawn out fish.

April 11: Today a total **of 0.6 nm of active spawn** was mapped in Salisbury Sound and Neva Strait. Additionally 9.9 nm of old spawn was mapped by skiff at low tide.

April 12: 8:40-10:00 Coonradt/Gordon/Jensen. Today's aerial survey covered Sitka Sound north of Cape Burunof to Salisbury Sound. Spotting conditions were good with mostly overcast skies and winds NW 10-15 knots. No herring or herring spawn was observed.

Herring egg deposition survey began.

April 13: Case. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. Today a total **of 0.9 nm of active spawn** was mapped in Salisbury Sound.

In Hoonah Sound herring predators were observed scattered broadly. Thirty-five sea lions were observed off Ushk Point,10 north of Ostoia Island, 13 north of Vixen Islands, 19 north of Emmons Island, 26 east of Emmons Island, 16 in the south arm and 8 in the North Arm. Whales appeared to concentrate in the waters north of Ford Rock. No herring or herring spawn was observed.

-continued-

April 15: Case. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. No herring or herring spawn was observed in Sitka Sound.

In Hoonah Sound herring predators were observed scattered broadly, however significantly reduced from the previous survey. Twenty-eight north of Vixen Islands, three north of Emmons Island, and fifteen west of Vixen Islands. Only one whale was observed on today's flight east of Ford Rock. No herring or herring spawn was observed

April 17: Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. No herring or herring spawn was observed in Sitka Sound.

In Hoonah Sound herring predators were observed scattered broadly, and remained at significantly reduced numbers from previous surveys. One sealion north of Vixen Islands, six north of Emmons Island, one south of Pedersen Point, three north of Poison Cove and three off Ushk Point. Only one whale was observed on today's flight south of Moser Island. Herring schools were observed west of Emmons Island and along the Chichigof Island shore west of vixen Islands, no herring spawn was observed.

April 18: 8:15-9:30 Case/ Coonradt. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound south to Rodman Bay. No herring or herring spawn was observed in Sitka Sound.

In Hoonah Sound herring predators were observed scattered broadly, and remained at significantly reduced numbers from initial surveys. Three sea lions north of Vixen Islands, two off Rodgers Point, seven off Fick Cove, one south of Poison Cove, and three off Ushk Point. Only one whale was observed on today's flight south of Poison Cove. No herring or herring spawn was observed.

April 19: 13:00-14:00 Case. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. No herring or herring spawn was observed in Sitka Sound. Spotting conditions were poor with mostly cloudy skies and windy.

In Hoonah Sound herring predators were observed scattered around Emmons and Vixen Islands and remained at significantly reduced numbers from initial surveys. Two whales were observed on today's flight north of Emmons Island. Herring schools were observed west of Vixen Islands, no herring spawn was observed.

April 20: 9:00-10:15 Jensen. Today's aerial survey covered north Sitka Sound, Salisbury Sound and Hoonah Sound. Spotting conditions were poor with mostly clear skies and winds SE 20-25 knots. No herring or herring spawn was observed in Sitka Sound. In Hoonah Sound **0.6 nmi of active spawn** was mapped on the north end of Emmons Island and on the Chichigof Island shore south of Fick Cove.

April 21: 11:30-13:00 Case/Matz. Today's aerial survey covered north Sitka Sound, Salisbury Sound and Hoonah Sound. Spotting conditions were good with mostly clear skies and winds SE 15. No herring or herring spawn was observed.

Appendix C5.–Aerial and skiff herring spawn surveys by date, in Hoonah Sound (Sitka Management Area), Southeast Alaska in 2012.

April 13: Case. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. Today a total **of 0.9 nmi of active spawn** was mapped in Salisbury Sound.

In Hoonah Sound herring predators were observed scattered broadly. Thirty-five sea lions were observed off Ushk Point, 10 north of Ostoia Island, 13 north of Vixen Islands, 19 north of Emmons Island, 26 east of Emmons Island, 16 in the south arm and 8 in the North Arm. Whales appeared to concentrate in the waters north of Ford Rock. No herring or herring spawn was observed

April 15: Case. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. No herring or herring spawn was observed in Sitka Sound.

In Hoonah Sound herring predators were observed scattered broadly, however significantly reduced from the previous survey. Twenty-eight north of Vixen Islands, 3 north of Emmons Island, and 15 west of Vixen Islands. Only one whale was observed on today's flight east of Ford Rock. No herring or herring spawn was observed.

April 17: Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. No herring or herring spawn was observed in Sitka Sound.

In Hoonah Sound herring predators were observed scattered broadly, and remained at significantly reduced numbers from previous surveys. One sealion north of Vixen Islands, six north of Emmons Island, one south of Pedersen Point, three north of Poison Cove and three off Ushk Point. Only one whale was observed on today's flight south of Moser Island. Herring schools were observed west of Emmons Island and along the Chichigof Island shore west of vixen Islands, no herring spawn was observed.

April 18: 8:15-9:30 Case/ Coonradt. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound south to Rodman Bay. No herring or herring spawn was observed in Sitka Sound.

In Hoonah Sound herring predators were observed scattered broadly, and remained at significantly reduced numbers from initial surveys. Three sea lions north of Vixen Islands, two off Rodgers Point, seven off Fick Cove, one south of Poison Cove, and three off Ushk Point. Only one whale was observed on today's flight south of Poison Cove. No herring or herring spawn was observed.

April 19: 13:00-14:00 Case. Today's aerial survey covered Sitka Sound north of Eliason Harbor Breakwater to Salisbury Sound and Hoonah Sound. No herring or herring spawn was observed in Sitka Sound. Spotting conditions were poor with mostly cloudy skies and windy.

In Hoonah Sound herring predators were observed scattered around Emmons and Vixen Islands and remained at significantly reduced numbers from initial surveys. Two whales were observed on today's flight north of Emmons Island. Herring schools were observed west of Vixen Islands, no herring spawn was observed.

-continued-

April 20: 9:00-10:15 Jensen. Today's aerial survey covered north Sitka Sound, Salisbury Sound and Hoonah Sound. Spotting conditions were poor with mostly clear skies and winds SE 20-25 knots. No herring or herring spawn was observed in Sitka Sound. In Hoonah Sound **0.6 nmi of active spawn** was mapped on the north end of Emmons Island and on the Chichigof Island shore south of Fick Cove.

April 21: 11:30-13:00 Case/Matz. Today's aerial survey covered north Sitka Sound, Salisbury Sound and Hoonah Sound. Spotting conditions were good with mostly clear skies and winds SE 15. No herring or herring spawn was observed.

April 22: 8:00-9:40 Coonradt/Gordon. Today's aerial survey covered only **Hoonah Sound**. Spotting conditions were good with mostly clear skies and calm winds. No herring or herring spawn was observed.

April 23: 10:50-11:30 Coonradt/Gordon. Today's aerial survey covered only **Hoonah Sound**. Spotting conditions were good with mostly clear skies and winds SE 15. Herring spawn was observed on the Chichigof shoreline south of Fick Cove. Total **active spawn was 0.5 nmi**. Additionally **4.2 nmi of spawn** was mapped on the Chichigof Island shore, and Emmons and Vixen Islands during a skiff survey earlier in the day.

April 24: 8:00- 8:30 Davidson. Today's aerial survey covered only **Hoonah Sound**. Spotting conditions were good with mostly clear skies and winds SE 15. No herring or herring spawn was observed.

Appendix C6.–Aerial and skiff herring spawn surveys by date, at Bradfield Canal, Ernest Sound, Ship Island, Zimovia Strait and Eastern Passage, and Bear Creek, within Petersburg-Wrangell Management Area in Southeast Alaska, 2012.

Bradfield Canal

Total miles of spawn: ~18.0 nmi

Spawning dates: most likely between 4/05 & 4/10

Peak spawning: unknown

4/6 ~6.0 nm of active spawn and scattered schools; 23 Sea Lions; 500 Gulls; 2,000 Scoters.

4/9 No active spawn or herring observed; 60 Sea Lions; 200 Gulls; 365 Scoters.

Vixen Inlet/ Union Bay/Emerald Bay

Total miles of spawn: ~9.1 nmi

Spawning dates: 4/16 through 4/22

Peak spawning: 4/17

4/6 No active spawn or herring observed; 18 Sea Lions.

4/9 No active spawn or herring observed, 16 Sea Lions.

4/13 No active spawn or herring observed, 16 Sea Lions, 160 Gulls.

4/16 ~1.2 nm of active spawn; 100 Sea Lions; 1,700 Gulls.

4/17 ~1.5 nm of active spawn; 77 Sea Lions; 2 Whales; 1,900 Gulls.

4/18 ~0.5 nm of active spawn; 70 Seas Lions; 2,400 Gulls.

4/19 ~0.4 nm of active spawn, 15 schools of herring observed; 112 sea lions, 1,600 Gulls; 100 Scoters.

4/20 ~0.3 nm of active spawn, 1 school of herring observed; 2,500 Gulls.

4/21 ~0.3 nm of active spawn; 42 Sea Lions; 2,000 Gulls; 2,000 Scoters.

4/22 ~0.2 nm of active spawn, 3 schools of herring observed; 60 Sea Lions; 1,000 Scoters.

4/23 No active spawn or herring observed; 16 Sea Lions; 1,000 Gulls; 1,000 Scoters.

4/25 No active spawn or herring observed; 500 Gulls; 1,500 Scoters.

-continued-

Onslow/Stone/Brownson Island/Canoe Pass
Total miles of spawn: ~1.0 nmi
Spawning dates: 4/16 through 4/19
Peak spawning: 4/19

4/16 ~0.5 nm of active spawn; 5 Sea Lions; 500 Gulls.
4/17 ~0.5 nm of active spawn; 7 Sea Lions; 300 Gulls; 100 Scoters.
4/18 ~0.5 nm of active spawn; 8 Sea Lions; 550 Scoters.
4/19 ~0.7 nm of active spawn; 2 Sea Lions; 650 Scoters.
4/20 No active spawn or herring observed; 300 Gulls; 650 Scoters.
4/21 No active spawn or herring observed; 800 Gulls; 600 Scoters.
4/22 No active spawn or herring observed; 600 Scoters.
4/23 No active spawn or herring observed; 300 Gulls; 800 Scoters.
4/25 No active spawn or herring observed; 500 Gulls; 100 Scoters.

Zimovia St. and Eastern Passage

Not Surveyed in 2012

Bear Creek

Not Surveyed in 2012

Farragut Bay
Total miles of spawn: ~2.0 nmi
Spawning dates: 4/22 through 4/25
Peak spawning: 4/23

4/21 Herring schools on the beach; 35 Sea Lions.
4/22 ~0.4 nm of active spawn; 75 Sea Lions; 200 Gulls.
4/23 ~0.5 nm of active spawn; 50 Sea Lions; 100 Gulls.
4/24 ~0.3 nm of active spawn and several schools near beach; 23 Sea Lions; 300 Gulls.
4/25 ~0.5 nm of moderate spawn and no schools near beach; 20 Sea Lions; 3,000 Gulls.
4/26 ~2.0 nm of spawn mapped during a skiff survey.
4/27 No active spawn or herring observed; 3Sea Lions.
5/4 No active spawn or herring observed; 4 Sea Lions; 1,000 Scoters.

-continued-

Hobart Bay

Total miles of spawn: ~2.1 nmi

Spawning dates: 4/21 through 4/25

Peak spawning: 4/22

4/18 No active spawn or herring observed; 47 Sea Lions.

4/21 ~0.7 nm of active spawn and schools on the beach; 40 Sea Lions; 500 Gulls.

4/22 ~1.1 nm of active spawn and 1 school on beach; 29 Sea Lions; 2 Whales.

4/23 ~0.7 nm of active spawn; 75 Sea Lions; 1 Whale; 500 Gulls; 3,000 Scoters.

4/24 Small spot spawn observed; 65 Sea Lions; 2,000 Gulls; 2,000 Scoters.

4/25 Small spot spawn observed; 6 Sea Lions; 2,300 Gulls; 4,000 Scoters.

4/27 No active spawn, 1 school of herring; 29 Sea Lions; 10,000 Scoters.

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

Port Houghton

Total miles of spawn: 0.0 nmi

4/18 No active spawn or herring observed.

4/21 No active spawn or herring observed.

4/22 No active spawn or herring observed.

4/23 No active spawn or herring observed.

4/24 No active spawn or herring observed; 30 Sea Lions.

4/25 No active spawn, 1 Schools of herring; 9 Sea Lions.

4/27 No active spawn or herring observed; 30 Sea Lions.

5/4 No active spawn or herring observed; 88 Sea Lions.

Sunset Cove/Windham Bay

Total miles of spawn: 0.0 nmi

4/18 No active spawn or herring observed; 2 Sea Lions; 1 Whale.

4/21 No active spawn or herring observed.

4/22 No active spawn or herring observed; 7 Sea Lions.

-continued-

4/23 No active spawn, 1 school of herring; 40 Sea Lions.

4/24 No active spawn or herring observed; 75 Sea Lions.

4/25 No active spawn or herring observed; 40 Sea Lions.

4/27 No active spawn or herring observed; 38 Sea Lions.

5/4 No active spawn or herring observed; 3 Sea Lions.

Gambier Bay/Pybus Bay

Total miles of spawn: 0

4/27 No active spawn or herring observed; five Sea Lions in Gambier Bay.

Port Camden

Total miles of spawn: ~0.5 nmi

Spawning dates: 5/15

Peak spawning: unknown

4/27 No active spawn, herring, or predators observed.

5/15 ~0.5 nm of active spawn.

Appendix C7.–Aerial and skiff herring spawn surveys by date, in Seymour Canal (Juneau Management Area), in Southeast Alaska, 2012.

Seymour Canal

Number of times surveyed: 43 total. Includes one flight by Petersburg staff, two flights our pilot only, and one industry flight.

Total miles of spawn: 6.9 nmi

Spawning dates: 426; 4/27; 5/4-5/12

Peak spawn: 5/10-5/12

4/12 RV Media, returning from Port Armstong, reported gull and eagle activity at Pt. Hugh while passing the area. No whales sighted in the area.

4/16: No herring or herring spawn observed. Eight whales and 150 sea lions, most between the Swimming Pool and Twin Islands, on either side of Glass Peninsula. No herring or spawn observed.

4/18 No herring or herring spawn observed. Seven whales and 175 sea lions observed, most between Swimming Pool and Point Hugh. Whales observed near shore, predators moderately active. Quiet along the Big Bend shoreline.

4/20 No herring or herring spawn observed. Ten whales and 206 sea lions observed, most between Sorethumb Cove and Point Hugh. Little change since last survey.

4/21 No herring or herring spawn observed. Twelve whales and 235 sea lions, concentrated between Swimming Pool and Point Hugh.

4/22: No herring or herring spawn observed. Sea lion numbers down – 75 observed and seven whales. Spawning event ongoing in Hobart. Most between Pt. Hugh and Blackjack Cove.

4/23 9:15: No herring or herring spawn observed. One hundred fifteen sea lions and fourteen whales, most between Pt. Hugh and Rockgarden. Fishery on 12 hour notice.

4/23 18:00: Schools on the beach at Cloverleaf Rocks, no spawn observed. Seventy-five sea lions and eight whales, majority again between Blackjack and Point Hugh.

4/24 6:45: Petersburg staff survey – no herring or spawn. One hundred forty-five sea lions and twelve whales. One concentration of predators in the vicinity of Pt. Hugh Light. Another near Blackjack and to the north.

4/24 08:00 No herring or herring spawn observed. One hundred eighty sea lions and ten whales. Predator groups at Pt Hugh Lt and Cloverleaf Rocks; sea lions spread from Blackjack to Twin Islands. Big Bend very quiet.

4/24 09:00 No herring or herring spawn observed. Fifty-plus sea lions and eleven whales scattered long Glass Peninsula from Blackjack to Dogleg.

-continued-

4/24 16:00 Small and medium sized schools on beach for a mile south of Cloverleaf Rocks, flighty, not yet committed to the beach. More than 175 sea lions and 17 whales observed, more spread out on both sides of Glass Peninsula north of Pt. Hugh to the lat of halfway between Twin Is and Swimming Pool. Three whales inside Mole Harbor.

4/25 8:00 Two small schools on beach just NE of Pt. Hugh, no spawn observed. Most predators on east side of Glass Peninsula between Pt. Hugh Light and Pt. Hugh. Numerous whales near Pt Hugh.

4/26 12:30 Herring on beach in same place as morning survey, no spawn. Predators observed on both sides of Glass Peninsula – no major change in distribution from morning. Two orca off Swimming Pool.

4/26 17:00 No spawn observed. Schools of herring on the beach in Blackjack Cove and by the D10/D11 Boundary. Another small school halfway to Twin Islands, and north east of Point Hugh. Most predators between Cloverleaf Rocks and Point Hugh, with three groups of 10 sealions each between herring schools N of Blackjack. Fish on the beach set but flighty.

4/26 08:00 **0.3 nmi light spawn** on E side of Pt Hugh – deep. Small school ≈.75 nm south of Sorethumb Cove. Wind and seas made poor vis, few predators observed.

4/26 11:40 Surveyed north to Sorethumb. One very small school just north of Cloverleaf Rocks, one small school on Big Bend near cut to Gambier. Fewer predators, 160 sea lions and three whales scattered from Cloverleaf Rocks to Twin Islands.

4/27 08:30 **Intense spot spawn** just north of the Swimming Pool. Schools of herring observed along a mile of beach around the spawn; for a half mile beginning at the D10/D11 Boundary south; large dense schools on eastern Point Hugh. Predators associated with spot spawn and Pt Hugh. Surveyed from Sorethumb to Gambier Point, no other herring observed.

4/28 08:40 No herring or herring spawn observed. One hundred eighty sea lions and three whales observed. Predators mostly in scattered groups of ≈20, both side of Glass Peninsula south of the latitude of Twin Islands.

4/28 17:05 Two small and one medium school near Blackjack, one possible small school NW of Pt Hugh. One hundred three sea lions eight whales, sea lions similar to morning flight, group of five whales feeding together offshore of medium sized school at Swimming Pool.

4/29 07:10 Weather poor (SE 20-25) No herring or herring spawn observed, few predators. Nothing on Big Bend shoreline.

4/29 ≈18:00 Pilot only survey due to weather and Medeia standing by for medivac from Island Dancer. No herring or spawn, few predators observed due to weather.

4/30 08:00 No herring or spawn, survey conducted at 500' due to low overhead. One hundred twenty-eight sea lions and five whales observed. Majority of predators observed between Twin Islands and Pt. Hugh, very quiet on Stephens Passage shoreline and Big Bend.

-continued-

4/30 17:00 No spawn observed. One small school on beach at Twin Islands. One hundred ten sea lions observed between Pt. Hugh and half way between Swimming Pool and Twin Islands. Six whales and 25 sea lions off Blackjack Cove.

5/1 08:00 No herring or spawn observed. Poor visibility due to low clouds and rain. One hundred fifteen sea lions and seven whales observed; six whales outside and just south of Blackjack Cove where volume of fish observed from skiff on 4/30.

5/1 16:30 No herring or spawn observed. Good visibility ≈100 sea lions six whales from Pt. Hugh to Sore Thumb.

5/2 08:00 Poor Vis due to weather, no spawn observed; small school at Pt. Hugh Light. Few predators, four whales by Rockgarden, another north of Swimming Pool.

5/2 15:40 Vis good to fair, no spawn observed; small school at Twin Islands. A few scattered predators from Pt. Hugh to Swimming Pool. Sonar survey found numerous schools from Twin Island to just north of Point Hugh.

5/3 08:00 No herring or spawn observed. Good visibility. Predators scattered from Sorethumb to Pt. Hugh. Fish near beach, tight to bottom in 18 ft at low tide observed by Swimming Pool and one to two miles to the north during skiff survey, withdrew in an hour or two.

5/3 17:00 No herring or spawn observed. Excellent visibility. Predators scattered from Swimming Pool to Pt. Hugh.

5/4 07:45 Small light spawn between Mole and Pleasant Harbors; additional small but more intense spawn south of Pleasant Harbor for a total of approximately **0.3 nmi of spawn**. Several small and flighty schools on Stephens Passage shore north of Cloverleaf Rocks. Majority of predators observed two miles both north and south of Blackjack. Big Bend shore quiet.

5/4 16:30 Schools on the beach north of Cypress Rock, north of Sorethumb, north of the Rock Garden and north of the Twin Islands. None on East Glass Peninsula. New **spot spawn** just north of Pleasant Harbor, and the light spawn south of Pleasant continues. Fifty sea lions and five whales observed.

5/5 07:45 An eight of a mile active spawn in Sorethumb Cove, observed to expand on sonar survey at noon, plus extra small spawns on either side of the finger, to the south and in the Rockgarden for a **total of 0.8 nmi** observed for the day. Small active spawn just north of Pt. Hugh Light on Stephens shore.

5/5 16:30 Sorethumb vicinity spawn dissipating, **two active spots** between Pt Hugh Light and Dogleg. Small schools observed on the beach at Twin Islands and Swimming Pool and north of Pt Hugh Light.

5/6 13:10 Pilot surveyed and **observed spawn** and the north of the Rockgarden. Mediea survey in morning found spawn in Sorethumb.

5/7 08:00 **0.75 nmi spawn** in Sorethumb and Rockgarden. No herring observed. Few predators and nothing along Big Bend.

-continued-

5/7 04:15 Dissipating spawn in Sorethumb, several small light schools between Sore Finger and Rockgarden. Few predators along west Glass, more along East Glass, with several areas of bird activity but no herring observed.

5/8 Weather too poor for aerial survey; in afternoon sonar surveyed area with Mediea, observed **0.8 nm of spawn** in Rockgarden. Major concentration of fish located near Pt. Hugh Light and north.

5/9 08:00 light dissipating spawn in Sorethumb. Light dissipating spawn observed from skiff south of Rockgarden. No herring and few predators.

5/9 16:00 Verbal report on SKs back flight. No change, two small schools at Blacckjack Cove, otherwise all quiet.

5/10 07:00 **1.0 nm discontinuous spawn** from N. Sorethumb to Twin Islands. Two small schools on beach in Blackjack Cove. Few predators.

5/11 12:00 Industry pilot observed a **total of 2.9 nm of spawn** between Blackjack and Twin Islands, including a small amount north of Sorethumb. No herring or predators observed in the ver poor weather.

5/12 08:00 **1.8 nm of spawn** observed between the Swimming Pool and south of the District Boundary. No herring, but a few whales observed off the active spawn near the District Boundary.

5/13 13:30 No herring or herring spawn, and few predators observed.

5/14 10:30 No herring or herring spawn, and few predators observed.

5/21 Ward Air pilot report of 600 yards of active spawn between Sorefinger and Shortfinger.

Appendix C8.–Aerial and skiff herring spawn surveys by date, in Tenakee Inlet (Juneau Management Area), in Southeast Alaska, 2012.

Tenakee Inlet

Number of times surveyed: 7

Total miles of spawn: 4.6

Spawning dates: 4/20-4/23

Peak spawn: 4/22

4/16: No herring or herring spawn observed. Seventy-one sea lions (three groups of 14, several groups of five or less) between Corner Point and Crab Bay. One whale observed near Cannery Point. One hundred to one hundred fifty sea lions hauled out at Cannery Point. In Chatham, 12 sea lions observed between S Passage Pt. and Basket Bay.

4/20 **1.4 nm of spawn** observed west of Kadashan flats, with several schools observed nearby. five whales and 95 sea lion observed associated with spawn.

4/21 **2.4 nm of spawn** observed, most to the west of Kadashan, but developing spawn to the east of Kadashan adjacent to the Strawberry Island pound area. Five whales and 148 sea lions observed, most whale in Corner Bay.

4/22: **3.1 nm active spawn** observe, both shores of the mouth of Crab Bay, discontinuously to Kadashan flats, and two sections to the east of the Kadashan flats. Eight-five sea lions in four rafts evenly spaced between Crab Bay and Strawberry Island, Cannery Point haulout also full. Five whales near Cannery Point. Nothing east of Corner Point and Chatham.

4/23: **A total of 0.4 nmi active spawn** observed on either shore at the mouth of Crab Bay. Twenty sea lions; a raft of 15 in Crab Bay, and five off Kadashan flats. Birds on beach feasting on spawn. Two sea lion at Corner and six at S. Passage Point. No whales observed.

4/24: No herring or herring spawn observed. Forty-six sealions and zero whales, scattered from Crab Bay to S. Passage Pt.

4/25: No herring or herring spawn observed. Two whales in Crab Bay, one off Tenakee Springs. Twenty-five sea lions and one whale scattered along Chatham shore.

Number of times surveyed: 11

Total miles of spawn: 8.3

Spawning dates: 5/2-5/5

Peak spawn: 5/3-5/4

4/16: No herring or herring spawn observed. South of Mabb Is., seven scattered sea lions observed; Berners Bay, 38 scattered sealions. No herring or spawn observed.

4/20: No herring or herring spawn observed. Two whales and 20 sea lions observed between Bridget Cove and in Berners Bay.

4/23: No herring or herring spawn observed. One hundred fifty sea lions hauled out at Benjamin Is. No other predators observed. Fifteen sea lions observed just east of Pt. Bridget, no other predators in Berners Bay.

4/25: No herring or herring spawn or hooligan observed. Three whales between Echo Cove and Pt Bridget, scattered sea lions.

4/28: No herring or herring spawn observed. Twenty-two sea lions and three whales along Lynn Canal shoreline, sea lions north of Eagle River; two whales off S. Shelter, one near Sunshine Cove; 100 on haulout at Benjamin Island. In Berners Bay, ≈25 sea lions in vicinity north of Pt. Bridget; 125 sealions in several rafts (one of ≈80) near Slate Cove – possibly eulachon staging in the area. One whale in Lynn Canal off Pt. St Mary.

5/1: No herring or herring spawn, and few predators observed south of Bridget Cove. Large schools of herring developing in S Bridget Cove. Schools observed on W Mabb Is and several small schools along shore north to Pt. Bridget. Small active spawn on north end of reef on west side of Point Bridget. Seven whales and 100 sea lions (plus 100 at Benjamin Is haulout), Associated with herring and on south and east shore of Berners Bay and from Pt. St Mary north.

5/2: Moderate biomass of herring observed in Bridget Cove, little else in Lynn Canal. 1.24 nmi of spawn observed. **Active intense spawn** observed at Pt. Bridget and on west Pt. St Mary, spawn also observed on either side of Sawmill Creek on eastern shore of Berners Bay.

5/3: **5.5 nmi of active spawn** observed. ≈1.5 nm heavy Spawn from Pt. Bridget east, spawn from mouth of Echo cove north to Sawmill Creek,; heavy at Sawmill Creek, and additional mile of active spawn to the north, and two small spawns outside Pt. St. Mary. A small spot spawn at south Bridget Cove, and a tide pool with spawning, stranded fish inside the south part of Bridget Cove

5/4: **4.9 nmi of active spawn** observed, from Pt Bridget east and Cascade Pt north with a smaller amount north of Pt St Mary. Spot spawn just south of Bridget Cove. ≈150 sea lions on Benjamin Is. haulout.

5/5: **0.4 nm of active spawn**, just south of Bridget Cove and three spot spawns on Bridget

-continued-

shoreline. Few predators aside from 80 harbor seal and very few birds on Berners flats, no hooligan present. Several small schools of fish in Echo Cove, but did not look like herring. ≈200 sea lions on Benjamin Is.

5/7: No herring, spawn, and few predators observed.

6/4-6/6: Resident of Tee Harbor reported a total of 1.5 miles of spawn in N Tee Harbor (Beardsley Bay), one mile on the east side and 0.5 mile on the west side.

Appendix C10.–Aerial and skiff herring spawn surveys by date, in Port Frederick, Oliver Inlet, Taku Harbor, and Stephens Passage (Juneau Management Area), in Southeast Alaska, 2012.

Port Frederick

Number of times surveyed: Five

Total miles of spawn: non observed

4/16: No herring or herring spawn observed. Four whales and three sea lions in deep water between the Narrows and Neka Bay

4/20: No herring or herring spawn observed.

4/21: No herring or herring spawn observed. Two whales south of the Narrows, and 4 sea lions in the vicinity of Burnt Point.

4/23: No herring or herring spawn observed. Thirty-two sea lion and one whale observed; 10 sea lions off Game Creek and the rest near the Narrows.

4/25: Small school on shore south of Bear Creek, 20 sea lions near Hoonah. No spawn observed.

Oliver Inlet

Number of times surveyed: many, incorporated in Seymour surveys.

Total miles of spawn: 0

4/16: No herring, spawn, or predators.

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

4/21: No herring, spawn, or predators.

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

4/25 One small school observed just inside entrance narrows. Likely clam spawn outside on both sides of entrance. No birds or predators.

4/28 - 5/12 No herring, herring spawn, or predators observed.

Taku Harbor

Number of times surveyed: 0

Stephens Passage

4/28 No herring or spawn observed, scattered groups of sea lions along Glass Peninsula shore.

4/30 No herring or spawn observed in Endicott Arm while investigating pilot report of miles of spawn at Sumdum.

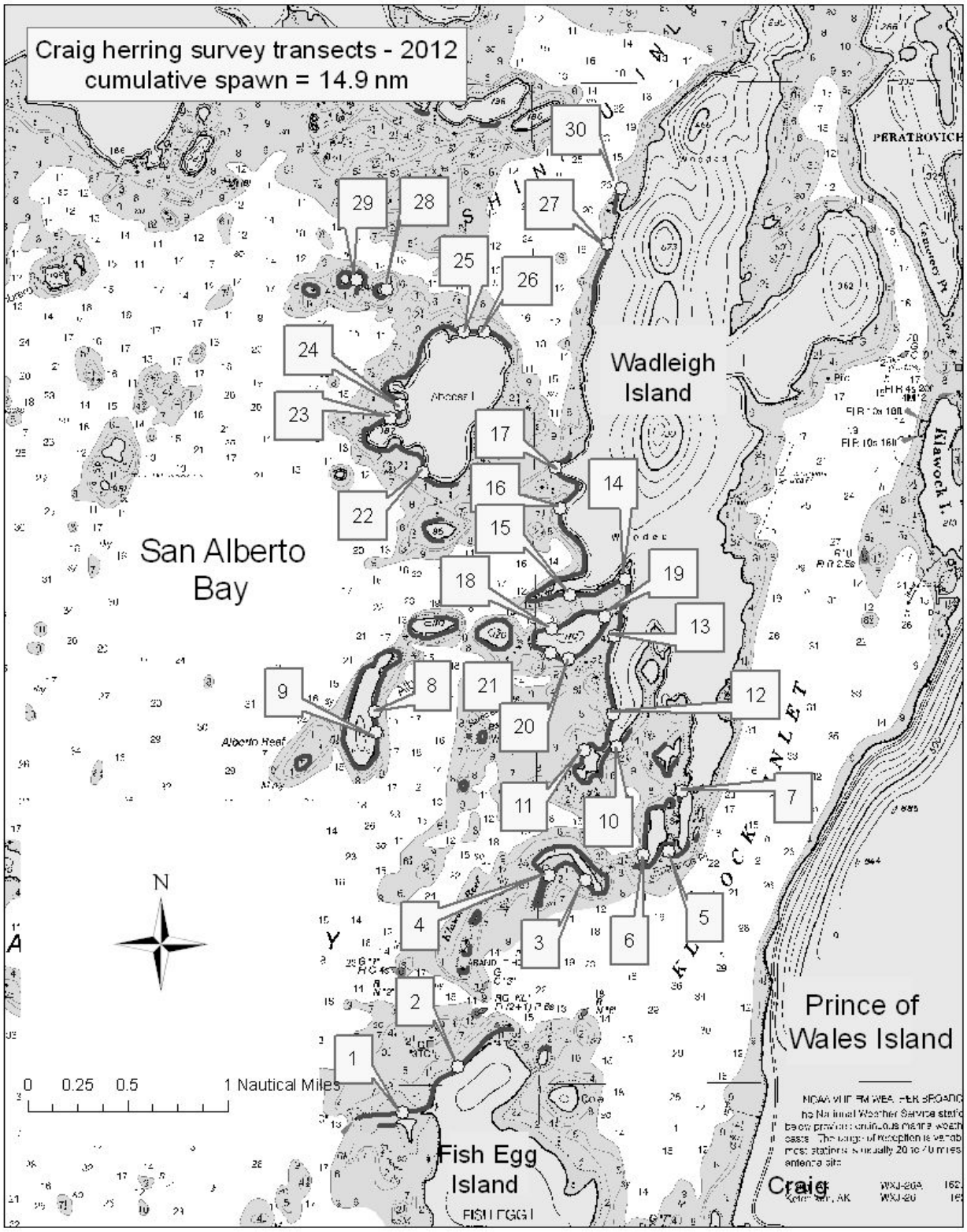
Appendix C11.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2012.

Yakutat Bay

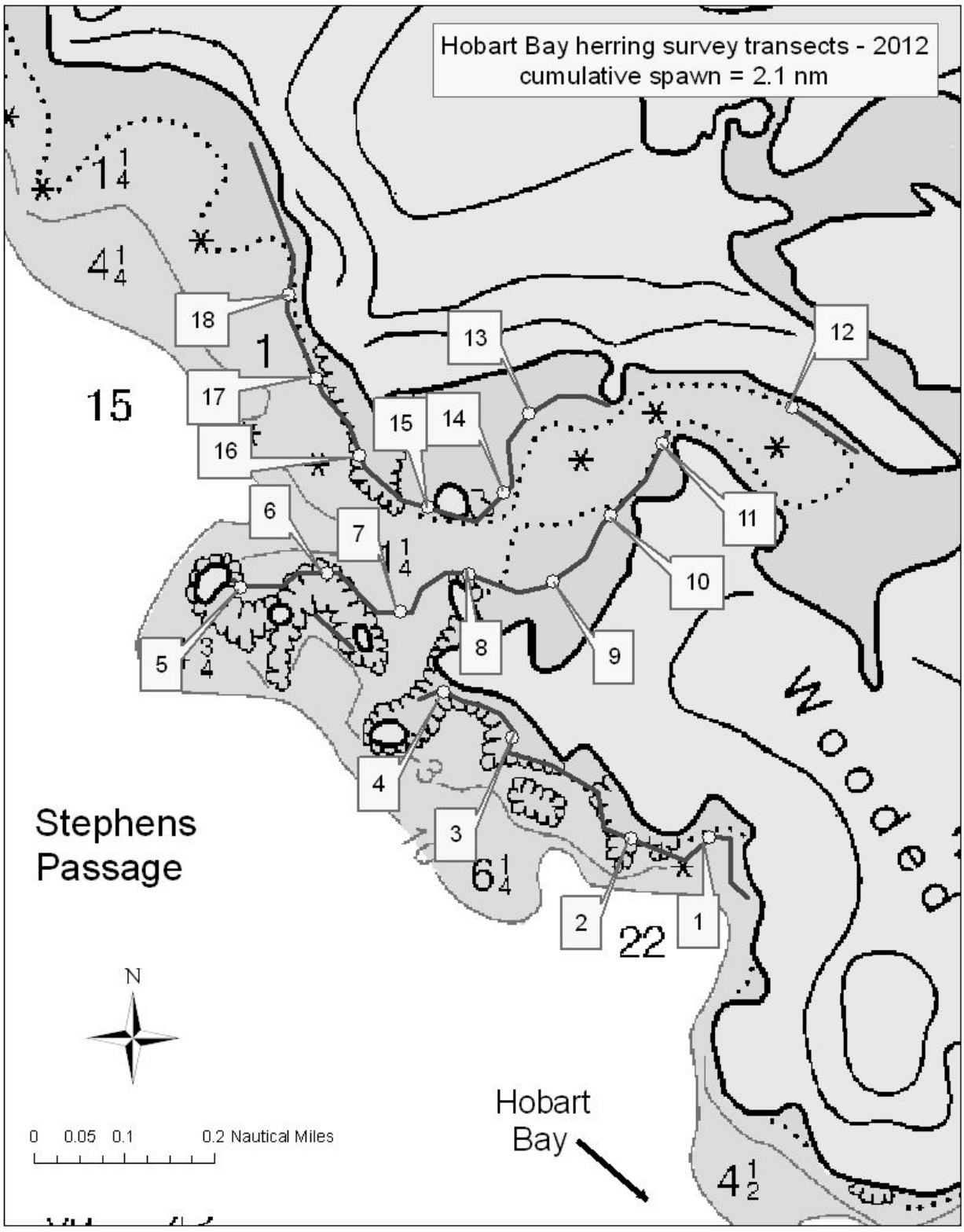
On Monday, April 16, 2012, a couple of local residents and one of our local pilots reported seeing herring spawn around the vicinity of Yakutat. Due to lack of funding, no ADF&G herring aerial surveys were conducted this year. The Yakutat office of the Forest Service has been conducting hooligan surveys for the past several weeks and Zeiser was able to ride along on their hooligan surveys today while conducting a herring survey at the same time. Survey conditions were excellent. No hooligans were seen but heavy bird activity was observed in the New Italio and Akwe Rivers. A whale breached just offshore outside the mouth of the Situk River. No schools of herring were seen either. Spawning activity was seen on the south end of Knight Island, the west side of Eleanor Island and along the shoreline of Eleanor Cove and in Chicago harbor. Lots of bird activity in Humpback Cove with about a mile of spawn along the shore. A big patch of spawn was present in Redfield Cove which according to the pilot was new active spawn. A mile of spawn on the west side of Doggie Island but appeared to be older spawn. Spot spawn seen around Fitzgerald and Gregson Islands (locally named Twin Islands). Four bays on Khantaak Island contained spawn with small patches off the southern end of the island. Around 2 mi of heavy spawn all throughout Monti Bay which appeared to be the most concentrated area as well as the most recent spawning activity. Sea lions and birds were also observed in this area. Total spawn is estimated to be approximately 7 mi.

APPENDIX D: SPAWN AND SPAWN DEPOSITION SURVEY TRANSECT LOCATIONS

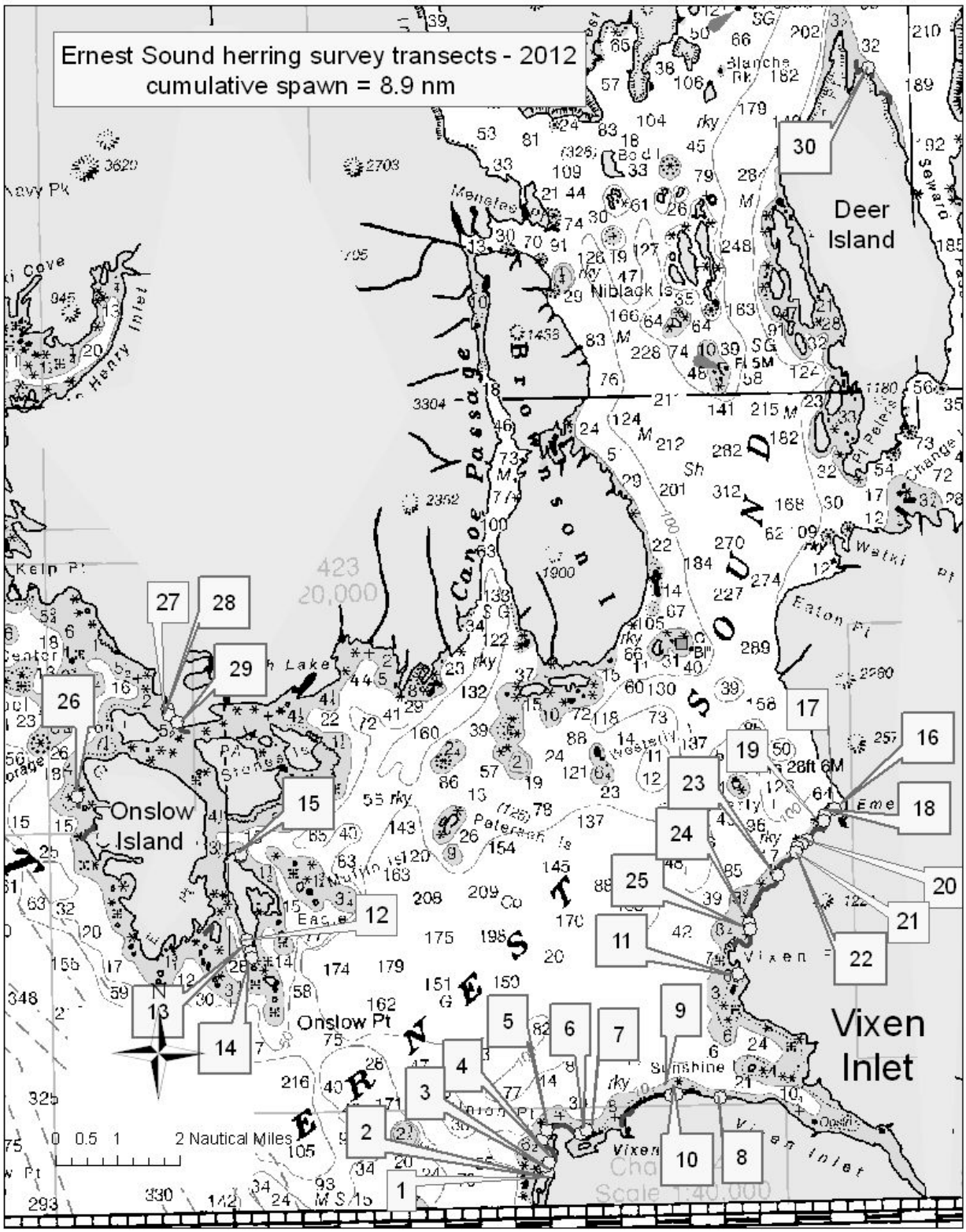
Appendix D1.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Craig herring stock in 2012.



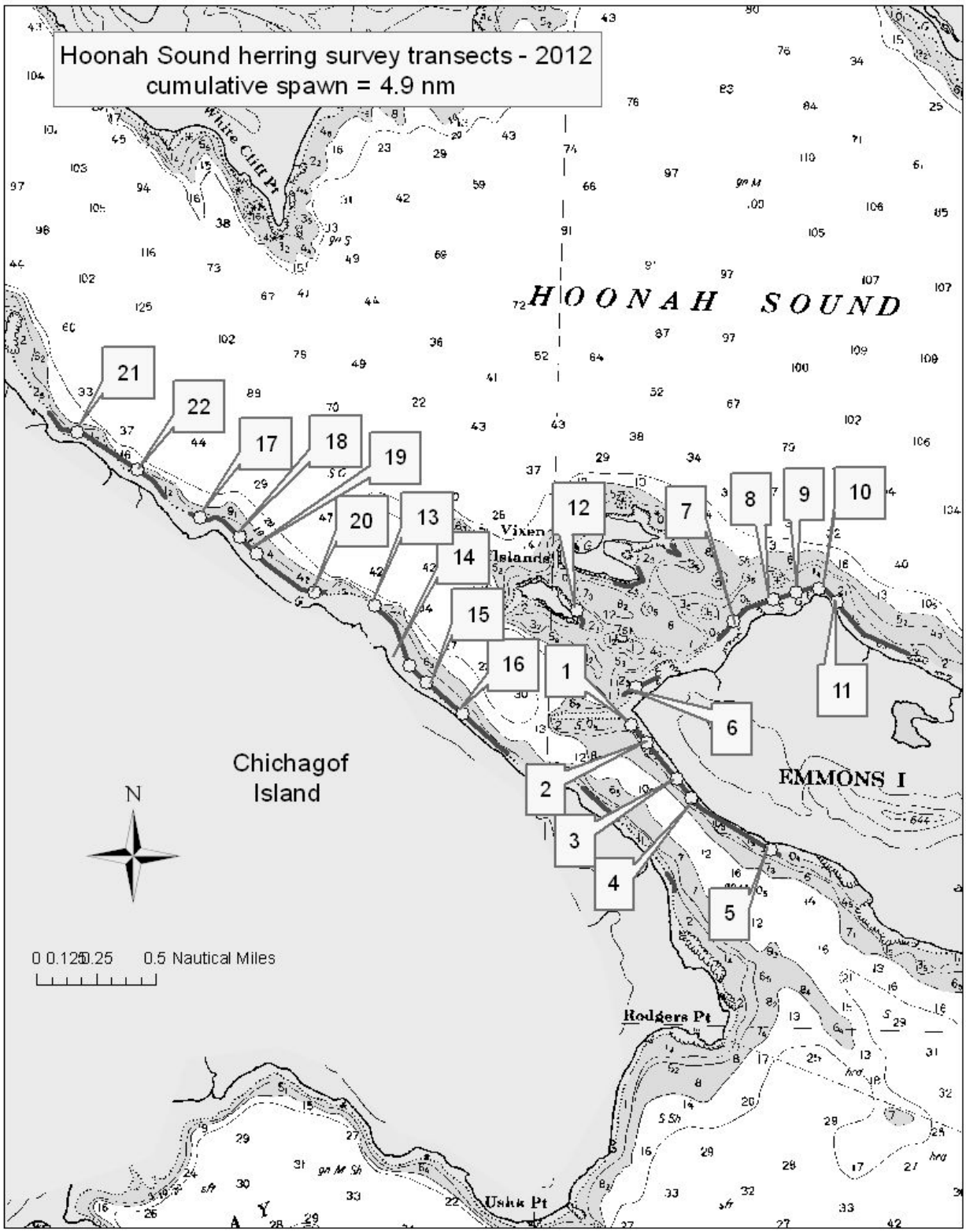
Appendix D2.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hobart Bay/Port Houghton herring stock in 2012.



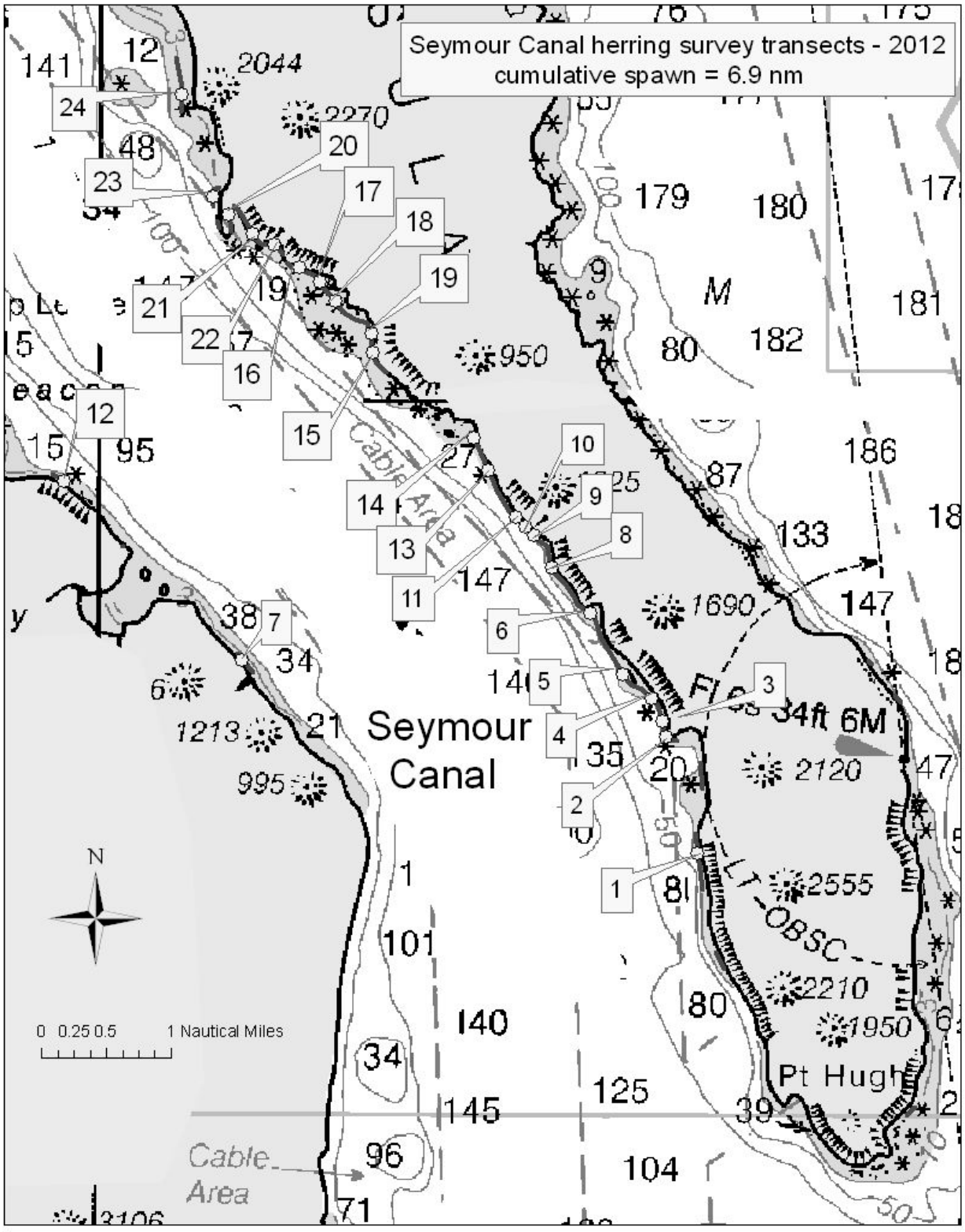
Appendix D3.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Ernest Sound herring stock in 2012.



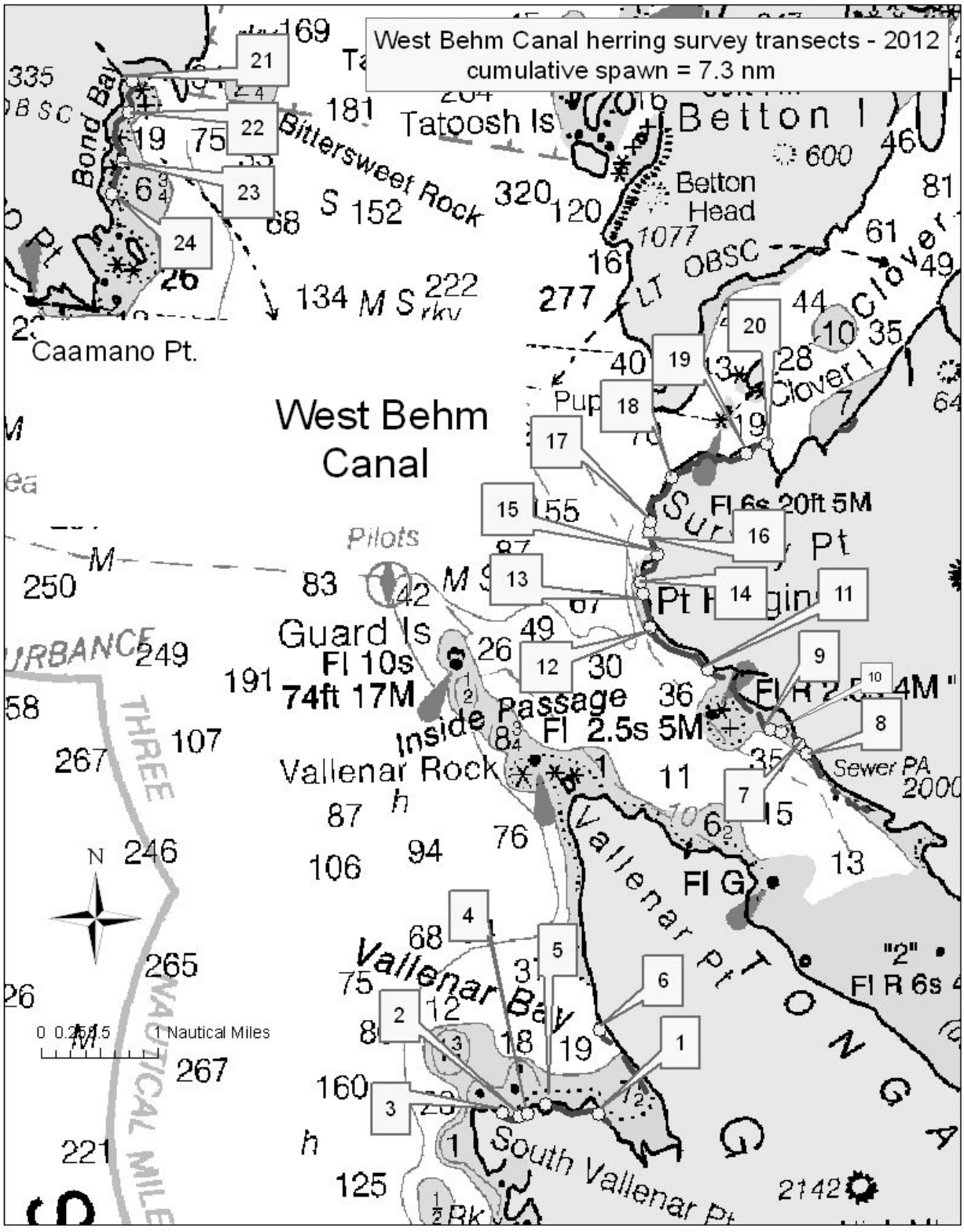
Appendix D4.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hoonah Sound herring stock in 2012.



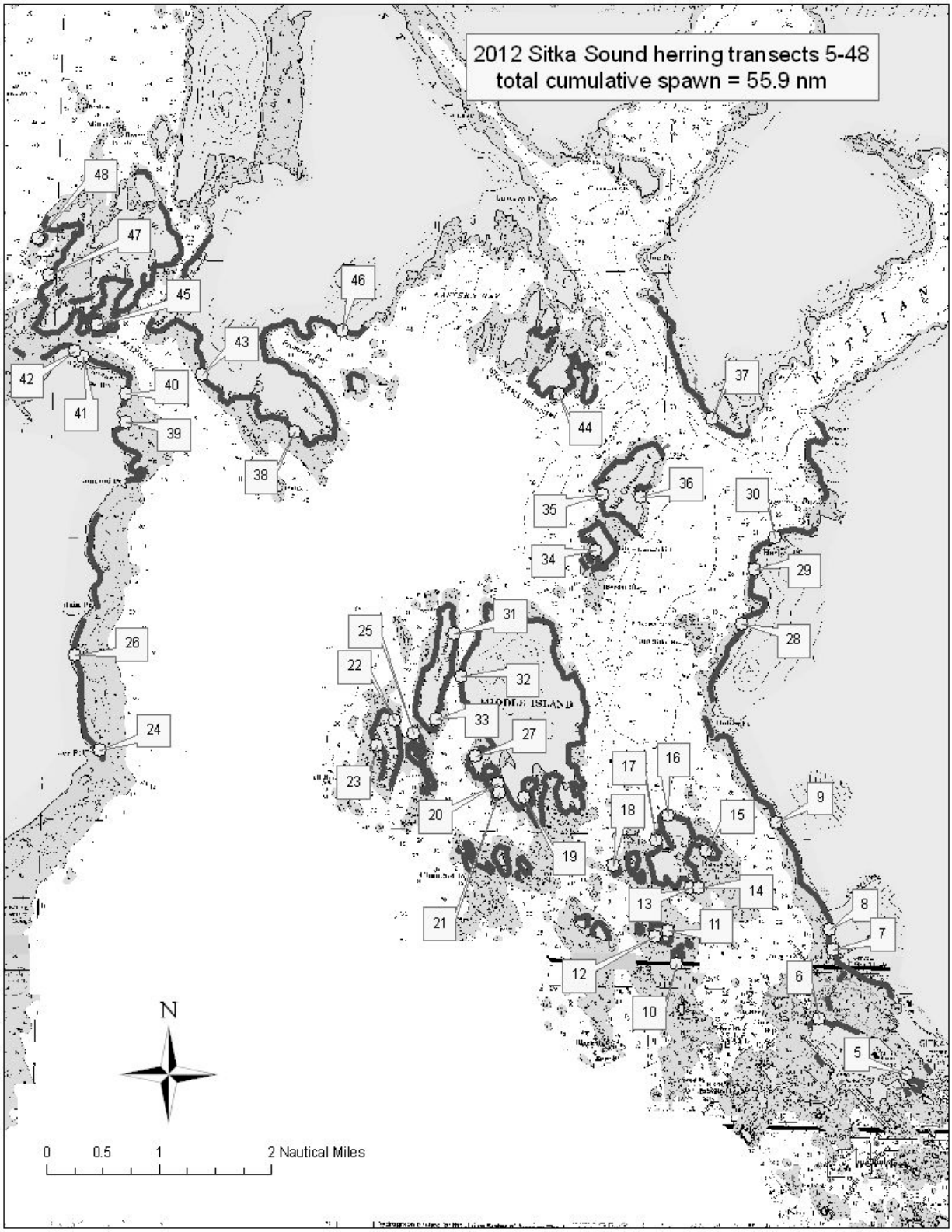
Appendix D5.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Seymour Canal herring stock in 2012.



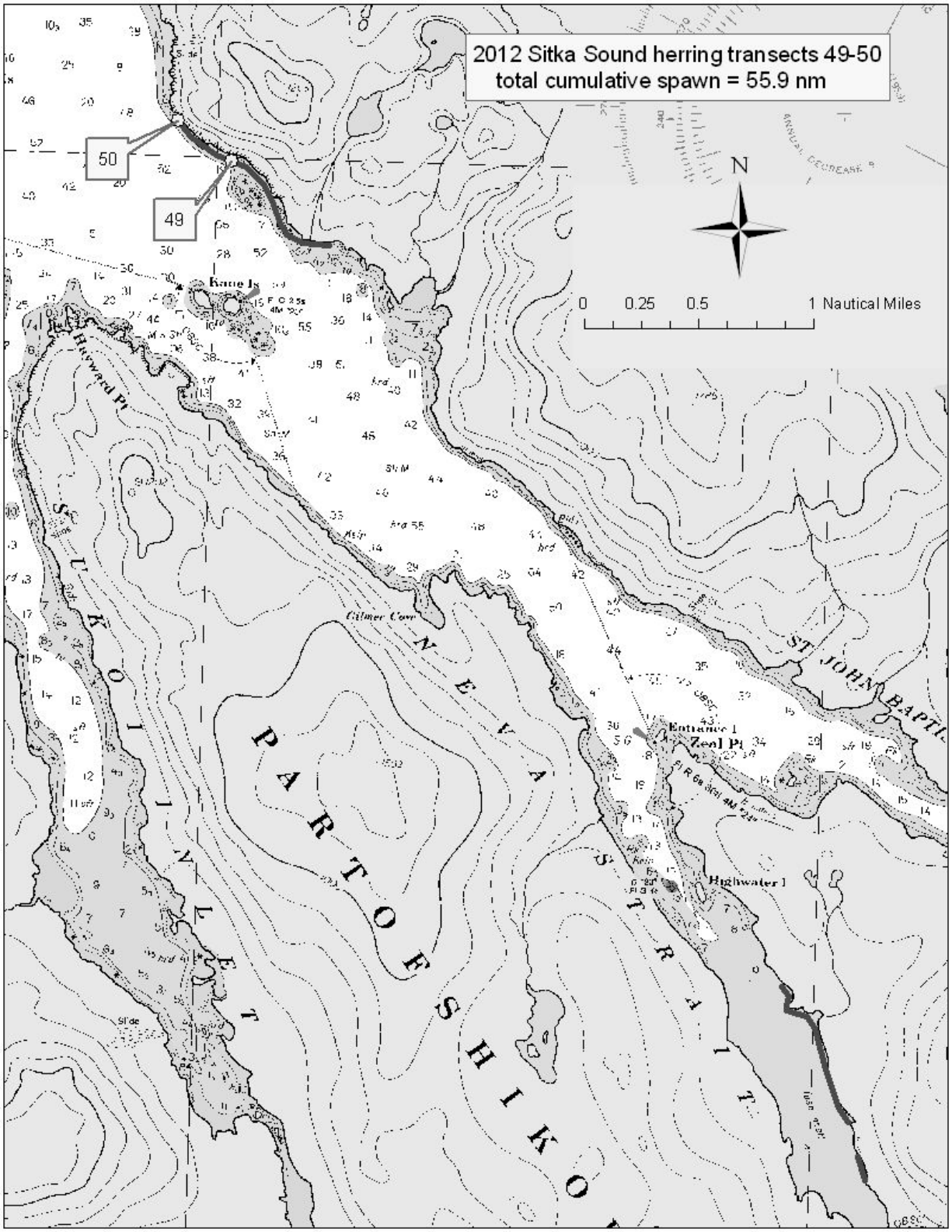
Appendix D6.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2012.



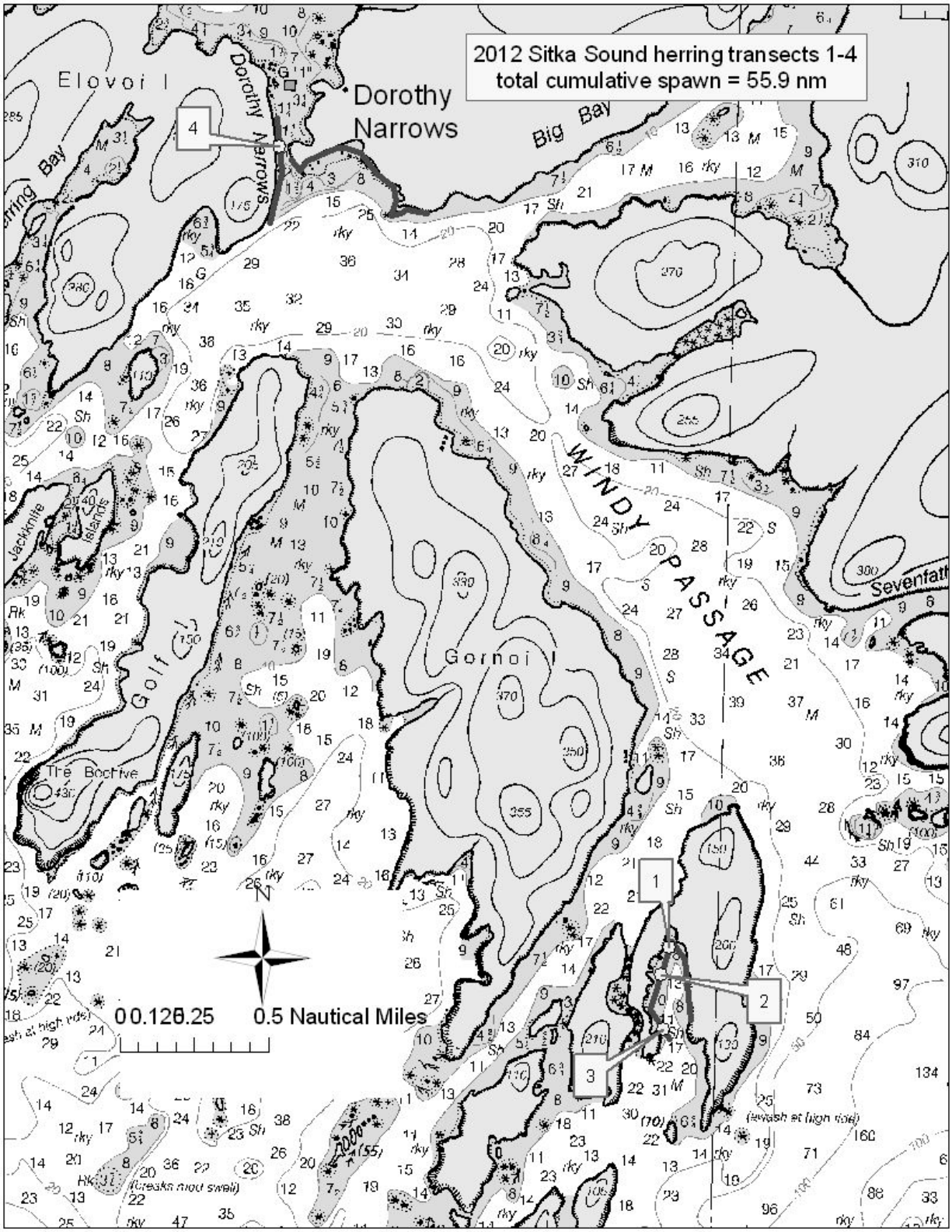
Appendix D7.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2012 (transects 5-48 only).



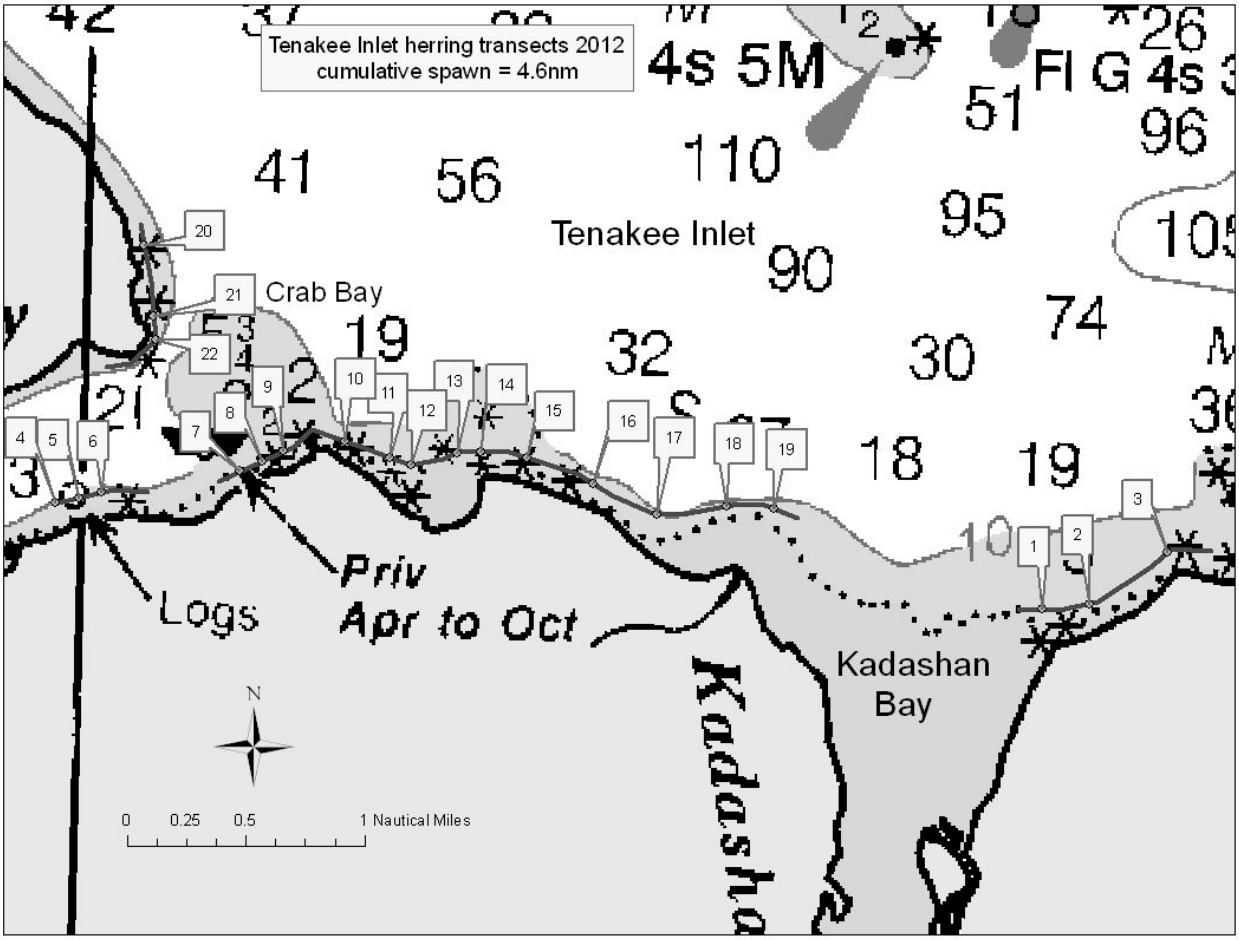
Appendix D8.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2012 (transects 49-50 only).



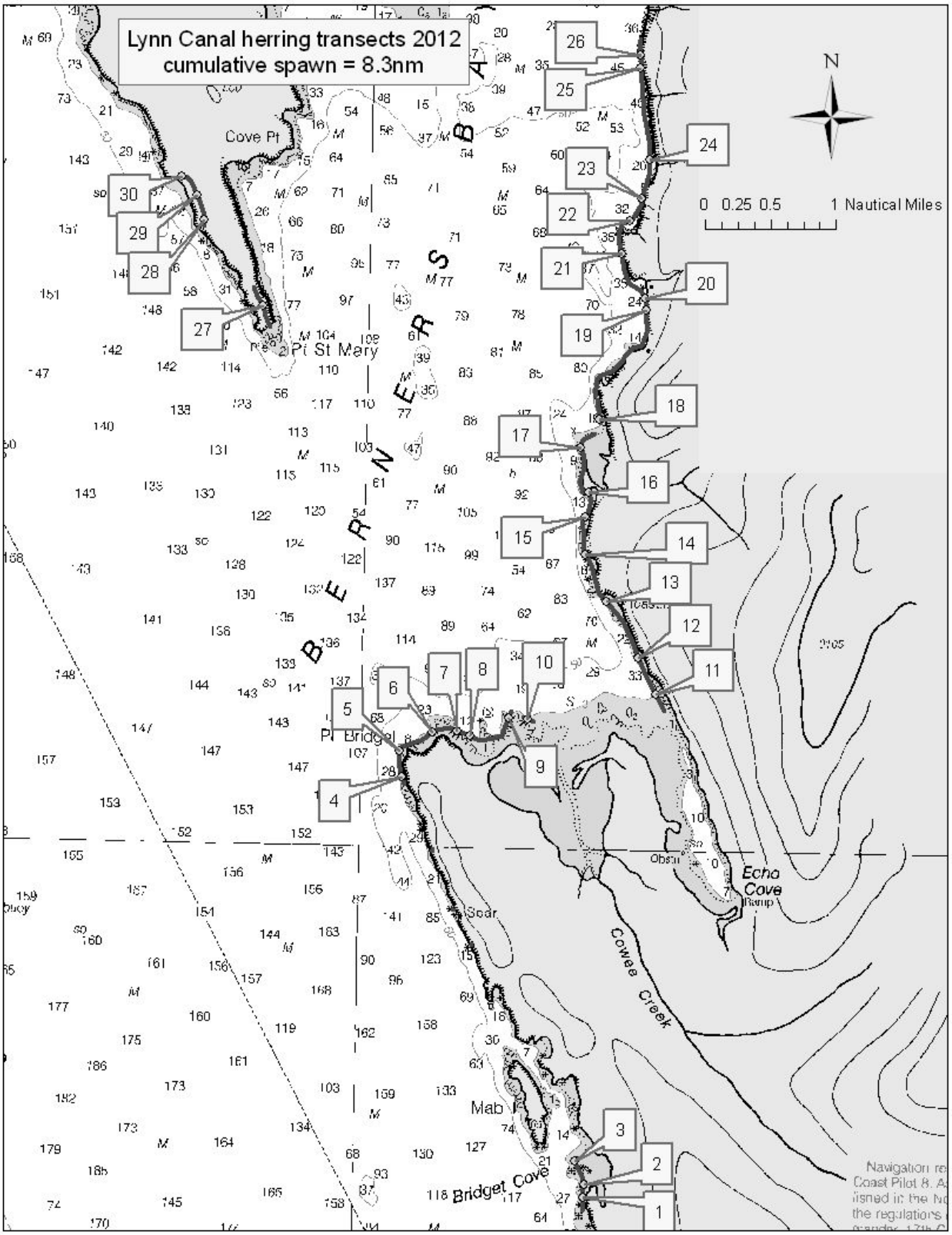
Appendix D9.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2012 (transects 1-4 only).



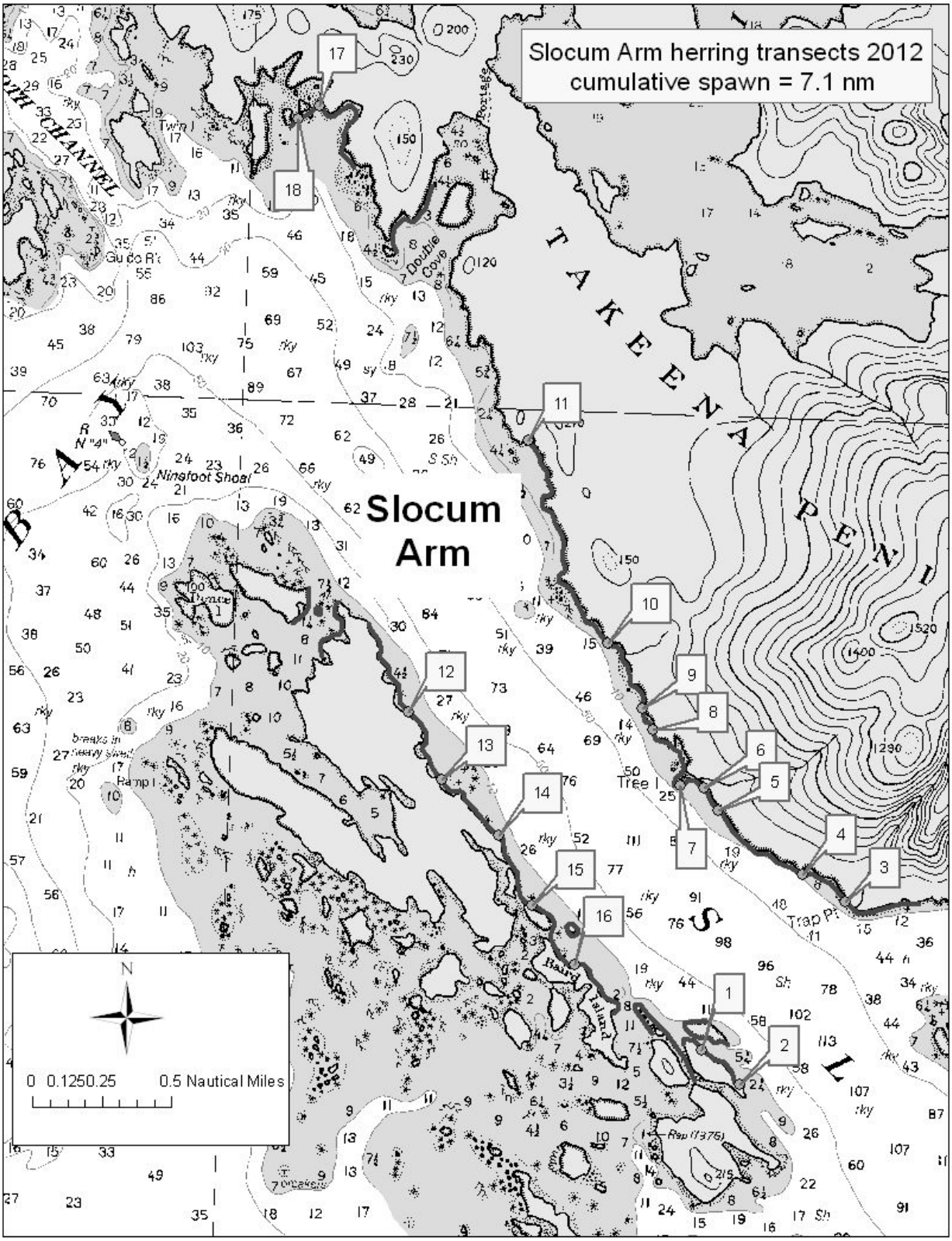
Appendix D10.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Tenakee Inlet herring stock in 2012.



Appendix D11.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Lynn Canal herring stock in 2012.



Appendix D12.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) in Slocum Arm in 2012.



Appendix D13.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) in Farragut Bay in 2012.