Fishery Data Series No. 12-46

Southeast Alaska 2010 Herring Stock Assessment Surveys

by

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September 2012

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, 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 REPORT NO. 12-46

SOUTHEAST ALASKA 2010 HERRING STOCK ASSESSMENT SURVEYS

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ABSTRACT

Pacific herring, *Clupea pallasii*, is important to many marine species found in Southeast Alaska and is also harvested in fisheries for commercial bait, commercial sac roe, commercial spawn-on-kelp, subsistence spawn-on-branches, subsistence spawn-on-kelp, personal use, and research/cost-recovery purposes. The *Southeast Alaska Herring Management Plan* (5 AAC 27.190.(3)) requires the Alaska Department of Fish and Game to assess the abundance of mature herring for each stock before allowing commercial harvest. This report reviews methods and results of herring stock assessment surveys and sampling completed primarily during 2010 in Southeast Alaska, 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 nine areas, including Sitka Sound, Seymour Canal, Craig, Hobart Bay-Port Houghton, Hoonah Sound, Ernest Sound, West Behm Canal, Tenakee Inlet, and Lynn Canal. In these areas, during 2010, a total of 167.7 nautical miles of spawn were mapped along shorelines. In 2010, post-fishery biomass estimates, combined for all stocks, totaled 185,024 tons, which was the second highest over the period 1980–2010.

Also included are summaries of commercial fisheries that occurred during the 2009–10 season. During the 2009–10 season, winter bait fisheries were open in Craig, Ernest Sound, Hobart-Houghton and Tenakee Inlet with guideline harvest levels totaling 2,381 tons. Gillnet sac-roe fisheries were open in Seymour Canal and Hobart-Houghton with guideline harvest levels totaling 1,002 tons. A purse seine sac-roe fishery was open in Sitka Sound with a guideline harvest level of 18,293 tons. Spawn-on-kelp fisheries were open in Craig, Hoonah Sound, and Tenakee Inlet. No commercial fisheries were opened in West Behm Canal, Kah Shakes/Cat Island, or Lynn Canal in 2009–10 due to below-threshold forecasts. Herring harvested commercially during the 2009–10 season totaled 19,635 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 stocks in Southeast Alaska. This project was developed in response to greater demands on the resource by the commercial bait and developing sac roe fisheries. The goal of the project is to provide the biological data necessary for the scientific management of the region's herring stocks.

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

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

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

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

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

METHODS AND PROCEDURES

AERIAL AND SKIFF SURVEYS

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

SPAWN DEPOSITION SURVEYS

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

Shoreline Measurement

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

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

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

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

sample the entire width of the spawn, without biasing the estimate. A second objective of measuring the spawn observed along shorelines is to obtain an estimate of spawn length, which factors into the estimate of overall spawn area, and is discussed more below.

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

Sample Size

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

The desirable number of transects is estimated as follows:

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

where,

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

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

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

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

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

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

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

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

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

Field Sampling

Transect direction was determined by comparing the dive location to a chart with the spawn shoreline, and setting a compass bearing perpendicular to the spawn shoreline. Transects began

at the highest point of the beach where eggs were observed and continued down to a depth in the sub tidal zone until no further egg deposition was observed, or to a maximum of 21 m (70 fsw) of depth. The portion of transects above the waterline were surveyed by walking until the water reached diving depth (usually 2 to 3 feet), at which point diving commenced. Dives were limited to 21 m because deeper dives severely limit total bottom time for SCUBA divers and pose safety risks when conducting repetitive dives over several days. All diving was conducted in compliance with procedures and guidelines outlined in the ADF&G Dive Safety Manual (Hebert 2006). Normally, little if any herring egg deposition occurs deeper than 21 m.

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

VISUAL ESTIMATE CORRECTION

Since visual estimates rather than actual counts of eggs within the sampling frame are recorded, measurement error occurs. To minimize bias and the influence of measurement error on estimates of egg deposition within each frame, estimator-specific correction coefficients were used to adjust egg estimates either up or down depending on an estimators tendency to underestimate or overestimate. Correction coefficients were estimated by double sampling (Jessen 1978) frames independent of those estimates obtained along regular spawn deposition transects. Samples for correction coefficients were collected by visually estimating the number of eggs within a 0.1m^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 2008, 2009, and 2010 were used if there were at least a total of six samples for each estimator and kelp type, with at least three samples in at least two of the three years. If this was not satisfied, then samples from prior years were added until the minimum sampling guideline was met. The intent of these sampling guidelines was to achieve a reasonably adequate sample size to minimize variation, but also to develop correction coefficients that reflected an estimator's tendency to estimate high or low in the most recent years.

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

ESTIMATES OF TOTAL EGG DEPOSITION

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

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

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

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

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

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

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

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

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

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

SPAWNING BIOMASS ESTIMATION

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

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

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

where,

b = estimated total spawning biomass;

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

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

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

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

where,

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

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

AGE AND SIZE

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

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

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

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

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

Aging Methods Drift

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

Condition Factor

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

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

where,

w = whole body wet weight in grams; and,

l = standard length in millimeters.

Sea Temperature

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

COMMERCIAL FISHERIES

During the 2009–10 season, several commercial herring fisheries were conducted in Southeast Alaska. Products resulting from these fisheries included food and bait, sac roe, and spawn on kelp. Threshold biomass levels have been established, which are intended to reduce the risk of sharp declines in abundance due to recruitment failure, and to maintain adequate herring abundance for predators. Commercial harvest of herring is not permitted unless the forecast of mature herring meets or exceeds the threshold. In Southeast Alaska, a threshold has been established for each herring stock supporting a commercial fishery. For Sitka Sound and West Behm Canal, threshold levels were based on 25% of estimated average unfished biomass (AUB) as determined through simulation models (Carlile 1998a; Carlile 2003). In the case of Sitka Sound, the threshold was subsequently increased by the Board of Fisheries on two occasions (1997 and 2009) to provide additional protection to help alleviate concerns about subsistence uses of the resource. For the Tenakee Inlet stock, 25% of AUB was estimated, however because the value was lower than the existing threshold of 3,000-tons, the existing threshold was retained (Carlile 1998b). For all other stocks in Southeast Alaska, thresholds were established after considering estimates of abundance, historical knowledge of stock size and distribution, and manageability of minimum quotas. Threshold levels during the 2009–10 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 2009–10 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 15, 2010 in Sitka Sound and ending on May 19, 2010 in Seymour Canal and Juneau areas. Notes of activity related to herring or herring spawning were recorded in logs, which are presented in Appendix C. Surveys were

conducted by staff in each area office (Ketchikan, Petersburg, Sitka, Juneau, Yakutat) and covered major and traditional herring spawning locations within each management area. Spawning timing for each major spawning area, including dates of first, last, and major spawning events, is summarized in Figure 2. Minor spawning areas, where spawn was observed during aerial or beach surveys, but where no spawn deposition survey were completed, included Bradfield Canal (15 nmi) and Port Frederick (3.0 nmi). Aerial surveys were conducted in other traditional spawning areas where spot spawns or no spawning was observed in 2010 (see Appendix C). The department documented about 9 nmi of herring spawn in Yakutat Bay in 2010, primarily around Knight Island. The department also documented a total of 7.7 nmi of herring spawn on Annette Island in 2010.

SPAWN DEPOSITION SURVEYS

In 2010, spawn deposition surveys were conducted in the Craig, Ernest Sound, Hobart Bay/Port Houghton, Hoonah Sound, Lynn Canal, Seymour Canal, Sitka Sound, Tenakee Inlet, and West Behm Canal. Surveys began in Craig on April 14, and were completed in Lynn 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 2010 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 2010 spawning stock abundance to prior years, estimates of spawning biomass are presented in Figures 3 to 8.

The total documented spawn for major spawning areas in Southeast Alaska in 2010 was 167.7 nmi (Table 5). This did not include spawning in minor spawning areas, or around Annette Island, or Yakutat (see Appendix C for a detailed accounting of minor spawn areas throughout Southeast Alaska).

Visual Estimate Correction

Minimum sample size guidelines (at least three samples per kelp type for the most recent three years) were met using data from 2008 through 2010 for most (6 of 7) estimators. For one estimator it was necessary to add data from 2006 to achieve the minimum sample guideline. Correction coefficients applied to 2010 spawn deposition visual estimates ranged from 0.821 to 1.876, and are presented in Table 6.

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

AGE AND SIZE

A combined total of 9,651 herring were sampled from all stocks and gear types (cast net, purse seine, pound, gillnet) during the 2009–10 season. Of these, 8,939 herring were processed to determine age, weight, length and sex. The reduction of sample size was due to fish that could not be aged due to regenerated or data was otherwise unusable. Most of this reduction was due to

scales that had not been re-aged yet at the time this report was published. Of the aged fish, only one was considered an outlier, and was removed from the analysis.

Samples of the spawning population were taken from Craig, Ernest Sound, Hobart Bay/Port Houghton, Hoonah Sound, Lynn Canal, Seymour Canal, Sitka Sound, Tenakee Inlet and West Behm Canal. Samples of the spawning population were collected throughout the geographic extent of the active spawn in most spawning areas (Figures 9-17). An exception in 2010 was Seymour Canal, where sample collection was concentrated in a narrow segment of shoreline, relative to the full shoreline that received spawn (Figure 14). For most spawning areas, collection of samples from the spawning population was also distributed throughout the duration of spawning, or was focused on the most intense spawning events (Figure 2). Two areas where this was not achieved in 2010 are Seymour Canal and Lynn Canal, where sampling was limited to a relatively narrow time window, relative to the full duration of spawning.

Samples were obtained from commercial fisheries for all areas where fisheries were conducted in 2009-10. Fisheries sampled included Craig winter bait, Craig spawn on kelp, Sitka sac roe, Sitka winter test fishery, Ernest Sound winter bait, Tenakee winter bait, Hoonah Sound spawn on kelp, Seymour Canal gillnet sac roe, and Hobart Bay/Port Houghton gillnet sac roe. Samples were obtained opportunistically from vessels or tenders, during or shortly after the fisheries. Sample locations during fisheries are also shown in Figures 9-17.

The minimum sample goal of 500 aged fish was met or exceeded in most cases (Tables 7 and 8). For two areas, Seymour Canal (cast net) and Ernest Sound (commercial purse seine), sample size fell below the minimum goal.

Age Composition

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

Upon completion of re-aging archived scales, a different pattern emerged in age compositions for all stocks than existed before re-aging. A primary difference was that substantial proportions of age-3 and age-4 herring were observed in cast net and commercial samples during 2009–10 (Tables 12-20; Figures 18-27), and during the period 2003–2010. It is now evident that age-3 and age-4 herring were present in the mature population and their apparent absence reported previously was due entirely to the drift of the scale reading method. When age compositions of re-aged data are plotted as a time series, cohorts are now relatively easy to follow through time, with age-3 proportions generally increasing at age-4 and then gradually decreasing with subsequent years (Figures 28-36). This is the expected progression, since between age-3 and age-4 more fish become mature than die from natural or fishery mortality, followed each year by fewer additions from maturation, but steady removals due to mortality. Prior to the scale re-aging

project, herring appeared to mature later in life, because although mature age-3 fish were not observed in samples, cohorts were clearly present in subsequent years. And, herring appeared to live considerably longer, well past age-8, than was observed in the past. Now it is clear from re-aged data that the absence of age-3 fish was a mistake and because ages of older fish were over estimated as well, the maturation rates and the survival rates that had been estimated prior to scale re-aging were incorrect as well.

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

Size-at-Age

Based on cast net samples in 2010, there is a clear distinction between mean weight-at-age for most age-classes for Sitka Sound spawning herring, and all other herring stocks in Southeast Alaska (Figure 42). The divergence between Sitka Sound herring weight-at-age and other stocks in the region increases with age. There also appears to be a difference in weight-at-age among major Southeast Alaska stocks other than Sitka Sound. Herring from some stocks appear to have consistently higher mean weights-at-age, across all ages, than others. Tests of significance were not performed as the primary intent of this report is to present 2010 data with general observations of trends and characterization of stocks.

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

Trends in weight-at-age are variable among stocks (Figures 44 to 52). 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-class increases. The exception is Sitka Sound, where weight-at-age has increased over the past 20 years.

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

To determine whether changes in weight-at-age have resulted from changes in length-at-age, or other reasons, condition factors were calculated for some stocks. Condition factors were calculated to index the physical dimensions of herring (i.e. weight-to-length ratio) over time, to roughly gauge herring health. Condition factors were calculated for Sitka Sound and Craig to compare fish condition in an area where weight-at-age has been increasing (Sitka) to an area where weight-at-age has been decreasing (Craig). Mean condition factors of herring in Sitka Sound appear to be stable or increasing over the period 1990–2010 (Figure 53), while mean condition factor in Craig has decreased over the period 1998–2010 (Figure 54).

Sitka Sound Winter Test Fishery

Winter sampling was conducted in Sitka Sound by the department in January 2010 using a purse seine. The purpose of the Sitka winter sampling was to provide data to update weight-at-age used to calculate the final 2010 forecast of the mature population. The Sitka winter test fishery does not cover a wide geographical area or sample from a large number of herring schools, and therefore is not expected to provide an accurate estimate of age composition. Using weight-at-age data from fish collected during the 2009 winter test fishery, the department issued a preliminary 2010 forecast and guideline harvest level for the Sitka Sound herring stock. The final forecast was calculated using 2010 winter test fishery data, which is believed to increase accuracy of forecasts. Department analysis has shown that using weight-at-age from the winter immediately preceding the spring of the forecast results in the most accurate forecasts (ADF&G unpublished data). The preliminary forecast and guideline harvest level of mature herring in Sitka Sound for 2010 was 94,332 tons and 18,866 tons, respectively. The final forecast and guideline harvest level, after updating with winter test fishery weight-at-age declined to 91,467 tons and 18,293 tons, respectively. The final forecast and guideline harvest level declined 3% from the preliminary estimates due to lower weight-at-age for age-6 and age-7 herring.

In retrospect, the weight at age data obtained from the 2009 and 2010 winter test fisheries were biased as a result of the aging errors that were discovered in November 2010 (see Methods). However, because aging methods did not shift substantially between 2009 and 2010, weight-at-age between the two years was probably comparable and the aging errors likely did not influence the change between preliminary and final forecasted biomass for 2010.

COMMERCIAL FISHERIES

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

Sac Roe Fisheries

Commercial sac roe fisheries were conducted in the Hobart Bay-Port Houghton, Sitka Sound, and Seymour Canal areas during 2010. There were no sac roe fisheries in the Kah Shakes/Cat Island, West Behm Canal, or Lynn Canal areas because spawning biomass was estimated to be below threshold.

Seymour Canal

The Seymour Canal commercial gillnet fishery opened April 24, 2010 at 2100 hours and closed on April 25, 2010 at 0500 hours. Sixty-three permit holders participated in the fishery harvesting 710 tons.

Hobart Bay-Port Houghton

The Hobart Bay commercial set net sac roe fishery was opened for two fishing periods, opening on April 23, 2010 at 0930 hours and closing on April 23 at 2130 hours, then reopening on April 24 at 0730 hours and closing April 24, 2010 at 1130 hours. The total harvest was 302 tons.

Sitka Sound

The Guideline Harvest Level (GHL) was achieved with four competitive openings, ranging from 1 hour, 25 minutes to 2 hours, 55 minutes in duration. The first opening (1 hour, 25 minutes), occurred March 24 in the Gavanski Islands area; approximately 6,414 tons of herring were harvested with about 12.9% roe by weight. The second opening (2 hours, 55 minutes) occurred on March 27 in the Siginaka/Gavanski Islands area; about 3,362 tons were harvested with roe percentage about 12.5%. The third opening (2 hours, 40 minutes) occurred on March 30 near Old Sitka Rocks; about 4,181 tons were harvested with roe percentage of 12.4%. The fourth and final opening (2 hours, 16 minutes) occurred on April 2 in Eastern Channel; about 3,917 tons were harvested with roe percentage of 11.9%. The total harvest was 17,602 tons.

Winter Bait Fisheries

Winter food and bait fisheries were opened near Craig, Hobart Bay/Port Houghton, Ernest Sound, and Tenakee Inlet. All four areas were opened on December 9, 2009. The Ernest Sound area was closed by emergency order on January 12, 2010 and all other areas closed by regulation on February 28, 2010. Hobart Bay/Port Houghton was the only area where no harvest occurred.

Spawn-on-Kelp Pound Fisheries

Three areas were open to the commercial harvest of spawn on kelp (SOK) during the 2009–10 season: Hoonah Sound, Craig, and Tenakee Inlet. There was harvest only from Hoonah Sound and Craig and there was no participation in Tenakee Inlet.

Hoonah Sound

A total of 100 closed pounds were actively fished, of which 97 were single-permit pounds, 2 were double-permit pounds, and one was an experimental pound. About 290 tons of SOK was harvested.

Tenakee Inlet

The GHL permitted a fishery for open pounds only; however there was no participation and no SOK harvest.

Craig

A total of 63 closed pounds were actively fished, of which 19 were single-permit, and 44 were double-permit pounds. About 117 tons of SOK were harvested.

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2009–10 season, no herring were harvested for fresh bait pounds or tray-pack in Southeast Alaska.

Test Fisheries

The one herring test fishery conducted in Southeast Alaska during the 2009–10 season was in Sitka Sound, for bait, using purse seine gear during January, 2010. A total of 55 tons were harvested on January 22, 2010. The department obtained samples from the catch to update weight-at-age for the 2010 Sitka Sound area final forecast.

DISCUSSION

Spawn Deposition

Spawning population biomass estimates, as calculated from spawn deposition estimates, increased between 2009 and 2010 for seven of nine stocks that were surveyed in Southeast Alaska. In three areas the increases from were substantial. These areas include West Behm Canal, Seymour Canal, and Lynn Canal. Although error surrounding biomass estimates was not calculated, the magnitudes of these increases were large and likely reflect actual changes of the spawning population levels. In other areas modest increases were observed or spawning biomass did not change appreciably from 2009. These areas included Sitka Sound, Craig, Hoonah Sound, and Ernest Sound. Based on the magnitude of change in these areas, it is less clear whether the apparent increase in biomass reflects an actual change in the population, because estimates are likely within the probable error range surrounding the estimates.

Tenakee Inlet and Hobart Bay/Port Houghton were the only spawning areas where estimates of spawning biomass declined from 2009. The decline was relatively substantial in Tenakee Inlet. In fact, the spawn deposition-derived estimate of spawning biomass was the second lowest on record. Historically, large fluctuations of the spawning population level have been observed in Tenakee. In Hobart Bay/Port Houghton, the decline in estimated spawning biomass was severe. The 2010 estimate of 299 tons was the lowest on record and follows three years of relatively high estimates of spawning biomass. The magnitude of the decline suggests a true change in the population; however the magnitude of the decline is probably too great to attribute solely to natural mortality and fishing mortality. One possible explanation for the change is that in 2010 some herring from the Hobart Bay/Port Houghton area spawned in the Seymour Canal area, which is in close geographical proximity. Although there is no direct evidence to confirm such a shift, there is some circumstantial evidence. For example, in 2010 the Seymour Canal estimated spawning biomass more than doubled relative to 2009, which is an unexpectedly large increase barring a very large recruitment event, which was not apparent in Seymour Canal. Additionally, the estimated age composition of the Seymour Canal spawning population was very similar to the Hobart Bay/Port Houghton spawning population, suggesting that the same body of fish may have spawned in both areas.

It is unknown whether the changes in estimated spawning biomass over the past year are primarily due to population fluctuations, or a function of estimate variation, or both. Although error estimates were not calculated for spawn deposition estimates, it is possible that large fluctuations in estimates were due in part to variability. Therefore, estimates of spawning biomass presented in this report, which are based primarily on egg deposition estimates (as

opposed to model-derived results), are useful for providing a general view of trends in stock size but should not necessarily be considered the most accurate estimate of stock size in any given year. For all major herring stocks in Southeast Alaska, the results of ASA or biomass accounting models are considered to provide a more accurate estimate of spawning biomass. A primary reason that the ASA model is considered to be more appropriate when fully evaluating stocks is that it incorporates other sources of data (primarily age composition), and combines a long time series of data to estimate spawning biomass, whereas spawn deposition-derived estimates rely on a single year of spawn deposition data. An advantage of using biomass estimates derived from spawn deposition is that they provide a consistent time series with fixed historical values, unlike ASA model derived hind cast estimates, which change with each model run.

The general trend for herring biomass in Southeast Alaska, based on spawn deposition estimates, is slightly increasing over the period 1980–2010 (Figure 8). This is true whether or not the largest stock in the region, Sitka Sound, is included. Biomass estimates from 2010 are 102% and 53% higher than the long-term average (1980–2009) for all stocks combined, and for all stocks combined except Sitka Sound, respectively. The general trend of spawning stock size for most spawning areas where data is available in Southeast Alaska is either increasing or stable (Figures 3 to 7). An exception 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 2010 suggest that abundance of herring in Southeast Alaska is at a high level relative to the period 1980–2009.

Age Composition

Re-aging scales collected during the period 1999–2010 has substantially changed the estimated age composition for the region's herring stocks. Whereas prior to the re-aging of scales, herring appeared to begin maturing at age-4 or older and surviving until 13–14 years of age, after the re-aging of scales, herring appear to begin maturing at age-3 and surviving to about 10–11 years of age. These results are more aligned with historical patterns observed for herring age composition in Southeast, in other regions of Alaska, and along the west coast of North America.

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

Recruitment of mature age-3 herring may be connected to the latitude of the spawning stock. There appears to be a break between two categories of median age-3 recruitment among stocks: 17–26% for stocks south of latitude 56 degrees (Craig, West Behm Canal, Ernest Sound, and Kah Shakes), and 5–12% for stocks at 57 degrees and northward (Sitka, Hobart Bay, Seymour Canal, Hoonah Sound, Tenakee Inlet, and Lynn Canal). Not surprisingly, the north-south

delineation appears related to sea temperature, which decreases with increasing latitude. Age-3 median recruitment is generally highest where mean annual temperature and mean minimum temperature are highest; however since the correlation is weak, other factors linked to latitude may play a role as well. Interestingly, the mean maximum sea temperature appears to have a non-linear relationship to median age-3 recruitment. This relationship suggests that an optimal maximum sea temperature exists around 14.5 C and at higher or lower sea temperature, the median proportion of mature age-3 herring is less. It is beyond the scope of this report to further explore whether an actual relationship exists between recruitment success and sea temperature, or biological explanations of such a relationship; however the patterns in the data are suggestive enough to warrant additional investigation.

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REFERENCES CITED

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

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

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

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

Carls, M.G. and S.D. Rice. 2007. Prince William Sound Herring: An Updated Synthesis of Population Declines and Lack of Recovery. Exxon Valdez Oil Spill Restoration Project 050794 Final Report, Chapter 3.

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

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

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

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

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

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

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

Oxman, D.S. and D. Buettner. *In prep*. 2012. Southeast Alaska Pacific herring *Clupea pallasii* 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 2010 herring spawn deposition surveys.

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

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

Table 2.–Fecundity relationships used for estimating 2010 herring spawning biomass for stocks in Southeast Alaska.

Sampling year	Stock sampled	Fecundity equation	Stocks to which Fecundity Equation was applied in 2010
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 2010 herring spawn deposition surveys conducted in Southeast Alaska.

Survey area	Survey Leg	Survey Dates
Craig	I	April 14–15
Sitka Sound	I	April 16– 19
West Behm Canal	I	April 20
Ernest Sound	I	April 22
Hobart Bay/Port Houghton	II	May 5–6
Seymour Canal	II	May 7–8
Hoonah Sound	II	May 9–10
Tenakee Inlet	II	May 11
Lynn Canal	II	May 12–13

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

	Craig		Ernest Sound		Hobart/Houghton		Hoonah Sound		Seymour Canal		Sitka Sound		Tenakee Inlet		West Behm		Lynn Canal	
Transect Number	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count	egg estimate	frame count
1	308	62	0	0	3	1	347	32	2,209	74	421	35	16	2	727	61	0	0
2	0	0	403	34	50	13	403	50	4,051	96	1,132	60	581	39	94	9	6	2
3	83	12	27	5	6	1	512	47	1,158	28	1	0	1,231	22	1,667	104	1,335	191
4	80	16	49	3	41	5	30	4	1,091	32	1,318	57	715	28	82	12	264	53
5	497	83	518	43	154	6	848	45	3,226	75	1,098	92	13	7	21	7	23	6
6	424	15	605	34	76	4	476	30	3	1	1,416	62	1,348	43	450	56	257	37
7	284	36	1,690	53	23	1	1,980	82	39	4	0	0	135	12	122	14	1,616	44
8	631	49	151	25	118	11	477	10	303	76	475	53	249	12	0	0	266	33
9	2,318	77	249	31	114	8	1,553	55	1,348	42	553	69	37	9	0	0	328	55
10	1,132	71	281	70	111	11	4,270	59	179	30	0	0	69	17	815	43	446	56
11	3,896	195	451	56	10	2	8	2	194	39	0	0	197	15	54	7	54	13
12	1,623	95	1,274	127	100	7	556	23	44	6	9,237	298	22	7	208	21	417	26
13	2,591	118	65	11	64	7	262	17	1,867	62	246	35	579	20	3,188	128	1,501	24
14	107	27	115	29	487	14	249	10	135	6	4,961	124	242	40	723	36	919	51
15	127	18	313	39	53	2	80	8	132	15	177	25	637	58	11	3	5,063	281
16	1,952	85	40	8	159	12	25	3	367	23	0	0	61	15	0	0	202	29
17	1,636	56	336	15	19	5	1	0	65	7	773	16	476	43	77	19	900	82
18	270	27	459	66	52	6	2,374	91	229	18	819	43	331	47	111	19	423	47
19	0	0	395	66	44	2	3,716	74	3	0	2,947	105			739	46	189	27
20	105	21	190	38	0	0	362	36	0	0					818	164	1,354	25
21	0	0	53	13	0	0	762	32	0	0	1,431	130			291	48	0	0
22	0	0	537	49	54	8			255	16	1,342	89			116	11	47	9
23	0	0	106	15					778	86	866	79			245	41	0	0
24	139	10	636	58					379	24	3,869	176			163	27	0	0
25	1,105	74	203	41					697	22	717	42			227	57		
26	1,073	36	684	38					319	13	1,928	96			148	25		
27	0	0	71	8					2,077	59	848	94			127	18		
28	4,773	136	0	0					2,130	82	862	96						
29	0	0							289	22	3,838	56						
30	171	17							165	17	1,421	102						
31	1,123	42									2,695	159						
32	55	11									67	17						
33	179	22									223	37						
34	0	0									392	56						
35											23	2						
36											774	97						
37											260	32						
38											456	51						

-continued-

Table 4.-Page 2 of 2.

Transect Number	Craig egg estimate	Craig frame count	Ernest Sound egg estimate	Ernest Sound frame count	Hobart/Houghton egg estimate	Hobart/Houghton frame count	Hoonah Sound egg estimate	Hoonah Sound frame count	Seymour Canal egg estimate	Seymour Canal frame count	Sitka Sound egg estimate	Sitka Sound frame count	Tenakee Inlet egg estimate	Tenakee Inlet frame count	West Behm egg estimate	West Behm frame count	Lynn Canal egg estimate	Lynn Canal frame count
39											878	44						
40											328	41						
41											1,169	90						
42											272	39						
43											128	32						
44											635	58						
45											783	46						
46											881	68						
47											185	23						
48											98	11						
49											248	25						
Average	785	41	354	35	79	6	919	34	791	33	1,108	62	385	24	416	36	650	45

Table 5.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2010.

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	2010 escapement (tons)
Craig	34	60	18.7	2,077,944	653,995	1.510	84.4	16,665	181,215,046	16,851
Ernest Sound	28	46	7.8	670,689	380,846	0.284	63.9	11,595	48,952,312	3,446
Hobart/Houghton	22	65	3.9	466,199	61,213	0.032	84.5	17,215	3,211,569	299
Hoonah Sound	21	106	12.3	2,413,553	433,476	1.162	108.0	18,434	126,118,407	15,013
Seymour Canal	30	91	10.4	1,759,153	433,096	0.847	78.4	15,853	106,795,066	9,224
Sitka Sound	48	71	87.7	11,470,941	784,557	10.000	139.4	24,680	810,338,054	124,526
Tenakee Inlet	18	72	2.7	361,140	266,857	0.107	119.9	20,795	10,298,843	1,361
West Behm Canal	27	44	15.9	1,281,481	477,664	0.680	60.5	10,913	124,645,850	8,310
Lynn Canal	24	63	8.3	967,130	516,933	0.555	87.0	17,769	62,524,149	5,994
Total	252	--	167.7	21,468,229	--	15.177	--		1,474,099,296	185,024
Average	28	69	--	2,385,359	445,404	1.686	91.8	17,102	--	--

Table 6.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2010. Data was combined for years 2008 through 2010 unless otherwise noted.

	Estimator initials							
Kelp type	**BM**	**DG**	**JM**	**KH**	**SD**	**TT**	**SW[a]**	**Average**
Eelgrass	1.222	0.853	1.156	0.891	1.170	1.337	1.436	1.152
n =	10	19	23	22	23	15	6	
Fucus	1.527	1.116	0.946	1.073	1.341	1.511	1.739	1.322
n =	7	19	19	14	12	15	6	
Fir kelp	0.821	1.048	1.053	0.771	1.210	0.914	1.418	1.034
n =	9	18	22	13	13	13	8	
Hair kelp	1.080	1.027	1.133	0.876	1.055	1.099	1.495	1.109
n =	8	16	24	17	17	14	10	
Large brown kelp[b]	0.946	1.265	0.986	1.578	1.564	1.837	1.876	1.436
n =	6	18	24	18	18	12	10	
Average[c]	1.119	1.062	1.055	1.038	1.268	1.339	1.593	

[a] Data from years 2008 and 2010 except eelgrass was 2006 and 2010.

[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 2009–10.

	Commercial fishery			Survey	Test Fishery	
Stock	**Herring gillnet**	**Pound**	**Purse seine**	**Cast net**	**Purse seine**	**Total**
Craig	—	543	432	562	—	1,537
Ernest Sound	—	—	550	556	—	1,106
Hobart/Houghton	562	—	—	553	—	1,115
Hoonah Sound	—	559	—	557	—	1,116
Lynn Canal	—	—	—	557	—	557
Seymour Canal	556	—	—	371	—	927
Sitka Sound	—	—	559	553	524	1,636
Tenakee Inlet	—	—	550	551	—	1,101
West Behm Canal	—	—	—	556	—	556
Total	1,118	1,661	1,532	4,816	524	9,651

Table 8.–Summary herring samples aged for Southeast Alaska stocks in 2009–10. DNA signifies that data is not available due to scale re-aging in progress.

	Commercial fishery			Survey	Test Fishery	
Stock	**Herring gillnet**	**Pound**	**Purse seine**	**Cast net**	**Purse seine**	**Total**
Craig	—	537	423	539	—	1,499
Ernest Sound	—	—	528	550	—	1,078
Hobart/Houghton	558	—	—	550	—	1,108
Hoonah Sound	—	558	—	545	—	1,103
Lynn Canal	—	—	—	489	—	489
Seymour Canal	550	—	—	371	—	921
Sitka Sound	—	—	548	549	DNA	1,097
Tenakee Inlet	—	—	541	550	—	1,091
West Behm Canal	—	—	—	553	—	553
Total	1,108	1,095	2,040	4,696	0	8,939

Table 9.–Proportion of mature age-3 herring (cast net, 1988-2010), latitude and mean sea temperature of herring spawning stocks in Southeast Alaska.

Stock	**Latitude (decimal degrees)**	**Median proportion of mature age-3 herring**	**Mean proportion of mature age-3 herring**	**Mean annual sea temperature (^{0}C)**	**Mean minimum annual sea temperature (^{0}C)**	**Mean maximum annual sea temperature (^{0}C)**
Kah Shakes	55.0300	21%	27%	8.6	5.9	14.7
Craig	55.4770	17%	22%	9.0	4.7	14.1
WBC	55.4846	26%	30%	8.8	5.3	14.3
Ernest Sound	55.8307	25%	29%	—	—	—
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	8%	15%	7.9	2.0	15.0
Tenakee Inlet	57.7381	11%	11%	7.8	1.9	15.0
Lynn Canal	58.6402	12%	16%	7.1	2.6	15.4

Table 10.–Summary of Southeast Alaska herring target levels for the 2009–10 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target Exploitation Rate (%)	Guideline harvest level (tons)[a]
Craig	5,000	14,870	13.9	2,074
Ernest Sound	2,500	2,879	10.3	297
Hobart Bay/Port Houghton	2,000	3,110	11.1	345
Hoonah Sound	1,000	15,912	20.0	3,182
Seymour Canal	3,000	5,602	11.7	657
Sitka Sound	25,000	91,467	20.0	18,293
Tenakee Inlet	3,000	5,109	11.4	583
West Behm Canal	6,000	3,805	0.0	0
Lynn Canal	5,000	—	0.0	0
Kah Shakes	6,000	—	0.0	0

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

Table 11.–Summary of commercial herring harvest during the 2009–10 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	1–Dec–09	28–Feb–10	121
Winter food and bait	Purse seine	Tenakee Inlet	12	1–Dec–09	16–Feb–10	
Winter food and bait	Purse seine	Ernest Sound	7	1–Dec–09	12–Jan–10	
Winter food and bait	Purse seine	Hobart Bay	10	1–Dec–09	28–Feb–10	0
Sub-total						1,021
Sac roe	Purse seine	Sitka Sound	13	24–Mar–10	2–Apr–10	17,602
Sac roe	Purse seine	Lynn Canal	11	Not Open		--
Sac roe	Gillnet	Seymour Canal	11	24–Apr–10	25–Apr–10	710
Sac roe	Gillnet	Hobart Bay	10	23–Apr–10	24–Apr–10	302
Sac roe	Gillnet	Kah Shakes	1	Not Open		--
Sac roe	Gillnet	West Behm Canal	1	Not Open		--
Sub-total						18,614
Spawn on kelp	Pound	Hoonah Sound	13	21–Apr–10	28–Apr–10	290
Spawn on kelp	Pound	Tenakee Inlet[d]	12	--	--	0
Spawn on kelp	Pound	Ernest Sound	7	Not Open		--
Spawn on kelp	Pound	Craig	3	5–Apr–10	16–Apr–10	117
Sub-total						407
Test fishery - bait	Purse seine	Sitka	13	22–Jan–10	22–Jan–10	55.0

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

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

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

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

Table 12.–Summary of age, weight, and length for the Sitka Sound herring stock in 2009–10.

		Age Category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	47	113	180	108	40	61	549
	percent age composition	9%	21%	33%	20%	7%	11%	100%
	average weight (g)	69.1	94.4	124.0	142.0	154.4	183.7	125.6
	standard dev. of weight (g)	11.2	21.2	24.1	29.6	34.7	37.2	40.8
	average length (mm)	175.9	193	209	218	223	237	209
	variance of length (mm)	72.3	161	149	137	186	115	407
commercial purse seine–spring	number of fish	83	111	155	89	39	71	548
	percent age composition	15%	20%	28%	16%	7%	13%	100%
	average weight (g)	78.4	101.7	144.1	165.5	187.9	209.3	140.6
	standard dev. of weight (g)	14.7	22.4	26.4	31.1	32.1	33.3	49.7
	average length (mm)	179.1	192	213	222	232	239	210
	variance of length (mm)	92.0	145	138	137	80	183	507
test fishery purse seine–winter	number of fish	DATA NOT AVAILABLE						
	percent age composition							
	average weight (g)							
	standard dev. of weight (g)							
	average length (mm)							
	variance of length (mm)							

Table 13.–Summary of age, weight, and length for the Craig herring stock in 2009–10.

		Age Category						
Gear type/season	**parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	155	168	76	98	22	20	539
	percent age composition	29%	31%	14%	18%	4%	4%	100%
	average weight (g)	61.2	76.6	88.4	97.6	112.6	118.4	80.7
	standard dev. of weight (g)	15.2	16.3	17.0	19.7	17.9	29.2	23.9
	average length (mm)	167.3	181	189	195	204	205	183
	variance of length (mm)	114.2	96	102	80	146	277	245
commercial pound–spring	number of fish	88	214	55	113	37	36	543
	percent age composition	16%	39%	10%	21%	7%	7%	100%
	average weight (g)	61.7	84.3	101.9	106.4	117.5	133.6	92.5
	standard dev. of weight (g)	12.7	15.8	18.4	18.2	22.8	25.9	26.3
	average length (mm)	167.1	183	193	196	202	211	187
	variance of length (mm)	70.5	82	84	79	120	182	234
commercial seine–winter	number of fish	106	158	70	112	49	30	525
	percent age composition	20%	30%	13%	21%	9%	6%	100%
	average weight (g)	64.6	85.0	98.8	109.8	122.3	138.0	94.5
	standard dev. of weight (g)	12.5	14.8	20.6	17.1	17.0	23.4	26.7
	average length (mm)	168.6	183	191	197	206	216	188
	variance of length (mm)	93.1	91	148	83	89	137	277

Table 14.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2009–10.

		Age Category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	6	38	119	305	66	16	550
	percent age composition	1%	7%	22%	55%	12%	3%	100%
	average weight (g)	47.3	71.0	79.5	85.7	92.3	113.5	84.0
	standard dev. of weight (g)	10.5	15.9	16.7	15.7	19.2	22.1	18.0
	average length (mm)	151.2	175	182	187	191	201	185
	variance of length (mm)	96.2	122	134	97	136	108	145
commercial gillnet–spring	number of fish	0	9	85	345	107	12	558
	percent age composition	0%	2%	15%	62%	19%	2%	100%
	average weight (g)	0.0	97.6	106.9	111.1	116.3	131.5	111.0
	standard dev. of weight (g)	0.0	9.9	10.6	10.4	13.5	15.1	12.0
	average length (mm)	0.0	189	195	198	201	211	198
	variance of length (mm)	0.0	42	45	34	54	98	48

Table 15.–Summary of age, weight, and length for the Ernest Sound herring stock in 2009–10.

		Age Category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	337	56	27	98	21	11	550
	percent age composition	61%	10%	5%	18%	4%	2%	100%
	average weight (g)	45.0	54.9	66.5	70.6	75.3	79.5	53.5
	standard dev. of weight (g)	7.8	13.0	10.5	12.5	15.1	15.1	15.4
	average length (mm)	152.8	162	174	176	179	180	161
	variance of length (mm)	48.7	106	71	59	86	106	170
commercial seine–winter	number of fish	342	53	26	83	16	8	528
	percent age composition	65%	10%	5%	16%	3%	2%	100%
	average weight (g)	51.2	65.8	86.7	89.5	99.0	104.3	62.0
	standard dev. of weight (g)	8.3	15.9	18.7	14.0	25.2	23.7	21.0
	average length (mm)	153.6	165	180	182	187	189	161
	variance of length (mm)	58.2	155	148	74	245	211	251

Table 16.–Summary of age, weight, and length for the Hoonah Sound herring stock in 2009–10.

		Age Category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	24	46	227	179	52	17	545
	percent age composition	4%	8%	42%	33%	10%	3%	100%
	average weight (g)	64.8	86.0	99.4	109.0	123.9	129.6	103.2
	standard dev. of weight (g)	13.9	16.4	15.4	19.5	18.9	17.6	21.6
	average length (mm)	170.8	187	194	199	206	214	196
	variance of length (mm)	133.0	96	55	72	67	85	128
commercial pound–spring	number of fish	58	67	245	127	50	11	558
	percent age composition	10%	12%	44%	23%	9%	2%	100%
	average weight (g)	69.0	86.4	103.2	116.6	130.4	154.2	104.0
	standard dev. of weight (g)	13.0	12.8	16.2	20.5	18.9	19.3	24.0
	average length (mm)	171.3	183	191	197	204	214	191
	variance of length (mm)	82.9	51	59	99	64	70	152

Table 17.–Summary of age, weight, and length for the Tenakee Inlet herring stock in 2009–10.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	60	54	191	167	54	24	550
	percent age composition	11%	10%	35%	30%	10%	4%	100%
	average weight (g)	62.6	80.0	86.7	92.5	104.2	118.1	88.3
	standard dev. of weight (g)	10.1	13.1	15.9	14.3	20.2	21.3	19.6
	average length (mm)	168.1	181	185	190	197	207	187
	variance of length (mm)	78.6	71	65	72	116	157	151
commercial seine–winter	number of fish	40	59	195	171	54	22	541
	percent age composition	7%	11%	36%	32%	10%	4%	100%
	average weight (g)	72.2	95.0	106.5	119.2	131.4	148.8	110.9
	standard dev. of weight (g)	11.8	15.4	15.3	19.8	23.4	29.5	24.5
	average length (mm)	177.3	191	197	203	209	218	199
	variance of length (mm)	68.0	81	63	99	126	172	158

Table 18.–Summary of age, weight, and length for the Seymour Canal herring stock in 2009–10.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	23	33	118	130	39	28	371
	percent age composition	6%	9%	32%	35%	11%	8%	100%
	average weight (g)	50.5	67.0	76.2	80.4	82.9	107.8	78.4
	standard dev. of weight (g)	18.9	16.6	16.6	17.7	22.5	19.6	21.2
	average length (mm)	154.0	170	176	178	180	194	177
	variance of length (mm)	206.6	196	103	110	159	101	186
commercial gillnet–spring	number of fish		8	136	242	85	79	550
	percent age composition	0%	1%	25%	44%	15%	14%	100%
	average weight (g)		109.7	113.0	116.3	118.4	124.4	116.9
	standard dev. of weight (g)		6.7	11.9	13.2	13.6	12.7	13.3
	average length (mm)		191	194	196	199	202	197
	variance of length (mm)		20	43	48	53	38	52

Table 19.–Summary of age, weight, and length for the West Behm Canal herring stock in 2009–10.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net–spring	number of fish	273	80	51	123	19	7	553
	percent age composition	49%	14%	9%	22%	3%	1%	100%
	average weight (g)	48.2	59.6	75.0	76.7	80.3	89.0	60.3
	standard dev. of weight (g)	10.5	13.4	14.3	15.8	18.9	23.0	18.7
	average length (mm)	157.0	167	179	181	183	190	167
	variance of length (mm)	83.8	108	84	100	143	163	218

Table 20.–Summary of age, weight, and length for the Lynn Canal herring stock in 2009–10.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey bottom trawl–winter	number of fish	21	44	199	130	40	55	489
	percent age composition	4%	9%	41%	27%	8%	11%	100%
	average weight (g)	60.5	75.8	84.6	88.6	96.8	103.0	86.0
	standard dev. of weight (g)	11.4	16.4	14.8	19.0	19.8	19.8	19.0
	average length (mm)	165.1	174	182	184	189	195	183
	variance of length (mm)	107.1	97	74	128	92	77	133

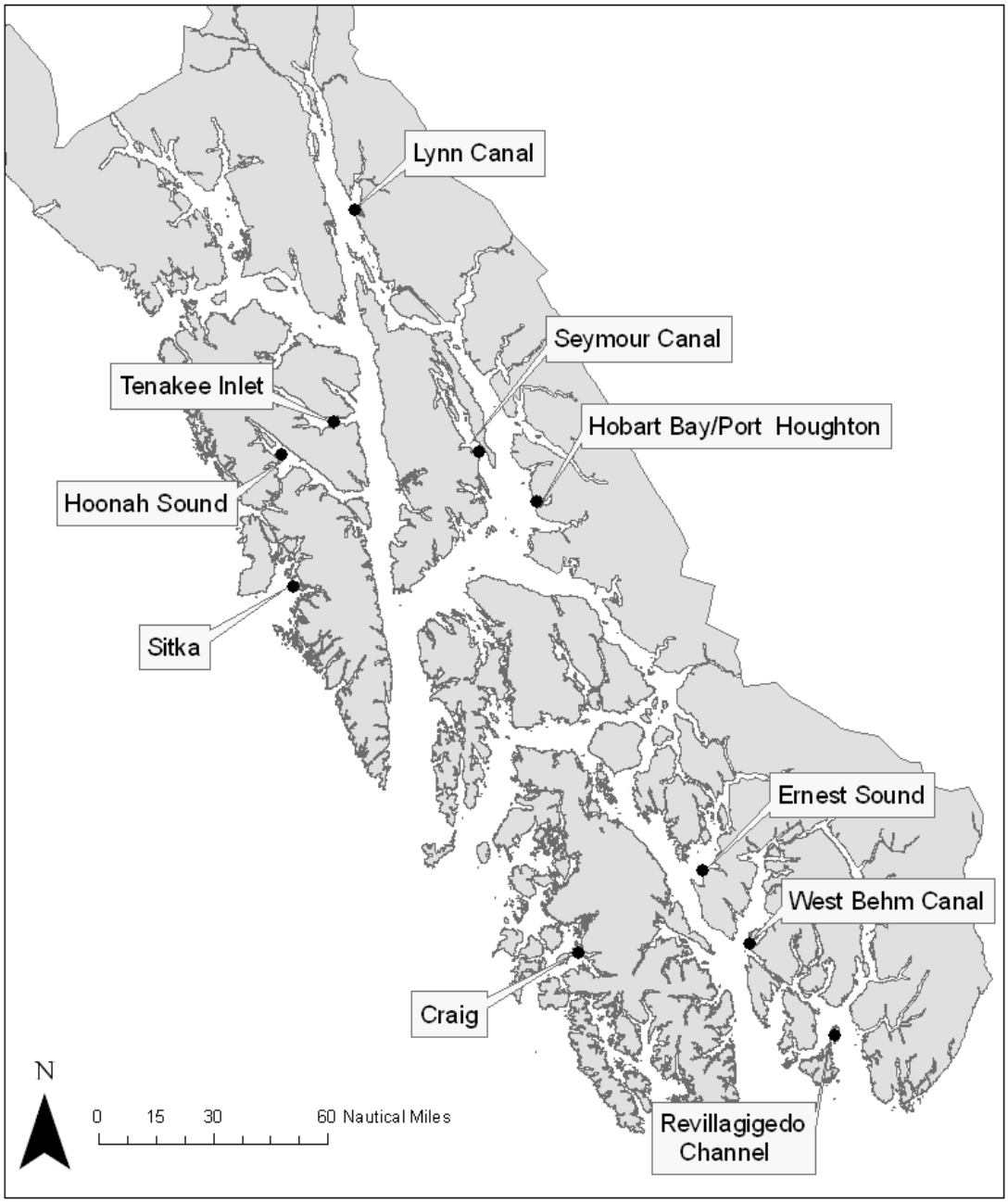
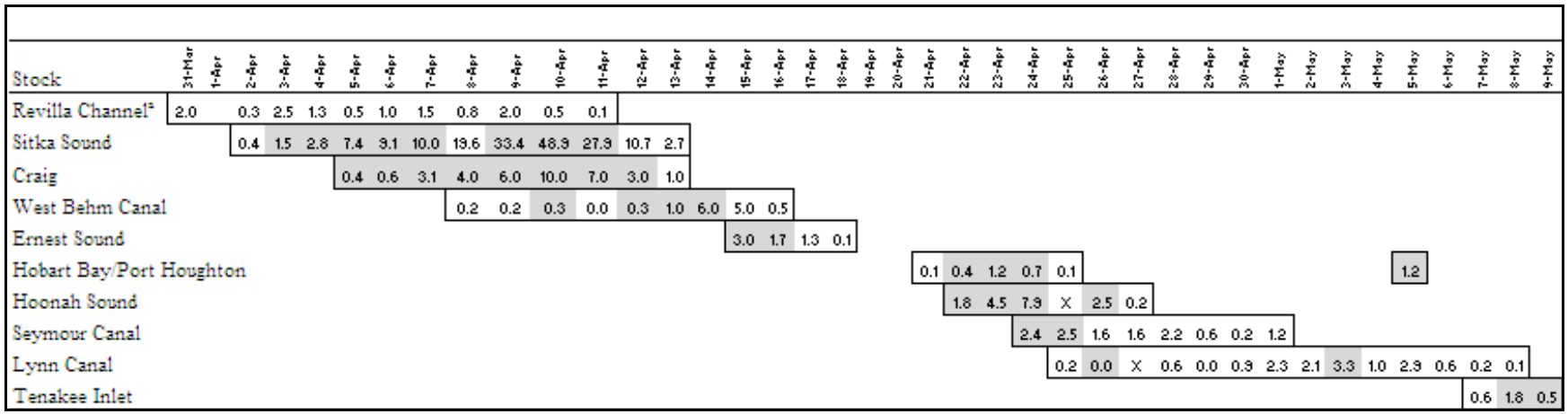


Figure 1.–Major herring spawning areas in Southeast Alaska.



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

Figure 2.–Spawn timing of herring stocks in Southeast Alaska during spring 2010. Values indicate daily measurements of nautical miles of active spawn recorded during aerial surveys. Shaded area depict dates when cast-net samples were taken. Dates with "X" indicate no aerial survey was conducted. Boxed areas indicate duration of spawning (first to last dates).

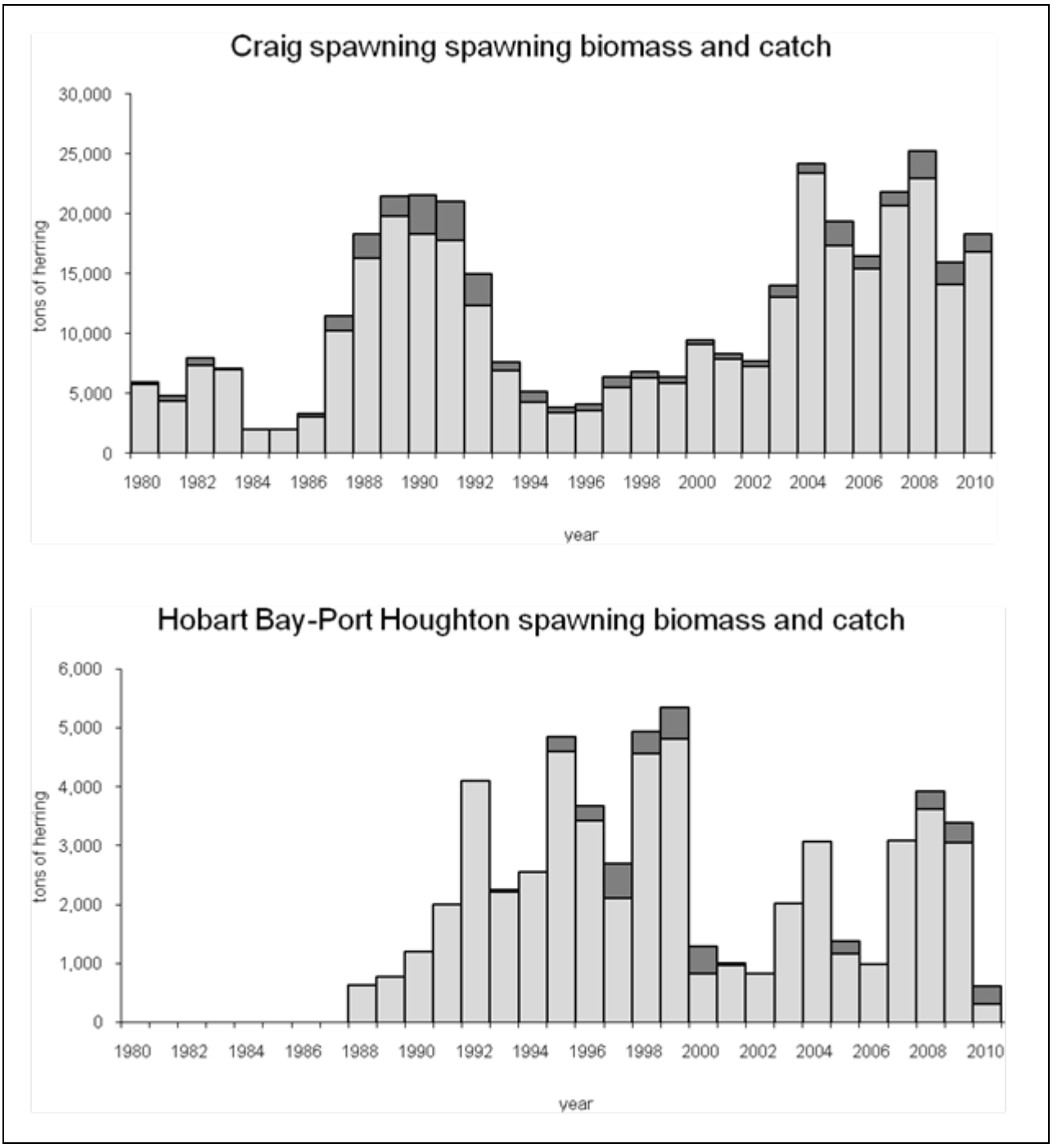


Figure 3.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Craig and Hobart Bay-Port Houghton areas, during 1980–2010.

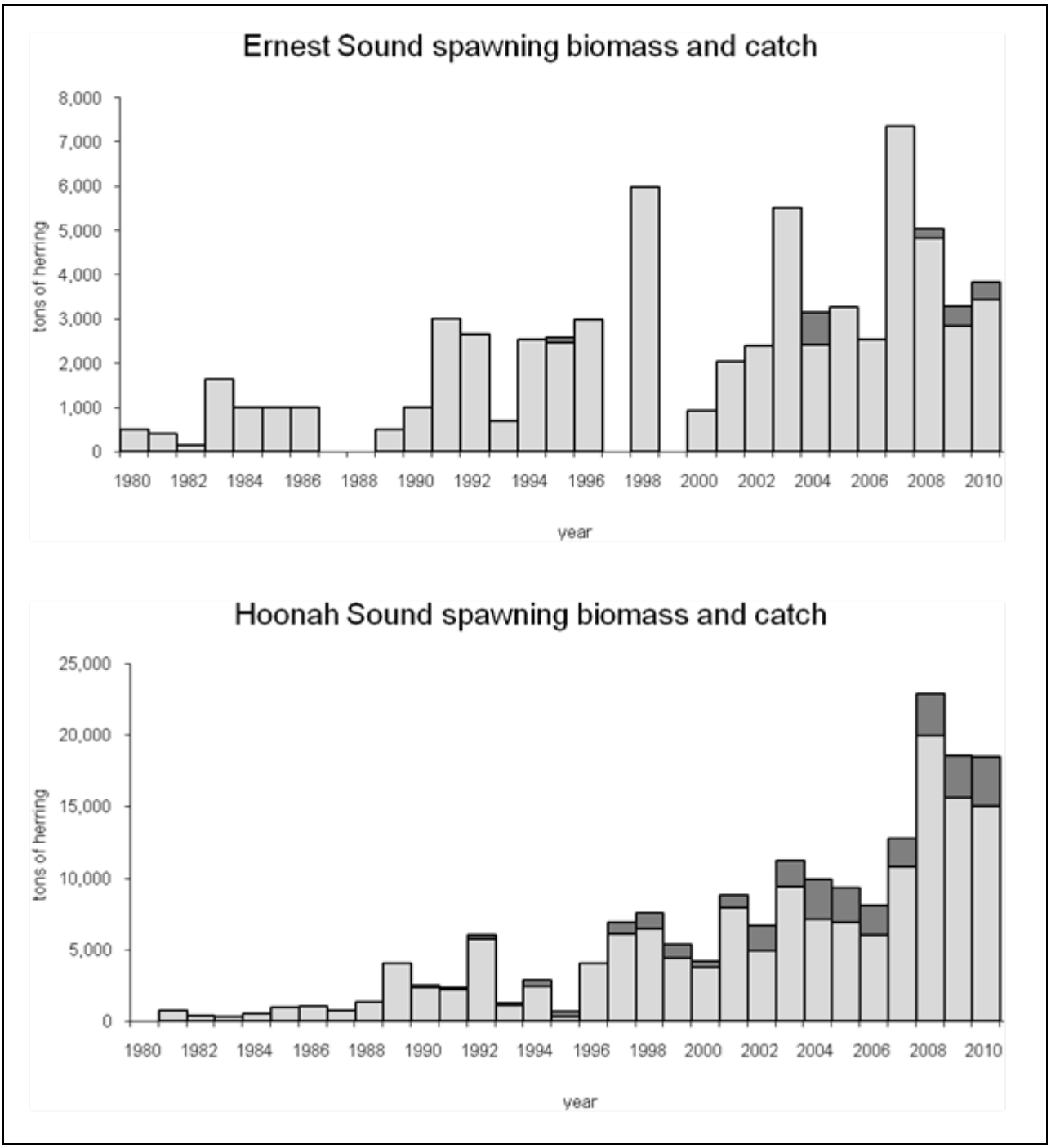


Figure 4.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2010.

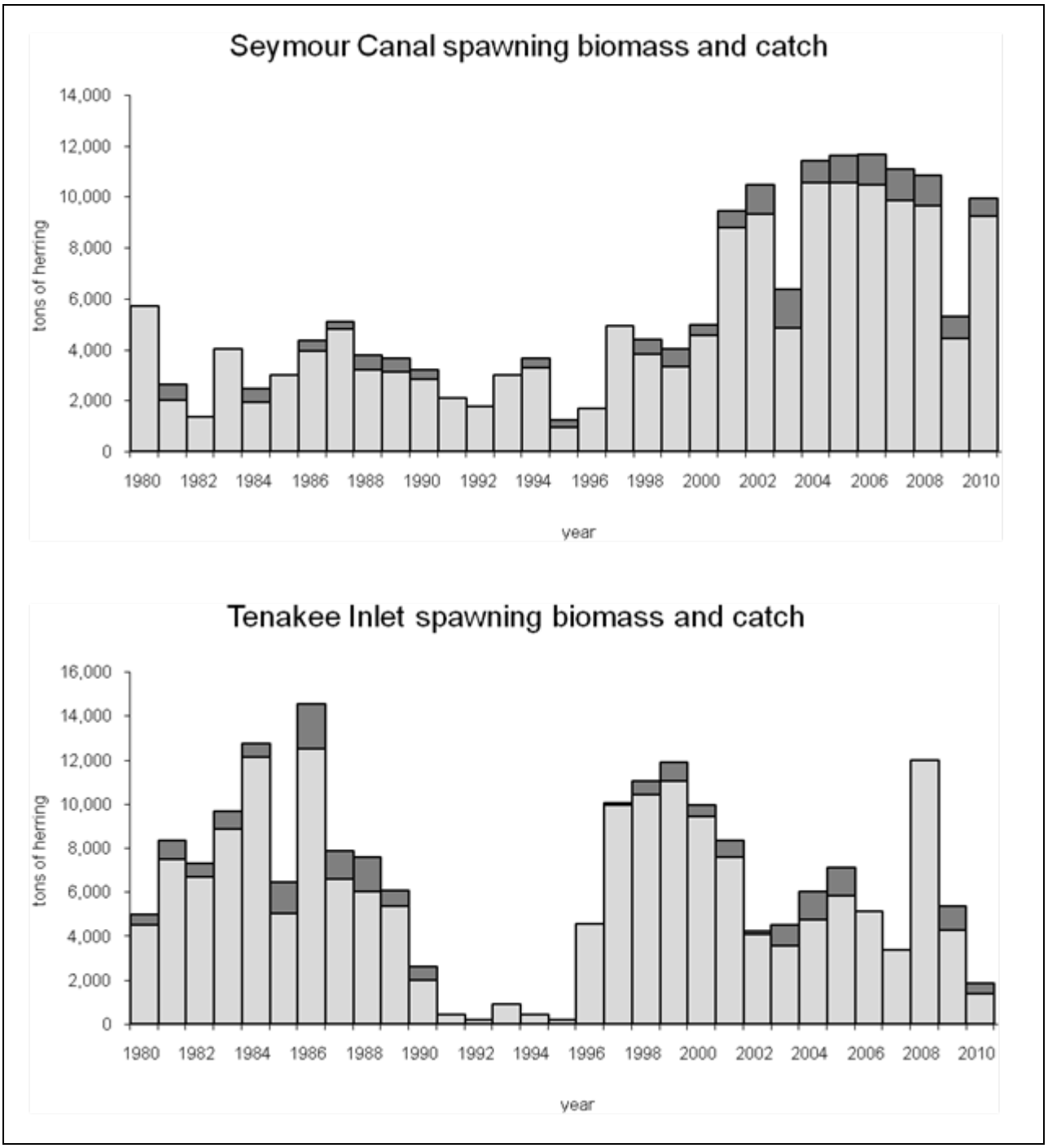


Figure 5.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys ,and catch (dark gray bars) for stocks in the Tenakee Inlet and Seymour Canal areas, during 1980–2010.

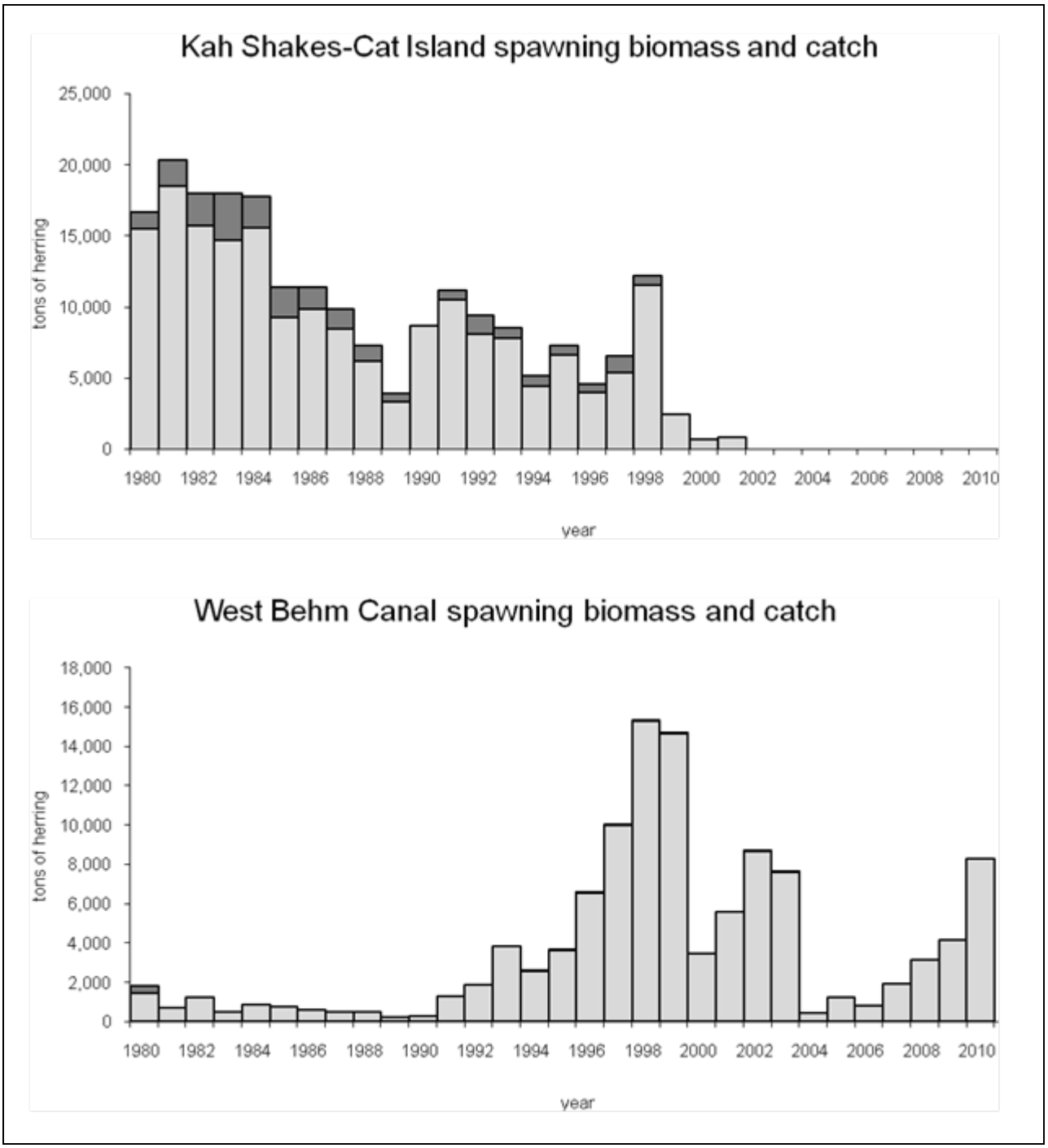


Figure 6.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, or hydro-acoustic surveys, and catch (dark gray bars) for stocks in the West Behm Canal and Kah Shakes-Cat Island areas, during 1980–2010.

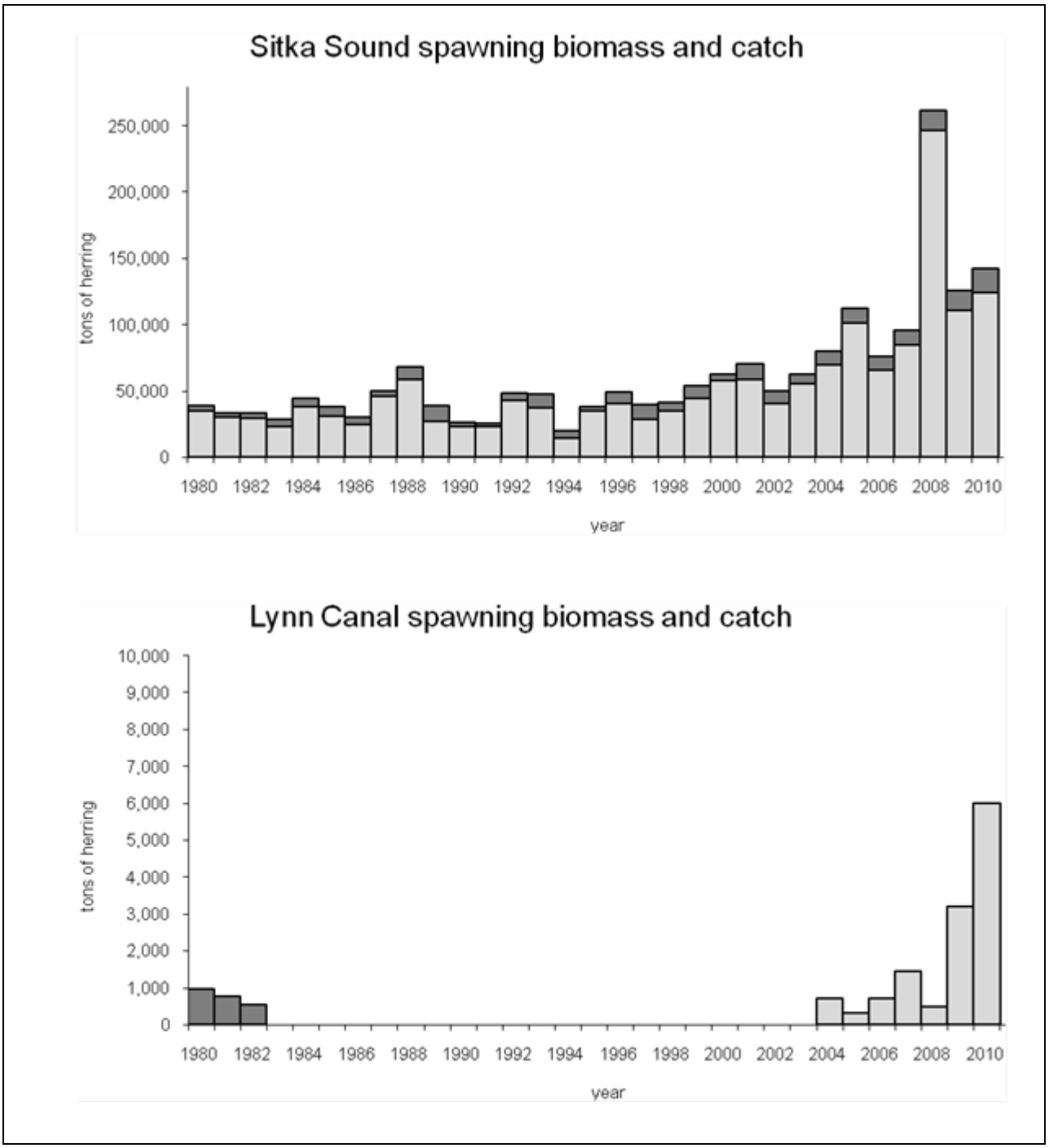


Figure 7.–Herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2010. Estimates of spawning biomass for Lynn Canal prior to 2004 area not presented due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

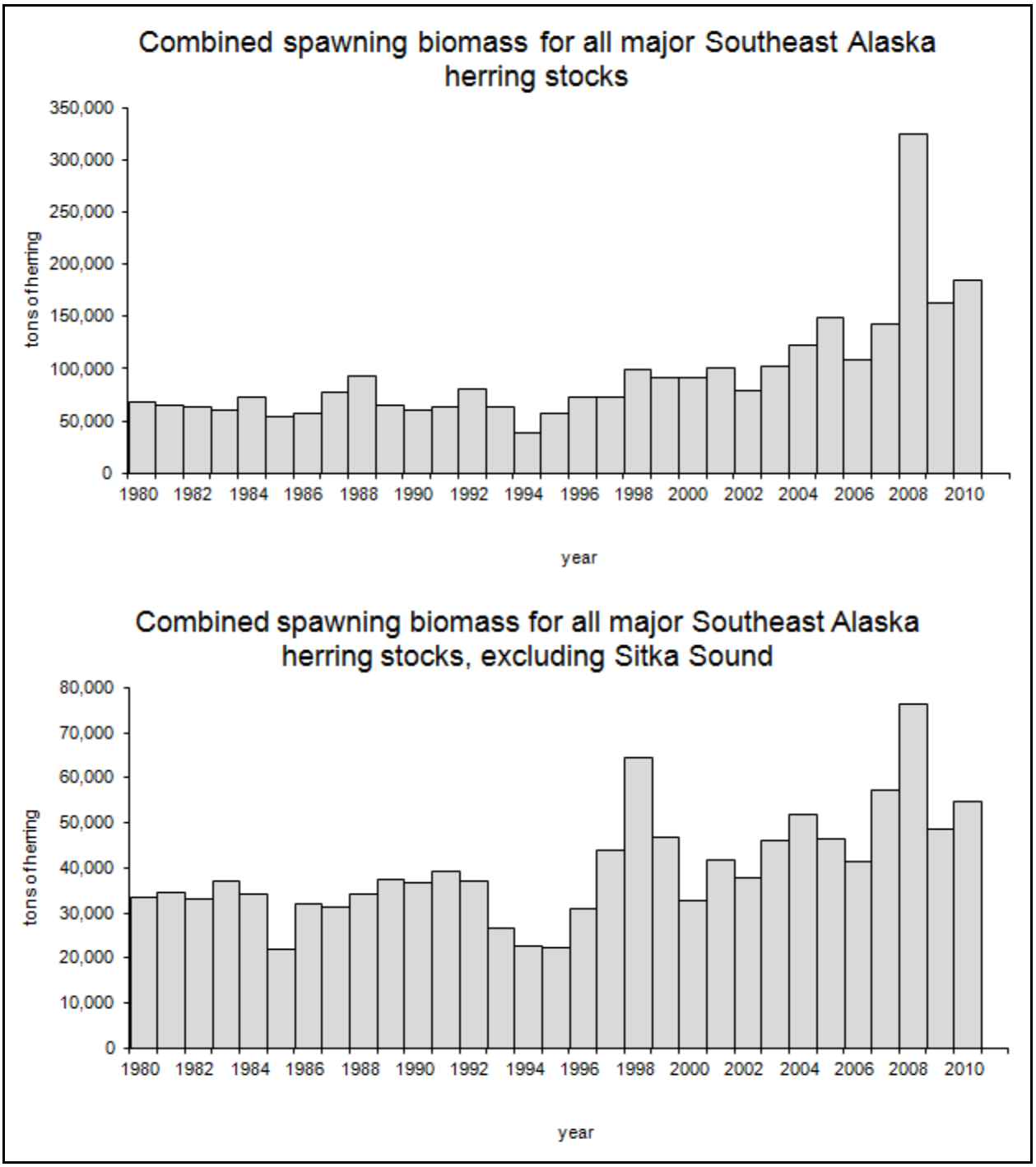


Figure 8.–Combined post-fishery spawning biomass, based on spawn deposition surveys, or hydro-acoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2010. Estimates of spawning biomass for Lynn Canal area not included due to variable methods, areas, and timing of surveys, that produced results not directly comparable to recent surveys.

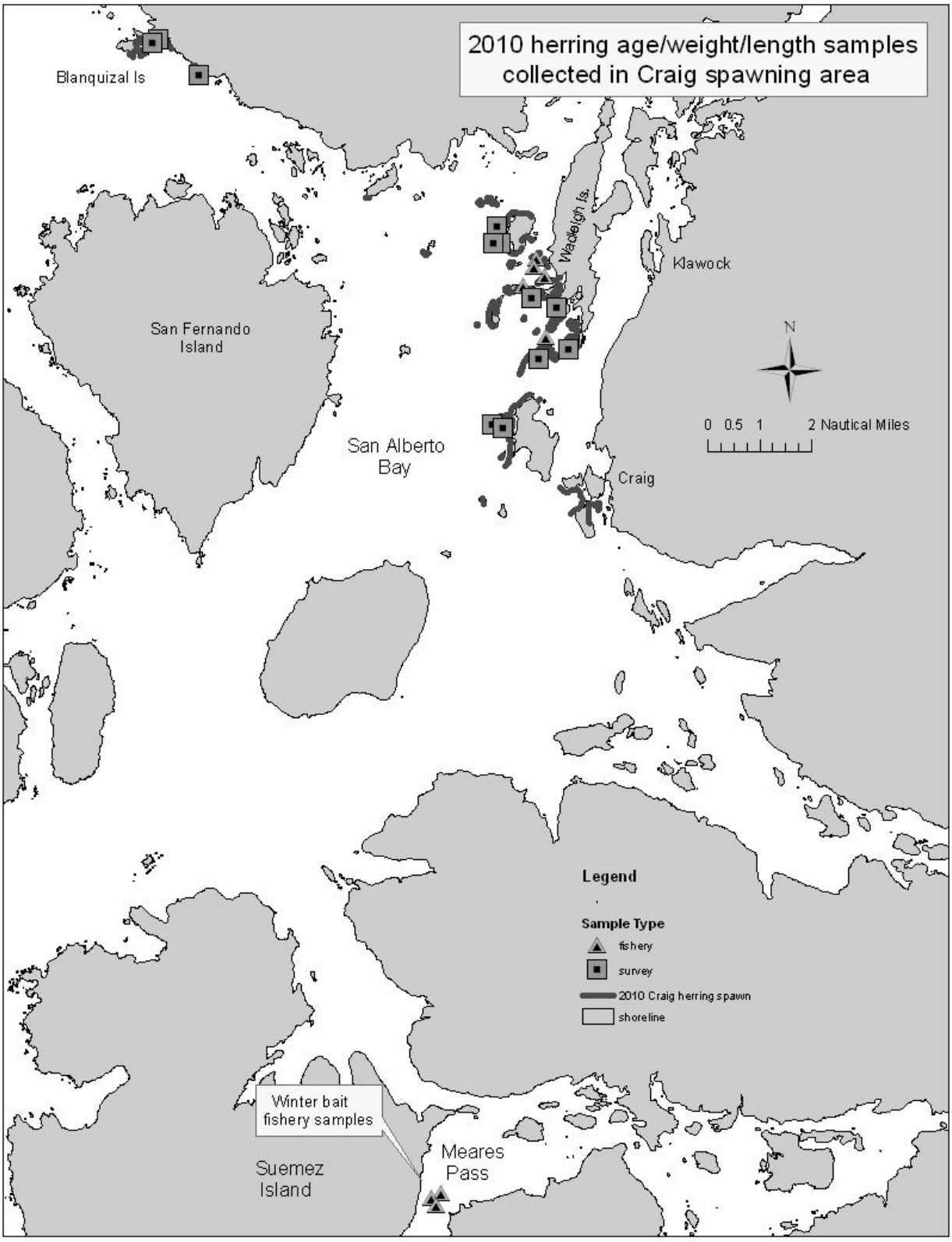


Figure 9.–Locations of herring samples collected for estimates of age and size for the Craig herring stock, 2010.

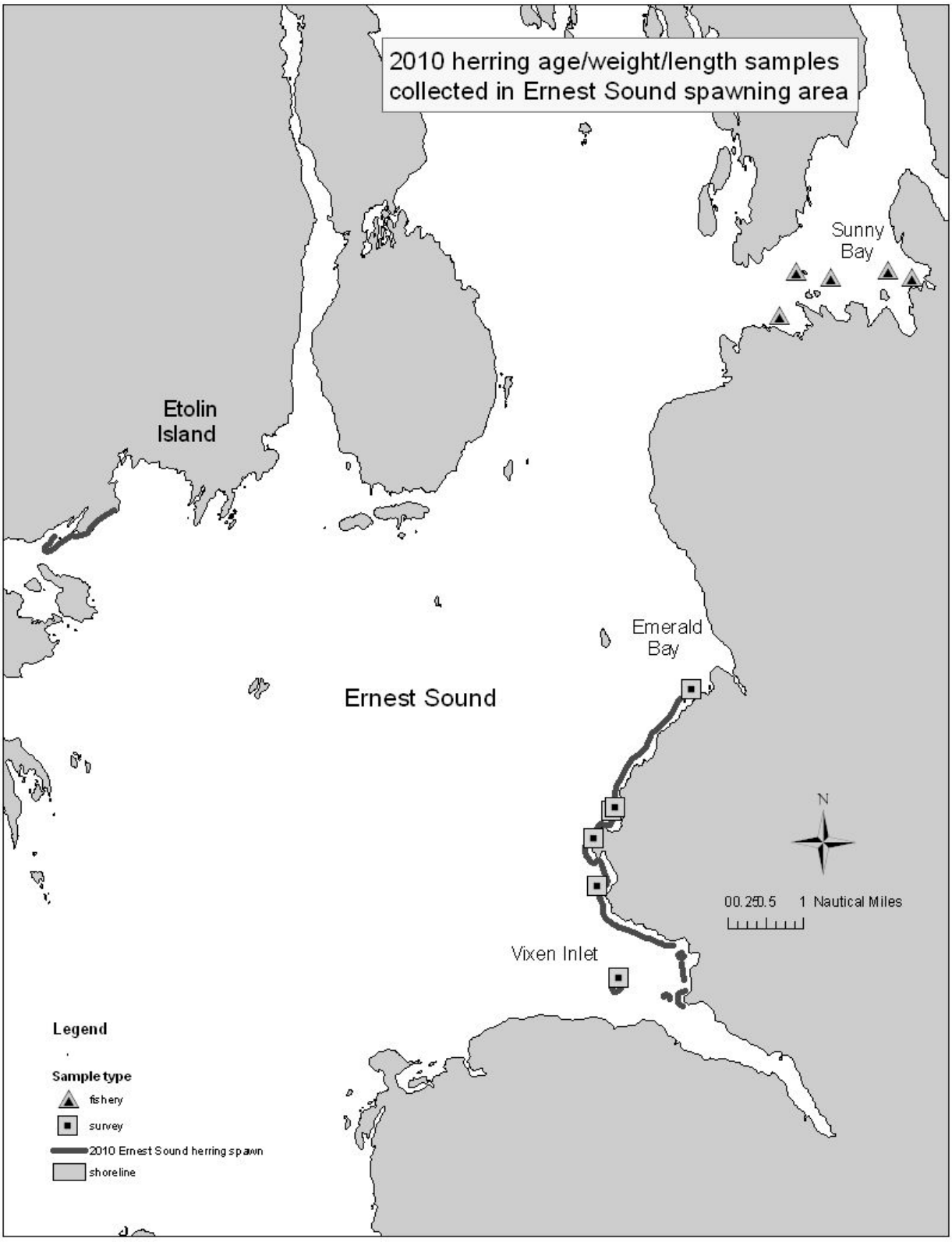


Figure 10.–Locations of herring samples collected for estimates of age and size for the Ernest Sound herring stock, 2010.

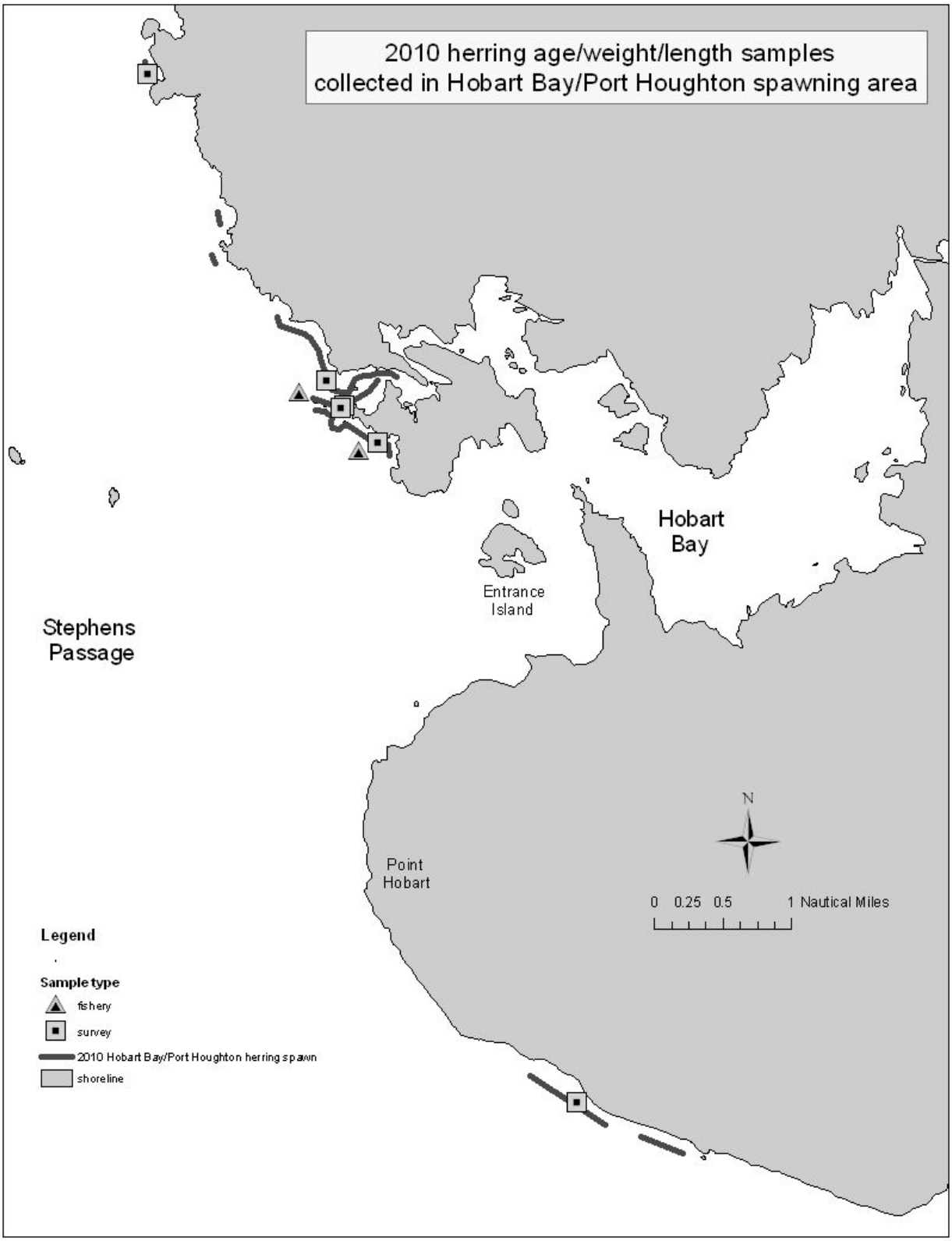


Figure 11.–Locations of herring samples collected for estimates of age and size for the Hobart bay-Port Houghton herring stock, 2010.

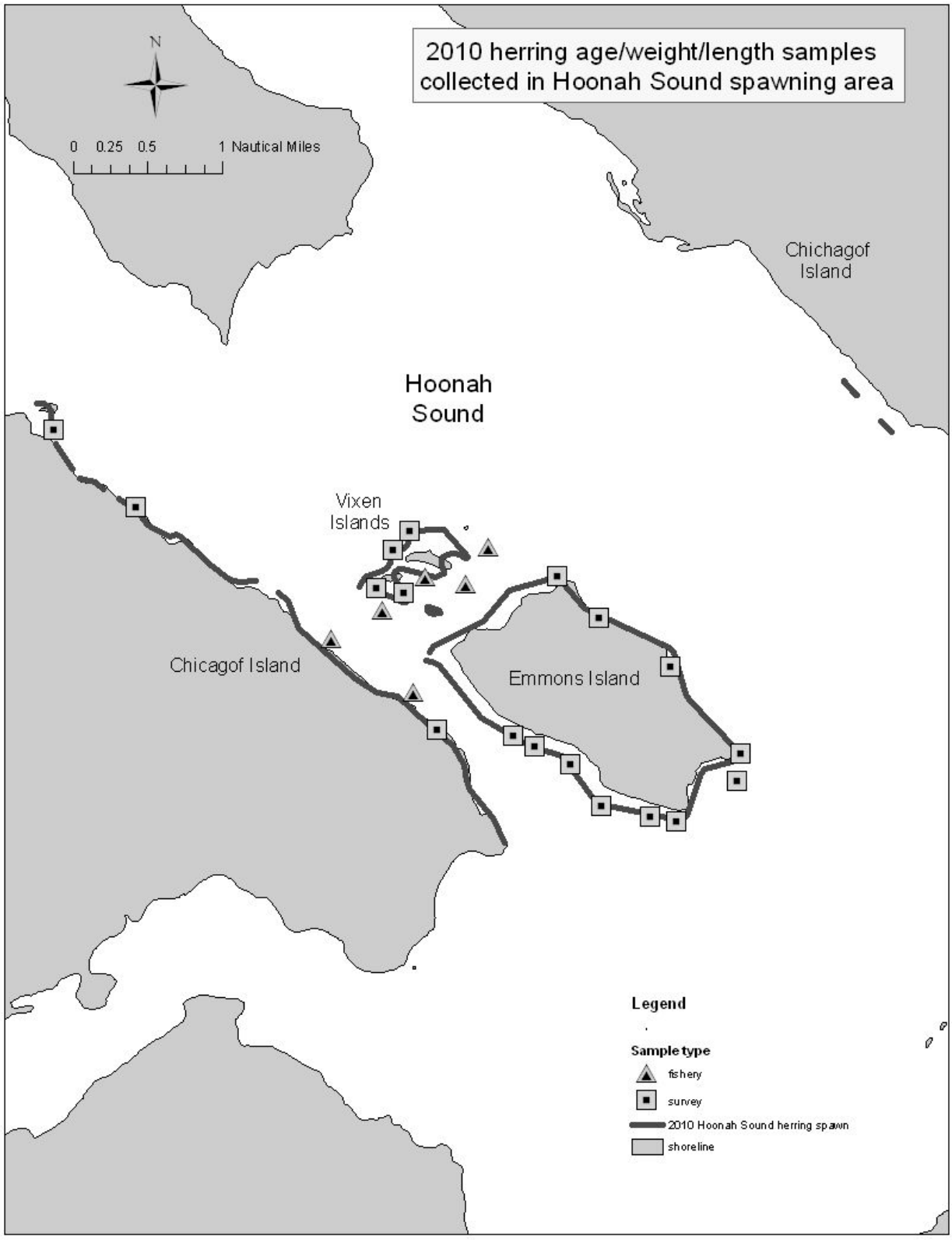


Figure 12.–Locations of herring samples collected for estimates of age and size for the Hoonah Sound herring stock, 2010.

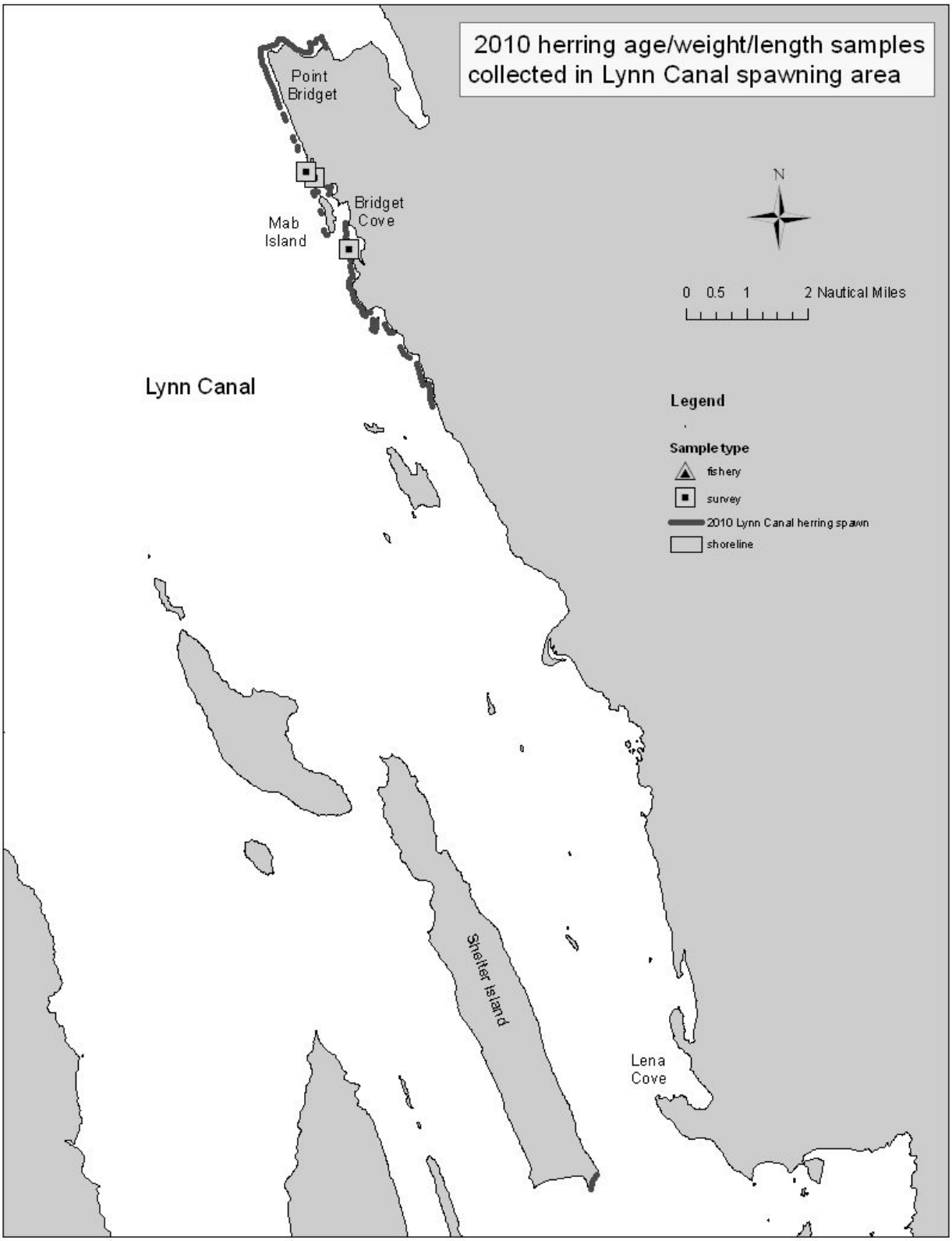


Figure 13 .–Locations of herring samples collected for estimates of age and size for the Lynn Canal herring stock, 2010.

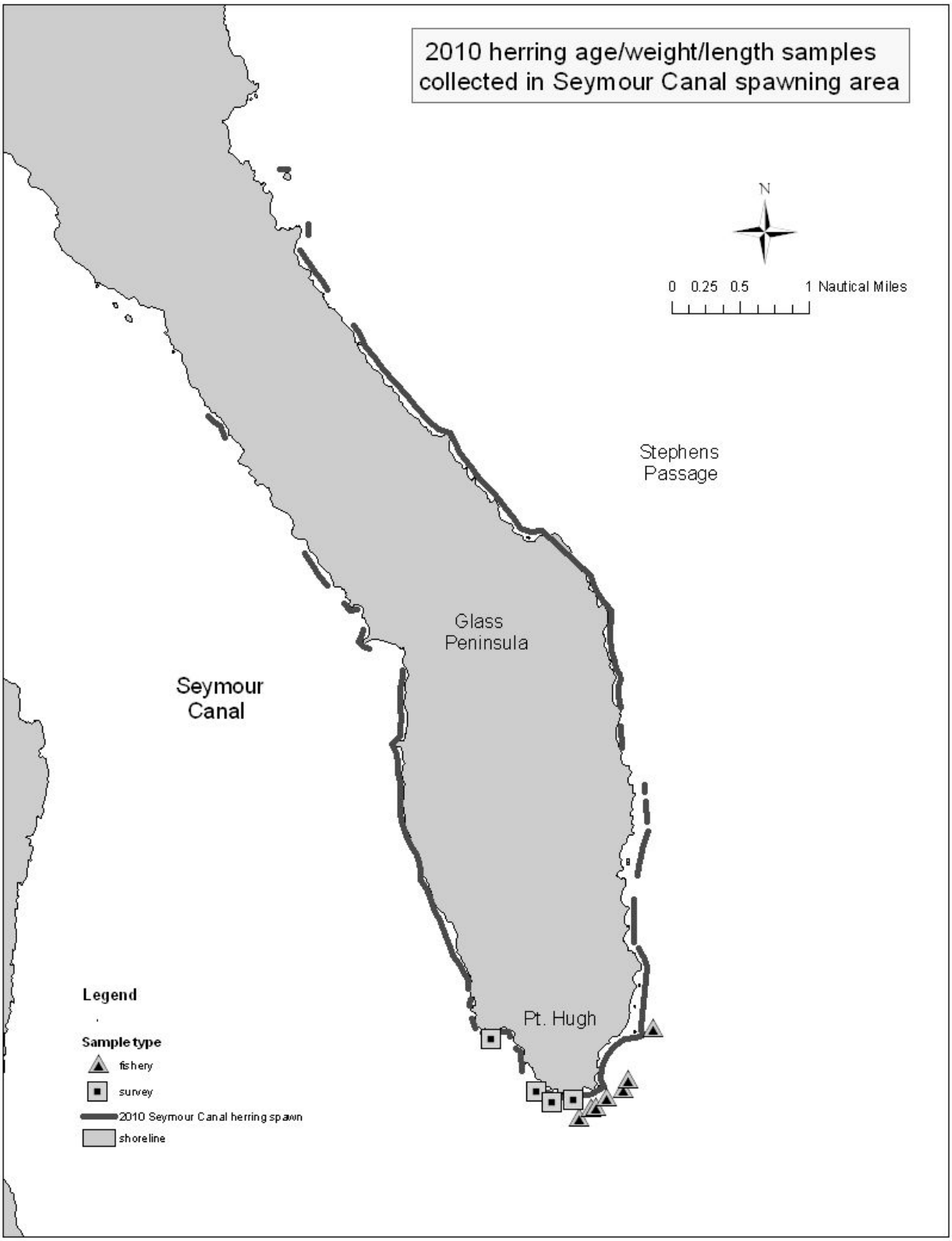


Figure 14.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock, 2010.

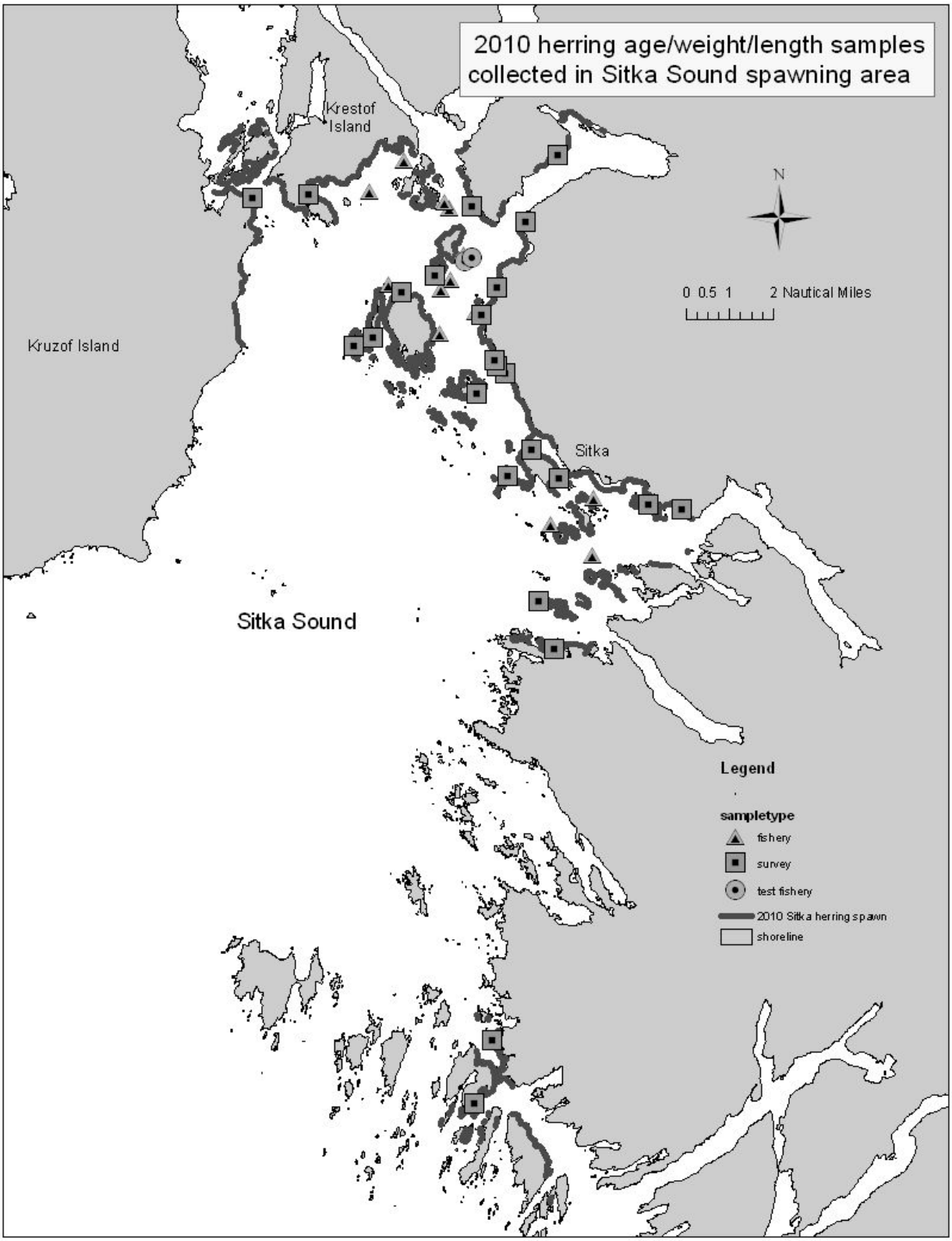


Figure 15.–Locations of herring samples collected for estimates of age and size for the Sitka Sound herring stock, 2010.

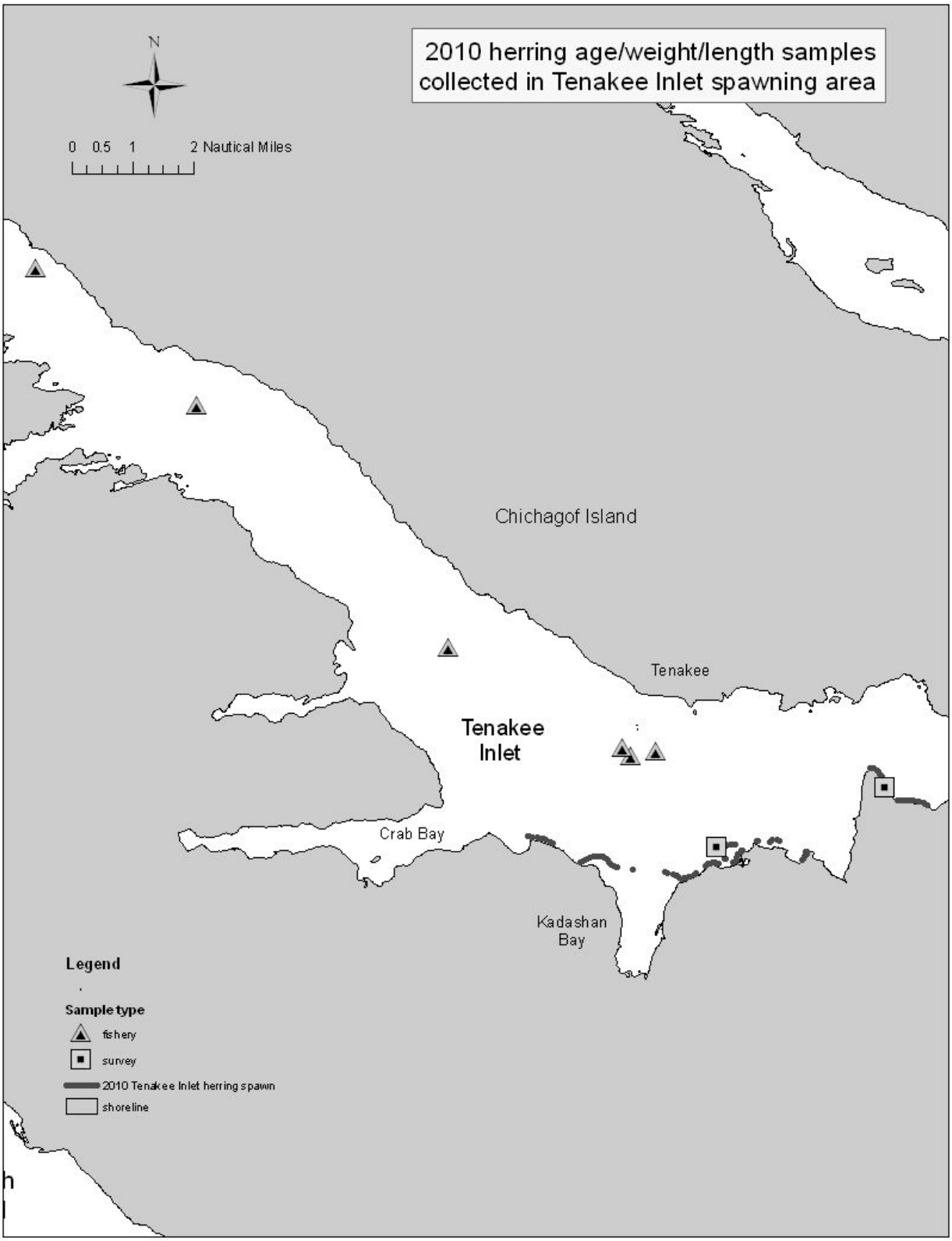


Figure 16.–Locations of herring samples collected for estimates of age and size for the Tenakee Inlet herring stock, 2010.

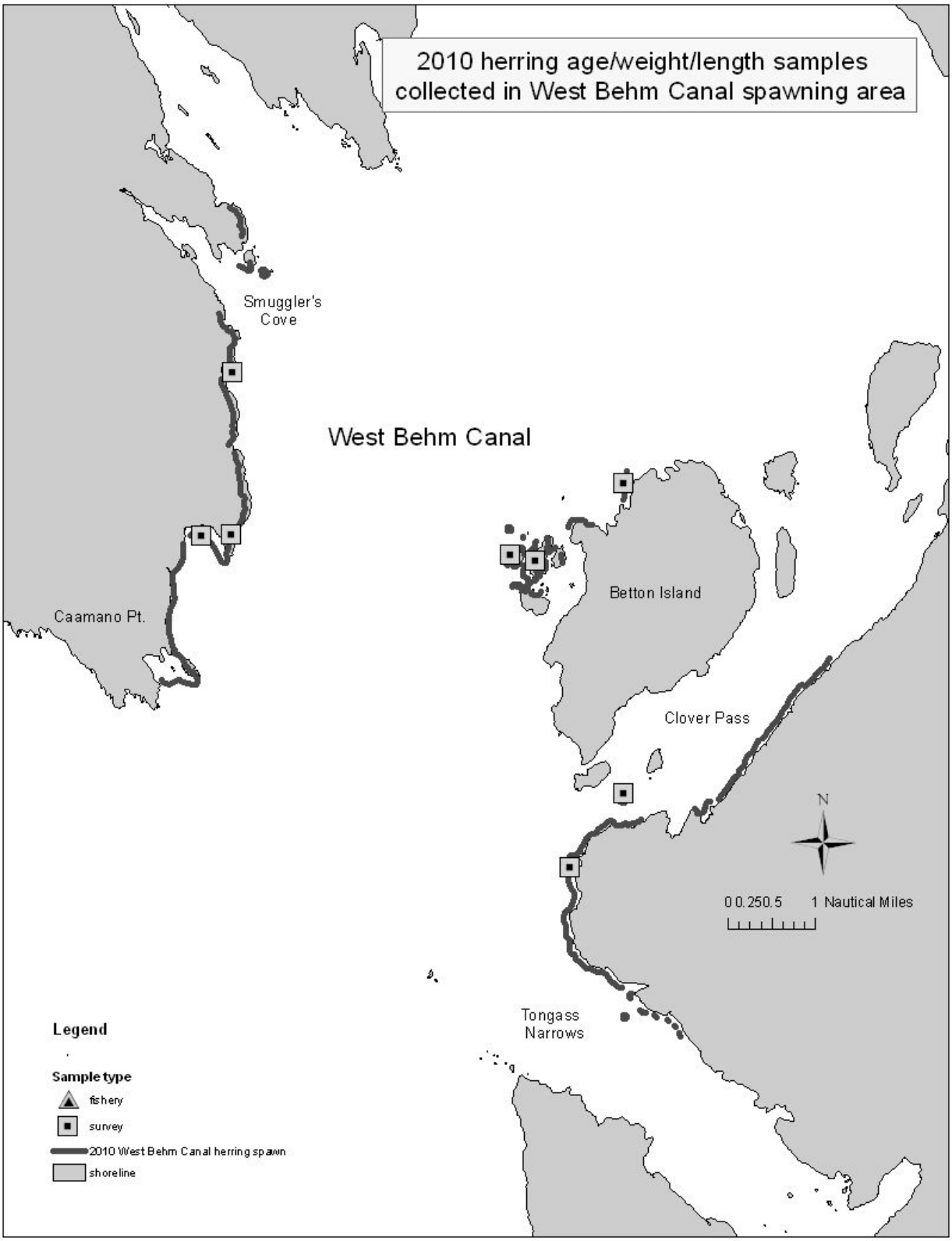


Figure 17.–Locations of herring samples collected for estimates of age and size for the West Behm Canal herring stock, 2010.

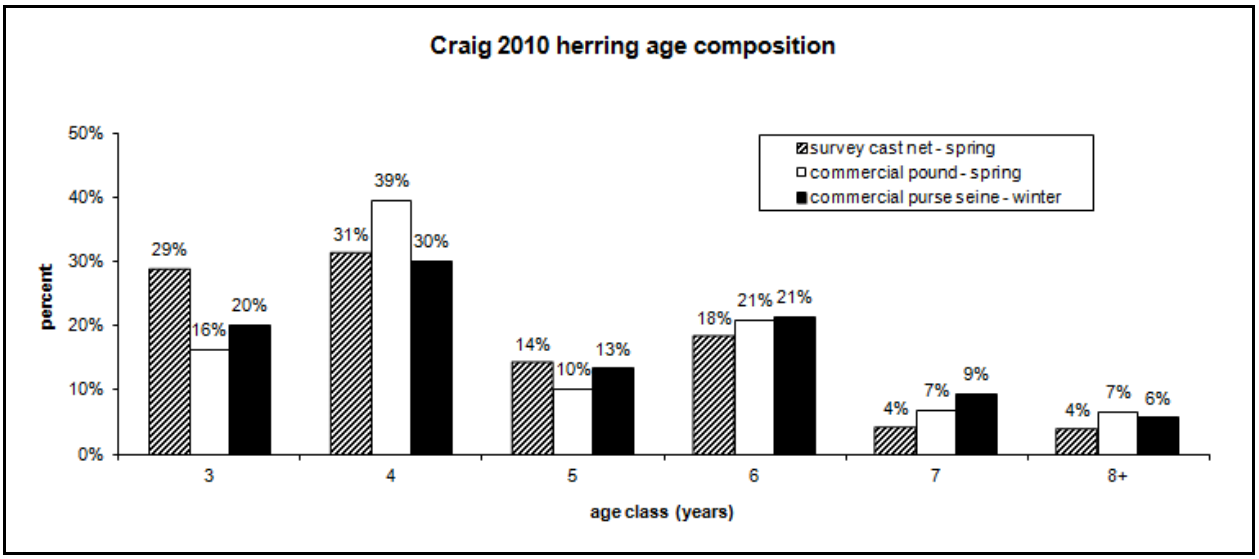


Figure 18.–Age composition for Craig herring stock in 2009–10.

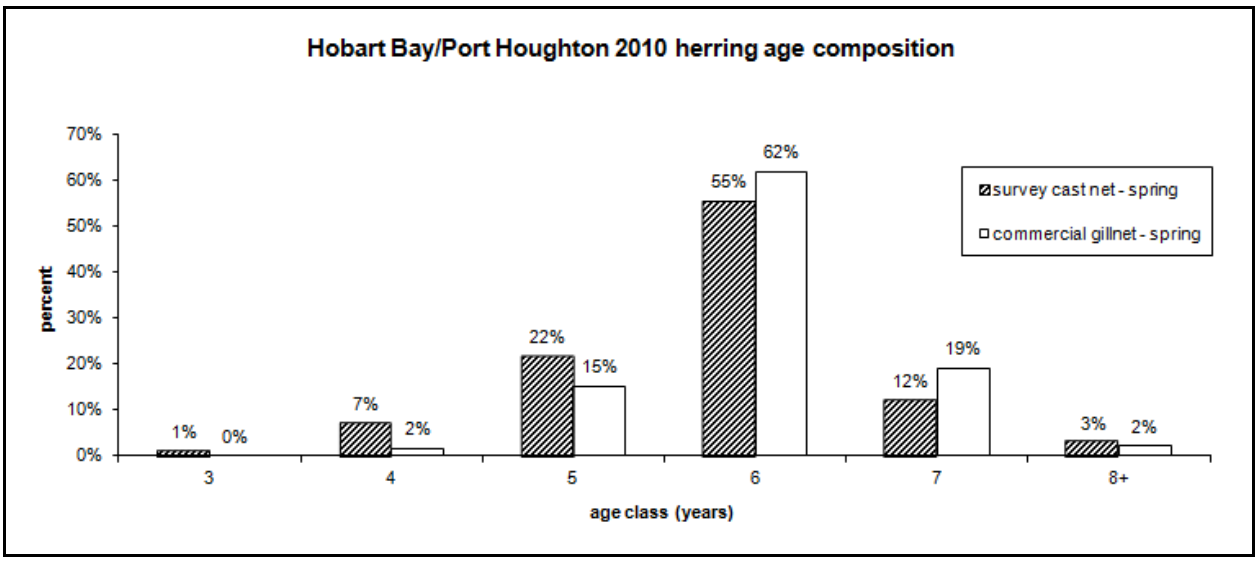


Figure 19.–Age composition for Hobart Bay/Port Houghton herring stock in 2009–10.

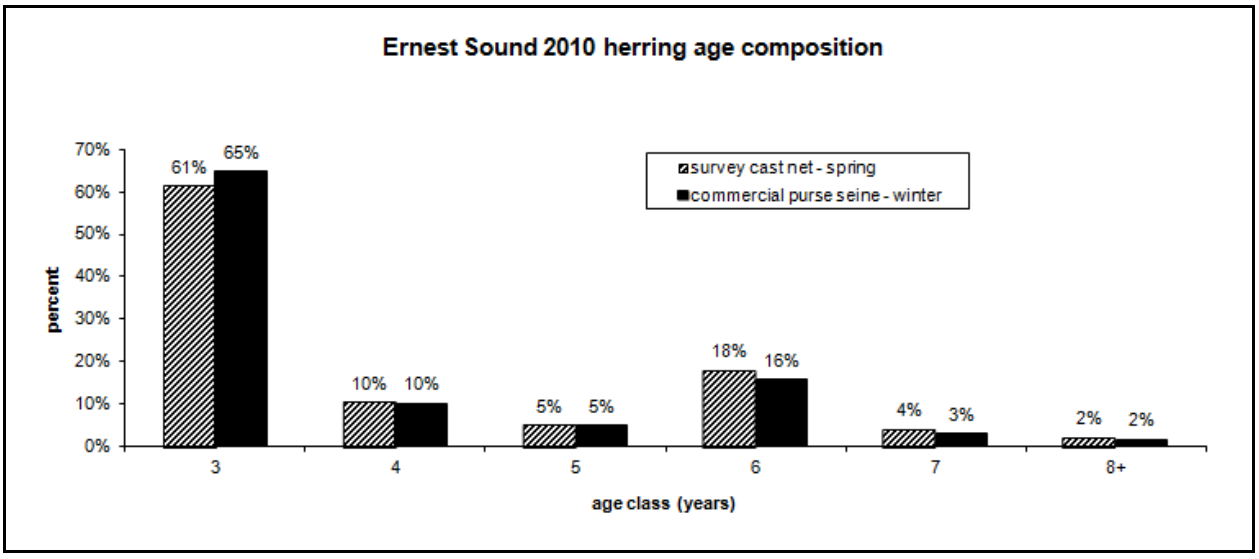


Figure 20.–Age composition for Ernest Sound herring stock in 2009–10.

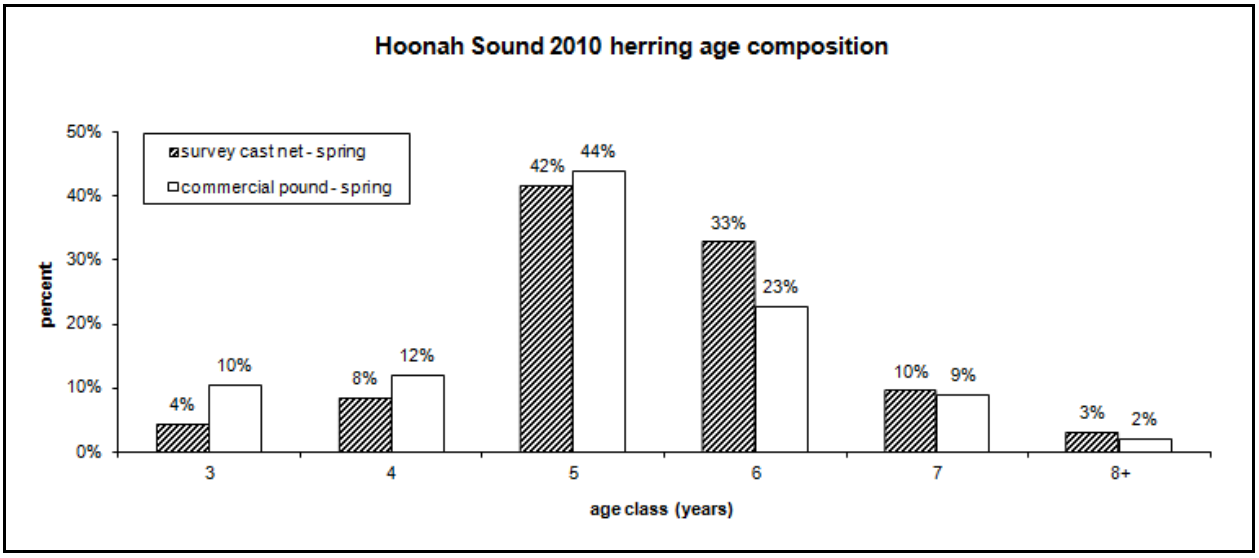


Figure 21.–Age composition for Hoonah Sound herring stock in 2009–10.

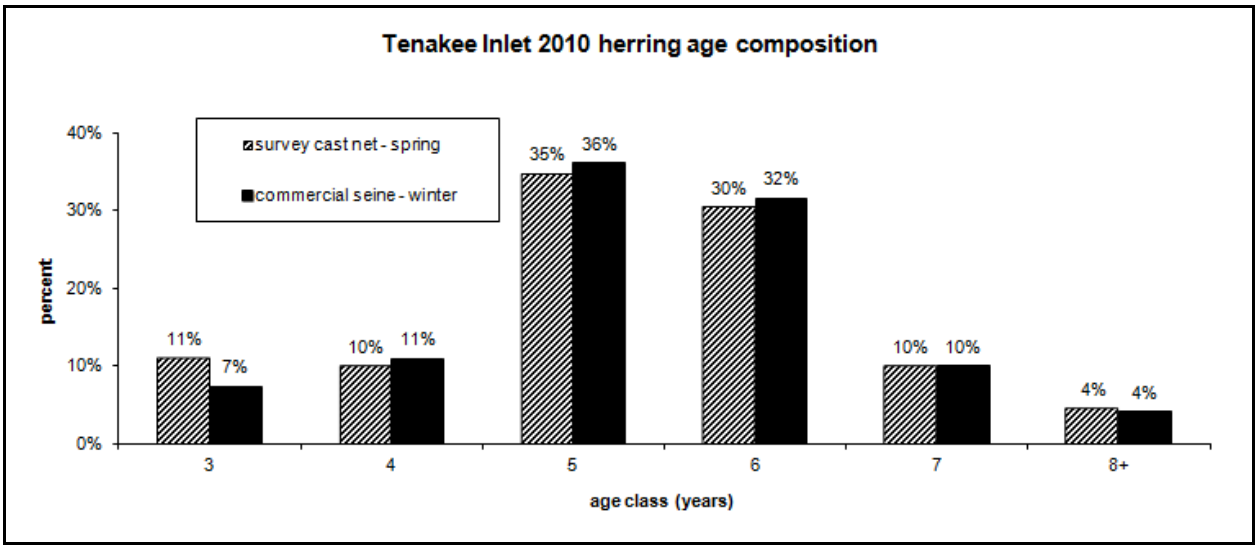


Figure 22.–Age composition for Tenakee Inlet herring stock in 2009–10.

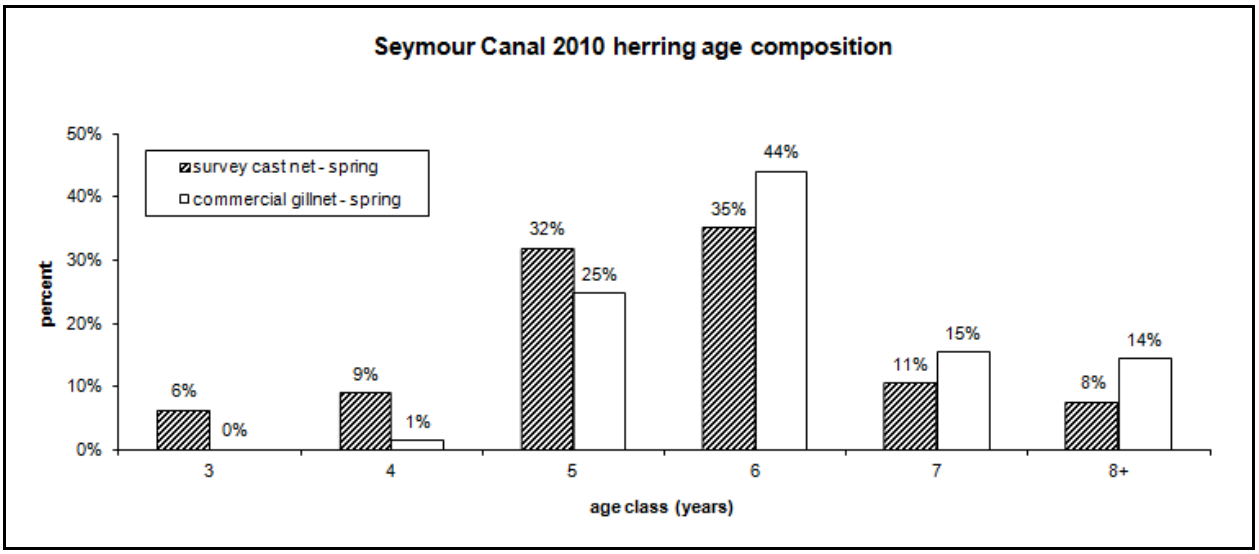


Figure 23.–Age composition for Seymour Canal herring stock in 2009–10.

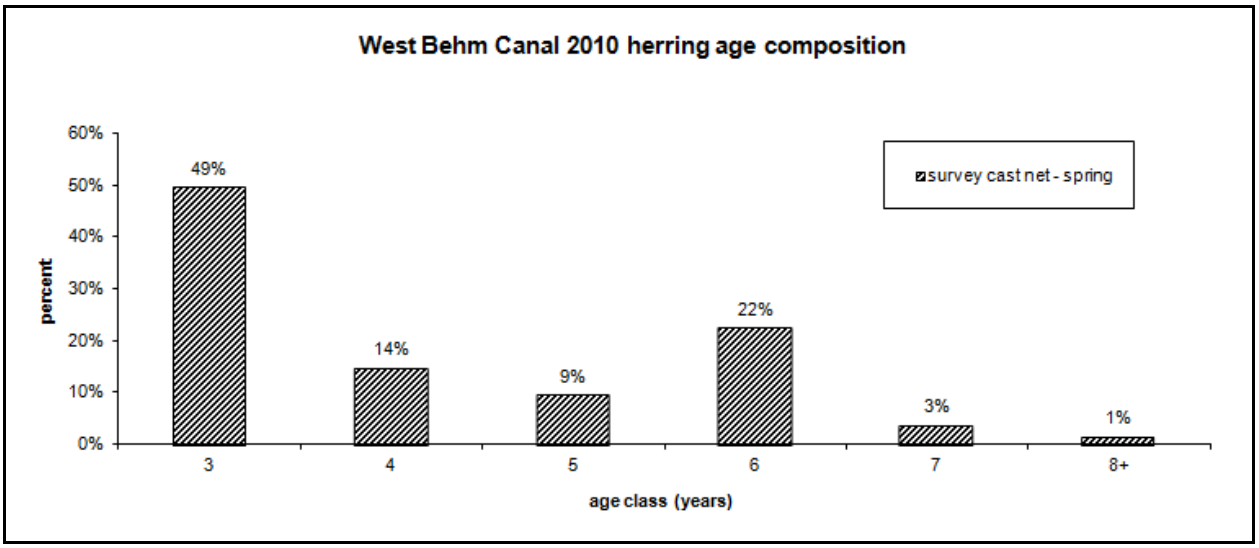


Figure 24.–Age composition for West Behm Canal herring stock in 2009–10.

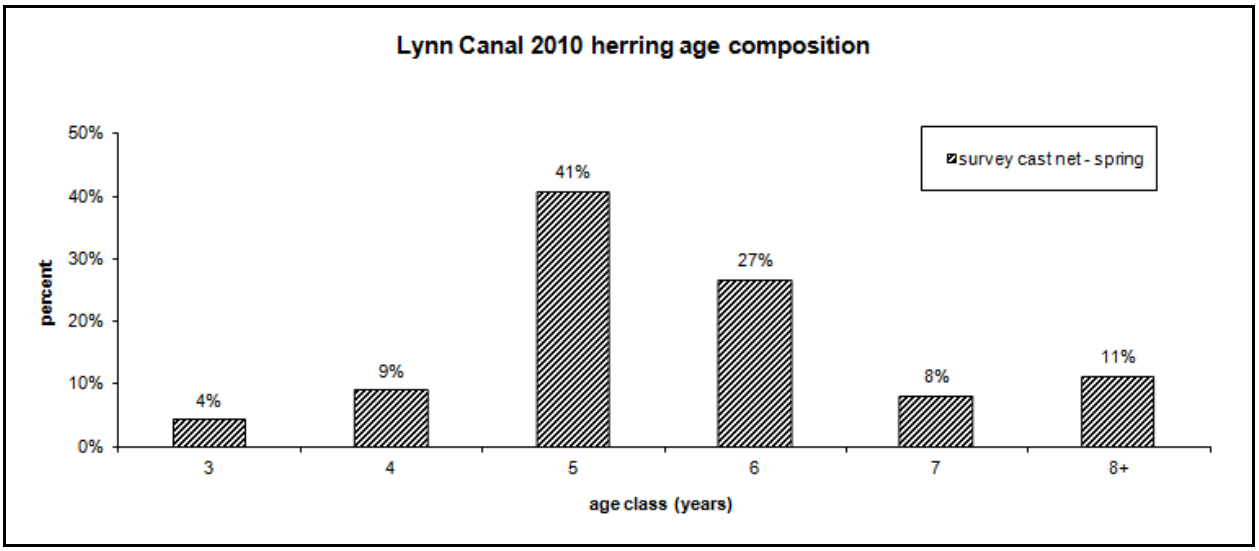


Figure 25.–Age composition for Lynn Canal herring stock in 2009–10.

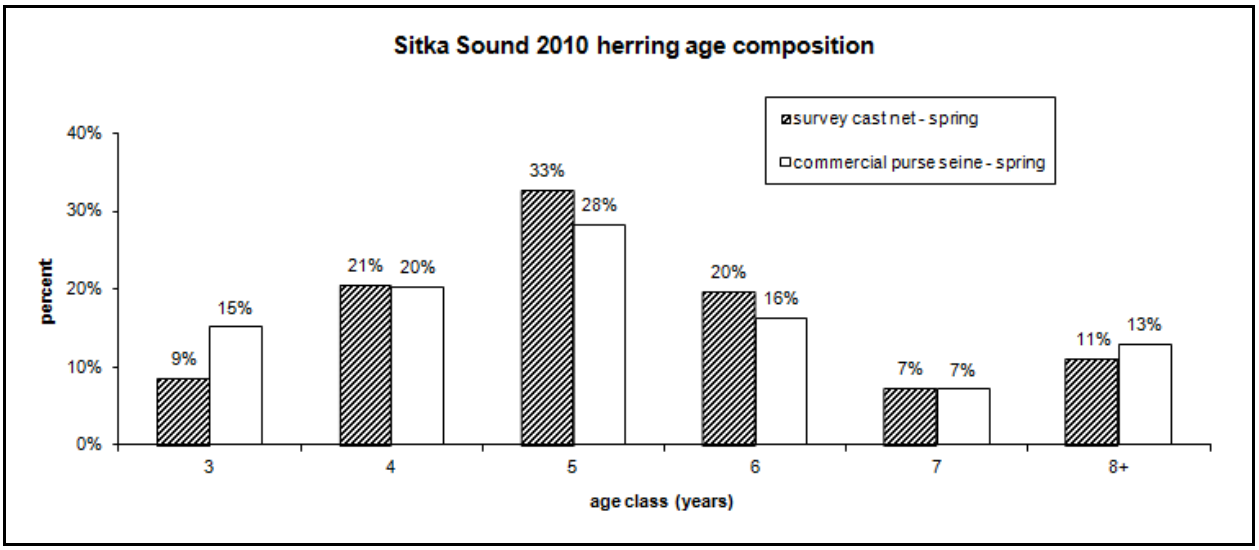


Figure 26.–Age composition for Sitka Sound herring stock in 2009–10. Results of winter test fishery not available due to scale re-aging in progress.

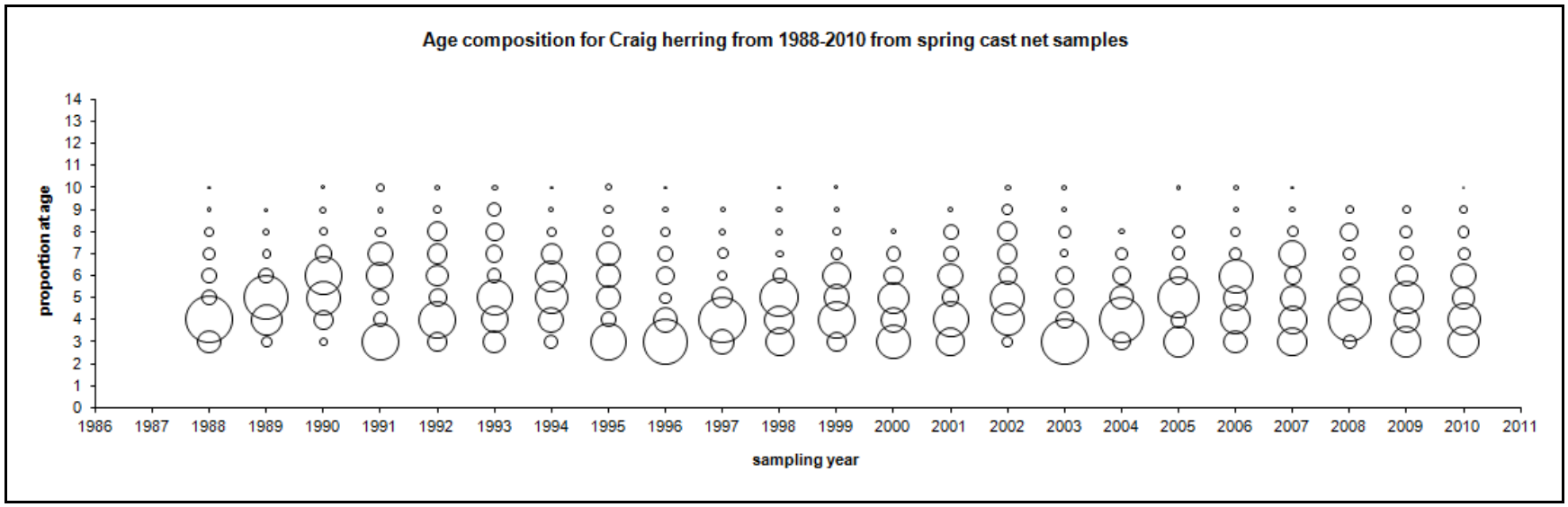


Figure 27.–Age composition from sampling data for the Craig herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

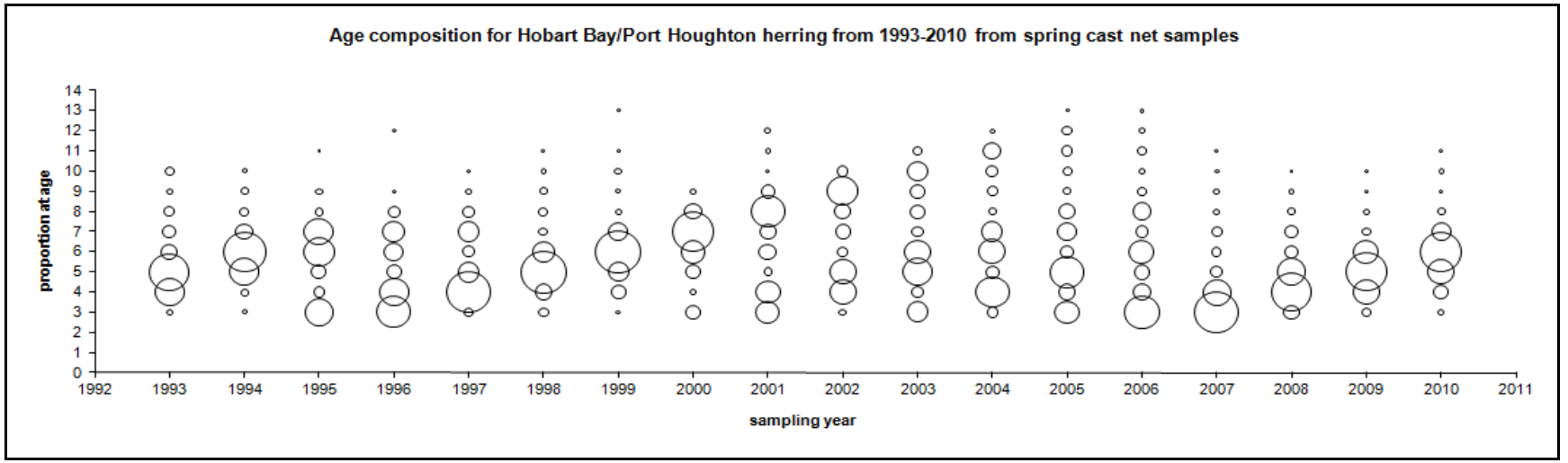


Figure 28.–Age composition from sampling data for the Hobart Bay/Port Houghton herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

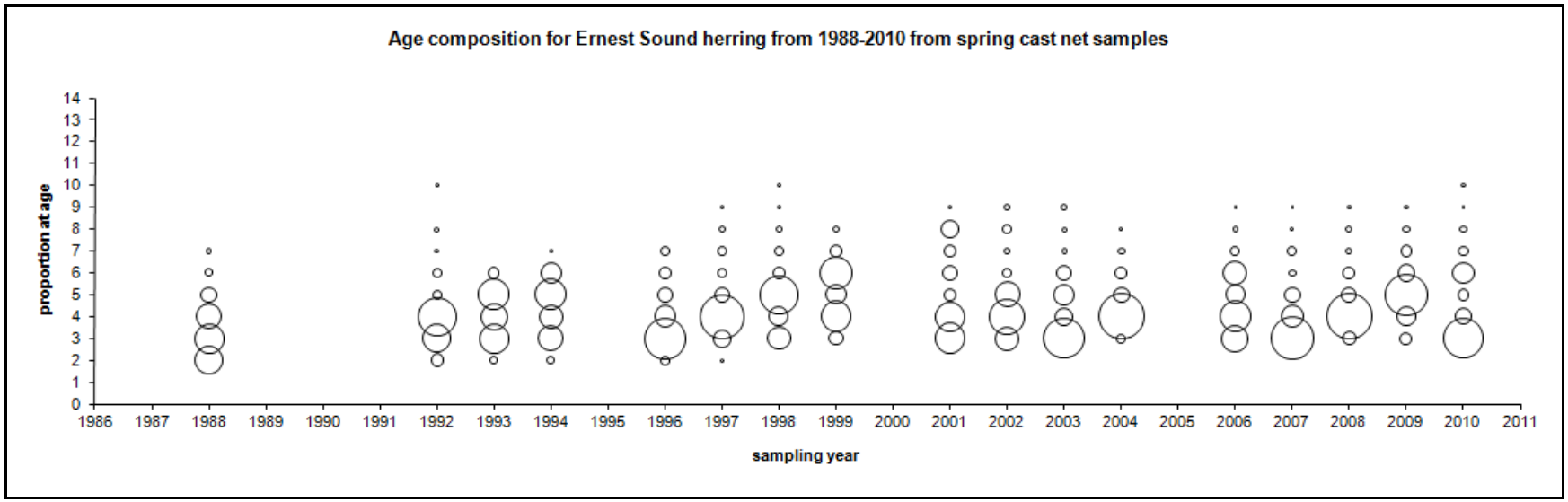


Figure 29.–Age composition from sampling data for the Ernest Sound herring stock.

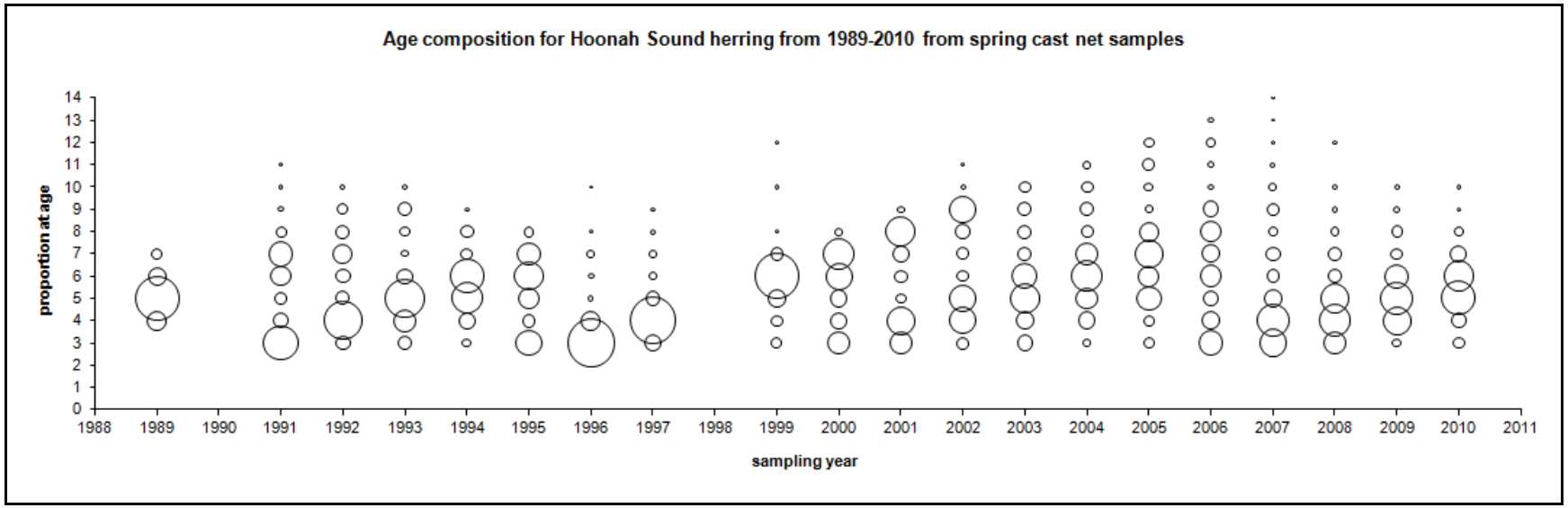


Figure 30.–Age composition from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

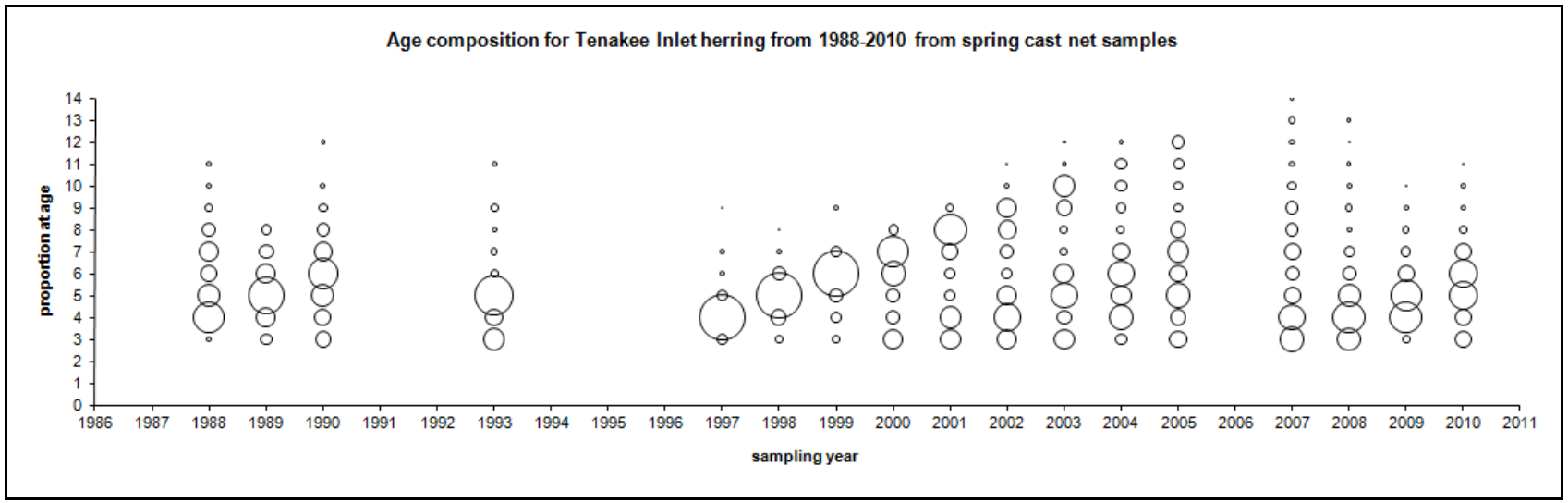


Figure 31.–Age composition from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

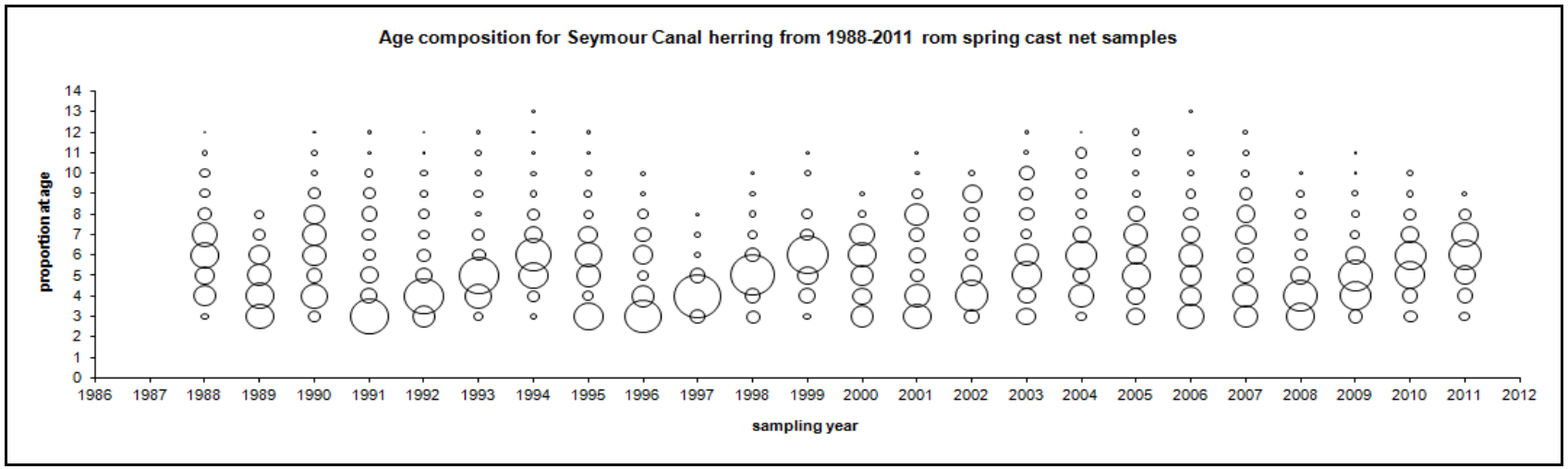


Figure 32.–Age composition from sampling data for the Seymour Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

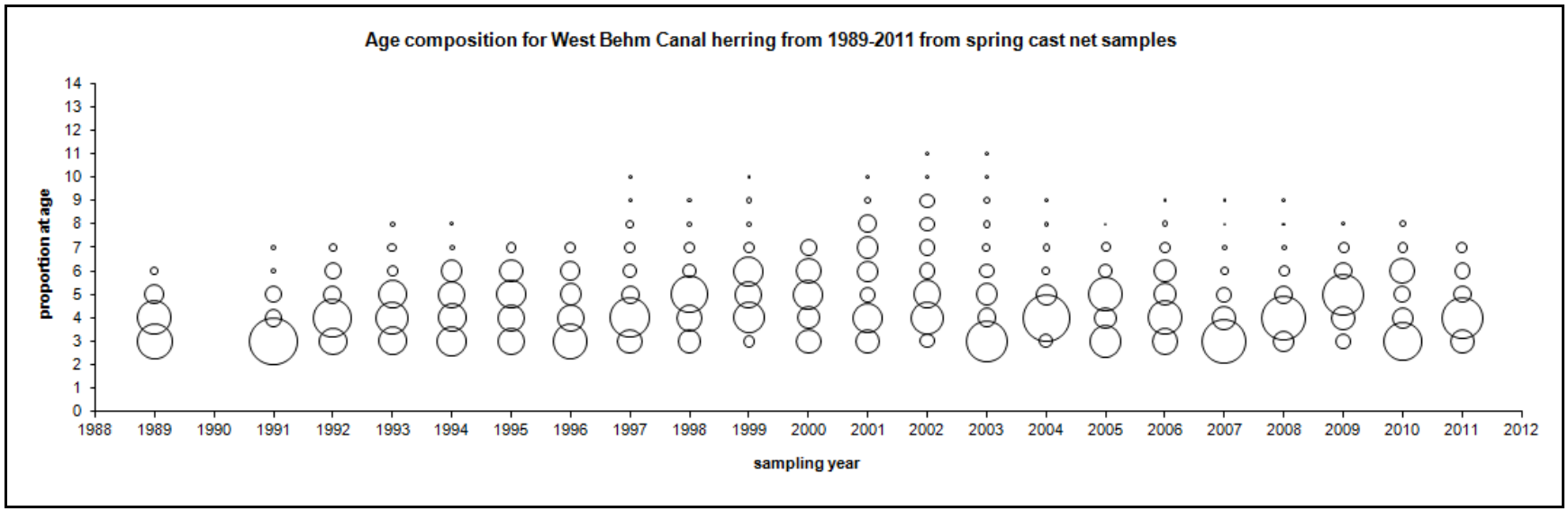


Figure 33.–Age composition from sampling data for the West Behm Canal herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

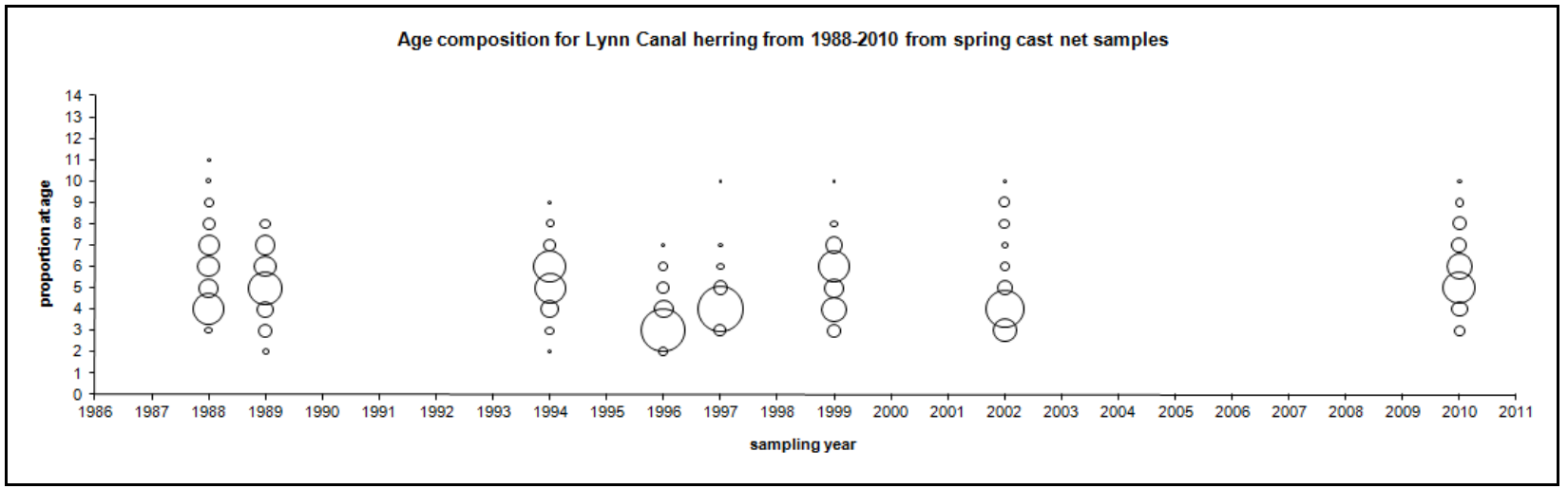


Figure 34.–Age composition from sampling data for the Lynn Canal herring stock.

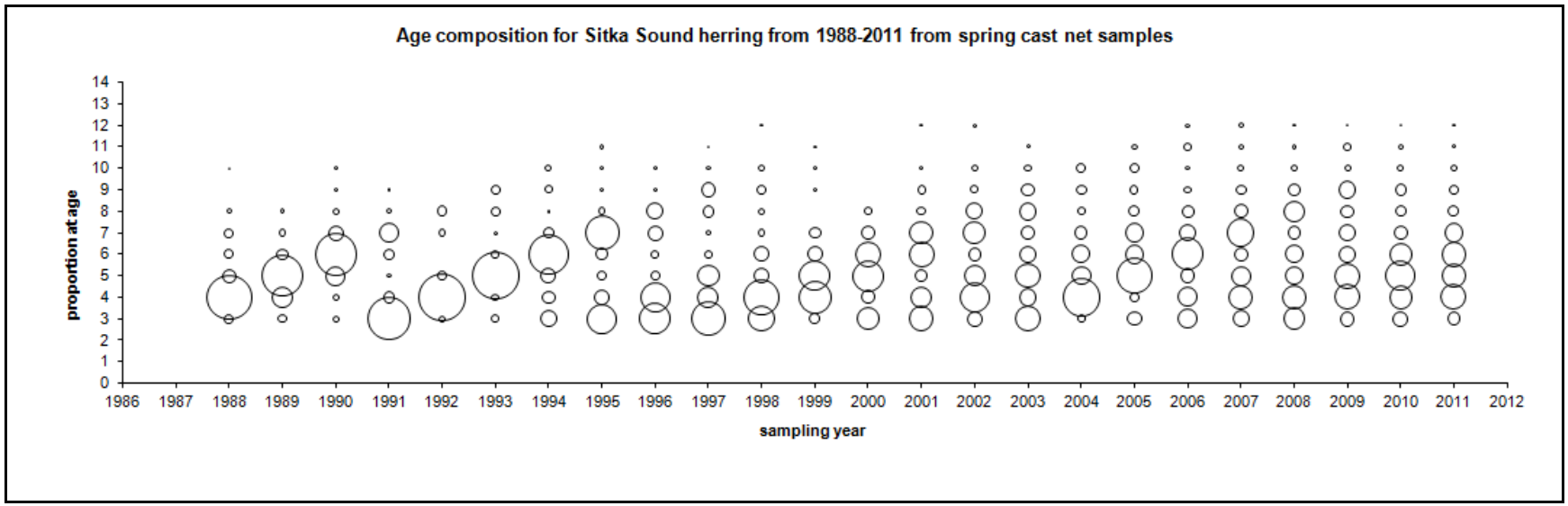


Figure 35.–Age composition from sampling data for the Sitka Sound herring stock. Ages presented for 2000 were not re-aged, and may be biased slightly high.

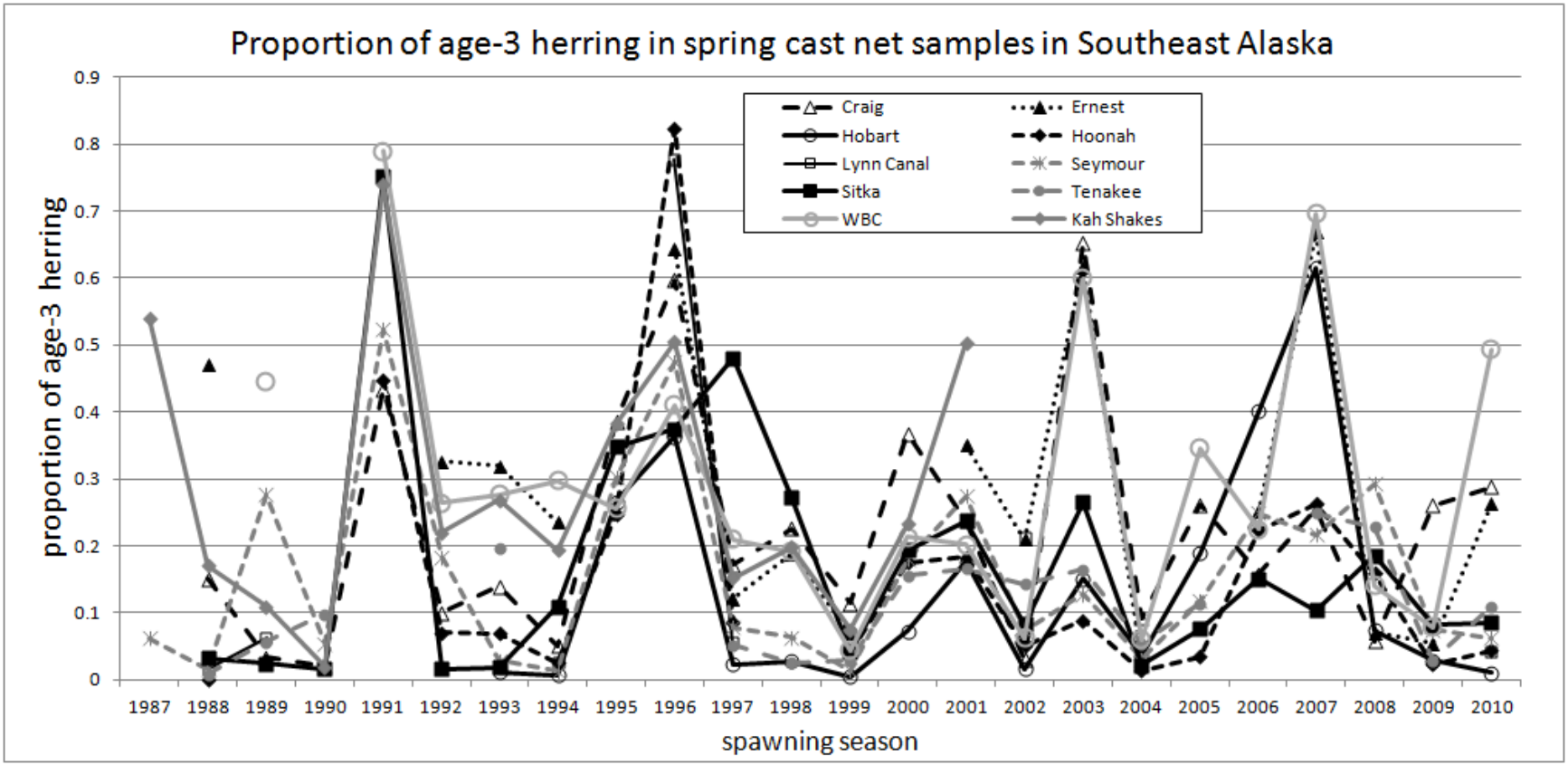


Figure 36.–Proportion of age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

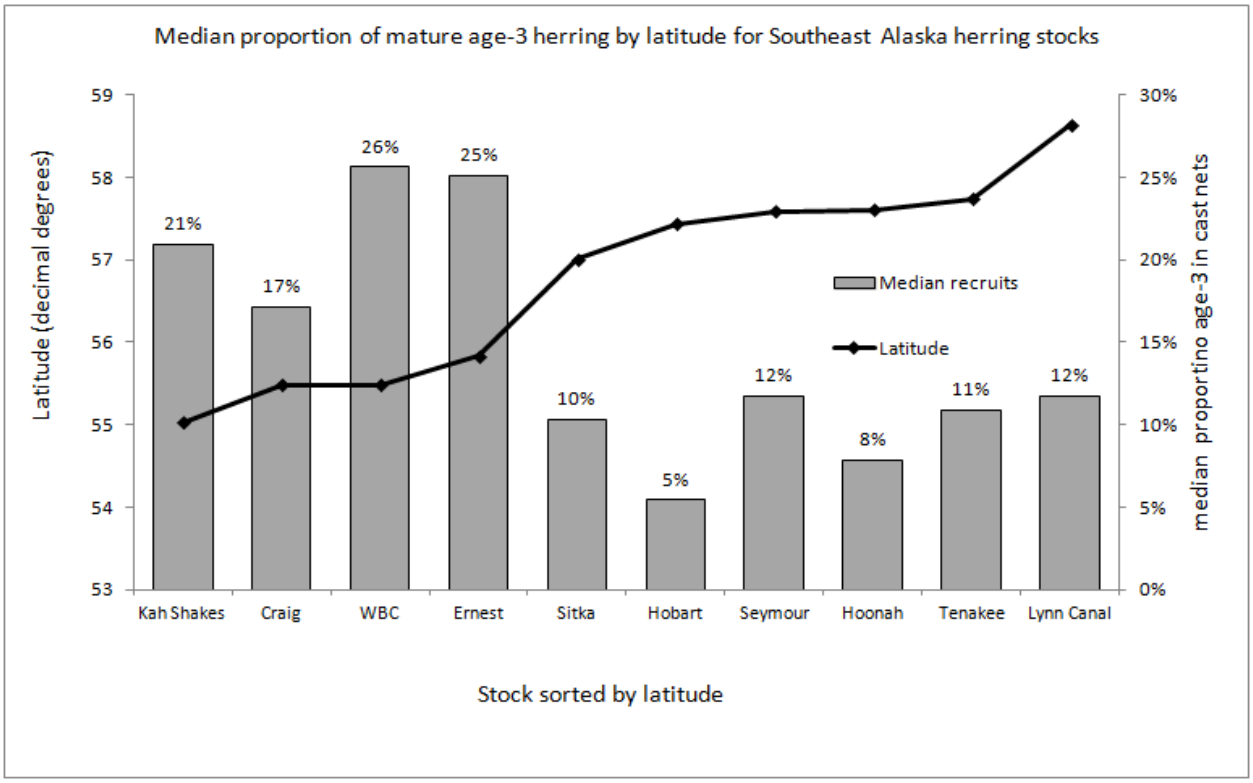


Figure 37.–Median proportion of age-3 herring in spring cast nest samples (1988-2010) and latitude of spawning populations for stocks in Southeast Alaska.

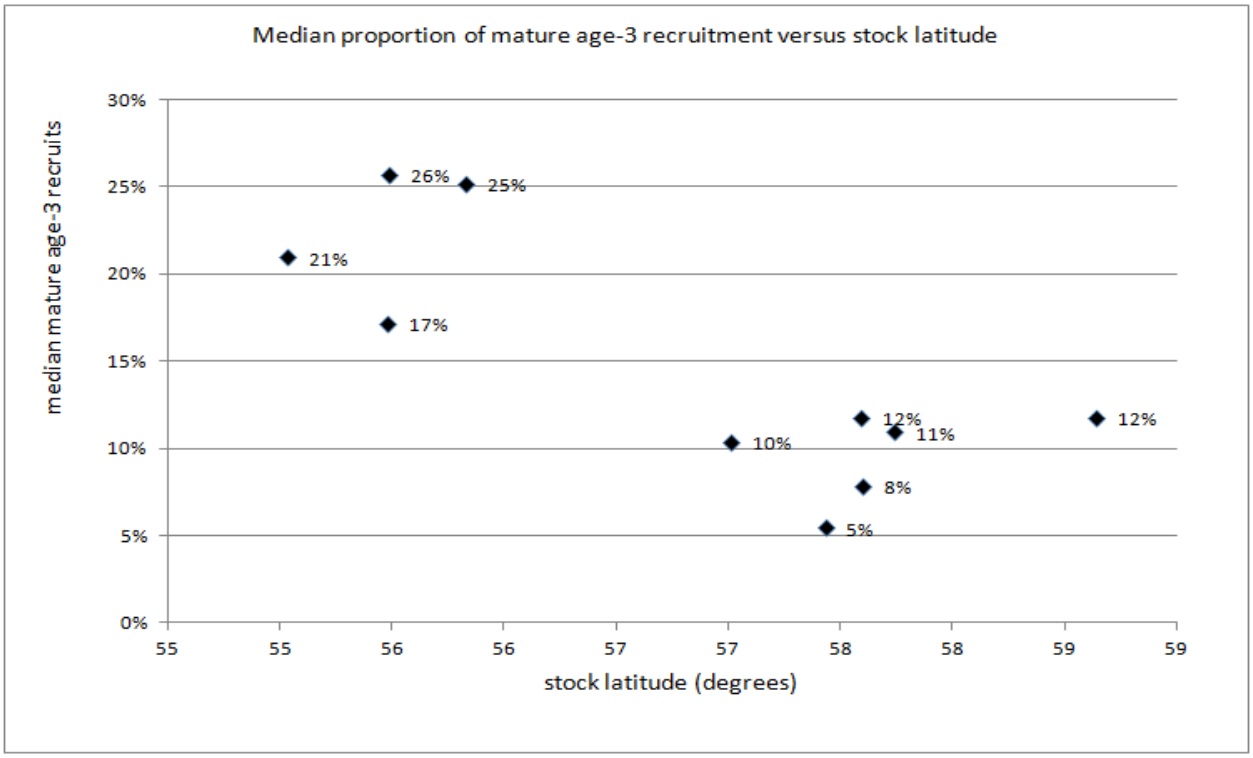


Figure 38.–Proportion of age-3 herring in spring cast nest samples versus stock latitude of spawning stocks in Southeast Alaska.

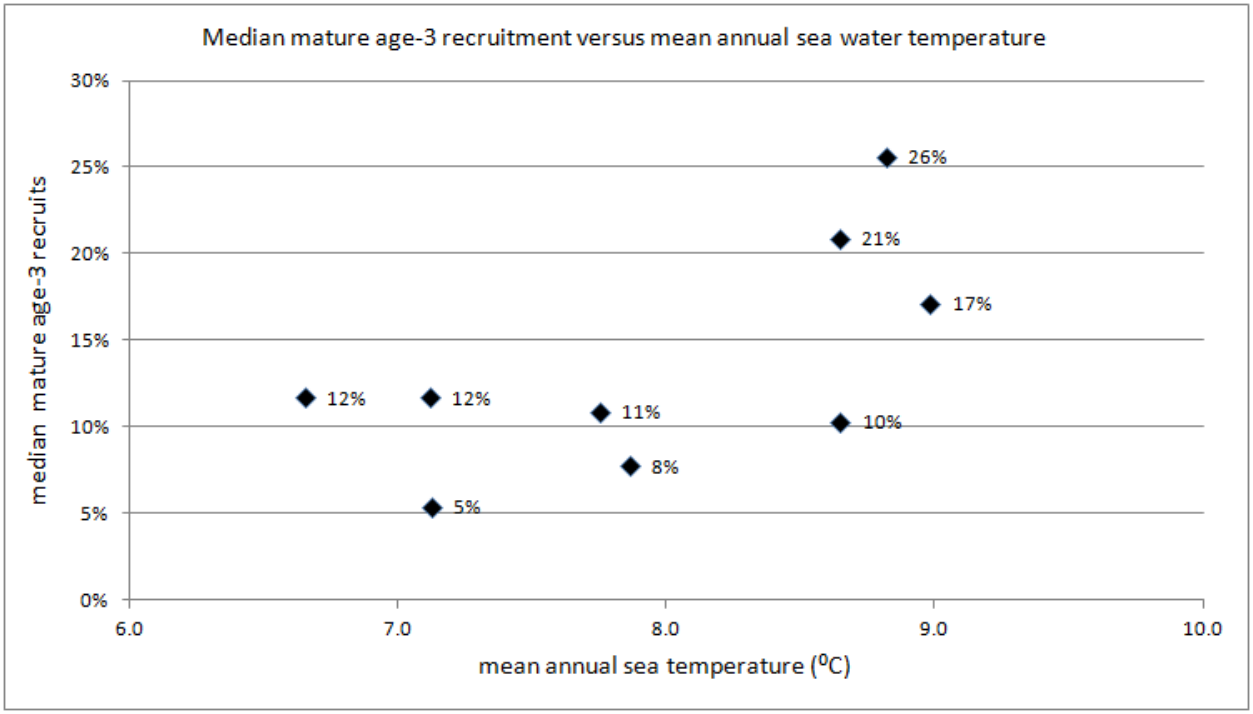


Figure 39.–Median proportion of age-3 herring in spring cast nest samples versus mean annual sea water temperature at location of spawning stocks in Southeast Alaska.

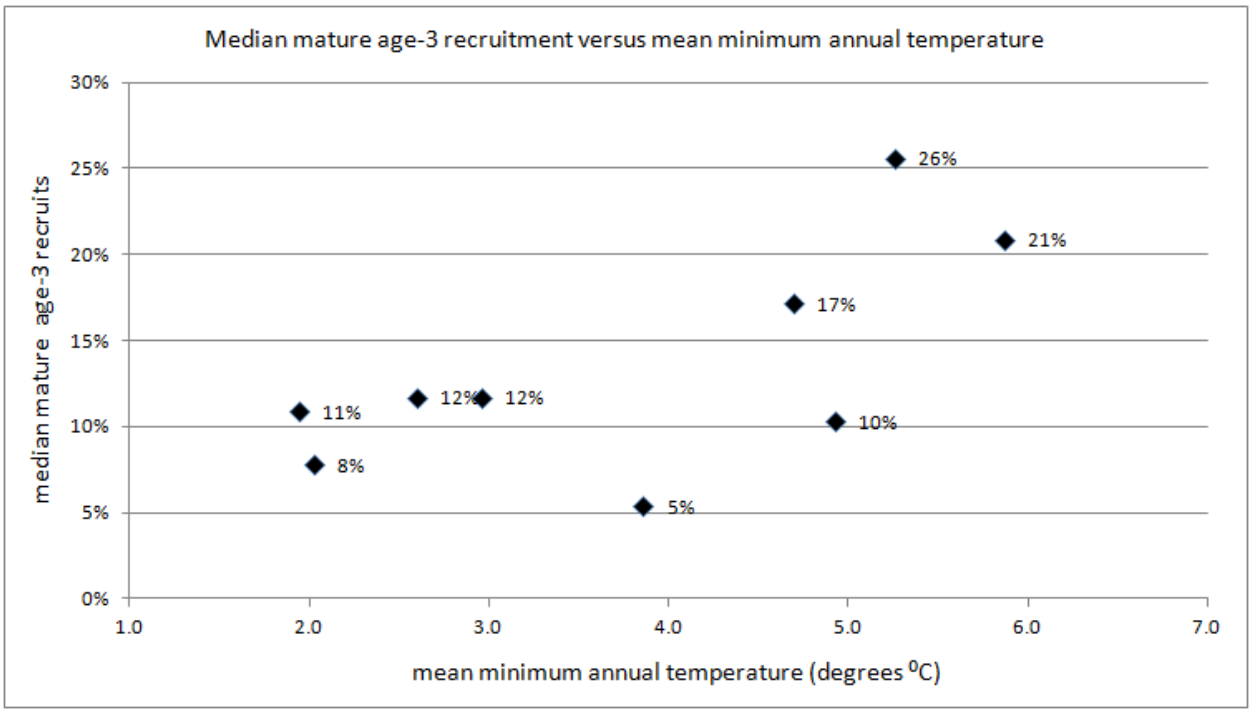


Figure 40.–Median proportion of age-3 herring in spring cast nest samples versus mean minimum annual sea water temperature at location of spawning stocks in Southeast Alaska.

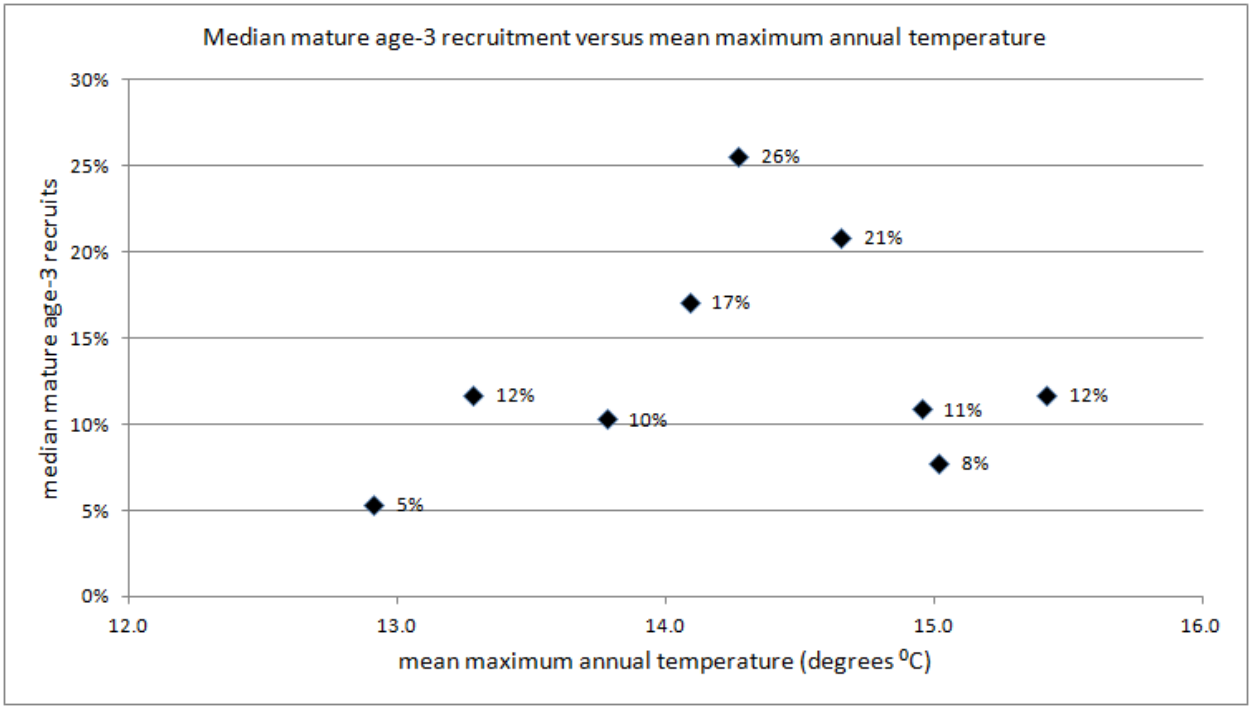


Figure 41.–Median proportion of age-3 herring in spring cast nest samples versus mean maximum annual sea water temperature at location of spawning stocks in Southeast Alaska.

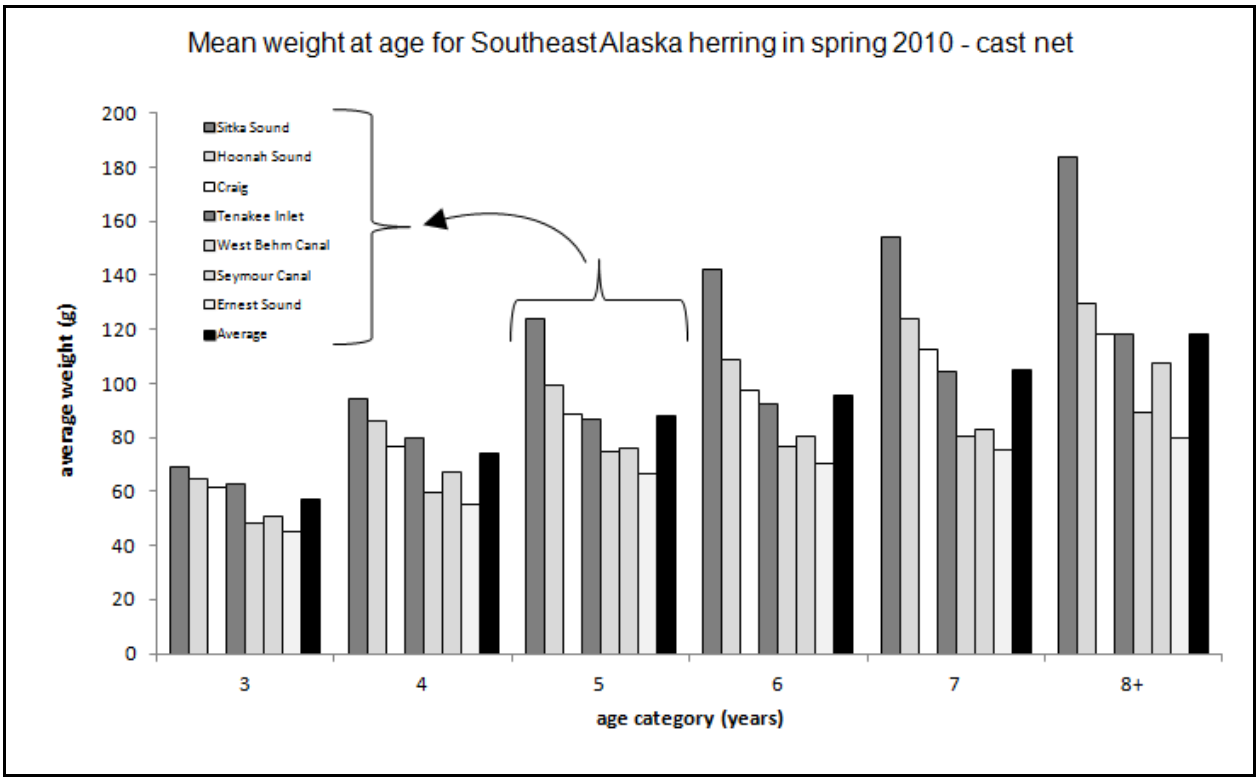


Figure 42.–Mean weight-at-age for Southeast Alaska herring stocks in spring 2010.

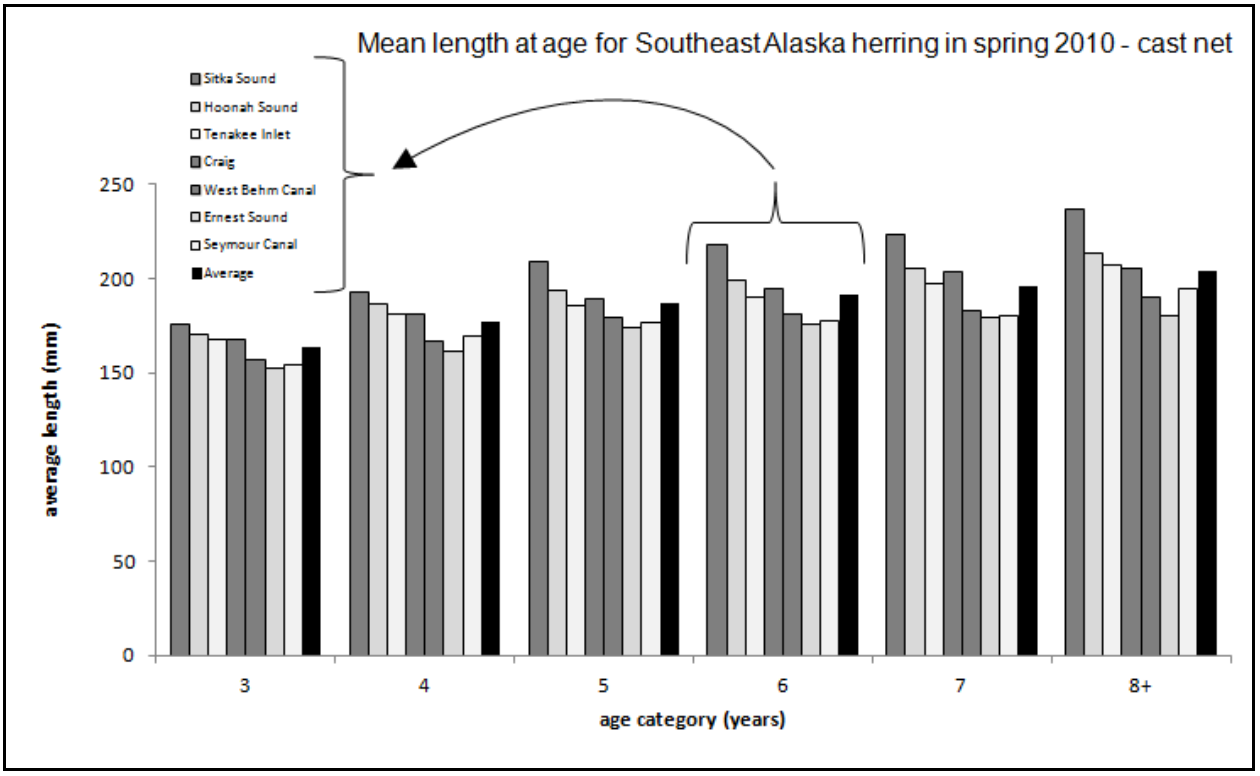


Figure 43.–Mean length at age for Southeast Alaska herring stocks in spring 2010.

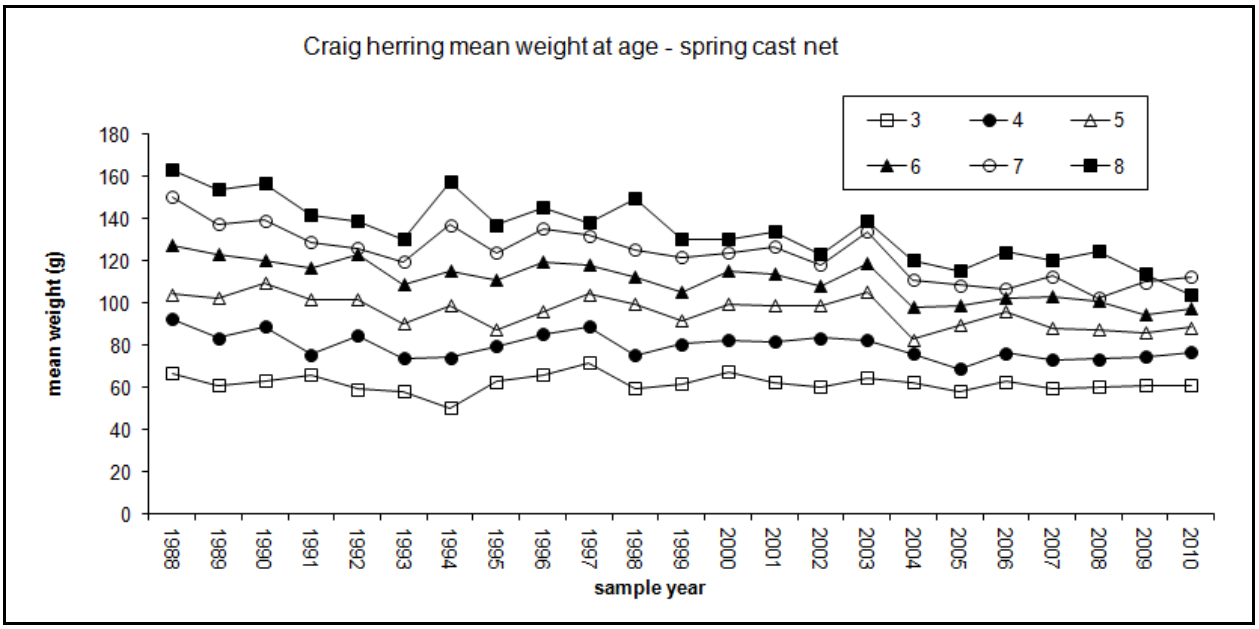


Figure 44.–Mean weight-at-age of the Craig herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

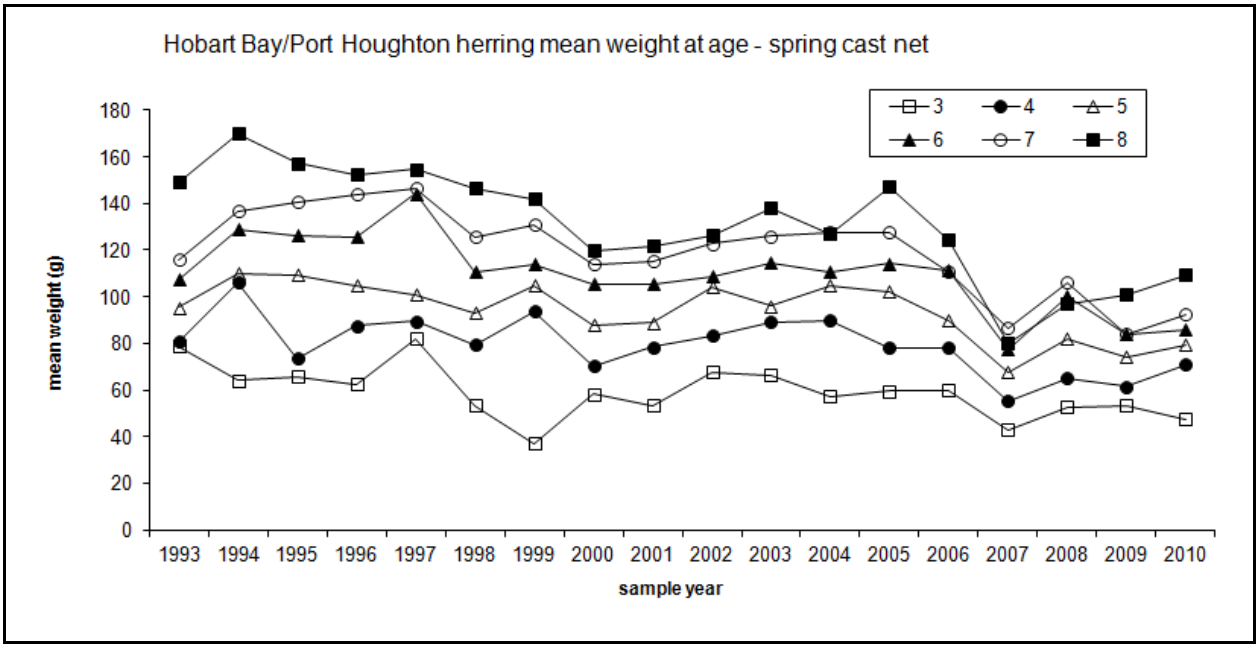


Figure 45.–Mean weight at age of the Hobart Bay/Port Houghton herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

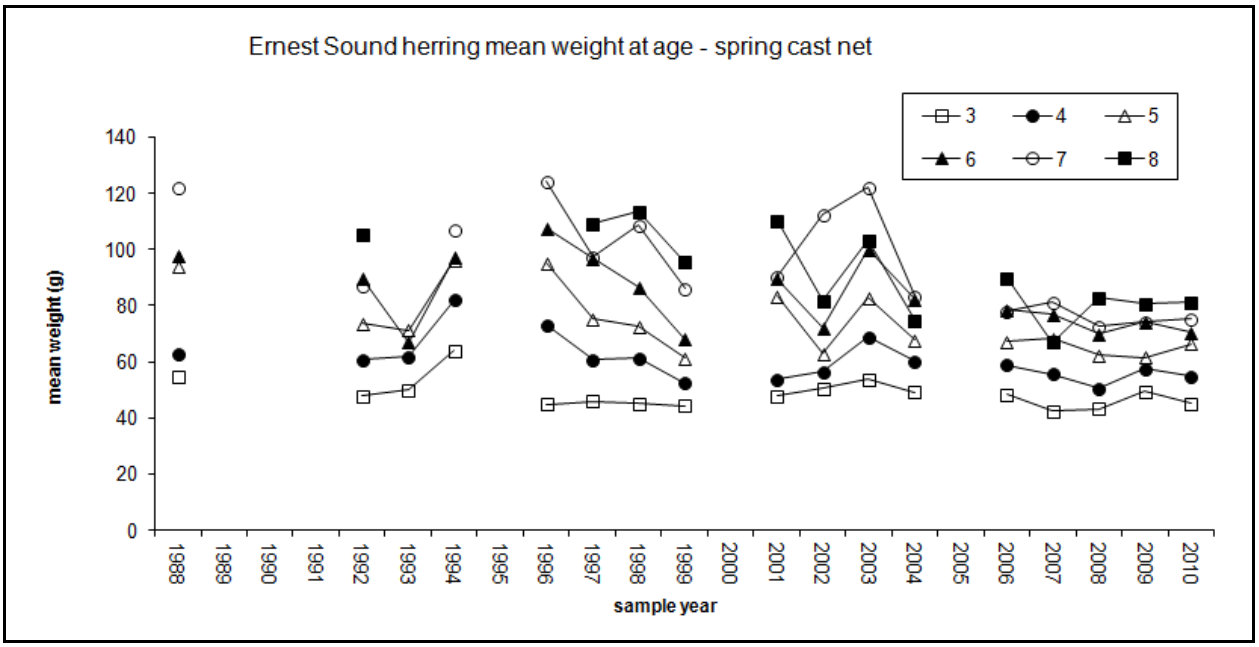


Figure 46.–Mean weight at age for the Ernest Sound herring spawning population.

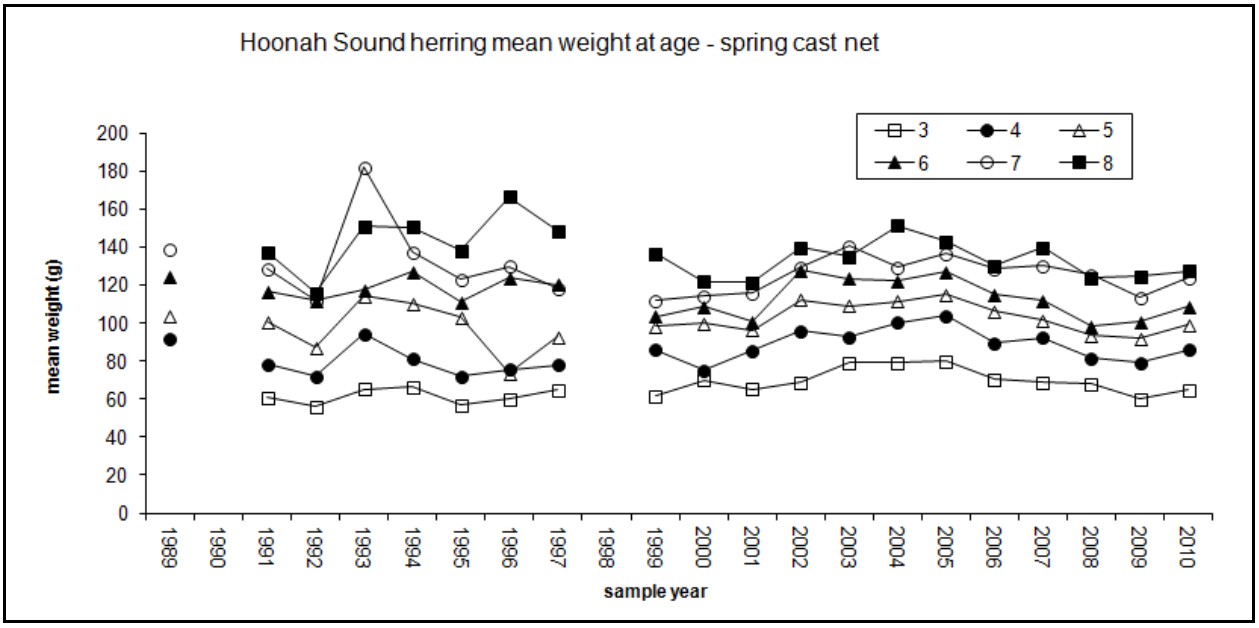


Figure 47.–Mean weight at age for the Hoonah Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

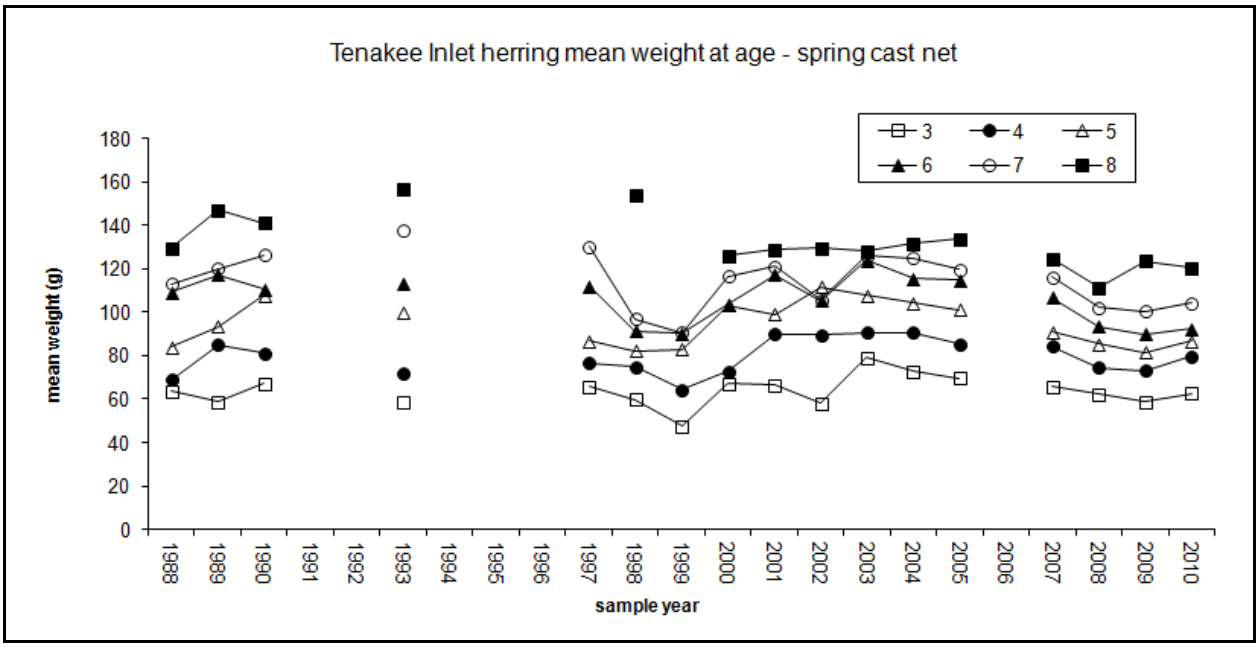


Figure 48.–Mean weight at age for the Tenakee Inlet herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

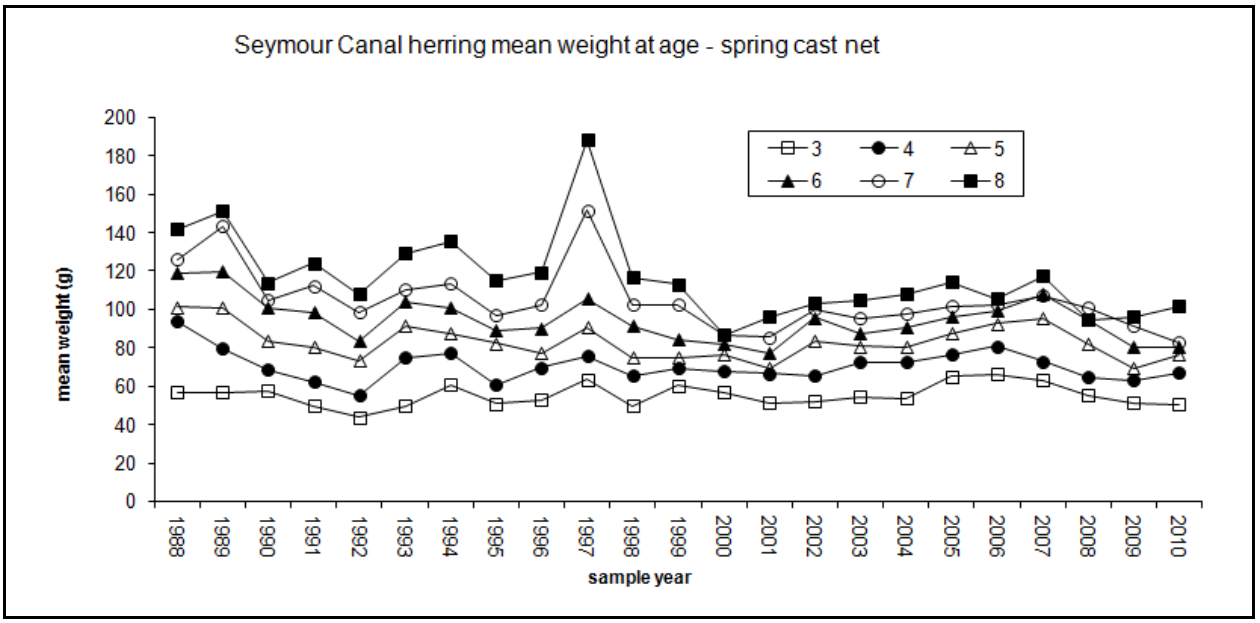


Figure 49.–Mean weight at age for the Seymour Canal herring stock. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

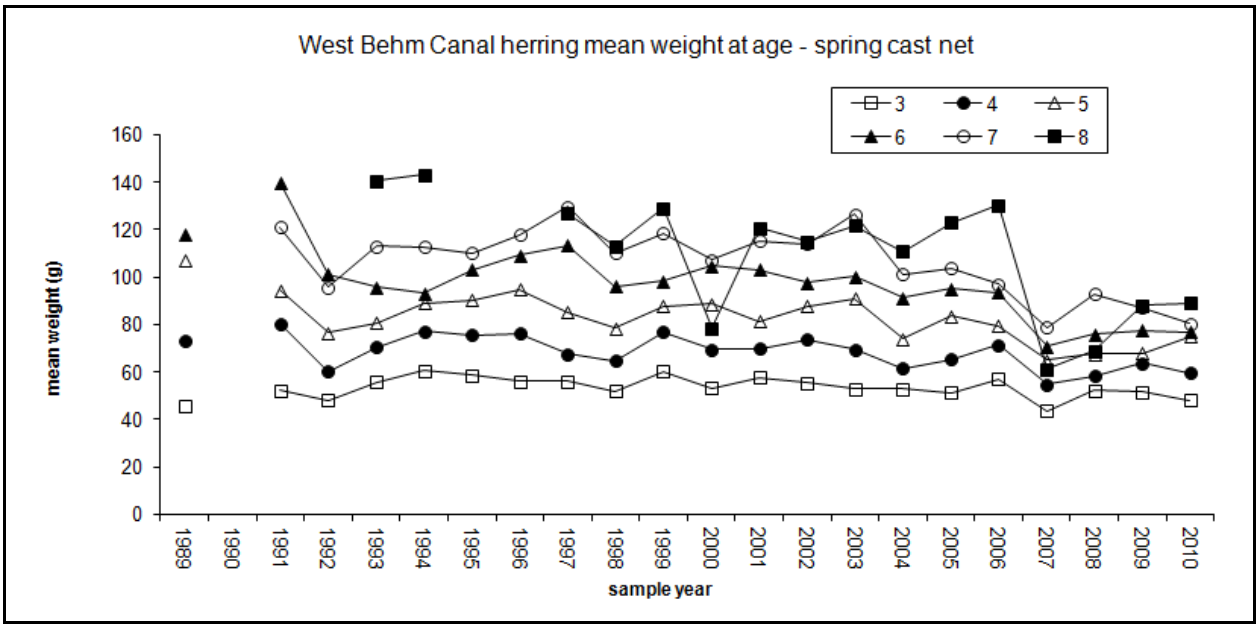


Figure 50.–Mean weight at age for the West Behm Canal herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

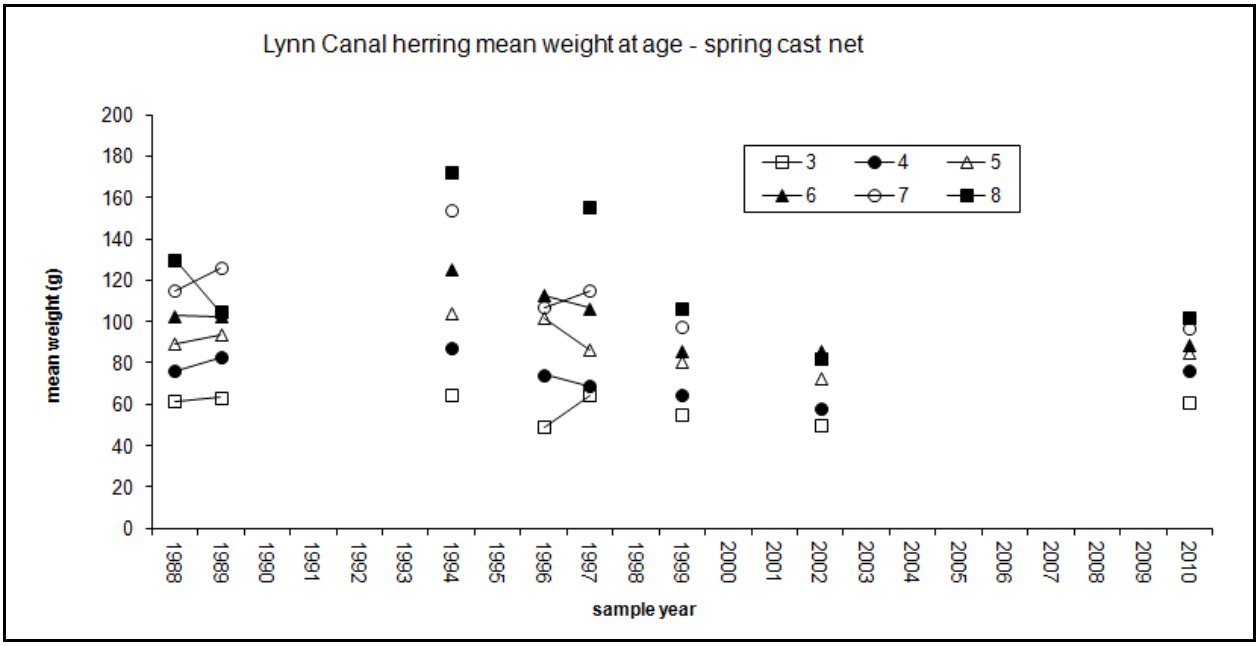


Figure 51.–Mean weight at age for the Lynn Canal herring spawning population.

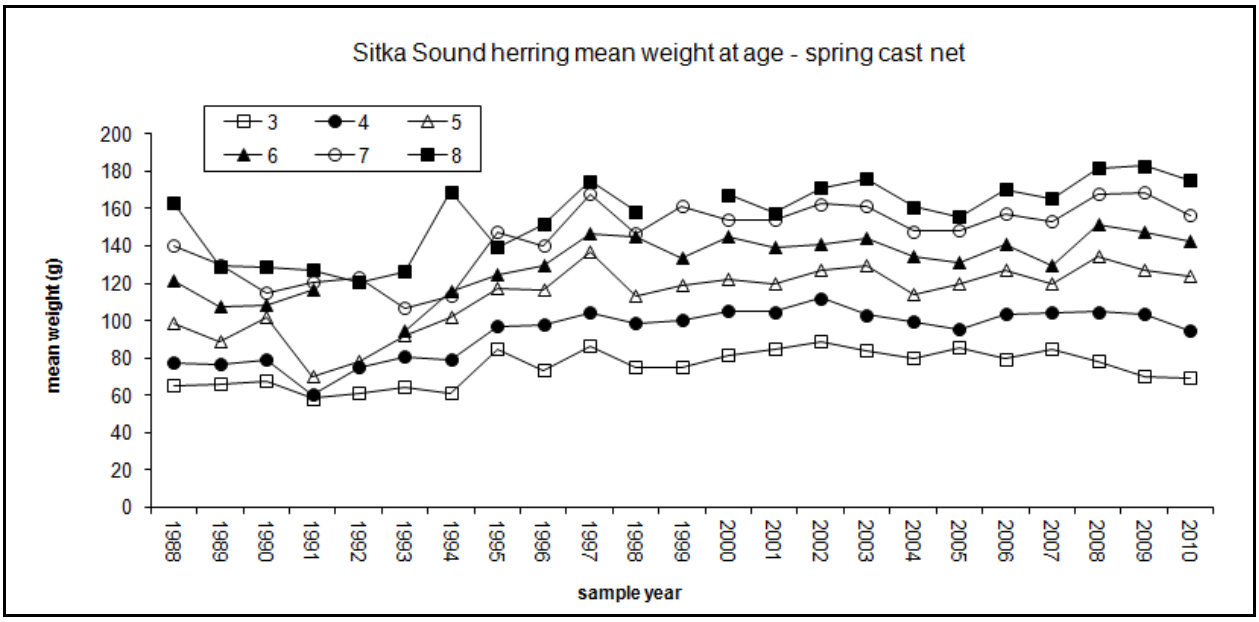


Figure 52.–Mean weight at age for the Sitka Sound herring spawning population. Ages for 2000 were not re-aged, making weight-at-age potentially biased slightly high.

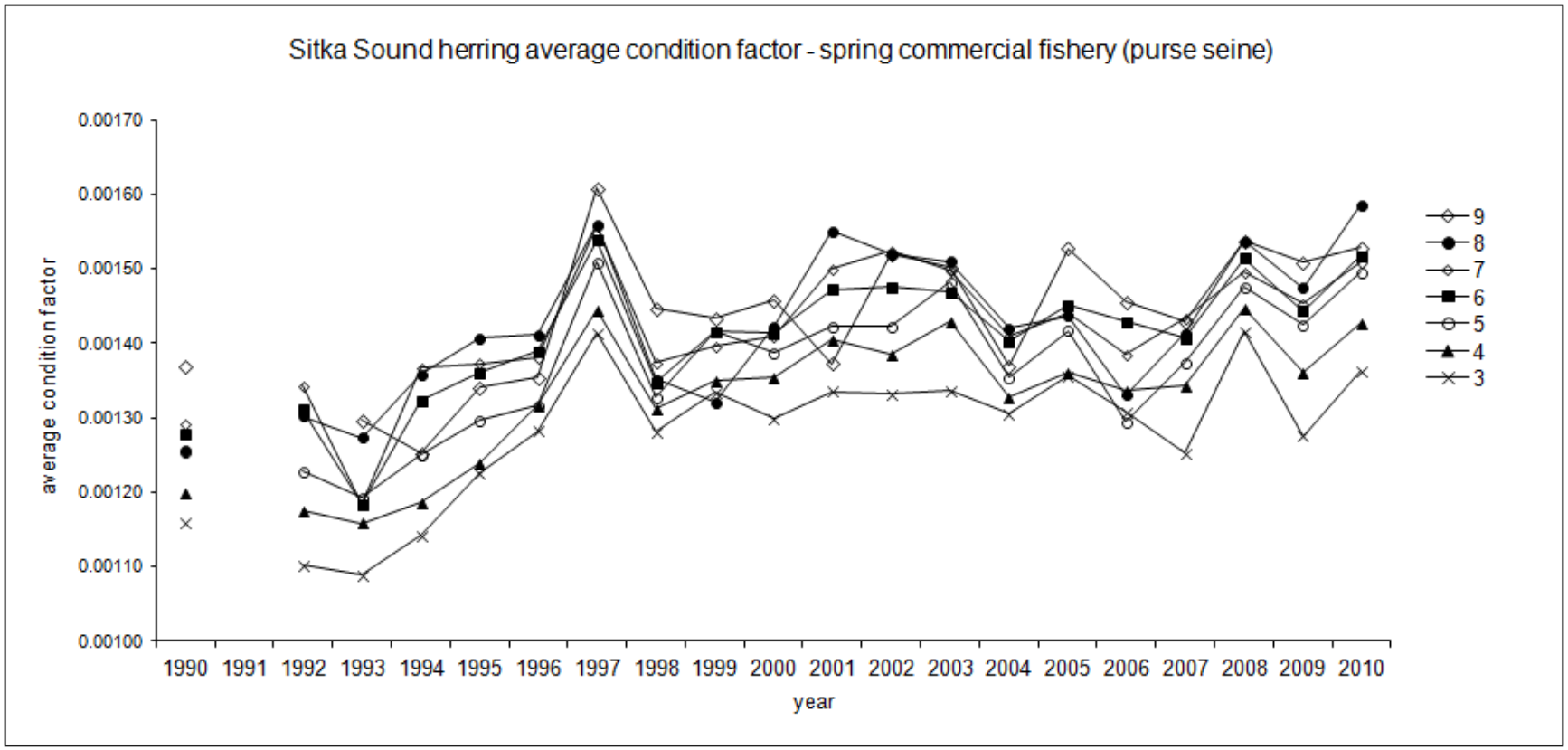


Figure 53.–Mean condition factors of age-3 through age-9 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning.

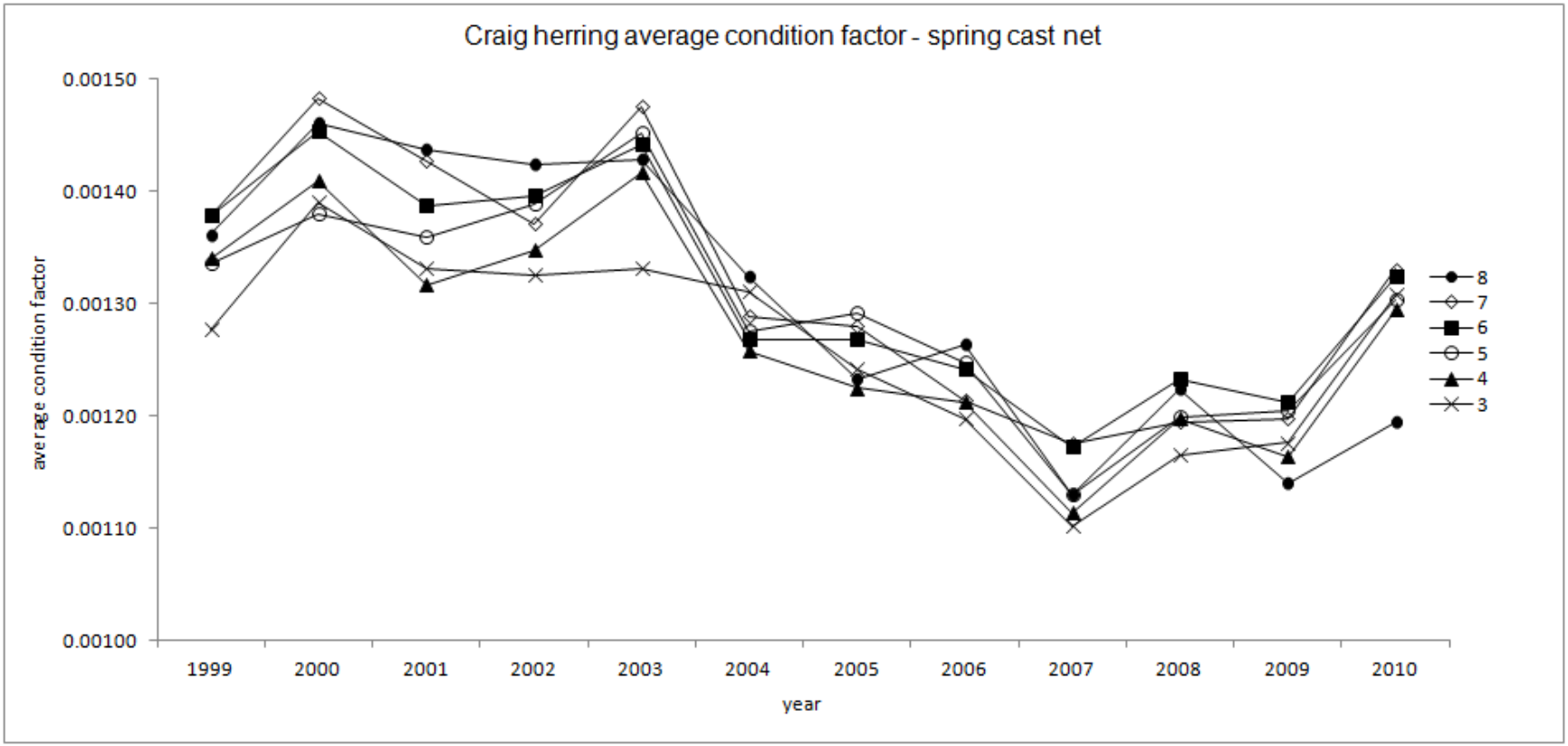


Figure 54.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

APPENDIX A

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

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

Appendix C1.–Aerial and skiff herring spawn surveys by date, near Craig (Ketchikan Management Area), Southeast Alaska in 2010.

3-18-10:

The first aerial survey of the Ketchikan area was completed today. The Craig and Revilla areas had high overcast clouds with moderate winds and no rain. Water visibility was very good. High winds are forecasted for tomorrow. No spawn seen–sea lions active near Coronado Islands, west shore of Alberto Islands, and in Trocadero Bay near Canoe Point. Possible spot spawn on Abyss Island.

3-22-10:

A aerial survey of the Craig area was completed today. No herring or herring spawn was observed. Weather conditions were cloudy with scattered rain and snow squalls. 2 whales were seen on the outside of the Ballenas Islands and another whale was observed near the outside of Trocadero Bay. Approximately 30 sea lions were observed near the Coronados Islands. No other significant predator activity was seen. There are 26 pound structures in place.

3-25-10:

A skiff survey was completed on Friday March 25. Conditions were cloudy with light winds. No herring or herring spawn was observed. 10 whales were seen off of the southwest side of San Juan Bautista Island and 6 whales were seen in between Pt. Amargura and Fern Point. No other significant predator activity was seen in the Craig/Klawock area. An aerial survey will be conducted today.

3-31-10:

A skiff survey was conducted in the Craig area today. Weather conditions during the survey began with partly cloudy skies and calm winds and changed to light southeast winds with snow squalls. There continues to be significant whale activity in San Alberto Bay with approximately 20 whales in between Pt. Ildefonso and Parida Island. A small school of herring was seen in deep water below San Christoval Channel. Three whales observed below Pt. Cuerbo on the southeastern side of San Fernando Island. There was no significant sea lion activity seen during the survey. There are approximately 55 functioning pound structures in place near Wadleigh Island. No herring have been introduced into the pound structures.

4-2-10:

A skiff survey was conducted in the Craig area today. Weather conditions were poor with rain showers and moderate to strong winds. There continues to be whale activity in-between Pt. Ildefonso and Parida Island. No herring or herring spawn were seen

4-3-10:

A skiff survey was conducted today. The weather was good with increased numbers of sea lions. Two small pods and one larger pod of sea lions were seen in Trocadero Bay. Two larger pods of around 25 and 20 were seen near Parida Island. There continued to be good whale activity between Parida Island and Point Ildefonso. Schools of herring were visible on the sounder in this area.

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4-5-10:

An aerial survey of the Revilla Channel herring stock and the Craig/Klawock herring stock was completed today Monday, April 5. Weather conditions were high overcast with light winds. 0.4 nmi. of active spawn was observed near Blanquizal Point. This was a small but intense spawn in a small bite directly south of Blanquizal Point. Large volumes of herring were observed against the beach in this area. Three whales and a small pod of sea lions were seen south of Blanquizal Point. The whale activity has dispersed around the Pt. Ildefonso area as the herring have begun to move in and around Wadleigh Island and the Alberto Island area. Herring have been moving through the pounding area and fishermen were actively filling their pounds. Approximately 30 pounds have had herring introduced.

4-6-10:

An aerial survey of the Revilla Channel herring stock and the Craig/Klawock herring stock was completed today, Tuesday, April 6. Weather conditions were partly cloudy with snow and rain squalls and light winds. There was approximately 0.6 nmi. of active spawn observed in the Craig area. An active spawn was beginning on the western shore of Wadleigh Island and a small spot spawn was beginning on the southern side of Abess Island. Herring schools were seen throughout the Craig area and spawn is expected to build and intensify over the next few days. Three whales and 25 sea lions were seen off of the Coronados Islands south of Craig. Fishermen are actively filling pounds and as of today 30 pounds have had herring introduced.

4-7-10:

An aerial survey to Craig was attempted, but terminated due to intense snow squalls. A skiff survey was conducted in the Craig/Klawock area today. Due to heavy snow squalls the department was not able to conduct an aerial survey. There was intense spawn around the Alberto Islands, along the southwest shore of Wadleigh Island and on the northern shore of Clam Island. A total of 3.1 nautical miles of spawn was observed. Two whales and a pod of 25 sea lions were seen in between Fish Egg Island and Clam Island. Whales continue to be seen in deeper water near the Witness Islands, on the north shore of Abbess Island and off of Alberto Reef. This is the third day of active spawn in the Craig/Klawock area.

4-8-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was completed today Thursday, April 8. Approximately 4 nmi. of spawn was observed in the Craig area. There was intense spawn around the Alberto Islands, along the southwest shore of Wadleigh Island and on the northern shore of Clam Island. Additional spawn was observed near Blanquizal Point and Port Bagial near the city of Craig. Large numbers of sea lions were observed near the spawning areas. Fishing activity was ongoing throughout the day and most of the herring pounds have fish. The weather was high overcast with light winds.

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4-9-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was completed today Friday, April 9. Approximately 6 nmi. of active spawn was observed in the Craig area. There was intense spawn around the Alberto Islands, along the southwest shore of Wadleigh Island, around Clam Island extending through the Klawock Reef, and around most of Abess Island. Large numbers of sea lions were observed near the spawning areas and a large pod of 50 sea lions was seen on the north end of Fish Egg Island. Fishing activity was ongoing throughout the day and all of the herring pounds have fish. The weather was mostly sunny with calm winds.

4-10/11-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was conducted on Saturday and Sunday, April 10 and 11. There was a major spawning event on Saturday, probably the largest amount of spawn at a single time so far this season with 10 nmi, of active spawn. Spawn continued through both days in the Blanquizal area. Spawn started on the north side of Fish Egg Island on Saturday and continued to build through Sunday. There are a large numbers of Sea Lions spread through the area, but whale activity seems to be decreasing. The spawn on Saturday continued to be strong from Entrance Point to the outside of Abbess Island including all areas in between. The Saturday spawn continued at Abbess Island all day long, and was still active Sunday, although the areas north of Fish Egg Island appeared to be decreasing in extent and intensity. The only strong area of spawn for Sunday was the section on Fish Egg Island. Approximately 7 nmi. of active spawn was observed on Sunday.

4-12-10:

An aerial survey of the West Behm Canal stock and the Craig/Klawock stock was conducted today, Monday, April 13, 2010. Approximately 3 nmi. of active spawn was seen today in the Craig/Klawock area. Spawn was observed on the western side of Fish Egg Island and a small spot spawn was seen on the southern tip of the Witnesses. The R/V Kestrel is on the grounds and is expected to begin spawn deposition surveys later this week in Craig.

4-13-10:

An aerial survey of the West Behm Canal stock and the Craig/Klawock stock was conducted today, Tuesday, April 13, 2010. Approximately 1 nmi. of active spawn was seen today in the Craig/Klawock area. Spawn was observed on the western side of Fish Egg Island and a small spot spawn was seen on the southern tip of the Witnesses. Total cumulative spawn for 2010 in the Craig area is approximately 18.5 nautical miles. The R/V Kestrel is on the grounds and is expected to begin spawn deposition surveys later this week in Craig.

4-14-10:

An aerial survey of the West Behm Canal stock and the Craig/Klawock stock was conducted today, Wednesday, April 14, 2010. There was no herring spawn observed in the Craig/Klawock area today. Total cumulative spawn for 2010 in the Craig area is approximately 18.5 nautical miles. The R/V Kestrel is on the grounds and began conducting spawn deposition surveys today. This is the last scheduled survey for the Craig/Klawock area.

Appendix C2.–Aerial and skiff herring spawn surveys by date, in Revilla Channel (Ketchikan Management Area), Southeast Alaska in 2010.

3-18-10:

The first aerial survey of the Ketchikan area was completed today. The Craig and Revilla areas had high overcast clouds with moderate winds and no rain. Water visibility was very good. High winds are forecasted for tomorrow. No spawn seen – sea lions active near Coronado Islands, west shore of Alberto Islands, and in Trocadero Bay near Canoe Point. Possible spot spawn on Abyss Island.

3-25-10:

A aerial survey of the Revilla Channel herring stock area was completed today. No herring spawn observed. Weather was overcast, light rain and light north wind. Water visibility was excellent. Sea Lion and bird activity on SW Annette Island (between Deer Point and Point Davison). Sea Lion activity in Cascade Inlet and around Ham Island.

3-29-10:

No herring spawn observed. Weather was rain, fog and light winds. Water visibility was still good in most areas. Sea Lion and bird activity was observed on SW Annette Island (between Deer Point and Point Davison). Sea Lion activity was observed in Cascade Inlet and around Ham Island. No survey was done in the Cat Island and Kah Shakes area.

3-31-10:

An aerial survey of the Revilla Channel herring stock was completed today Wednesday, March 31. Approximately 2 nmi. of herring spawn was observed. Weather was light overcast with calm winds. The Annette Island reserve was conducting a commercial fishery on the east side of the Island with approximately 45 vessels. Sea Lion and bird activity was observed around the Island. No survey was done in the Cat Island and Kah Shakes area.

4-2-10:

An aerial survey of the Revilla Channel herring stock was completed today Friday, April 2. Approximately 0.25 nmi. of herring spawn was observed on the eastern shore of Annette Island north of Crab Bay and in Kwain Cove. Weather was light overcast with calm winds. The Annette Island reserve was conducting a commercial fishery on the island with the majority of vessels on the east side of the Island. Approximately 44 vessels were observed fishing. Sea Lion and bird activity was observed around the Island.

No sea lion or herring activity was seen in the vicinity of the Cat Island and Kah Shakes area.

4-3-10:

An aerial survey of the Revilla Channel herring stock was completed today Saturday, April 3. Approximately 2.5 nmi. of herring spawn was observed on the eastern shore of Annette Island north of Crab Bay. Weather was light overcast with moderate winds and rain squalls. The Annette Island reserve was conducting a commercial fishery on the island with the majority of vessels on the east side of the Island. Approximately 45 vessels were observed fishing. Sea Lion and bird activity was observed around the Island.

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No survey was done on the Cat Island and Kah Shakes area.

4-4-10:

An aerial survey of the Revilla Channel herring stock was completed today Sunday, April 4. Yesterday, April 4 – Approximately 1.25 nmi. of herring spawn was observed on the eastern shore of Annette Island north of Crab Bay and in Kwain Bay. Weather was clear with occasional fog. The Annette Island reserve was conducting a commercial fishery on the island in the vicinity of Crab and Kwain Bays. Approximately 45 vessels were observed fishing. Sea Lion and bird activity was observed primarily on the eastern shore of the Island.

No survey was done on the Cat Island and Kah Shakes area.

4-5-10:

An aerial survey of the Revilla Channel herring stock and the Craig/Klawock herring stock was completed today Monday, April 5. Approximately 0.5 nmi. of herring spawn was observed on the eastern shore of Annette Island around Crab Bay. Weather was clear with light winds. Sea Lion and bird activity was observed primarily on the eastern shore of the Island.

No survey was done on the Cat Island and Kah Shakes area.

4-6-10:

An aerial survey of the Revilla Channel herring stock and the Craig/Klawock herring stock was completed today, Tuesday, April 6. Approximately 1 nmi. of herring spawn was observed on the eastern shore of Annette Island around Crab and Kwain Bays. Weather was overcast with moderate winds. Sea Lion and bird activity was observed primarily on the eastern shore of the Island.

No survey was done on the Cat Island and Kah Shakes area.

4-7-10:

An aerial survey of the Revilla Channel herring stock was completed today Wednesday, April 7. Approximately 1.5 nmi. of herring spawn was observed on the eastern shore of Annette Island around Crab and Kwain Bays. Weather was snow squalls with moderate winds. Sea Lion and bird activity was observed primarily on the eastern shore of the Island.

No survey was done on the Cat Island and Kah Shakes area.

4-8-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was completed today Thursday, April 8. Approximately 0.75 nmi. of herring spawn was observed on the eastern shore of Annette Island around Crab and Kwain Bays. Weather was snow squalls with heavy winds. Sea Lion and bird activity was observed primarily on the eastern shore of the Island.

No herring or herring activity was observed on the Cat Island and Kah Shakes area.

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4-9-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was completed today Friday, April 9. Approximately 2.0 nmi. of active herring spawn was observed around Annette Island. There was approximately one nautical mile

of spawn extending south from the southern end of Cascade Inlet on the Annette shore and two separate spawn occurring in between Pt. Davidson and Canoe Cove. Weather was mostly sunny with calm winds. Sea Lion and bird activity was observed primarily on the eastern shore of the Island.

4-10/11-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was conducted on Saturday and Sunday, April 10 and 11.

Saturday April 10–Approximately 0.5 nmi. of herring spawn was seen today near Kwain Bay. Limited activity was observed around the Island. Weather was overcast with light winds and occasional snow squalls.

Sunday April 11–No active spawn was seen in the area except for a small spot spawn on the eastern shore of Annette Island. Weather was clear and windy.

Total miles of spawn estimated for Revilla Channel area by ADF&G biologists is 7.7 nmi.

Appendix C3.–Aerial and skiff herring spawn surveys by date, in West Behm Canal (Ketchikan Management Area), Southeast Alaska in 2010.

4-8-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was completed today Thursday, April 8. Approximately 0.2 nmi. of herring spawn was seen today near Survey Point. A quick flyby of West Behm today resulted in herring spawn and so a complete survey was done. It is unclear if this is the start of major spawning or just a spot spawn.

4-9-10:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was completed today Friday, April 9. Approximately 0.25 nmi. of herring spawn was seen today near Survey Point along with 30 sea lions. No other activity was observed in the area. Weather was overcast with light winds and occasional snow squalls.

4-10/11-2010:

An aerial survey of the Revilla Channel herring stock, the West Behm Canal stock and the Craig/Klawock stock was conducted on Saturday and Sunday, April 10 and 11.

Saturday April 10–Approximately 0.25 nmi. of herring spawn was seen today near Survey Point along with 30 sea lions. No other activity was observed in the area. Weather was overcast with light winds and occasional snow squalls.

Sunday April 11–No active spawn was seen in the area. Sea lions were seen near Survey Point.

4-12-10:

An aerial survey of the West Behm Canal stock and the Craig/Klawock stock was conducted today, Monday, April 12, 2010. Approximately 0.25 nmi. of active spawn was observed in West Behm Canal. There was a small spot spawn around Survey Point and progressing spawn on the northwest side of Betton Island. There are still sea lions around Survey Point and Caamano Point.

4-13-10:

An aerial survey of the West Behm Canal stock and the Craig/Klawock stock was conducted today, Tuesday, April 13, 2010. Approximately 1 nmi. of active spawn was observed in West Behm Canal. There were small spawning events spread throughout the area including a small spot spawn in front of Whipple Creek, several small spawns around Tatoosh Rocks and on the northwest side of Betton Island and approximately .5 nmi. of spawn in Bond Bay on the Cleveland Penninsula. There are still sea lions around Survey Point and Caamano Point.

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4-14-10:

An aerial survey of the West Behm Canal stock and the Craig/Klawock stock was conducted today, Wednesday, April 14, 2010. Approximately 6 nmi. of active spawn was observed in West Behm Canal. Active spawn was seen immediately north of Pond Reef and extended north past Survey Point on Revillagigedo Island, small ongoing spot spawns around Tatoosh Rocks, and active spawn from the southern end of Bond Bay extending northward to the southern end of Smugglers Cove.

4-15-10:

An aerial survey of the West Behm Canal stock was conducted today. Approximately 5 nmi. of active spawn was observed in West Behm Canal. Active spawn was seen on Pond Reef and small spot spawns were ongoing around Whipple Creek. There was intense active spawn throughout Tatoosh Rocks and active spawn from Caamano Point extending northward sporadically to Smugglers Cove on the Cleveland Peninsula shoreline. This is the seventh day of spawn and the fourth consecutive day of active spawn in West Behm Canal. Cumulative spawn in West Behm through today is 10.8 nautical miles.

4-16-10:

An aerial survey of West Behm Canal was conducted today. Approximately 0.5 nmi. of active light spawn was seen. Spawn was seen around Light Island in Clover Pass and around the inside of Tatoosh Rocks.

4-17-10:

An aerial survey of West Behm Canal was conducted today. No herring or herring spawn was observed. This was the last aerial survey of West Behm Canal and the last aerial survey for the 2010 Ketchikan herring season.

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Sitka Sound (Sitka Management Area), Southeast Alaska in 2010.

3-15-10:

Spotting conditions were generally good with northwest winds 15-25 knots and mostly cloudy. This extensive survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. No herring were seen. All areas to the south of Sitka were quiet and the only observation of herring predators was eight sea lions off Vitskari Rocks and six near Silver Bay. North of Sitka, the largest concentration of sea lions was seen off Bieli Rock, with an estimated count of 150, with additional smaller groups in the vicinity. Another 50 sea lions were seen in the Inner Point and Mountain Point area and six whales were observed scattered in the trench between Inner Point and the Siginaka Islands. Several groups totaling 45 sea lions were seen in Nakwasina Sound, and 60 sea lions were scattered in groups around the trench between Lisianski Peninsula and the Siginaka Islands. In Salisbury Sound two sea lions were seen north of Gilmer Cove, 14 sea lions were seen in northern portion of Neva Strait and two whales were observed near Sinitsin Island.

3-16-10:

No aerial survey was scheduled for today. A vessel survey conducted on the Department's Attack Whaler showed a significant number of herring predators in the Nakwasina Sound area and along the Lisianski Peninsula. Herring predators were also observed in the trench southwest of the Siginaka Islands

3-15-10:

No aerial survey was conducted today due to marginal weather. It was announced today the Sitka Sound sac roe herring fishery will be on two-hour notice effective 12:00 noon, Friday, March 19, 2010. A vessel survey conducted on the Department's Attack Whaler showed very few herring predators in the Nakwasina Sound area and along the Lisianski Peninsula. Predators appear to have moved south and west into the trenches southwest of the Siginaka Islands and east of Kasiana Island.

3-18-10:

Spotting conditions were generally good with northwest winds 10-15 knots and mostly cloudy. Today's survey covered Sitka Sound, south to Cape Burunof and north to Nakwasina Sound. No herring were seen. All areas to the south of Sitka were quiet and the only observation of herring predators was seven sea lions near Silver Bay. North of Sitka, the largest concentration of sea lions was seen off Inner Point on Kruzof Island, with an estimated count of 200, additionally six whales were also seen in the vicinity. Concentrations of herring predators were also observed east of Middle Island, in Nakwasina Sound between Crosswise Island and Allen Point, and west of the Lisianski Peninsula.

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3-19-10:

No aerial survey was conducted today due to meeting schedule and the need for managers to see firsthand the distribution of fish thru a sonar survey on the R/V Kestrel. During the vessel survey of northern Sitka Sound significant schools of herring were found in the trench east of Middle Island, South of the Siginaka Islands and south of Crosswise Island. No survey was conducted on the Kruzof Island shore or south Sitka Sound.

3-20-10:

Spotting conditions were generally good with northwest winds 10-15 knots and partly cloudy. Today's aerial survey covered Sitka Sound north of Cape Burunof. No spawn or herring schools were seen during the survey. The largest concentration of sea lions was on the Kruzof Island shoreline with approximately 375 counted off the shoals immediately south of Fred's Creek and another 175 sea lions were off Inner Point. Numerous whales were also seen in the area. Sea lions continue to be seen in scattered groups between the Siginaka Islands and Crosswise Island and in Nakwasina Sound. The vessel survey covered the road system north of town, the Inner Point area, Promisla Bay, Siginaka Islands, and Nakwasina Sound. A large school of herring was seen near Old Sitka Rocks, and several deep schools were seen in Nakwasina Sound and east of the Siginaka Islands. A number of large herring schools were seen near shore in an area extending from Inner Point to Mountain Point.

3-21-10:

Spotting conditions were generally good with northwest winds 10-15 knots and partly cloudy. Today's aerial survey covered Sitka Sound south to windy Pass and north of Salisbury Sound. No spawn or herring schools were seen during the survey. Significant herring predator concentrations were observed in: Nakwasina Sound, along the Kruzof Island shore between Inner Point and Brent's Beach, east of Middle Island and west of the Lisianski Peninsula.

3-22-10:

Spotting conditions were generally good with northwest winds 10-15 knots and partly cloudy. Today's aerial survey covered Sitka Sound north of Cape Burunof. No spawn or herring schools were seen during the survey. The largest concentration of sea lions was on the Kruzof Island shoreline with approximately 275 in the area from Inner Point to Mountain Point. Smaller groups of sea lions were scattered along the east side of Middle Island, north of Kasiana Island and off Halibut Point. Sea lions continue to be seen in Nakwasina Sound but there were fewer numbers than what had been observed over the past week.

3-23-10: No aerial survey was conducted today due to poor weather. Heavy Rain with winds SW 35.

3-24-10: No aerial survey was conducted today due to poor weather. Low overcast with limited visibility, winds SE 15. The Sitka Sound herring sac roe fishery was opened from 5:10 p.m. until 6:35 p.m.

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3-25-10:

Spotting conditions were generally good with northwest winds 5-10 knots and clear skies. Today's aerial survey covered Sitka Sound north of Windy Pass and south of Nakwasina Sound. No spawn or herring schools were seen during the survey. Herring predator concentrations were found; along the Kruzof Island shore between Inner Point and Rob Point, around Middle and Crow Islands, in the waters west of the Lisianski Peninsula, and in the mouth of Nakwasina Sound.

3-26-10:

Spotting conditions were generally good with northwest winds 15 knots and partly cloudy skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Salisbury Sound. No spawn or herring schools were seen during the survey. Herring predator concentrations were found; along the Kruzof Island shore between Inner Point and Rob Point, around Middle and Crow Islands, in the waters west of the Lisianski Peninsula, in Eastern Bay and in Nakwasina Sound. Herring predators were also observed in Neva Strait.

3-27-10:

Spotting conditions were generally poor with northwest winds 20-35 knots and partly cloudy. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Nakwasina Sound, conducted in marginal viewing conditions, showed no active spawn. The Sitka Sound herring sac roe fishery was opened from 1:00 p.m. until 3:55 p.m.

3-28-10:

No aerial survey was conducted today due to poor weather. High wind warning, winds SE 40 with gusts to 50 knots.

3-29-10:

Spotting conditions were good with calm winds and clear skies. Today's aerial survey covered Sitka Sound north of Windy Passage and south of Nakwasina Sound. Herring predator concentrations were found; along the Kruzof Island shore between Fred's Creek, around Middle and Crow Islands, in the waters east of Kasiana Island, and in Eastern Anchorage/ Silver Bay. Herring were visible from the air in Leesoffskaia Bay.

3-30-10:

Spotting conditions were good with winds SW 10-15 knots and partly overcast skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Nakwasina Sound. Herring predator concentrations were found; around Middle and Crow Islands, in the waters east of Kasiana Island, and in Eastern Anchorage/ Silver Bay. Herring were visible from the air in Eastern Anchorage. The Sitka Sound herring sac roe fishery was opened from 1:45 p.m. until 4:25 p.m.

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3-31-10:

Spotting conditions were good with winds SW 10-15 knots and partly overcast skies. During today's Aerial survey no herring spawn was observed. Herring schools were observed in large concentrations in Crescent Bay/Eastern Anchorage and inside the breakwater near Eliason Harbor. A couple of small schools of herring were observed in the Siginaka Islands. Herring predators were widely distributed.

4-1-10:

Spotting conditions were windy with overcast skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Eastern Bay. Herring predator concentrations were found; around Middle and Crow Islands, in the waters east of Inner Point, and around Kasiana Island.

4-2-10:

Spotting conditions were windy with overcast skies. During today's aerial survey there was 0.4 nautical miles of spawn from Halibut Point to Old Sitka Rocks. The fourth and final Sitka Sound herring sac roe opening occurred from 1:00 p.m. until 3:16 p.m. in Eastern Channel south of Sitka.

4-3-10:

Spotting conditions were good with calm winds and overcast skies. There was 1.5 nautical miles of active spawn today. A number of herring schools were visible in the Crescent Bay area. Schools were also visible along the south and west sides of Kasiana Island. Whales were scattered around the northeastern areas of Sitka Sound including several offshore of the Chaichei Island group. Three Whales and two small groups of sea lions were seen in Windy Pass. Nothing was seen along the Kruzof Island shoreline.

4-4-10:

Spotting conditions were good with calm winds and overcast skies. We surveyed Sitka Sound and south to Windy Pass. There was 2.8 nautical miles of active spawn today. A number of herring schools were visible in the Crescent Bay area. Schools were also visible along the south and west sides of Kasiana Island. Whales were scattered around the northeastern areas of Sitka Sound including several offshore of the Chaichei Island group. A herring school was seen at the entrance of Redoubt Bay near Povorotni

Point and one whale was seen across from Kidney Cove. Three Whales and two small groups of sea lions were seen in Windy Pass. Nothing was seen along the Kruzof Island shoreline.

4-5-10:

Due to gusty wind conditions the flight was short and was focused primarily on the mapping of spawn. Today's aerial survey covered Sitka Sound north of Cape Burunof. Due to gusty wind conditions the flight was short and we focused primarily on the mapping of spawn. Some herring schools were observed in the Crescent Bay area. Spawning is expanding and there was 7.4 nautical miles of active spawn today. Spawning continued to be heavy on the Halibut Point Road shoreline expanding some both to the north and south since yesterday. Spawn was also beginning on Middle Island, Kasiana Island, and Whiting Harbor area.

-continued-

4-6-10:

Spotting conditions were relatively good with NW winds 5-10 knots and overcast skies. Today's survey covered Sitka Sound and south to Windy Pass. There was 9.1 nm of active spawn. Total shoreline with spawn to date is 11.7 nm. There was a spawn starting off the mouth of Indian River though it appears, given the lack of herring predators or visible schools, that the large volume of herring in Crescent Bay has moved elsewhere, possibly through the channel to the north side of town. A couple of smaller schools were seen in the middle of Jamestown Bay. Two whales were seen in between Crow Island and Gagarin Island. Twenty sea lions and one whale were seen near Inner Point. Further to the south there were about 100 sea lions and four whales in the Windy Pass area. Most of the activity was between Elovoi and Golf Islands.

4-7-10:

Spotting conditions were poor due to heavy snow squalls. Today's aerial survey covered Sitka Sound south to Cape Burunof. Spawn along HPR road appears to be dissipating, except for a couple of areas that are still going strong. There was 10.0 nm of active spawn today. Due to the weather we were unable to do a more extensive and detailed survey.

4-8-10

Today's aerial survey covered Sitka Sound north of Cape Burunof. Due to conditions the flight was short and we focused primarily on the mapping of spawn. Spawning is expanding and there was 19.6 nautical miles of active spawn today. Fresh spawn was found randomly from the Magoun Islands to Whale Island.

4-9-10:

Spotting conditions were relatively good with NW winds 5-10 knots and overcast skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning is expanding and there was 33.4 nautical miles of active spawn today. Spawning continued to be heavy on the Middle, Crow and Gagarin Islands. Current spawn was also observed between Inner Point and Port Krestof, on Lisianski Peninsula, in Starrigavan Bay and in Crescent Bay. Spawn was also beginning on Elovoi Island.

4-10-10:

Spotting conditions were relatively good with NW winds 5-10 knots and overcast skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning continued expanding and today was peak spawn, 48.9 nautical miles of active spawn today. Spawning continued to be heavy in northern Sitka Sound between Kruzof Island and Katlian Bay. Current spawn was also observed on the Makhnati Island Causeway, in Jamestown and Thimbleberry Bay, on the islands southeast of Middle Channel and in Crescent Bay. Spawn continued expanding on Elovoi Island and in Dorothy Narrows.

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4-11-10:

Spotting conditions were good with N winds 15 knots and clear skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning began to contract and **27.9 nautical miles of active spawn** was observed today. Spawning continued to be active to the north in Hayward Straight, on Middle Island and in Promisla Bay. Current spawn was also observed on the Makhnati Island Causeway, in Jamestown and Thimbleberry Bay, on the islands in the Aleutkina vicinity. Spawn continued expanding in Windy Pass and in Dorothy Narrows.

4-12-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass and Hoonah Sound. Spawning continued to contract and **10.7 nautical miles of active spawn** was observed today. Spawning continued to be active to the north on Kruzof Island between Inner Point and Mountain Point and south of Sitka in the Samsing Cove area. Spawn continued expanding in the Windy Pass/Dorothy Narrows vicinity.

4-13-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning continued to contract and only **2.7 nautical miles of active spawn** was observed today. The only areas of active spawn were in the Windy Pass/Dorothy Narrows vicinity and in the Samsing Cove area. No active spawn was observed in Northern Sitka Sound.

4-14-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass. No active spawn was observed today.

4-15-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass and Hoonah Sound. No active spawn was observed today. A vessel survey conducted at low tide found an additional **4.5 nm of spawn primarily in the Northern Sitka Sound area.**

4-20-10:

Spotting conditions were good with light winds and partly cloudy skies. Today's survey covered Hoonah Sound and Salisbury Sound. In Salisbury Sound sea lions were scattered from Sukoi Point to St. John Baptist Bay and off of Olga Point.

3-15-10:

Spotting conditions were generally good with northwest winds 15-25 knots and mostly cloudy. This extensive survey covered all areas of Sitka Sound, south to West Crawfish Inlet and north to Salisbury Sound. No herring were seen. All areas to the south of Sitka were quiet and the only observation of herring predators was eight sea lions off Vitskari Rocks and six near Silver Bay. North of Sitka, the largest concentration of sea lions was seen off Bieli Rock, with an estimated count of 150, with additional smaller groups in the vicinity. Another 50 sea lions were seen in the Inner Point and Mountain Point area and six whales were observed scattered in the trench between Inner Point and the Siginaka Islands.

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Several groups totaling 45 sea lions were seen in Nakwasina Sound, and 60 sea lions were scattered in groups around the trench between Lisianski Peninsula and the Siginaka Islands. In Salisbury Sound two sea lions were seen north of Gilmer Cove, 14 sea lions were seen in northern portion of Neva Strait and two whales were observed near Sinitsin Island.

3-16-10:

No aerial survey was scheduled for today. A vessel survey conducted on the Department's Attack Whaler showed a significant number of herring predators in the Nakwasina Sound area and along the Lisianski Peninsula. Herring predators were also observed in the trench southwest of the Siginaka Islands

3-15-10:

No aerial survey was conducted today due to marginal weather. It was announced today the Sitka Sound sac roe herring fishery will be on two-hour notice effective 12:00 noon, Friday, March 19, 2010. A vessel survey conducted on the Department's Attack Whaler showed very few herring predators in the Nakwasina Sound area and along the Lisianski Peninsula. Predators appear to have moved south and west into the trenches southwest of the Siginaka Islands and east of Kasiana Island.

3-18-10:

Spotting conditions were generally good with northwest winds 10-15 knots and mostly cloudy. Today's survey covered Sitka Sound, south to Cape Burunof and north to Nakwasina Sound. No herring were seen. All areas to the south of Sitka were quiet and the only observation of herring predators was seven sea lions near Silver Bay. North of Sitka, the largest concentration of sea lions was seen off Inner Point on Kruzof Island, with an estimated count of 200, additionally six whales were also seen in the vicinity. Concentrations of herring predators were also observed east of Middle Island, in Nakwasina Sound between Crosswise Island and Allen Point, and west of the Lisianski Peninsula.

3-19-10:

No aerial survey was conducted today due to meeting schedule and the need for managers to see firsthand the distribution of fish thru a sonar survey on the R/V Kestrel. During the vessel survey of northern Sitka Sound significant schools of herring were found in the trench east of Middle Island, South of the Siginaka Islands and south of Crosswise Island. No survey was conducted on the Kruzof Island shore or south Sitka Sound.

3-20-10:

Spotting conditions were generally good with northwest winds 10-15 knots and partly cloudy. Today's aerial survey covered Sitka Sound north of Cape Burunof. No spawn or herring schools were seen during the survey. The largest concentration of sea lions was on the Kruzof Island shoreline with approximately 375 counted off the shoals immediately south of Fred's Creek and another 175 sea lions were off Inner Point. Numerous whales were also seen in the area. Sea lions continue to be seen in scattered groups between the Siginaka Islands and Crosswise Island and in Nakwasina Sound. The vessel survey covered the road system north of town, the Inner Point area, Promisla Bay, Siginaka Islands, and Nakwasina Sound. A large school of herring was seen near Old Sitka Rocks, and several deep schools were seen in Nakwasina Sound and east of the Siginaka Islands. A number of large herring schools were seen near shore in an area extending from Inner Point to Mountain Point.

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3-21-10:

Spotting conditions were generally good with northwest winds 10-15 knots and partly cloudy. Today's aerial survey covered Sitka Sound south to windy Pass and north of Salisbury Sound. No spawn or herring schools were seen during the survey. Significant herring predator concentrations were observed in: Nakwasina Sound, along the Kruzof Island shore between Inner Point and Brent's Beach, east of Middle Island and west of the Lisianski Peninsula.

3-22-10:

Spotting conditions were generally good with northwest winds 10-15 knots and partly cloudy. Today's aerial survey covered Sitka Sound north of Cape Burunof. No spawn or herring schools were seen during the survey. The largest concentration of sea lions was on the Kruzof Island shoreline with approximately 275 in the area from Inner Point to Mountain Point. Smaller groups of sea lions were scattered along the east side of Middle Island, north of Kasiana Island and off Halibut Point. Sea lions continue to be seen in Nakwasina Sound but there were fewer numbers than what had been observed over the past week.

3-23-10: No aerial survey was conducted today due to poor weather. Heavy Rain with winds SW 35.

3-24-10: No aerial survey was conducted today due to poor weather. Low overcast with limited visibility, winds SE 15. The Sitka Sound herring sac roe **fishery was opened** from 5:10 p.m. until 6:35 p.m.

3-25-10:

Spotting conditions were generally good with northwest winds 5-10 knots and clear skies. Today's aerial survey covered Sitka Sound north of Windy Pass and south of Nakwasina Sound. No spawn or herring schools were seen during the survey. Herring predator concentrations were found; along the Kruzof Island shore between Inner Point and Rob Point, around Middle and Crow Islands, in the waters west of the Lisianski Peninsula, and in the mouth of Nakwasina Sound.

3-26-10:

Spotting conditions were generally good with northwest winds 15 knots and partly cloudy skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Salisbury Sound. No spawn or herring schools were seen during the survey. Herring predator concentrations were found; along the Kruzof Island shore between Inner Point and Rob Point, around Middle and Crow Islands, in the waters west of the Lisianski Peninsula, in Eastern Bay and in Nakwasina Sound. Herring predators were also observed in Neva Strait.

3-27-10:

Spotting conditions were generally poor with northwest winds 20-35 knots and partly cloudy. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Nakwasina Sound, conducted in marginal viewing conditions, showed no active spawn. The Sitka Sound herring sac roe **fishery was opened** from 1:00 p.m. until 3:55 p.m.

3-28-10:

No aerial survey was conducted today due to poor weather. High wind warning, winds SE 40 with gusts to 50 knots.

-continued-

3-29-10:

Spotting conditions were good with calm winds and clear skies. Today's aerial survey covered Sitka Sound north of Windy Passage and south of Nakwasina Sound. Herring predator concentrations were found; along the Kruzof Island shore between Fred's Creek, around Middle and Crow Islands, in the waters east of Kasiana Island, and in Eastern Anchorage/ Silver Bay. Herring were visible from the air in Leesoffskaia Bay.

3-30-10:

Spotting conditions were good with winds SW 10-15 knots and partly overcast skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Nakwasina Sound. Herring predator concentrations were found; around Middle and Crow Islands, in the waters east of Kasiana Island, and in Eastern Anchorage/ Silver Bay. Herring were visible from the air in Eastern Anchorage. The Sitka Sound herring sac roe **fishery was opened** from 1:45 p.m. until 4:25 p.m.

3-31-10:

Spotting conditions were good with winds SW 10-15 knots and partly overcast skies. During today's Aerial survey no herring spawn was observed. Herring schools were observed in large concentrations in Crescent Bay/Eastern Anchorage and inside the breakwater near Eliason Harbor. A couple of small schools of herring were observed in the Siginaka Islands. Herring predators were widely distributed.

4-1-10:

Spotting conditions were windy with overcast skies. Today's aerial survey covered Sitka Sound north of Cape Burunof and south of Eastern Bay. Herring predator concentrations were found; around Middle and Crow Islands, in the waters east of Inner Point, and around Kasiana Island.

4-2-10:

Spotting conditions were windy with overcast skies. During today's aerial survey there was 0.4 nautical miles of spawn from Halibut Point to Old Sitka Rocks. The **fourth and final Sitka Sound herring sac roe opening** occurred from 1:00 p.m. until 3:16 p.m. in Eastern Channel south of Sitka.

4-3-10:

Spotting conditions were good with calm winds and overcast skies. There was **1.5 nautical miles of active spawn** today. A number of herring schools were visible in the Crescent Bay area. Schools were also visible along the south and west sides of Kasiana Island. Whales were scattered around the northeastern areas of Sitka Sound including several offshore of the Chaichei Island group. Three Whales and two small groups of sea lions were seen in Windy Pass. Nothing was seen along the Kruzof Island shoreline.

4-4-10:

Spotting conditions were good with calm winds and overcast skies. We surveyed Sitka Sound and south to Windy Pass. There was **2.8 nautical miles of active spawn** today. A number of herring schools were visible in the Crescent Bay area. Schools were also visible along the south and west sides of Kasiana Island. Whales were scattered around the northeastern areas of Sitka Sound including several offshore of the Chaichei Island group. A herring school was seen at the entrance of Redoubt Bay near Povorotni Point and one whale was seen across from Kidney Cove. Three Whales and two small groups of sea lions were seen in Windy Pass. Nothing was seen along the Kruzof Island shoreline.

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4-5-10:

Due to gusty wind conditions the flight was short and was focused primarily on the mapping of spawn. Today's aerial survey covered Sitka Sound north of Cape Burunof. Due to gusty wind conditions the flight was short and we focused primarily on the mapping of spawn. Some herring schools were observed in the Crescent Bay area. Spawning is expanding and there was **7.4 nautical miles of active spawn** today. Spawning continued to be heavy on the Halibut Point Road shoreline expanding some both to the north and south since yesterday. Spawn was also beginning on Middle Island, Kasiana Island, and Whiting Harbor area.

4-6-10:

Spotting conditions were relatively good with NW winds 5-10 knots and overcast skies. Today's survey covered Sitka Sound and south to Windy Pass. There was **9.1 nm of active spawn**. Total shoreline with spawn to date is 11.7 nm. There was a spawn starting off the mouth of Indian River though it appears, given the lack of herring predators or visible schools, that the large volume of herring in Crescent Bay has moved elsewhere, possibly through the channel to the north side of town. A couple of smaller schools were seen in the middle of Jamestown Bay. Two whales were seen in between Crow Island and Gagarin Island. Twenty sea lions and one whale were seen near Inner Point. Further to the south there were about 100 sea lions and four whales in the Windy Pass area. Most of the activity was between Elovoi and Golf Islands.

4-7-10:

Spotting conditions were poor due to heavy snow squalls. Today's aerial survey covered Sitka Sound south to Cape Burunof. Spawn along HPR road appears to be dissipating, except for a couple of areas that are still going strong. There was **10.0 nm of active spawn** today. Due to the weather we were unable to do a more extensive and detailed survey.

4-8-10:

Today's aerial survey covered Sitka Sound north of Cape Burunof. Due to conditions the flight was short and we focused primarily on the mapping of spawn. Spawning is expanding and there was **19.6 nautical miles** of active spawn today. Fresh spawn was found randomly from the Magoun Islands to Whale Island.

4-9-10:

Spotting conditions were relatively good with NW winds 5-10 knots and overcast skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning is expanding and there was **33.4 nautical miles of active spawn** today. Spawning continued to be heavy on the Middle, Crow and Gagarin Islands. Current spawn was also observed between Inner Point and Port Krestof, on Lisianski Peninsula, in Starrigavan Bay and in Crescent Bay. Spawn was also beginning on Elovoi Island.

4-10-10:

Spotting conditions were relatively good with NW winds 5-10 knots and overcast skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning continued expanding and today was peak spawn, **48.9 nautical miles of active spawn** today. Spawning continued to be heavy in northern Sitka Sound between Kruzof Island and Katlian Bay. Current spawn was also observed on the Makhnati Island Causeway, in Jamestown and Thimbleberry Bay, on the islands southeast of Middle Channel and in Crescent Bay. Spawn continued expanding on Elovoi Island and in Dorothy Narrows.

-continued-

4-11-10:

Spotting conditions were good with N winds 15 knots and clear skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning began to contract and **27.9 nautical miles of active spawn** was observed today. Spawning continued to be active to the north in Hayward Straight, on Middle Island and in Promisla Bay. Current spawn was also observed on the Makhnati Island Causeway, in Jamestown and Thimbleberry Bay, on the islands in the Aleutkina vicinity. Spawn continued expanding in Windy Pass and in Dorothy Narrows.

4-12-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass and Hoonah Sound. Spawning continued to contract and **10.7 nautical miles of active spawn** was observed today. Spawning continued to be active to the north on Kruzof Island between Inner Point and Mountain Point and south of Sitka in the Samsing Cove area. Spawn continued expanding in the Windy Pass/Dorothy Narrows vicinity.

4-13-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass. Spawning continued to contract and only **2.7 nautical miles of active spawn** was observed today. The only areas of active spawn were in the Windy Pass/Dorothy Narrows vicinity and in the Samsing Cove area. No active spawn was observed in Northern Sitka Sound.

4-14-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass. No active spawn was observed today.

4-15-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass and Hoonah Sound. No active spawn was observed today. A vessel survey conducted at low tide found an additional **4.5 nm of spawn primarily in the Northern Sitka Sound area.**

4-20-10:

Spotting conditions were good with light winds and partly cloudy skies. Today's survey covered Hoonah Sound and Salisbury Sound. In Salisbury Sound sea lions were scattered from Sukoi Point to St. John Baptist Bay and off of Olga Point.

Appendix C5.–Aerial and skiff herring spawn surveys by date, in Hoonah Sound (Sitka Management Area), Southeast Alaska in 2010.

4-12-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass and Hoonah Sound. In Hoonah Sound herring predator activity was concentrated around Emmons Island. Additionally two whales were seen north of Vixen Islands, one whale off of Finger River and three whales south of Rodgers Point.

4-15-10:

Spotting conditions were good with NW winds 20 knots and partly cloudy skies. Today's survey covered Sitka Sound and south to Windy Pass and Hoonah Sound. In Hoonah Sound herring predator activity was concentrated around Vixen Islands. Additionally two whales were seen in the mouth of Ushk Bay, four whales south of Rodgers Point and seven sea lions along the southeast Emmons Island shoreline.

4-16-10:

Spotting conditions were good with light winds and partly cloudy skies. Water visibility, for spotting herring schools was poor. Today's survey covered only Hoonah Sound. No herring or active herring spawn was observed today. In Hoonah Sound herring predator activity was concentrated around Emmons and Vixen Islands. Additionally, sea lions were scattered along the Chichigof Island shore from Vixen Islands to north of Fick Cove and whales were seen east of Poison Cove and west of Broad Island.

4-19-10:

Spotting conditions were good with light winds and partly cloudy skies. Today's survey covered only Hoonah Sound. No herring or active herring spawn was observed today. In Hoonah Sound herring predator activity was concentrated around Emmons Island and along the Chichigof Island shore from Ushk Point to Fick Cove. Additionally, sea lions were scattered along Peril Strait and between Finger River and West Broad Creek.

4-20-10:

Spotting conditions were good with light winds and partly cloudy skies. Today's survey covered Hoonah Sound and Salisbury Sound. Herring schools were observed along the shore of Emmons Island. No active herring spawn was observed today. In Hoonah Sound herring predator activity was concentrated around Emmons and Vixen Islands and in the mouth of Ushk Bay. Additionally, sea lions were observed off of Fick Cove and Pederson Point.

4-21-10:

Spotting conditions were good with calm winds and overcast skies. Today's survey covered only Hoonah Sound. Herring schools were observed north of Emmons Island. The first active herring spawn was observed today south of Vixen Islands, 0.5 nm of active spawn was mapped today. Herring predator activity was concentrated around Emmons and Vixen Islands. Additionally, sea lions were observed off of Rodgers Point.

-continued-

4-22-10:

Spotting conditions were good with winds SW 15 knots and overcast skies. Today's survey covered only Hoonah Sound. Spawning continued to expand and 1.8 nautical miles of active spawn was observed today, on Vixen Islands and north Emmons Island. Herring predator activity was concentrated around Emmons and Vixen Islands. Additionally, one hundred sea lions were observed off of Rodgers Point.

4-23-10:

Spotting conditions were good with calm winds and overcast skies. Today's survey covered only Hoonah Sound. Spawning continued to expand and 4.5 nautical miles of active spawn was observed today, on Vixen Islands (1.0nm), Emmons Island (3.1nm) and on the Chichigof Island shore east of Emmons Island (0.4nm).

4-24-10:

Spotting conditions were good with calm winds and clear skies. Today's survey covered only Hoonah Sound. Spawning continued to expand and 7.9 nautical miles of active spawn was observed today, on Vixen Islands (1.3nm), Emmons Island (4.7nm) and on the Chichigof Island shore east of Emmons Island (1.9nm).

4-25-10:

Due to poor weather no aerial survey was conducted today. Overcast skies with winds gusting to SE 45.

4-26-10:

Spotting conditions were good with calm winds and clear skies. Today's survey covered only Hoonah Sound. Spawning began to contract and 2.4 nautical miles of active spawn was observed today, on Vixen Islands, Emmons Island and on the Chichigof Island shore south of Fick Cove.

4-27-10:

Spotting conditions were good with calm winds and clear skies. Today's survey covered only Hoonah Sound. Spawning began to contract and 0.2 nautical miles of active spawn was observed today, on south Emmons Island, and on the Chichigof Island shore south of Fick Cove and south of Finger River. Additionally, a vessel survey was conducted at low tide to map additional spawn locations and 0.8 nautical miles of additional spawn was added.

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, 2010.

Bradfield Canal

4-9-10:

No spawn or herring observed. 3 Sea Lions; 100 Gulls; 150 Scoters.

4-14-10 and 4-15-10:

Skiff survey for egg deposition; spawning dates most likely between 4-5 & 4-12; mapped **approximately 15 nm of eggs on beach.**

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

4-9-10:

No active spawn or herring observed; 19 Sea Lions; 50 Gulls; 100 Scoters.

4-12-10:

No active spawn or herring observed; 44 Sea Lions; 100 Gulls.

4-15-10:

Approximately **3.0 nm of active spawn**; 85 Sea Lions; 1 Whale; 350 Gulls.

4-16-10:

About **1.5 nm of active spawn**; 18 Sea Lions; 700 Gulls, 220 Scoters.

4-17-10:

One drift **spot spawn**; 33 Sea Lions; 1,000+ Gulls.

4-18-10:

No active spawn or herring observed; 4,000+ Gulls.

4-20-10:

No active spawn or herring observed; 3,500 Gulls.

4-15-10 & 4-16-10:

Skiff survey for egg deposition; mapped **approximately 6.5 nm of eggs on beach**.

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

4-15-10:

No active spawn, herring, or predators observed.

4-16-10:

About **0.2 nm of active spawn**; 2 Sea Lions; 360 Gulls.

-continued-

4-17-10:

About **1.25 nm of active spawn**; 2 Sea lions; 500 Gulls.

4-18-10:

One **spot spawn** north of Onslow; 2,000 Gulls; 500 Scoters.

4-20-10:

No active spawn or herring observed; 300 Gulls; 200 Scoters.

Ship Island

4-9-10:

No active spawn, herring, or predators observed.

4-12-10:

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

4-15-10:

No active spawn or herring observed; 7 Sea Lions.

4-16-10:

No active spawn, herring, or predators observed.

4-17-10:

No active spawn or herring observed; 4 Sea Lions.

Zimovia St. and Eastern Passage

4-7-10:

Active spawn reported from McCormacks Creek to Pats Creek.

4-9-10:

No active spawn, herring, or predators observed.

4-12-10:

No active spawn or herring observed; 1 Sea Lion; 200 Gulls.

4-17-10:

No active spawn or herring observed; 1 Sea Lion; 3,000 Gulls.

4-18-10:

No active spawn or herring observed; 2,000 Scoters.

4-20-10:

No active spawn or herring observed; 1,000 Scoters.

-contiuned-

Bear Creek

Not Surveyed in 2010

Farragut Bay

Not Surveyed in 2010

Hobart Bay/Port Houghton (Hobart Bay only)

4-16-10:

No active spawn or herring observed; 27 Sea Lions.

4-19-10:

No active spawn or herring reported from a non-ADF&G survey.

4-20-10:

No active spawn or herring observed; 30 Sea Lions.

4-21-10:

About **0.1 nm of active spawn**; 3 schools; 75 Sea Lions.

4-22-10:

Two aerial surveys; **0.4 nm of active spawn**; 5 schools; 58 Sea Lions.

4-23-10:

3 aerial surveys; **~1.2 nm of active spawn**; schools on beach; 175 Sea Lions; 500 Gulls; 500 Scoters; Fishery opened for 13 hours.

4-24-10:

About **0.7 nm of active spawn**; schools on beach; 51 Sea Lions; 300 Scoters.

4-25-10:

About **0.1 nm of active spawn**; 7 schools; 37 Sea Lions; 1,000 Gulls; 1,000 Scoters.

4-26-10:

No active spawn or herring observed; 16 Sea Lions; 1,500 Gulls.

4-28-10:

No active spawn or herring observed; 5 Sea Lions; 4,800 Gulls; 2,000 Scoters.

5-3-10:

No active spawn or herring observed; 3 Sea Lions; 2,000 Gulls; 2,500 Scoters.

-continued-

Hobart Bay/Port Houghton (Port Houghton)

4-20-10:

No active spawn or herring observed; 1 Sea Lion.

4-21-10:

No active spawn or herring observed; 2 Sea Lions.

4-23-10:

No active spawn, herring, or predators observed.

4-25-10:

No active spawn or herring observed; 12 Sea Lions.

4-26-10:

No active spawn, herring, or predators observed.

4-28-10:

No active spawn or herring observed; 5 Sea Lions.

5-3-10:

No active spawn or herring observed; 3 Sea Lions.

5-5-10:

Skiff survey; **~1.2 nm of active spawn**; 30+ Sea Lions; 300 Gulls.

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

4-16-10:

No active spawn, herring, or predators observed.

4-20-10:

No active spawn observed; 1 small school; 28 Sea Lions.

4-21-10:

No active spawn, herring, or predators observed.

4-22-10:

2 aerial surveys; no active spawn observed; 4 schools; 10 Sea Lions.

4-23-10:

3 aerial surveys; no active spawn observed; 3 schools; 3 Sea Lions.

4-24-10:

No active spawn observed; 1 small school; 10 Sea Lions.

-contiuned-

4-25-10:

No active spawn or herring observed; 7 Sea Lions.

4-26-10:

No active spawn observed; 1 small school; 10 Sea Lions.

4-28-10:

No active spawn observed; 3 schools; 30 Sea Lions; 1 pod of Killer Whales.

5-3-10:

No active spawn, herring, or predators observed.

Gambier Bay

4-26-10:

No active spawn or herring observed; 3 Sea Lions; 1 Whale.

Port Camden

4-26-10:

No active spawn, herring, or predators observed.

Appendix C7.–Aerial and skiff herring spawn surveys by date, in Seymour Canal (Juneau Management Area), in Southeast Alaska, 2010.

4-16-10:

Winds SE 15-20, fair visibility. No herring or herring spawn was observed. A total of 50 sea lions were counted. Most were in small groups and scattered along the entire western shoreline of Glass Peninsula. Two whales were observed in deep water east of Point Hugh Light.

4-19-10:

Winds calm, good visibility. No herring or herring spawn was observed. Survey conditions were very good. A total of 160 sea lions and 6 humpback whales were counted. Most of the sea lions were rafted near Point Hugh. One group of 3 whales was located off shore of Point Hugh and the other group of 3 was north of Point Hugh Light. There was very little bird activity in the area.

4-21-10:

Winds SE 15-20, fair visibility. No herring or herring spawn was observed. A total of 135 sea lions and 4 humpback whales were counted. Most of the sea lions were rafted near Point Hugh. There was very little bird activity in the area.

4-23-10:

1115 – Winds N 20. Good visibility. Several herring schools were observed on the east side of Glass Peninsula in shallow water between Point Hugh Light and Point Hugh. These fish were flighty and did not appear to be committed to the beach. No herring or herring spawn was observed. No herring and few predators were seen on the west side of Glass Peninsula. A total of 120 sea lions and 5 whales were counted in the area.

1600 – Winds 15-20, good visibility. One school of herring at Cloverleaf Rocks and fish banded along the shoreline from the Dogleg north to the latitude of Twin Islands on the Stephens Passage shoreline, with other schools just north.

4-24-10:

0700 - Calm and excellent visibility. Numerous small spawns were observed on both the east and west shoreline of Glass Peninsula south of Point Hugh Light. There was also a significant amount of herring in shallow water dispersed from Midway Point to Point Hugh and a couple schools were seen south of Black Jack Cove. The fishery was placed on advanced 12-hour notice today at 11:00 am.

1740 – Calm and excellent visibility. Large schools of herring banding the shoreline Blackjack Cove and Swimming Pool, Twin Islands and on the Stephens passage shore north of the Dogleg. Several spot spawns from Pt Hugh Light to Pt Hugh, intense spawn around Pt Hugh and significant spawn from Pt Hugh up to the District 10 Boundary.

Spawn observed: 2.4 nm

4-25-10:

Winds SE 15 and fair visibility. 2.5 nm of spawn at Pt Hugh and from Blackjack Cove south past the District 10 Boundary, with an additional spot just above the Dogleg on Stephens Passage.

-continued-

Spawn observed: 2.5 nm

4-26-10:

At 9:45 am, calm winds and approximately 1.6 miles of active spawn, 125 sea lions and one whale from Pt Hugh to Latitude of rock garden on Stephens Passage shoreline.

At 11:00 am, winds SE 10 and good visibility, no herring or herring spawn observed. 120 sea lions around the South end of Glass Peninsula between Swimming Pool and up to the latitude of Twin Islands on the Stephens Passage shoreline. Nothing on Big Bend shoreline.

Spawn observed: 1.6 nm

4-27-10:

Calm and excellent visibility. 20 ton school on beach outside Winning Cove, a moderate school north of Sore Thumb Cove, and fish on the beach north of Pt Hugh Light. Several spot spawns north of Pt Hugh Light up Stephens Passage coast to latitude of Twin Island.140-150 sea lions: 50 at Pt Hugh and small numerous groups all along east Glass Peninsula and 2 whales.

Spawn observed: 1.6 nm

4-28-10:

Calm and excellent visibility. No herring or spawn on the Big Bend shoreline, one whale and 20 sea lions near Gambier Island. Small schools by the Swimming Pool and Blackjack Cove, 30 sea lion and thousands of scoters at Pt Hugh. Approximately 2 nm of light or deep spawn.

Spawn observed: 2.2 nm

4-29-10:

Winds SE 15-20, fair visibility. Three separate but active spot spawns, one north of Pt Hugh light, the other two on the Stephens Passage shoreline opposite Twin Islands.

Spawn observed: 0.6 nm

4-30-10:

Calm with good visibility. Intense spot spawns by Blackjack Cove and Swimming Pool, dissipating remains of spawn at Pt Hugh and opposite Twin Islands on Stephens Passage shoreline. 51 sea lions, 8 at Blackjack, 17 at Pt Hugh, 10 north of Cloverleaf Rocks, and 15 above the Dogleg.

Spawn observed: 0.2 nm

5-1-10:

Calm and excellent visibility. Several active spawns observed on west Glass Peninsula totaling 1.2 nm located near the District 10 Boundary, Blackjack Cove, Swimming pool and another halfway up to Twin Islands. 45 sea lions and 3 whales in vicinity of the spawns.

-continued-

Spawn observed: 1.2 nm

5-2-10:

Light winds with good visibility. No herring or spawn observed. 14 sealions at Rockgarden, large rafts of scoters at Blackjack Cove and Pt Hugh, 48 sea lions in large groups between cloverleaf Rocks and The Dogleg.

5-3-10:

Winds N10, excellent visibility. No herring or spawn, a few scattered predators, thousands of scoters at Pt Hugh.

5-4-10:

Winds SE 10-15, good visibility. Received an industry pilot report of spawn by Buck Island, but no herring or spawn observed, few predators, large rafts of scoters at Pt Hugh.

5-6-10

Industry pilot flew and no herring or spawn was observed.

5-13-10:

Industry pilot few and observed numerous small to mid-sized schools of herring on the beach from Sore thumb Cove to #9 Rock.

5-14-10:

Winds calm and excellent visibility. Four small schools near Sore Finger Cove, nearshore but not banded, two schools off the beach between Faust Is and Winning Cove. One whale and 20 sea lions near #9 Rock.

5-18-10:

Industry pilot reported herring spawn on Glass Peninsula just opposite south end of Dorn Island. Good sized schools tight to the beach reported just north. Five whales sighted in the vicinity.

5-19-10:

Winds SE 15+ visibility good to fair. Several small schools spread out between Winning Cove and Sore Finger. No evidence of spawn, a few scattered sea lions.

4-16-10:

Calm and excellent visibility. No herring or herring spawn was observed. Survey conditions were excellent. Very few predators were seen throughout the entire inlet. The Chatham shoreline south of Tenakee Inlet was also very quiet.

4-19-10:

Calm and fair visibility. No herring or herring spawn was observed. No predators were observed inside the inlet. Several small groups of sea lions were observed near the Basket Bay shoreline.

4-21-10:

Winds SE 15, fair visibility. No herring or herring spawn was observed. Survey conditions were good with relatively calm winds and high overcast skies. Only one sea lion was observed at Cannery Point inside of Tenakee Inlet. The Basket Bay shoreline was relatively quiet with a few scattered sea lions. No whales and little bird activity was noted throughout the area.

4-23-10:

Calm and excellent visibility. Two small schools of herring were seen in Finn Cove. There were a few sea lions and one whale in the vicinity. No spawning activity was observed. An increase in large predators was noted along the Basket Bay shoreline with 3 whales and 40 sea lions counted from South Passage Point to Little Basket Bay.

4-24-10:

Calm and excellent visibility. No herring or spawn was observed. Predators continue to increase around the Basket Bay area where 6 humpback whales and 48 sea lions were counted. Inside Tenakee Inlet remains relatively quiet.

4-25-10:

Winds SE 30, fair visibility. No herring, spawn, or predators. Survey flown at 3-5,000 ft. due to turbulence.

4-26-10:

Winds E 15-20 kts, good visibility. No herring or spawn in Inlet, with one whale between cannery Pt and Finn Cove. One small school of herring on beach north of Basket Bay, with 45 sea lions in groups along Chatham shoreline.

4-27-10:

Calm with excellent visibility. No herring no spawn, 19 sea lions in small groups between Kadashan and E Trap Bay. 10 sea lions near S Passage Point, and 20 outside Basket Bay.

4-28-10:

Calm with good visibility. No herring or spawn. 8 sea lions near Crab Bay and 30 near S Passage Point.

-continued-

4-30-10:

Winds south 10-15 good visibility. No herring, spawn, or predators in Inlet, 12 sea lions at S Passage Point, and 5 north of Basket Bay.

5-1-10:

Calm and excellent visibility. No herring or spawn, 5 sea lions and one whale in Finn Cove, 10 sea lions near Dons Creek and 10 sea lions just north of Basket Bay.

5-2-10:

Winds south 10, excellent visibility. No herring or spawn observed. Four whales in the vicinity of Kadashan, and 8 sea lions in Finn Cove. 52 sea lions observed between South Passage Point and Basket Bay.

5-3-10:

Winds west 10-15, good visibility. No herring or spawn, 8 sea lions at Corner Point. 10 sea lions near S Passage Point and 20 more near Don's Creek.

5-4-10:

Calm and excellent visibility. No herring or spawn, 10 sea lions at Corner Point and 3 in Finn Cove. 122 sea lions on Chatham coast, most between S Passage appoint and Basket Bay.

5-5-10:

Calm and excellent visibility. No herring or spawn. 22 sea lions in Tenakee Inlet, 2 near Crab Bay, 5 at Corner Point, 10 on N shore opposite Corner Pt, and 5 near S Passage Point. 30 sea lions off East Point, 130 sea lions along Chatham shoreline between S Passage Pt and Basket Bay in groups of 10-40 animals.

5-7-10:

Light winds and good visibility. A total of 0.6 nm of light spawn observed mostly on the west side of Kadashan flats, with a short stretch on the east side of the flats. No herring observed. Four sea lions observed near the spawn. 126 sea lions on the Chatham coast between S Passage Pt and Little Basket Bay.

Spawn observed: 0.6 nm

5-8-10:

Light winds and good visibility. A total of 1.8 nm of mostly light spawn observed in numerous spots and discontinuous stretches between Crab and Corner Bays, with the most intense spawn on northwest Strawberry Island. Developing spawn was observed on the eastern side of Corner Point and in Finn Cove. First surveyed at ≈10:00 am and after sampling surveyed again at ≈2:00 pm with the Finn Cove spawn increasing. Very few predators observed in the Inlet, with 97 sea lions along the Chatham coast rafted in several large groups between S Passage Point and Basket Bay.

-contiuned-

Spawn Observed: 1.8 nm

5-9-10:

Light winds and good visibility. A very light spot spawn east of Strawberry Island and more extensive spawn in the cove just west of the Corner Bay LTF. Several more intense and developing spawns observed from Corner Point to western Finn Cove. Fish observed lining the beach in eastern Finn Cove. Two whales observed just off the beach adjacent to the spawn and 82 sea lions observed between S Passage point and Basket Bay, in smaller groups and a more concentrated area than last survey.

Spawn Observed: 0.5 nm

5-10-10:

Calm and excellent visibility. Several schools of herring observed on the beach in Finn Cove. No spawn observed. Few predators in the Inlet, with 99 sea lions between S Passage Point and Basket Bay, and an additional 11 sea lions between Basket Bay and White Rock.

5-11-10:

Calm and excellent visibility. One good sized school of herring on the beach at west Corner Point. No other herring or spawn observed. No predators observed in the Inlet, 70 sea lions and one whale observed between Ss Passage Point and Basket Bay.

5-12-10:

Winds SE 15-20 with fair visibility. No herring or spawn, and few predators observed.

5-14-10:

Winds calm with excellent visibility. Abbreviated survey, but no herring or spawn, few predators observed.

5-19-10:

Winds SE 15-20 visibility good to excellent. No herring or spawn, a few scattered sea lions. Very light possible clam spawn at S Passage Point.

Appendix C9.–Aerial and skiff herring spawn surveys by date, in Lynn Canal (Juneau Management Area), in Southeast Alaska, 2010.

4-16-10:

Calm, excellent visibility. No herring or herring spawn was observed. Survey conditions were ideal. Many small groups of sea lions were observed from Eagle Beach to Point Bridgett and along the eastern shoreline of Berners Bay. A total of 90 seal lions were counted. One group of 30 animals was observed just off the sand flats of the Lace and Antler Rivers. Another group of 20 animals was observed near Mabb Island where two whales were also seen. A third whale was observed near Point Saint Mary.

4-19-10:

Calm and good visibility. No herring or herring spawn was observed. Small groups of sea lions were observed from Sunshine Cove to Point Bridgett. A few individuals were scattered along the eastern shoreline of Berners Bay. An estimated 150 animals were hauled out on Benjamin Island. One whale was seen on the west side of Benjamin Island. Very little bird activity was noted on the Berners flats. There was no evidence that eulachon have shallowed up or entered fresh water.

4-21-10:

Winds SE 15, fair visibility. No herring or herring spawn was observed. A very small possible spawn of undetermined nature was observed near the USFS cabin on Berners Bay NE shoreline. Five sea lions were observed along the shore between Tee Harbor and Amalga Harbor, with a group of 30 near Gull Island. In Berners Bay 34 sea lions and five whales were observed, with most of the sea lions and three whales between Pt Bridget and Cascade Point. The haul out at Benjamin Island had very few sea lions present. Based on a high concentration of eagles actively feeding in one portion of the Berners River, it is assumed eulachon have moved into the lower river.

4-22-10:

Winds S 10-15, good visibility. No herring spawn was observed. Several small balls of herring were observed in Auke Bay, near Lena Point, and Yankee Cove. Five sea lions were observed near Sunshine cove, and one whale inside Benjamin Island.. Two whales were observed in Berners Bay, one between Pt Bridget and Cascade Point and another near Pt St Mary. A few scattered sea lions were observed in Berners Bay and the Benjamin Island haul out had about 150 sea lions present.

4-24-10:

Ward Air pilot reported herring in Bridget Cove.

4-25-10:

Calm and good visibility. Several small schools in Auke Bay, 2 whales off Eagle River. Several large schools inside Bridget Cove and 6 sea lions present. Several large schools east of Pt Bridget with 2 spot spawns, 20 sea lions and 2 whales.

-continued-

Spawn observed: 0.15 nm

4-26-10:

Calm and excellent visibility. No herring spawn observed. Good schools in Bridget Cove, 5 sea lions in sunshine Cove, and 20 in Bridget Cove with one whale on the beach north of Mabb Island. 18 sea lions in Berners Bay. North winds 15-20 kts.

4-28-10:

Calm and good visibility. No herring observed, but 0.64 nm of a mile of active spawn in Bridget Cove. No predator activity. Quiet from Auke Bay to Bridget Cove.

Spawn observed: 0.6 nm

4-29-10:

Winds S10, good visibility. No herring or spawn observed. One whale near Amalga Harbor, 12 sealions in Bridget Cove, 8 sealions and 3 whales near Pt Bridget.

4-30-10:

Winds N 10, good visibility. 0.25 nm active spawn observed on South Shelter Island, and a total of 0.7 nm of spawn at S Bridget Cove and Point Bridget. 3 whales and 23 sea lions at Point Bridget, 10 sea lions at Bridget Cove and 5 sea lions at Sunshine Cove.

Spawn observed: 0.9 nm

5-1-10:

Calm and excellent visibility. One school of herring south of Eagle River, 0.3 nm of active spawn in Bridget Cove, and 2 nm at Pt Bridget. 110 sea lions and 4 whales observed.

Spawn observed: 2.25 nm

5-2-10:

Winds S 10, excellent visibility. Several small schools of herring were observed in Indian Cove and along the Breadline just north of Tee Harbor. 0.1 nm of active spawn at South Shelter Island, 0.6 nm active spawn between Sunshine Cove and Bridget Cove, and 1.3 nm of active spawn at Pt Bridget. 48 sea lions and 3 whales observed in the vicinity of Pt Bridget.

Spawn observed: 2.1 nm

5-3-10:

Calm and good visibility. Several schools observed in the Auke Rec vicinity, Tee Harbor, and Amalga Harbor. Numerous small spawns from Yankee Cove to Bridget Cove, with additional spawn at north Bridget Cove. More small spawns along the shoreline from Bridget Cove to Pt Bridget, and east of Pt Bridget. 0.6 nm of active spawn on the east shore of Berners Bay north of Petroglyph beach. 130 sea lions, most in two large rafts just east of Pt Bridget, and 5 whales observed.

-continued-

Spawn observed: 3.3 nm

5-4-10:

Light winds and excellent visibility. Numerous small schools in Auke B ay along Mendenhall Peninsula, Sphun, Coghlan and Portland Islands, Auk Nu, Indian Cove, and Tee Harbor. Intense spawn on artificial reef in Yankee Cove, dissipating spawn on the point to the north and in

Appendix C9.–Page 3 of 3.

Sunshine cove, a small spot on the outside of Mabb Island and another small spot on East Berners Bay south of the USFS cabin.

Spawn observed: 1.0 nm

5-5-10:

Winds SE 10-15 with good visibility. Numerous schools of herring around Sphun and Coghlan Islands, 9 schools of herring in S Tee Harbor and 2 more in the north end. Active spawn on several sections of beach between Yankee Cove and Sunshine Cove, in Bridget Cove, and along the east shoreline of Berners Bay south of the USFS cabin and Cascade Point.

Spawn observed: 2.9 nm

5-6-10:

Calm and excellent visibility. Numerous schools along Mendenhall Peninsula, Sphun and Coghlan Islands in Auke Bay, and Tee Harbor. A total of 0.6 nm active spawn in Yankee Cove, Sunshine Cove, and north of Cascade Point. Few predators observed.

Spawn observed: 0.6 nm

5-7-10:

Light winds and good visibility. Numerous schools in Auke Bay, Indian Cove and Tee Harbor. A light spot spawn in Yankee Cove and several active spot spawns in Sunshine cove and both north and south Mabb Island. Burners Bay was quiet. Few predators observed

Spawn observed: 0.2 nm

5-8-10:

Winds calm to light N, good visibility. Numerous schools around Coghlan Island, Indian Cove, and Tee Harbor. Spot spawns in Sunshine Cove and on the north end of Mabb Island. Burners Bay was quiet. Few predators observed.

Spawn observed: 0.1 nm

5-9-10:

Winds calm and good visibility. Schools of herring observed around Coghlan Island, Indian Cove, and Tee Harbor. No spawn and few predators observed.

5-11-10:

Winds SE 10-15, good visibility. A few schools observed around Coghlan Island, Indian Cove, and Lena Point. Two whales near Benjamin Island, sea lion haulout around half full (≈150 animals). No spawn and few predators observed.

Appendix C10.–Aerial and skiff herring spawn surveys by date, in Port Frederick, Oliver Inlet, and Taku Harbor (Juneau Management Area), in Southeast Alaska, 2010.

Port Frederick

4-16-10:

Calm and fair visibility. No herring or herring spawn was observed. 11 whales, most between Neka Bay and the Narrows.

4-19-10:

No herring or herring spawn was observed. I humpback and 2 orca observed near Neka Bay.

4-21-10:

Winds E 15, fair visibility. No herring or herring spawn was observed. No whales and 8 sea lions were observed at the west end of the Narrows. Gulls and scoters in 8-fathom Bight possibly feeding on salmon fry.

4-23-10:

Calm and excellent visibility. No herring or herring spawn was observed in 8-fathom Bight, no predator activity. Lots of birds possibly feeding on salmon fry.

4-26-10:

Calm and excellent visibility. No herring, spawn, or predators. Very quiet.

4-28-10:

Calm and good visibility. No herring observed, but 50 yards of light spawn south of Seagull Creek. 13 sea lions and 1 whale observed.

4-30-10:

Winds N 10 and good visibility. Herring and 0.1 nm of spawn observed on S flank of Seagull Creek, 8 sea lions and 2 whales in vicinity.

Spawn observed: 0.1 nm

5-1-10:

Calm and excellent visibility. No herring observed 0.4 nm spawn between Seagull and Bear Creek.

5-2-10:

Winds W 15, excellent visibility. Several schools of herring just north of Burnt Point, 0.4 nm of spawn between Seagull and Bear Creek. Five sea lions at Pt Sophia, and one whale in 8-fathom Bight.

Spawn observed: 0.4 nm

-contiuned-

5-3-10:

Calm and excellent visibility. Several schools near Burnt Point. 1.8 nm of active sapwn all around alluvial fan of Seagull Creek. 3 whales in 8 Fathom Bight.

Spawn observed: 1.8 nm

5-4-10:

Light winds and good visibility. Schools of herring observed near Long Island and in the vicinity of Burnt Point. Spawn at Burnt Point, Seagull Creek and to the south of Bear Creek. No predators.

Spawn observed: 1.2 nm

5-5-10:

Calm and good visibility. Numerous schools from Cannery Point to north of Burnt Point. Active spawn at Burnt Point and between it and Seagull Creek. Additional spot south of Bear Creek. No predators observed.

Spawn Observed: 0.6 nm

5-7-10:

Light winds and good visibility. Numerous schools observed from Cannery Point to Burnt Point. A small spawn was observed at the east end of the Narrows. No predators observed.

Spawn observed: 0.1 nm

5-8-10:

Calm and excellent visibility. Many small schools of herring observed in the vicinity of Hoonah and Burnt Point. No predators observed.

Total linear miles of spawn observed during spawning season: **3.0 nm**

Oliver Inlet

4-19-10:

Winds calm, good visibility. No herring or herring spawn was observed. No predator activity.

4-21-10:

Winds SE 15-20. No herring or herring spawn was observed. No predator activity. Did not survey inside Inlet.

4-24-10:

0620–Winds calm. Four schools observed near head of inlet, no spawn or predators.

1715–Winds calm good visibility. Two schools near head of inlet and one school just outside mouth of Inlet, no spawn or predators.

-continued-

4-26-10:

Winds calm. No herring, spawn, or predators.

4-29-10

Calm and fair visibility. One school of herring observed near head of Inlet. No spawn or predators.

4-30-10:

Calm and good visibility. Flew past mouth of inlet - no herring spawn or predators

5-1-10:

Calm and excellent visibility. Several small schools east of entrance in Stephens Passage, no spawn or predators.

5-2-10:

Calm and good visibility. Small ball of herring near mouth of Inlet in Stephens Passage, no spawn or predators.

5-3-10:

Winds west 15, good visibility. No herring, spawn, or predators.

5-4-10:

Winds S 10 good visibility. Two small schools near mouth of Inlet. No spawn or predators.

Taku Harbor

4-23-10:

Winds N 15-20 good visibility. No herring or herring spawn was observed. No predator activity.

4-29-10:

Winds SE 15-20, fair visibility. No herring or herring spawn was observed. No predator activity.

5-19-10:

Winds SE10-15, good visibility. Two small schools at head of harbor, no spawn or sea lions, one whale near Grave Point.

Hood Bay

4-23-10:

No herring or herring spawn was observed. No predator activity.

5-2-10:

Calm and good visibility. No herring, spawn, or predator activity.

-continued-

Freshwater Bay

4-24-10

Calm, excellent visibility. No herring, spawn, or predators.

5-3-10

Calm, good visibility. No herring or spawn, 5 sea lions near Redcliff Islands.

5-5-10

Visibility excellent. No herring, spawn, or predators.

Funter Bay

5-12-10

0.05 nm spawn observed on west shore of the north cove.

Appendix C11.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2010.

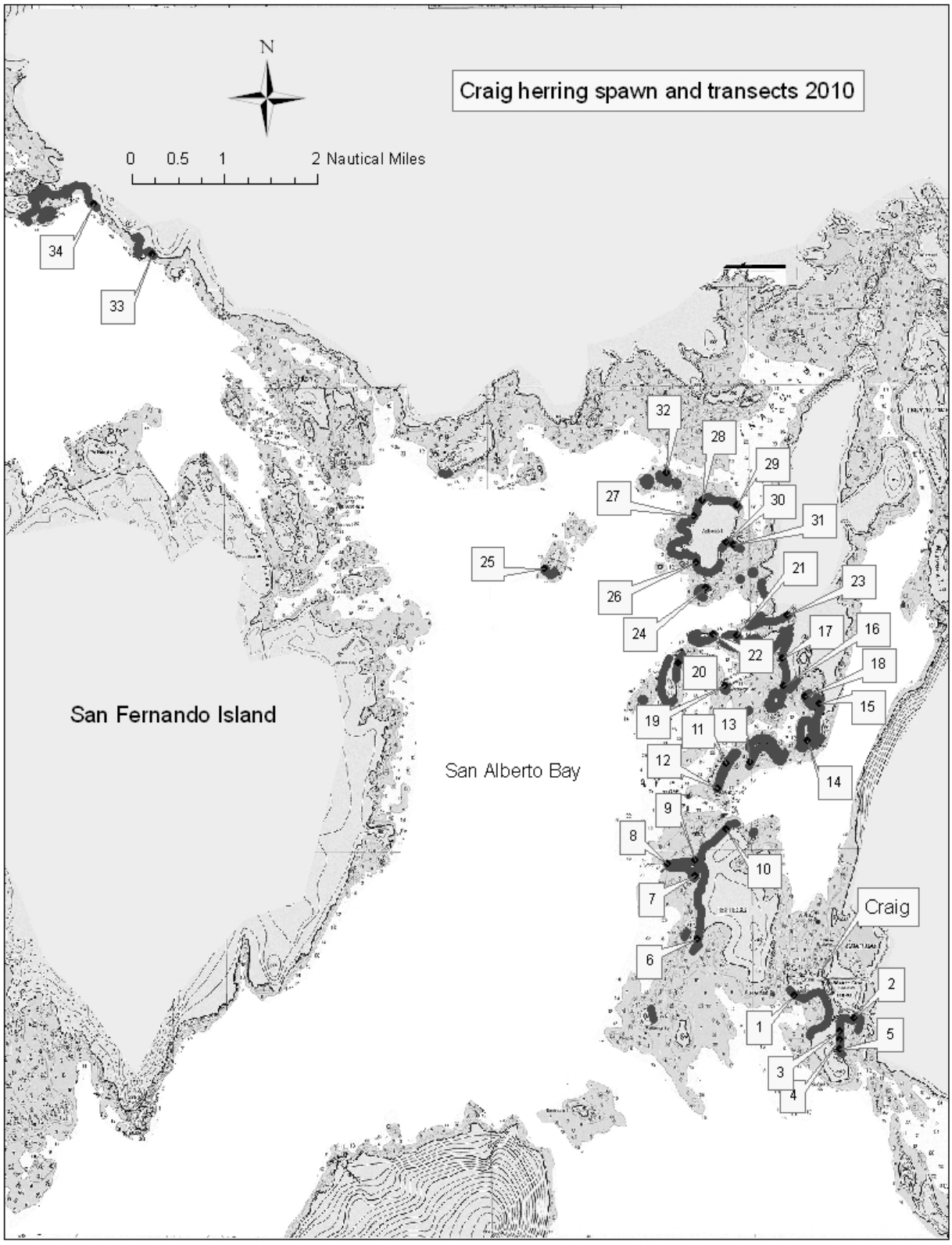
4-19-10:

Today is the first herring aerial survey of the season. Large balls in Yakutat Bay for the past three weeks, first spawning in Monti Bay yesterday. Found about half a mile of spawn on the south shore of Monti Bay inside the mouth of Ankau Creek. Three bays on Khantaak Island contained spawn. Spawn in the small boat harbor and in the mouth of Village Creek. The middle islands in the Bay had nothing, the north shore of Khantaak, usually a hot spot, also had none. The NE shore of Kriwoi Island was completely covered with spawn, also a short spawn on the NW shore. The N and W shores of Otmeloi Island also had spawn. Headed up the mainland shore and found all of Humpback Creek Cove covered in spawn, easily another mile. Two small patches on the SE end of Knight Island, and Eleanor Cove was covered with spawn. Also three small areas in Redfield Cove with spawn. Total mileage observed today was **3, maybe 3 ½ miles of spawn**. That is excellent early in the game.

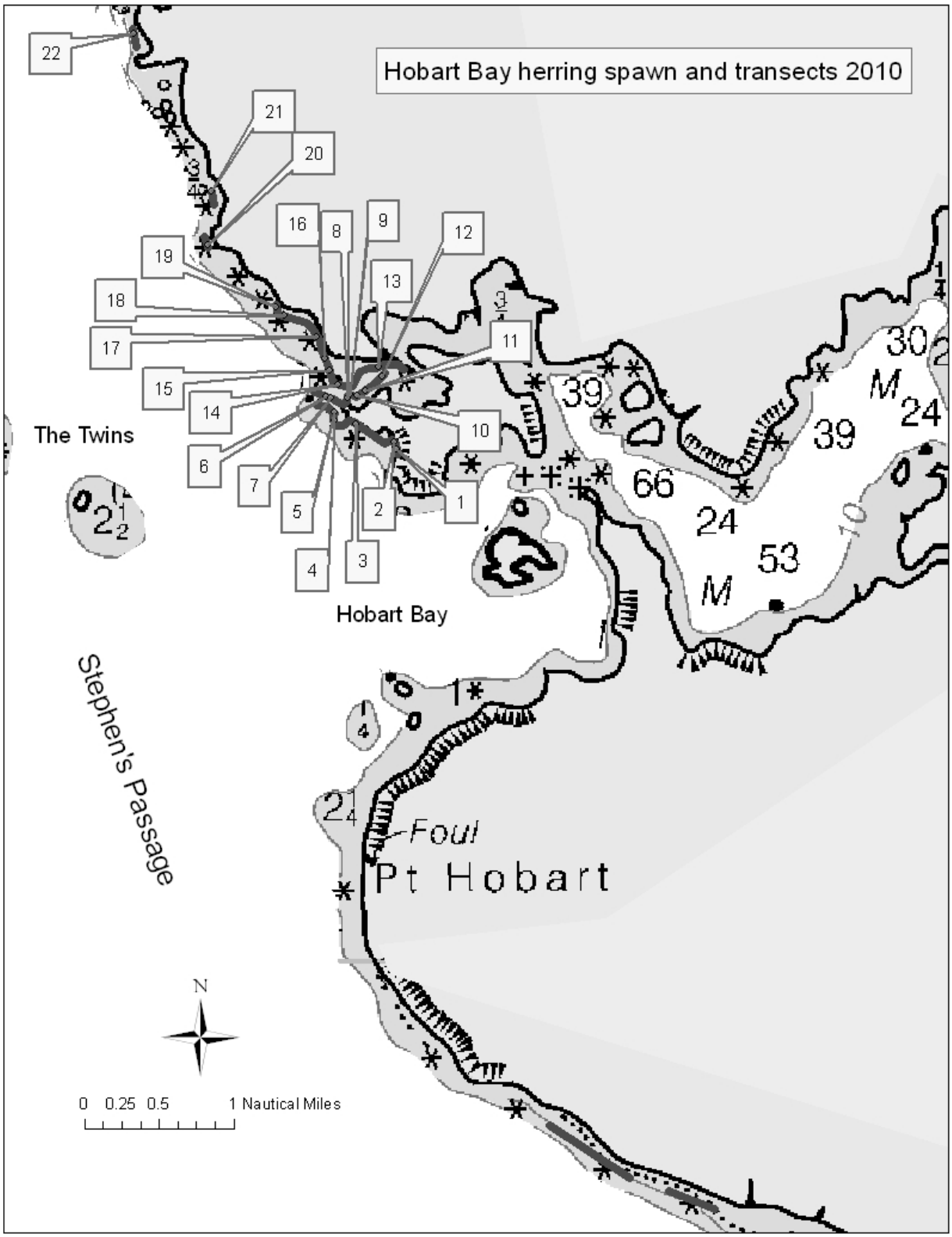
4-21-10:

Yakutat herring survey #2 was flown late yesterday afternoon. No new spawn was observed in the main group of islands in the vicinity of town. Approximately **5.5 miles of spawn** was observed around Knight Island, the largest island in the Bay, and in Eleanor Cove on the mainland just inside Knight Island. **Total spawn is now estimated at 9 miles**. This will be the last survey unless local pilots alert us to more.

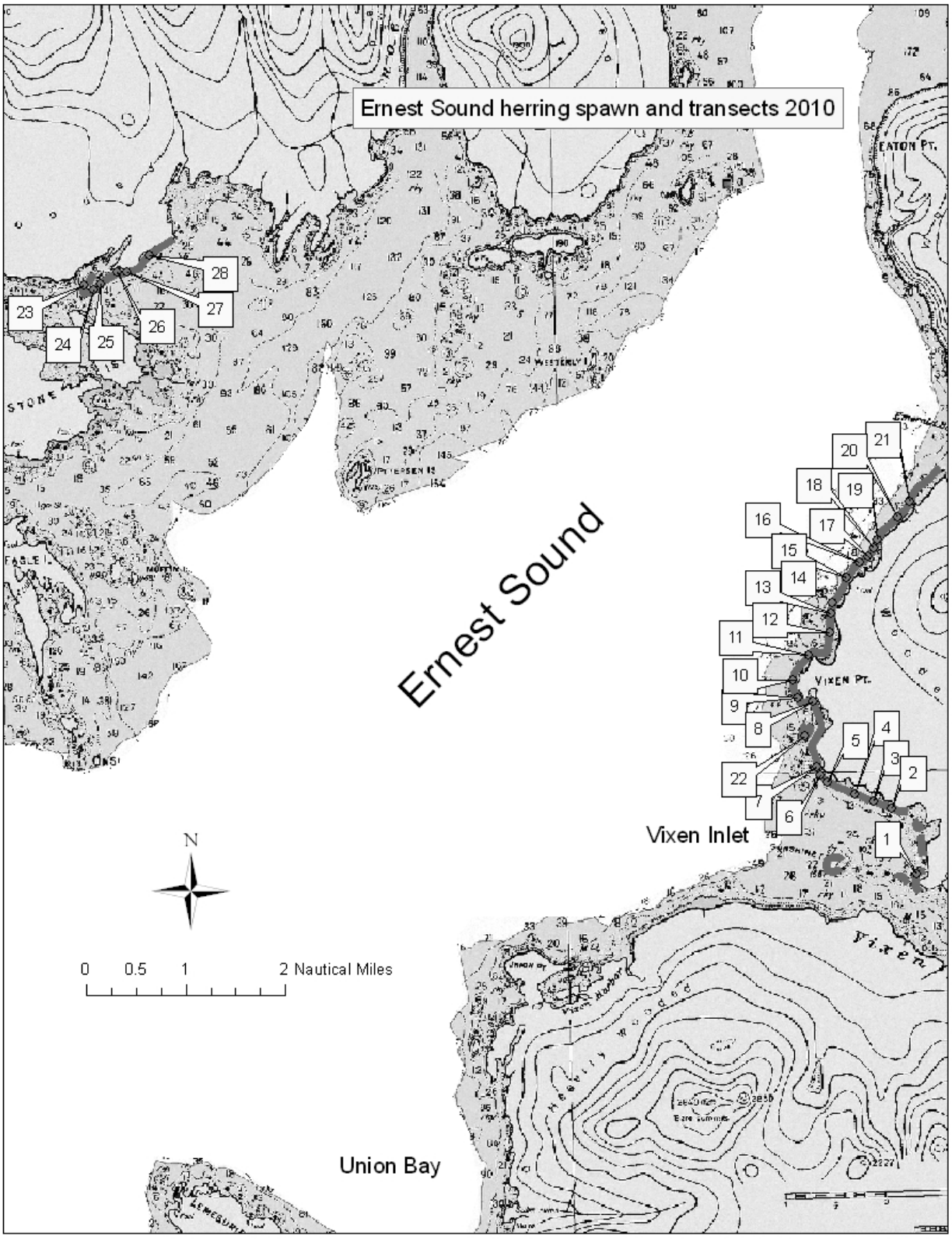
APPENDIX D



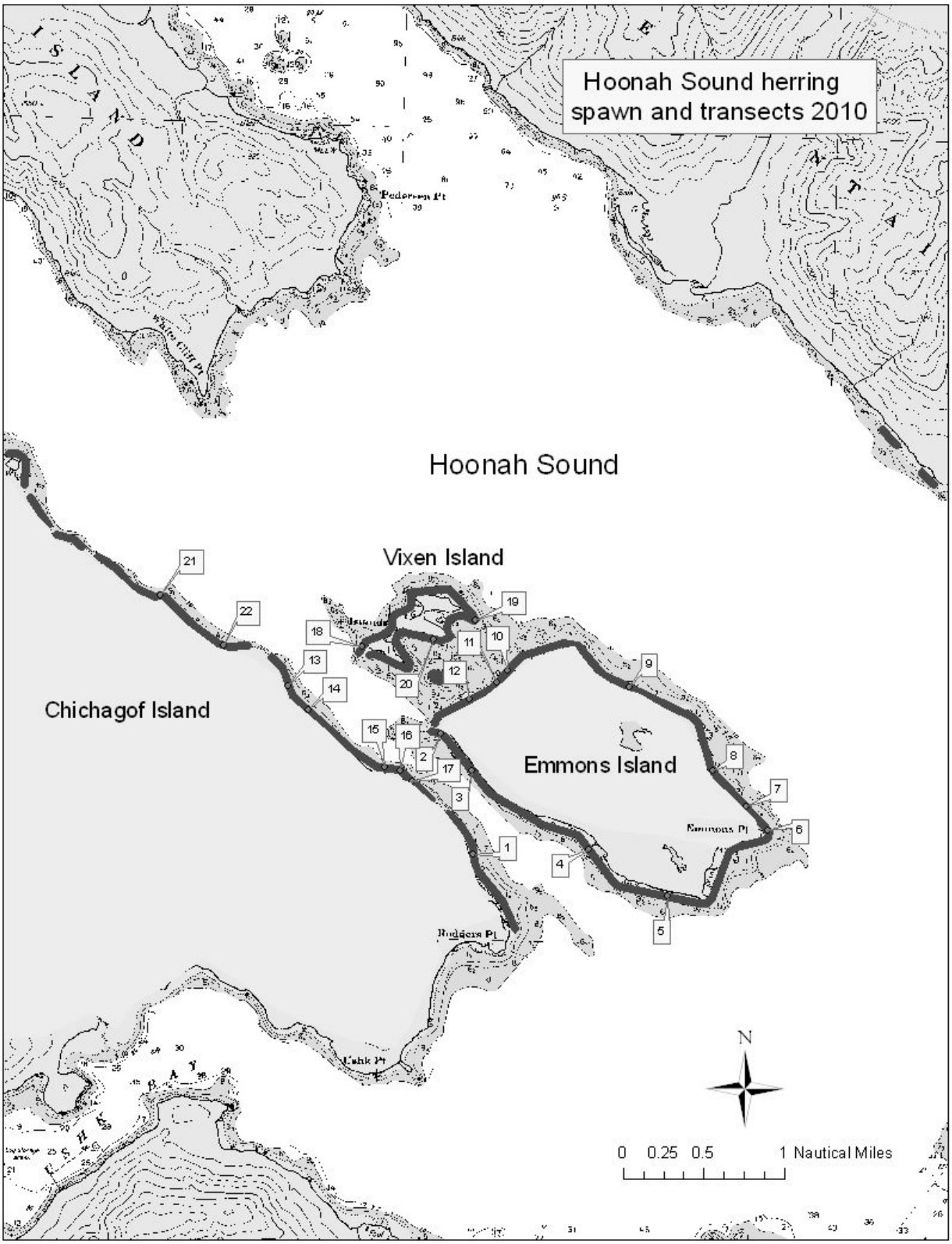
Appendix D1.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Craig herring stock in 2010.



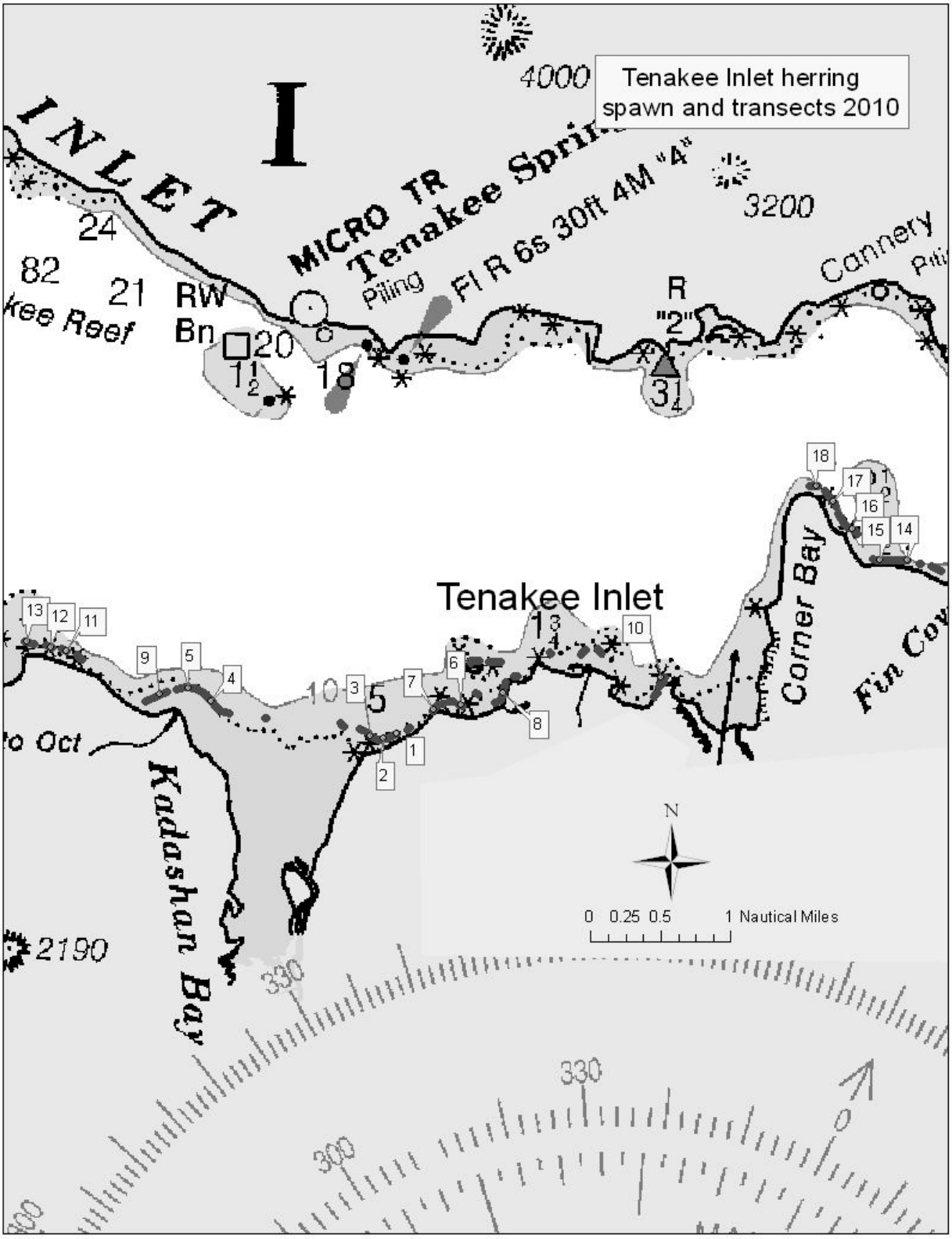
Appendix D2.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hobart Bay/Port Houghton herring stock in 2010.



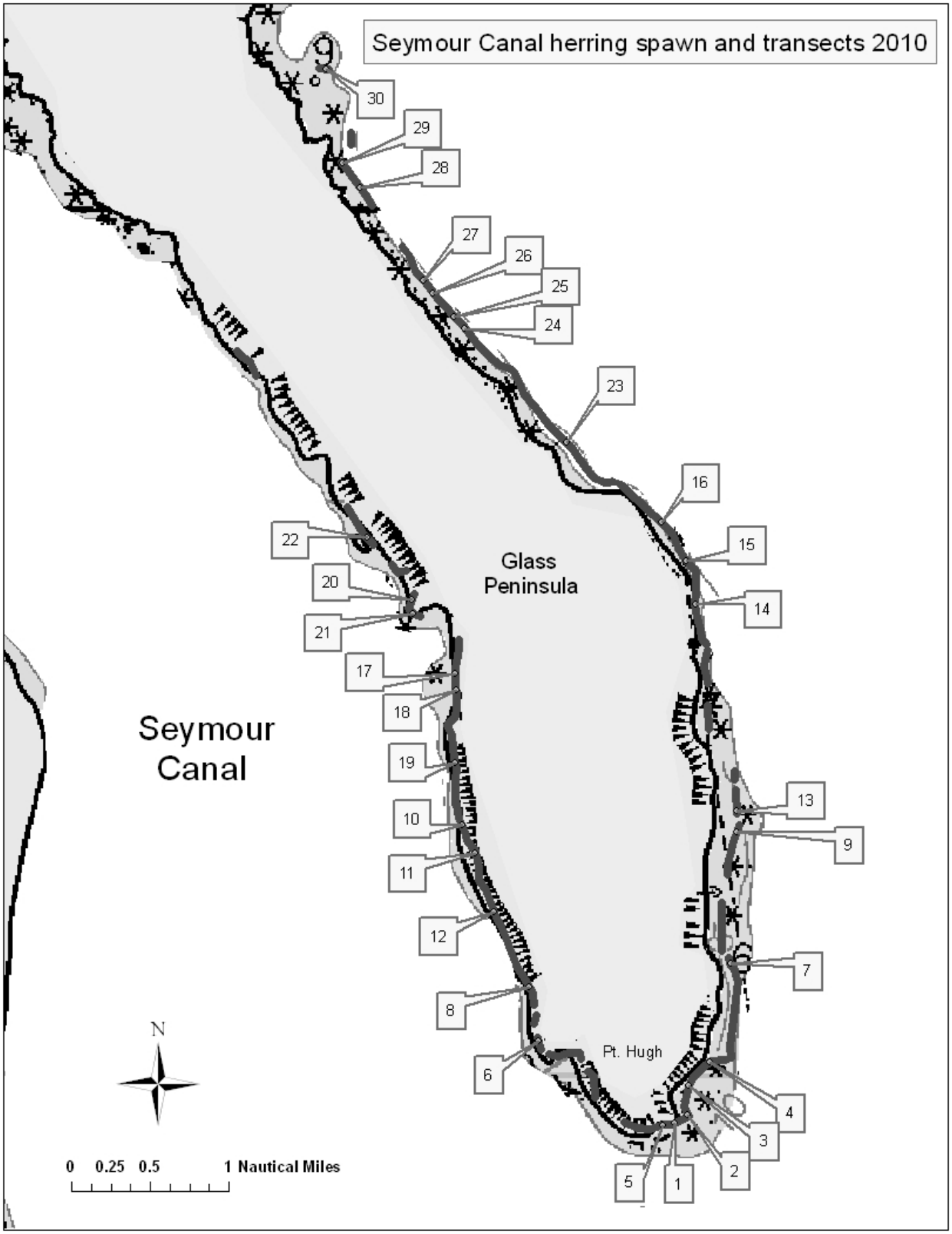
Appendix D3.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Ernest Sound herring stock in 2010.



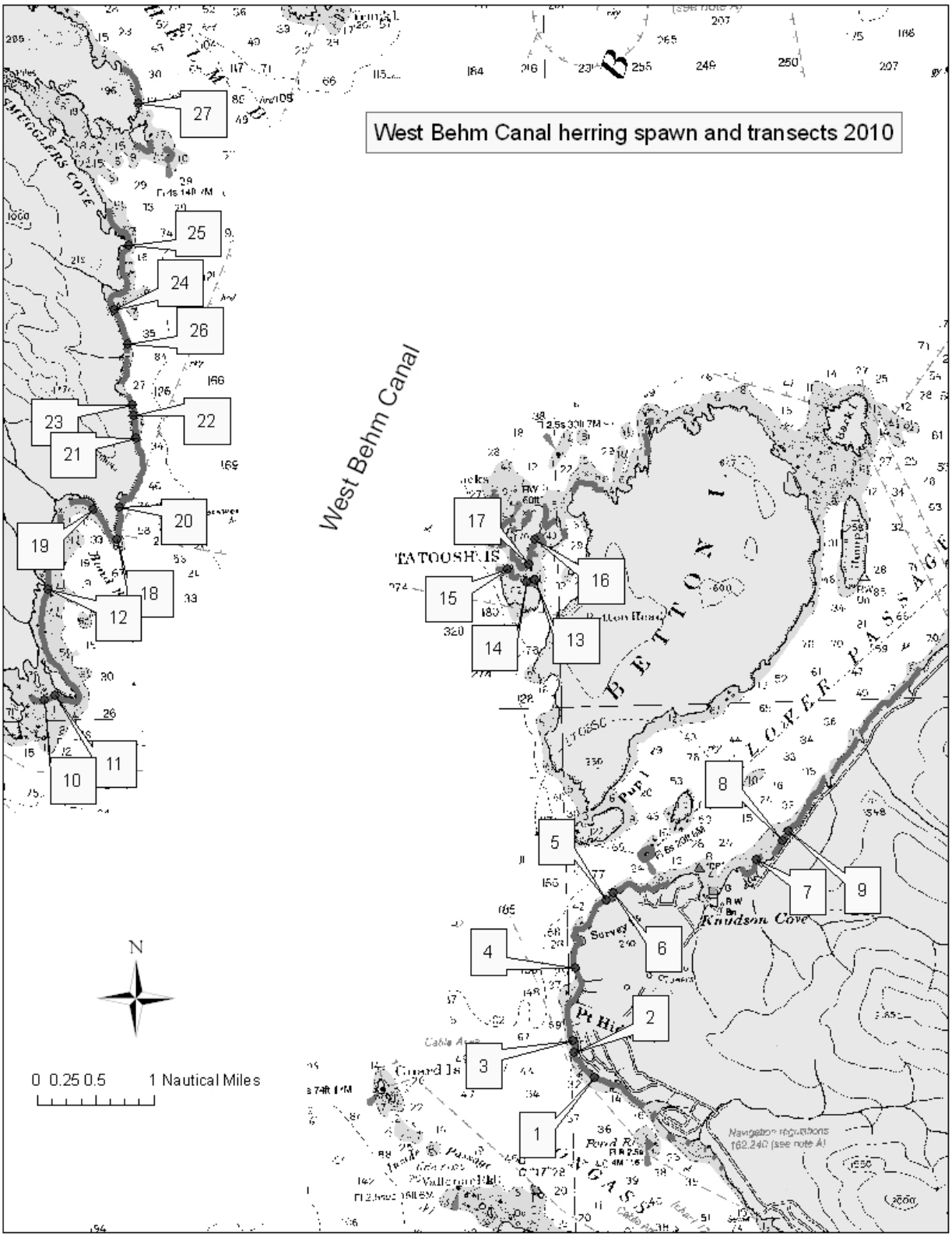
Appendix D4.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hoonah Sound herring stock in 2010.



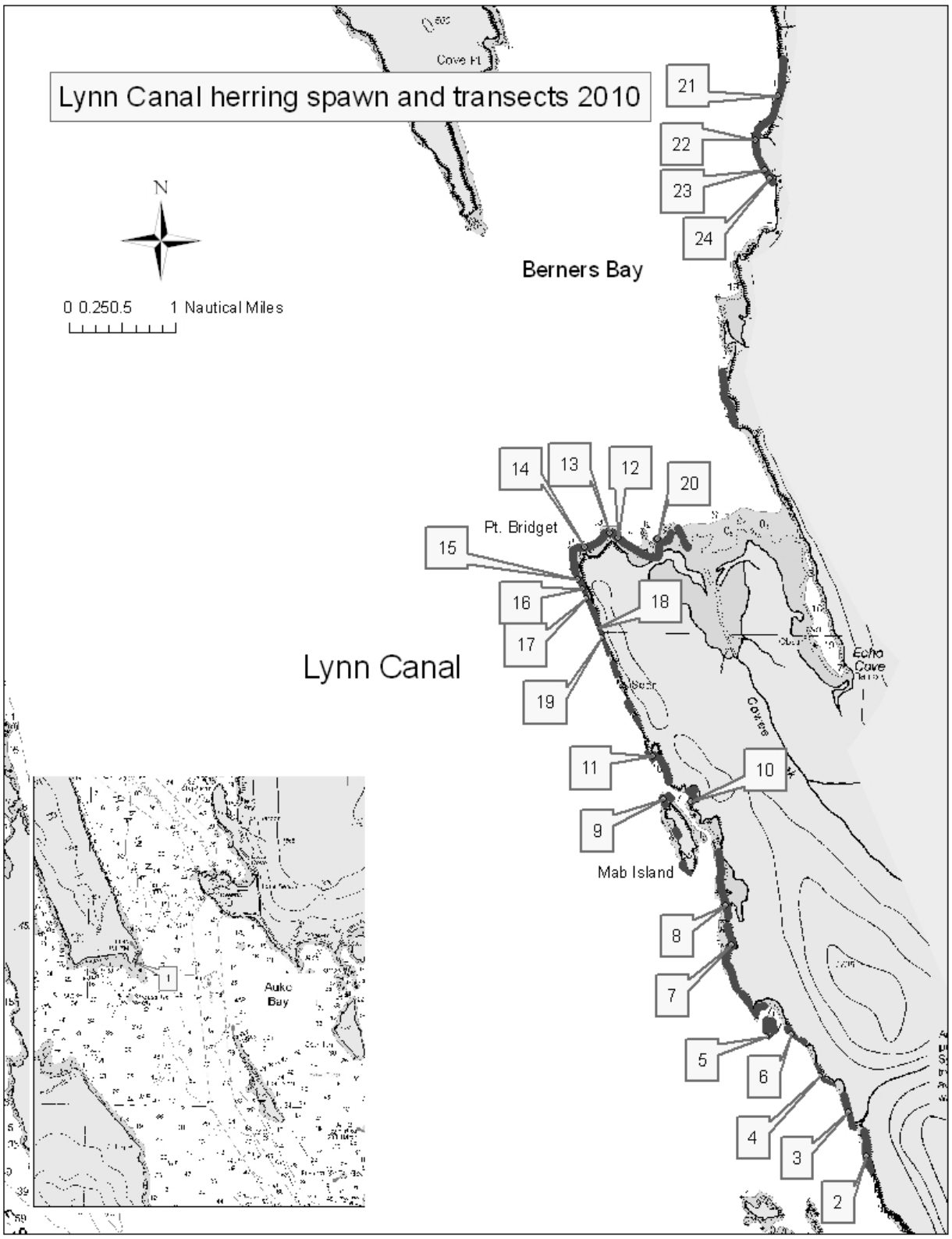
Appendix D5.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Tenakee Inlet herring stock in 2010.



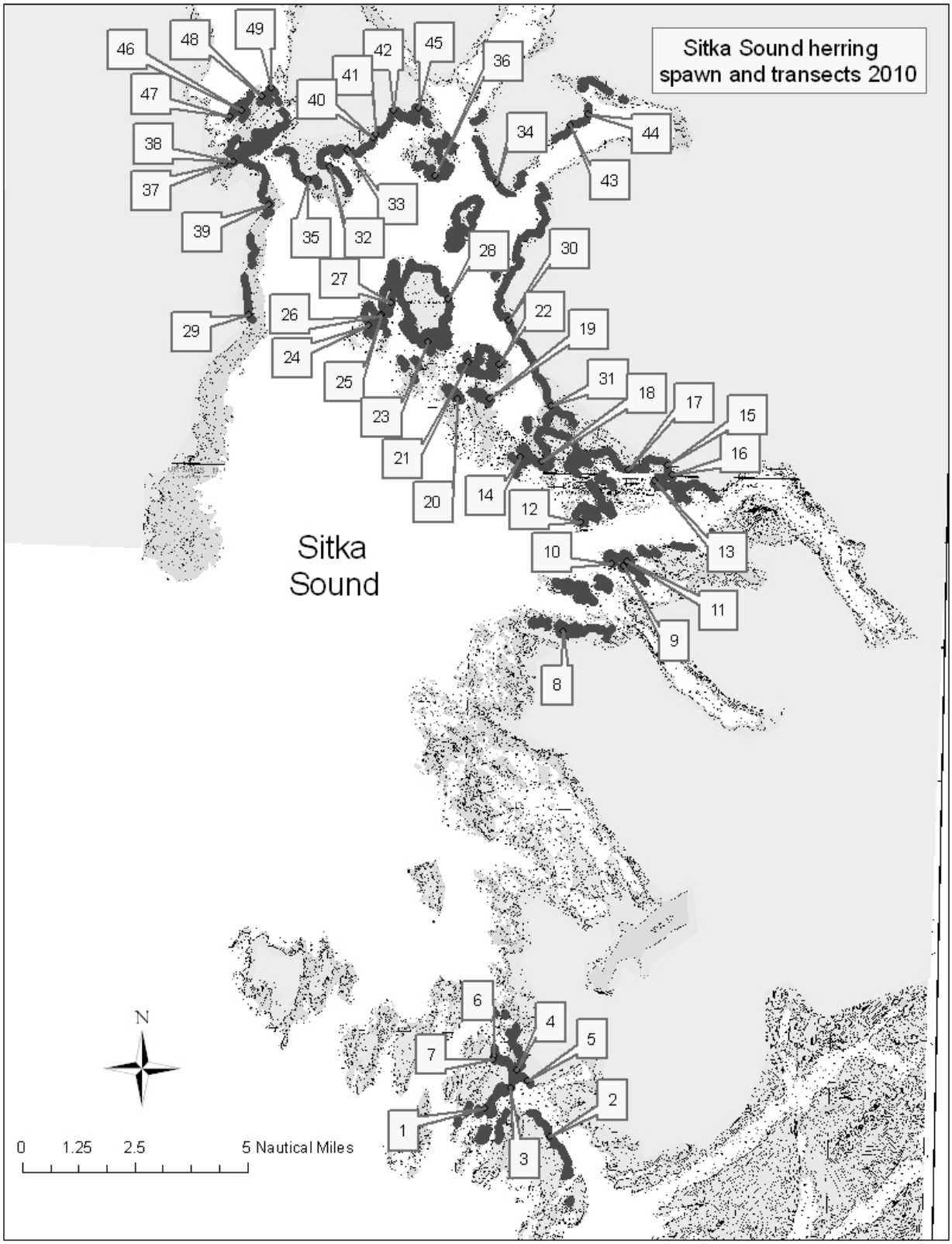
Appendix D6.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Seymour Canal herring stock in 2010.



Appendix D7.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2010.



Appendix D8.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Lynn Canal herring stock in 2010.



Appendix D9.–Sitka Sound only spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2010.