Fishery Data Series No. 09-72

Southeast Alaska 2009 Herring Stock Assessment Surveys

by

Kyle Hebert

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

Symbols and Abbreviations

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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. 09-72

SOUTHEAST ALASKA 2009 HERRING STOCK ASSESSMENT SURVEYS

by
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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF APPENDICES

LIST OF APPENDICES (Continued)

ABSTRACT

Pacific herring, *Clupea pallasi*, is a primary forage fish 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 during 2009 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 2009, a total of 151.8 nautical miles of spawn were mapped along shorelines. In 2009, post-fishery biomass estimates, combined for all stocks, totaled 162,774 tons.

Also included are summaries of commercial fisheries that occurred during the 2008–09 season. During the 2008–09 season, winter bait fisheries were open in Craig, Ernest Sound, Hobart-Houghton and Tenakee Inlet with guideline harvest levels totaling 2,807 tons. Gillnet sac-roe fisheries were open in Seymour Canal and Hobart-Houghton with guideline harvest levels totaling 1,847 tons. A purse seine sac-roe fishery was open in Sitka Sound with a guideline harvest level of 14,504 tons. Spawn-on-kelp fisheries were open in Craig, Hoonah Sound, Ernest Sound, and Tenakee Inlet. No commercial fisheries were opened in West Behm Canal, Kah Shakes/Cat Island, or Lynn Canal in 2008–09 due to below-threshold forecasts. Herring harvested commercially during the 2008–09 season totaled 16,767 tons, not including herring pounded for spawn-on-kelp fisheries.

Key words: Pacific herring, *Clupea pallasi,* 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 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 more than 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 needed to conduct the respective analyses. Biomass estimates derived from the spawn deposition method used only the most recent spawn deposition data, and did not factor in age composition or weight data. A conversion factor based on an estimate of the number of eggs per ton of herring, was 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 spawn deposition to estimate biomass. Biomass accounting 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 hindcasting historical 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 biomass accounting forecasts have been made 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, key data inputs for these models are presented in this report. The primary intent of this report is to document data collected during winter 2008 through spring 2009 and provide historical perspective to present 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 commercial fishing quota.

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 in all major spawning areas (Figure 1), and many minor spawning areas in Southeast Alaska. Aerial surveys began prior to historical spawning and 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 limiting the time eggs are exposed to predation or wave action that can remove eggs from the spawning area. To account for egg loss from the study site prior to survey, a 10% correction factor is used when estimating egg loss. 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; 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 deposition is key to extent of egg loss, a serious attempt was made to conduct surveys within 10 days; however at times surveys were delayed slightly to accommodate schedules of survey participants.

Shoreline Measurement

Spawn documented during aerial surveys was transcribed in ArcGIS (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, but without adhering closely to the shore on a small scale, nor 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 shore with a narrow band of spawn habitat (e.g. Sitka) requires much finer shoreline mapping as opposed to an area with broad shallow waters (e.g. Craig) interspersed with rocks and reefs at some distance from shore.

Although the same procedure and patterns of drawing spawn were followed as in past years, the process requires that judgment be used based on knowledge and experience of the local spawning areas. The intent of drawing a smoothed spawn line is to produce a survey area that is oriented along the spawn and is such that transects laid perpendicularly to the spawn line will sample the entire width of the spawn, without biasing the estimate. A second objective of measuring the spawn observed along shorelines is to obtain an estimate of spawn length, with 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 X Tools 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 0.1 nmi relative to each other.

Sample Size

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

The desirable number of transects is estimated as follows:

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

where,

n	=	number of transects needed to achieve the specified precision;
S_b^2	=	estimated variance in egg density among transects;
S_2^2	=	estimated variance in egg density among quadrates within transects;
$\overline{M}$	=	estimated mean width of spawn;
$\overline{m}$	=	estimated mean number of 0.1 m quadrates per transect;
x	=	specified precision, expressed as a proportion (i.e. 0.3 = 30%);
$\overline{d}$	=	overall estimated mean egg density;
t_a	=	critical t value for a one-sided, 90% confidence interval; and,
N	=	estimated total number of transects possible within the spawning area.

Field Sampling

Transect direction was determined by comparing the dive location to a chart with the spawn shoreline, and setting a compass bearing perpendicular to the spawn shoreline. Transects began at the highest point of the beach where eggs were observed and continued down to a depth in the sub tidal zone until no further egg deposition was observed, or to a maximum of 21 m (70 fsw) of depth. The portion of transects above the waterline were surveyed by walking until the water reached diving depth (usually 2 to 3 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 2007, 2008, and 2009 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:

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

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,

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

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

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

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

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:

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

where,

b = estimated total spawning biomass;

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

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

The number of fish of mean weight ($h_{\overline{g}}$) 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 3.

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 (the chances of rejecting a true value is about 10 percent). The minimum sampling goal was set at 500 fish (producing ageable samples), 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 using a dissecting microscope, varying the light source for optimum image of the annuli. Scale reading results were spot-checked by a second reader for age verification. 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.

Condition Factor

Condition of fish (CF) 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.

COMMERCIAL FISHERIES

During the 2008–09 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, Tenakee Inlet, and West Behm Canal, threshold levels were based on simulation models that estimated average unfished biomass (Carlile 1998a; Carlile 1998b; Carlile 2003). 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 2008–09 season ranged from 1,000 tons to 20,000 tons.

Management Strategy

The following management plan was in place for the 2008–09 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 around major stock locations beginning on March 14, 2009 in Sitka Sound and ending on May 21, 2009 in Hobart Bay/Port Houghton. 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 aerial surveys were conducted, but where no spawn deposition survey were completed, included Bradfield Canal (12.1 nmi) and

Farragut Bay (1.0 nmi). Aerial surveys were conducted in other traditional spawning areas where spot spawns or no spawning was observed in 2009 (see Appendix C). The department documented about 4.6 nmi of herring spawn in Yakutat Bay in 2009. The department also documented a total of 6.6 nmi of herring spawn on Annette Island in 2009.

SPAWN DEPOSITION SURVEYS

In 2009, 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 15, and were completed in Hobart Bay/Port Houghton on May 15 (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 2009 survey results, including spawn mileage, average transect, area of egg deposition, egg density, estimated egg deposition, and estimated spawning biomass is presented in Table 5. For comparison of current spawning stock abundance to prior years, estimates of pre-fishery spawning biomass are presented in Figures 3 to 8.

The total documented spawn for major spawning areas in Southeast Alaska in 2009 was 151.8 nmi (Table 5). This did not include spawning in minor spawning areas, or around Annette Island, or Yakutat (see Appendix C for a detailed accounting of minor spawn areas throughout Southeast Alaska).

Visual Estimate Correction

Minimum sample size guidelines were met using data from 2007 through 2009 for most (5 of 7) estimators. For two estimators it was necessary to add data from 2005 or 2006 to achieve the minimum sample guideline. Correction coefficients applied to 2009 spawn deposition visual estimates ranged from 0.888 to 1.670, 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 for observed estimates to diverge from laboratory estimates as the magnitude of estimates increased, as studies of other species has found (see Jones and Quinn 1998). Therefore, an overall ration of sums, across the entire range of estimate magnitudes, was considered reasonable and was used to calculate correction coefficients.

AGE AND SIZE

A combined total of 10,543 herring were sampled from all stocks and gear types (cast net, purse seine, gillnet, trawl) during the 2008–09 season. Of these, 9,591 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 otherwise unavailable scales. Of the 9,591 processed fish, 9,582 herring were used in the analysis, because data from nine fish were considered outliers, and were removed.

Samples were taken from Craig, Ernest Sound, Hobart Bay/Port Houghton, Hoonah Sound, Lynn Canal, Seymour Canal, Sitka Sound, Tenakee Inlet and West Behm Canal. The minimum sample goal of 500 ageable fish was met in only a few instances. However, sample size fell just below the minimum in most cases (Tables 7 and 8). There were few areas where the sample size was substantially below the sampling goal.

Typically, there is a relatively small proportion of herring greater than age-8 in Southeast Alaskan stocks; age-8 and older fish were therefore combined into one age-class. However, in recent years in the Sitka Sound spawning area, there has been a substantial proportion of herring age-9 through age-13. To fully visualize the age composition for Sitka Sound, the individual age classes have been separated out (Table 9, Figure 9).

Size-at-Age

Based on cast net samples in 2009, 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 10). There is less distinction between spawning areas for the youngest observed age-class (age-4). No age-3 herring were collected in Sitka Sound, nor from any other stocks, so valid comparison could not be made. Weight-at-age for all other major Southeast Alaska stocks were grouped and there is no clear distinction between any stock, although 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 2009 data with general observations of trends.

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 11). 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 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.

Weight-at-age appears to be declining for some stocks and remaining stable in others (Figures 12 to 21). There appear to be no stocks where weight-at-age has increased over the past 20 years.

In Sitka Sound, weight-at-age appears to have declined over the past eight years, particularly for ages 4 through 7. Due to lack of age-3 fish in recent years, a trend is less clear for age-3 herring. To determine whether declining weight-at-age has had an obvious detrimental effect on the condition of Sitka Sound herring, condition factors were calculated, which essentially determine if the physical proportion of herring (i.e. weight-to-length ratio) has changed over time. Based on this approach, average condition of herring in Sitka Sound appears to be generally stable or increasing over the period 1990–2009. However, there was an apparent decline over the period 2002 to 2007, with an increase over the past two years (Figure 22).

Winter Test Fishery and Trawl Survey Sampling

Winter sampling was conducted by the department in January 2009 in Sitka Sound, using a purse seine and in Lynn Canal using a trawl. The purpose of the Sitka winter sampling was to provide data to update weight-at-age used to calculate the final forecast of the mature population. The Sitka winter test fishery does not cover a wide geographical area and is not expected to provide an accurate estimate of age composition. Using weight-at-age data from fish collected by purse seine during the department's winter test fishery in January 2008, ADF&G issued a preliminary forecast for 2009 Sitka Sound herring stock. The final forecast was calculated using 2009 winter test fishery data (Table 9), 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 2009 was 76,542 tons and 15,308 tons, respectively. The final forecast and guideline harvest level, after updating with winter test fishery weight-at-age declined to 72,521 tons and 14,504 tons, respectively. The final forecast and guideline harvest level declined from the preliminary estimates due to lower weight-at-age for age-3 through age-7 herring.

National Oceanic and Atmospheric Administration-Ted Stevens Laboratory conducted trawling in Lynn Canal during mid-February through mid-March, 2009. This sampling was part of a separate study on whale prey selection in the Juneau area. The intent of the trawling was to verify species composition of whale prey after estimating school size using hydroaccoustic techniques (J. J. Vollenweider, NOAA, *personal communication*). Sampling effort was limited to a small number of targeted schools and it is unlikely that samples were representative of the true age composition of the entire stock. Estimates of weight-at-age were likely to be more representative of the entire stock, since less variation is typically associated with weight-at-age than with age composition. ADF&G obtained herring from the NOAA trawl sampling to help provide some indication of the age composition and size-at-age, because no other samples were available and because of anticipated difficulty in obtaining cast net samples during the spring.

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 2009. 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 30, 2009 at 0900 and closed on May 2, 2009 at 17:00 hours. Seventy-three permit holders and four processors participated in the fishery harvesting 866 tons.

Hobart Bay-Port Houghton

The Hobart Bay commercial set net sac roe fishery opened on May 2 at 13:30 hours and closed on May 3 at 07:00 hours. The total harvest of 341 tons by 62 permit holders. Average roe content was 12.5%.

Sitka Sound

The Guideline Harvest Level (GHL) was achieved with five competitive openings, ranging from 15 minutes to 2.5 hours in duration. The first opening (15 minutes), occurred March 22 in the Hayward Strait area; approximately 2,600 tons of herring were harvested. The second opening (1 hour, 55 minutes) occurred on March 24 in the Hayward Strait area; about 4,750 tons were harvested. The third opening (2 hours, 30 minutes) occurred on March 28 in the Starrigavin Bay area; about 3,640 tons were harvested. The fourth opening (2 hours, 5 minutes) occurred on March 31 in the Starrigavin Bay area; about 2,540 tons were harvested. The final opening (15 minutes) occurred on April 1 in the Silver Bay area; about 1,300 tons were harvested. The total harvest was 14,755 tons, made by 50 permit holders.

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 8, 2008 and closed on February 28, 2009. Hobart Bay/Port Houghton was the only area that had no harvest.

Spawn-on-Kelp Pound Fisheries

Four areas were open to the commercial harvest of spawn on kelp (SOK) during the 2008–09 season: Hoonah Sound, Craig, Tenakee Inlet, and Ernest Sound. Landings were made in all fisheries.

Hoonah Sound

A total of 98 closed pounds were actively fished, of which 92 were single-permit pounds, and six were double-permit pounds.

Tenakee Inlet

A total of 45 closed pounds were actively fished, of which 11 were single-permit, 27 were double-permit, and 7 were triple-permit pounds.

Craig

A total of 96 closed pounds were actively fished, of which 34 were single-permit, and 62 were double-permit pounds.

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2008–09 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 2008–09 season was in Sitka Sound, for bait, using purse seine gear during January and March, 2009. A total of about 60 tons were harvested on January 30, 2009 and March 2, 2009. The department obtained samples from the catch to update weight-at-age for the 2009 Sitka Sound area forecast.

DISCUSSION

Spawn Deposition

Spawn deposition estimates for 2009 were lower than 2008 estimates for all stocks, with the exception of West Behm Canal. In many cases, the decline was substantial (e.g. Sitka Sound, Seymour Canal, Tenakee, and Craig). However, the most dramatic declines between 2008 and 2009 followed sharp increases that occurred between 2007 and 2008, which is the case for Sitka Sound and Tenakee Inlet. It is unclear whether the variation in spawn deposition estimates over the past three years was primarily due to population fluctuations, or a function of estimate variation, or both. Although estimates of variability were not calculated for spawn deposition estimates (variability estimates have been calculated for Sitka Sound and will be presented in a subsequent report), it is possible that large fluctuations in estimates were due in part to large estimate variation and do not necessarily represent the best estimate of true stock size in any given year. This is almost certainly true for the Sitka Sound area in 2008, when an unusually high estimate of egg deposition and spawning biomass was calculated, as a result of a small number of survey transects intersecting a *Macrocystis* kelp bed containing heavy egg deposition. Therefore, estimates of spawning biomass presented in this report, which are based solely on egg deposition (as opposed to model-derived results), offer a general view of trends in stock size and should not 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 the most accurate estimates 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 information, and does not rely on a single time series to estimate spawning biomass. 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 hindcast estimates, which change with each model run.

The general trend for herring biomass in Southeast Alaska, based only on spawn deposition estimates, is slightly increasing over the period 1980 to 2009 (Figure 8). This is true whether or not the largest stock (Sitka Sound) is included. Biomass estimates from 2009 are 76% and 30% higher than the long-term average (1980–2009) for all stocks, and all stocks 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 adjacent to the Kah Shakes-Cat Island area—the trend in spawning stock size for this greater area is unclear. Spawn deposition estimates suggest that abundance of herring in Southeast Alaska is at a high level relative to the period 1980–2008.

Age Composition

A consistent pattern for all stocks in Southeast Alaska in 2009 is the absence of age-3 fish observed in cast net and commercial fishery samples (see Tables 9 and 12 to 17, and Figures 9 and 23 to 31). Very low levels of age-3 fish have been observed in samples for several years in most stocks. Although this observation would normally be considered to signal an alarming lack of recruitment, there are two other patterns that are contrary to this. First, in recent years, despite few or no age-3 fish appearing in samples of spawning fish, these cohorts have been observed, often as substantial proportions, in samples of the spawning population in subsequent years

(Figures 32 to 40). This suggests that age-3 fish were present in the population, but had not yet recruited to the *mature* population, and did not spawn as age-3 fish. A second pattern that runs contrary to a lack of recruitment is that estimates of egg deposition have continued to increase or remain at high levels, when a decrease would be expected after several years of little or no recruitment. ASA modeling for some areas has resulted in high survival estimates (e.g. average of 87% for Sitka Sound during 1999–2009) as result of continued high egg deposition estimates. Although age-3 has historically been considered the age at which herring begin to recruit to the spawning population, there is evidence that herring may be maturing later and entering the spawning population as older fish. However, if maturation rate is assumed to be correlated with the condition of fish, which appears to be stable at least for herring in the Sitka Sound area, then at this point it is unclear why Southeast Alaska herring may be experiencing delayed maturation. Although condition of herring in Sitka Sound may have declined during 2002–2007, it does not appear to be lower than during the early 1990s, when age-3 recruitment was regular. ASA modeling for some Southeast Alaska herring stocks suggests that shifts in ocean conditions may have resulted in delayed age of maturation and increased survival. Presently, it is not possible to make conclusions regarding success or failure of recruitment to the spawning population, based solely on the absence of age-3 fish in 2009 samples. Sampling over the next few years will help determine the strength of this cohort.

Another pattern that is apparent from 2009 age data is that nearly all herring stocks in Southeast Alaska are comprised of older age classes of fish, primarily dominated by age-6, -7, and -8+ (Figures 9 and 23 to 31). The only exceptions may be in Craig and Lynn Canal, where age-5 herring appear to be a relatively large percentage of the stock. However, the Lynn Canal samples were intended for a different study, and the Lynn Canal stock was the only stock from which samples were collected using trawls, thereby making direct comparisons to other stocks less appropriate (see Winter Test Fishery and Trawl Survey Sampling, below). For all other major stocks in Southeast Alaska, age-3 and age-4 fish were absent from samples, or contributed a very small percentage to the stock; age-5 fish were at low levels relative to other age classes.

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TABLES AND FIGURES

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

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

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

Table 2.–Dates of 2009 herring spawn deposition surveys conducted in Southeast Alaska.

Survey area	Survey Leg	Survey Dates
Craig	I	April 15–16
Sitka Sound	I	April 18– 20
West Behm Canal	I	April 21–22
Ernest Sound	I	April 23
Hoonah Sound	II	May 6–7
Tenakee Inlet	II	May 8–9
Lynn Canal	II	May 11–12
Seymour Canal	II	May 13–14
Hobart Bay/Port Houghton	II	May 14–15

Table 3.–Fecundity relationships used for estimating 2009 herring spawning biomass for stocks in Southeast Alaska.

Sampling year	Stock sampled	Fecundity equation	Stocks to which Fecundity Equation was applied in 2009
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 4.–Summary of herring egg estimates (in thousands) by transect for 2009 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	294	14	0	1	774	17	0	1	0	1	0	4	53	13	19	4	334	6
2	396	31	37	4	853	37	307	10	150	6	863	22	122	8	63	5	743	7
3	193	15	0	1	134	15	22	8	116	7	2,157	40	0	4	0	3	138	13
4	745	28	559	7	355	5	162	9	0	1	1,994	36	173	14	56	12	361	10
5	1,127	16	316	15	0	1	482	11	95	8	2,102	47	522	13	278	7	163	15
6	8	7	1,857	15	3,041	21	135	12	120	7	6,682	87	95	6	0	3	0	2
7	56	10	413	11	564	21	8	5	1,096	17	1,499	41	153	5	119	6	0	1
8	4,761	55	269	8	916	23	1,948	33	18	4	206	21	1,070	22	241	6	0	1
9	1,020	32	91	13	73	13	818	35	185	5	962	17	184	6	93	5	96	7
10	2,267	22	1,113	8	28	9	2,115	24	38	7	308	30	165	15	503	40	172	13
11	65	6	128	11	973	27	1,244	31	810	16	456	21	642	17	399	9	938	7
12	24	4	882	6	2,190	37	1,078	19	9	7	1,694	15	462	12	0	1	399	14
13	749	19	286	15	506	18	5,434	63	98	5	142	8	0	1	324	14	158	16
14	245	12	87	11	1,524	40	5,815	86	95	8	2,243	14	1	1	715	20	315	10
15	169	12	101	8	372	26	700	17	547	15	2,464	24	25	8	371	6	666	6
16	2,479	63	550	12	0	3	2,673	22	199	8	7,258	65	2,318	32	193	10	118	7
17	1,249	23	102	7	8	2	1,050	24	39	4	3,378	25	0	3	550	39	3	3
18	663	10	0	1	0	4	707	36	27	7	4,751	30	2,073	23	0	6	286	10
19	395	13	156	11	0	1	398	9	159	20	1,746	9	514	15	336	9	616	8
20	741	8	465	13	65	6	530	7	888	12	936	10	1,155	18	102	7	47	7
21	1,443	12	60	5	100	2	526	9	78	9	956	17	245	7	90	6	142	10
22	62	12	0	4	10	3	1,466	19	631	38	92	9	0	1	87	7	530	7
23	109	10	—	—	0	1	490	7	447	7	1,897	28	96	8	11	3	—	—
24	0	1	—	—	0	1	134	8	738	6	152	3	422	37	635	10	—	—
25	0	1	—	—	239	5	789	21	294	7	1,027	18	518	28	13	2	—	—
26	157	7	—	—	0	1	15	6	748	9	1,576	38	704	43	57	6	—	—
27	584	14	—	—	—	—	—	—	688	6	1,816	26	—	—	139	8	—	—
28	1,519	34	—	—	—	—	—	—	355	5	1,828	14	—	—	198	12	—	—
29	2	7	—	—	—	—	—	—	0	5	2,678	26	—	—	—	—	—	—
30	171	9	—	—	—	—	—	—	163	9	84	4	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	207	8	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	0	2	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—	—	—	102	5	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	0	5	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	801	13	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	337	13	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	26	5	—	—	—	—	—	—
38	—	—	—	—	—	—	—	—	—	—	723	8	—	—	—	—	—	—
39	—	—	—	—	—	—	—	—	—	—	1	5	—	—	—	—	—	—
40	—	—	—	—	—	—	—	—	—	—	310	8	—	—	—	—	—	—
41	—	—	—	—	—	—	—	—	—	—	136	6	—	—	—	—	—	—
42	—	—	—	—	—	—	—	—	—	—	1	4	—	—	—	—	—	—
43	—	—	—	—	—	—	—	—	—	—	0	6	—	—	—	—	—	—
44	—	—	—	—	—	—	—	—	—	—	5,030	33	—	—	—	—	—	—
45	—	—	—	—	—	—	—	—	—	—	1,801	16	—	—	—	—	—	—
Average	723	17	340	9	489	13	1,117	20	294	9	1,409	20	451	14	200	10	283	8

Table 5.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2009.

Spawning Stock	Number of Transects Completed	Average Length of Transects (m)	Nautical Miles of Spawn Observed	Nautical Miles of Spawn used for Estimation	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	2009 escapement (tons)
Craig	30	85	17.0	17.0	2,660,398	427,864	1.265	85.1	16,825	150,339,894	14,106
Ernest Sound	22	43	6.6	6.6	519,486	399,622	0.231	54.7	9,750	47,315,576	2,854
Hobart/Houghton	26	65	5.5	5.5	664,049	375,392	0.277	72.5	14,554	38,061,726	3,042
Hoonah Sound	26	102	10.3	10.3	1,951,581	545,950	1.184	96.8	16,209	146,076,849	15,586
Seymour Canal	30	44	13.2	13.2	1,083,790	331,964	0.400	69.0	13,782	58,011,459	4,415
Sitka Sound	42	98	65.5	62.1	11,322,017	715,851	9.005	152.9	27,354	658,424,205	110,946
Tenakee Inlet	26	69	6.9	6.9	884,686	325,364	0.320	74.3	11,736	54,505,512	4,464
West Behm Canal	28	48	16.7	16.7	1,469,099	210,309	0.343	66.9	12,202	56,270,429	4,147
Lynn Canal	22	41	10.1	10.1	765,213	345,859	0.294	76.3	15,393	38,207,955	3,213
Total	252	—	151.8	148.4	21,320,319	—	13.319	—	—	1,247,213,605	162,774
Average	28	66	—	—	2,368,924	408,686	1.480	83.2	15,312	—	—

Table 6.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2009. Data was combined for years 2007 through 2009 unless otherwise noted.

	Estimator initials							
Kelp type	BM	DG	JM	KH[a]	SD	TT	WB[b]	Average
Eelgrass	1.245	1.041	1.266	0.810	1.246	1.331	1.606	1.224
n =	11	21	26	17	14	15	11	—
Fucus	1.236	1.266	1.047	1.011	1.218	1.381	2.044	1.327
n =	8	29	30	18	12	12	15	—
Fir kelp	1.028	1.002	1.126	0.781	0.901	1.073	1.349	1.016
n =	6	20	23	15	8	8	10	—
Hair kelp	1.048	0.911	1.329	0.834	0.949	1.163	1.374	1.095
n =	13	25	29	14	16	16	12	—
Large brown kelp	0.863	1.251	1.004	0.968	1.204	1.449	1.978	1.265
n =	15	25	29	25	19	19	12	—
Average[c]	1.084	1.094	1.154	0.880	1.104	1.279	1.670	—

[a]Data from years 2005 and 2007–2009.
[b]Data from years 2007–2009, except for Hair (2006,2007, 2009) and Large brown kelp (2006–2009).
[c]Values are applied to estimates of eggs that are loose, on rock, or on unclassified kelp types.
[d]Values applied to *Laminara, Agarum, Alaria*, 3-ribbed kelp, 5-ribbed kelp, *Macrocystis*.

Table 7.–Summary of samples collected from Southeast Alaska herring stocks in 2008–09.

	Commercial fishery			Survey		Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Bottom trawl	Purse seine	Total
Craig	—	540	528	520	—	—	1,588
Ernest Sound	—	508	525	528	—	—	1,561
Hobart/Houghton	525	—	—	526	—	—	1,051
Hoonah Sound	—	528		528	—	—	1,056
Lynn Canal	—	—	—	—	594	—	594
Seymour Canal	478	—	—	527	—	—	1,005
Sitka Sound	—	—	533	532	—	525	1,590
Tenakee Inlet	—	525	525	528	—	—	1,578
West Behm Canal	—	—	—	520	—	—	520
Total	1,003	2,101	2,111	4,209	594	525	10,543

Table 8.–Summary herring samples aged for Southeast Alaska stocks in 2008–09.

	Commercial fishery			Survey		Test Fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Bottom trawl	Purse seine	Total
Craig	—	488	485	477	—	—	1,450
Ernest Sound	—	432	492	449	—	—	1,373
Hobart/Houghton	471	—	—	477	—	—	948
Hoonah Sound	—	473	—	470	—	—	943
Lynn Canal	—	—	—	—	560	—	560
Seymour Canal	408	—	—	459	—	—	867
Sitka Sound	—	—	505	519	—	509	1,533
Tenakee Inlet	—	468	496	478	—	—	1,442
West Behm Canal	—	—	—	475	—	—	475
Total	879	1,861	1,978	3,804	560	509	9,591

Table 9.–Summary of age, weight, and length for the Sitka Sound herring stock in 2008–09.

		Age category													
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+[a]**	**8**	**9**	**10**	**11**	**12**	**13**	**15**	**Total**
survey cast net—spring	number of fish	0	19	62	129	113	196	63	43	53	29	6	2	0	519
	percent age composition	0%	4%	12%	25%	22%	38%	12%	8%	10%	6%	1%	0%	0%	100%
	average weight (g)	—	56.3	81.3	109.6	135.2	176.7	151.2	178.6	189.3	201.0	199.3	183.8	—	135.2
	standard dev. of weight (g)	—	8.4	20.8	17.7	27.2	34.7	23.7	27.9	31.6	39.2	19.8	11.7	—	46.2
	average length (mm)	—	168	184	201	213	232	223	231	237	241.4	242	240	—	212
	variance of length (mm)	—	106	215	138	181	197	141	158	132	204.9	23	98	—	522
commercial seine—spring	number of fish	1	12	60	132	112	188	64	42	47	30	3	1	1	505
	percent age composition	0%	2%	12%	26%	22%	37%	13%	8%	9%	6%	1%	0%	0%	100%
	average weight (g)	46.1	63.0	81.0	127.5	154.7	199.9	178.0	200.2	214.2	215.2	262.3	257.7	223.0	153.3
	standard dev. of weight (g)	—	67.8	19.8	24.6	25.4	32.5	24.9	23.3	26.3	37.6	8.8	—	—	50.7
	average length (mm)	158	172	186	211	221	238	230	238	243	242	258	258	252	219
	variance of length (mm)	—	32,345	149	137	128	136	80	60	68	255.4	7	—	—	477
test fishery seine—winter	number of fish	7	52	68	46	42	293	54	87	94	40	14	4	0	508
	percent age composition	1%	10%	13%	9%	8%	58%	11%	17%	19%	8%	3%	1%	0%	100%
	average weight (g)	40.1	63.5	81.9	124.8	167.3	214.9	194.1	209.5	222.0	225.8	242.7	238.6	—	167.1
	standard dev. of weight (g)	9.7	15.0	18.0	36.0	26.8	23.9	25.4	16.7	19.6	20.7	21.6	19.6	—	65.9
	average length (mm)	152	168	181	204	225	241	233	240	243	246	251	253	—	220
	variance of length (mm)	166	127	167	307	115	74	84	43	49	58	15	42	—	952

[a] Shown for comparison to other stocks; includes ages 8–15.

Table 10.–Summary of Southeast Alaska herring target levels for the 2008–09 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target Exploitation Rate (%)	Guideline harvest level (tons)[a]
Craig	5,000	14,213	13.7	1,945
Ernest Sound	2,500	4,545	11.6	529
Hobart Bay/Port Houghton	2,000	3,324	11.3	376
Hoonah Sound	1,000	11,191	20.0	2,238
Seymour Canal	3,000	10,023	14.7	1,471
Sitka Sound	20,000	72,521	20.0	14,504
Tenakee Inlet	3,000	6,931	12.6	875
West Behm Canal	6,000	3,178	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 2008–09 season. Blacked out values signify confidential data due to fewer than three participants (either permit holders or processors).

Fishery	Gear	Area	District	Opening[a]	Closing[b]	Harvest (tons)[c]
Winter food and bait	Purse seine	Craig	3/4	8-Dec-08	28-Feb-09	143
Winter food and bait	Purse seine	Tenakee Inlet	12	8-Dec-08	28-Feb-09	[redacted]
Winter food and bait	Purse seine	Ernest Sound	7	8-Dec-08	28-Feb-09	[redacted]
Winter food and bait	Purse seine	Hobart Bay	10	8-Dec-08	28-Feb-09	0
Sub-total						805
Sac roe	Purse seine	Sitka Sound	13	22-Mar-09	2-Apr-09	14,755
Sac roe	Purse seine	Lynn Canal	11	Not Open		0
Sac roe	Gillnet	Seymour Canal	11	30-Apr-09	2-May-09	866
Sac roe	Gillnet	Hobart Bay	10	2-May-09	3-May-09	341
Sac roe	Gillnet	Kah Shakes	1	Not Open		0
Sac roe	Gillnet	West Behm Canal	1	Not Open		0
Sub-total						15,962
Spawn on kelp	Pound	Hoonah Sound	13	21-Apr-09	13-Apr-09	234.7
Spawn on kelp	Pound	Tenakee Inlet	12	28-Apr-09	5-May-09	64.1
Spawn on kelp	Pound	Ernest Sound	7	17-Apr-09	21-Apr-09	[redacted]
Spawn on kelp	Pound	Craig	3	1-Apr-09	7-May-09	137.3
Sub-total						[redacted]
Test fishery-bait	Purse seine	Sitka	13	3-Jan-09	2-Mar-09	60.0

[a] For spawn-on-kelp fisheries, represents start of seining / transferring herring to 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.

Table 12.–Summary of age, weight, and length for the Craig herring stock in 2008–09.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	0	49	99	136	108	85	477
	percent age composition	0%	10%	21%	29%	23%	18%	100%
	average weight (g)	0.0	54.6	62.8	78.7	91.4	110.9	81.5
	standard dev. of weight (g)	—	12.3	8.7	11.5	15.5	21.8	23.1
	average length (mm)	—	169	175	188	196	209	189
	variance of length (mm)	—	97	54	63	81	148	248
commercial pound–spring	number of fish	0	72	94	147	108	67	488
	percent age composition	0%	15%	19%	30%	22%	14%	100%
	average weight (g)	0.0	55.6	66.1	83.1	94.7	115.4	82.8
	standard dev. of weight (g)	—	9.7	11.4	12.2	14.7	20.3	23.0
	average length (mm)	—	168	175	188	196	209	187
	variance of length (mm)	—	83	73	69	82	117	249
commercial seine–winter	number of fish	0	13	80	100	157	134	484
	percent age composition	0%	3%	17%	21%	32%	28%	100%
	average weight (g)	0.0	46.0	64.0	76.8	91.4	115.7	89.3
	standard dev. of weight (g)	—	8.8	9.1	14.3	14.0	20.8	25.0
	average length (mm)	—	163	177	186	195	206	192
	variance of length (mm)	—	111	74	114	97	196	252

Table 13.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2008–09.

		Age Category						
Gear type/season	Parameter	3	4	5	6	7	8+	Total
survey cast net–spring	number of fish	0	2	55	153	198	69	477
	percent age composition	0%	0%	12%	32%	42%	14%	100%
	average weight (g)	0.0	52.0	51.9	64.4	78.7	89.6	72.5
	standard dev. of weight (g)	—	16.6	10.3	9.5	13.4	15.6	16.8
	average length (mm)	—	165	167	178	187	195	183
	variance of length (mm)	—	392	117	75	84	116	157
commercial gillnet–spring	number of fish	0	—	1	38	183	248	470
	percent age composition	0%	0%	0%	8%	39%	53%	100%
	average weight (g)	0.0	—	62.7	101.5	110.2	119.0	114.0
	standard dev. of weight (g)	—	—	—	103.4	9.9	15.0	14.2
	average length (mm)	—	—	181	196	202	208	205
	variance of length (mm)	—	—	—	39,323	47	81	80

Table 14.–Summary of age, weight, and length for the Ernest Sound herring stock in 2008–09.

		Age Category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net—spring	number of fish	1	5	31	161	166	85	449
	percent age composition	0%	1%	7%	36%	37%	19%	100%
	average weight (g)	17.6	34.7	50.8	57.6	63.7	73.5	62.1
	standard dev. of weight (g)	—	39.1	11.3	8.3	9.7	16.3	13.1
	average length (mm)	127	144	161	169	173	179	171
	variance of length (mm)	—	26,127	76	47	54	103	96
commercial pound—spring	number of fish	0	2	25	145	197	63	432
	percent age composition	0%	0%	6%	34%	46%	15%	100%
	average weight (g)	0.0	29.2	45.4	50.2	56.0	66.4	54.8
	standard dev. of weight (g)	—	11.5	9.2	7.3	9.9	13.6	11.4
	average length (mm)	—	138	162	167	171	180	171
	variance of length (mm)	—	242	90	38	60	118	90
commercial seine—winter	number of fish	2	7	51	201	169	62	492
	percent age composition	0%	1%	10%	41%	34%	13%	100%
	average weight (g)	27.0	54.9	63.8	74.0	81.8	98.4	78.2
	standard dev. of weight (g)	3.4	10.5	10.1	9.5	11.4	18.0	15.4
	average length (mm)	136	165	171	178	182	192	180
	variance of length (mm)	25	94	59	41	60	132	103

Table 15.–Summary of age, weight, and length for the Hoonah Sound herring stock in 2008–09.

		Age Category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net—spring	number of fish	0	3	49	161	137	120	470
	percent age composition	0%	1%	10%	34%	29%	26%	100%
	average weight (g)	0.0	52.1	70.9	82.0	95.8	112.5	92.5
	standard dev. of weight (g)	—	5.4	10.0	13.9	14.1	21.7	21.4
	average length (mm)	—	168	183	190	199	210	197
	variance of length (mm)	—	37	64	72	77	159	176
commercial pound—spring	number of fish	0	2	57	151	161	101	472
	percent age composition	0%	0%	12%	32%	34%	21%	100%
	average weight (g)	0.0	67.6	74.7	85.5	100.5	117.5	96.1
	standard dev. of weight (g)	—	8.2	16.6	17.6	18.0	23.3	23.6
	average length (mm)	—	168	183	190	198	208	196
	variance of length (mm)	—	13	140	61	75	128	159

Table 16.–Summary of age, weight, and length for the Tenakee Inlet herring stock in 2008–09.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net—spring	number of fish	0	3	30	176	181	87	477
	percent age composition	0%	1%	6%	37%	38%	18%	100%
	average weight (g)	—	53.5	63.2	71.0	82.5	99.0	79.8
	standard dev. of weight (g)	—	9.5	8.4	9.4	11.6	22.4	17.3
	average length (mm)	—	168	178	183	189	201	188
	variance of length (mm)	—	30	34	50	62	200	130
commercial pound—spring	number of fish	1	7	50	205	130	75	468
	percent age composition	0%	1%	11%	44%	28%	16%	100%
	average weight (g)	29.0	42.4	54.6	63.9	79.3	92.8	71.4
	standard dev. of weight (g)	—	46.1	7.1	9.9	14.7	19.7	18.2
	average length (mm)	145	158	170	178	186	198	182
	variance of length (mm)	—	29,069	54	54	69	165	156
commercial seine—winter	number of fish	0	12	83	176	148	77	496
	percent age composition	0%	2%	17%	35%	30%	16%	100%
	average weight (g)	—	53.0	67.0	78.0	90.0	118.6	85.4
	standard dev. of weight (g)	—	5.8	9.2	12.9	13.4	23.4	22.1
	average length (mm)	—	168	179	188	194	212	192
	variance of length (mm)	—	12	50	81	79	161	200

Table 17.–Summary of age, weight, and length for the Seymour Canal herring stock in 2008–09.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net—spring	number of fish	0	8	51	148	158	94	459
	percent age composition	0%	2%	11%	32%	34%	20%	100%
	average weight (g)	0.0	34.6	52.3	61.7	73.5	85.2	69.0
	standard dev. of weight (g)	—	4.1	15.0	13.1	18.4	26.9	21.7
	average length (mm)	—	143	159	167	175	183	172
	variance of length (mm)	—	49	130	96	169	268	225
commercial gillnet—spring	number of fish	0	0	0	20	104	282	406
	percent age composition	0%	0%	0%	5%	26%	69%	100%
	average weight (g)	0.0	—	—	94.2	102.0	110.9	107.8
	standard dev. of weight (g)	—	—	—	12.2	9.7	13.8	13.7
	average length (mm)	—	—	—	188	193	198	196
	variance of length (mm)	—	—	—	64	53	72	74

Table 18.–Summary of age, weight, and length for the West Behm Canal herring stock in 2008–09.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey cast net—spring	number of fish	3	17	61	234	132	28	475
	percent age composition	1%	4%	13%	49%	28%	6%	100%
	average weight (g)	30.5	43.6	58.4	65.9	72.4	84.7	66.9
	standard dev. of weight (g)	1.9	8.7	11.0	11.1	13.6	15.5	14.4
	average length (mm)	140	155	171	177	181	191	177
	variance of length (mm)	16	99	85	76	90	87	129

Table 19.–Summary of age, weight, and length for the Lynn Canal herring stock in 2008–09.

		Age category						
Gear type/season	**Parameter**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**
survey bottom trawl—winter	number of fish	3	22	115	202	111	105	558
	percent age composition	1%	4%	21%	36%	20%	19%	100%
	average weight (g)	23.9	41.1	55.3	69.7	86.0	110.5	76.3
	standard dev. of weight (g)	6.8	7.8	13.8	14.4	17.9	21.8	26.0
	average length (mm)	127	153	167	178	188	203	181
	variance of length (mm)	63	89	141	120	133	135	323

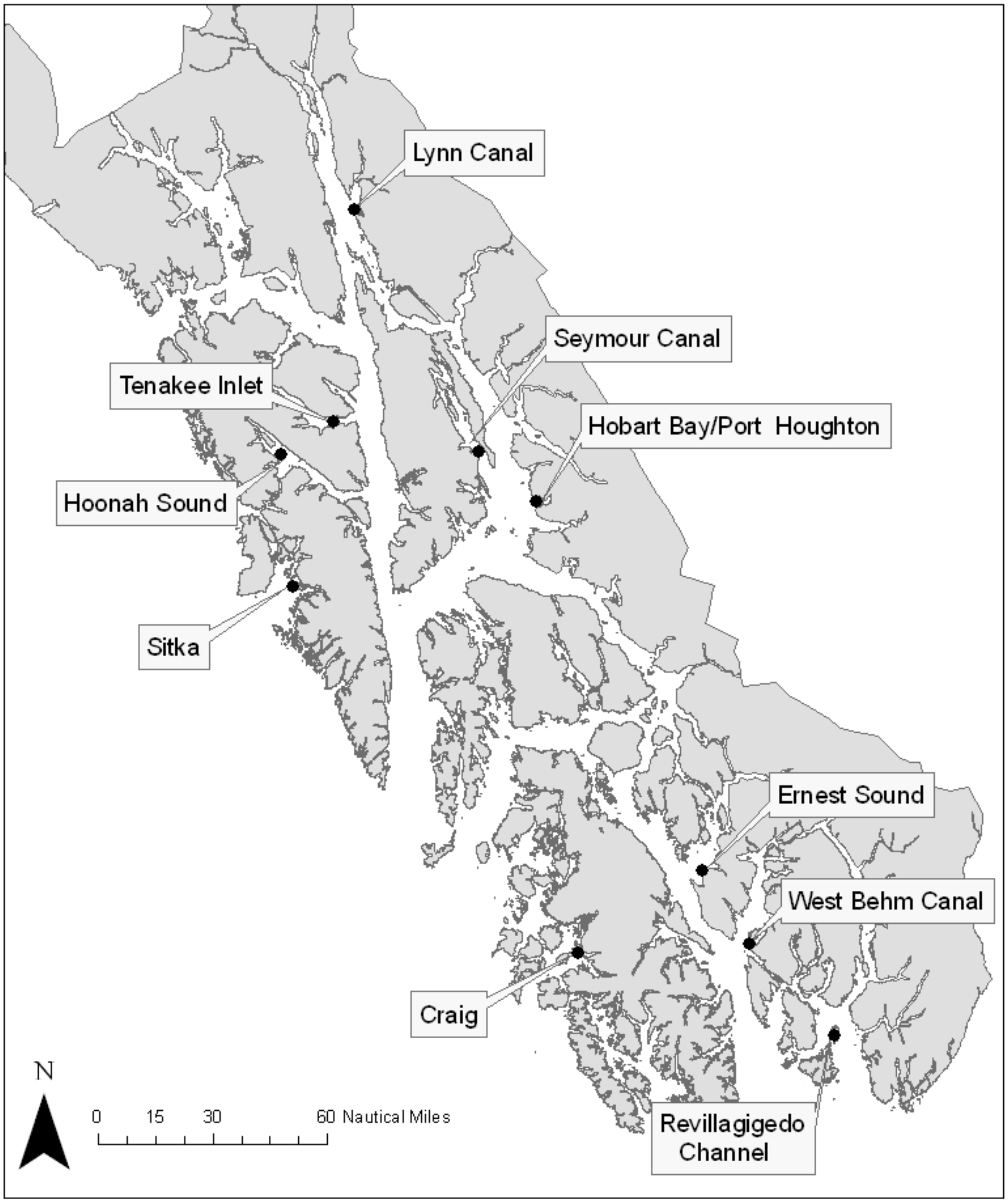


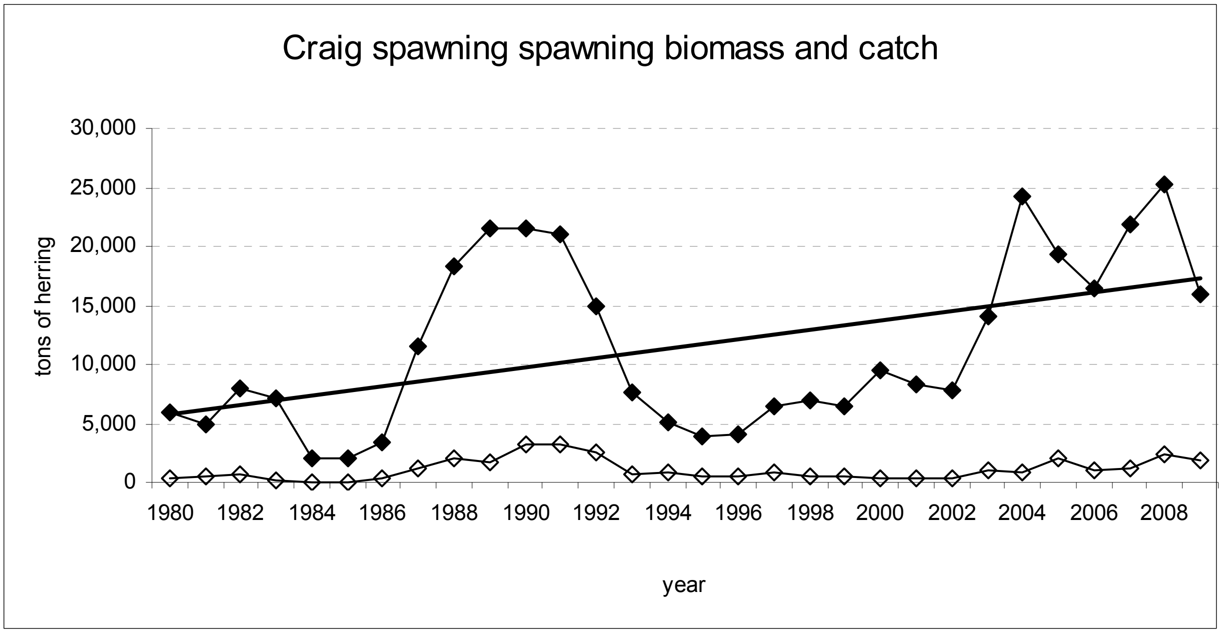
Figure 1.–Major herring spawning areas in Southeast Alaska.

Stock	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	9-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-Apr	15-Apr	16-Apr	17-Apr	18-Apr	19-Apr
Craig[a]			0.8	X	6.0	4.8	6.6	6.1	5.8		0.1								
Sitka Sound		0.2	0.5	X	0.6	1.4	3.1	14.4	30.9	38.7	6.9	3.3		3.5	1.4	X	1.3	X	2.1
Revilla Channel								1.0	2.0	5.0	1.0	0.1							
West Behm Canal												0.8	12.0	3.0					
Ernest Sound																	4.0	5.0	0.5
Hoonah Sound																			
Tenakee Inlet																			
Seymour Canal																			
Lynn Canal																			
Hobart Bay/Port Houghton																			

Stock	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May	4-May	5-May	6-May	7-May
Craig[a]																		
Sitka Sound	2.2	4.7	1.0															
Revilla Channel																		
West Behm Canal																		
Ernest Sound																		
Hoonah Sound			2.1	5.7	1.9		2.6	2.9										
Tenakee Inlet					0.3	2.0	0.1	0.1	0.1	1.3	2.5	0.3	0.1					
Seymour Canal									0.3	1.0	8.0	4.0	0.1		0.1	0.1	0.1	
Lynn Canal											4.0	0.1		0.3	0.5	1.0	0.3	
Hobart Bay/Port Houghton													2.2		0.5	1.1	2.4	

[a] A spot spawn was recorded on March 20, 2009.

Figure 2.–Spawn timing of herring stocks in Southeast Alaska during spring 2009. 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).



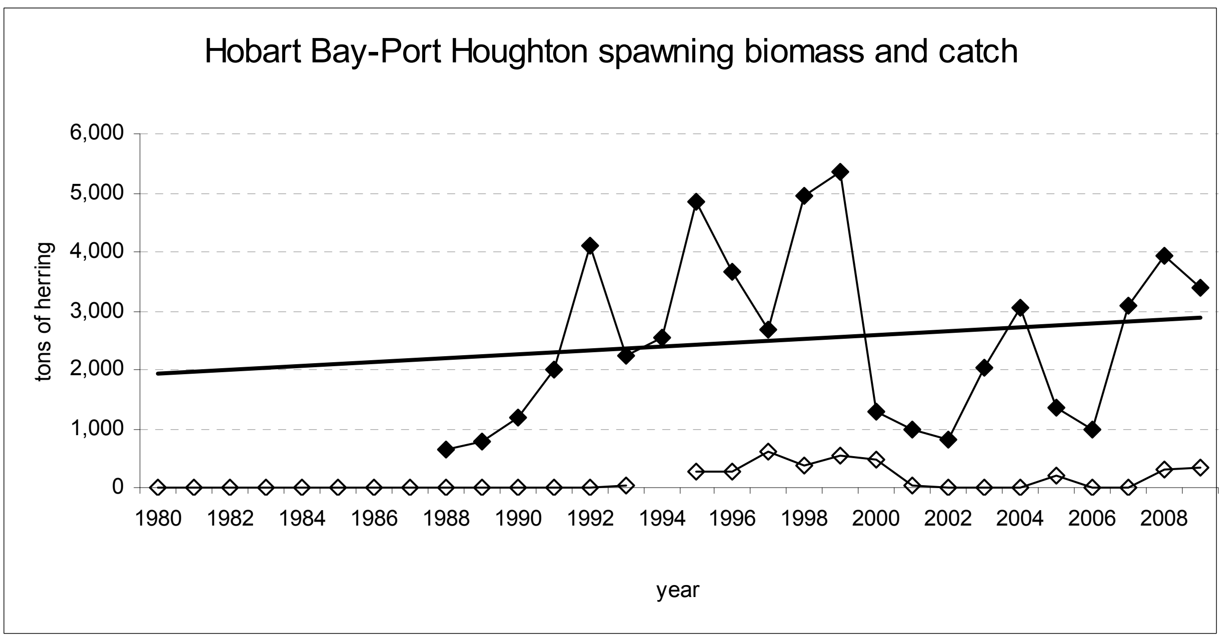
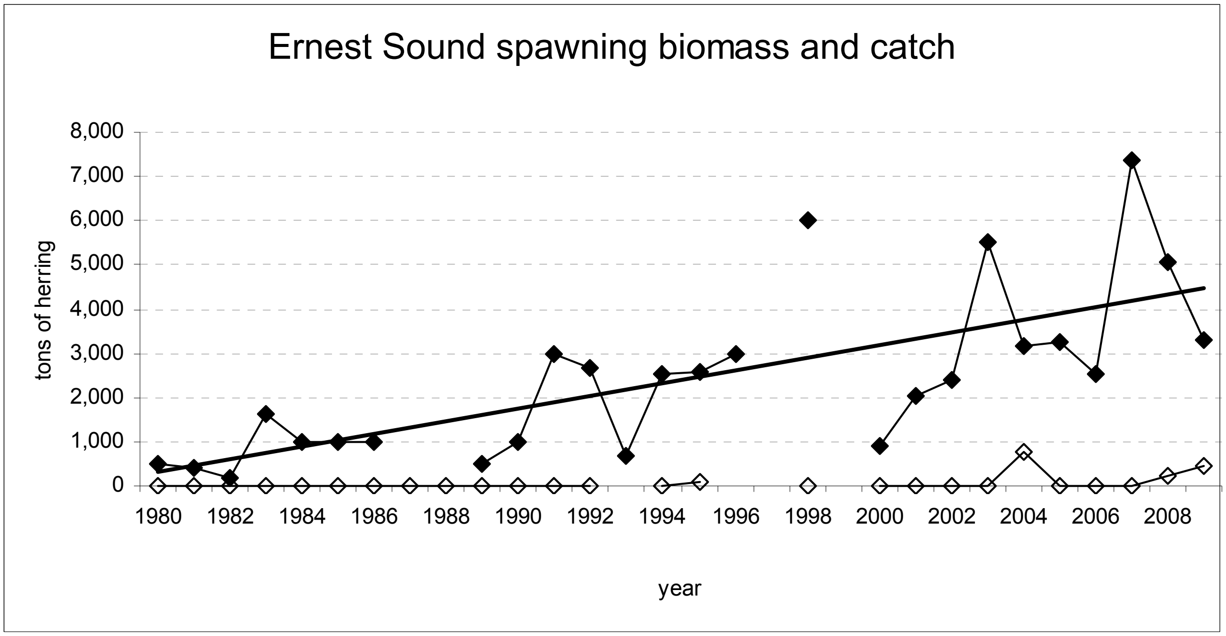


Figure 3.–Herring pre-fishery spawning biomass (solid points), based on spawn deposition surveys, and catch (open points) for stocks in the Craig and Hobart Bay-Port Houghton areas, during 1980–2009. Solid black line is a linear trend line added for visual reference. Gaps in catch signify confidential data due to fewer than three participants.



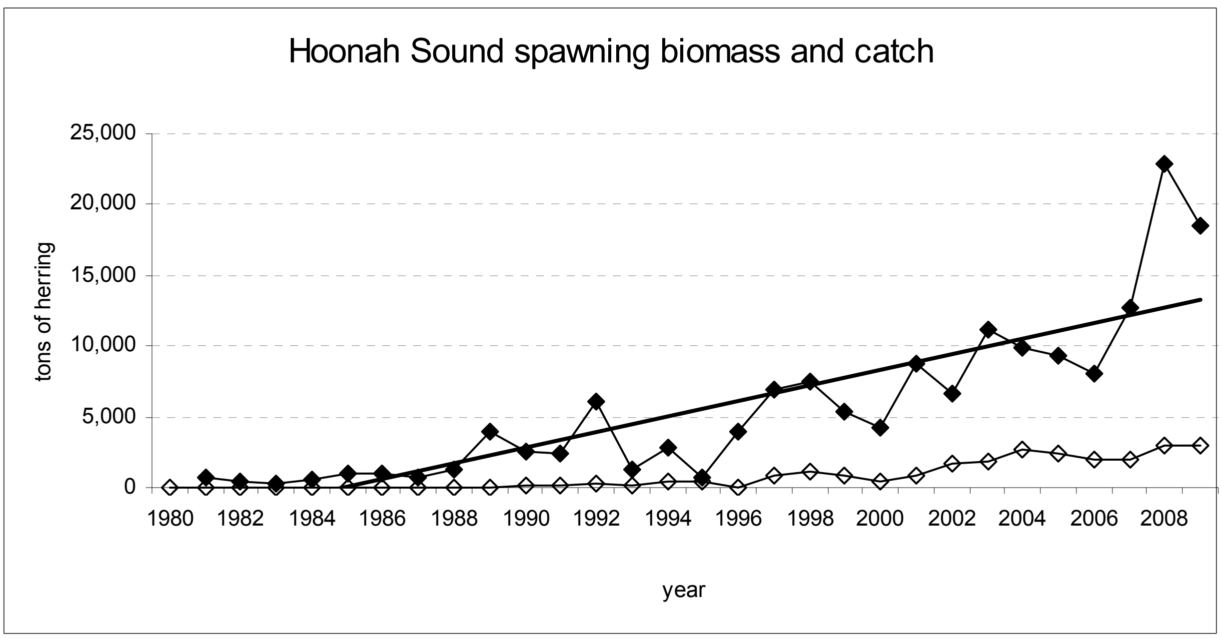
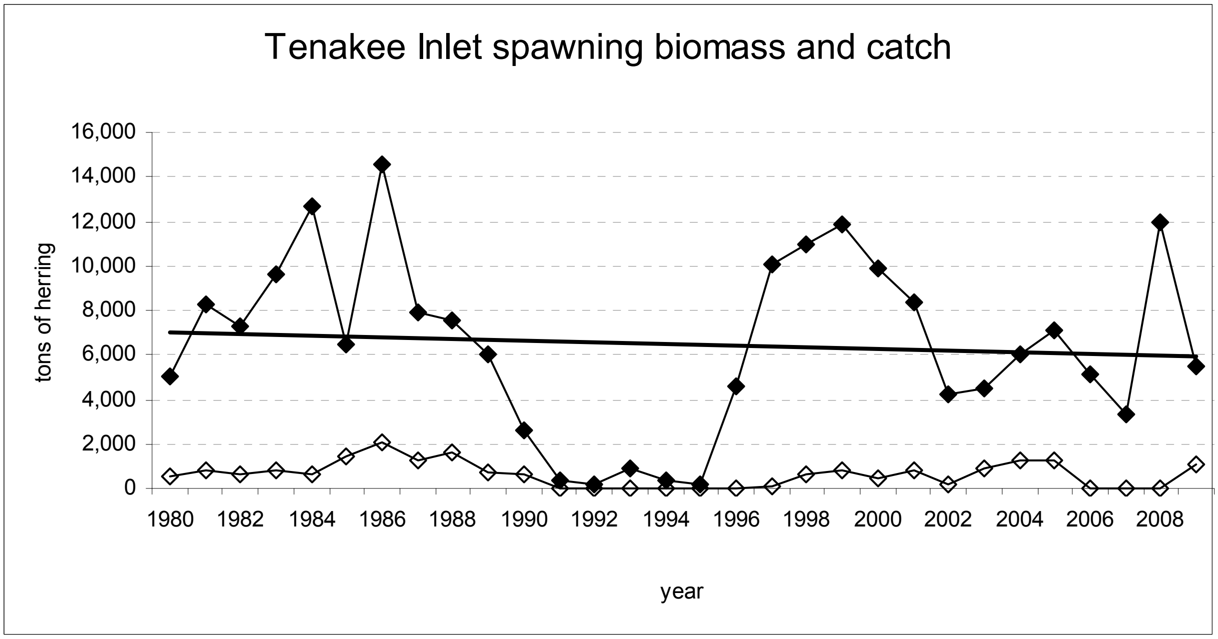


Figure 4.–Herring pre-fishery spawning biomass (solid points), based on spawn deposition surveys, and catch (open points) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2009. Solid black line is a linear trend line added for visual reference. Gaps in catch signify confidential data due to fewer than three participants.



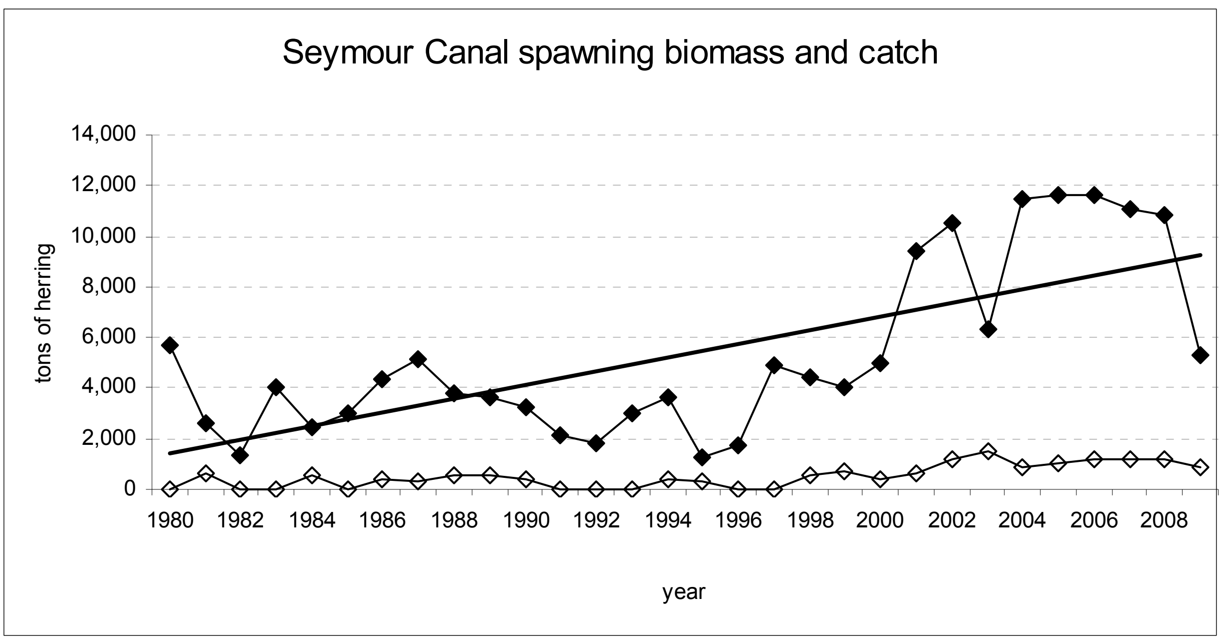
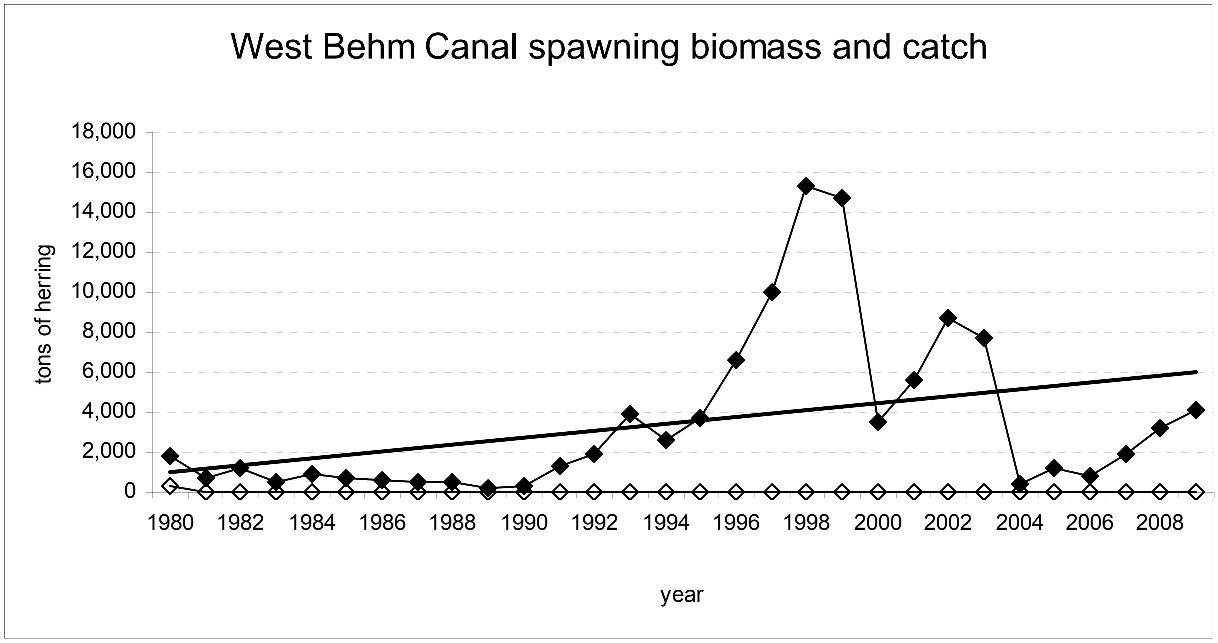


Figure 5.–Herring pre-fishery spawning biomass (solid points), based on spawn deposition surveys, and catch (open points) for stocks in the Tenakee Inlet and Seymour Canal areas, during 1980–2009. Solid black line is a linear trend line added for visual reference.



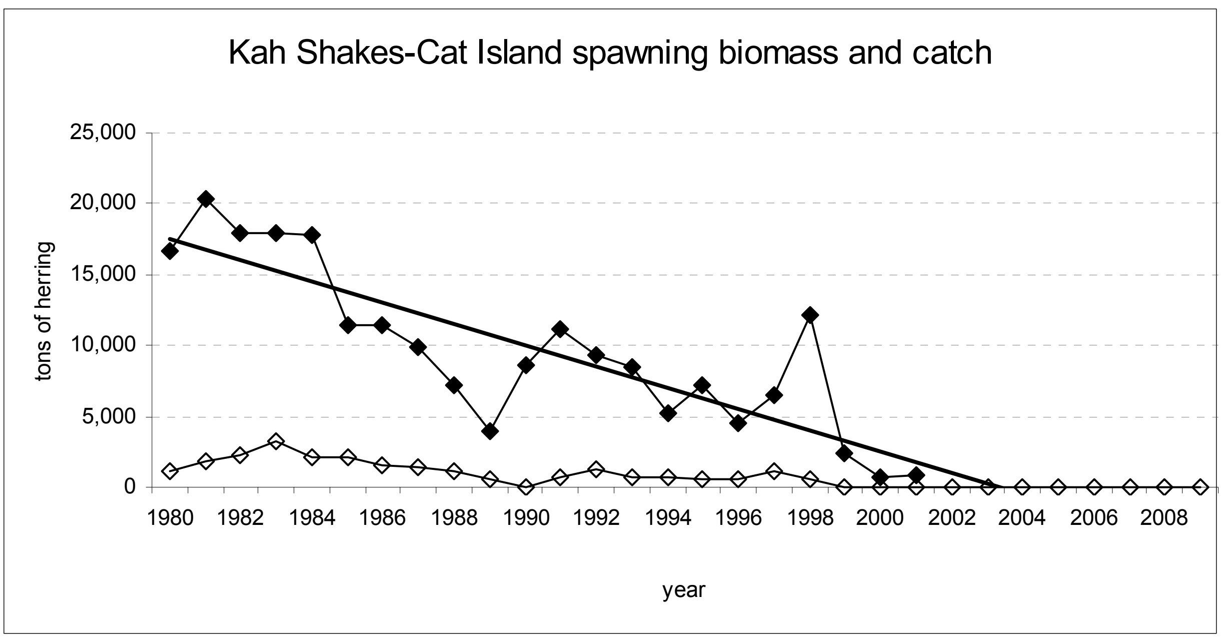


Figure 6.–Herring pre-fishery spawning biomass (solid points), based on spawn deposition surveys, and catch (open points) for stocks in the West Behm Canal and Kah Shakes-Cat Island areas, during 1980–2009. Solid black line is a linear trend line added for visual reference.

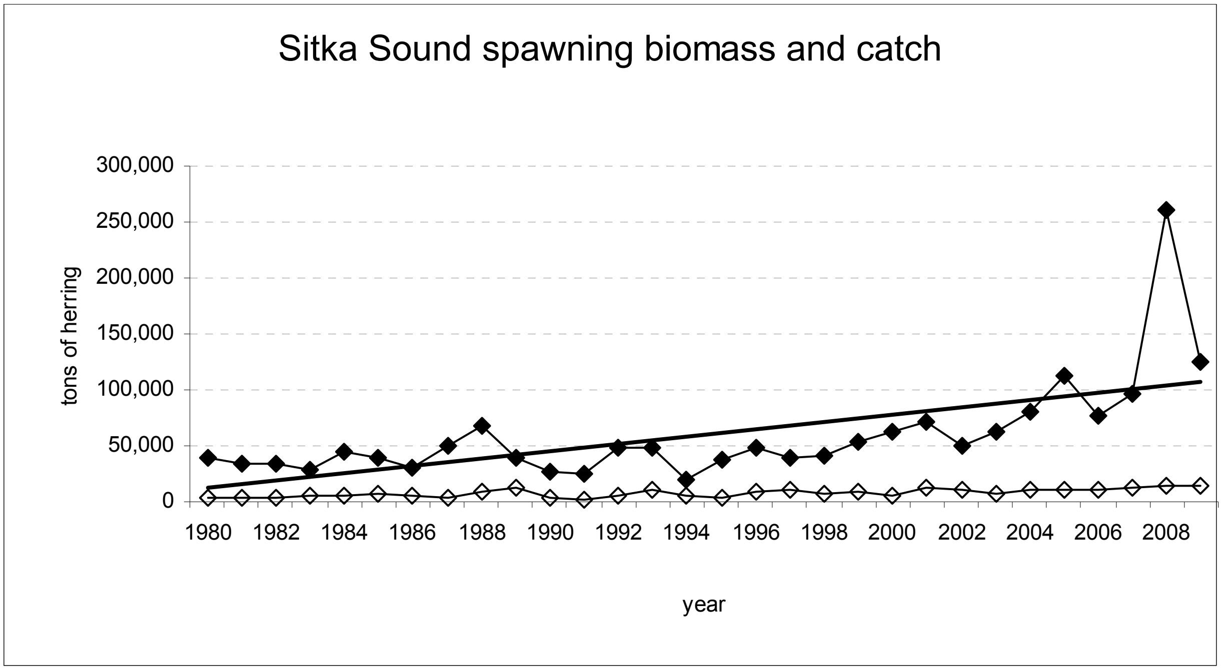
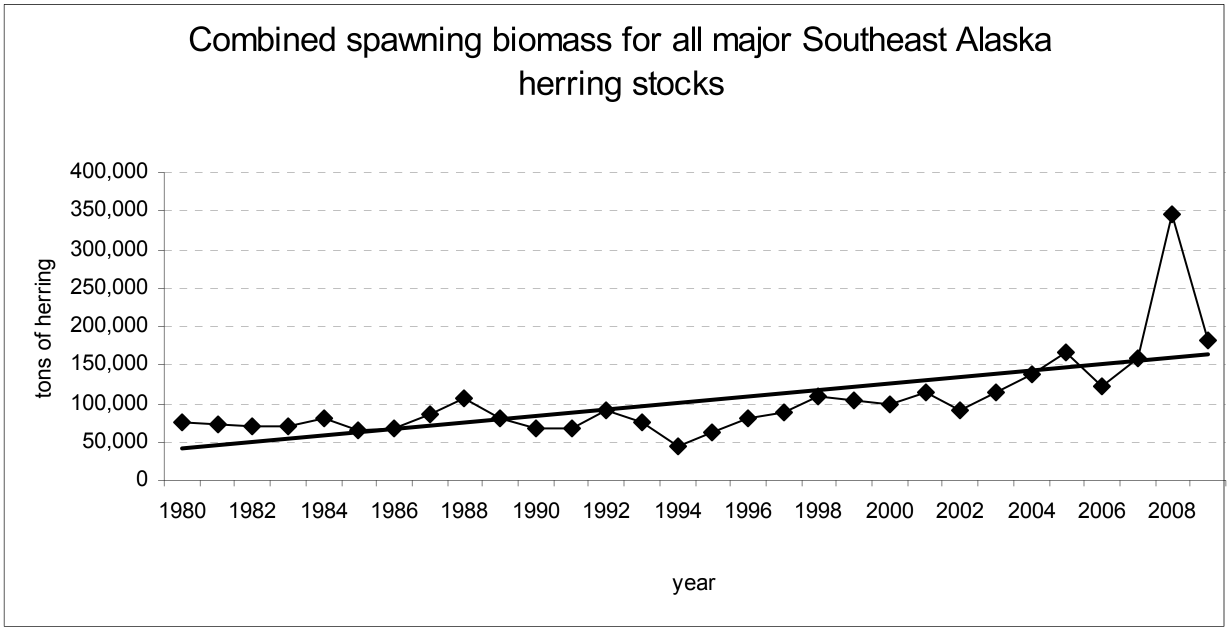


Figure 7.–Herring pre-fishery spawning biomass (solid points), based on spawn deposition surveys, and catch (open points) for stock in the Sitka Sound area, during 1980–2009. Solid black line is a linear trend line added for visual reference.



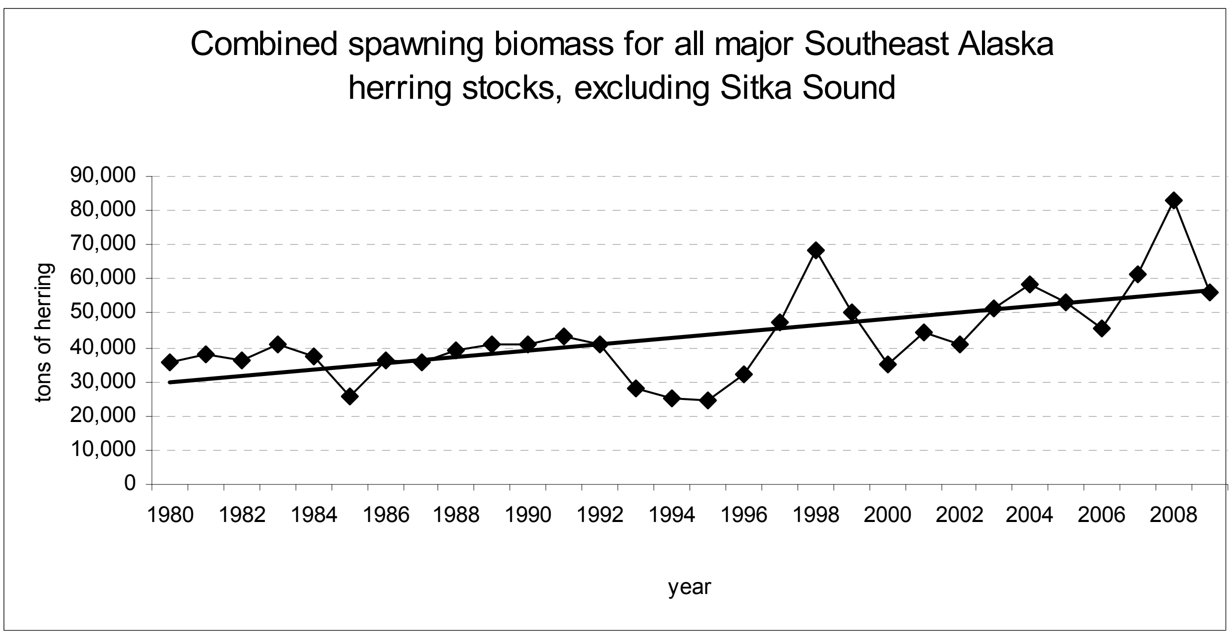


Figure 8.–Combined pre-fishery spawning biomass, based on spawn deposition surveys, for major herring stocks in Southeast Alaska, during 1980–2009. Solid black line is a linear trend line added for visual reference.

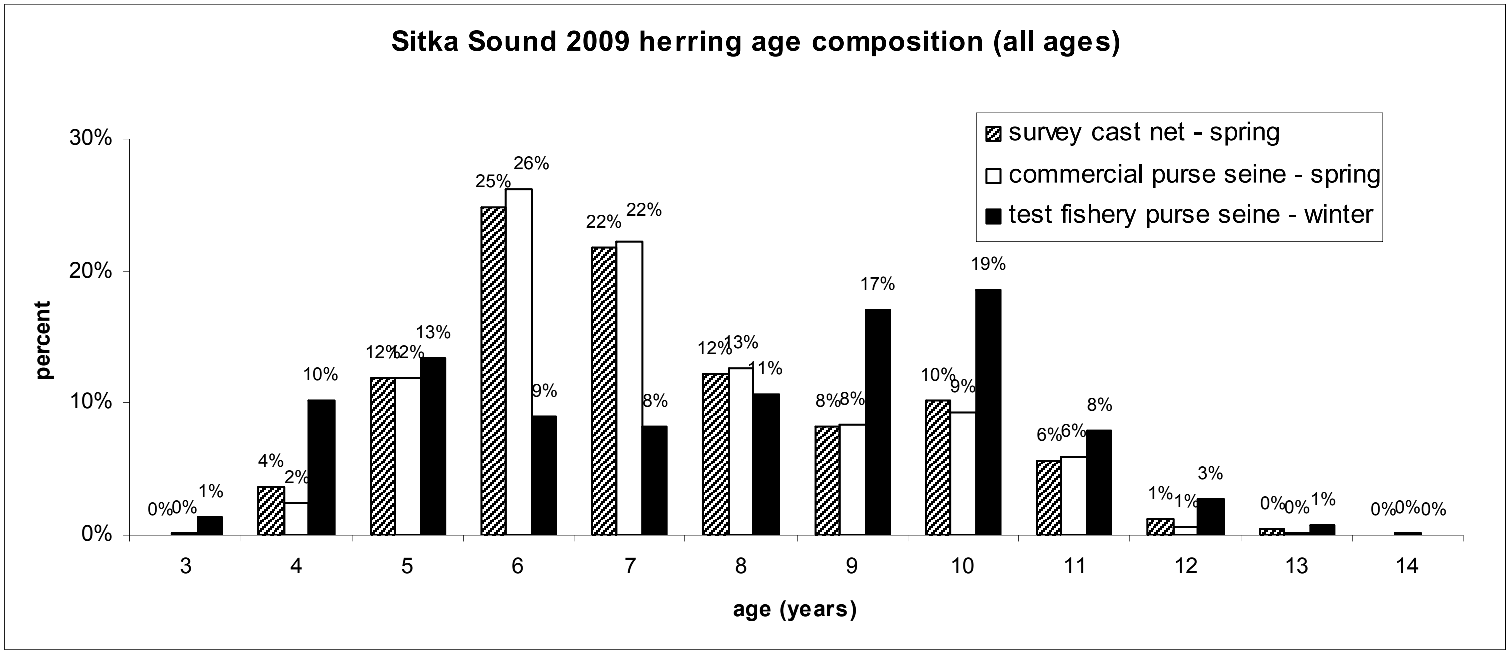


Figure 9.–Age composition, showing all ages, for Sitka Sound herring stock in 2008–09.

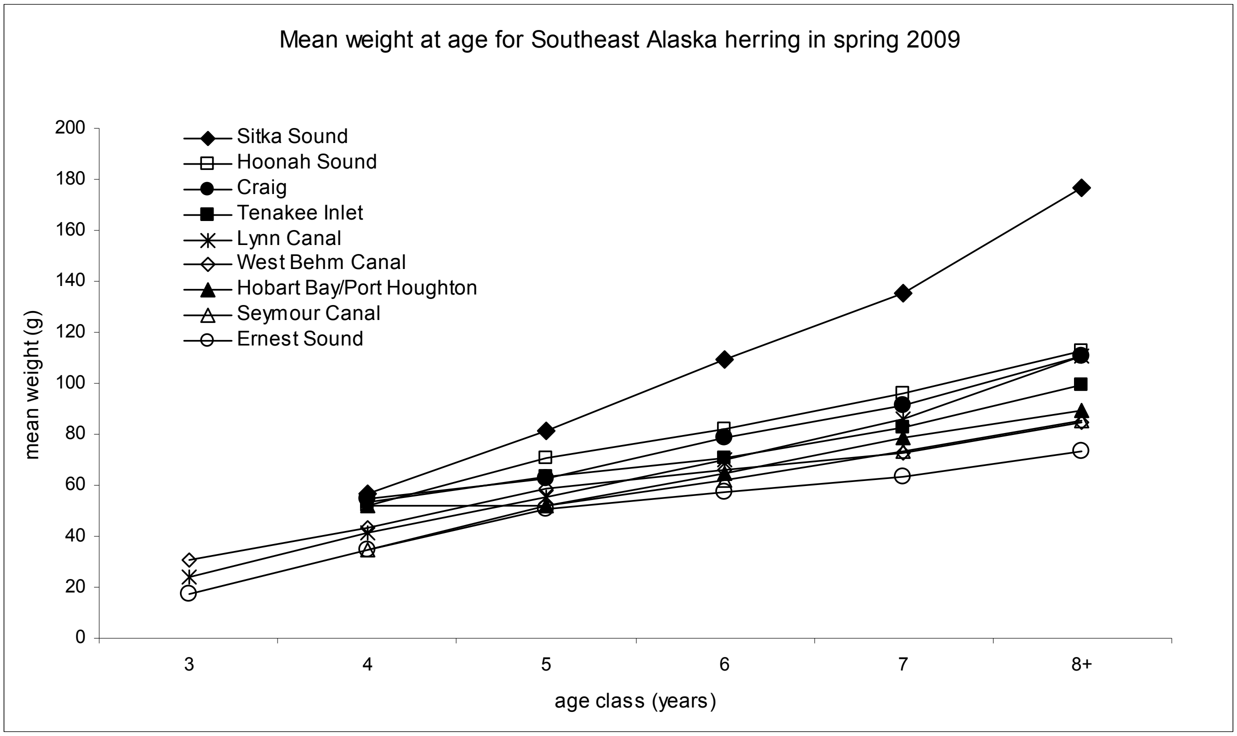


Figure 10.–Mean weight-at-age for Southeast Alaska herring stock in 2008–09.

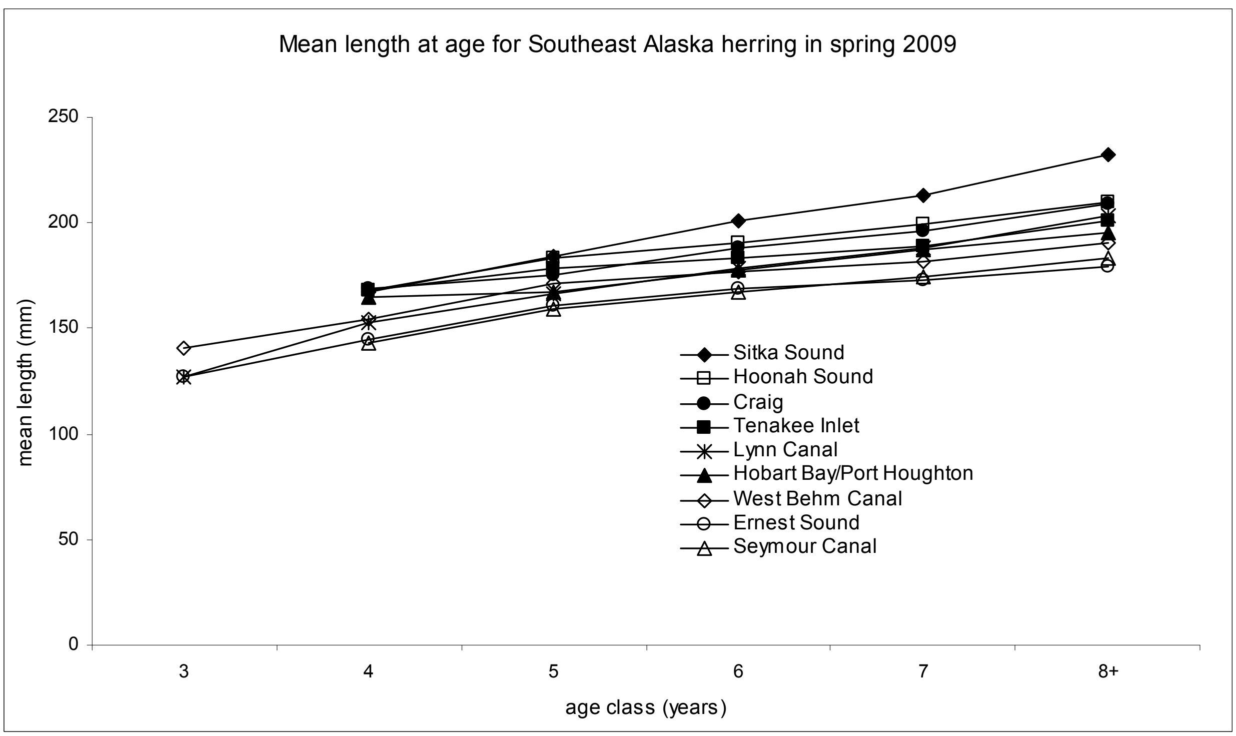


Figure 11.–Mean length at age for Southeast Alaska herring stock in 2008–09.

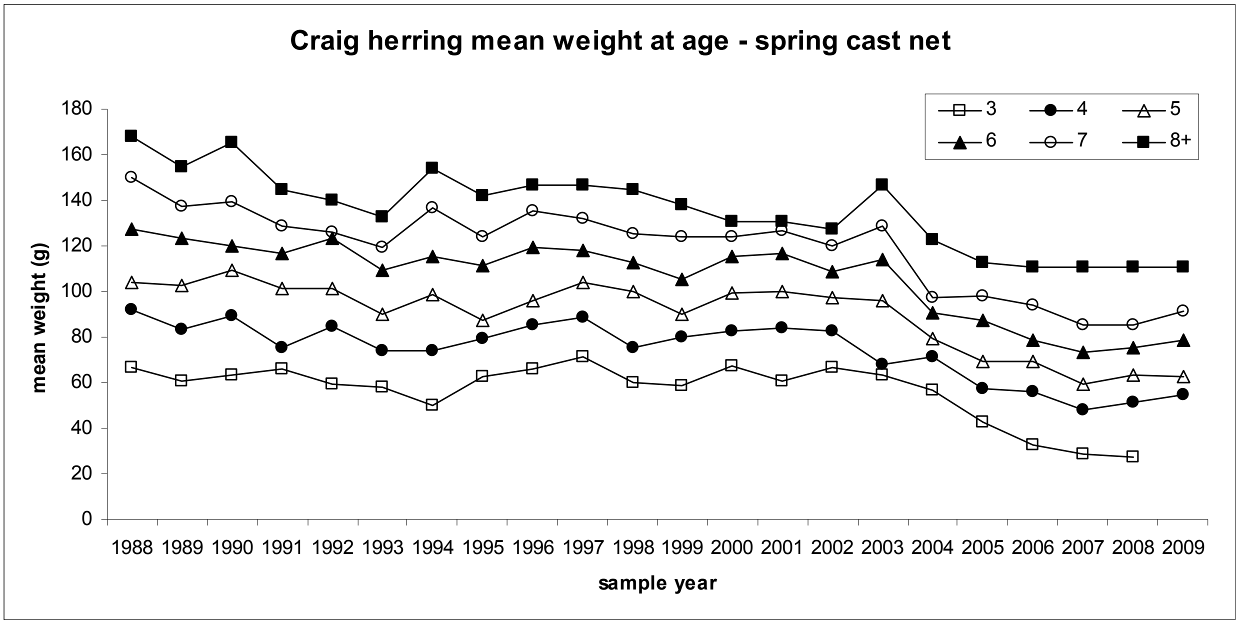


Figure 12.–Mean weight-at-age for the Craig herring stock.

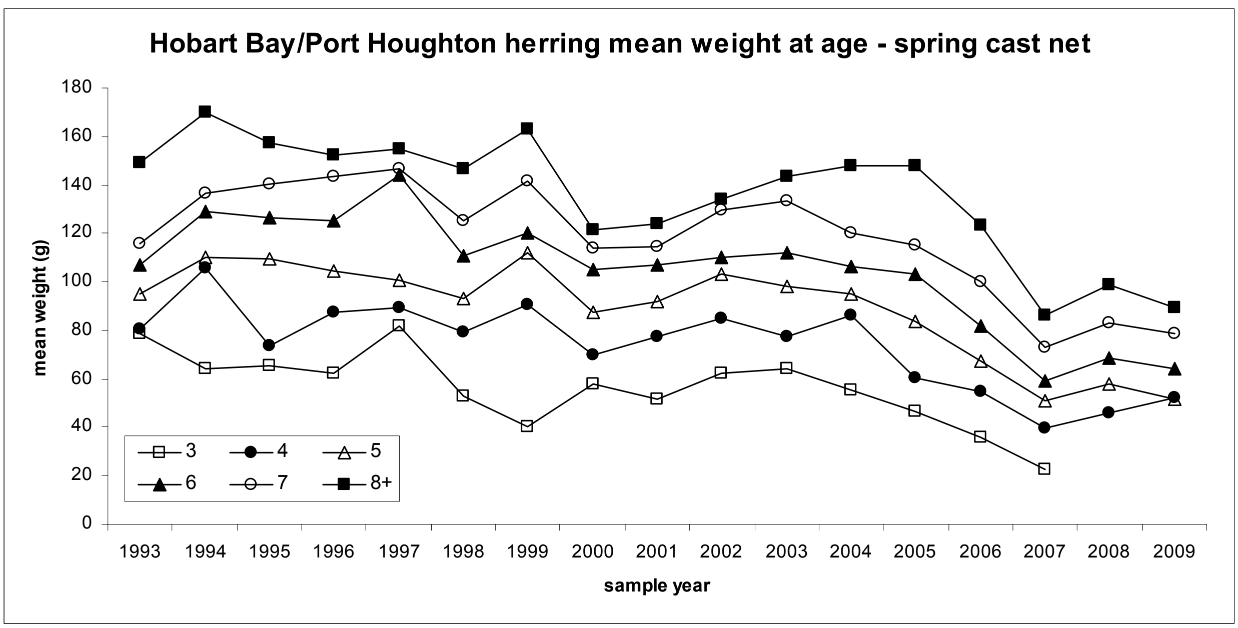


Figure 13.–Mean weight at age for the Hobart Bay/Port Houghton herring stock.

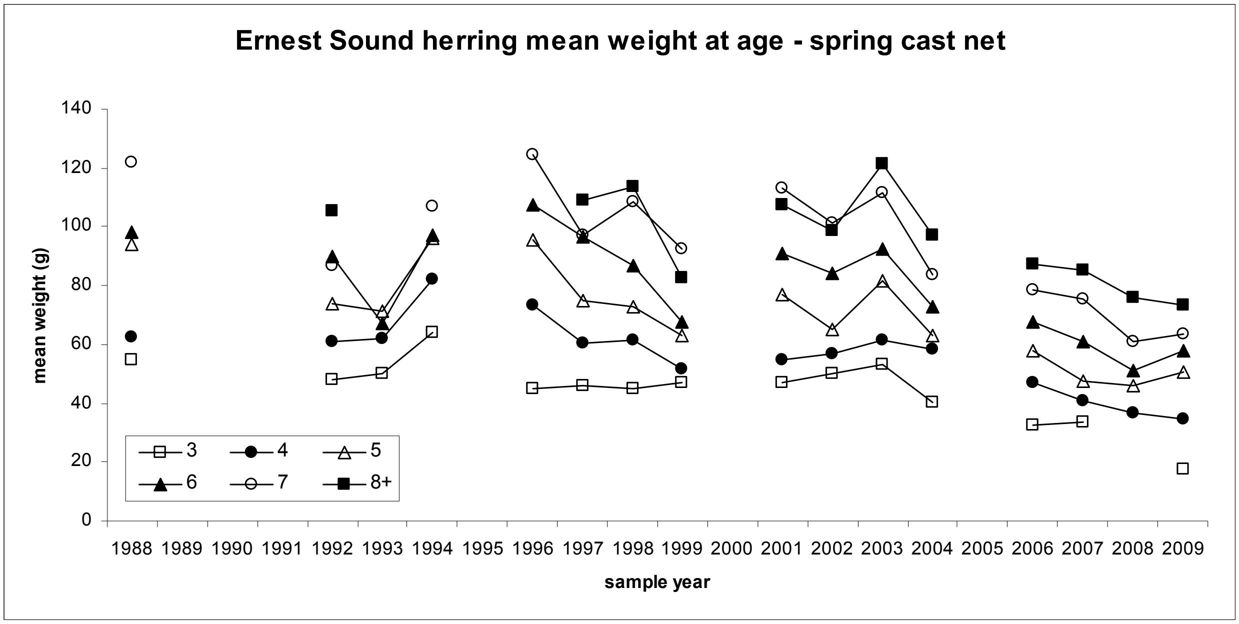


Figure 14.–Mean weight at age for the Ernest Sound herring stock.

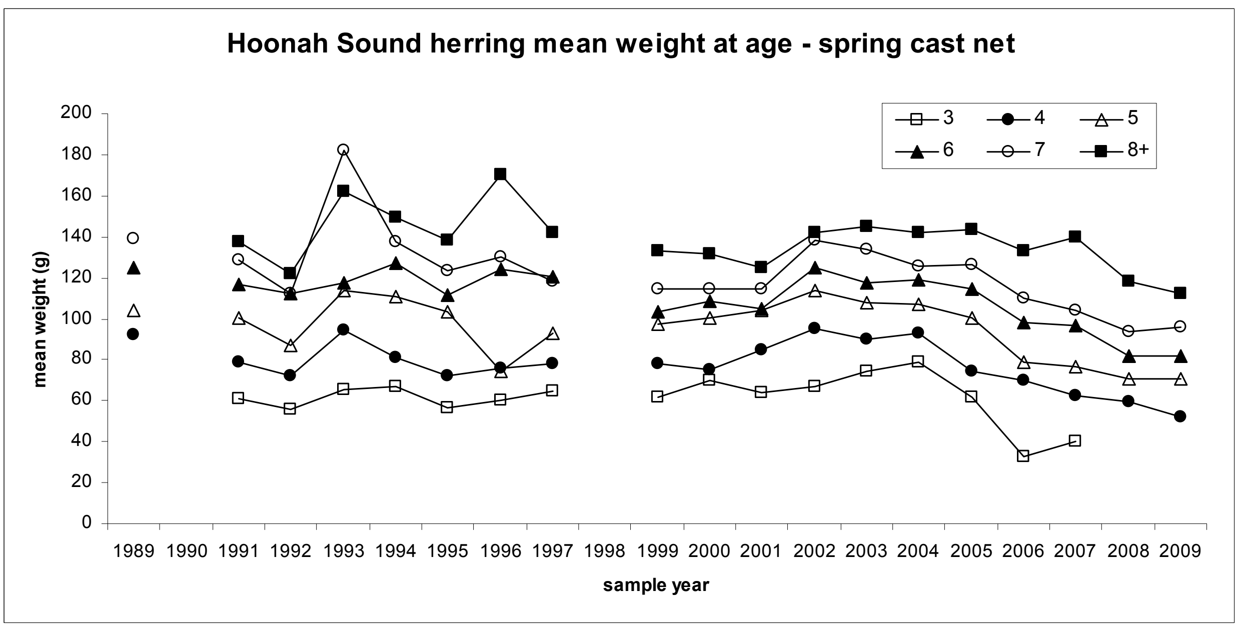


Figure 15.–Mean weight at age for the Hoonah Sound herring stock.

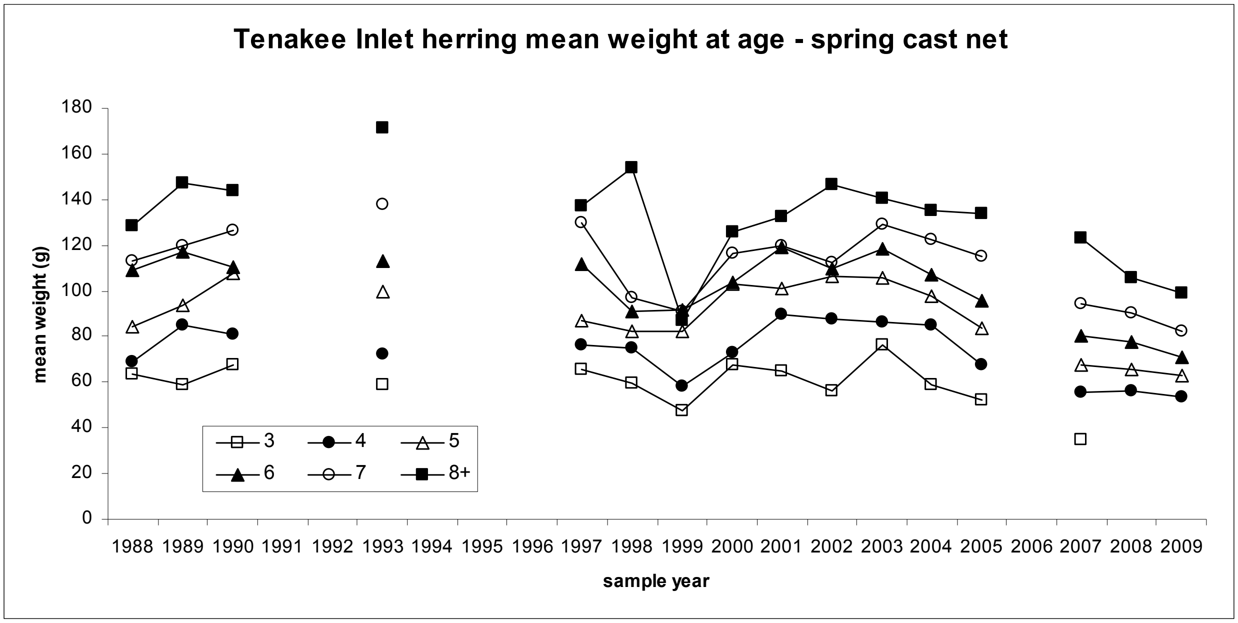


Figure 16.–Mean weight at age for the Tenakee Inlet herring stock.

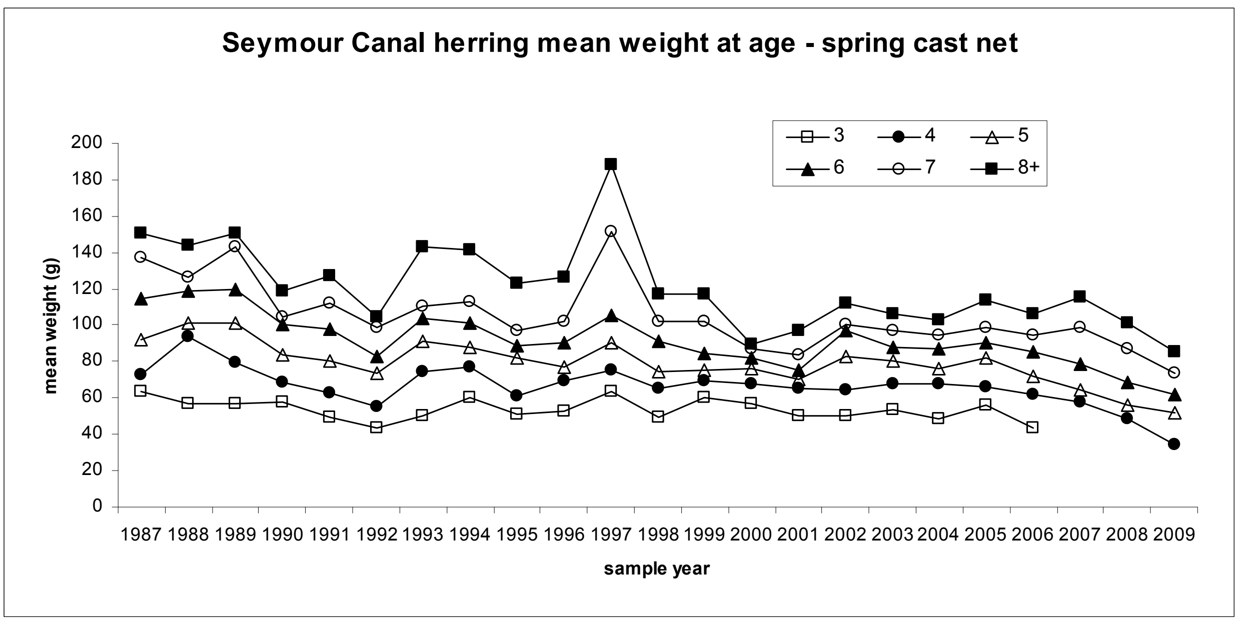


Figure 17.–Mean weight at age for the Seymour Canal herring stock.

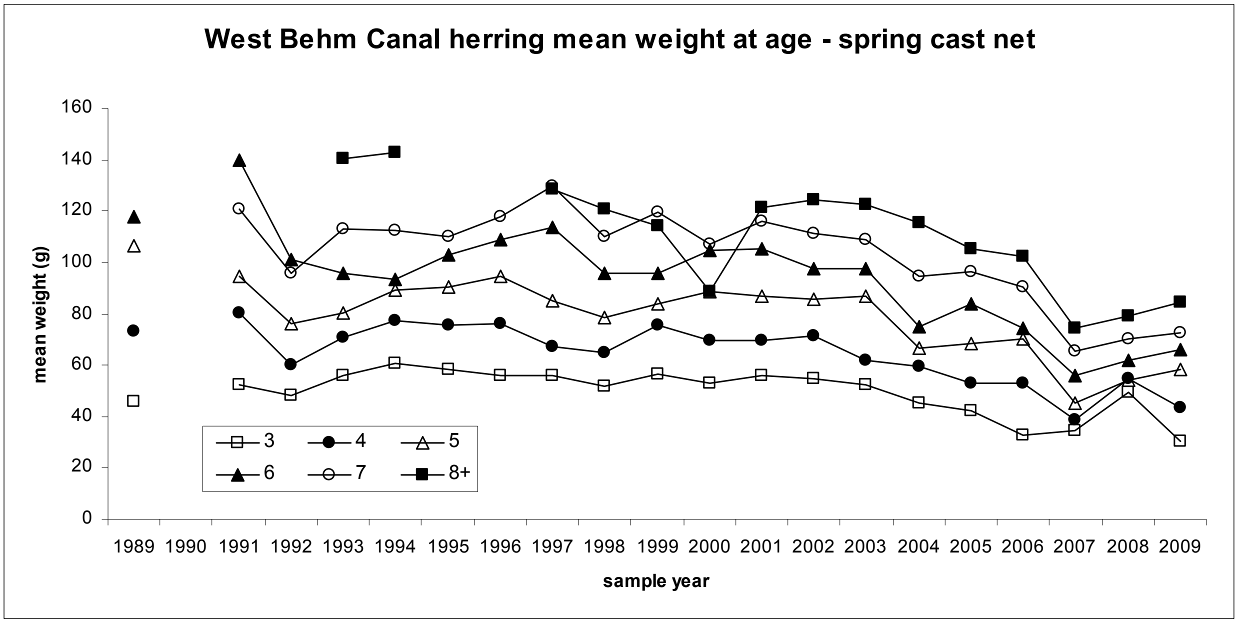


Figure 18.–Mean weight at age for the West Behm Canal herring stock.

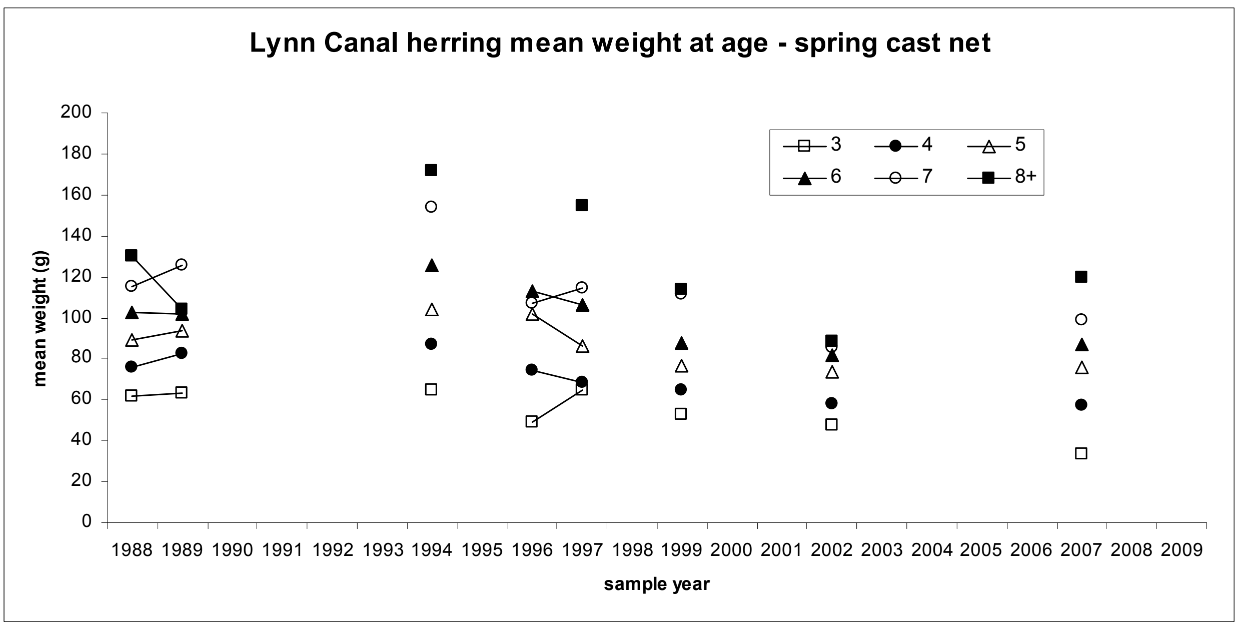


Figure 19.–Mean weight at age for the Lynn Canal herring stock.

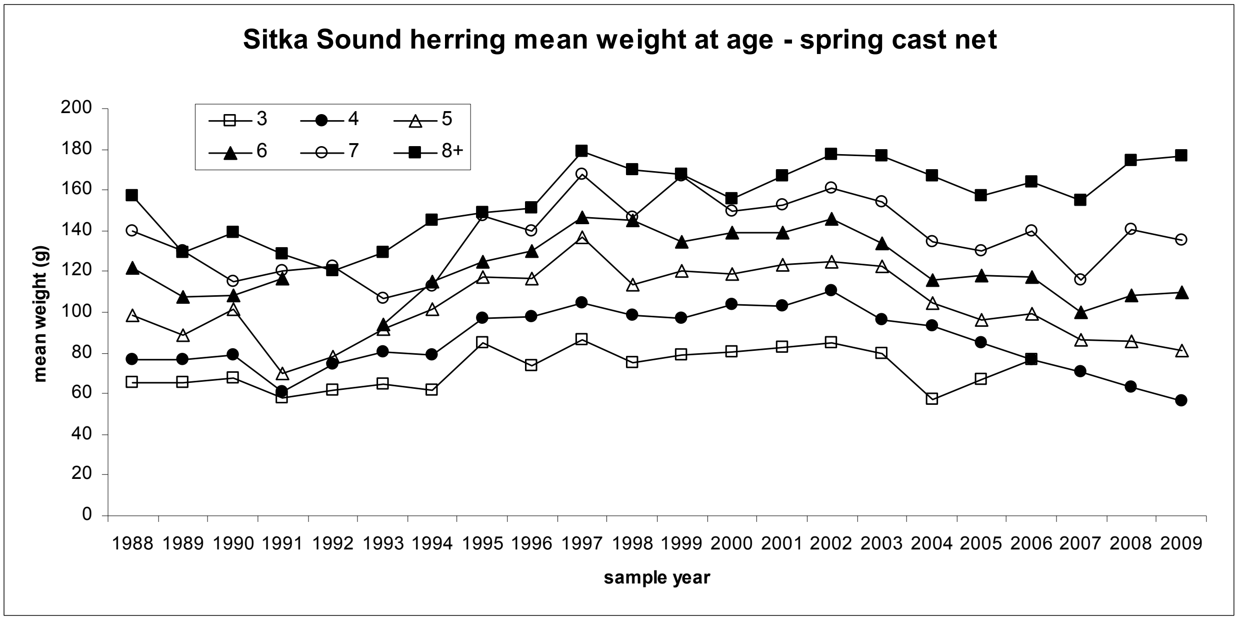


Figure 20.–Mean weight at age (3 through 8+) for the Sitka Sound herring stock.

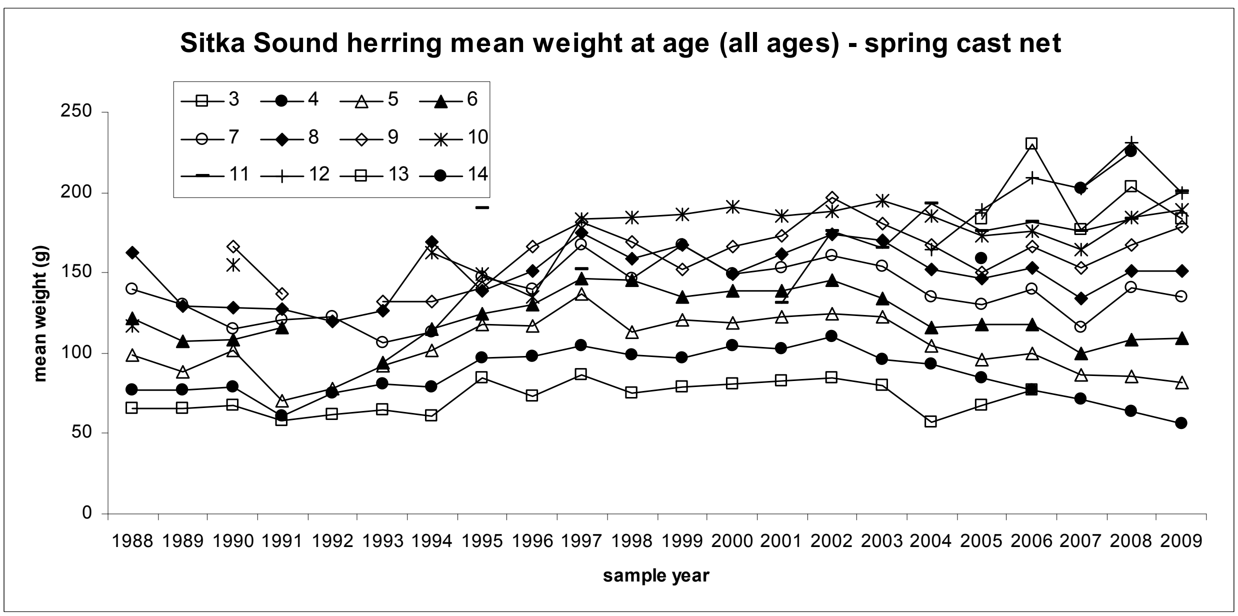


Figure 21.–Mean weight at age (all ages) for the Sitka Sound herring stock.

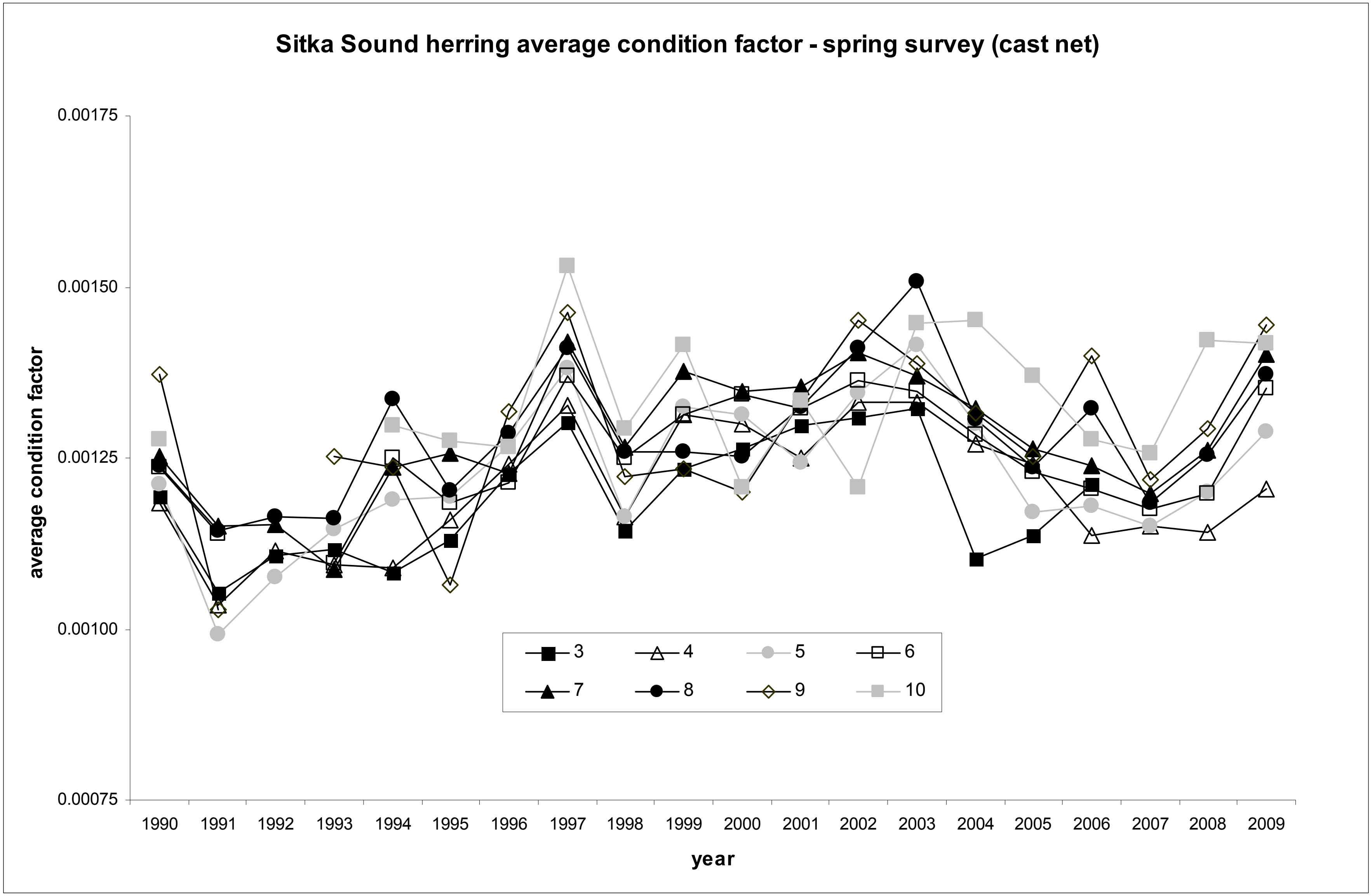


Figure 22.–Mean condition factors of age-3 through age-10 herring for the Sitka Sound stock.

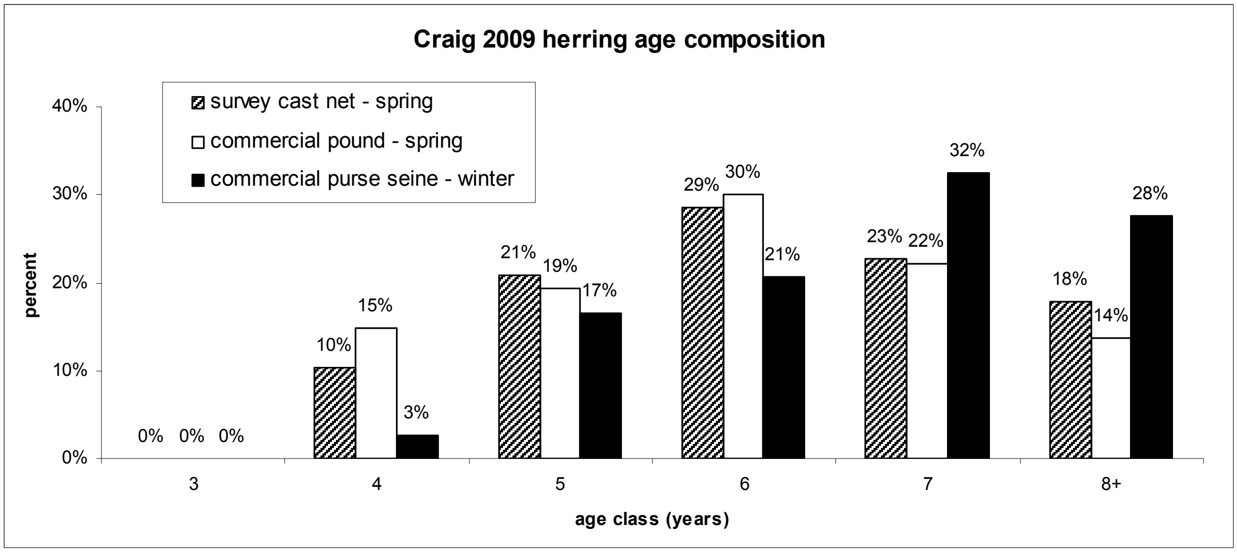


Figure 23.–Age composition for Craig herring stock in 2008–09.

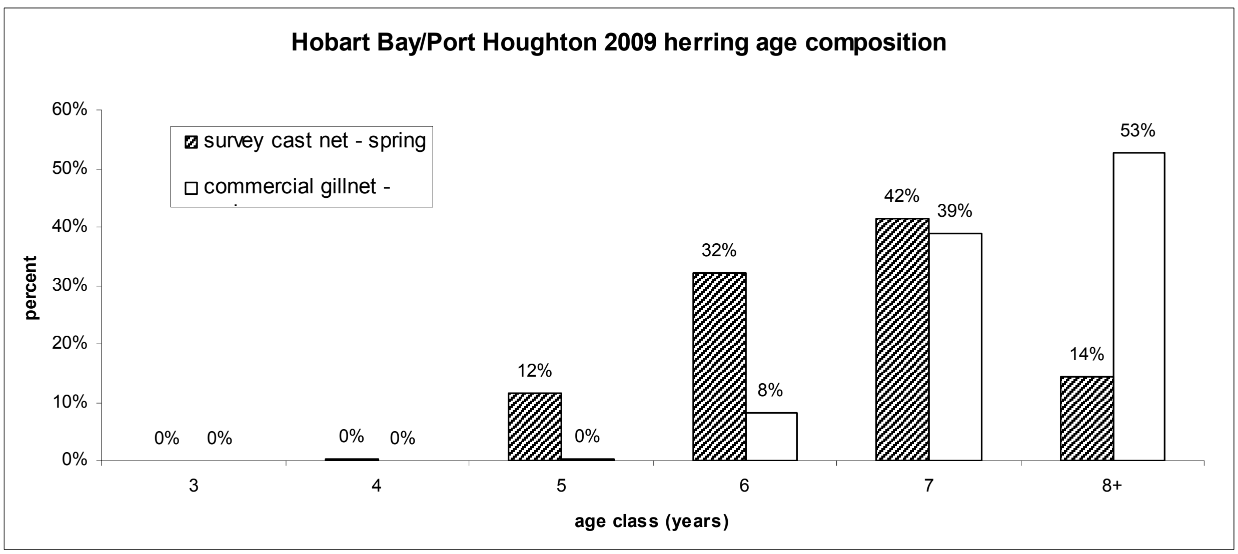


Figure 24.–Age composition for Hobart Bay/Port Houghton herring stock in 2008–09.

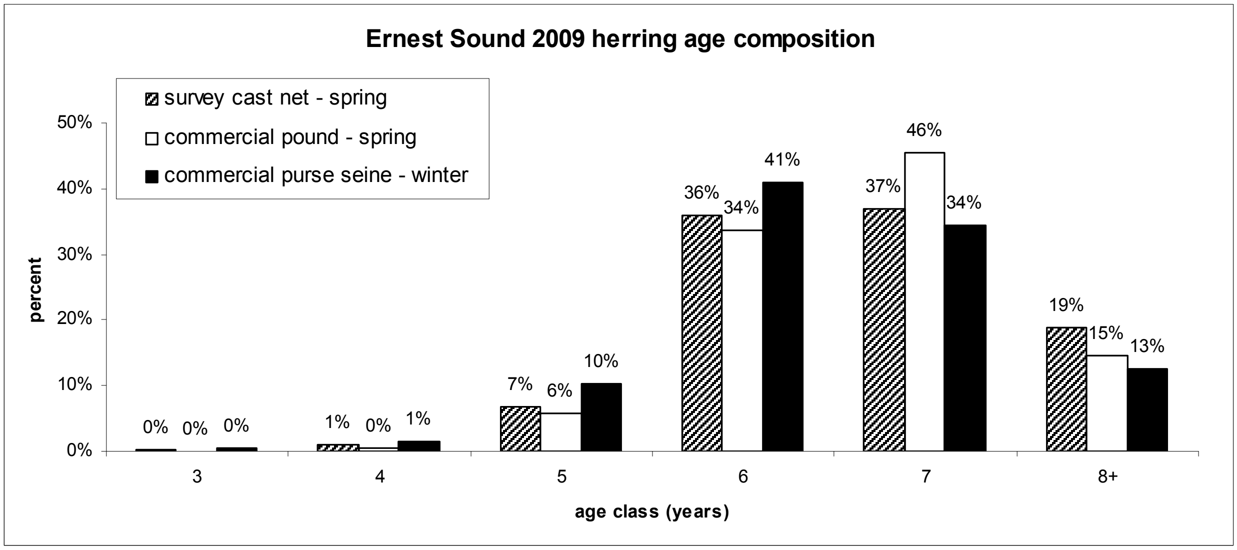


Figure 25.–Age composition for Ernest Sound herring stock in 2008–09.

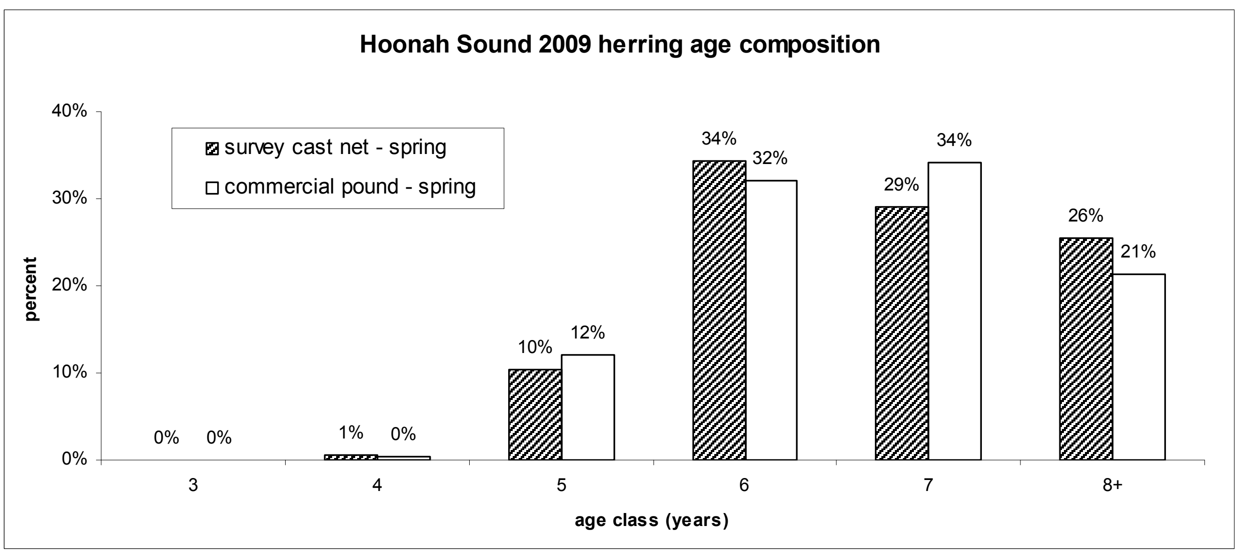


Figure 26.–Age composition for Hoonah Sound herring stock in 2008–09.

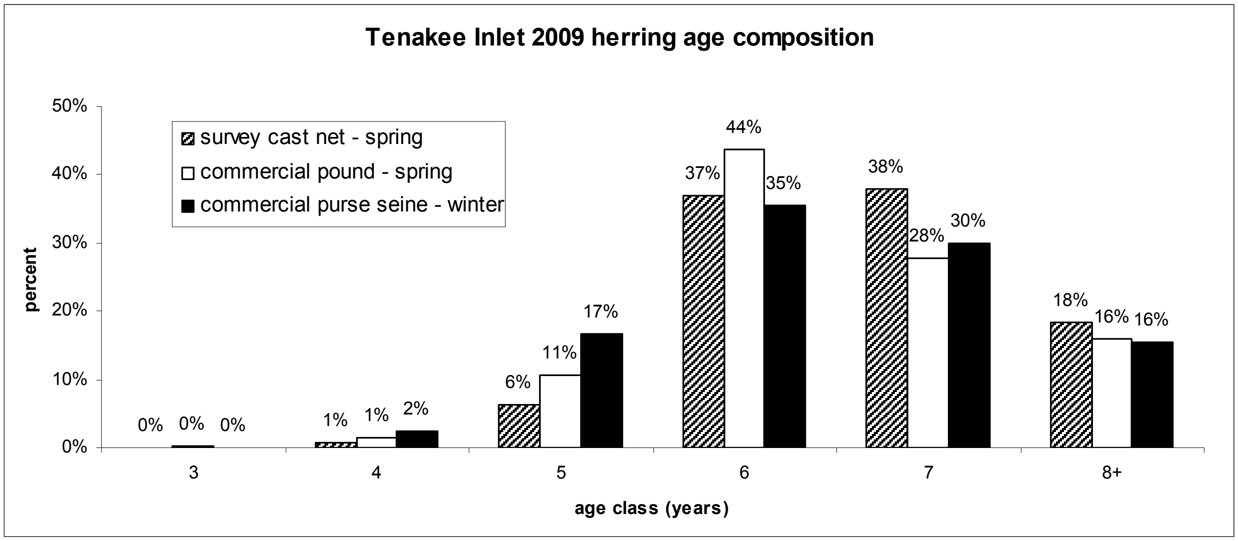


Figure 27.–Age composition for Tenakee Inlet herring stock in 2008–09.

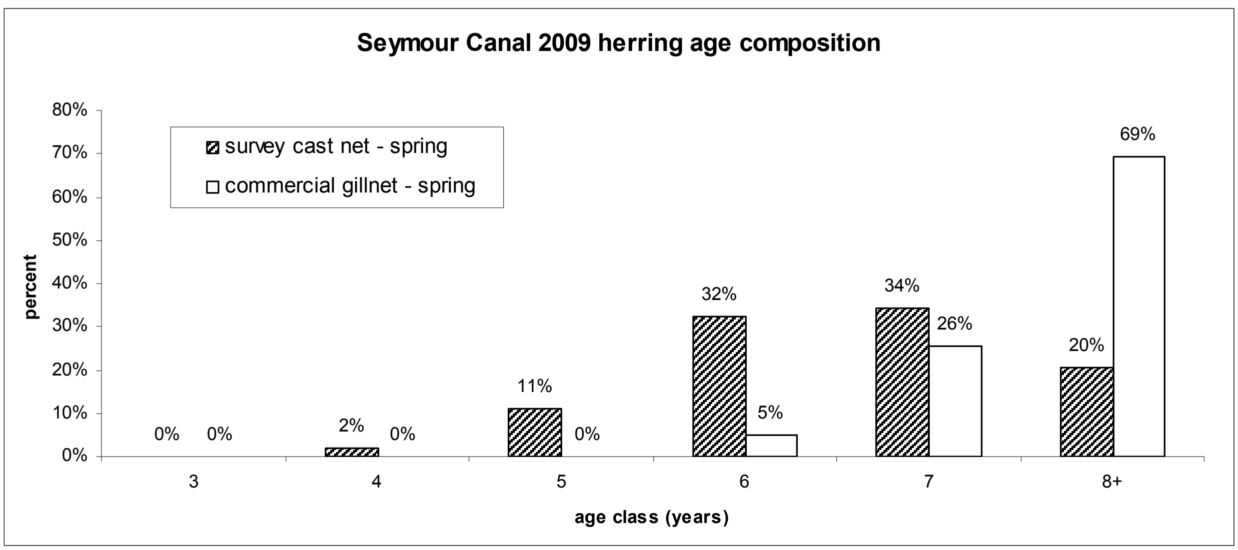


Figure 28.–Age composition for Seymour Canal herring stock in 2008–09.

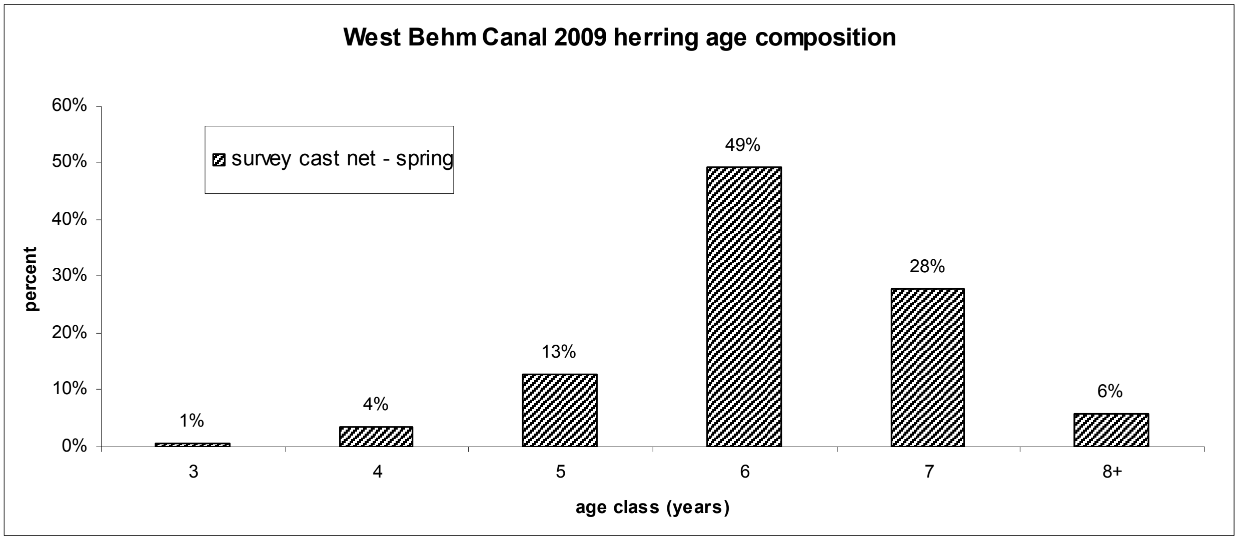


Figure 29.–Age composition for West Behm Canal herring stock in 2008–09.

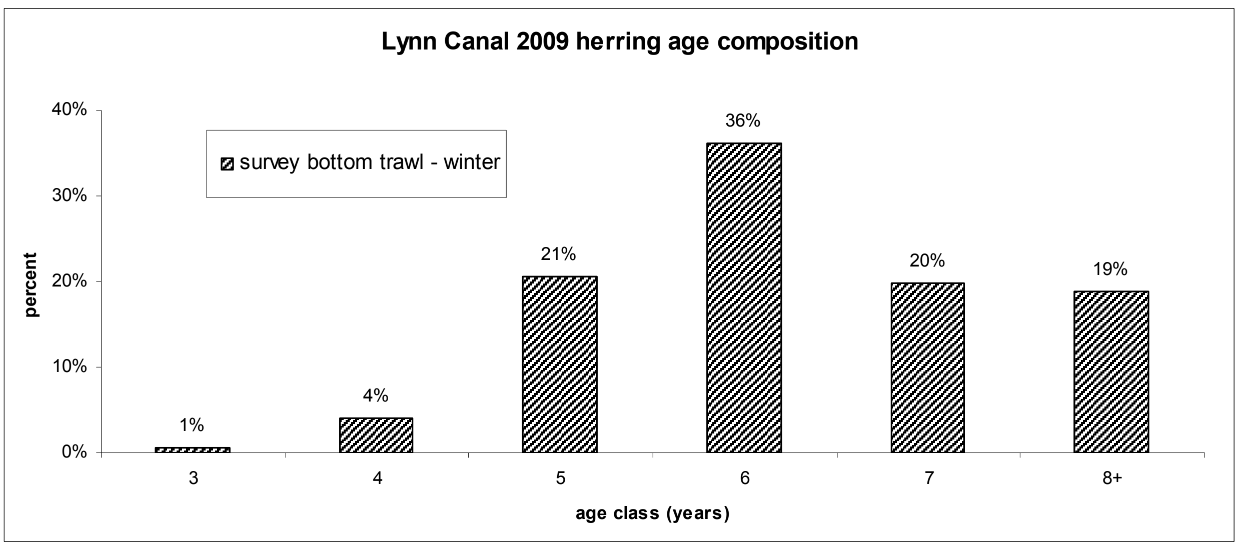


Figure 30.–Age composition for Lynn Canal herring stock in 2008–09.

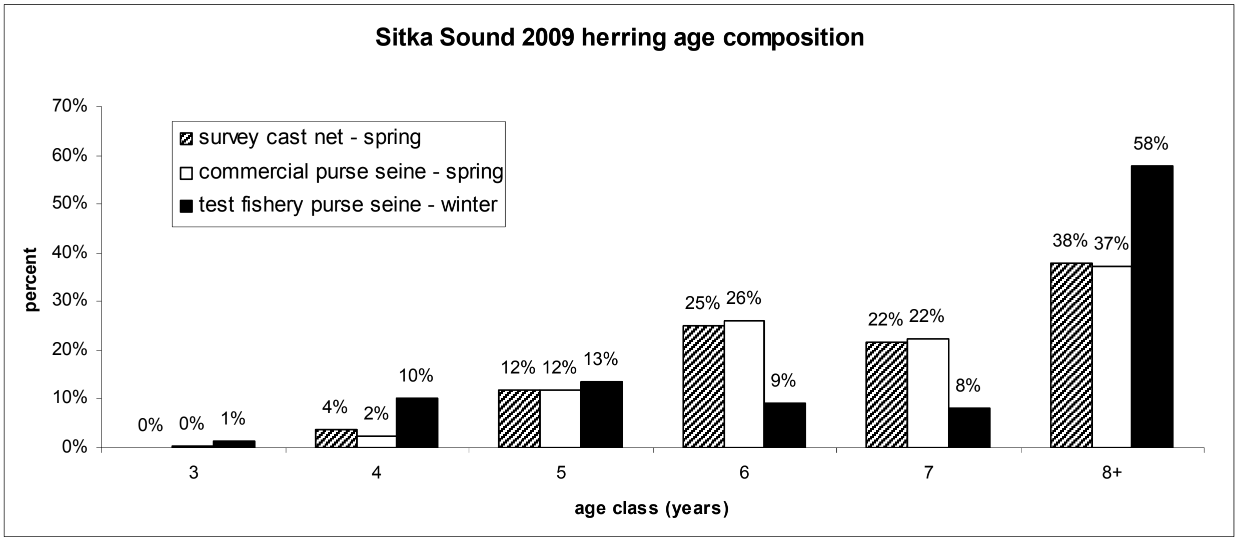


Figure 31.–Age composition for Sitka Sound herring stock in 2008–09.

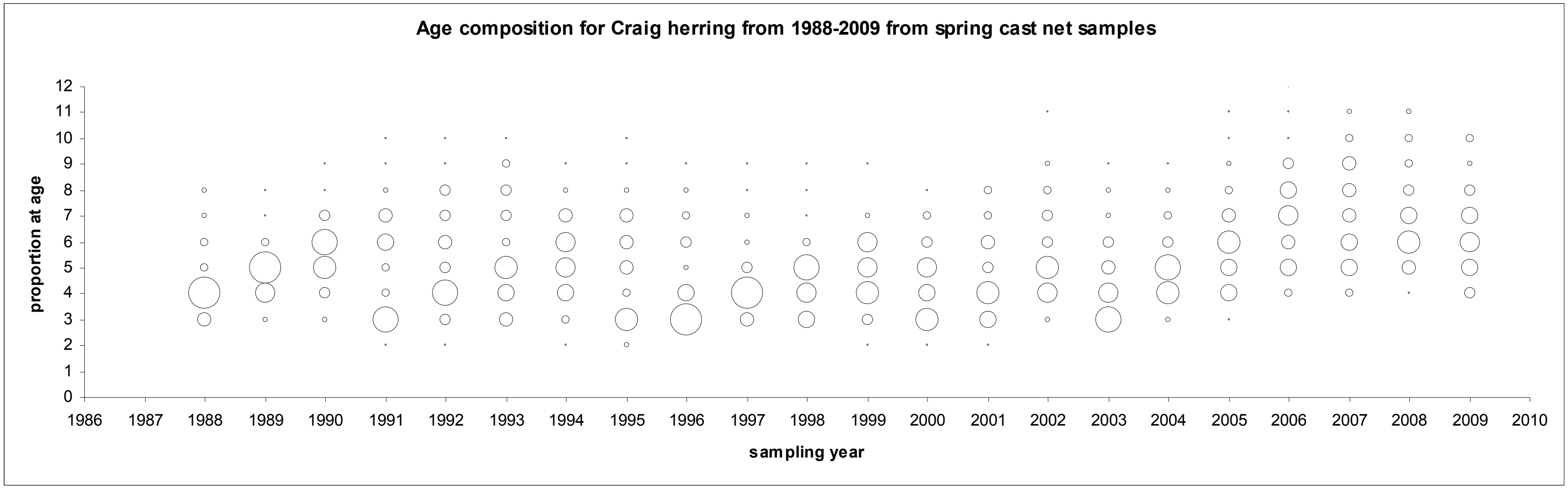


Figure 32.–Age composition from sampling data for the Craig herring stock.

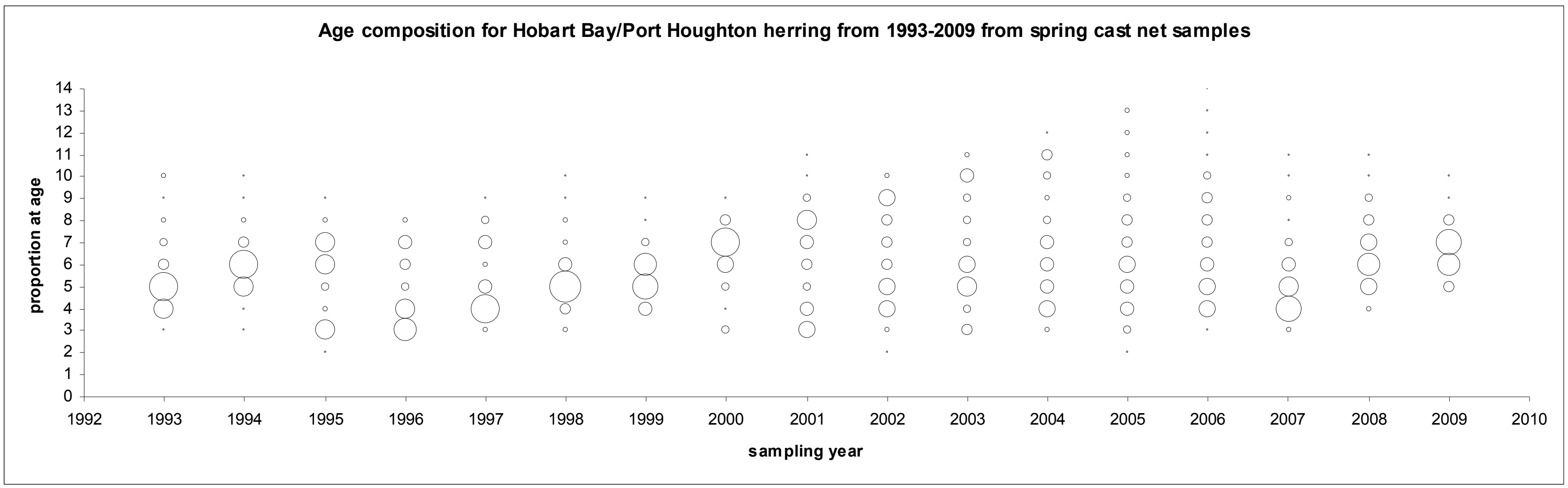


Figure 33.–Age composition from sampling data for the Hobart Bay/Port Houghton herring stock.

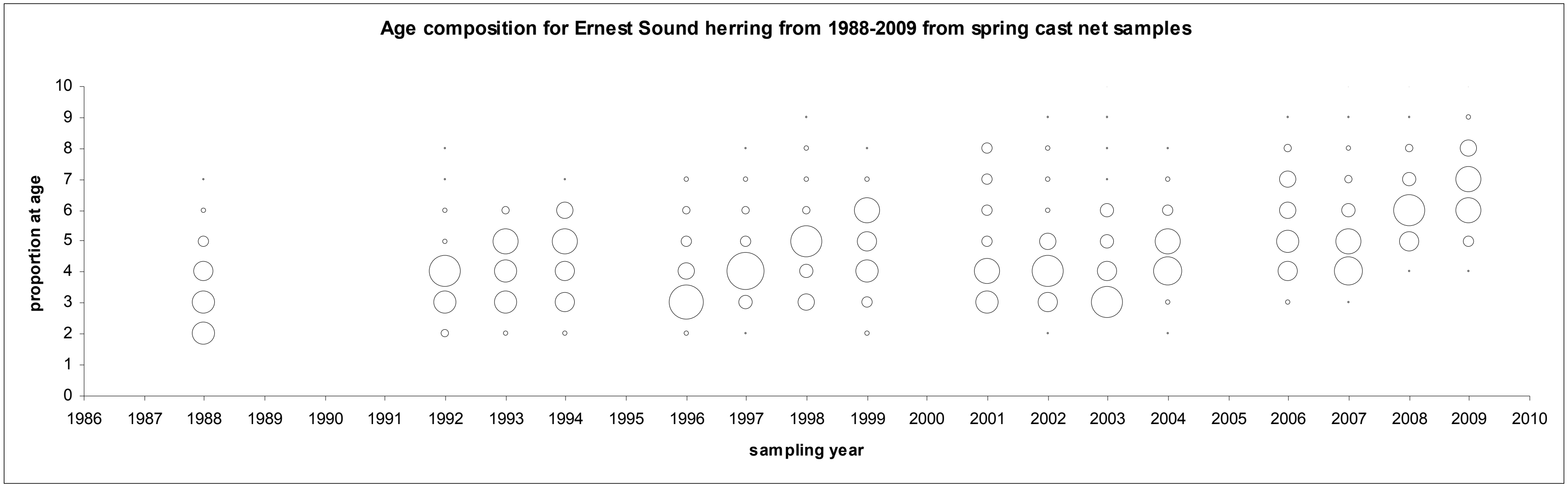


Figure 34.–Age composition from sampling data for the Ernest Sound herring stock.

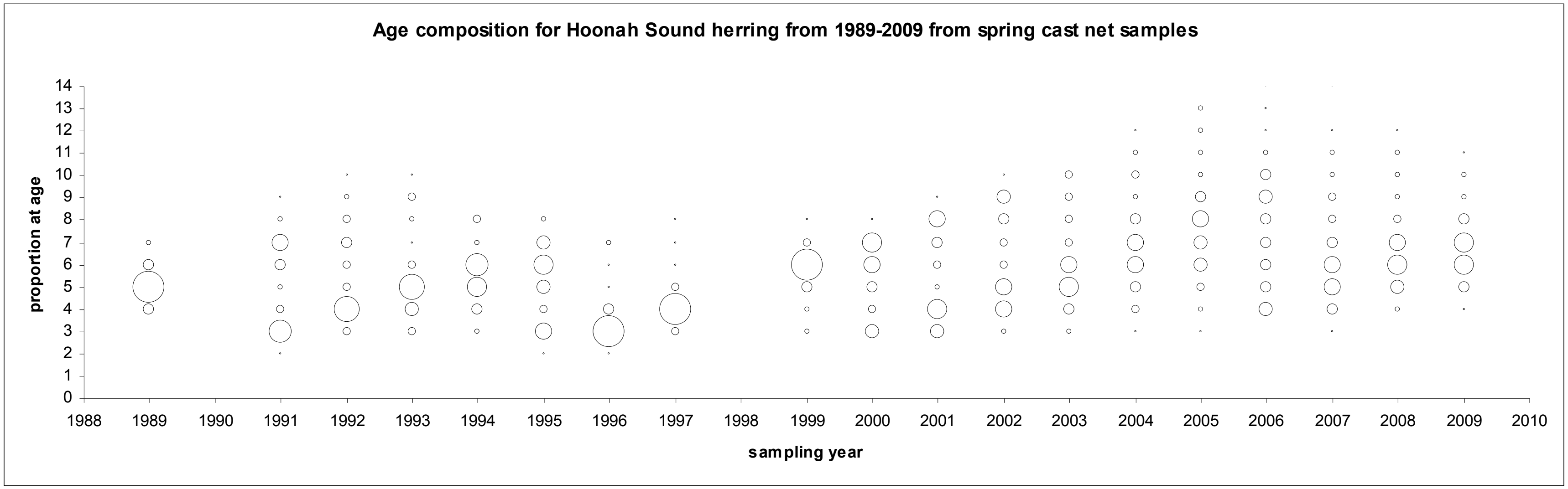


Figure 35.–Age composition from sampling data for the Hoonah Sound herring stock.

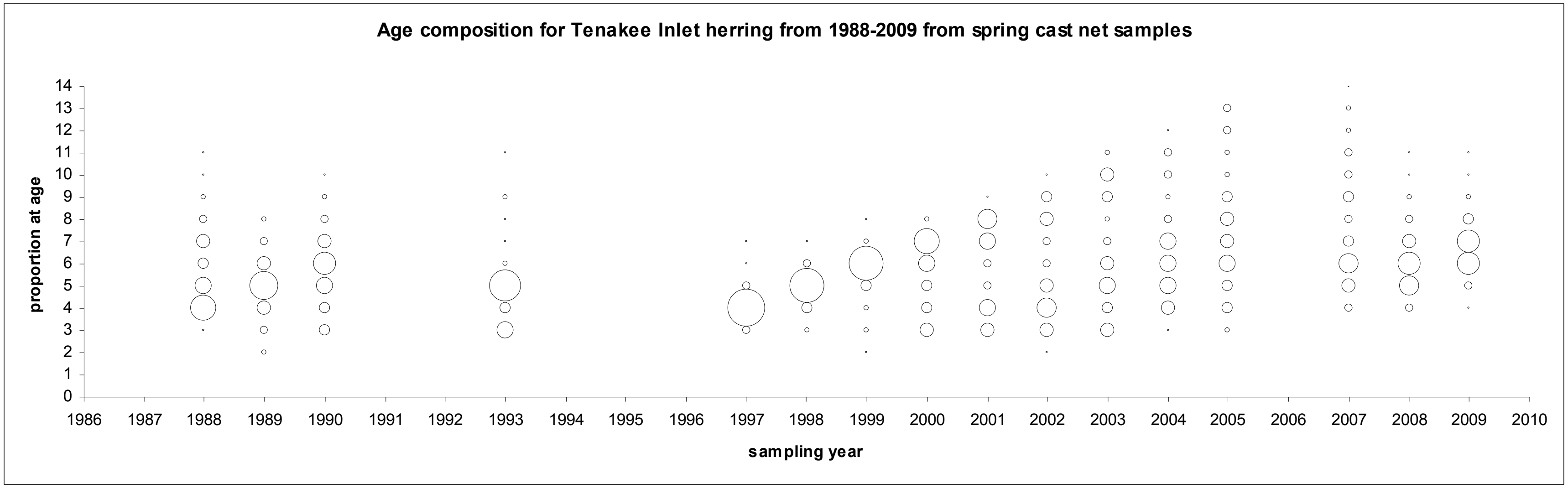


Figure 36.–Age composition from sampling data for the Tenakee Inlet herring stock.

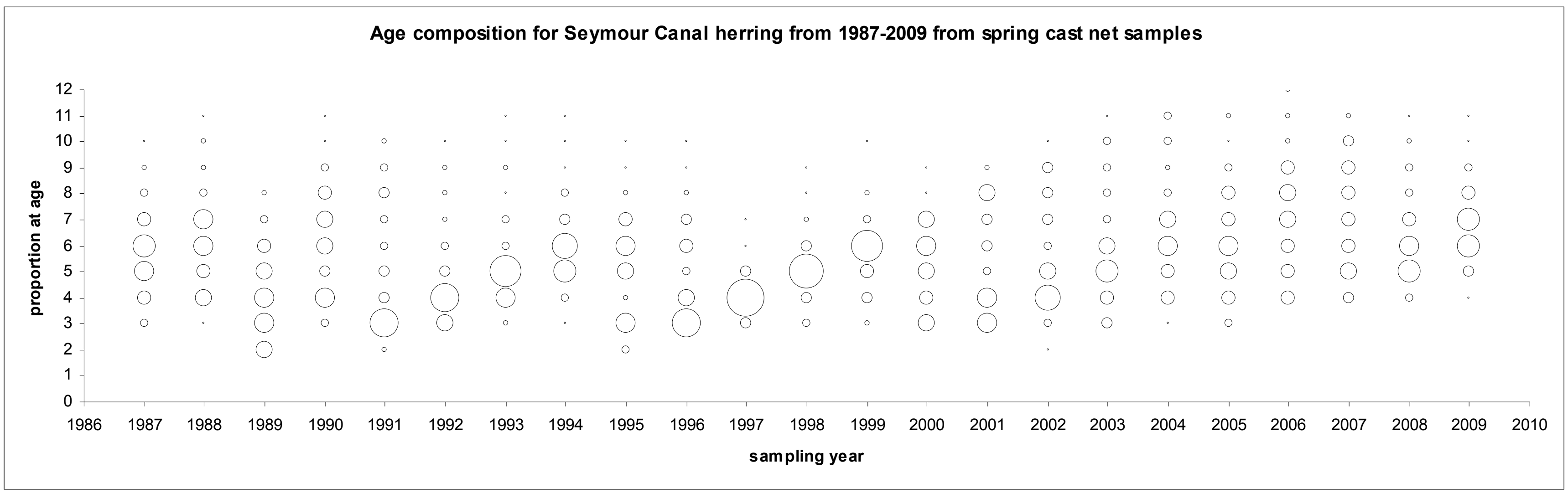


Figure 37.–Age composition from sampling data for the Seymour Canal herring stock.

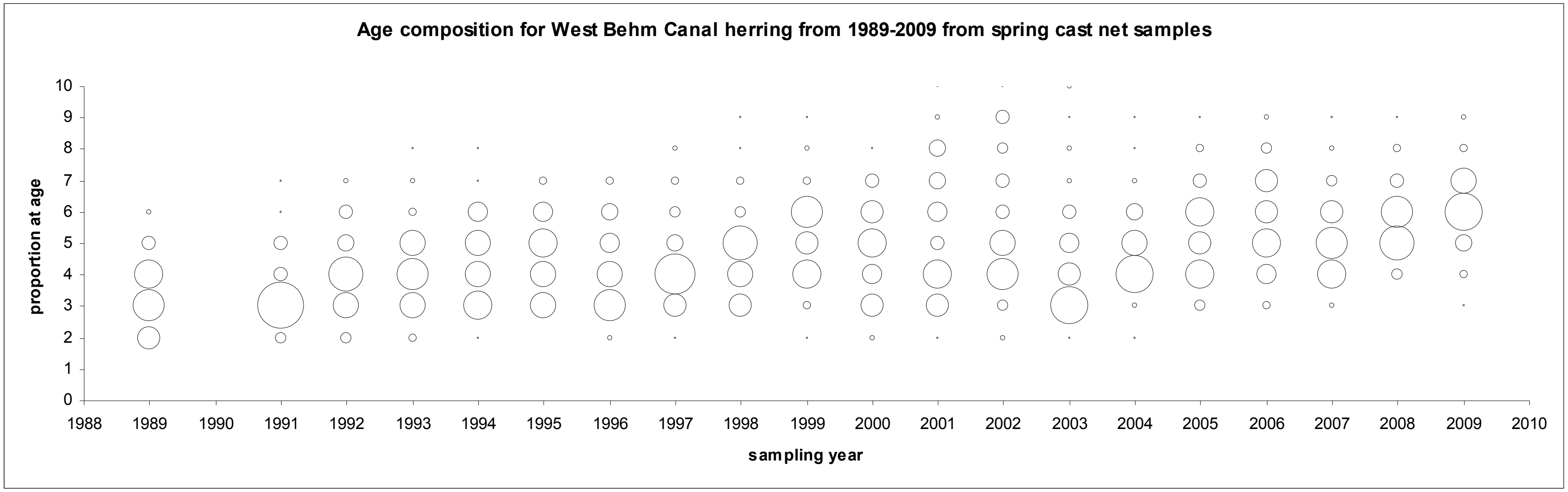


Figure 38.–Age composition from sampling data for the West Behm Canal herring stock.

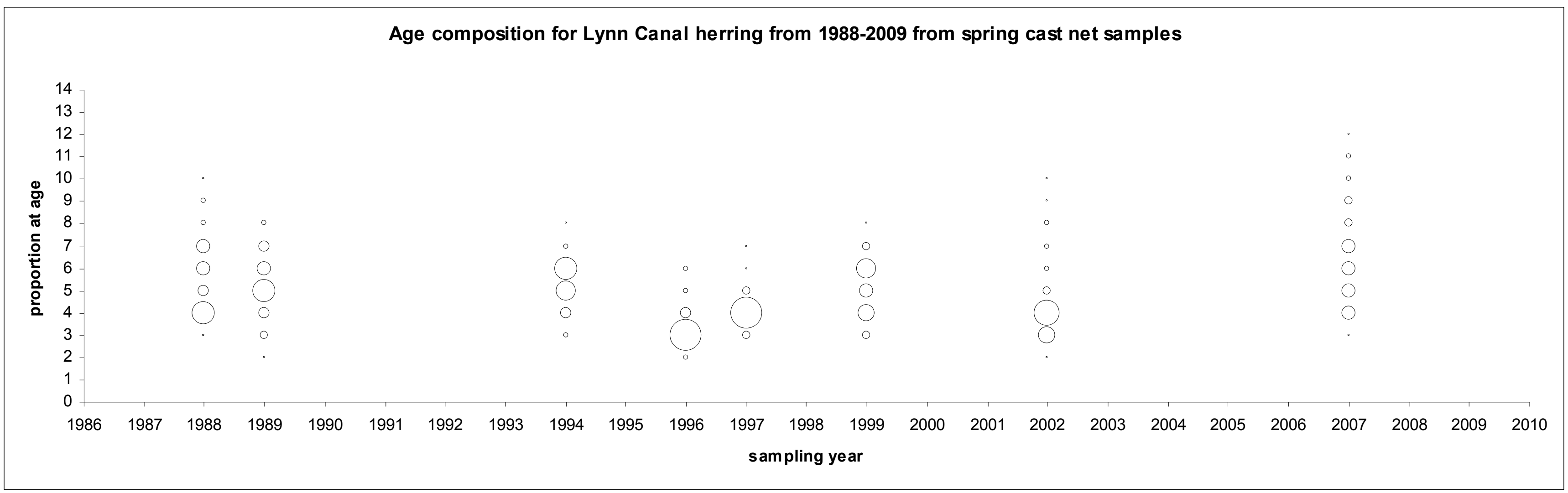


Figure 39.–Age composition from sampling data for the Lynn Canal herring stock.

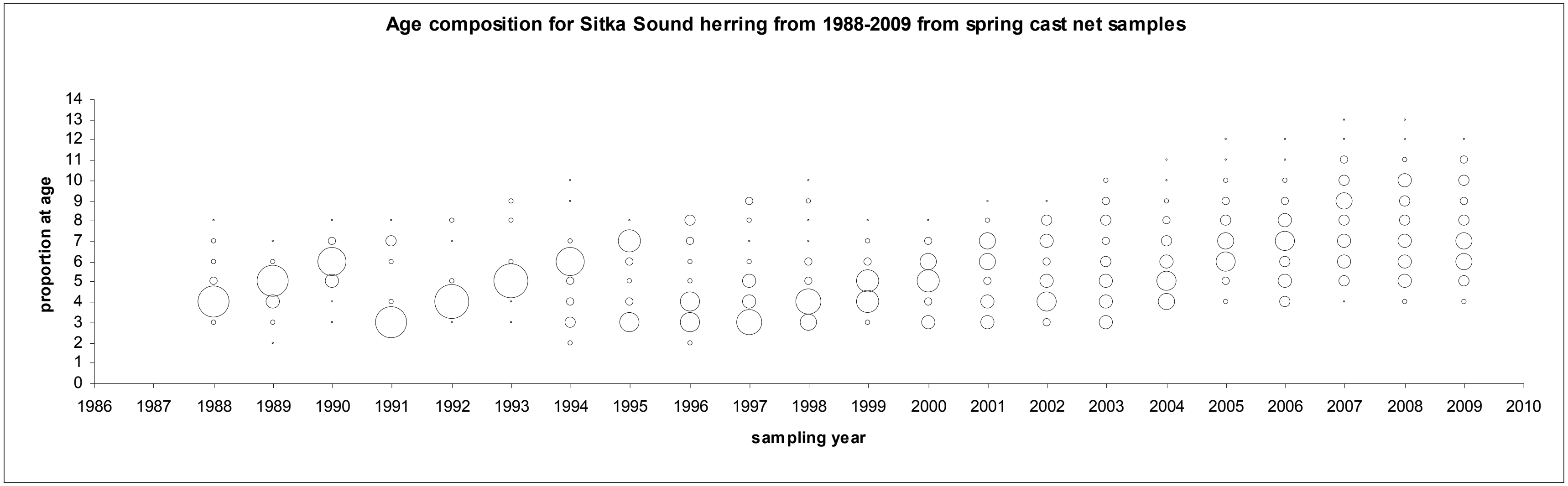


Figure 40.–Age composition from sampling data for the Sitka Sound herring stock.

APPENDIX A: KEY TO SUBSTRATE TYPES

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

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

APPENDIX B: KEY TO BOTTOM TYPES

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: HERRING SPAWN SURVEYS BY LOCATION

Appendix C1.–Aerial and skiff herring spawn surveys by date, near Craig (Ketchikan Management Area), Southeast Alaska in 2009.

3-20-09:

The Alaska Department of Fish and Game conducted its first herring aerial survey of the Craig area today, Friday March 20, 2009. Quite a bit of activity was seen around the immediate Craig area along with some **small spot spawns** around the Ballena Islands. No fish or marine mammal activity was seen in the herring pounding area.

3-26-09:

A skiff survey around the Craig area showed six whales south of the Coronados Islands, three whales off of Pt. Amargura working a small school of herring on the bottom. There was a pod of aprroximately 25 sea lions and two whales off of Pt. Ildefonso. No other concentrated predator activity was observed in the area. There are approximately 35 pound structures in the pounding area, about 1/3 of these are ready with there webbing in place.

3-29-09:

Intense sea lion activity can be seen on the east shore of Annette Island. Sea lions can be seen from Cascade Inlet to Annette Point, although most of the sea lions are concentrated by Crab Bay. No fish, bird or marine mammal activity was seen in state waters.

3-31-09:

An aerial survey was conducted in the Craig area today. Weather conditions were cloudy with scattered snow squalls. 20 whales were feeding on herring just south of Pt. Ildefonso. Approximately 200 sea lions were in the immediate vicinity of Pt. Ildefonso. No herring or herring spawn was observed.

4-1-09:

A skiff survey was conducted today. Weather was lousy with strong northwest winds, fog and snow squalls. No herring spawn was seen. There continues to be significant predator activity on the south end of San Christoval Channel, approximately 15 whales were seen working a large biomass of herring in this area. Five whales were observed on the eastern shore of San Fernando Island. There were schools of herring in and around the pounding area and three whales and 50 sea lions were in the area feeding on the herring. The herring were available for harvest and fishers began actively filling their pounds. There is little to no activity around Fish Egg Island. There are currently 65 pound structures in place.

4-3-09:

A skiff survey was conducted throughout the Craig area today. The weather was sunny with light winds. Approximately **0.8 nautical miles of active herring spawn** was seen on the western shore of Wadleigh Island in the vicinity of the net pens. This was the first day of spawn in the Craig/Klawock area. Fishers were actively filling their pounds and approximately 25 pound structures have had herring introduced into them. There was significant predator activity concentrated in the pounding area. 10 whales were also seen along the eastern shore of San Fernando Island from Pt. Polocano to Pt. Amargura. There was no activity around Fish Egg Island.

4-5-09

An aerial survey was conducted of the Craig area today. Weather prevented an aerial survey from being conducted on Saturday, April 4, but undoubtedly there was active spawn occurring that was missed. Skiff surveys will be conducted at extreme low tides as the week progresses to document any spawn that may have been missed. Approximately **6 nmi of active spawn** was observed during today's aerial survey. Spawn was observed on the west and southwest side of Wadleigh Island, on the south end of the inner Alberto Islands, and around the north, south and west side of Abess Island.

–continued–

4-6-09:

An aerial survey was conducted in the Craig area today. This is the third day of **active intense spawn (4.8 nmi)**. Spawn was observed on the southwest side of Wadleigh Island, around the two innermost Alberto Islands and almost encompassed Abbess Island.

4-7-09:

An aerial survey was conducted in the Craig area today. Weather conditions were poor with low clouds and snow squalls. Aprroximately **6.6 nmi of active spawn** was observed. Spawn ranged from the northwest side of Clam Island, to the southwest side of Wadleigh Island, around the two innermost Alberto Islands and almost encompassed Abbess Island. A large school of herring was observed just north of the pounding area.

4-8-09:

An aerial survey was conducted again today. Weather conditions were good with high overcast skies and light winds. This was the fifth of intense **active spawn**. Spawn was occurring in many of the same places as the previous days. New spawn was occurring around Entrance Point on the east side of Wadleigh Island, and on the outer Alberto Island. A skiff survey was also conducted today during low tide to map additional spawn the aerial surveys may have missed. Approximately 2 nmi of additional spawn was mapped (total spawn mapped **6.1 nmi**).

4-9-09:

Approximately **5.8 nmi. of active spawn** was observed. Herring spawn is concentrated around Clam Island and continues around the Albertos Islands, and Abbess Islands. Additional spawn was seen all around the Point Ildefonzo area (2 of the 5.8 nmi). Harvest of herring for use in herring pounds is nearing completion, with harvesting of product going on. No herring activity was seen near Point Amargura, and San Juan Bautista Island. The weather was fair with high clouds and patchy fog.

4-10-09:

An aerial survey was conducted today. Weather conditions were poor with low clouds, wind and snow squalls. No active spawn was observed and the predator activity was beginning to disperse. Approximately 150 sea lions were still observed in the area.

4-11-09:

The last aerial survey was conducted in the Craig area today. A small **active spawn** was observed on the inside of Pt. Ildefonso. Cumulative spawn in the Craig area totaled 17.0 nautical miles. The R/V Kestrel is scheduled to conduct spawn deposition surveys of the Craig herring spawn on April 15, 2009.

Appendix C2.–Aerial and skiff herring spawn surveys by date, in Revilla Channel (Ketchikan Management Area), Southeast Alaska in 2009.

3-20-09:

An aerial survey was conducted in the Revilla Channel area. Weather conditions were fair. No herring or predator activity was observed.

3-24-09:

An aerial survey was conducted in the Revilla Channel area. Weather conditions were good. Predator activity increased significantly from the previous aerial survey. 138 sea lions were observed spread from Cascade Inlet to Annette Point.

3-27-09:

An aerial survey was conducted in the Revilla Channel area. Weather conditions were good. Sea lions continue to be concentrated from Cascade Inlet to Annette Point. No activity was observed in state waters.

3-29-09:

Intense sea lion activity can be seen on the east shore of Annette Island. Sea lions can be seen from Cascade Inlet to Annette Point, although most of the sea lions are concentrated by Crab Bay. No fish, bird or marine mammal activity was seen in state waters.

3-31-09:

An aerial survey was conducted in the Revilla Channel area. Weather conditions were good. Sea lions continue to be concentrated from Cascade Inlet to Annette Point. No activity was observed in state waters.

4-2-09:

Intense sea lion activity can be seen on the east shore of Annette Island. Sea lions can be seen from Cascade Inlet to Annette Point, although most of the sea lions are concentrated by Crab Bay. No fish, bird or marine mammal activity was seen in state waters. Weather conditions were poor with strong winds and snow squalls.

4-6-09:

An aerial survey was conducted today. Intense sea lion activity can be seen on the east shore of Annette Island. Sea lions can be seen from Cascade Inlet to Annette Point, although most of the sea lions are concentrated around Cascade Inlet.

4-7-09:

Sea lion activity can be seen on the east shore of Annette Island. Sea lions can be seen from Cascade Inlet to Annette Point. No fish, bird or marine mammal activity was seen in state waters. The weather was overcast with light winds.

4-8-09:

Sea lion activity can be seen on the east shore of Annette Island from Cascade Inlet to Annette Point. Around **1 nmi of spawn** was seen just north of Crab Bay. The Annette Island fleet was fishing as of 9:00 am this morning. No fish, bird or marine mammal activity was seen in state waters. The weather was overcast, patchy fog with light winds.

–continued–

4-9-09:

Approximately **2 nmi of spawn** was seen from Crab Bay north on the east side of Annette Island. An additional 1 nmi of spawn was seen near Point Davidson, near the southwest shore of Annette Island. The Annette Island gillnet fleet was fishing as of 9:30 am this morning on both locations of spawn. No fish, bird or marine mammal activity was seen in state waters. The weather was clear with light winds.

4-10-09:

Approximately **5 nmi. of spawn** was seen around Crab Bay, between Point Davidson and Tamgass Harbor and near Cedar Point. The Annette Island gillnet fleet was fishing as of 9:30 am this morning at several locations around Annette Island. No herring activity was seen in state waters. The weather was overcast with moderate winds.

4-11-09:

Approximately **1 nmi. of active spawn** was observed between Cedar Point and the City of Metlakatla harbor. The Annette Island gillnet fleet was fishing as of 11:30 am this morning in this spawning location. The weather was dense fog with moderate winds.

4-12-09:

Approximately **0.1 nmi. of active spawn** was observed north of Cedar Point. The Annette Island gillnet fleet was fishing as of 8:30 am. at this location. The weather was rain, fog and moderate winds.

4-14-09:

No spawn or herring activity was seen on the eastern shore of Annette Island. This was the last aerial survey conducted in the Revilla Channel area. Total spawn around Annette Island was 6.6 nautical miles. No spawn occurred in state waters during the 2009 herring season.

Appendix C3.–Aerial and skiff herring spawn surveys by date, in West Behm Canal (Ketchikan Management Area), Southeast Alaska in 2009.

4-6-09:

A condensed aerial survey was conducted today. No herring or herring spawn was observed. Light predator activity was observed throughout the area.

4-8-09:

A herring aerial survey of the West Behm area occurred today. Today's weather was patchy fog with light winds. A truncated survey was completed and sea lions were seen from Survey Point into Clover Passage. No herring spawn was seen.

4-12-09:

Approximately **0.75 nmi. of active spawn** was observed in the Clover Pass, Betton Island area. Eight areas of spawn were seen around the north side of Betton Island (near Tatoosh Rocks) to Back Island. The most intense spawn was around Back Island. Sea lion activity observed at Helm Point and Survey Point. The weather was overcast, rain and light winds.

4-13-09:

Approximately **12 nmi. of active spawn** was observed in Clover Pass, Betton Island, Moser Bay Islands, Indian Point, near the mouth of Traitors Cove and Cleveland Peninsula. The most aggressive spawn was located around Betton, Hump and Back Islands. The weather was clear with heavy NW winds.

4-14-09:

Approximately **3 nmi. of active spawn** was observed in Clover Pass, around Betton Island, Hump Island and near Point Francis on the Cleveland Peninsula. The most aggressive spawn was located around Betton Island and Clover Pass. The weather was clear with light winds.

4-15-09:

No herring or herring activity seen. All indications are that the spawn in West Behm is over. The weather was clear with light winds. Total spawn in West Behm Canal was 16.7 nautical miles.

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Sitka Sound (Sitka Management Area), Southeast Alaska in 2009.

3-14-09:

Spotting conditions were generally good with east winds 10–20 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 five sea lions off Kayak Island located in Middle Channel. North of Sitka, a large concentration of sea lions, with an estimated count of 350, was seen off Bieli Rock, in two large groups, with scattered smaller groups working off shore. One whale was also seen in the vicinity. Otherwise only one or two sea lions were seen in any specific location around northern Sitka Sound with the exception of seven sea lions seen off Guide Island. In Salisbury Sound only two sea lions were seen north of Gilmer Cove, though a total of 28 sea lions were seen in Neva Strait with higher numbers in the northern portion of the Strait. These observations are normal for this date.

3-17-09:

Spotting conditions were generally good with southeast winds 15–25 knots and mostly cloudy. The department conducted an aerial survey today covering Sitka Sound north of Cape Burunof and Salisbury Sound. No herring were seen. All areas to the south of Sitka were quiet. North of Sitka, a large concentration of sea lions, with an estimated count of 475, was seen off Bieli Rock, in three large groups, with scattered smaller groups working off shore. Seven whales were also seen offshore northwest of Bieli Rock. Otherwise only five to six sea lions were seen in any specific location around northern Sitka Sound with the exception of twenty sea lions seen off Inner Point, on Kruzof Island. In Salisbury Sound only one sea lion was seen south of Entrance Island.

3-19-09:

Spotting conditions were generally good with southeast winds 15–25 knots and mostly cloudy. An aerial survey conducted this morning covered Sitka Sound, from Nakwasina Sound to West Crawfish Inlet, including the Kruzof Island shoreline. Sea lions continue to be concentrated near Bieli Rock with an estimated count of 350. Also, approximately 100 sea lions were seen west of the Little Gavanski Island and 20 sea lions were seen along the north side of Middle Island. Small numbers of sea lions were seen scattered in areas east of the island groups on the north side of town. Additionally, six whales were north of Middle Island, one whale was off the northeast shore of Middle Island, one whale was west Bieli Rock, two whales were seen northeast of St. Lazaria Island, and one whale was south of Makhnati Island. South of Sitka no significant concentrations of sea lions were seen.

3-20-09:

Weather forecast very poor (S GALE TO 40 KT. SEAS 18 FT. RAIN.). No aerial survey conducted.

–continued–

3-21-09:

Spotting conditions were generally good with east winds 10–55 knots and mostly cloudy. An aerial survey conducted this morning covered Sitka Sound, from Windy Passage to the Magoun Islands. Sea lions continue to be concentrated near Bieli Rock with an estimated count of 375. Also, approximately 25 sea lions were seen east of Inner Point, 25 sea lions were seen along the north side of Middle Island, and 45 were seen along Old Sitka Rocks. Small numbers of sea lions were seen scattered in areas east of the island groups on the north side of town. Additionally, two whales were north of Middle Island, four whales were off the east shore of Middle Island, one whale was east of Kasiana Island, nine whales were seen in the deep water east of Inner Point on Kruzof Island, and one whale was south of Makhnati Island. South of Sitka sea lion concentrations were seen by Kayak Island (5), Thimbleberry Bay (5), Crescent Bay (5), and in the mouth of Deep Inlet (7).

3-22-09:

Spotting conditions were generally good with southeast winds 15–25 knots and mostly cloudy. An aerial survey conducted this morning covered Sitka Sound, from Redoubt Bay to Sinitsin Cove in Salisbury Sound South of town two whales were seen south of Galankin Island and three whales were seen in Aleutkina Bay. North of town several hundred sea lions were seen in the vicinity of Inner Point along with five whales. There were 60 sea lions off the shoals near Fred's Creek as well. 200 sea lions were seen near Bieli Rock. Scattered groups of sea lions and several whales were seen in the area of Halibut Point and north Kasiana Island. There were a total of three whales and 20 sea lions in lower Salisbury and in St. John Baptist Bay.

The morning vessel survey found several large schools of herring between Halibut Point and Middle Island, several large schools were seen in the vicinity of Inner point and Mountain Point, a large school of herring was found in the area of Samsing Cove and another large school was seen in Aleutkina Bay. Also, there was a large school seen just south of Whale Island in Eastern Channel. In Hayward Strait, and afternoon vessel survey found a large biomass of herring located between Kamenoi Point and Point Brown

3-23-09:

Weather forecast very poor (S GALE TO 35 KT. SEAS 20 FT.). No aerial survey conducted. Fishery stood down for the day.

3-24-09:

An aerial survey conducted this morning covered Sitka Sound between Cape Burunof and Hayward Strait. Sea lion and whale activity was highly concentrated in the area from Inner Point into Hayward Strait and to Kresta Point. Additionally, whales and smaller groups of sea lions were seen scattered around northern Sitka Sound. South of town, two whales were seen west of Galankin Island and one whale was seen near The Eckholms in Eastern Channel. Scattered small groups of sea lions were seen near Deep inlet and in Middle Channel. The vessel survey conducted on March 24 focused in the area of Hayward Strait where a substantial body of herring continued to be found. The herring were highly concentrated inside of Hayward Strait with several large schools around Kresta Point.

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3-25-09:

An extensive aerial survey was conducted covering areas from Redoubt Bay to Salisbury Sound. Survey conditions were excellent. No spawn was observed during the survey. Herring schools were seen in the Crescent Bay area, on the beach near Sea Mart, in the mouth of Katlian Bay, and on the southeast corner of Big Gavanski Island. A number of large schools were also seen in and around St John Baptist Bay in lower Salisbury Sound. A total of 25 whales were seen scattered throughout northern Sitka Sound. Sea lions continued to be in highest concentrations in the Hayward Strait area. Additionally, approximately 80 sea lions were seen in the vicinity of Bieli Rock, 20 were in Western Channel, and smaller groups of sea lions were seen scattered around the islands near to town. No vessel survey was conducted today.

3-26-09:

Survey conditions were windy and overcast. An aerial survey was conducted this morning covering Sitka Sound and south to Cape Burunof. No significant herring predator activity was noted in areas south of Sitka. Large numbers of sea lions continue to be found on the Kruzof shoreline from Inner Point to Mountain Point, off of Bieli Rock, off Old Sitka Rocks and off Guide Island. One herring school was observed near Old Sitka Rocks.

3-27-09:

In the afternoon and an aerial survey was conducted covering Sitka Sound and south to Windy Pass. The Eastern Channel area was not surveyed. No spawn was seen during the survey. Large seas and surge today had stirred up silt making it difficult to see into the water and no herring were seen. No significant herring predator activity was noted in areas south of Sitka. Large numbers of sea lions continue to be found on the Kruzof shoreline from Inner Point to Mountain Point, off of Bieli Rock, and off Guide Island. Five whales and 30 sea lions were seen between Kasiana Island and the Parker Group, three whales and 15 sea lions were seen near Halibut Point, one whale and 30 sea lions were seen in the Middle Channel area, and five whales were seen in the Starrigavin Bay area.

3-28-09:

Survey conditions were mostly cloudy with light winds. An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. No herring spawn was seen. Large schools of herring were seen in the area between the breakwater and Kasiana Island, in the area between the breakwater and Eliason Harbor, and in the Crescent Bay and Mermaid Cove areas. Sea lions and whales continue to be distributed throughout northern Sitka Sound.

3-29-09:

Survey conditions were mostly cloudy with light winds. An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. No herring spawn was seen. Large schools of herring were seen in the area between the breakwater and Kasiana Island, in the area between the breakwater and Eliason Harbor, and in the Crescent Bay and Mermaid Cove areas. Sea lions and whales continue to be distributed throughout northern Sitka Sound.

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3-30-09:

Survey conditions were mostly cloudy and windy. An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. No herring spawn was seen. One school of herring were seen in the area north of Kasiana Island, other schools were not evident likely due to sea surface conditions. Sea lions and whales continue to be distributed throughout northern Sitka Sound.

3-31-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. No herring spawn was seen. Large schools of herring were seen in the area between the breakwater and Kasiana Island, in the area between the breakwater and Eliason Harbor, and in the Crescent Bay and Mermaid Cove areas. Sea lions and whales continue to be distributed throughout northern Sitka Sound.

4-1-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. No herring spawn was seen. Large schools of herring were seen in the area between the breakwater and Kasiana Island, in the area between the breakwater and Eliason Harbor, and in the Crescent Bay and Mermaid Cove areas. Sea lions and whales continue to be distributed throughout northern Sitka Sound.

4-2-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. The **first spot spawn (0.2 nmi)** was recorded on the southwest side of Middle Island. The timing of this first spawn is about one week later than the recent 10-year average start date of March 24.

4-3-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. Today the spawning on the southwest side of Middle Island had increased slightly to **0.5 nmi.**

4-4-09:

No Flight

4-5-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. Today the spawning on the southwest side of Middle Island had increased to **0.6 nmi**.

4-6-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. Today the spawning on the southwest side of Middle Island had increased to **1.4 nmi**.

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4-7-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. Today the spawning expanded from Middle Island to other islands and to the north road system. A total of **3.1 nmi of spawn** was mapped today.

4-8-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. Today the spawning expanded significantly from Middle, Kasiana, Crow, and Gagarin Islands to other islands and to the north road system. Active spawn totaling .3 nm was also observed on Japonski Island. Spot spawns were also observed in Jamestown Bay and on Kruzof Island north of Shoals Point. A second aerial survey was conducted in the afternoon after a pilot reported significant spawn occurring in Salisbury Sound. A total of **14.4 nmi of spawn** was mapped today.

4-9-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof and Salisbury Sound. Today's spawning activity was on HPR Road, Salisbury Sound, Kruzof Island and, on Middle Island and it's surrounding islands. A total of **30.9 nmi of spawn** was mapped today.

4-10-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof and Salisbury Sound. Today's spawning activity was primarily on HPR Road, Salisbury Sound, Kruzof Island, Promisla/Eastern Bay and on Middle Island and surrounding islands. A total of **38.7 nmi of spawn** was mapped today.

4-11-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof and Salisbury Sound. Today the spawning activity was primarily on The Causeway, in the Channel, on the small islands both north and south of the causeway and in Salisbury Sound. A total of 2.8 nm of spawn was mapped from the air and an additional 4.1 nm was mapped by skiff today for a total of **6.9 nmi of spawn**.

4-12-09:

Survey conditions were mostly cloudy with light winds. The aerial survey conducted this morning covered Sitka Sound north of Cape Burunof. Today the spawning activity was primarily on The Causeway, in the Channel, in Jamestown Bay and on the beach in front of Totem Park. A total of **3.3 nmi of spawn** was mapped today.

4-13-09:

Survey conditions were mostly cloudy with light winds. The aerial survey conducted this morning covered Sitka Sound north of Cape Burunof, and Salisbury Sound. In Sitka Sound no herring or herring spawn was observed.

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4-14-09:

Survey conditions were clear skies and calm. The aerial survey conducted this morning covered Sitka Sound north of Windy Pass. Today the spawning activity was primarily on Elovoi Island and on the Baranof Island shore south of Goddard. A total of **3.5 nmi of spawn** was mapped today.

4-15-09:

Survey conditions were clear skies and calm. The aerial survey conducted this morning covered Sitka Sound north of Windy Pass. Today the spawning activity was primarily on Elovoi Island, on the Baranof Island shore south of Goddard and in Jamestown Bay. A total of **1.4 nmi of spawn** was mapped today.

4-16-09:

No Survey.

4-17-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof to Salisbury Sound.. A total of **1.3 nmi of spawn** was mapped today in Jamestown Bay.

4-18-09:

No survey.

4-19-09:

An aerial survey conducted this morning covered Sitka Sound north of Cape Burunof to Salisbury Sound. A total of **2.1 nmi of spawn** was mapped today on the shoreline north and south of Gilmer Cove in Salisbury Sound.

4-20-09:

Survey conditions were mostly cloudy with light winds. The aerial survey conducted this morning covered Sitka Sound north of Cape Burunof, and Salisbury Sound. A total of **2.2 nmi of spawn** was mapped today on the shoreline north and south of Gilmer Cove in Salisbury Sound, and a small amount in Jamestown Bay. Herring Schools were also observed in Sukoi Inlet and near Entrance Island

4-21-09:

Survey conditions were mostly cloudy with light winds. The aerial survey conducted this morning covered Sitka Sound north of Cape Burunof, Salisbury Sound. A total of **4.7 nmi of spawn** was mapped today on the shoreline north and south of Gilmer Cove in Salisbury Sound and in Sukoi Inlet.

4-22-09:

Survey conditions were mostly clear with moderate winds. The aerial survey conducted this morning covered Sitka Sound north of Cape Burunof, and Salisbury Sound. A total of **1.0 nmi of spawn** was mapped today on the shoreline north of Gilmer Cove in Salisbury Sound and in Sukoi Inlet.

Appendix C5.–Aerial and skiff herring spawn surveys by date, in Hoonah Sound (Sitka Management Area), Southeast Alaska in 2009.

4-13-09:

Survey conditions were mostly cloudy with light winds. Predator concentrations were observed south of Emmons Island, east of Moser Island and north of Vixen Island.

4-14-09:

Survey conditions were clear skies and calm. Predator concentrations were observed south of Emmons Island, east of Moser Island and north of Vixen Island.

4-15-09:

No survey.

4-16-09:

No survey.

4-17-09:

Predator concentrations were observed south of Emmons Island, east of Moser Island and north of Vixen Island.

4-18-09:

No survey.

4-19-09:

No spawn observed.

4-20-09:

Predator concentrations were observed south of Emmons Island, east of Moser Island and north of Vixen Island. Herring schools were observed off White Cliff Pt. and on the Chichigof Island shore between Fick Cove and Emmons Island.

4-21-09:

Herring schools were observed banded along beach north of Finger River for approximately 4 miles almost continuously. Herring Schools were also observed in the narrows north of Deep Bay and Poison Cove.

4-22-09:

Survey conditions were mostly clear with moderate winds. Herring schools were observed banded along beach from Finger River to beyond Oly Creek. Herring schools were also observed around Emmons Island and on the Chichigof Island shore north of Rodgers Point. A total of **2.1 nmi of spawn** was mapped today on the north shoreline of Emmons Island and on Vixen Islands.

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4-23-09:

Survey conditions were mostly clear with moderate winds. Herring schools were observed along beach from north of Finger River to beyond Oly Creek. Herring schools were also observed around Emmons Island, on the Chichigof Island shore north of Rodgers Point and on the Moser Island shore from White Cliff Pt to Pedersen Pt and into the North Arm. A total of **5.7 nmi of spawn** was mapped today on Emmons Island, Vixen Islands and on the Chichigof Island shore north of Rodgers Pt.

4-24-09:

Survey conditions were mostly clear with moderate winds. No herring schools were observed. A total of **1.9 nmi of spawn** was mapped today on Emmons Island, on the Chichigof Island shore north of Rodgers Pt. and on the Finger River shoreline.

4-25-09:

Survey conditions were mostly cloudy with mild winds. No herring schools or herring spawn was observed.

4-26-09:

Survey conditions were mostly clear with moderate winds. The aerial survey conducted this morning covered Hoonah Sound, Lisianski and west Chichagof Island. No herring schools were observed. A total of **2.6 nmi of spawn** was mapped today on Emmons Island, and on the Chichigof Island shore north of Rodgers Pt.

4-27-09:

Survey conditions were mostly clear and calm. No herring schools were observed. A total of **0.8 nmi of spawn** was mapped today on Emmons Island, and on the Baranof Island shore south of Otstoia Island.

A skiff survey conducted earlier in the day during low tide mapped an additional **2.1 nmi of spawn** on Emmons Island, Vixen Island, on the Chichigof Island shore south of Finger River and on the Chichigof Island shore north of Rodgers Pt.

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, 2009.

Bradfield Canal

4-15-09: No spawn, herring, mammals, or birds observed from Anan River to Pt. Ward.

4-15-09 and 4-16-09:

Skiff survey to map eggs on beach. Mapped approximately **12.1 nmi of eggs** on beach; 20 gulls; 100 Scoters; 2 Sea lions. Spawning dates are unknown, but prior to 4-16-09.

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

4-15-09: No active spawn or herring observed; 92 Sea lions; 100 Gulls; 300 Scoters.

4-17-09: About **4.0 nmi of active spawn**; 110 Sea lions; 1,000 + gulls; 500 Scoters.

4-18-09: About **5.0 nmi of active spawn**; 124 Sea lions; 1 Whale; 1,000 Scoters.

4-19-09: About **0.5 nmi of active spawn**; 112 Sea lions; 2,500 gulls.

4-20-09: No active spawn or herring observed; 30 Sea lions; 1,000+ gulls.

4-27-09: No active spawn or herring observed; 2,500+ gulls.

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

4-15-09: No active spawn or herring observed; 1 Sea Lion.

4-17-09: No active spawn or herring observed.

4-19-09: No active spawn or herring observed.

4-27-09: No active spawn or herring observed.

Ship Island

4-18-09: No active spawn or herring observed.

4-20-09: No active spawn or herring observed.

4-27-09: No active spawn or herring observed.

Zimovia St. and Eastern Passage

4-15-09: No active Spawn or herring observed; 1,500 Snow Geese near Little Dry Is.

Bear Creek

5-21-09: No active spawn; 10 schools; 1 Sea Lion; 700 Scoters.

5-22-09: About **0.1 nmi of active spawn** with spawn drifting offshore; 10 schools; 700 Scoters.

Appendix C7.–Aerial and skiff herring spawn surveys by date, in Farragut Bay (Petersburg-Wrangell Management Area), in Southeast Alaska, 2009.

4-21-09: No active spawn or herring observed; 15 Sea lions.

4-23-09: No active spawn or herring observed; 19 Sea lions; 1 Whale; 50 gulls.

4-25-09: No active spawn or herring observed; 29 Sea lions.

4-27-09: No active spawn or herring observed; 16 Sea lions.

4-28-09: No active spawn observed; 2 schools; 49 Sea lions.

4-29-09: No active spawn or herring observed; 54 Sea lions; 2 Whales.

5-4-09: No active spawn or herring observed; 19 Sea lions; 2 Whales.

5-5-09: No active spawn or herring observed; 12 Sea lions.

5-6-09: No active spawn or herring observed; 2 Sea lions.

5-7-09: About 4.0 nm of scattered schools along the beach; 5 Sea lions; 1 Whale.

5-8-09: About 3.0 nm of scattered schools along the beach; 13 Sea lions.

5-10-09: About **1.0 nm of active spawn**; about 3.0 nm of scattered schools along the beach; 10 Sea lions; 1 Whale.

5-10-09: **8 small spot spawns**; 5 small schools; 5 Sea lions; 50 gulls.

5-21-09: No active spawn or herring observed; 3,000 Scoters.

Appendix C8.–Aerial and skiff herring spawn surveys by date, in Hobart Bay (Hobart Bay/Port Houghton section within Petersburg-Wrangell Management Area), in Southeast Alaska, 2009.

4-20-09: No active spawn or herring observed; 30 Sea lions.

4-21-09: No active spawn or herring observed; 34 Sea lions; 20 gulls.

4-23-09: No active spawn or herring observed; 80 Sea lions; 300 gulls.

4-25-09: No active spawn or herring observed; 67 Sea lions; 4 Whales.

4-27-09: No active spawn or herring observed; 78 Sea lions; 1 Whale.

4-28-09: No active spawn or herring observed; 58 Sea lions; 2 Whales.

4-29-09: No active spawn or herring observed; 69 Sea lions.

4-30-09: No active spawn or herring observed; 52 Sea lions; 3 Whales.

5-1-09: No active spawn or herring observed; 46 Sea lions; 3 Whales.

5-2-09: No active spawn; 4 schools; 32 Sea lions; 1 Whale.

5-3-09: No active spawn; 9 schools.

5-4-09: **0.5 nm of active spawn**; 8 schools; 65 Sea lions.

5-5-09: About **1.1 nm of active spawn**; 5 schools; 53 Sea Lions.

5-6-09: About **2.3 nm of active spawn**; Schools observed intermixed with spawn; 50 Sea lions; 1,500 Scoters.

5-7-09: No active spawn; 3 schools along north shore of Hobart to Boom Point; 6 Sea Lions; 1,000 Scoters.

5-8-09: No active spawn or herring observed; 10 Sea lions; 1,000 Scoters.

5-10-09: No active spawn or herring observed; 17 Sea lions; 3,000 Scoters.

5-12-09: No active spawn or herring observed; 15 Sea lions; 3 Whales; 3,800 Scoters.

5-21-09: No active spawn or herring observed; 5 Sea lions; 1,000 Scoters.

Appendix C9.–Aerial and skiff herring spawn surveys by date, in Port Houghton (Hobart Bay/Port Houghton section within Petersburg-Wrangell Management Area), in Southeast Alaska, 2009.

4-20-09:	No active spawn or herring observed.
4-21-09:	No active spawn or herring observed; 3 Sea lions; 70 gulls.
4-23-09:	No active spawn or herring observed.
4-25-09:	No active spawn or herring observed; 2 Sea lions; 1 Whale.
4-27-09:	No active spawn or herring observed.
4-28-09:	No active spawn or herring observed; 400 Scoters.
4-29-09:	No active spawn or herring observed; 3 Sea lions.
4-30-09:	No active spawn or herring observed; 3 Sea lions.
5-1-09:	No active spawn; 1 school observed offshore.
5-2-09:	No active spawn or herring observed; 1 Sea Lion.
5-3-09:	No active spawn or herring observed; 6 Sea lions.
5-4-09:	No active spawn or herring observed; 1 Sea Lion; 500 Scoters.
5-5-09:	No active spawn or herring observed; 1,500 Scoters.
5-6-09:	About **0.1 nm of active spawn**; 1 school; 1,000 Scoters.
5-7-09:	No active spawn; 10 small schools; 1,500 Scoters.
5-8-09:	No active spawn or herring observed; 5 Sea lions; 200 Scoters.
5-10-09:	No active spawn or herring observed; 2 Sea lions; 1,500 Scoters.
5-21-09:	No active spawn observed; 1 small school; 10 Sea lions.

Appendix C10.–Aerial and skiff herring spawn surveys by date, in Sunset Cove/Windham Bay (Hobart Bay/Port Houghton), Gambier Bay, and Port Camden, within Petersburg-Wrangell Management Area), in Southeast Alaska, 2009.

Sunset Cove/Windham Bay

4-20-09: No active spawn or herring observed.

4-21-09: No active spawn or herring observed.

4-23-09: No active spawn or herring observed.

4-25-09: No active spawn or herring observed; 8 Sea lions.

4-27-09: No active spawn or herring observed; 5 Sea lions.

4-28-09: No active spawn or herring observed.

4-29-09: No active spawn or herring observed; 16 Sea lions.

4-30-09: No active spawn or herring observed.

5-1-09: No active spawn or herring observed; 13 Sea lions.

5-2-09: About **2.2 nm of active spawn**; 6 schools of herring seen; 10 Sea lions; 2 Whales.

5-3-09: No active spawn or herring observed.

5-4-09: No active spawn or herring observed; 15 Sea lions; 3,200 Scoters.

5-5-09: No active spawn or herring observed; 5 Sea lions; 5,500 Scoters.

5-6-09: No active spawn observed; 1 school; 2 Sea lions.

5-7-09: No active spawn or herring observed; 2 Sea lions; 300 Scoters.

5-8-09: No active spawn or herring observed.

5-10-09: No active spawn or herring observed.

5-12-09: No active spawn or herring observed.

5-21-09: No active spawn or herring observed; 2 Sea lions.

Gambier Bay

5-1-09: No active spawn or herring observed; 11 Sea lions.

Port Camden

Not surveyed in 2009.

Appendix C11.–Aerial and skiff herring spawn surveys by date, in Seymour Canal (Juneau Management Area), in Southeast Alaska, 2009.

4-17-09: No herring activity seen. Predators spread out & inactive.

4-20-09: No significant change from prior survey.

4-22-09: No herring activity. Predators spread out in small active groups in the core area (Blackjack Cove to Sore Finger Cove).

4-24-09: No herring or spawn. Increase in predator numbers and activity in core area.

4-26-09: Schools of herring observed near Sore Finger with active predators nearby, rafts of sea lions near Sore Thumb, Blackjack, and Pt Hugh.

4-27-09: 10–12 small- to medium-sized schools between Point Hugh and Point Hugh Light. Most predators in Seymour Canal spread out from Point Hugh to Sore Thumb Cove.

4-28-09: **Spot spawns** on Big Bend shoreline totaling about **0.3nmi** Several small schools from Pt Hugh up the Stephens Passage shoreline. Many predators at Pt Hugh, with others at Twin Island, Swimming Pool, Blackjack Cove, Clover leaf Rocks and Pt. Hugh Light. Fishery placed on 2-hour advance notice.

4-29-09: **1 nmi of spawn** and 7 nmi of herring lined up along the Stephens Passage side of the Glass Peninsula shoreline.

4-30-09: **8 nmi** active spawn mostly along the Stephens Passage side of Glass Peninsula. Fishery opened 9:00 am.

5-1-09: **Active spawn down to 4 nmi**.

5-2-09: Fishery closed 5:00 pm and only a **few remnant spot spawns**.

5-3-09: No herring; no spawn. Few scattered predators. Very quiet.

5-4-09: **8 light spot spawns** and scattered small schools between Blackjack Cove and Twin Islands.

5-5-09: No evidence of yesterdays spot spawns but one **new active spawn** at Twin Islands along **200 yards** of shoreline. A couple small schools in the area.

5-6-09: Twin Islands **spawn remains** but is weak and dissipating. **Very light spot spawn** in Sore Thumb Cove.

5-7-09: No spawn; 2 small schools around Sore Thumb and Rock Garden area.

5-8-09 through 5-11-09:

No spawn; 2 small schools observed around Sore Thumb and Rock Garden area.

Appendix C12.–Aerial and skiff herring spawn surveys by date, in Tenakee Inlet (Juneau Management Area), in Southeast Alaska, 2009.

4-17-09: No herring activity seen. Predators active in core area.

4-20-09: No herring activity. Predators have decreased in number and many have moved to Chatham Strait north of Basket Bay.

4-22-09: Many large and small schools of herring just offshore in the core area.

4-23-09: No herring spawn. No herring observed in core area, 2 small schools on beach in Finn Cove. Many small schools on the beach along the Chatham shore between S Passage Pt and Basket Bay Active predators from S Passage Pt to Peninsular Pt.

4-24-09: **0.25 nmi of active expanding spawn** near Basket Bay. Several herring schools observed nearshore north of the spawn. Inside Tenakee inlet relatively quiet.

4-25-09: **2 nmi of active spawn** near Basket Bay. Tenakee Inlet quiet. Predator numbers have significantly decreased.

4-26-09: **Spot spawns** near Basket Bay, few predators in evidence.

4-27-09: **Spot spawn** near Basket Bay; Tenakee Inlet quiet.

4-28-09: **Spawn** in Little Basket Bay, spot spawns near Basket Bay. Small schools in western pounding area. Some fish caught to introduce into pounds.

4-29-09: **1 nmi spawn** west Kadashan; **0.25 nmi of spawn** Little Basket Bay. Spawn on Kelp permit holders fishing.

4-30-09: **2.5 nmi spawn** west Kadashan; Chatham shoreline quiet. Spawn on Kelp permit holders fishing.

5-1-09: **0.25 nmi spawn** west Kadashan; 0.25 nm spawn east Kadashan. Spawn on Kelp permit holders fishing.

5-2-09: Relatively quiet. One **spot spawn** observed east of Trap Bay but no other herring or spawn observed in the area. Spawn on Kelp permit holders begin harvesting product.

5-3-09: No herring activity. Spawn on Kelp harvesting continues.

5-4-09: No herring activity. Spawn on Kelp harvesting continues.

5-5-09: No herring activity. Spawn on Kelp harvesting complete.

5-6-09: Spot spawn in Finn Cove otherwise quiet.

5-7-09 and 5-8-09:

No herring activity; very quiet.

Appendix C13.–Aerial and skiff herring spawn surveys by date, in Lynn Canal (Juneau Management Area), in Southeast Alaska, 2009.

4-21-09: No herring activity seen. Predators were few and scattered.

4-26-09: No herring activity. Small groups of sea lions observed near Mabb Is, Pt Bridget, Cascade Point, and Pt. St Mary.

4-29-09: Herring schools observed in Lena Cove, Sunshine Cove, Bridgett Cove and Echo Cove. 3 whales at Sunshine Cove and sea lions scattered. No herring spawn observed. No eulachon.

4-30-09: **4 nmi active spawn** between Adlersheim Lodge and Point Bridgett. Herring schools in Lena Cove.

5-1-09: Only a few **spot spawns** remain near Adlersheim and Sunshine Cove. Numerous scattered herring schools from Tee Harbor to Sunshine Cove and along the east shoreline of Berners Bay.

5-2-09: No herring spawn. One herring school in Tee harbor and several schools at Point Bridgett.

5-3-09: **0.25 nmi of active spawn** at Point Bridgett. No other herring or herring spawn observed.

5-4-09: **0.5 nmi active** herring spawn at Point Bridgett extending east. Another 0.5 nm active spawn along east shoreline of Berners Bay north of Sawmill Creek. Herring schools in Tee Harbor.

5-5-09: **1.0 nmi of active spawn** wrapped around Point Bridgett. **1.0 nm of light dissipating spawn** north of Sawmill Creek. Herring schools in Tee Harbor and Sunshine Cove.

5-6-09: **0.25 nmi** spawn east side of Point Bridgett. Herring schools in Tee Harbor.

5-7-09 through 5-9-09:

No herring; no spawn. Very quiet.

5-26-09: Schools observed lining beach in Tee Harbor, locals report limited spawning.

Appendix C14.–Aerial and skiff herring spawn surveys by date, in Port Frederick, Oliver Inlet, and Taku Harbor (Juneau Management Area), in Southeast Alaska, 2009.

Port Frederick

4-20-09: Visibility good to fair, no predators, herring or spawn.

4-22-09: Visibility excellent, 4 whales, several small schools, no spawn.

4-23-09: Visibility excellent schools at cannery pt, and west of Bell Is. No predators or spawn.

4-25-09: Visibility good, schools in Eight Fathom Bight, no predators or spawn.

4-27-09: Visibility excellent, schools west of Narrows, no predators no spawn.

4-28-09: Several small schools, two **spot spawns** one N and S shore west of Narrows.

4-29-09: Visibility excellent no predators, herring schools near Burnt Pt., no spawn.

4-30-09: Visibility excellent no predators, herring schools near Burnt Pt. and head of inlet, no spawn.

5-1-09: Visibility excellent no predators, herring schools near Burnt Pt. and Narrows, no spawn.

5-2-09: Visibility excellent no predators, herring schools near Burnt Pt. and Narrows, no spawn.

5-3-09: Visibility good, small schools west of Narrows, no spawn.

Oliver Inlet

4-20-09: Visibility good no predators, no herring or spawn.

4-22-09: Visibility excellent, no predators, no herring or spawn.

4-24-09: Visibility fair, no predators, no herring or spawn.

4-26-09: Visibility excellent, no predators, no herring or spawn.

4-28-09: Visibility excellent, no predators, no herring or spawn.

4-30-09: Visibility excellent, no predators, no herring or spawn.

5-1-09: Visibility excellent, many small schools east of entrance, no predators, or spawn.

5-7-09: Visibility good: no herring, no spawn, no predators.

5-9-09: Visibility excellent: no herring, spawn or predators.

5-11-09: Visibility good to fair no herring, spawn or predators.

Taku Harbor

4-27-09: Visibility excellent no herring, spawn, or predators.

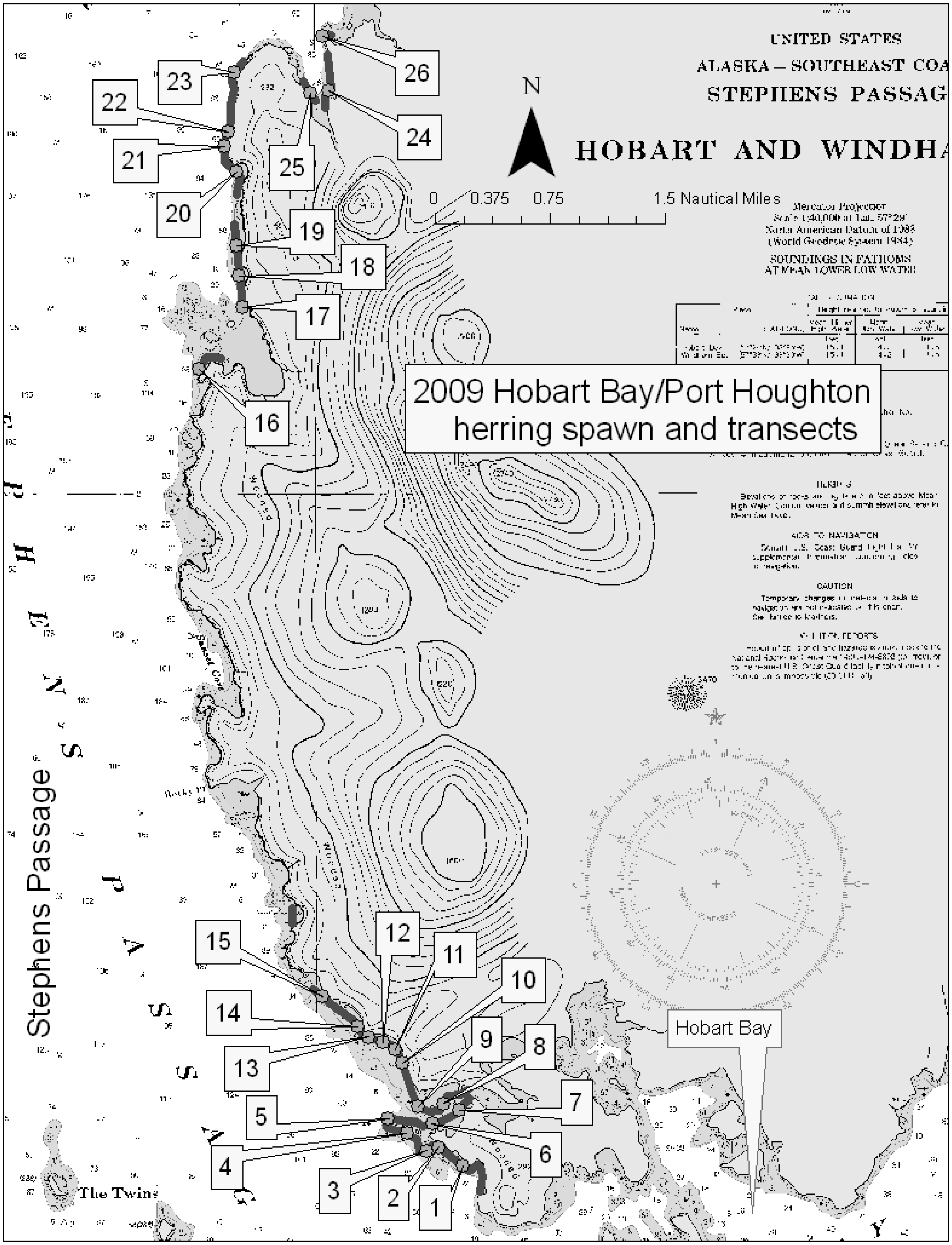
Appendix C15.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2009.

4-22-09:

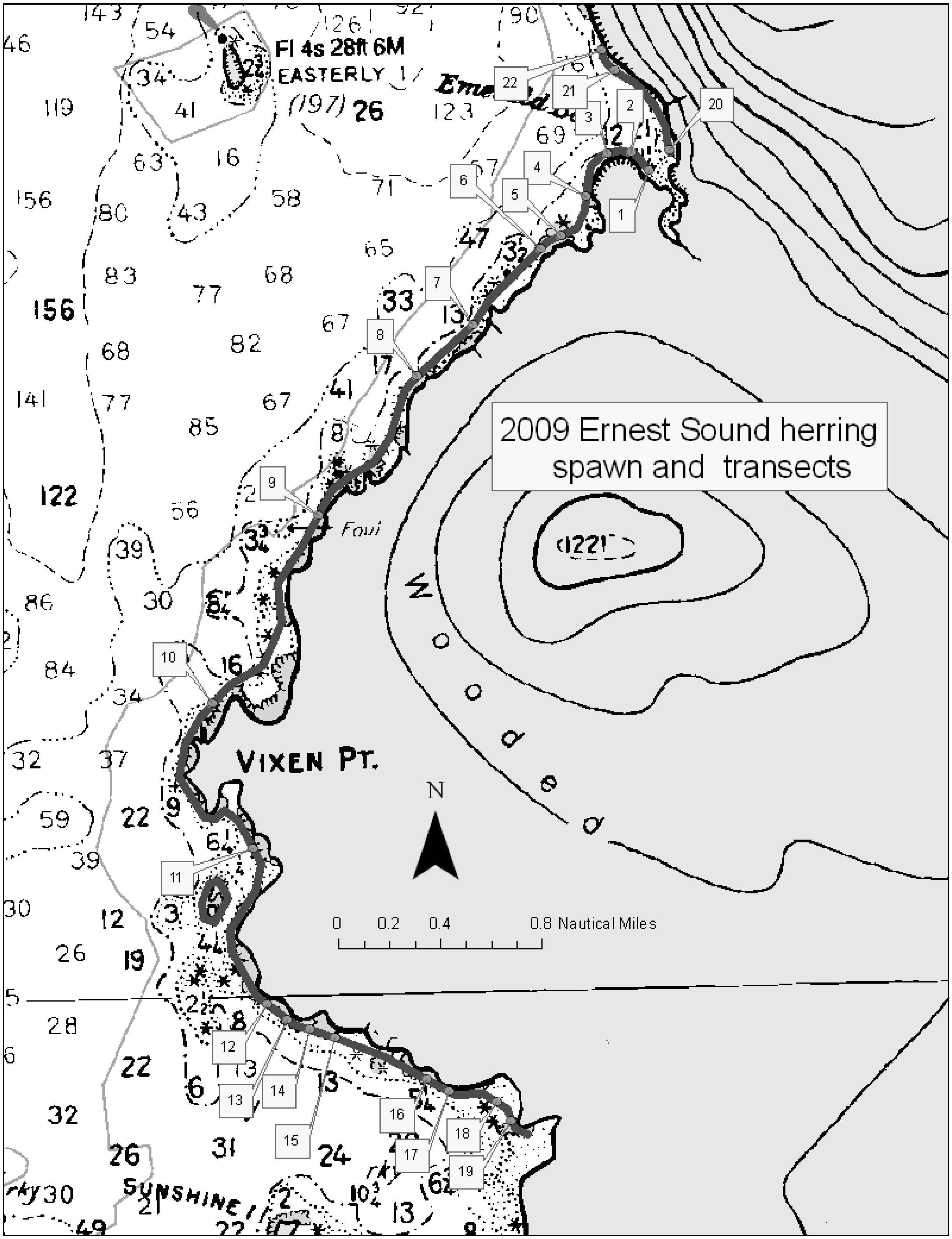
Several small active **spot spawns** along southeast bays of Khantaak Island and in Johnstone Passage; heavy **spawn (about 1.5 nmi)** along northern spit of Khantaak Island; several small herring balls around Northeast Point, Otmeloi Island, and Krutoi Island; several small herring balls in Eleanor Cove; very **light spawn (about 3.1 nmi)** along mainland coast to the northeast of Knight Island. Total spawn was about 4.6 nmi.

APPENDIX D: MAPS DISPLAYING HERRING SPAWN AND LOCATION OF TRANSECTS

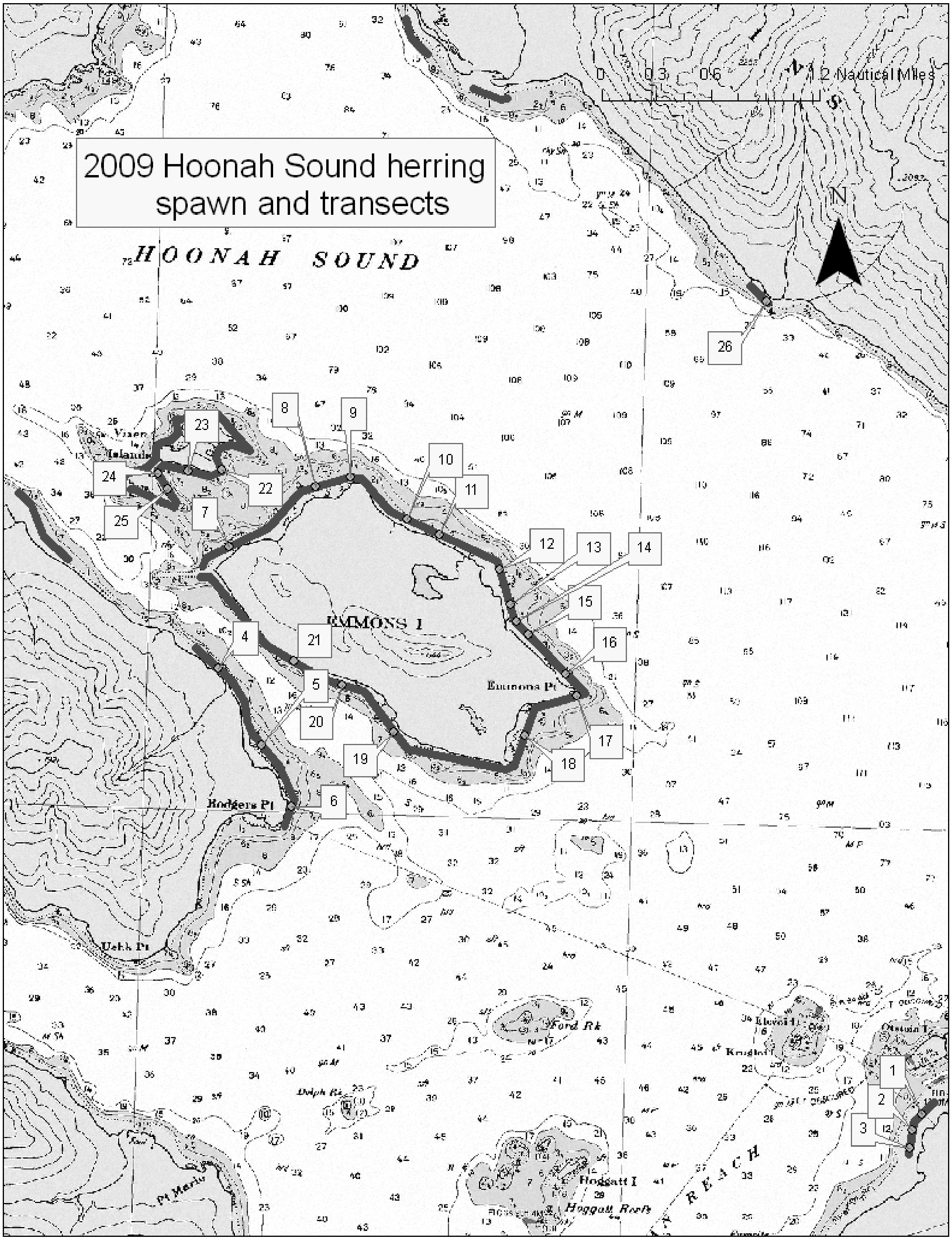
Appendix D1.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Craig herring stock in 2009.



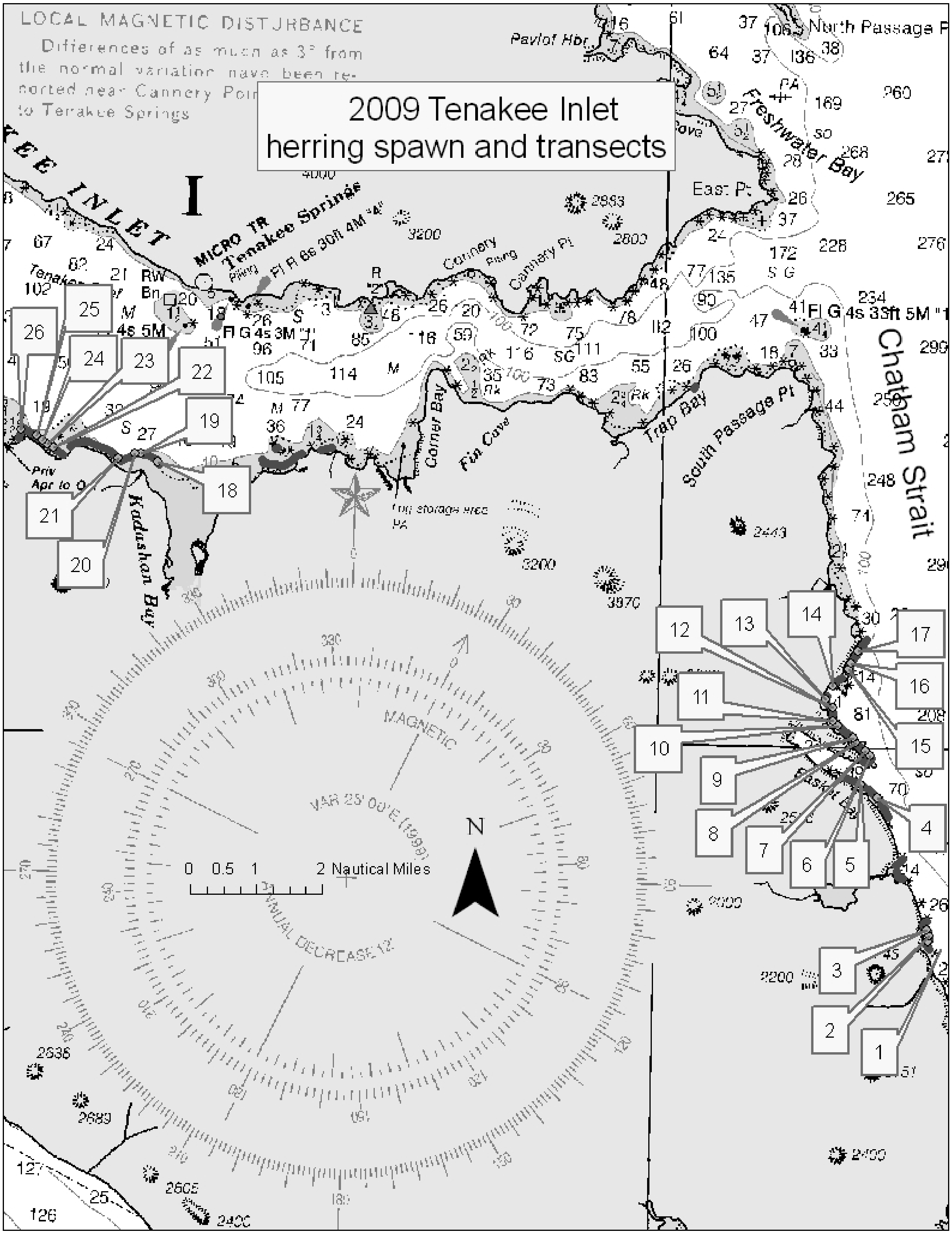
Appendix D2.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hobart Bay/Port Houghton herring stock in 2009.



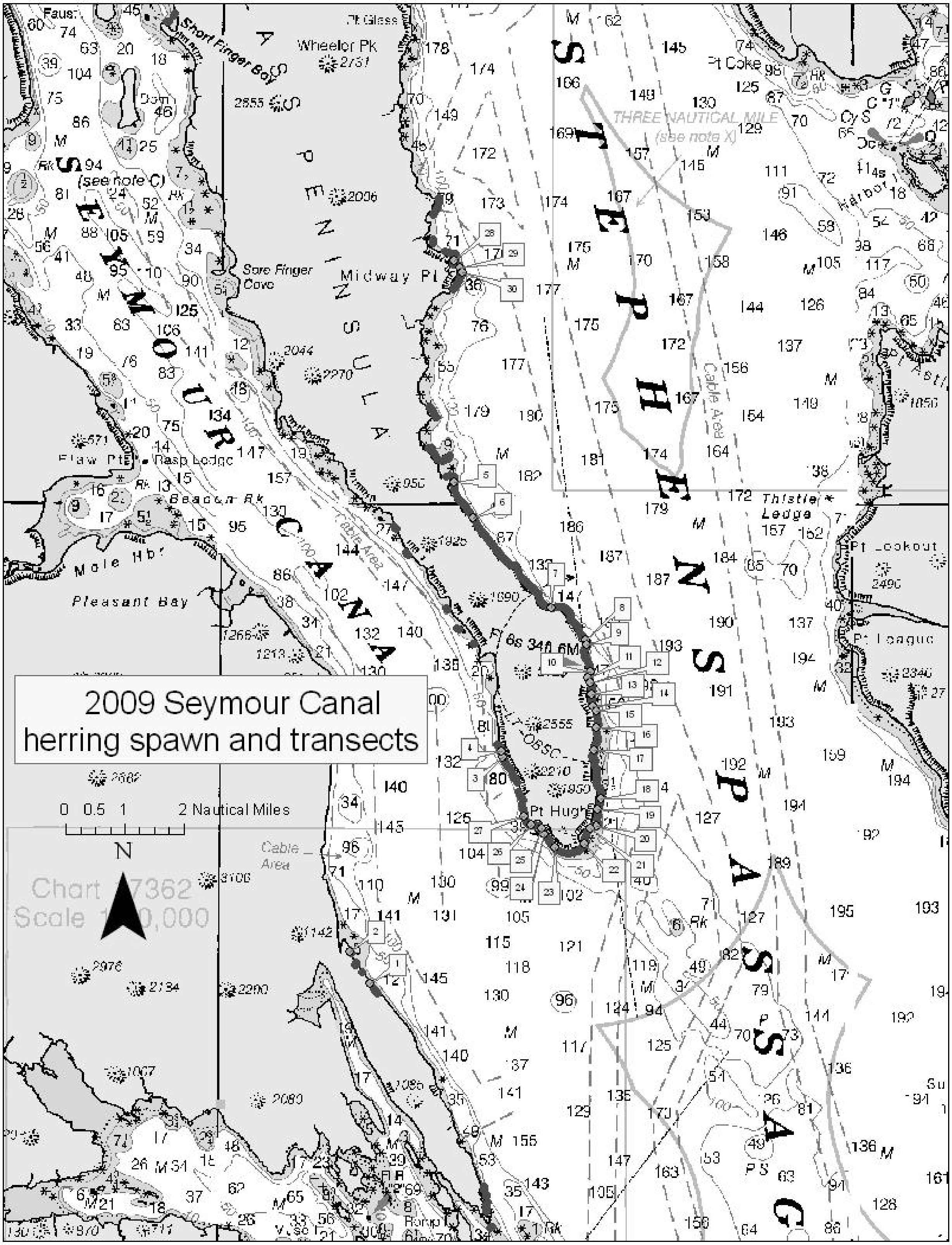
Appendix D3.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Ernest Sound herring stock in 2009.



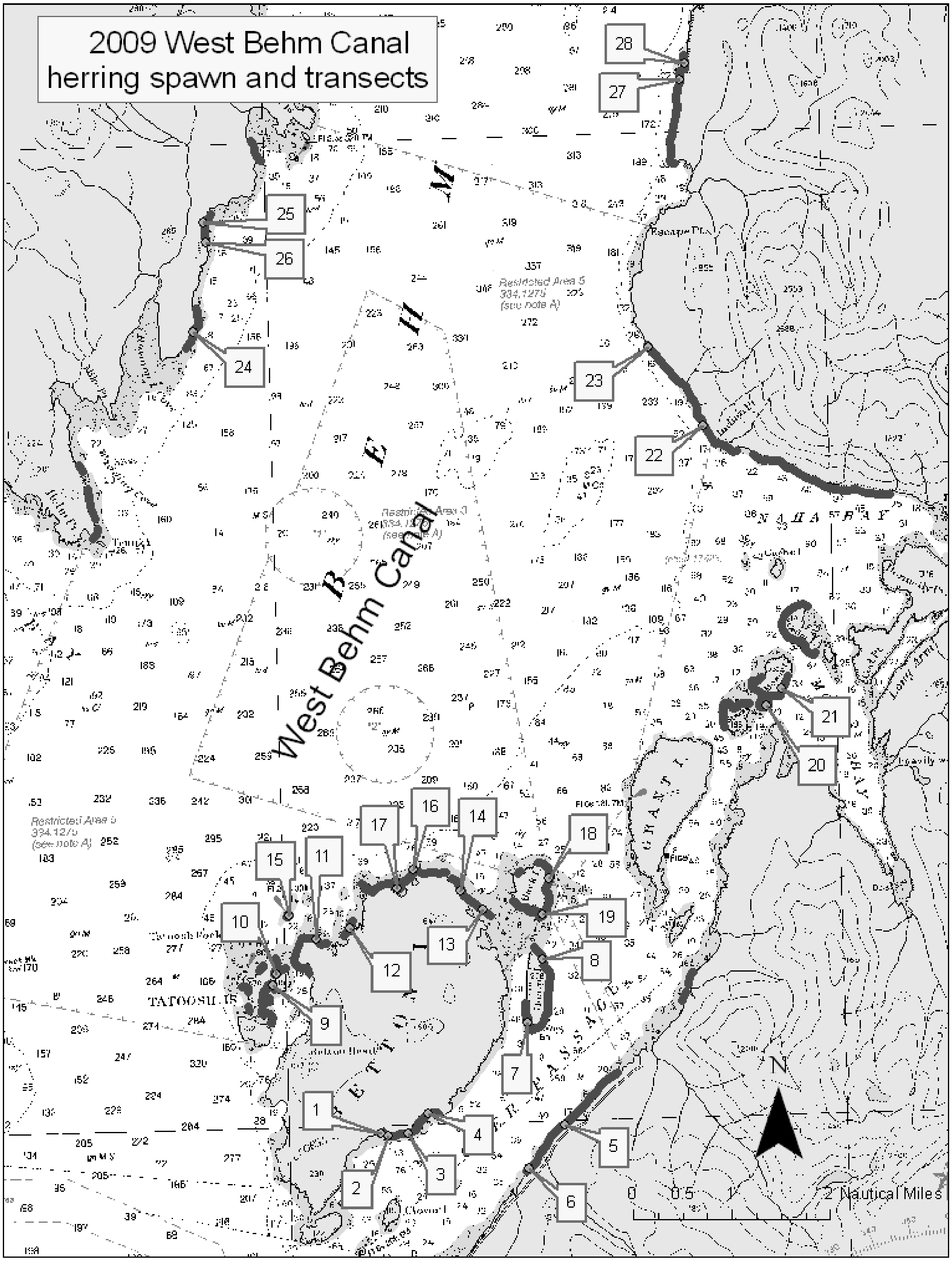
Appendix D4.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Hoonah Sound herring stock in 2009.



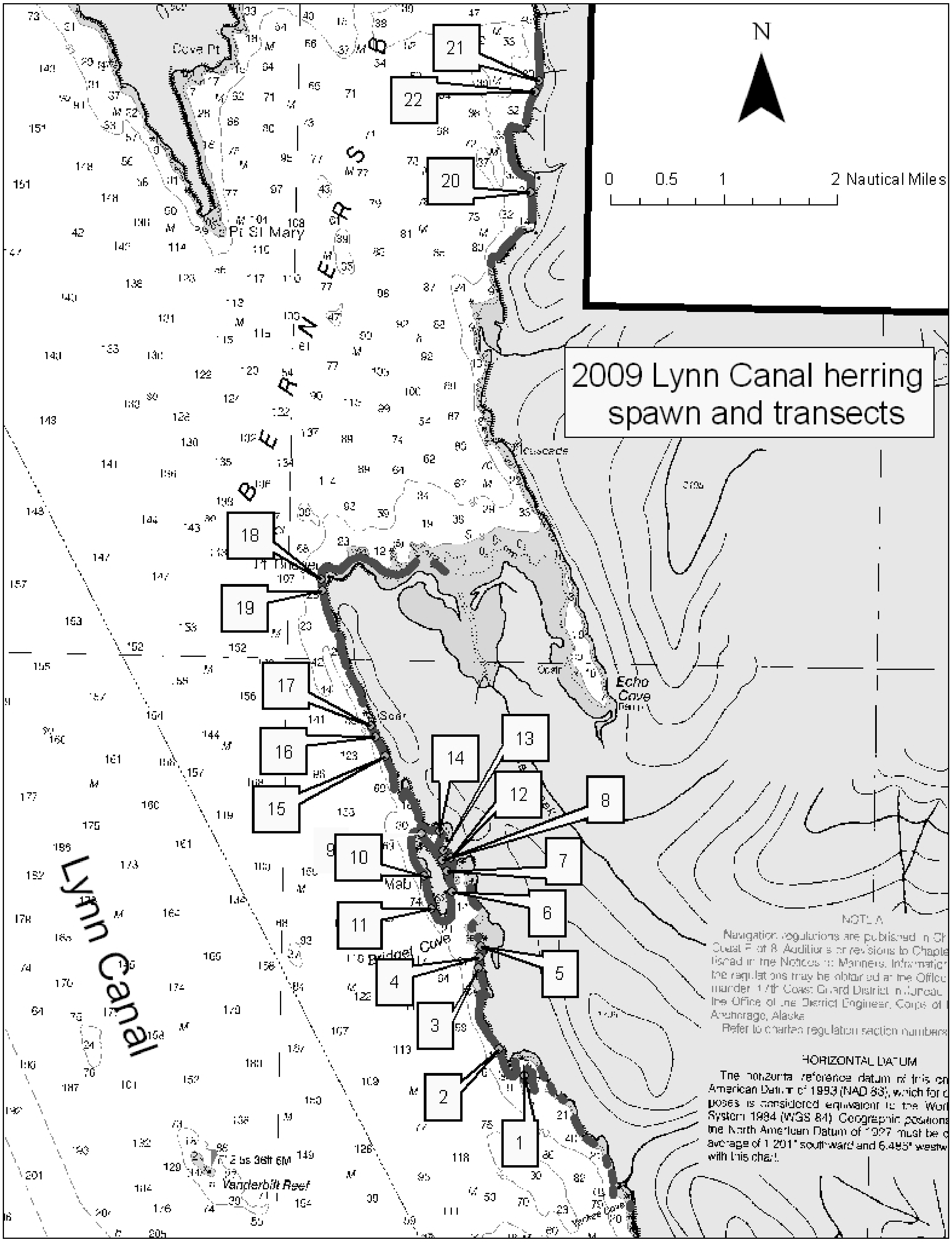
Appendix D5.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Tenakee Inlet herring stock in 2009.



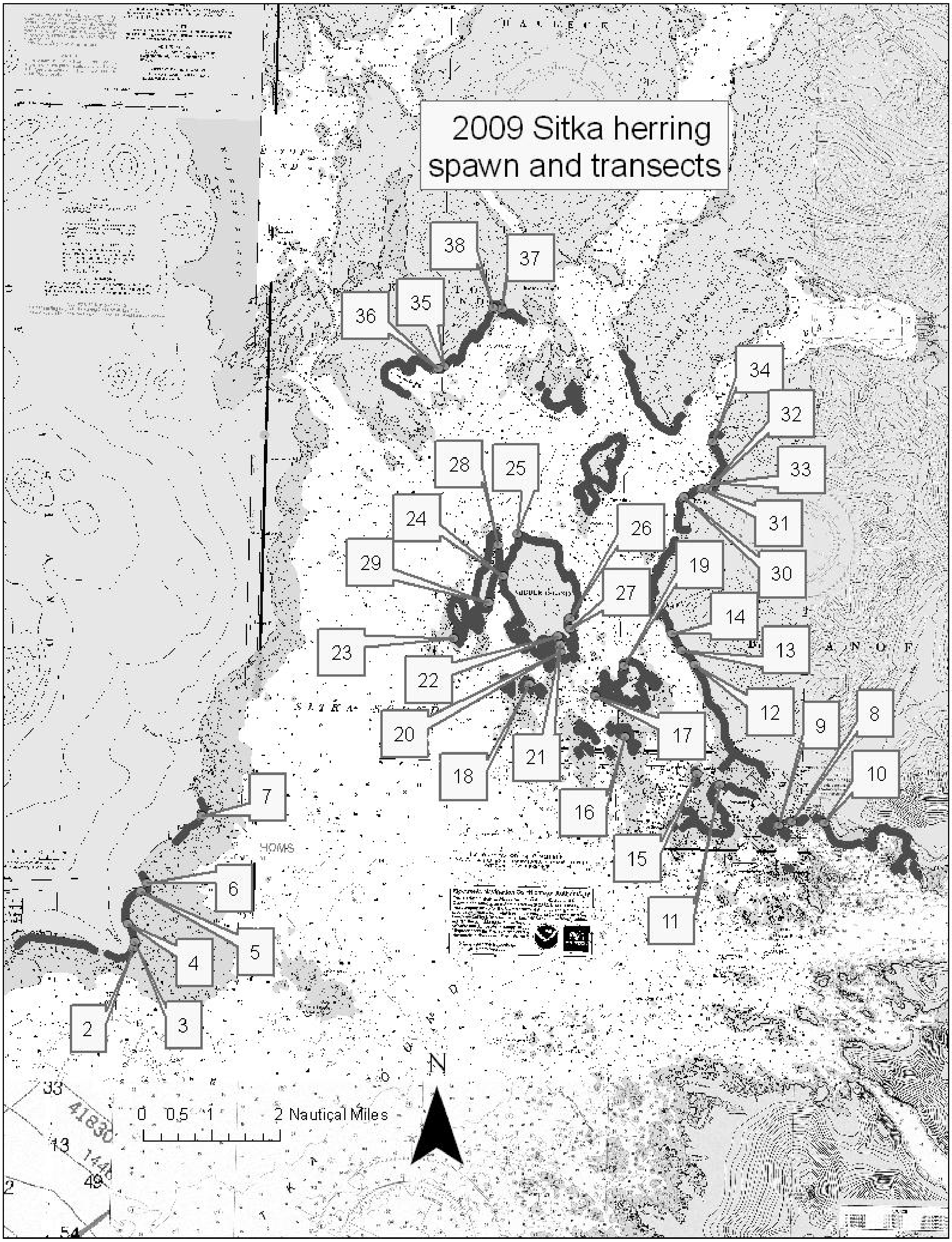
Appendix D6.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Seymour Canal herring stock in 2009.



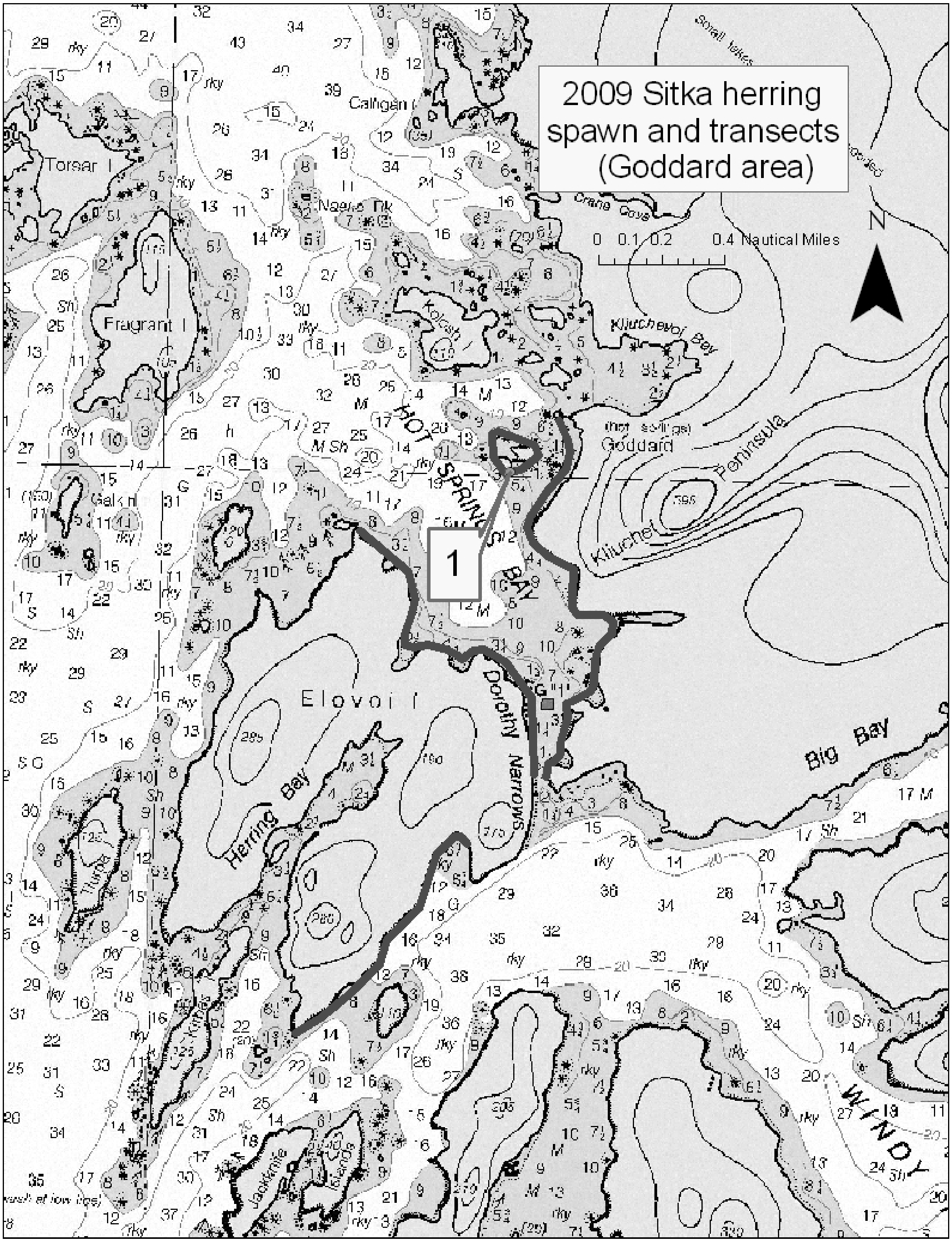
Appendix D7.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the West Behm Canal herring stock in 2009.



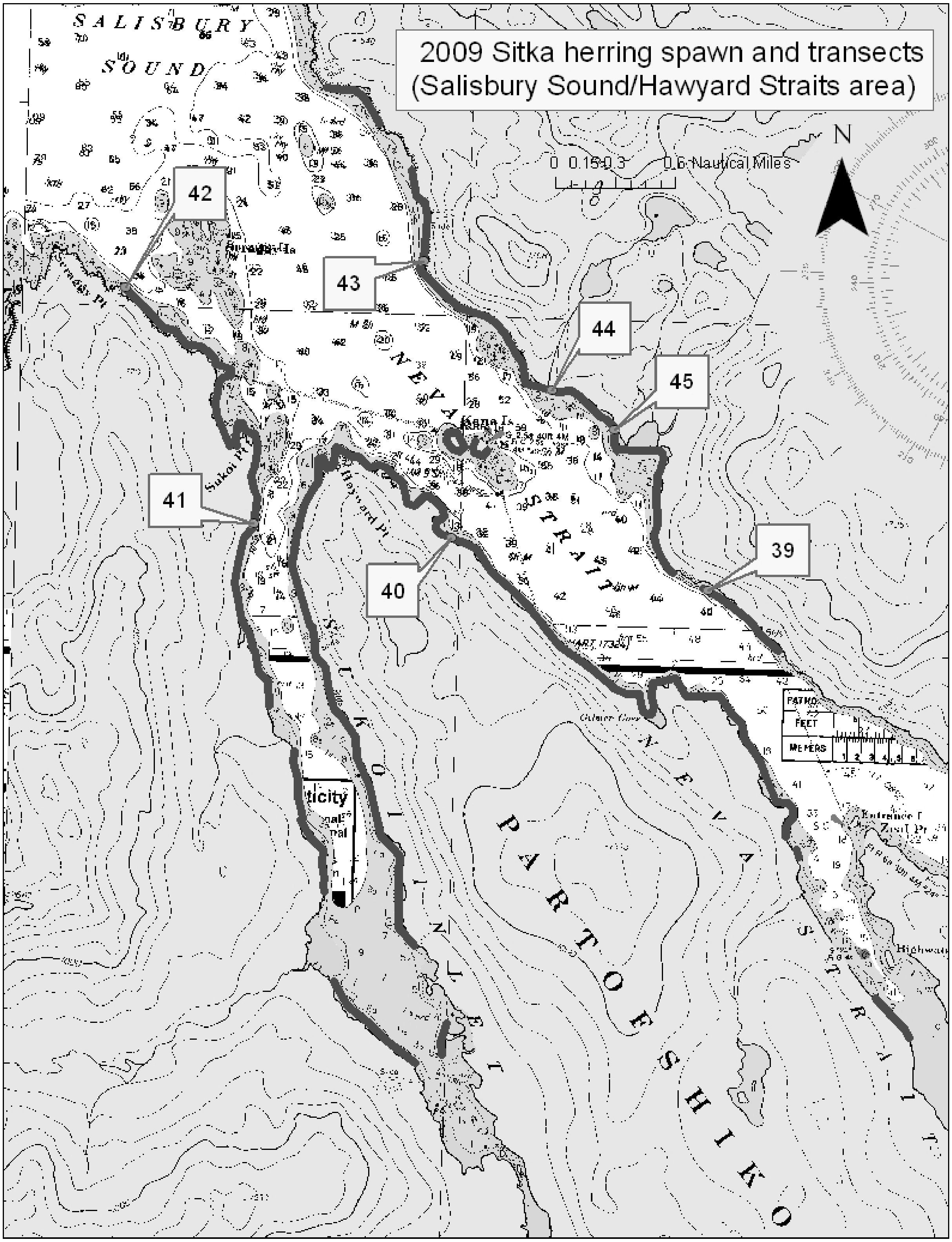
Appendix D8.–Spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Lynn Canal herring stock in 2009.



Appendix D. 9.–Partial (Sitka Sound only) spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2009.



Appendix D10.–Partial (Goddard area only) spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2009.



Appendix D11.–Partial (Salisbury and Hayward Strait area only) spawn (heavy gray line) and spawn deposition survey transect locations (numbered labels) for the Sitka Sound herring stock in 2009.