Fishery Data Series No. 25-34

2021 Southeast Alaska Herring Stock Assessment Survey

by

Kyle Hebert

August 2025

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figures or figure captions.

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	′
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	″
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 25-34

2021 SOUTHEAST ALASKA HERRING STOCK ASSESSMENT SURVEY

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

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

August 2025

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review.

Product names used in this publication are included for completeness and do not constitute product endorsement. The Alaska Department of Fish and Game does not endorse or recommend any specific company or their products.

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

This document should be cited as follows:
Hebert, K. 2025. 2021 Southeast Alaska herring stock assessment survey. Alaska Department of Fish and Game, Fishery Data Series No. 25-34, Anchorage.

The Alaska Department of Fish and Game (ADF&G) administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act (ADA) of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility please write:
ADF&G ADA Coordinator, P.O. Box 115526, Juneau, AK 99811-5526
U.S. Fish and Wildlife Service, 4401 N. Fairfax Drive, MS 2042, Arlington, VA 22203
Office of Equal Opportunity, U.S. Department of the Interior, 1849 C Street NW MS 5230, Washington DC 20240

The department's ADA Coordinator can be reached via phone at the following numbers:
(VOICE) 907-465-6077, (Statewide Telecommunication Device for the Deaf) 1-800-478-3648,
(Juneau TDD) 907-465-3646, or (FAX) 907-465-6078

For information on alternative formats and questions on this publication, please contact:
ADF&G, Division of Sport Fish, Research and Technical Services, 333 Raspberry Rd, Anchorage AK 99518 (907) 267-2517

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF APPENDICES

ABSTRACT

Pacific herring *Clupea pallasii* are important prey for many marine species found in Southeast Alaska and are harvested in fisheries for subsistence, personal use, commercial, and research purposes. The Southeast Alaska Herring Management plan (5 AAC 27.190(3)) requires the Alaska Department of Fish and Game to assess the abundance of mature herring for each stock before allowing commercial harvest. Included here are results of stock assessment surveys completed primarily during 2021, including summaries of herring spawn deposition surveys and age-weight-length sampling, which are the principal model inputs used to forecast herring abundance. In 2021, spawn deposition surveys were conducted only for Sitka Sound, Craig, and Revilla Channel area stocks. Spawn deposition surveys were not conducted in several other traditionally major spawning areas due to lack of funding or low levels of observed spawn, although aerial surveys of spawning were continued on a limited basis. The shoreline in state waters where spawn was documented in Southeast Alaska and Yakutat during aerial surveys for major spawn areas in 2021, combined for all areas, was 166.0 nautical miles. Post-fishery spawn deposition biomass estimates, combined for all surveyed stocks, totaled 451,071 tons. During the 2020–2021 season, a commercial winter bait fishery was opened in Craig with a guideline harvest level (GHL) of 11,674 tons. A commercial purse seine sac roe fishery was opened in Sitka Sound with a GHL of 33,304 tons. A commercial spawn-on-kelp fishery was open in Craig with an allocation of 18,916 tons of herring, allowing for the highest kelp allocation for pounds. There were no other herring commercial fisheries opened in 2021. Herring harvested commercially during the 2020–2021 season totaled 16,082 tons, not including herring impounded for spawn-on-kelp fisheries or spawn-on-kelp products.

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

PURPOSE

The primary intents of this report are to document data collected from fall 2020 through spring 2021 and to provide historical perspective by presenting general trends in Southeast Alaska herring populations.

The data presented in this report include the principal inputs for models that are used to forecast mature herring biomass and age compositions for the ensuing year. Per regulations, biomass forecasts are compared to stock-specific threshold biomass levels to determine whether a fishery will be allowed in a particular area. Biomass forecasts are coupled with appropriate exploitation rates (maximum of 20%) to determine the allowable harvest levels, and allocations for commercial quotas for each fishery are determined by the appropriate regulations and management plans.

INTRODUCTION

Pacific herring *Clupea pallasii* have been the target of commercial fisheries in Alaska since 1878, with harvests growing to multi-million pounds annually by 1882 (Cobb 1905). As fisheries developed, the desire for better knowledge and understanding of herring populations grew, leading to the initiation of research programs. Initially, studies were focused on observations made from trends in commercial catch, especially during the height of the large-scale reduction fishery that peaked in 1930. As questions arose about the cause of fluctuations in catch, the lack of herring availability, and the impact of commercial fishing on herring, and as fishery science theory developed worldwide, scientific techniques were applied to herring populations in Alaska. Quantitative, fishery-independent study of herring began in Alaska by the early 1930s, and research was carried out by the U.S. Department of Commerce, Bureau of Fisheries. Rounsefell and Dahlgren (1935) measured spawning levels by area and attempted to differentiate spawning populations in Southeast Alaska through analyzing vertebrae counts and growth rates and through tag–recapture studies. By the 1940s, the importance of age-class strength became recognized for monitoring and predicting herring abundance, and research was largely conducted by the U.S. Department of the Interior, Fish and Wildlife Service (USFWS). Estimates and forecasts of abundance and yield by age became mainstays of management during this time. By 1953, programs were in place for standardized, detailed collection of data from spawning grounds, including aerial surveys, measurements of spawn along shoreline, egg density, and egg mortality, which enabled estimation of spawning biomass (Grice and Wilimovsky 1957). The USFWS continued to lead herring research in Alaska after statehood in 1959, operating under a cooperative agreement with the State of Alaska during 1960 and 1961. However, in 1962 the cooperative agreement was discontinued, and herring spawn surveys conducted by USFWS were suspended. Starting in 1963 the Alaska Department of Fish and Game (ADF&G) began conducting aerial surveys in the Craig–Hydaburg and Sitka areas, which were later expanded to other important herring spawning areas.

The Alaska Department of Fish and Game (ADF&G) instituted a full 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 was to provide the biological data necessary for scientific-based fishery 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 using vessels, and spawn deposition surveys using scuba gear. 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 currently analyzed using 1 of 2 different stock assessment models used to estimate and to forecast mature herring abundance and biomass. These models include an age-structured analysis (ASA) model and a biomass accounting model.

Since 1971 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 time series of stock assessment data (i.e., generally a minimum of 10 years), and the biomass accounting model may be used for all other stocks where fisheries occur. These 2 models are not mutually exclusive of the spawn deposition method. Spawn deposition data (i.e., total egg deposition estimates) are an important element of ASA and biomass accounting models. A primary difference between the 2 approaches is the amount of data required to conduct the respective analyses. Biomass estimates derived from the spawn deposition method use only the most recent spawn deposition data, and do not factor in trends in age composition or weight-at-age. A conversion factor based on an estimate of the number of eggs per ton of herring is applied to the total egg estimate to compute spawning biomass. In contrast, the ASA model uses a time series of age compositions, weight-at-age, total egg deposition, and catch, along with fecundity relationships to estimate biomass. Biomass accounting, which does not require a data time series, is based on spawn deposition estimates adjusted for natural mortality, age-specific growth, and recruitment. A more detailed explanation of the ASA and biomass accounting models and how the objective estimates are used in these models are provided by Carlile et al. (1996).

Since 1993, when data have allowed, the ASA model has been used to estimate and forecast the abundance of herring for 4 major Southeast Alaska herring stocks: Sitka, Craig, Seymour Canal, and Revillagigedo Channel (also called *Revilla Channel*, which refers to the greater Kah Shakes–Cat Island and Annette Island spawning areas). The ASA model has been used for Tenakee Inlet since 2000. For these 5 potential commercial harvest areas or spawning populations, the time series of data has been or had been sufficient to permit the use of ASA for hindcasting historical biomass and forecasting future biomass. Other areas, which may support significant herring fisheries but lack data time series suitable for ASA, are candidates for biomass accounting. This simpler modeling approach began in 1996 and has been used to generate forecasts for West Behm Canal, Ernest Sound, Hobart Bay–Port Houghton, and Hoonah Sound. Age-structured analysis and biomass accounting models are mentioned here to provide historical perspective and because they are important elements of the overall stock assessment of herring in Southeast Alaska. Although results from these models are not discussed in this report, the key data inputs for these models are presented.

METHODS AND PROCEDURES

AERIAL AND SKIFF SURVEYS

A combination of aerial and skiff surveys was used to record spawning activities during the spring. These surveys were to document spawn timing and to estimate the distance of shoreline that received herring spawn for all major spawning areas (Figure 1) and several minor spawning areas in Southeast Alaska. Aerial surveys typically commenced prior to the historical first date of spawning for each stock. Historical spawning dates by stock are presented in Figures 2–11. In addition to documenting herring spawn and herring schools, estimates of numbers and locations of herring predators, such as birds, sea lions, and whales, were recorded. Once concentrations of predators were observed, aerial and skiff surveys were conducted more frequently (e.g., daily or multiple flights per day) to ensure accurate accounting of herring distribution and herring spawn. The shoreline where herring spawn (milt) was observed was documented on a paper chart or electronic handheld device during each survey and then later transferred to computer mapping software to measure shoreline receiving spawn. A chart depicting the cumulative shoreline that received spawn during the duration of the spawning event was used as the basis for targeting and designing the spawn deposition dive surveys.

SPAWN DEPOSITION SURVEYS

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

10-day period may tend to result in underestimates of egg deposition and mature biomass. Historical dates of spawn deposition surveys are presented in Table 1.

Shoreline Measurement and Transect Orientation

Spawn documented during aerial surveys was transcribed in ArcMap (version 10.3) over raster images of nautical charts published by the National Oceanic and Atmospheric Administration, using the NAD 1983 datum and State Plane Alaska FIPS 5001 (ft) Projected Coordinate System. 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 a tradeoff so that shoreline features could be smoothed without adhering too closely to the shore on a small scale, but also without drawing sweeping straight lines that did not adequately capture enough detail to design a meaningful survey.

Shoreline measurement, and consequently transect placement, can be subjective at times, depending 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 to sample across the spawn zone. 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 steeply sloped shoreline with a narrow band of spawn habitat (e.g., typical of Sitka Sound) requires much finer shoreline mapping as opposed to an area with a broad gentle slope (e.g., Craig) interspersed with rocks and reefs at some distance from shore.

Another consideration is that termination of transects while still in the egg zone may be necessary if spawn is present on the opposing shoreline. Transects are halted at the midpoint of opposing shoreline to prevent oversampling areas where a potential transect might have been placed. Similarly, transects that are surveyed within small coves are terminated at a central convergence point where potential transects would intersect. Transects are terminated for these 2 situations to minimize bias due to unequal sampling probability of the spawn zone, although it is unlikely that bias would be eliminated without further corrections (Li et al. 2011). A theoretical example of a spawn line drawn along the shore, and how the layout of potential transects are considered for these instances, is presented in Figure 12.

The same procedure and patterns of drawing spawn were followed as in past years; however, the process requires that judgment be used based on experience and knowledge of the local spawning areas. The intent of drawing a smoothed spawn line is to produce a survey area that is oriented along the spawn and is such that transects laid perpendicularly to the spawn line will sample egg density throughout the entire width of the spawn, while minimizing bias to the estimated egg abundance. A second objective of measuring the spawn observed along shorelines is to obtain an estimate of spawn length, which factors into the estimate of overall spawn area, and is discussed more below. For the Sitka Sound and Craig areas, standardized baseline representations of herring spawn shoreline have been developed and were used for analyses presented here. These baseline maps provide a predetermined line for drawing spawn in the current year that is consistent with prior years. The baseline maps were developed using documented historical spawn and local knowledge of the area to produce what was deemed the most sensible representation of shoreline for repeated use in herring aerial surveys and spawn deposition surveys.

Once the spawn shoreline was established, a single linear measurement of the shoreline was made using XTools Pro, a measuring tool extension used within ArcMap. The shoreline was divided evenly into 0.10 nautical mile segments, which were then randomly selected for transect placement. Therefore, transects were placed no closer than 0.10 nmi to each other, which was done to prevent adjacent transects from unintentional crossing due to slight errors in compass bearing or while navigating underwater.

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 2. Sampling rates in Table 2 were estimated using data from previous surveys. The statistical objective of the spawn deposition sampling was to estimate herring egg densities (per quadrate) such that the lower bound of a 90% confidence interval was at least within 30% of the mean egg density estimate. This would also achieve the objective of estimating the total egg 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 actual transects selected for a survey are frequently increased beyond the minimum suggested rate to increase transect spatial distribution, potentially reduce variance, and make efficient use of scheduled vessel time.

The minimum target number of transects is estimated as follows:

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

where

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

Field Sampling

Transect direction was determined by comparing the physical features of the actual dive location to a chart depicting the spawn along the shoreline, and then 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 the depth in the subtidal zone where no further egg deposition was observed—typically above 21 m (70 ft) of depth. The section of each transect that was above the waterline was surveyed by walking until reaching a depth in the water that required diving (usually about 2 feet), at which point diving commenced. 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, although occasionally eggs will occur to or below 24 m (80 ft).

A 2-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 2-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. Eggs throughout the entire water column were included if they were within the dimensions of the frame. Situations where eggs were found on vertical canopy kelps such as *Macrocystis* required divers to swim up along the length of the kelp to estimate eggs while maintaining reference to the sampling frame. To help estimate the number of eggs, estimators used the standard 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. Additional data recorded included bottom substrate type, primary vegetation type upon which eggs were deposited (Appendices A and B, respectively), percent vegetation coverage within the sampling frame, and frame depth. Because sampling frames were spaced equidistant along transects, the record of the number of frames was also used to compute transect length.

VISUAL ESTIMATE CORRECTION

Because 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 applied to adjust egg estimates either up or down depending on an estimator's tendency to underestimate or overestimate. Correction coefficients were estimated by double sampling (Jessen 1978) frames independent of those estimates obtained along regular spawn deposition transects. Samples for correction coefficients were collected by visually estimating the number of eggs within a 0.1 m^2 sampling frame and then collecting all the eggs within the frame for later more precise estimation in a laboratory. First, eggs on a variety of vegetations (e.g. algae, kelp, sea grass) were collected underwater and then while onboard a vessel assembled into a variety of sample sizes among vegetation categories. Approximately 10 samples for each of 5 vegetation categories were created, and attempts were made to create samples of varying egg density and varying total egg abundance within each vegetation type. Vegetation categories included eelgrass (ELG), fir kelp (FIR), large–leafy brown kelp (LBK), rockweed (FUC), and hair kelp (HIR; see Appendix A1 for species included within each category). Next, divers placed individual samples within sampling frames that were longlined along a shallow depth contour of about 10 ft. Next, potential herring survey egg estimators (i.e., someone who may make herring egg estimates along transects if they are properly calibrated) dove along the longline, making estimates of each sample, recording estimates on sample labels, and placing them in a mesh bag attached to each sampling frame. To collect the samples after estimation, divers removed the vegetation (e.g., algae, kelp, sea grass) along with the eggs and preserved them in 100% salt brine solution in heavy-grade plastic zip-sealing bags. Samples were transported to the ADF&G Mark, Tag and Age Laboratory in Juneau, where analysis was conducted within the following few months. Lab estimates were made for each sample by stripping eggs from vegetation, counting the number of eggs within 2 or 3 subsamples (typically about 1,000 eggs each), and then measuring the volumes of subsamples and full samples to calculate total eggs by proportion.

Correction coefficients were calculated as the ratio of sums of all laboratory estimates to all visual estimates, within each kelp type, for each estimator. To reduce potential of highly variable correction coefficients, minimum sample size guidelines were used. Data from the last 3 years were pooled if there were at least a total of 6 samples for each estimator and kelp type, with at least 3 samples in at least 2 of the 3 years. If this was not satisfied, then samples from prior years were added until the minimum sampling guideline was met. The intent of these sampling guidelines was to achieve a reasonably adequate sample size to minimize variation, but also to develop correction coefficients that reflected an estimator's tendency to estimate high or low in the most recent years.

Estimator/vegetation-specific correction coefficients were applied to egg estimates when the appropriate vegetation type matched. For example, the *large leafy brown kelp* correction coefficient was applied when kelp types that fit that description were encountered, and the *eelgrass* correction coefficient was applied when eelgrass was encountered. When eggs were encountered that were loose in the water column, were adhering to bare rock, or were on vegetation types that were not like the categories sampled for calibration of egg estimates, an estimator-specific correction coefficient based on the average of all estimator/vegetation-specific correction coefficients was applied.

ESTIMATES OF TOTAL EGG DEPOSITION

Total egg deposition for each 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

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

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

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

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

where v_{hij} is the visual estimate of egg numbers by estimator *h*, at area *i*, quadrate *j*, on vegetation type *k*. The c_{hk} term refers to a diver-specific, vegetation-specific correction coefficient to adjust visual estimates made by estimator h on vegetation type k; m_{hi} is the number of quadrates visually estimated by estimator h at area i. Because egg estimates are made within 0.1 m quadrates, multiplying by 10 expresses the mean density in per 1.0 m^2. Estimator/vegetation-specific correction coefficients (c_{hk}) are calculated as follows:

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

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

SPAWNING BIOMASS ESTIMATION

The total number of eggs per spawning area is a key element in assessing and forecasting herring spawning biomass. Although spawning biomass calculated directly from egg deposition is not an input for the SCAA or biomass accounting models, like total egg deposition estimates, it does provide a useful rough estimate of biomass each year. These values can be useful for comparison among years to track general trends in abundance. In addition, they are intuitive because the estimates do not change with subsequent years of data. Conversely, SCAA-derived hindcasted estimates change with each model run as new data is added.

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 3). The estimate for each area is calculated as follows:

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

where

b = estimated total spawning biomass;

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

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

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

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

where

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

$f_{\bar{g}}$ = estimated fecundity of fish of mean weight, using equations listed in Table 3.

AGE AND SIZE

Herring samples were collected from a combination of skiff spawn surveys, aerial spawn surveys, commercial fisheries, and test fisheries (when prosecuted) from major stocks located throughout

Southeast Alaska. Sample collection gear varied with location and historically may have included purse seines, gillnets, cast nets, or trawls. Cast nets were used when fish were in shallow water during active spawning. Herring sampled from commercial fisheries were collected from individual harvesters or tenders while on the fishing grounds. Dates, gear used, and geographic locations of all samples were recorded.

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

All samples were packaged and labeled in 5-gallon buckets and frozen for later processing at the ADF&G Mark, Tag and Aging Laboratory in Juneau, Alaska. 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 10th of a gram.

A scale was removed from each fish for age determination. The preferred location is on the left side anterior to the dorsal fin or beneath the left pectoral fin. Scales were cleaned and dipped in a solution of 10% mucilage and placed unsculptured side down on glass slides. Aging was conducted by viewing scale images on a microfiche projector to count annuli. Age data for early years (1980–1998) were obtained by viewing scales through a dissecting microscope, varying the light source for optimum image of the annuli. Ages from 1999 to present were determined by mounting scales on a microfiche reader to project a larger scale image to see annuli more easily. Each fish was assigned an anniversary date for each completed growing season. All samples were collected before growth resumed in the spring, and scales were aged based on the number of summer growth periods observed. For example, if a herring hatched in the spring of 2011 was collected in the fall of 2012, then 2 growing seasons had occurred (age-2). If the herring had been collected in the spring of 2013 before growth had resumed, it was also recorded as age-2. Scales were spot-checked by a second reader for age verification, and if agreement between readers was less than 80%, the entire sample was re-aged.

Condition Factor

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

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

where

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

Sea Temperature

Daily sea surface temperature was recorded in spawning areas for most stocks using Onset HOBO StowAway TidbiT temperature loggers that were submerged to depths ranging from about 10 ft mean lower low water (MLLW) to 20 ft MLLW. Temperature has been recorded daily at 6-hour intervals for up to 20 years in some spawning areas. Daily mean, minimum, and maximum sea temperature was calculated for each spawning area. Overall annual mean temperature was calculated as the mean of all daily values. Mean annual minimum temperatures and mean annual maximum temperatures were calculated as the mean of the minimum or maximum values that occurred during each annual cycle.

HARVEST STRATEGY

Allowable harvest levels for commercial herring fisheries in Southeast Alaska are set based on a harvest strategy that involves a graduated harvest rate paired with a minimum threshold of mature herring. When herring biomass is forecast to be at or above threshold, a harvest rate of 10–20% is applied to the biomass forecast. For most herring stocks, the harvest rate may be set at 10% when the biomass forecast is at threshold up to a maximum of 20% when the forecast is 6 times the threshold or greater. In the Sitka Sound area, the harvest rate is set at 12% when the forecast is at threshold, and at a maximum of 20% when the forecast is twice the threshold or greater. Maximum harvest rates used for herring in Southeast Alaska are based on studies in Alaska and elsewhere that concluded a maximum 20% harvest rate is sufficiently conservative to maintain healthy stocks of herring when paired with appropriate thresholds (Zheng et al. 1993; Doubleday 1985). The sliding scale element of the harvest rate calculation used for Southeast Alaska herring was included as an additional precautionary measure to reduce the harvest rate as stock biomass declines toward the threshold.

Threshold biomass levels have been established for each commercially exploited stock in Southeast Alaska and are intended to reduce the risk of sharp declines in abundance due to recruitment failure, and to maintain adequate herring abundance for predators. Commercial harvest of herring is not permitted unless the forecast of mature herring meets or exceeds the threshold. For Sitka Sound and West Behm Canal, threshold levels were based on analyses using simulation models to estimate 25% of the average unfished biomass (Carlile 1998a, 2003). In the case of Sitka Sound, the threshold was subsequently increased by the Board of Fisheries on 2 occasions (1997 and 2009) to provide additional protection to the stock and to help alleviate concerns over adequate subsistence opportunities to harvest the resource. For the Tenakee Inlet stock, 25% of the average unfished biomass was estimated using the same methods; however, because the resulting value was lower than the 3,000-ton threshold that existed at that time, the existing threshold was retained as a precaution (Carlile 1998b). For all other stocks in Southeast Alaska, thresholds were established using a less quantitative approach, which entailed reviewing historical estimates of abundance, historical knowledge of stock size fluctuation and distribution, and manageability of minimum quotas. Threshold levels during the 2020–2021 season ranged from 2,000 tons (Hoonah Sound and Hobart Bay) to 25,000 tons (Sitka Sound).

Management Plan

The following management plan was in place for the 2020–2021 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 Southeastern Alaska Area**. For the management of herring fisheries in the Southeastern Alaska Area, 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.

Additionally, the following regulation was in effect to set harvest levels in Sitka Sound:

5 AAC 27.160 Quotas and guideline harvest levels for Southeastern Alaska Area.

(g) The guideline harvest level for the herring sac roe fishery in Sections 13-A and 13-B shall be established by the department and will be a harvest rate percentage that is not less than 12 percent, not more than 20 percent, and within that range shall be determined by the following formula:

$$\text{Harvest Rate Percentage} = 2 + 8 \left[\frac{\text{Spawning Biomass (in tons)}}{20{,}000} \right]$$

The fishery will not be conducted if the spawning biomass is less than 25,000 tons.

Although there are several other regulations within the Alaska Administrative Code that pertain to specific herring fisheries in Southeast Alaska, the above general management plan represents the overarching requirements for setting harvest levels for herring fisheries in the region.

RESULTS

AERIAL AND SKIFF SURVEYS

Aerial and skiff surveys of herring activity, herring spawn, and marine mammal or bird activity were conducted at major stock locations beginning on March 9, 2021, in Sitka Sound and ending on May 25, 2021, in Seymour Canal. Notes of activity related to herring or herring spawning were recorded in aerial survey logs (see Appendix C). Surveys or observations were conducted by staff from each area office (Ketchikan, Petersburg, Sitka, Juneau, Haines, and Yakutat) and covered major or traditional herring spawning locations within each management area. Occasionally, private pilots or local residents may report observations of active spawning. Spawning timing for each major spawning area, including dates of first, last, and major spawning events, is summarized in Figure 13. ADF&G also completed aerial surveys of Annette Island Reserve while en route to other spawning areas located in state waters.

The total documented spawn for major spawning areas in state waters where aerial surveys were conducted in Southeast Alaska and Yakutat in 2021 was 166.0 nmi. This did not include spawning around Annette Island Reserve, or numerous minor spawning areas in Southeast Alaska or Yakutat (see Appendix C for a detailed accounting of other minor spawn areas throughout Southeast Alaska). The highest levels of spawn were observed in the Sitka Sound area (102.3 nmi) and in the Craig area (34.2 nmi). Spawning observed in other survey areas ranged from 0 nmi in Hoonah Sound to 8.5 nmi in West Behm Canal.

SPAWN DEPOSITION SURVEYS

During spring 2021, spawn deposition dive surveys were conducted only in Sitka Sound, Craig, and Revilla Channel (Kah Shakes–Cat Island). The first surveys were conducted during April 11-12 in the Revilla Channel area, followed by the Craig area during April 15–16, and finishing in Sitka Sound during April 17–21 (Table 1). Egg estimates by transect for each spawning area are presented in Table 4.

Due to low levels of observed spawning and budget constraints, spawn deposition surveys were not conducted in 2021 in Seymour Canal, Tenakee Inlet, Lynn Canal, Hoonah Sound, West Behm Canal, Ernest Sound, or Hobart Bay–Port Houghton. These areas are considered *inside* stocks (i.e., less exposed to open ocean as Sitka and Craig, which are considered *outside stocks*), and for several years have persisted at low levels based on observed spawn mileage levels. Although aerial surveys were conducted in several other minor spawning areas, no spawn deposition dive surveys were completed in these areas due to the low level of spawning, or in the case of some areas, because surveys conducted in previous years (e.g., Bradfield Canal) revealed that only a narrow band of spawning habitat exists resulting in relatively low egg deposition (see Appendix C).

In the Sitka Sound and Craig areas, egg deposition estimates in 2021 were relatively similar to those from 2020, although notable differences were evident. In Sitka Sound an increase from 23.1 trillion eggs to 27.3 trillion eggs was due to a substantial increase in spawn zone area. This was driven by a near-record spawn mileage of 102.3 nmi. In Craig, although egg deposition declined from 9.3 trillion to 8.4 trillion eggs, the estimate was still the second highest on record since surveys began in 1988. The decrease was attributable to a large drop in spawn mileage and subsequently spawning area; however, both metrics remained the second highest on record. The egg density estimate for Craig in 2021 was the highest on record and 34% higher than the second highest on record. For Sitka and Craig, the estimated spawning biomass in 2021 differed from 2020 in similar proportion to egg estimates. A summary of the 2021 survey results, including spawn mileage, average transect length, area of egg deposition, egg density, estimated egg deposition, and estimated spawning biomass is presented in Table 5. For comparison of 2021 spawning stock abundance to prior years, estimates of historical spawning biomass for each stock, including inside and outside stocks, are presented in Figures 14–19.

Visual Estimate Correction

Minimum sample size guidelines (at least 3 samples per vegetation type for 3 years) were met using data from 2019 through 2021 for all estimators. Correction coefficients applied to 2021 spawn deposition visual estimates ranged from 0.52 to 1.40 and are presented in Table 6.

Visual review of plots depicting observed versus laboratory estimates of eggs suggest the presence of linear relationships for some estimators, but nonlinear relationships for others caused by a tendency to underestimate when egg numbers in sample frames are high. A similar nonlinear pattern has been observed for aerial estimates of salmon in streams (see Jones et al. 1998); however, correction coefficients in that study were also calculated as straight ratios of known to estimated values. For herring egg correction coefficients presented here, values were calculated as an overall ratio of values summed across the entire range of lab-estimated and visually estimated values, which was considered to adequately correct visual estimates. However, because nonlinear relationships probably exist that bias correction coefficients low, the result is that estimates of egg abundance are also probably biased low.

AGE AND SIZE

A combined total of 4,290 herring were sampled from all stocks and gear types (cast net, purse seine, and pound) during the 2020–2021 season. Of those, 4,264 herring were processed to determine age, weight, length, and sex. The reduction of sample size was due to fish that could not be aged due to regenerated scales, or due to data that were otherwise unusable.

Samples of the spawning populations in Craig, Sitka Sound, Revilla Channel, and Seymour Canal were taken using cast nets. Samples from Craig and Sitka Sound were collected throughout the geographic extent of the active spawn (Figures 20–21), and throughout the duration of spawning (Figure 13), focusing on the most intense spawning events when feasible. Revilla Channel and Seymour Canal were sampled more sporadically, as weather permitted, but also focused on the intense spawning events that were observed (Figures 22-23).

Samples were also obtained from all commercial fisheries that were conducted in 2020–2021. Fisheries sampled included Sitka Sound sac roe, Craig winter bait, and Craig spawn on kelp. Samples were obtained opportunistically from vessels or tenders during, or shortly after, the fishery openings. Sample locations during fisheries are shown in Figures 20-21.

The minimum sample goal of 500 aged fish per sampling event (gear-fishery combination) was exceeded for every area/fishery where samples were obtained (Table 7). Although age and size samples were not obtained for several other traditionally sampled stocks, aerial surveys were completed and observed spawn locations are presented for those stocks in Figures 24-29.

Age Composition

Age composition data from spawning populations were obtained for only 4 stocks in the region in 2021: Sitka Sound, Craig, Seymour Canal, and Revilla Channel. Samples were not obtained from Ernest Sound, Tenakee Inlet, Lynn Canal, Hoonah Sound, Hobart Bay–Port Houghton, or West Behm Canal due to reduced budgets, low levels of observed spawn, or inability to sample due to weather or other circumstances. Frequency distributions of herring ages from sampled spawning areas are presented in Tables 8–11 and Figures 30–33.

Observed age distributions for most sampled areas were similar in that age-5 herring dominated the spawning populations. The one exception was at Revilla Channel, where the highest observed proportion were age-3 herring. Proportions of age-5 herring ranged from 36% in Revilla Channel to 82% in Craig. For all areas sampled, the proportion of age-5 herring in 2021 was the highest or second highest observed over the last 3 decades. The similar age compositions of spawning stocks in Southeast Alaska, and the dominant age-5 class, are a result of the extremely strong 2016 cohort, which was first observed in 2019 as a very high proportion of age-3 recruitment. For perspective, historical age compositions of spawning populations are presented in Figures 34–43.

Based on observed proportions of age-3 herring, recruitment in 2021 appears to have been low to moderate, following very weak recruitment in 2020. In 2021, age-3 proportions observed in sampled spawning populations ranged 7–55%, compared to 1% or less observed in 2020.

The proportions of age-3 herring entering the mature population each year seem to fluctuate in a similar, cyclical pattern among stocks in the region, with high and low years synchronized in many instances in magnitude, trajectory, or both (Figure 44). When northern and southern stocks are considered separately, the synchronized pattern is even more apparent within each group. For example, in 2015 a very high proportion of age-3 herring was observed for all stocks; however, in

2016 a relatively low to moderate proportion of mature age-3 herring were observed in most spawning areas. It appears that age-3 proportions for all sampled stocks in 2021 were notably higher than in 2020, yet relatively low compared to the last several decades—with the exception of Revilla Channel.

Size at Age

Based on cast net samples in 2021, there remains a clear distinction between mean weight-at-age for Sitka Sound and other spawning stocks of herring in Southeast Alaska (Figure 45). Sitka Sound herring attained a higher average weight than other stocks by age 4, and the divergence increased with each age group.

Mean length-at-age among spawning areas has a pattern similar to weight-at-age. Although the distinction between Sitka Sound herring mean length-at-age and other Southeast Alaska stocks is visually apparent, it is not as great as observed for mean weight-at-age (Figure 46).

Trends in weight-at-age over time are variable among stocks (Figures 47–56). For most stocks, a common pattern is evident: weights of age-3 herring have been relatively stable over the past few decades, whereas those of older ages appear to have gradually declined. The decline appears to be more pronounced for the oldest age classes. The current range of mean weight among age classes appears narrower than it was 3 decades ago. Although the mean weight-at-age of herring is less now than it was 30 years ago, weight generally declined during the late 1980s to the early to mid-2000s but then appears to have stabilized over the past 15 years for most stocks. The exception is Sitka Sound, where weight-at-age appears to have remained relatively stable over the past 20 years; however, this followed a period of low weight-at-age in the early 1990s, a time when anecdotally herring had been described as *pencil herring*. Data presented here only date back to the late 1980s, which coincided with the period of low weight and low condition factor of Sitka area herring.

To understand whether changes in weight-at-age are due solely to body mass or instead (or also) due to changes in length-at-age, it is helpful to calculate condition factors. Condition factors have been calculated to roughly gauge herring health using the physical dimensions of herring (i.e., weight-to-length ratio) over time (Figures 57–66). Data obtained from cast net samples during active spawn events were used to calculate condition factors, because a more complete and consistent data set exists for cast net samples than commercial samples, allowing easier comparison among stocks. Weight estimates derived from samples taking from actively spawning herring probably produce lower average values that contain more variability than would be expected from pre-spawning fish sampled during the commercial fishery; however, the overall trends in condition factor are expected to be the same. Another benefit of using data from cast net samples is that bias is expected to be lower than for fishery-dependent data that may be influenced by selection of larger fish.

Mean condition factors of herring from most stocks in Southeast Alaska follow the same general pattern over the last 2 decades: relatively low in the early 1990s, peaking in the early 2000s, followed by a decline until about 2007. Starting in 2008, condition factors for most stocks increased sharply, peaking in 2010, and then declined sharply to 2012. The condition factors calculated for 2021 for stocks where data were available are not notably different from those observed over the past 3 decades.

COMMERCIAL FISHERIES

Commercial harvest was permitted in an area only if the forecasted spawning biomass met or exceeded a minimum threshold (Table 12). If that threshold was met or exceeded, then a sliding-scale harvest rate of between 10 and 20 percent of the forecasted spawning biomass was calculated to determine the appropriate harvest level. For Sitka Sound, the allowable harvest rate ranges from 12 to 20 percent of the forecasted spawning biomass.

During the 2020–2021 fishing season, only 3 commercial herring fisheries were conducted in Southeast Alaska, from 2 spawning areas, Sitka Sound and Craig. Products resulting from these fisheries included sac roe, food and bait, and spawn on kelp. A summary of locations, harvest levels, and periods of harvest is presented in Table 13.

Sac Roe Fisheries

The only commercial sac roe fishery in 2021 was conducted in the Sitka Sound area. There were no sac roe fisheries announced for Seymour Canal, West Behm Canal, Hobart Bay–Port Houghton, or Kah Shakes–Cat Island areas, in most cases because estimates of spawning biomass and forecasts were not conducted, primarily due to budget cuts or low observed spawn. Lynn Canal was historically a sac roe fishery area; however, the Board of Fisheries rescinded regulations allowing a fishery in that area at its January 2018 meeting in Sitka.

Sitka Sound

In Sitka Sound the 2021 forecast was very high at 210,453 tons, and the guideline harvest level (GHL) was set at 33,304 tons. The GHL was calculated by reducing the maximum allowable 20% of the Age-Structured Analysis (ASA) forecasted biomass by 21%, which approximated the harvest level available if the number of age-5 fish was 75% of that projected. This approach was precautionary, taking into account the higher than usual uncertainty in the forecasted return of the unprecedented large age class of age-5 herring.

The fishery went on 2-hour notice on March 20, 2021, at 8:00 a.m. Beginning with the first fishery opening on March 27, 2021, the fishery was opened for 14 consecutive days, closing on April 9, 2021. The landed catch totaled 15,578 tons, with an average mature roe percentage of 11.5%. This harvest was the 4th largest in the fishery since 1970. Landings were made by 18 of the 47 active permit holders for the fishery.

Seymour Canal

There was no commercial fishery in the Seymour Canal area during the 2020–2021 season, because no stock assessment survey or forecast was conducted due to low levels of observed spawn and reduced funding.

West Behm Canal

There was no commercial fishery in the West Behm Canal area during the 2020–2021 season, because no stock assessment survey or forecast was conducted due to low levels of observed spawn and reduced funding.

Hobart Bay-Port Houghton

There was no commercial fishery in the Hobart Bay–Port Houghton area during the 2020–2021 season, because no stock assessment survey or forecast was conducted due to low levels of observed spawn and reduced funding.

Kah Shakes–Cat Island

There was no commercial fishery in the Kah Shakes–Cat Island area during the 2020–2021 season. A stock assessment survey was conducted; however, results suggested that the biomass would be forecast below threshold.

Winter Bait Fisheries

During the 2020–2021 season, the only winter food and bait fishery was in the Craig area. All other winter bait areas were closed due to low levels of observed spawn and reduced funding.

Craig

The fishery was opened in the Craig area on October 1, 2020, and was closed by regulation on February 28, 2021. The bait allocation was 11,674 tons, which was by regulation 60% of the total GHL of 19,456 tons. A total of 540 tons of herring were harvested.

Ernest Sound

There was no commercial fishery in Ernest Sound during the 2020–2021 season due to low levels of observed spawn and reduced funding.

Tenakee Inlet

There was no commercial fishery in Tenakee Inlet during the 2020–21 season due to low levels of observed spawn and reduced funding.

Spawn-on-Kelp Pound Fisheries

In the spawn-on-kelp (SOK) fisheries, closed-pound fishing involves capturing sexually mature herring and releasing them into a net impoundment within which kelp is suspended. The herring are released from the pound after they spawn on the kelp and the kelp with eggs is then sold. Open-pound fishing involves suspending kelp from a floating frame structure in an area where herring are spawning. The herring are not impounded but instead they naturally spawn on the suspended kelp. The kelp blades with eggs are removed from the water then sold. In the Southeast Alaska herring SOK fisheries, a closed or an open pound may be operated by one or more Commercial Fisheries Entry Commission (CFEC) permit holders (Coonradt et al. 2017).

These fisheries present unique challenges to fishery management, primarily because herring are released alive after spawning in pounds, which makes determining herring usage and mortality difficult to estimate. Attempts have been made to estimate the amount of herring placed into pounds by brailing and weighing herring from pounds instead of releasing after spawning; however, these were largely unsuccessful due to low sample size of pounds and uncertainty about herring losses (e.g., to sea lion or eagle predation) prior to brailing. Estimates of herring use in SOK pounds have been completed in Prince William Sound (PWS) by measuring egg deposition on kelp and pound webbing, egg retention within herring, and herring fecundity to back-calculate the number of herring (Morstad and Baker 1995; Morstad et al. 1992). These studies found that approximately 12.5 tons of herring are used for each ton of spawn-on-kelp product. However, because mean pound size in PWS fisheries is substantially larger than those used in Southeast Alaska fisheries, this ratio may not be directly comparable. Nevertheless, because no studies have been completed in Southeast Alaska, this conversion is used to approximate herring usage for Southeast Alaska pound fisheries, particularly when reporting estimates over time, for comparability. Other estimates of the amount of herring in pounds have also been used, which are based on observations of fishery managers during fisheries. These estimates have ranged from 10 to 20 tons of herring per closed pound structure and have been used as inputs to stock assessment models. To estimate herring deadloss from pounds, a mortality rate of 75% is assumed for herring that are placed into pounds.

The only area open to the commercial harvest of SOK during the 2020–2021 season was Craig. The other SOK areas in the region, Hoonah Sound, Ernest Sound, and Tenakee Inlet, were not opened during the 2020–2021 season because surveys and forecasts were not conducted, primarily due to low levels of observed spawn in 2020.

Craig

A total of 80 closed pounds were actively fished, by a total of 139 permit holders. Of the 80 closed pounds, there were 29 single, 48 double, and 3 triple-permit pounds. No open pounds were fished. Total harvest was 262 tons of spawn on kelp.

Hoonah Sound

There was no commercial fishery in Hoonah Sound during the 2020–2021 season due to low level of observed spawn and reduced funding.

Ernest Sound

There was no commercial fishery in Ernest Sound during the 2020–2021 season due to low level of observed spawn and reduced funding.

Tenakee Inlet

There was no commercial fishery in Tenakee Inlet during the 2020–2021 season due to low level of observed spawn and reduced funding.

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2020–2021 season, no herring were harvested for fresh bait pounds or tray-pack in Southeast Alaska.

Test Fisheries

There was no herring test fishery harvest in Southeast Alaska during the 2020–2021.

DISCUSSION

Annual spawn deposition surveys and sampling for age and size are the primary sources of fishery-independent data used to assess herring stocks in Southeast Alaska. These data are valuable inputs for the models used to estimate and forecast mature biomass, which provide the best estimates of biomass, and which are used to measure against fishery threshold levels to determine if commercial fisheries may be allowed. Although the models typically provide the department's best estimates of biomass, age composition, and other outputs such as recruitment and mortality rates, the egg deposition, age, and size data can also be used to roughly estimate biomass, age composition, and size. The results of the survey and sampling data provide a simple preview of raw data and trends in herring populations prior to the modeled results, and although they do not represent the final, best estimates, they provide an intuitive and quicker review of stock status until model estimates are available.

Spawn Deposition

The combined observed spawning biomass estimated in 2021 for Sitka Sound and Craig, as converted from egg deposition estimates, was 446,454 tons. This is about 4 times the mean biomass for all Southeast Alaska herring stocks combined and the highest estimate of regional biomass since the department instituted a herring stock assessment program in 1971. The estimate for these 2 stocks is only about 9% higher than the 408,245 tons estimated for 2020. In 2021 a survey was also conducted for the Kah Shakes–Cat Island (Revilla Channel) stock, which resulted in an estimate of an additional 4,616 tons. The Sitka Sound and Craig stocks typically account for about 80% of the spawning biomass in Southeast Alaska. Sitka Sound observed spawning biomass increased by 16% in 2021 relative to 2020, and Craig decreased by 9%. Because error estimates surrounding the biomass estimates were not calculated, it is unknown whether the magnitudes of these changes were large enough that they reflect statistically significant changes in the spawning population levels.

Spawn deposition estimates for 2021 suggest that herring spawning biomass in Southeast Alaska is at a very high level relative to the period 1980–2020. This theory holds despite only surveying 3 stocks in 2021, because Sitka Sound and Craig historically have accounted for a large proportion of the region's biomass. The 2021 combined estimate of all 3 surveyed areas of 452,121 tons is 406% of the mean regional spawning biomass (1980–2020), which is an underestimate for the region because so many areas were not surveyed in 2021.

After a period of building since about the late 1990s and peaking during 2008–2011, herring spawning biomass in Southeast Alaska began a period of decline, particularly for spawning stocks located in inside waters. Coincident with the decline were reductions to state budgets, which has prevented annual stock assessment surveys for most herring stocks in the region since 2016. Stock assessment surveys have continued uninterrupted for only the 2 largest stocks, Sitka Sound and Craig, and so firm conclusions cannot be made about broader herring biomass trends throughout the region. Limited aerial surveys have continued in most areas, which have provided some information about stock levels; however, miles of shoreline do not necessarily provide an accurate depiction of spawning biomass. Nonetheless, based on spawn mileage alone, herring stocks in the region other than Sitka and Craig appear to remain at low levels, relative to the past few decades. This continued pattern suggests that outer coastal stocks are faring far better than those located in inside waters, which are less exposed to open ocean influence. It is unknown why this pattern persists.

Although the increases observed for spawning biomass over the past year might be due to actual changes in the herring population, there is also a chance that the changes are at least partly a function of estimate variation, or a combination of both. Because error estimates were not calculated for spawn deposition estimates, it is possible that the changes in biomass were due, at least in part, to estimate error.

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

Age Composition

Age compositions of most sampled spawning populations in 2021 were dominated by age-5 herring, clearly showing the progression of the very large recruitment pulse of age-3 herring that was first observed in 2019. This very strong brood year was also reported for herring populations in Kodiak and Prince William Sound, corroborating the observed high recruitment event observed throughout the Gulf of Alaska in 2019. Broad-scale large recruitments have been observed in the past when Sitka Sound and Prince William Sound displayed very similar recruitment patterns (Carls and Rice 2007); however, the remarkable similarity and magnitude observed from Kodiak to southern Southeast Alaska is indicative of an uncommonly strong year class.

The specific mechanism that caused this recruitment spike over such a large scale is uncertain, but it was very likely linked to a common pattern in ocean temperature. This cohort was hatched in spring 2016, which was coincident with the tail end of an unusually warm water mass that circulated through the northern Pacific Ocean, commonly called the *blob* (Gentemann et al. 2017). Although speculation, it is possible that elevated sea temperatures from the blob helped produce marine conditions favorable to larval and juvenile herring survival in 2016, ultimately leading to a large recruitment 3 years later when those fish first entered the spawning population. This marine heatwave was well known to have widespread effects on other species and marine communities across the North Pacific, although the implications to populations and the ecosystem are not yet fully understood (Ferriss and Zador 2020).

The very high proportions of mature age-5 herring observed in 2021 increases the likelihood that herring populations will remain at a high level as this cohort matures into age-6 herring. This is especially true because a high spawning biomass was also observed in 2021; however, continued high mature biomass is not a foregone conclusion, because by age-5, herring approach full maturity and mortality rate begins to outweigh increases from maturing fish. This may already be apparent as egg deposition and spawning biomass observed in 2021 appears to have leveled off, compared to the large increases that were observed between 2019 and 2020. In addition, it is possible that survival rates could decline, or recruitment may be low in coming years, which could counter further biomass increases expected from this maturing cohort. The proportion of age-3 herring observed in spawning populations in 2021 appeared to be relatively low (though notably higher than 2020), which could eventually lead to declining biomass unless there is higher recruitment in coming years.

For herring stocks sampled, estimates of age composition in 2021 continued to follow patterns that are generally expected from tracking previous cohorts; that is, the proportion of cohort sizes either grew or declined as a result of increases due to maturation or decreases due to natural mortality and that no surprising or abrupt changes were observed in relative cohort strength (see Figures 34–42). These patterns also lend support to the assumption that the method of aging scales from 2021 samples was consistent with those methods used in prior years, which has been a concern in prior years (see Hebert 2012a and 2012b).

Historical patterns of age composition, and particularly proportions of age-3 herring, over time are also evident among stock groups within the region, suggesting that similar marine conditions may be present among certain areas within the region (Figure 44). The proportion of mature age-3 herring within each stock appears to be related to the latitude of the spawning stock. There appear to be 2 broad areas within the region where the mean proportion of age-3 herring is similar. For stocks south of latitude 56 degrees (i.e., those in the lower half of the region: Craig, West Behm Canal, Ernest Sound, and Kah Shakes), the mean proportion of age-3 herring is relatively high, but for stocks at 57 degrees and northward (Sitka, Hobart Bay, Seymour Canal, Hoonah Sound, Tenakee Inlet, and Lynn Canal), the proportions are relatively low. The strength of the 2019 age-3 pulse apparently overrode the usual pattern seen among stocks on separate sides of the latitudinal split, further indicating that the common influence seen across the Gulf of Alaska was exceptional.

ACKNOWLEDGMENTS

Herring and egg samples were processed at the ADF&G Mark, Tag, and Age Laboratory, and overseen by Eric Keller. Sara Miller (Southeast Alaska Biometrician) assisted with herring age and size data processing and calculation of spawn deposition estimates, and Sherri Dressel (Statewide Herring Fishery Scientist) advised on and reviewed calculation of spawn deposition estimates. Many department divers and boat officers contributed to the successful completion of the spawn deposition dive surveys.

REFERENCES CITED

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

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

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

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

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

Cobb, J. N. 1905. The commercial fisheries of Alaska in 1905. Bureau of Fisheries Document No. 603.

Coonradt, E., D. Harris, T. Thynes, and S. Walker. 2017. 2017 Southeast Alaska herring spawn-on-kelp pound fishery management plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J17-01, Douglas.

Doubleday, W. G. 1985. Managing herring fisheries under uncertainty. Canadian Journal of Fisheries and Aquatic Sciences 42(S1):245–257.

Ferriss, B. E., and S. Zador 2020. Ecosystem status report for the Gulf of Alaska, stock assessment and fishery evaluation report. North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage.

Gentemann, C. L., M. R. Fewing, and M. Garcia-Reyes. 2017. Satellite sea surface temperatures along the West Coast of the United States during the 2014–2016 northeast Pacific marine heat wave. Geophysical Research Letters 44(1):312–319.

Grice, D. G, and N. J. Wilimovsky. 1957. Herring spawning survey of Alaska with particular reference to Southeastern Alaska. Marine Fisheries Investigations Operations Report–1957. Department of the Interior, United States Fish and Wildlife Service, Bureau of Commercial Fisheries, Alaska Region.

Haegele, C. W. 1993a. Seabird predation of Pacific herring, Clupea pallasi, spawn in British Columbia. Canadian Field-Naturalist 107(1):73–82.

Haegele, C. W. 1993b. Epibenthic invertebrate predation of Pacific herring, Clupea pallasi, spawn in British Columbia. Canadian Field-Naturalist 107(1):83–91.

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

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

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

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

Jones, E. L., T. J. Quinn, and B. W. Van Alen. 1998. Observer accuracy and precision in aerial and foot survey counts of pink salmon in a Southeast Alaska stream. North American Journal of Fisheries Management 18(4):832–846.

Li, M., M. Stein, M. Wang, A. Shelton, C. Pfister, and K. Wilder. 2011. A method for unbiased estimation of population along curvy margins. Environmetrics 22(3):330–339.

REFERENCES CITED (Continued)

Morstad, S., and T. T. Baker. 1995. Pacific herring pound spawn-on-kelp fishery in Prince William Sound, Alaska, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A95-21, Anchorage.

Morstad, S., T. T. Baker, and J. A. Brady. 1992. Pacific herring pound spawn-on-kelp fishery in Prince William Sound, Alaska, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A92-02, Anchorage, AK.

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

Rounsefell, G. A., and E. H. Dahlgren. 1935. Races of herring, *Clupea pallasii* in Southeastern Alaska. Bulletin of the Bureau of Fisheries, Vo. XLVIII, Bulletin No. 17.

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

Schweigert, J. F., C. W. Haegele, and M. Stocker. 1985. Optimizing sampling design for herring spawn surveys in the Strait of Georgia, B.C. Canadian Journal of Fisheries and Aquatic Sciences 42(11):1806–1814.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. American Statistician. 41(1):42–46.

Zheng, J., F. Funk, G. Kruse, and R. Fagan. 1993. Evaluation of threshold management strategies for Pacific herring in Alaska. Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations, Alaska Sea Grant College Program, Report No. 93-02.

TABLES AND FIGURES

Table 1.–Historical dates of herring spawn deposition surveys in Southeast Alaska.

Year	Sitka	Craig	Ernest Sound	West Behm Canal	Revilla Channel	Hobart Bay	Seymour	Tenakee	Hoonah Sound	Lynn Canal
1976	5/1-6	–	–	–	4/13-24	–	–	–	–	–
1977	4/26-28	–	–	–	4/13-19	–	–	–	–	–
1978	4/18-21	–	–	–	4/10-11	–	5/14-16	–	–	5/2-4
1979	–	–	–	–	4/9-12	–	–	–	–	–
1980	–	–	–	–	4/7-11	–	5/15-16	–	–	5/13-15
1981	4/10-11	–	–	–	4/1-4	–	5/14-15	–	5/4	–
1982	4/13-22	–	–	–	4/4-18	–	5/24-25	–	–	–
1983	4/13-17, 29	–	–	–	4/5-11	–	5/9-11	–	–	5/6
1984	4/10-17	–	–	–	4/10-15	–	5/4	5/5-7	5/8	5/4
1985	*	*	*	*	*	*	*	*	*	*
1986	*	*	*	*	*	*	*	*	*	*
1987	*	*	*	*	*	*	*	*	*	*
1988	4/15-20	3/24-25	–	–	4/8-12	–	5/5-7	5/10-11	–	5/14
1989	4/10-16	4/7-9	–	–	–	–	5/17-19	5/10-12	4/18-19	–
1990	4/15-18	4/14	–	–	3/29-4/12	–	5/7-10	5/5-6	5/20-23	–
1991	4/25-27	*	*	*	*	*	*	*	*	*
1992	4/23-26	3/30, 4/18-21	5/2	–	4/14-17	5/10-11	5/9-10	–	5/5	–
1993	4/10-13	4/8	4/29-30	4/25-26	4/22-24	5/5	5/10-11	5/7-8	5/6	–
1994	4/8-11	4/18-19	5/6	5/4-5	4/15-17	5/7-8	5/12, 19	–	4/29-30	–
1995	4/7-10	4/6	5/2-3	–	4/20-22	5/4-6	5/23-24	–	4/27-28	–
1996	3/29, 4/2-4, 23-24	4/17-18	5/1	4/21	4/19-20	5/10	5/16, 29	5/15-16	5/12-13	–
1997	4/7-9	4/22-23	–	4/29-5/1	4/16-17	5/9	5/12-13	5/10-11	5/6-8	–
1998	4/1-3	4/12-14	4/22-23	4/20, 22-23	4/9	4/29-30	5/2, 8-9	5/5-7	5/4-5	–
1999	4/7-9	4/10, 20	–	4/16-17	4/14-15	4/4-5	5/11-12	5/7-8	5/9	–
2000	4/4-6	4/13-14	4/25	4/17-18	4/16-17	5/11	5/12-13	5/3-4, 6	5/7	–
2001	4/9-10	4/18-19	4/24	4/21-22	4/20	5/11-12	5/21-22	5/8-9	5/6-7	–
2002	4/8-11	4/16-18	4/21	4/19-20	–	5/10-11	5/30-31	5/3-4, 6	5/7	–
2003	4/8-11, 22	4/13-14	4/27	4/24-26	–	5/8-9	5/10	5/7	5/5-6	–

-continued-

Table 1.–Page 2 of 2.

Year	Sitka	Craig	Ernest Sound	West Behm Canal	Revilla Channel	Hobart Bay	Seymour	Tenakee	Hoonah Sound	Lynn Canal
2004	4/15-19	4/8-9	4/11, 21	4/19-20	–	5/9-10	5/11-12	5/7-8	5/5	5/13
2005	4/9-12	4/17-19	5/4	4/21	–	5/9-10	5/10-11	5/7	5/5-6	5/18
2006	4/7-8	4/10-11	4/14-15	4/29	–	5/7	5/10	5/8	5/4-5	5/26
2007	4/13-16, 24	4/18-19	4/24-25	4/23, 5/4	–	5/22	5/21	5/5	5/7	5/25
2008	4/10-14	4/15-16	5/2-3	4/18	–	5/13	5/16	5/10	5/7-8	5/21
2009	4/18-20	4/15-16	4/23	4/21-22	–	5/14-15	5/13-14	5/8-9	5/6-7	5/11-12
2010	4/16-19	4/14-15	4/22	4/20	–	5/5-6	5/7-8	5/11	5/9-10	5/12-13
2011	4/18-20	4/14-15	4/24	4/23	–	5/8-9	5/9-10		5/5-6	–
2012	4/13-16	4/21-22	4/24	4/23	–	5/5	5/12-13	5/8	5/7	5/10-11
2013	4/8-12, 5/2-5	4/14-15	4/17	4/16	–	5/8	5/13-14	5/11	5/12	5/10
2014	4/7-11, 24-26	4/13	4/22	4/15	–	5/1	5/10	5/7	5/8	5/9
2015	4/10-13, 5/6-7	4/8	4/21-22	–	4/6	5/5	5/11	5/9	5/6	5/10
2016	4/1-3, 20-21	4/8-9	4/26-27	–	–	–	5/8	–	–	5/7
2017	4/12-14, 28	4/7-8	–	–	–	–	5/15	–	–	–
2018	4/8-11, 24-25	4/13-14	–	–	–	–	–	–	–	–
2019	4/12-15	4/9-10	–	–	4/6	–	–	–	–	–
2020	4/4-6, 8-9	4/13-14	–	–	4/11	–	–	–	–	–
2021	4/17-21	4/15-16	–	–	4/11-12	–	–	–	–	–

Note: Dashes represent years without surveys and asterisks represent years when surveys were completed but records of dates are missing.

Table 2.–Transect sampling rates used for 2021 herring spawn deposition surveys.

	Estimated target transects per nautical mile of spawn[a]			
Area	Based on 1994 analysis	Based on 1997 analysis	Based on 2000 analysis	Average
Sitka	0.2	0.6	0.3	0.4
West Behm Canal	–	0.4	1.7	1.1
Seymour Canal	2.8	2.4	1.2	2.1
Craig	0.8	3.1	1.3	1.7
Hobart/Houghton	4.5	1.7	3.6	3.3
Ernest Sound	1.9	5.0	3.5	3.5
Hoonah Sound	2.9	1.0	0.7	1.5
Tenakee Inlet	5.1	1.2	1.6	2.6
Average	2.6	1.9	1.7	2.1

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

Table 3.–Fecundity relationships used for estimating 2021 herring spawning biomass for stocks in Southeast Alaska.

Sampling year	Stock sampled	Fecundity equation	Stocks to which fecundity equation is applied
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.– Herring egg estimates (in thousands) by transect for 2021 spawn deposition surveys conducted in Southeast Alaska. Frame counts are the number of quadrats estimated along each transect.

	Craig		Sitka Sound Kruzof Stratum		Sitka Sound Northern Stratum		Sitka Sound Southern Stratum		Revilla Channel	
Transect	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count
1	130	14	21,117	106	486	14	318	10	0	1
2	1,217	20	521	14	143	6	33	3	4	1
3	196	32	10,129	84	3,263	65	662	12	180	28
4	0	1	4,952	61	140	10	73	4	961	17
5	2,577	29	5,025	47	408	6	34	6	76	16
6	10,989	46	2,076	24	1,600	15	7,073	25	2,957	45
7	3,071	15	8,983	157	1,298	16	190	3	136	12
8	1,751	23	2,238	24	2,449	12	100	5	63	7
9	333	13	6,316	48	98	11	1,230	6	0	1
10	198	10	20,339	55	2,554	30	21	5	225	18
11	6,932	19	79,902	44	38	8	0	3	26	6
12	12,239	52	3,577	23	428	12	1	6	252	10
13	373	18	16,384	77	351	11	50	4	125	16
14	8,871	46	2,069	22	2,208	14	238	11	0	1
15	150	27	1,787	41	880	6	736	10	108	16
16	373	14	—	—	322	13	0	1	776	21
17	2,920	30	—	—	493	19	251	16	341	7
18	7,684	36	—	—	0	1	29	5	2,013	36
19	1,067	8	—	—	91	3	881	8	996	34
20	203	9	—	—	1,527	45	372	8	0	1
21	544	12	—	—	8,507	36	43	7	—	—
22	1,095	9	—	—	10,504	48	1,269	5	—	—
23	0	1	—	—	4,072	22	777	14	—	—
24	1,514	22	—	—	25	2	4,042	16	—	—
25	147	7	—	—	1,003	23	327	7	—	—
26	64	6	—	—	1,394	11	—	—	—	—
27	22,013	45	—	—	1,810	15	—	—	—	—
28	0	1	—	—	2,159	26	—	—	—	—
29	10,175	28	—	—	5,453	12	—	—	—	—
30	328	8	—	—	208	7	—	—	—	—
31	1,990	8	—	—	—	—	—	—	—	—
32	345	7	—	—	—	—	—	—	—	—

-continued-

Table 4.–Page 2 of 2.

Transect	Craig		Sitka Sound Kruzof Stratum		Sitka Sound Northern Stratum		Sitka Sound Southern Stratum		Revilla Channel	
	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count
33	360	6	—	—	—	—	—	—	—	—
34	11	2	—	—	—	—	—	—	—	—
35	2,001	21	—	—	—	—	—	—	—	—
36	943	13	—	—	—	—	—	—	—	—
37	83	5	—	—	—	—	—	—	—	—
38	101	6	—	—	—	—	—	—	—	—
39	1,031	27	—	—	—	—	—	—	—	—
40	0	1	—	—	—	—	—	—	—	—
41	605	9	—	—	—	—	—	—	—	—
42	0	1	—	—	—	—	—	—	—	—
43	152	7	—	—	—	—	—	—	—	—
44	34	11	—	—	—	—	—	—	—	—
45	1,326	12	—	—	—	—	—	—	—	—
46	6,655	26	—	—	—	—	—	—	—	—
47	737	6	—	—	—	—	—	—	—	—
48	1,369	25	—	—	—	—	—	—	—	—
Average	2,394	17	12,361	55	1,797	17	750	8	462	15
Total	114,897	794	185,416	827	53,913	519	18,749	200	9,239	294

Note: Dashes indicate no survey transects planned or completed.

Table 5.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2021.

Spawning Stock	Number of transects completed	Average length of transects (m)	Observed spawn (nmi)	Area of survey (m^2)	Average egg density ($eggs/m^2$)	Total eggs in survey area (trillions)	Mean fish weight (g)[d]	Estimated fecundity of fish of mean weight	Estimated number of fish	2021 post-fishery mature biomass (tons)
Craig	48	83	34.2	5,238,614	1,447,064	8.423	84.2	16,638	1,012,498,050	94,007
Sitka Sound (total)	70	92	102.3	17,221,563	1,426,809	27.302	108.3	18,491	2,952,935,632	352,447
West stratum	15	276	11.4	5,820,095	2,242,031	14.499	–	–	–	–
North stratum	30	87	54.2	8,682,732	1,038,781	10.022	–	–	–	–
South stratum	25	40	35.4	2,622,432	937,469	2.732	–	–	–	–
postsurvey[a]	–	40	1.3	96,304	468,735	0.050	–	–	–	–
Seymour Canal[b]	–	–	3.1	–	–	–	–	–	–	–
Ernest Sound[b]	–	–	0.6	–	–	–	–	–	–	–
Hobart/Houghton[b]	–	–	3.4	–	–	–	–	–	–	–
Hoonah Sound[b,c]	–	–	0.0	–	–	–	–	–	–	–
Kah Shakes/Cat Is.	20	74	7.9	1,075,364	314,266	0.375	57.5	10,316	72,797,773	4,616
Lynn Canal[b]	–	–	0.9	–	–	–	–	–	–	–
Tenakee Inlet[b]	–	–	1.7	–	–	–	–	–	–	–
West Behm Canal[b]	–	–	8.5	–	–	–	–	–	–	–
Yakutat Bay[b]	–	–	3.5	–	–	–	–	–	–	–
Total	138	–	166.0	23,535,540	–	36.100	–	–	4,038,231,456	451,071
Average	46	83	–	7,845,180	1,062,713	12.033	83.3	15,149	–	–

Note: Dashes indicate data not available due to lack of survey (no funding or little or no spawn observed), or a total/average is not appropriate.

[a] Not surveyed, but average transect length and 50% average egg density from South Stratum survey were applied to estimate spawn area and egg deposition.

[b] No spawn deposition survey conducted due to low observed mileage in traditional spawning areas and reduced funding.

[c] Very infrequent aerial surveys conducted, so spawning may have been present but not observed.

[d] Represents mean weight of fish (g) in spawning population, weighted by age composition.

Table 6.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2021.

	Estimator[a]						
Kelp type	A	B	C	D	E	F	Average
Eelgrass	0.94	0.98	1.14	1.00	1.06	0.89	1.00
n =	32	32	32	32	32	20	30
Fucus	1.31	0.69	1.40	0.93	0.89	0.85	1.01
n =	31	31	31	30	30	20	29
Fir kelp	0.75	0.54	0.83	0.63	0.67	0.52	0.66
n =	29	29	29	29	29	20	28
Hair kelp	1.03	0.89	0.82	0.88	0.72	0.84	0.86
n =	35	35	35	35	35	21	33
Large brown kelp[b]	1.02	0.84	1.26	0.72	0.63	0.82	0.88
n =	29	29	29	29	29	17	27
Average[c]	1.01	0.79	1.09	0.83	0.79	0.79	0.88

[a] Estimator identity is withheld to prevent results from altering estimating patterns in future years.

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

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

Table 7.–Summary herring samples aged for Southeast Alaska stocks in 2020–21.

	Commercial fishery			Survey	Test fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	584	545	540	–	1,669
Ernest Sound	–	–	–	–	–	–
Hobart/Houghton	–	–	–	–	–	–
Hoonah Sound	–	–	–	–	–	–
Lynn Canal	–	–	–	–	–	–
Seymour Canal	–	–	–	534	–	534
Sitka Sound	–	–	599	925	–	1,524
Tenakee Inlet	–	–	–	–	–	–
West Behm Canal	–	–	–	–	–	–
Revilla Channel	–	–	–	537	–	537
Yakutat	–	–	–	–	–	–
Total	–	584	1,144	2,536	–	4,264

Note: Dashes indicate that no samples were collected in 2020–21, either due to lack of funding or observed spawning.

Table 8.–Summary of age, weight, and length for the Sitka Sound herring stock in 2020–21.

Gear type, season	Parameter	Age category 3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	91	35	741	26	10	22	925
	Percent age composition	10%	4%	80%	3%	1%	2%	100%
	Average weight (g)	59.1	89.2	101.3	116.9	120.9	142.6	105.0
	Standard deviation of weight (g)	9.1	14.2	19.9	20.1	30.8	19.0	18.9
	Average length (mm)	167	186	194	203	205	215	195
	Standard deviation of length (mm)	7.1	6.9	10.0	9.6	7.5	10.5	8.6
Commercial purse seine, spring	Number of fish	74	32	466	10	5	12	599
	Percent age composition	12%	5%	78%	2%	1%	2%	100%
	Average weight (g)	67.4	92.2	111.4	136.1	154.7	142.3	117.3
	Standard deviation of weight (g)	11.5	19.2	19.7	24.1	18.3	27.5	20.0
	Average length (mm)	172	187	197	206	215	214	198
	Standard deviation of length (mm)	8.3	12.6	9.5	9.4	10.3	11.9	10.3

Table 9.–Summary of age, weight, and length for the Craig herring stock in 2020–21.

		Age category						
Gear type, season	Parameter	3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	59	15	480	16	10	4	584
	Percent age composition	10%	3%	82%	3%	2%	1%	100%
	Average weight (g)	56.5	71.2	81.8	93.0	89.6	103.8	82.7
	Standard deviation of weight (g)	11.1	16.4	18.3	20.1	12.9	21.2	16.7
	Average length (mm)	162	173	181	186	192	196	181
	Standard deviation of length (mm)	8.8	8.9	10.6	12.8	9.9	7.0	9.7
Commercial pound, spring	Number of fish	54	18	446	10	9	3	540
	Percent age composition	10%	3%	83%	2%	2%	1%	100%
	Average weight (g)	59.5	78.0	86.1	94.4	114.0	133.4	94.2
	Standard deviation of weight (g)	11.0	19.5	18.5	12.4	17.0	26.5	17.5
	Average length (mm)	162	173	180	186	195	203	183
	Standard deviation of length (mm)	8.1	12.3	9.8	7.1	9.1	5.0	8.6
Commercial purse seine, winter	Number of fish	66	35	342	46	32	24	545
	Percent age composition	12%	6%	63%	8%	6%	4%	100%
	Average weight (g)	51.6	61.6	71.4	88.4	97.6	113.2	80.6
	Standard deviation of weight (g)	10.7	10.6	12.1	14.0	15.5	19.5	13.7
	Average length (mm)	153	165	171	184	191	200	177
	Standard deviation of length (mm)	9.5	7.7	8.9	10.3	9.2	10.6	9.4

Table 10.–Summary of age, weight, and length for the Seymour Canal herring stock in 2020–21.

Gear type, season	Parameter	Age category 3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	37	10	433	19	10	25	534
	Percent age composition	7%	2%	81%	4%	2%	5%	100%
	Average weight (g)	52.9	64.0	62.9	73.4	89.5	101.3	74.0
	Standard deviation of weight (g)	11.4	18.9	14.1	14.2	13.7	19.9	15.4
	Average length (mm)	158	168	168	180	188	194	176
	Standard deviation of length (mm)	10.0	12.9	10.8	12.6	6.6	8.5	10.2

Table 11.–Summary of age, weight, and length for the Kah Shakes–Cat Island herring stock in 2020–21.

Gear type, season	Parameter	Age category 3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	295	17	195	28	1	1	537
	Percent age composition	55%	3%	36%	5%	0%	0%	100%
	Average weight (g)	48.2	52.7	69.4	73.5	66.6	101.6	68.7
	Standard deviation of weight (g)	9.9	11.8	12.4	12.7	–	–	11.7
	Average length (mm)	156	158	175	179	177	211	176
	Standard deviation of length (mm)	9.1	8.4	8.9	8.0	–	–	8.6

Note: Dashes indicate value cannot be calculated due to sample size limitations.

Table 12.–Summary of Southeast Alaska herring target levels for the 2020–21 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target exploitation rate (%)	Guideline harvest level (tons)[a]
Craig	5,000	97,282	20.0	19,456
Ernest Sound	2,500	–	0.0	–
Hobart Bay–Port Houghton	2,000	–	0.0	–
Hoonah Sound	2,000	–	0.0	–
Seymour Canal	3,000	–	0.0	–
Sitka Sound[b]	25,000	210,453	15.8	33,304
Tenakee Inlet	3,000	–	0.0	–
West Behm Canal	6,000	–	0.0	–
Lynn Canal	5,000	–	0.0	–
Kah Shakes–Cat Island	6,000	–	0.0	–

Note: Dashes indicate no data or data not applicable.

[a] Represents the 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.

[b] Guideline harvest level was calculated by reducing the allowable harvest level based on model forecast and 20% harvest rate by 21%, which approximated the harvest level available if the number of age-5 fish was 75% of that projected. This was a precautionary approach to account for higher than usual uncertainty in the forecasted return of the unprecedented large age class of age-5 herring.

Table 13.–Summary of commercial herring harvest during the 2020–21 season.

Fishery	Gear	Area	District	Opening[a]	Closing[b]	Harvest (tons)[c]
Winter food and bait	Purse seine	Craig	3/4	1 Oct 2020	28 Feb 2021	540
Winter food and bait	Purse seine	Tenakee Inlet	12	Not open	Not open	–
Winter food and bait	Purse seine	Ernest Sound	7	Not open	Not open	–
Winter food and bait	Purse seine	Hobart Bay	10	Not open	Not open	–
Subtotal						540
Sac roe	Purse seine	Sitka Sound	13	27 Mar 2021	9 Apr 2021	15,578
Sac roe	Purse seine	Lynn Canal	11	Not open	Not open	–
Sac roe	Gillnet	Seymour Canal	11	Not open	Not open	–
Sac roe	Gillnet	Hobart Bay	10	Not open	Not open	–
Sac roe	Gillnet	Kah Shakes	1	Not open	Not open	–
Sac roe	Gillnet	West Behm Canal	1	Not open	Not open	–
Subtotal						15,578
Spawn on kelp	Pound	Hoonah Sound	13	Not open	Not open	–
Spawn on kelp	Pound	Tenakee Inlet	12	Not open	Not open	–
Spawn on kelp	Pound	Ernest Sound	7	Not open	Not open	–
Spawn on kelp	Pound	Craig	3	17 Mar 2021	10 Apr 2021	262
Subtotal						262
Test fishery-bait	Purse seine	Sitka	13	No fishery	No fishery	–

[a] For spawn-on-kelp fisheries, represents when seining was opened.

[b] For spawn-on-kelp fisheries, represents end of removing spawn on kelp from pounds; for purse seine fisheries, represents date of last opening.

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

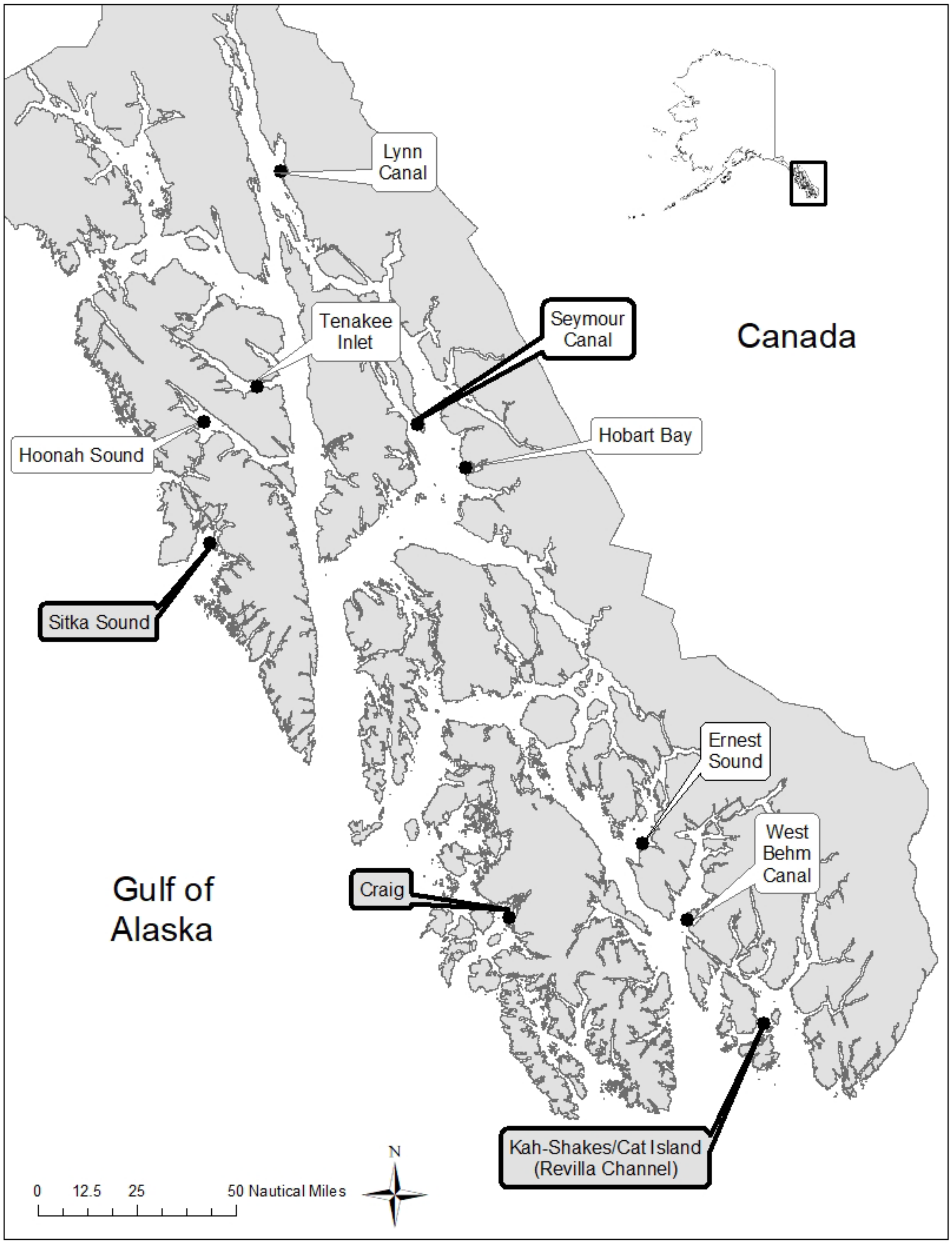

Figure 1.–Locations of major herring spawning areas in Southeast Alaska. Labels with shading and bold outline indicate areas where spawn deposition surveys and age-size sampling were conducted during the 2021 spawning season; labels with only bold outline indicate only age-size sampling of herring was completed during the 2021 spawning season; no sampling other than aerial surveys were conducted in areas where labels have no shading or bolding.

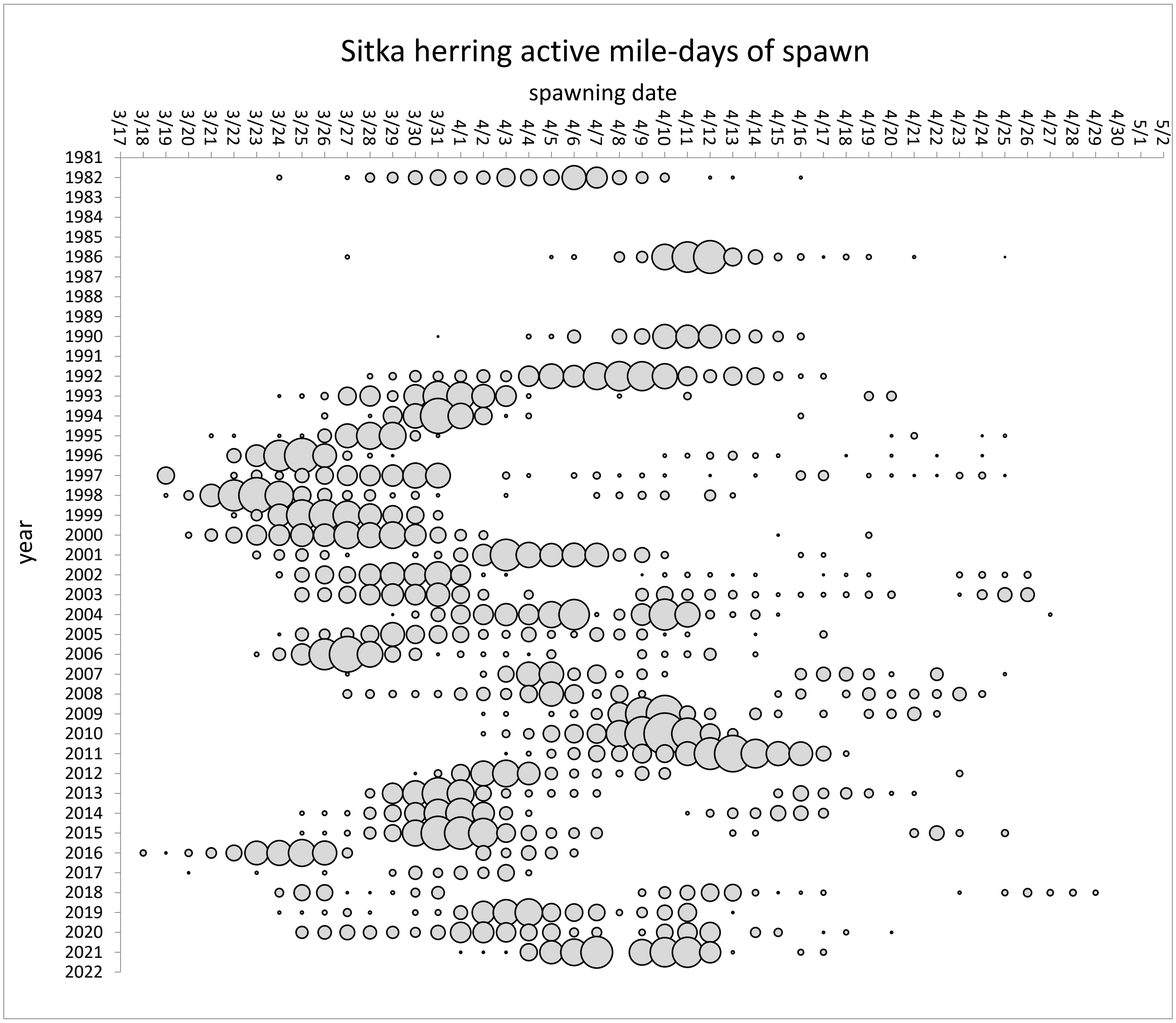

Figure 2.–Historical dates of active spawn observed for the Sitka Sound herring stock. The size of circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of 48 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For entire years with blanks, data could not be located.

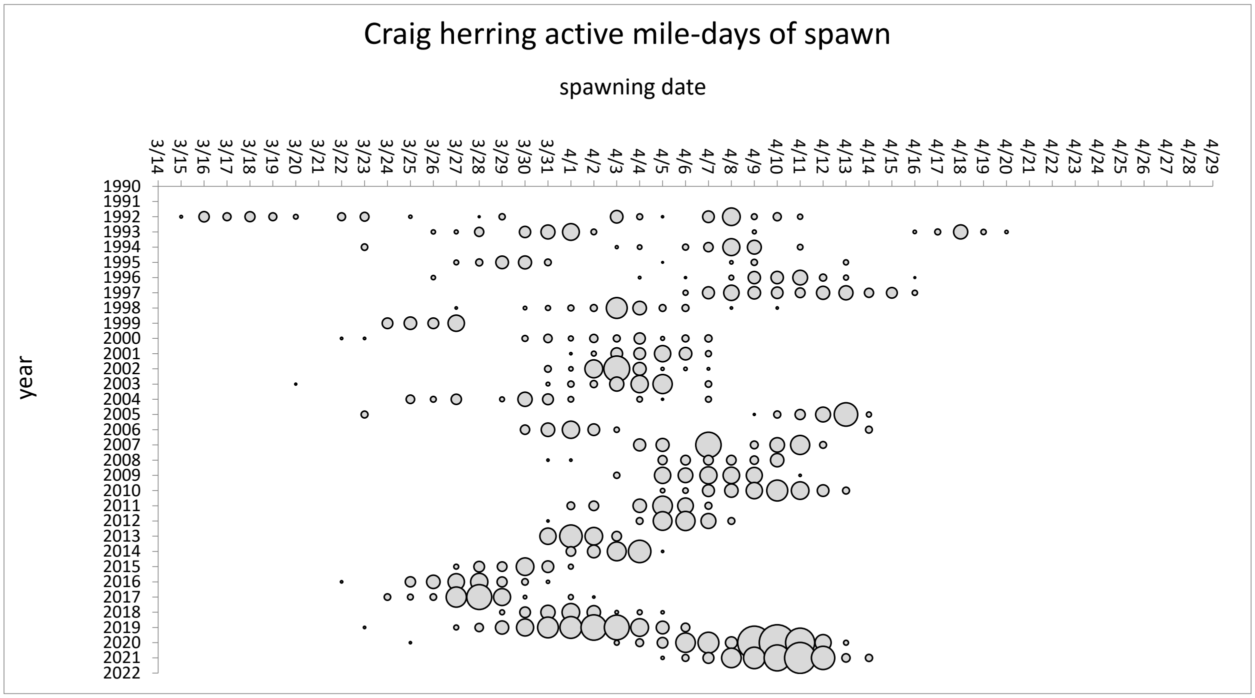

Figure 3.–Historical dates of active spawn observed for the Craig herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 30 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. Black circles represent days of active spawn, but for which no estimates of daily mileage are available.

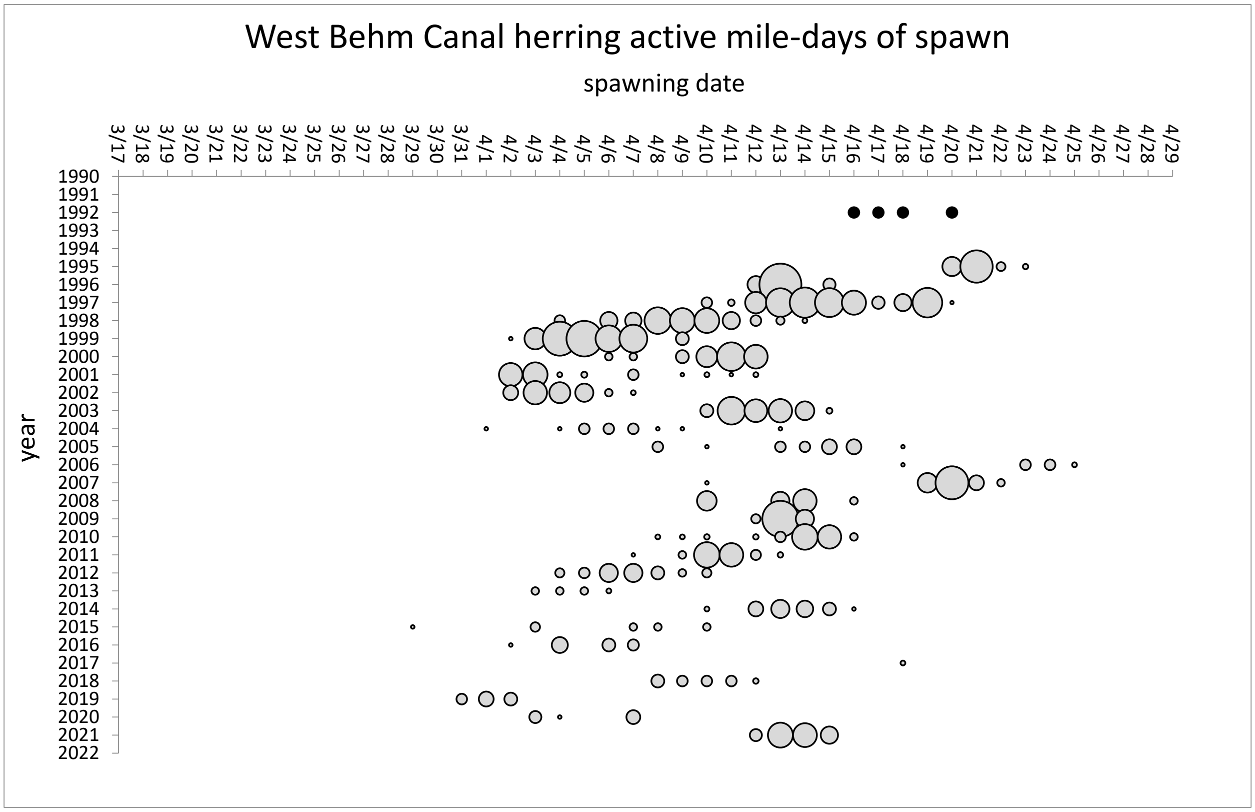

Figure 4.–Historical dates of active spawn observed for the West Behm Canal herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of 12 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. Black circles represent days of active spawn, but for which no estimates of daily mileage are available. For years with blanks, data could not be located.

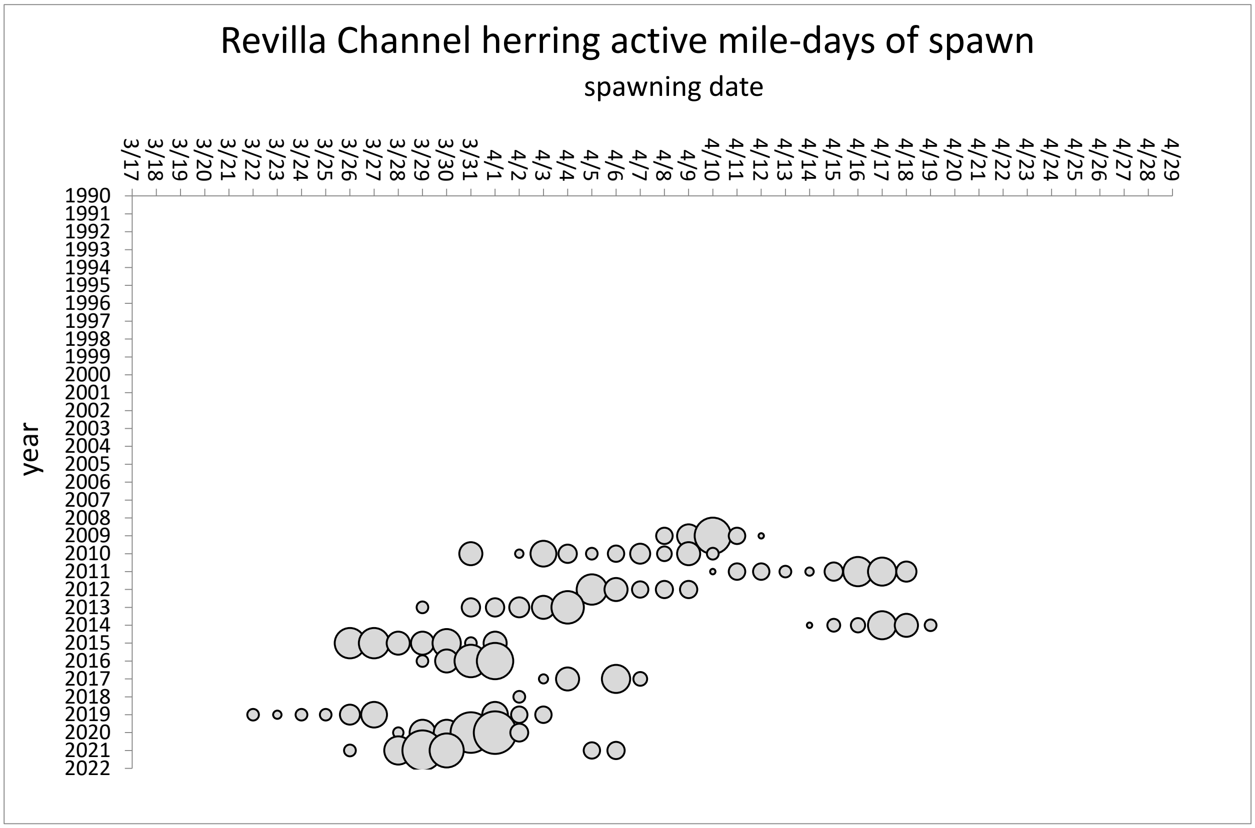

Figure 5.–Historical dates of active spawn observed for the Revilla Channel herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 7 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located or is not yet summarized.

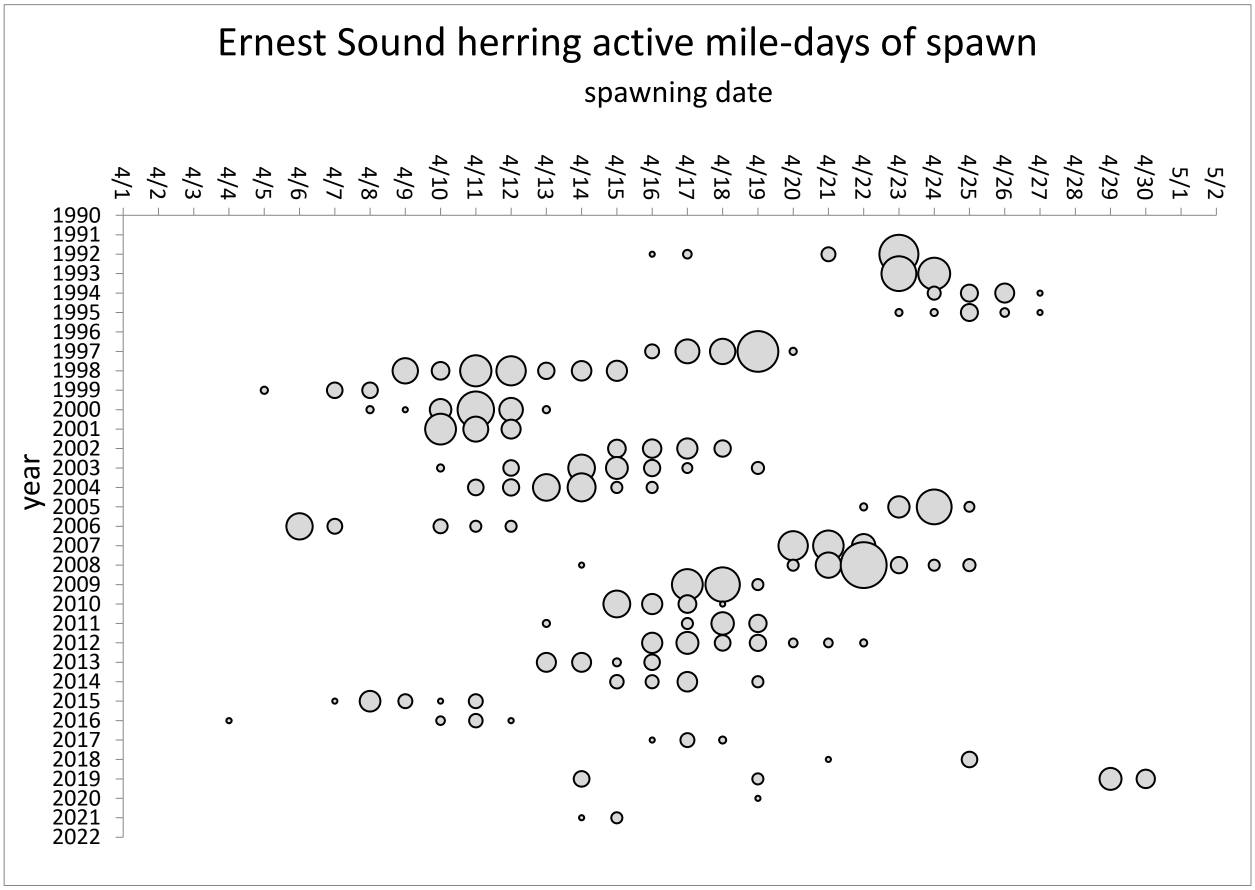

Figure 6.–Historical dates of active spawn observed for the Ernest Sound herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 9 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile.

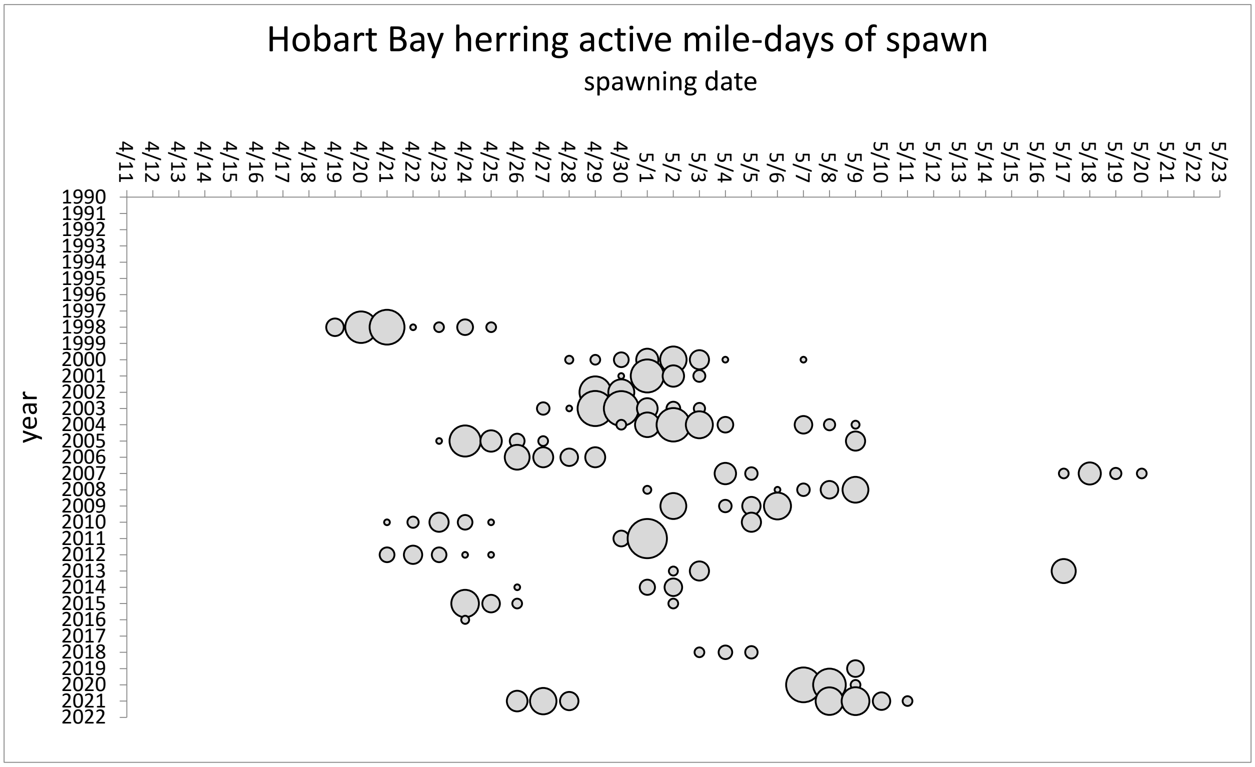

Figure 7.–Historical dates of active spawn observed for the Hobart Bay herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 6 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located.

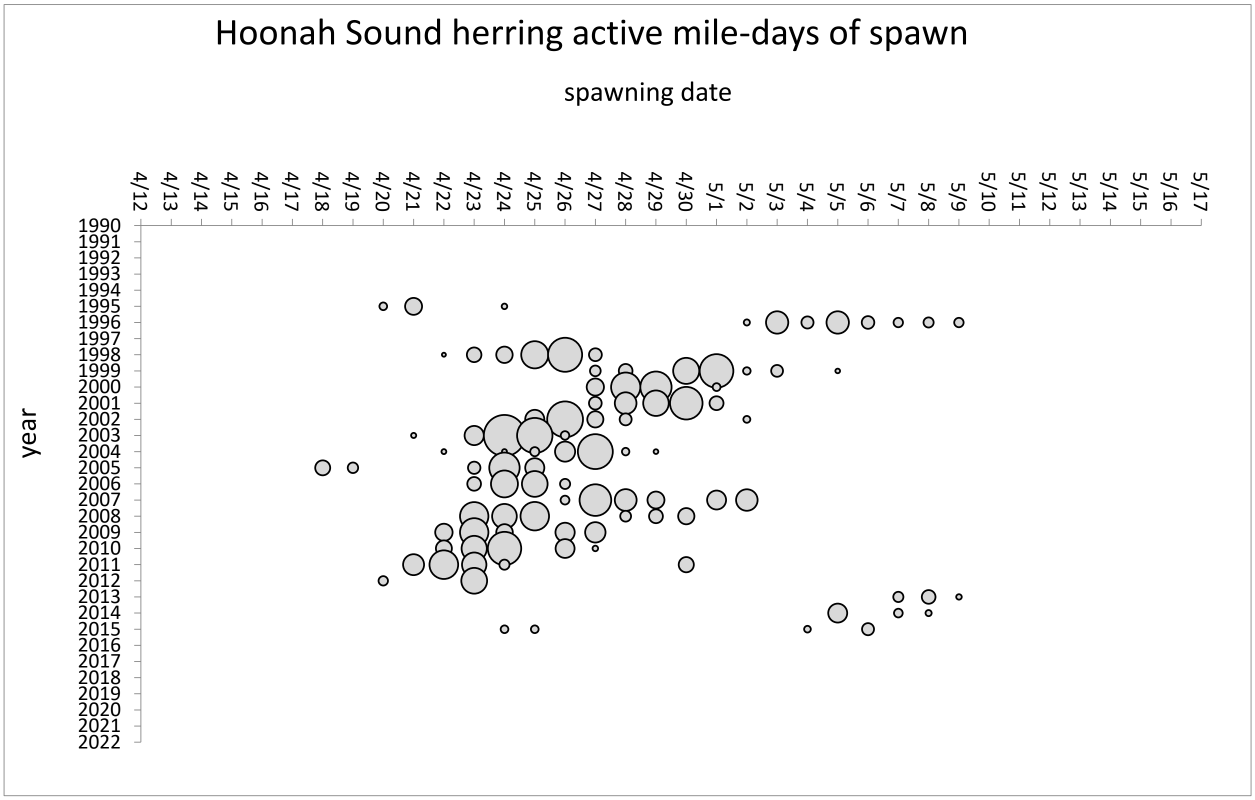

Figure 8.–Historical dates of active spawn observed for the Hoonah Sound herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 12 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For years prior to 1995, data could not be located. For entire blank years since 2015 spawn has not been observed, although aerial survey flights have been much less frequent than were done in prior years.

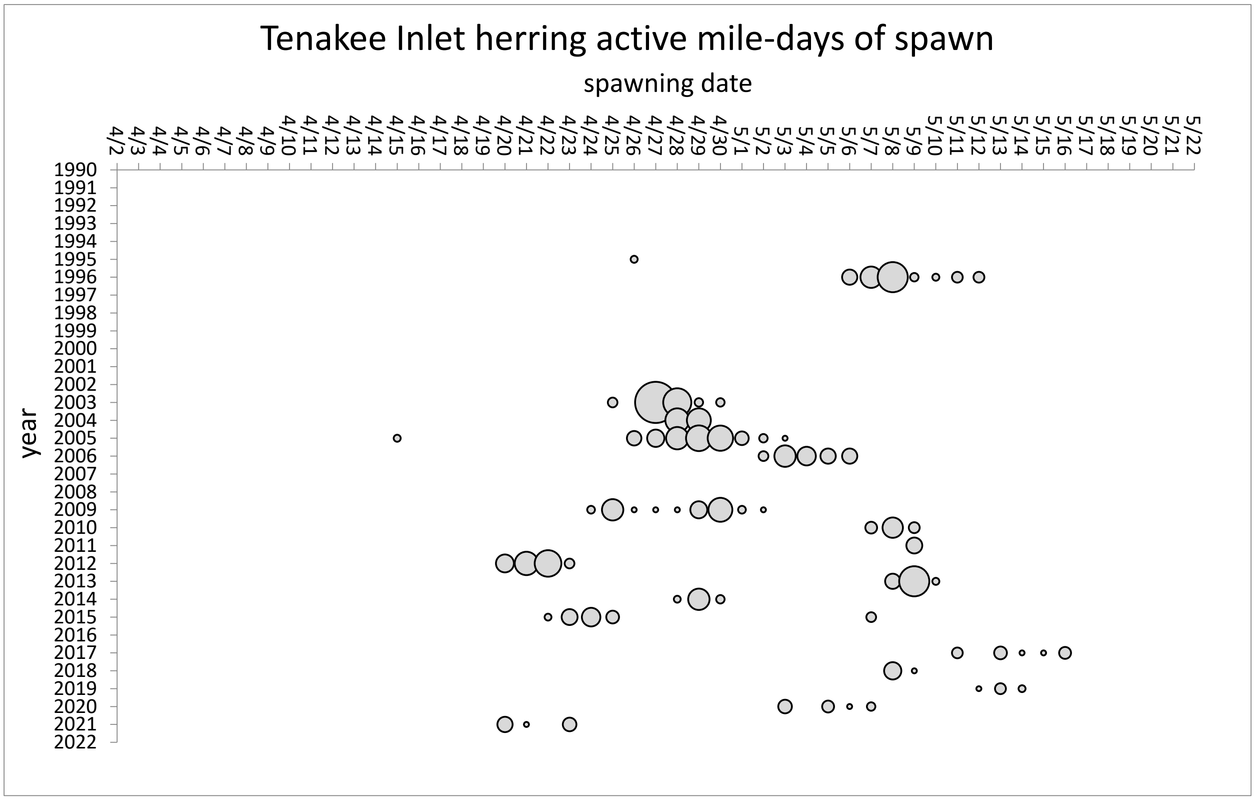

Figure 9.–Historical dates of active spawn observed for the Tenakee Inlet herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 8 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located.

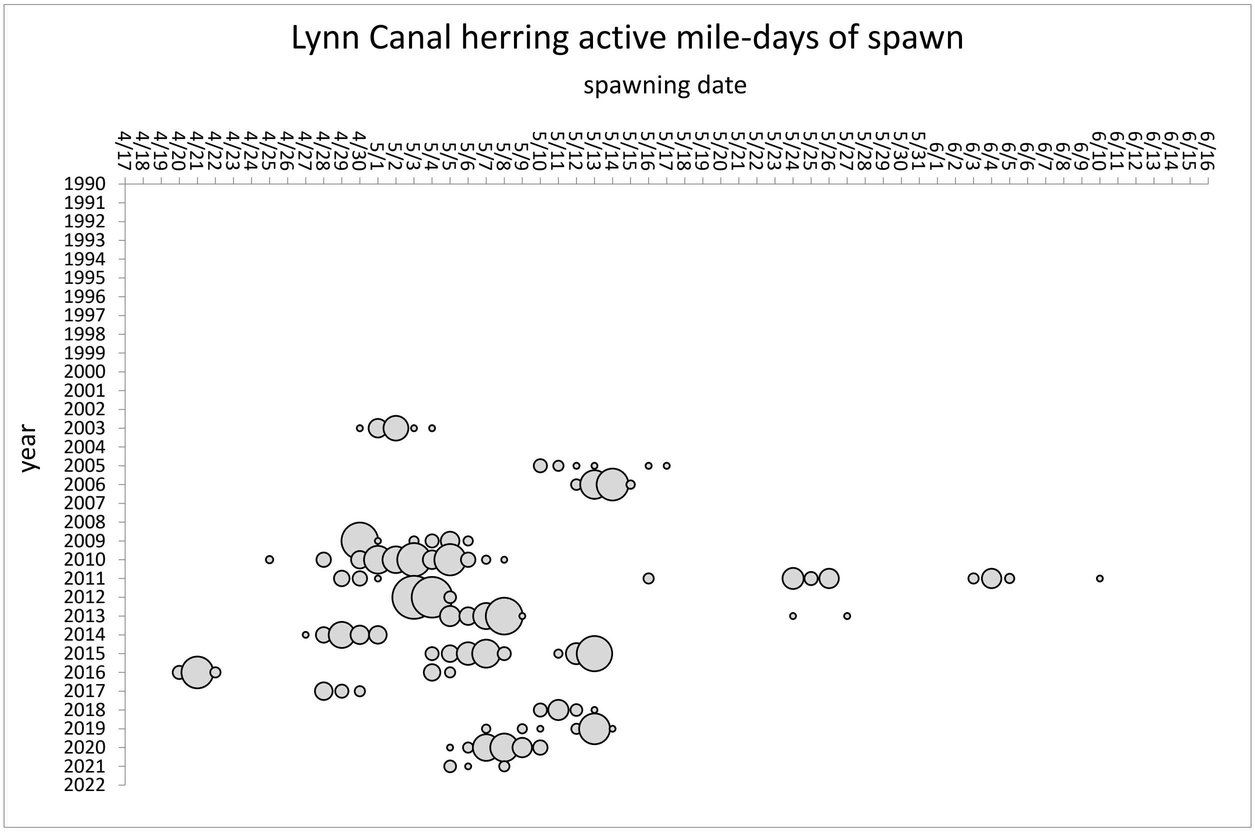

Figure 10.–Historical dates of active spawn observed for the Lynn Canal herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 5 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located or is not yet summarized.

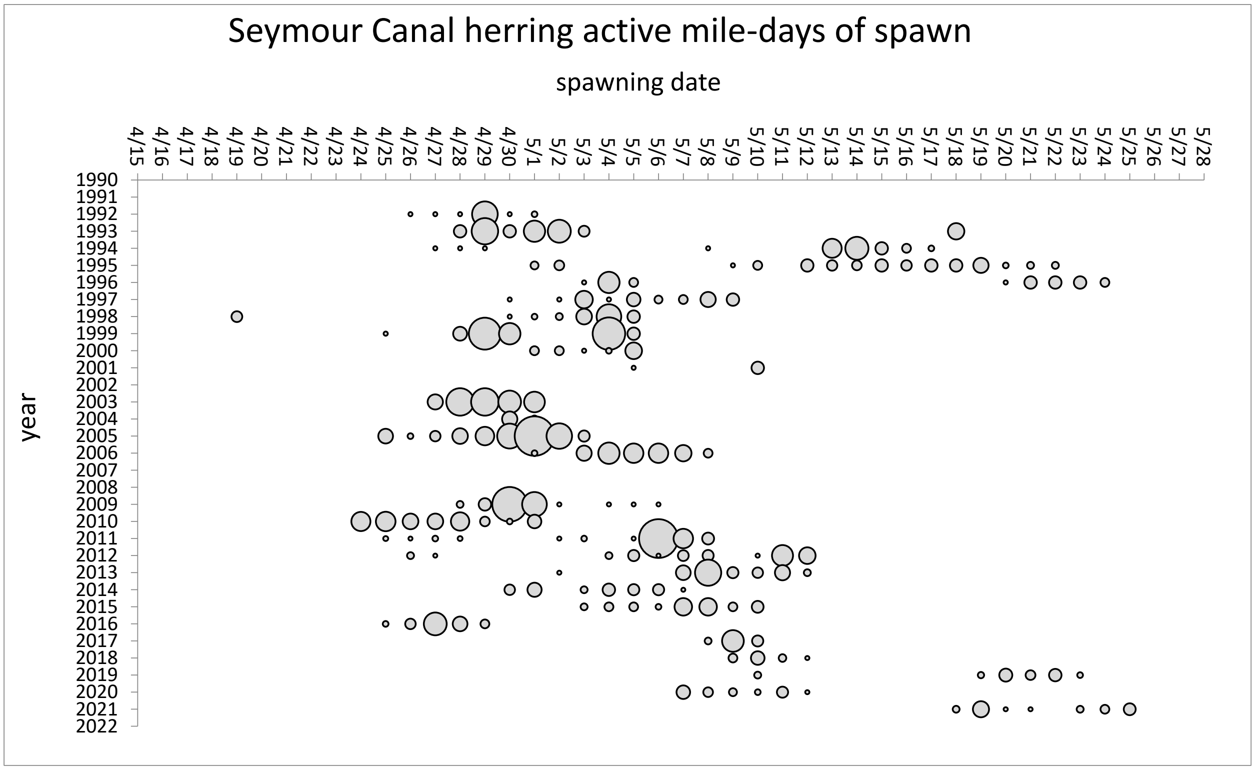

Figure 11.–Historical dates of active spawn observed for the Seymour Canal herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 10 nautical miles of spawn and the smallest circles represent *spot spawns*, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located.

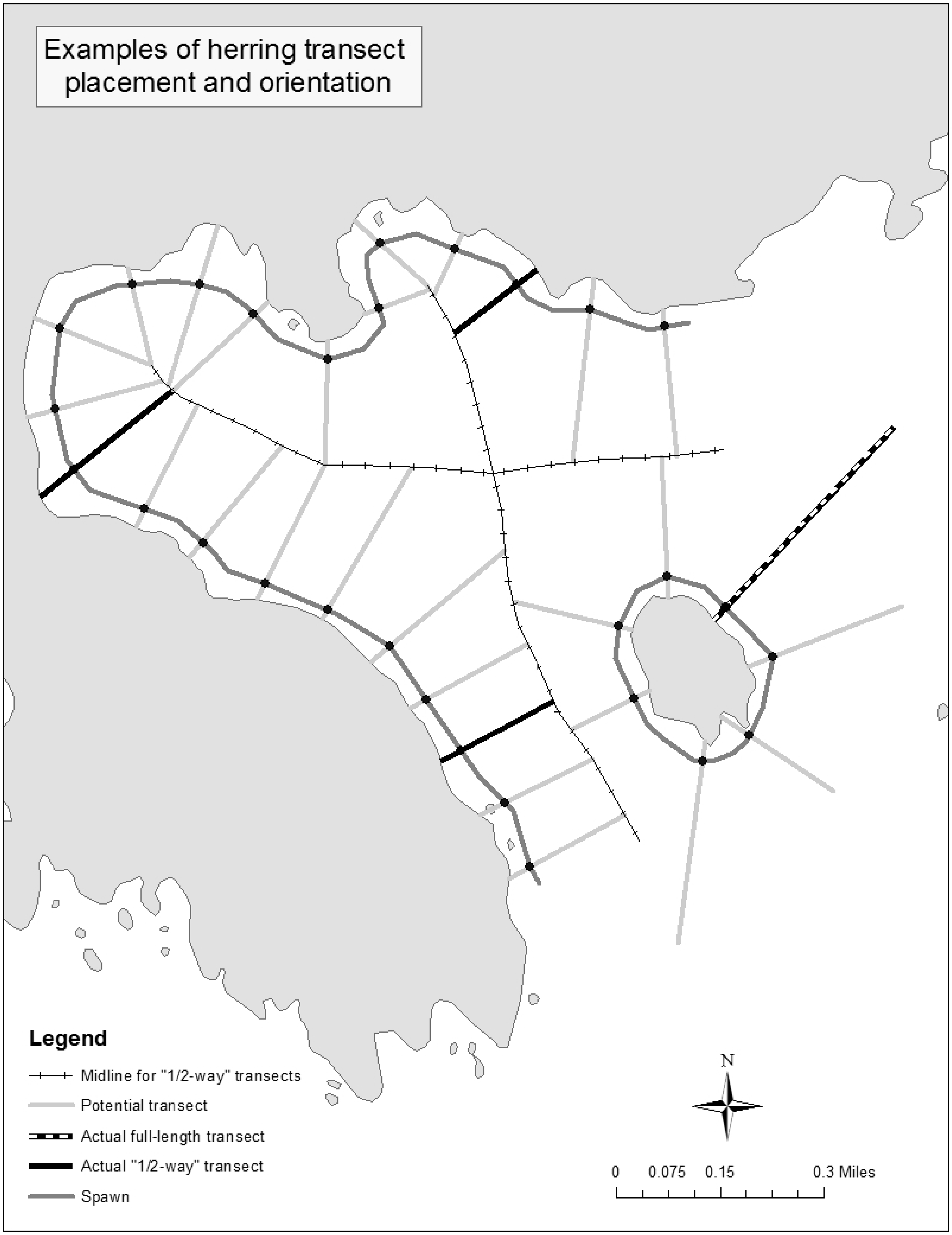

Figure 12.–Example of hypothetical herring transect placement and orientation, representing points at which transects should be halted to prevent over sampling.

Stock	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	14-Mar	15-Mar	16-Mar	17-Mar	18-Mar	19-Mar	20-Mar	21-Mar	22-Mar	23-Mar	24-Mar	25-Mar	26-Mar	27-Mar	28-Mar	29-Mar	30-Mar	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	9-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-Apr	15-Apr	16-Apr
Sitka Sound	0.0	ns	ns	0.0	ns	0.0	0.0	0.0	ns	0.0	0.0	0.1	0.0	0.0	ns	0.0	0.0	ns	ns	0.0	0.0	0.1	0.0	0.1	0.1	0.1	6.5	14.9	20.0	28.3	ns	18.4	24.2	25.7	12.5	ns	0.1	0.0	0.4
Revilla Channel									ns	0.0	ns	ns	ns	0.0	ns	ns	0.0	0.5	ns	3.0	5.8	3.3	ns	ns	ns	0.0	ns	0.3	0.1	ns									
Craig									ns	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	ns	ns	0.0	ns	0.2	1.0	2.6	8.7	10.5	15.5	22.0	12.4	1.5	1.1	0.0	ns
West Behm Canal																											ns	0.0	ns	ns	0.0	0.0	ns	ns	1.3	5.7	5.2	2.7	0.0
Ernest Sound																																	ns	0.0	ns	ns	0.1	0.5	0.0
Seymour Canal																																						ns	0.0
Tenakee Inlet																																						ns	0.0
Lynn Canal																																						ns	0.0

continued	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May	4-May	5-May	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May
Sitka Sound	0.9	ns	ns																																				
Ernest Sound	ns	ns	0.0	ns																																			
Hoonah Sound						ns	0.0	ns																															
Seymour Canal	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	0.1	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	0.3	1.3	0.1	0.1	ns	0.3	0.5	0.9
Tenakee Inlet	ns	ns	ns	1.0	0.1	ns	0.8	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	ns	ns	ns	ns	ns	0.0	ns							
Lynn Canal	ns	ns	ns	0.0	ns	0.0	ns	ns	ns	0.0	ns	ns	ns	ns	ns	0.0	ns	ns	0.4	0.1	ns	0.3	ns	ns	0.0	ns	ns	ns	ns	ns	0.0	ns							
Hobart/Houghton				ns	0.0	ns	0.0	ns	ns	1.4	2.3	1.1	0.0	ns	ns	0.0	ns	0.0	ns	ns	ns	2.5	2.6	1.0	0.3	0.0	ns												
Yakutat Bay											ns	0.3	ns	1.1	ns	3.0	ns	1.7	ns	1.0	ns																		

Figure 13.–Spawn timing of herring stocks in Southeast Alaska during spring 2021. Values indicate daily measurements of nautical miles of active spawn recorded during aerial surveys. Shaded area depicts dates when cast-net samples were taken. Boxed areas indicate duration of spawning (first to last dates of observed spawn). Dates with no survey are depicted by “ns”. Blank dates indicate dates that are outside of historical spawning timing and so surveys had not commenced or were concluded.

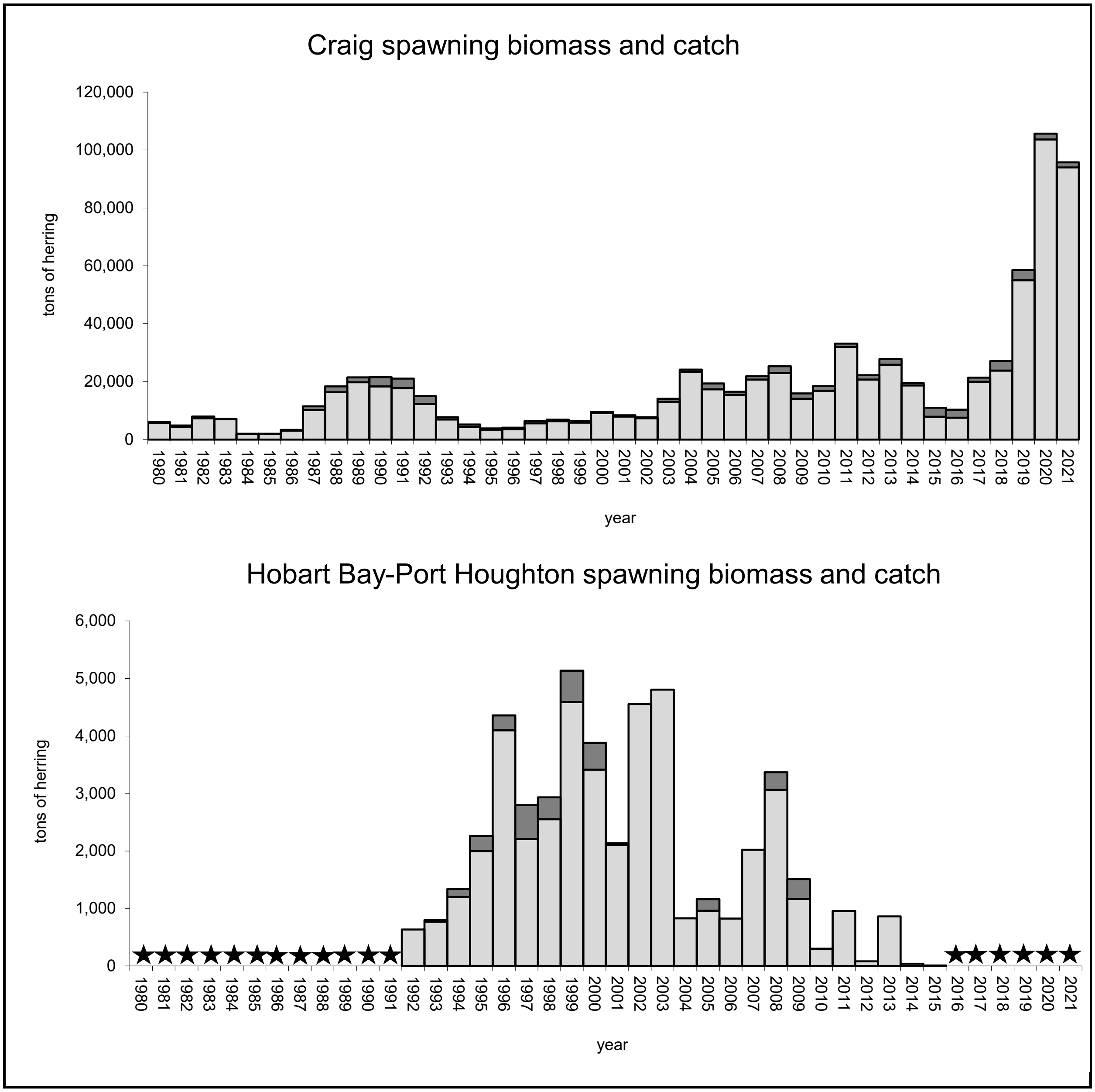

Figure 14.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Craig and Hobart Bay–Port Houghton areas, during 1980–2021. Stars represent years when spawn deposition surveys were not conducted.

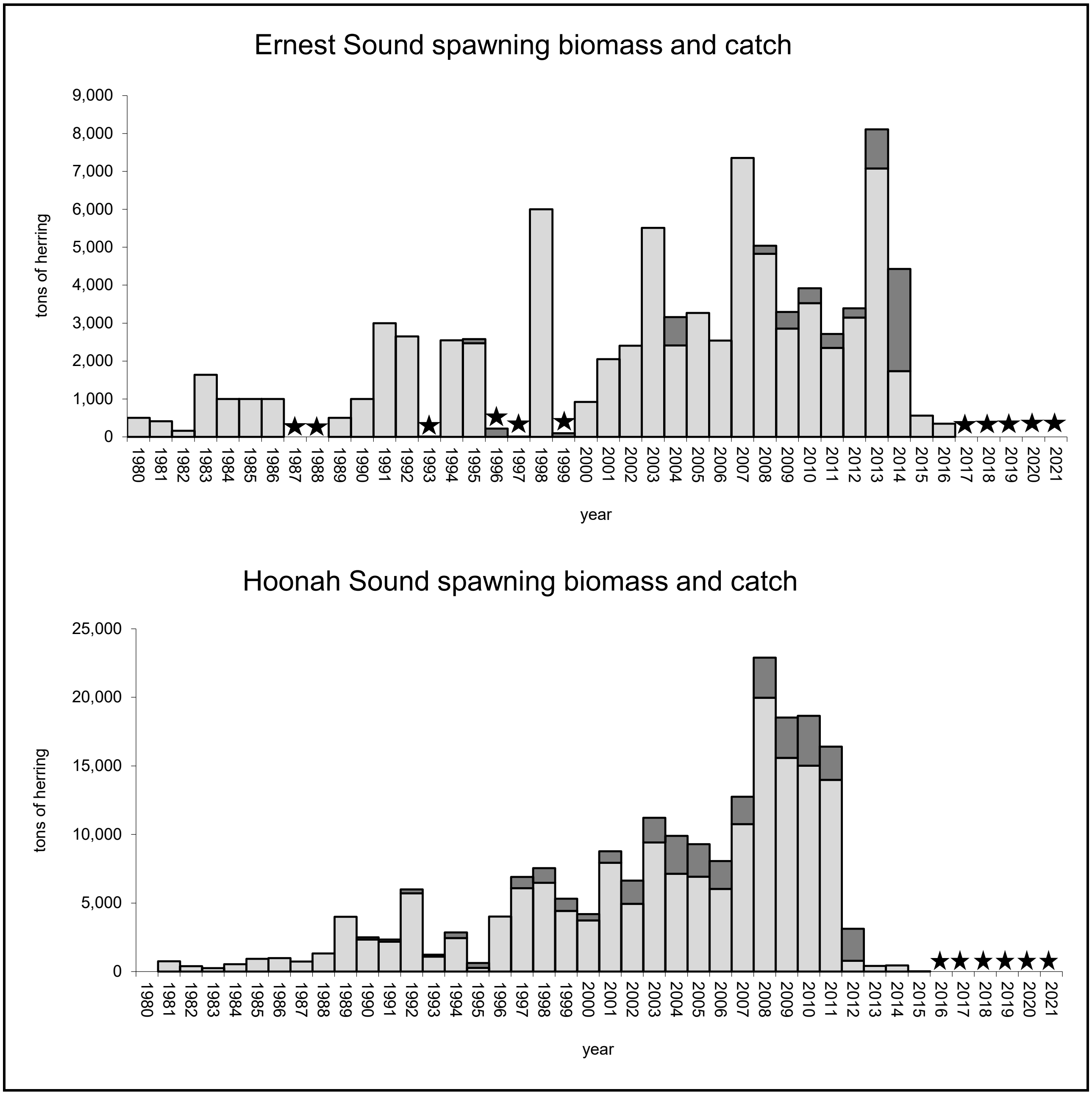

Figure 15.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys or hydroacoustic surveys, and catch (dark gray bars) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2021. Stars represent years when spawn deposition surveys were not conducted.

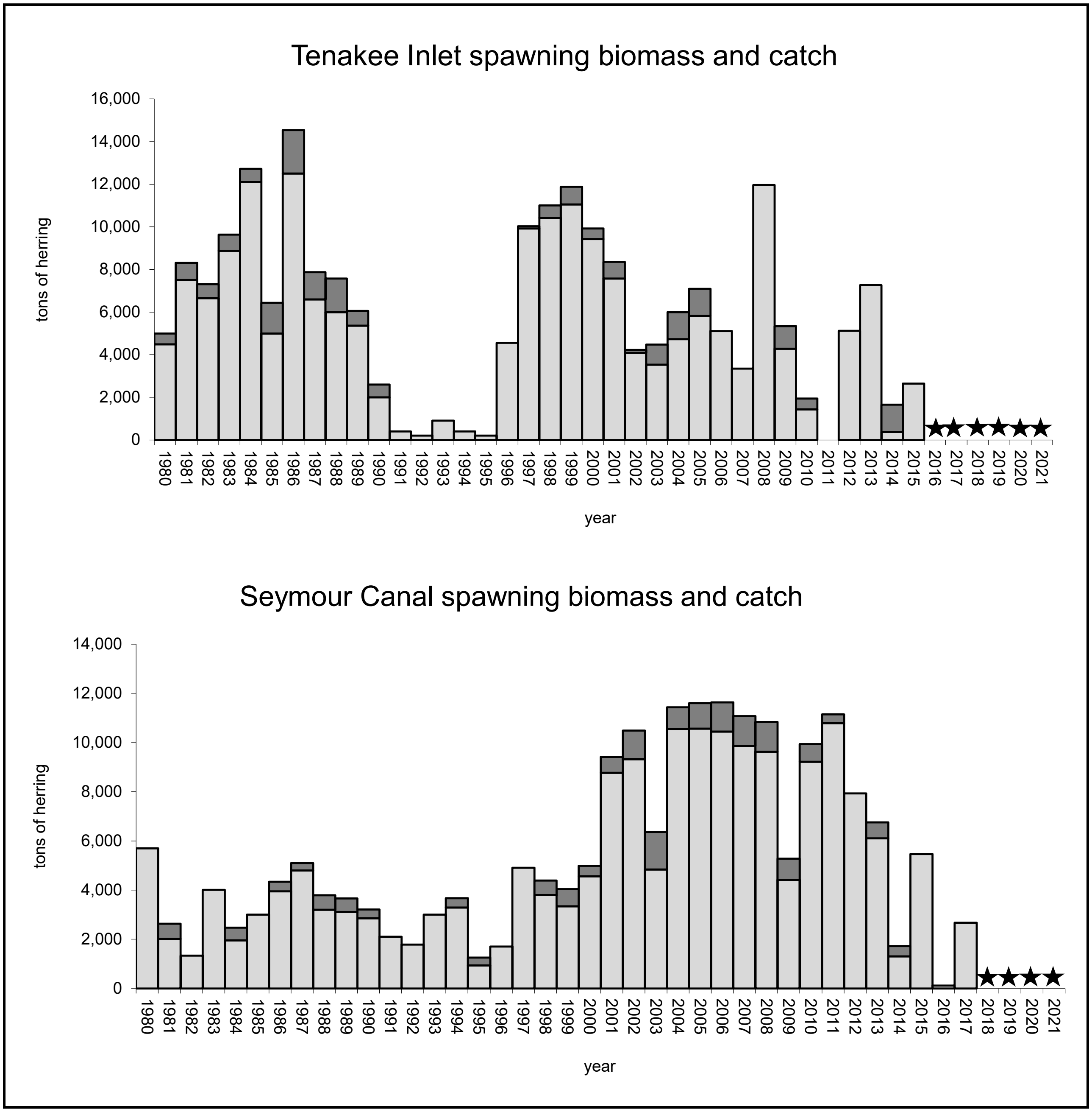

Figure 16.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys or hydroacoustic surveys, and catch (dark gray bars) for stocks in the Seymour Canal and Tenakee Inlet areas, during 1980–2021. Stars represent years when spawn deposition surveys were not conducted.

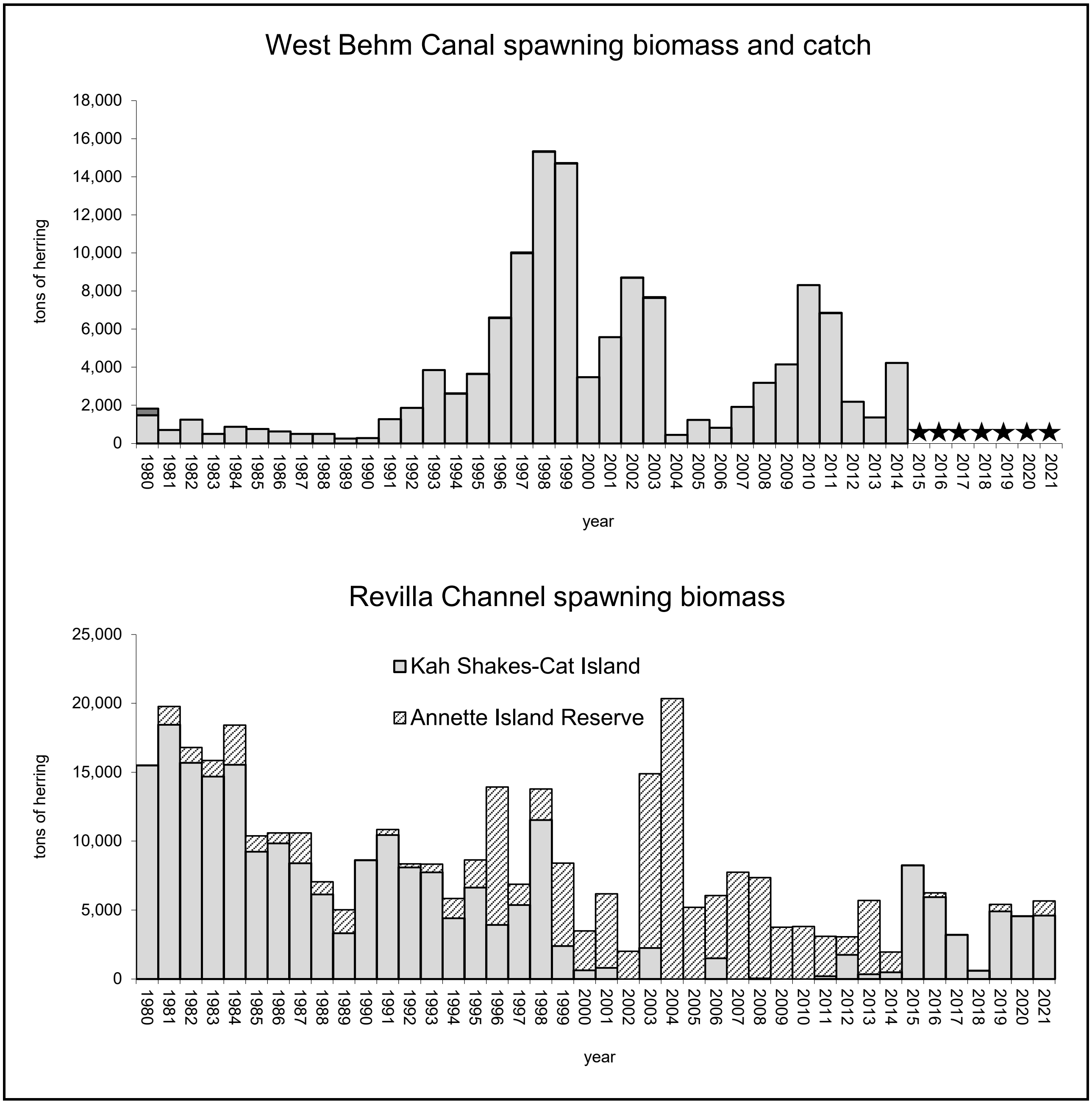

Figure 17.–Observed herring post-fishery spawning biomass, based on spawn deposition surveys or hydroacoustic surveys for stocks in the West Behm Canal and Revilla Channel (Kah Shakes–Cat Island–Annette Island) areas, during 1980–2021. Annette Island spawning biomass estimates between 1981 and 2016 were made as the product of the length of observed linear shoreline spawn mileage and a fixed approximated value of 500 tons of herring per nautical mileage of shoreline, based on the estimated mean value over the period 1991–2000. Stars represent years when spawn deposition surveys were not conducted.

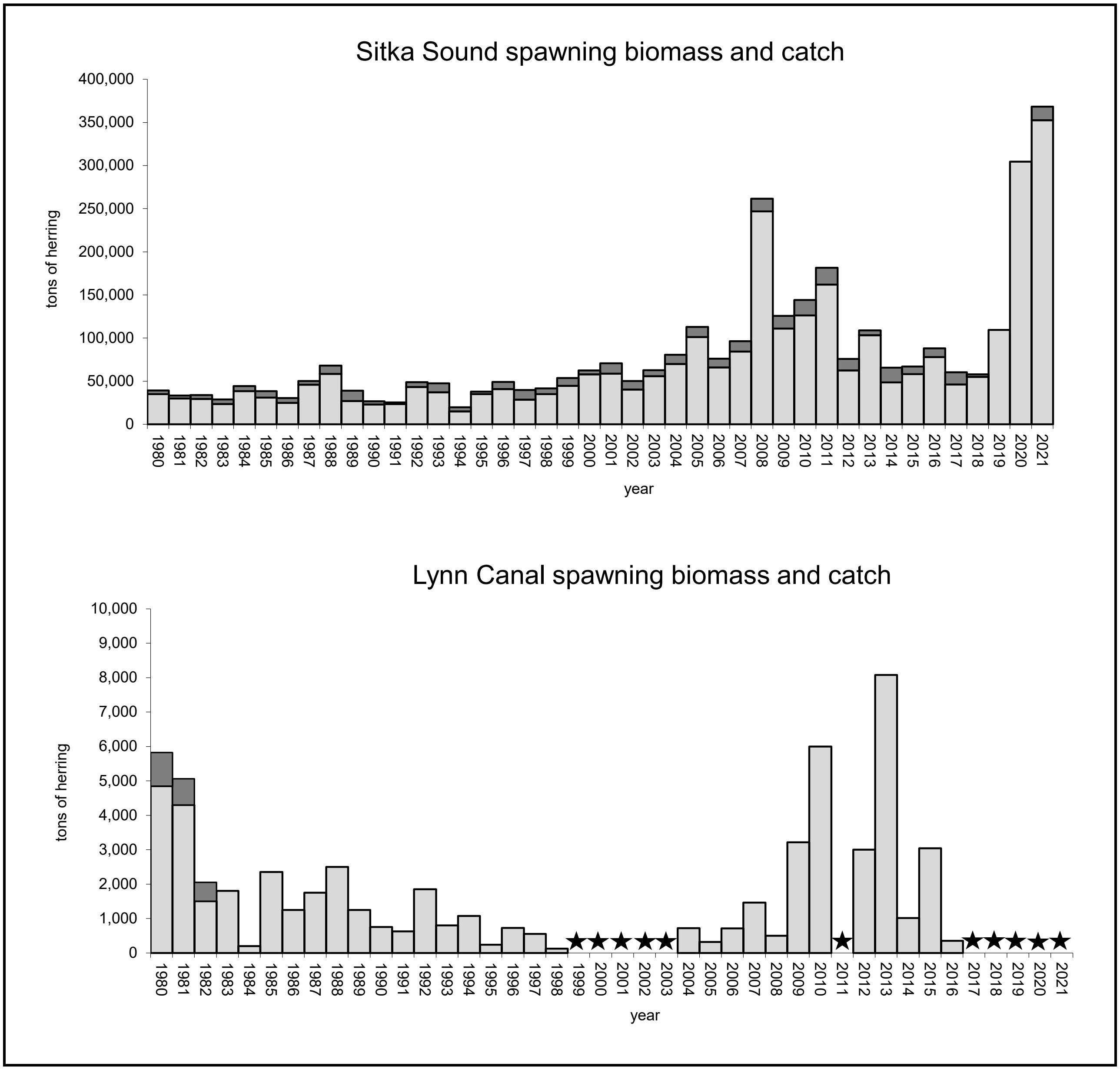

Figure 18.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2021. Estimates of spawning biomass for Lynn Canal prior to 2004 were made using a variety of methods (e.g., hydroacoustics or visual estimates of spawn density converted to biomass), and results should be viewed as approximations. Stars represent years when spawn deposition surveys were not conducted.

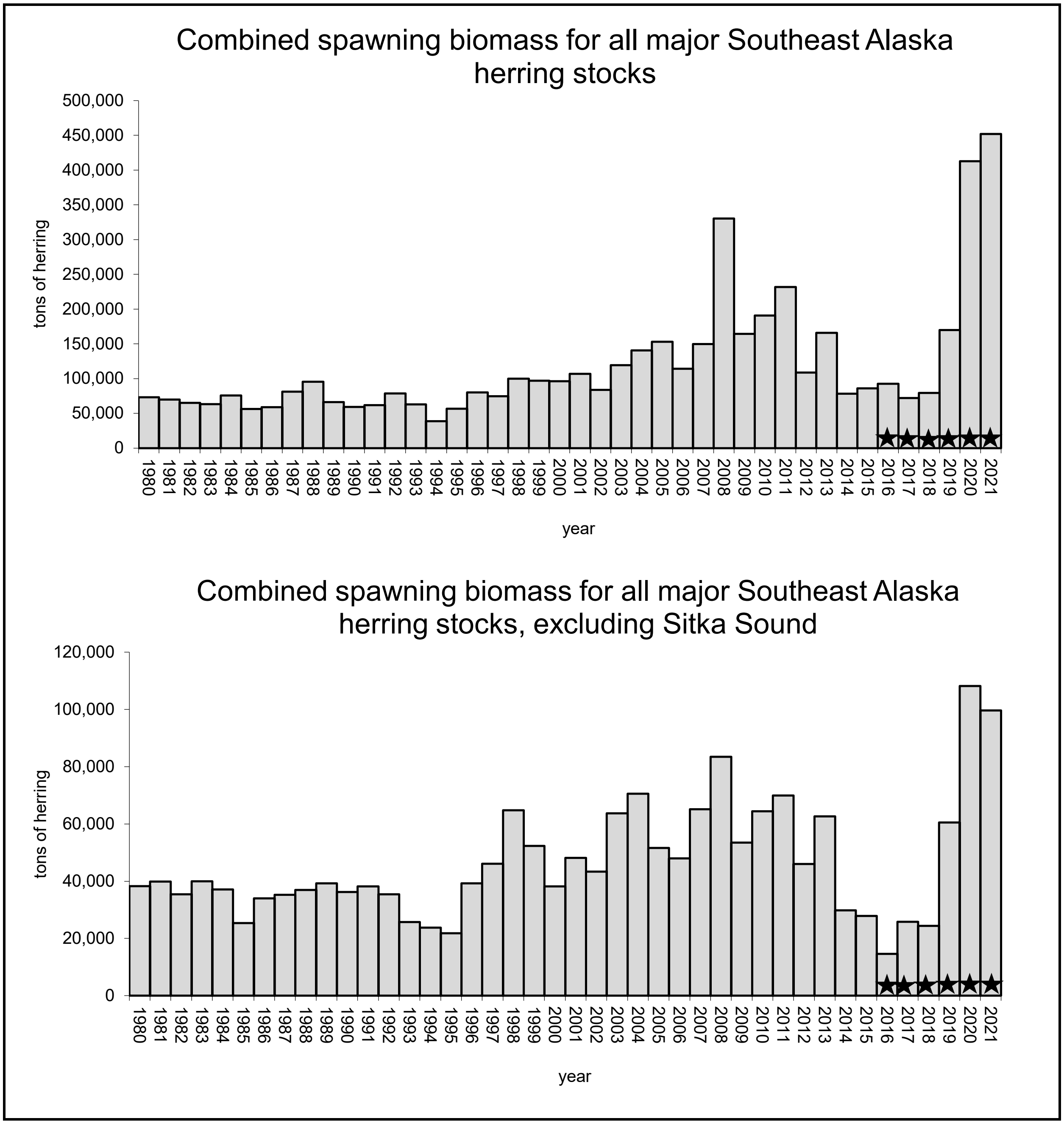

Figure 19.–Combined observed herring post-fishery spawning biomass, based on spawn deposition surveys or hydroacoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2021. Recent years represent an underestimate of regional total biomass, because of the ten major spawning areas that have been historically monitored, the following number of areas were surveyed in recent years: 2016, 6 areas; 2017, 7 areas; 2018, 2 areas; and 2019-2021, 3 areas. Stars represent years when spawn deposition surveys were not conducted in at least one of the ten major spawning areas since 2016.

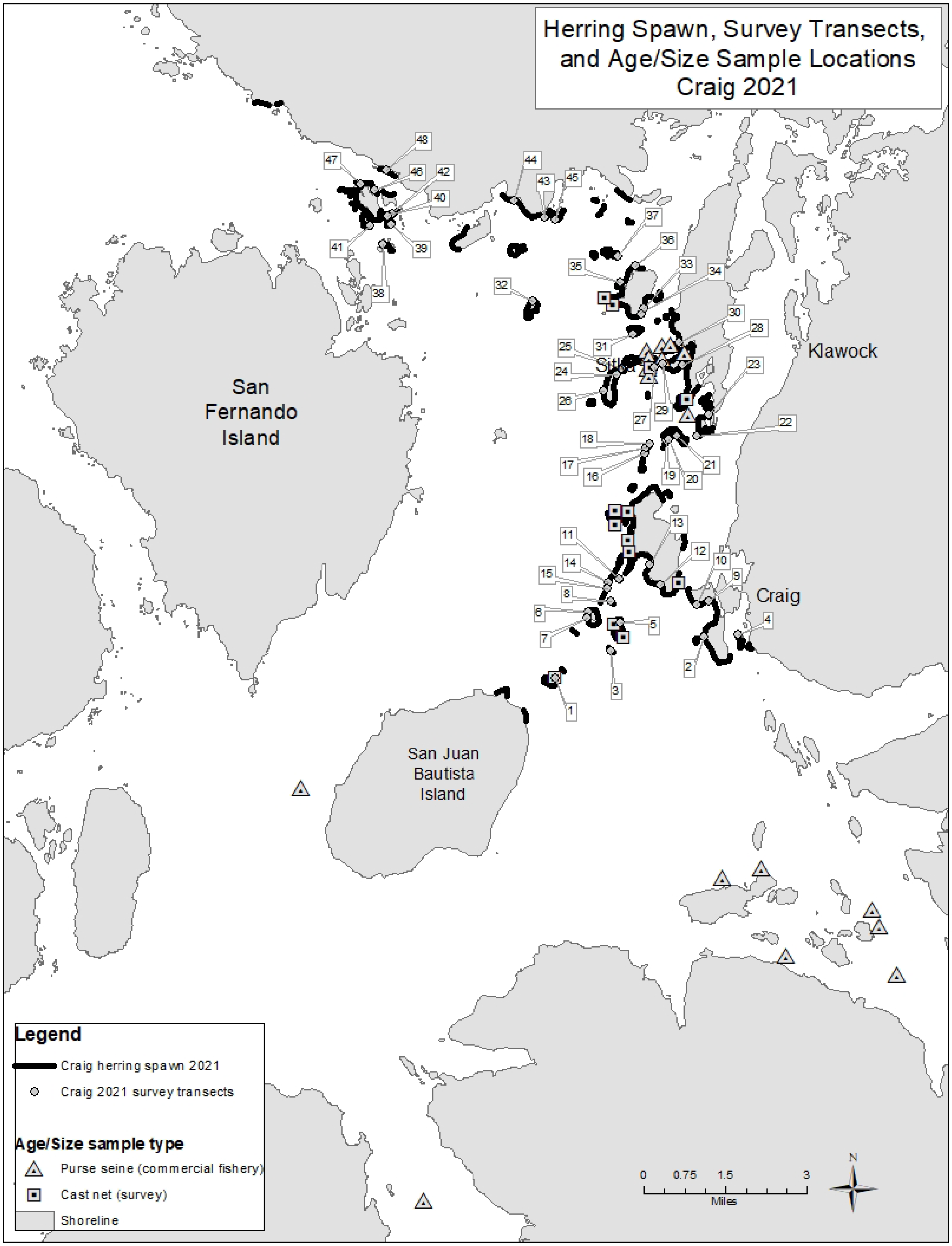

Figure 20.–Locations of herring egg survey transects and samples for estimates of age and size for the Craig herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

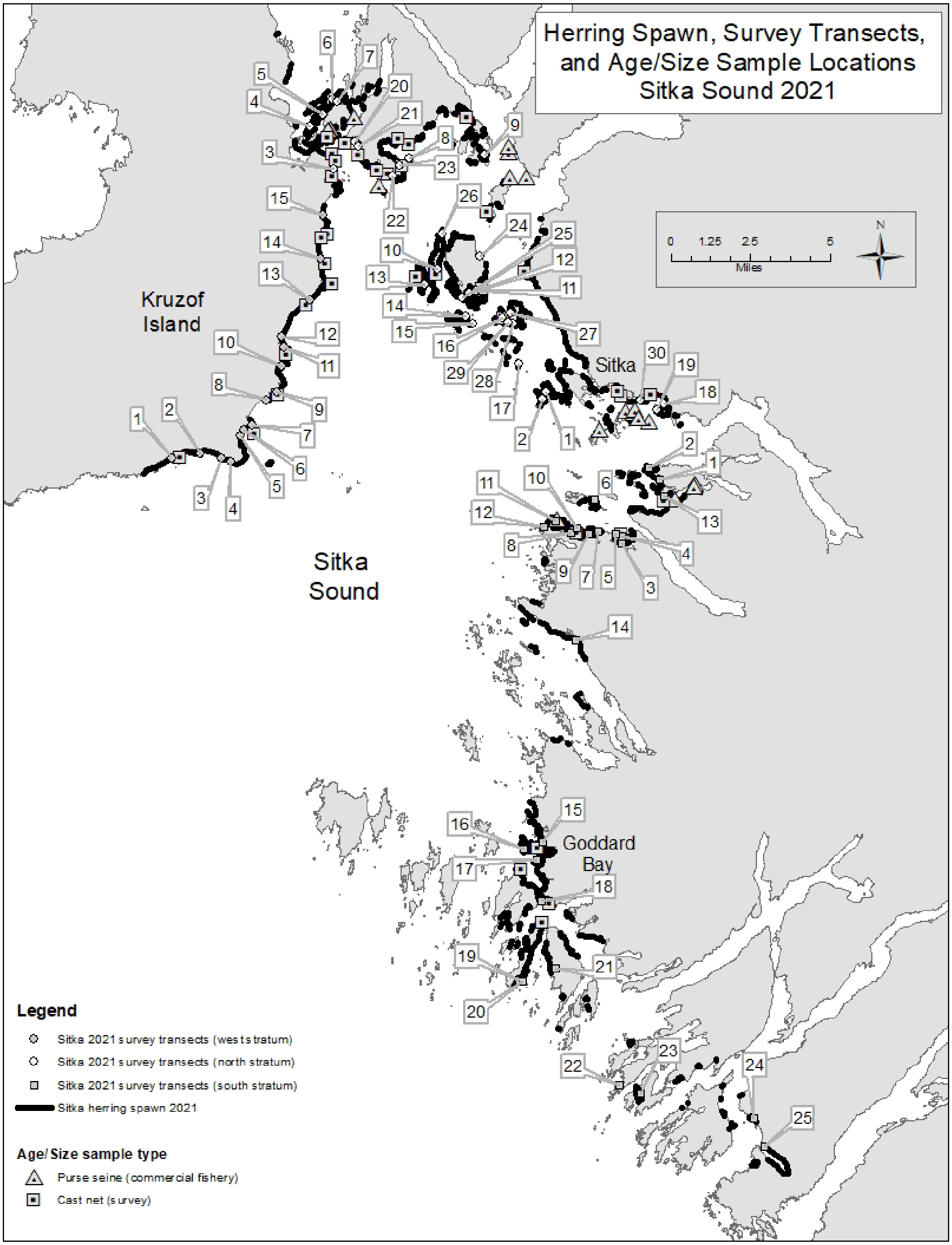

Figure 21.–Locations of herring egg survey transects and samples collected for estimates of age and size for the Sitka Sound herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

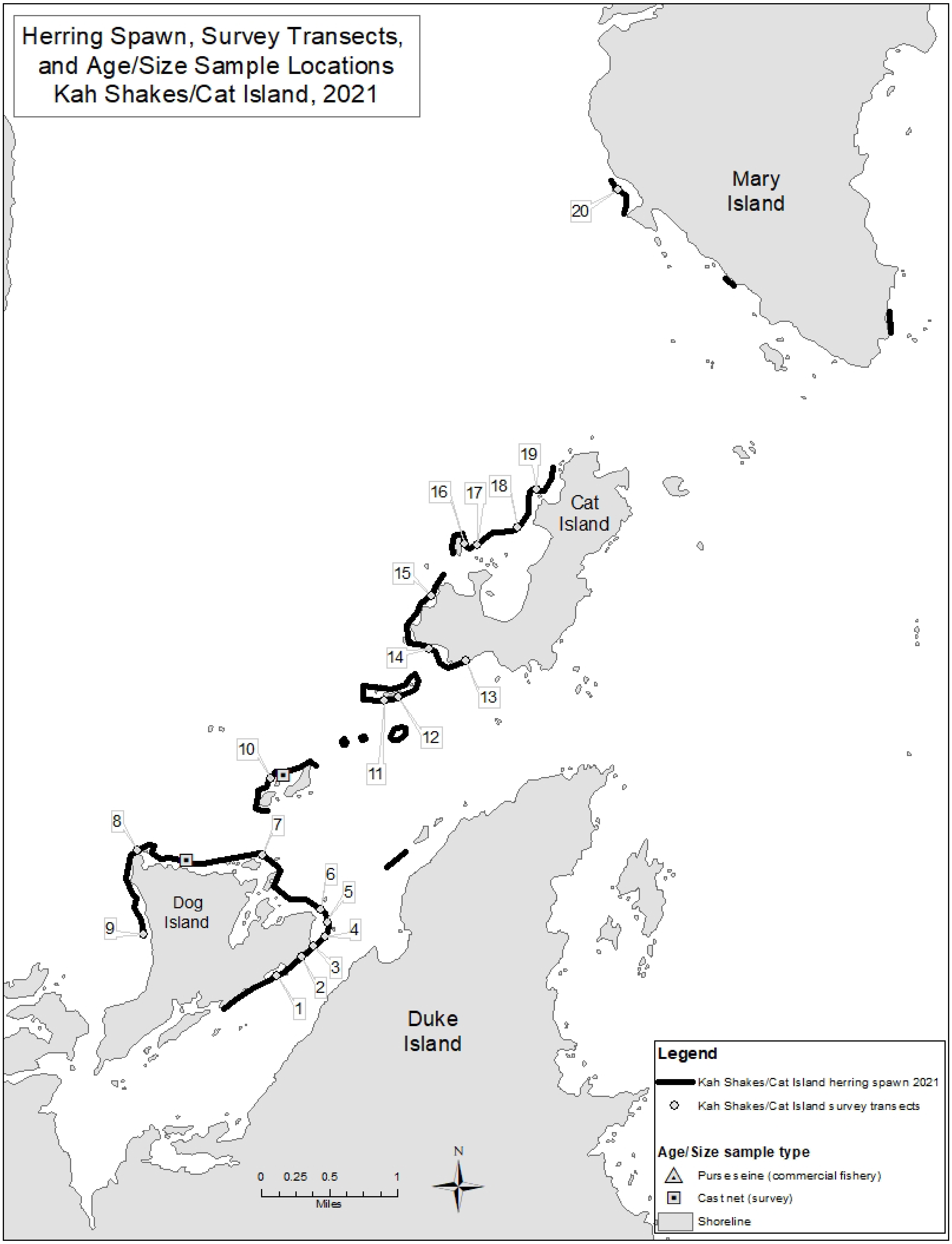

Figure 22.–Locations of herring egg survey transects and samples collected for estimates of age and size for the Kah Shakes–Cat Island (Revilla Channel) herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

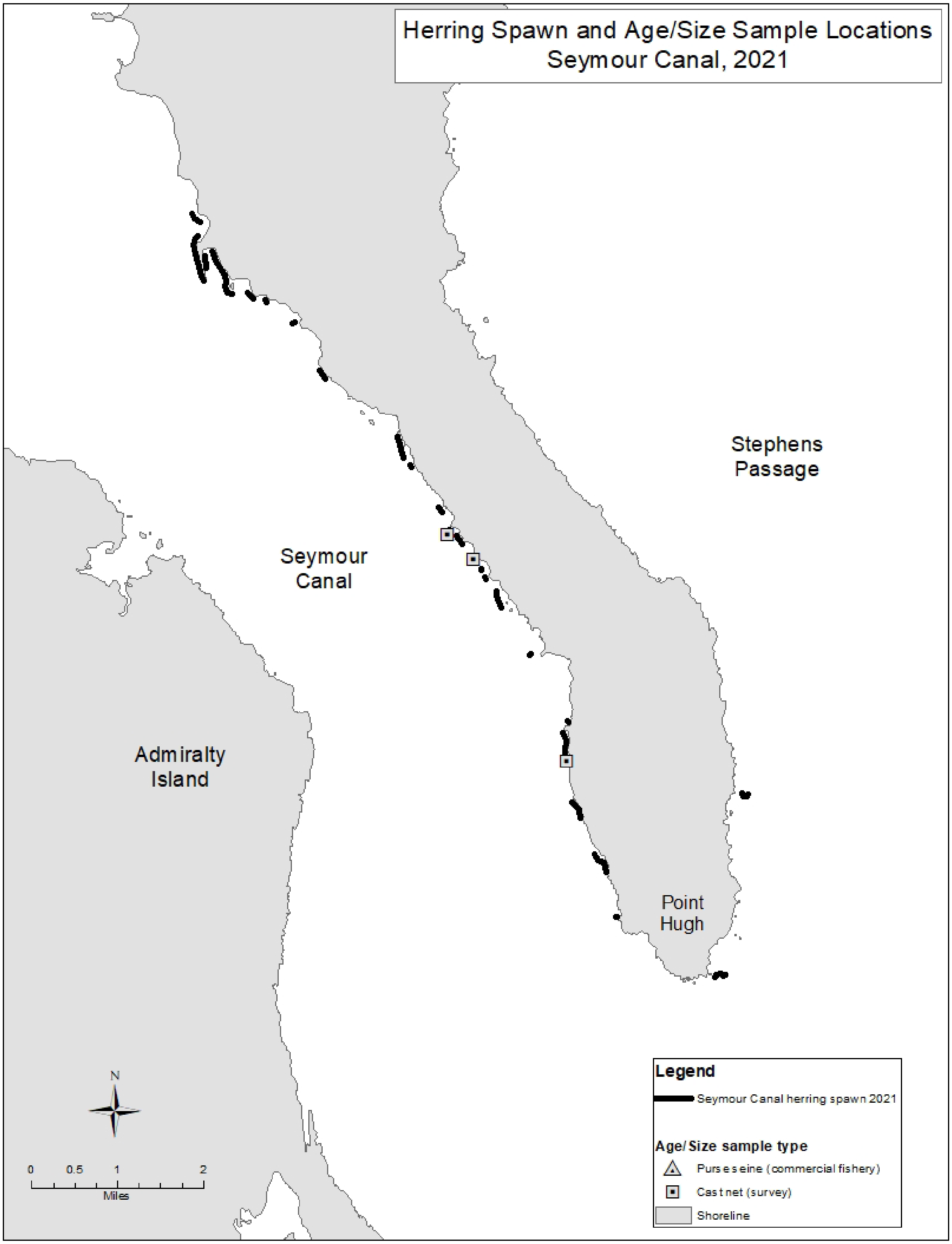

Figure 23.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

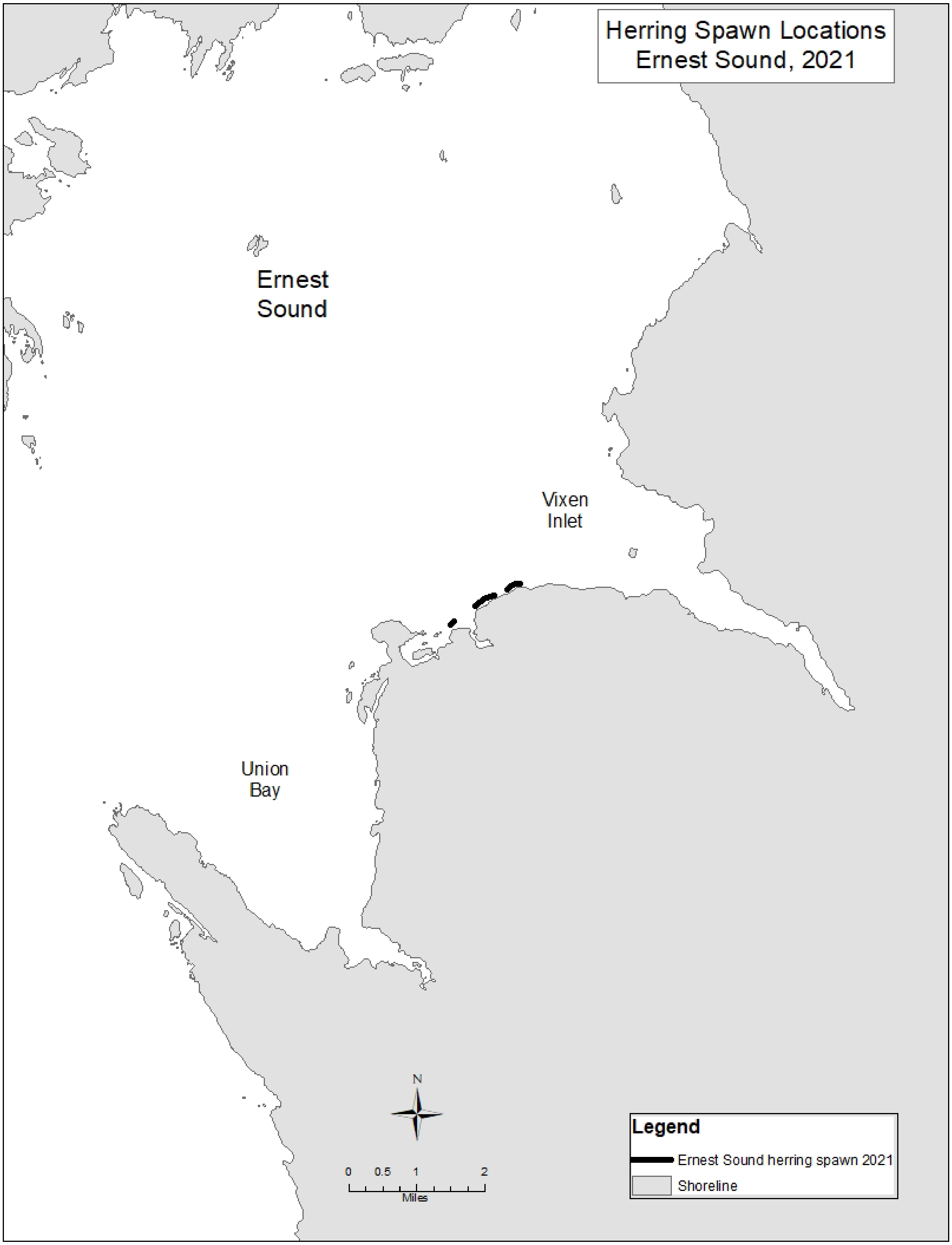

Figure 24.–Locations of herring spawn observed for the Ernest Sound herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

Figure 25.–Locations of herring observed for the Hobart Bay–Port Houghton herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

Figure 26.–Locations of herring observed for the Lynn Canal herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

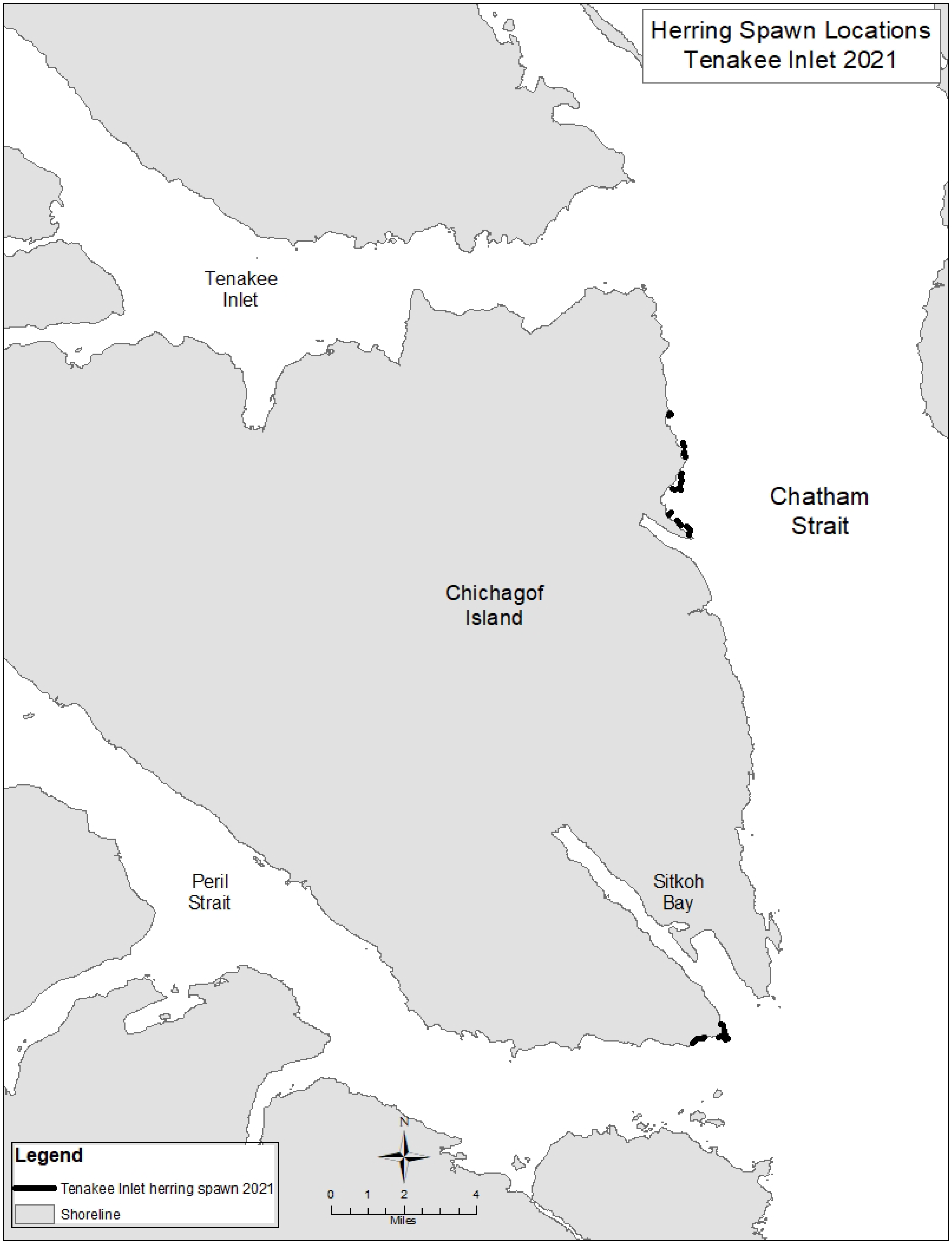

Figure 27.–Locations of herring observed for the Tenakee Inlet herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

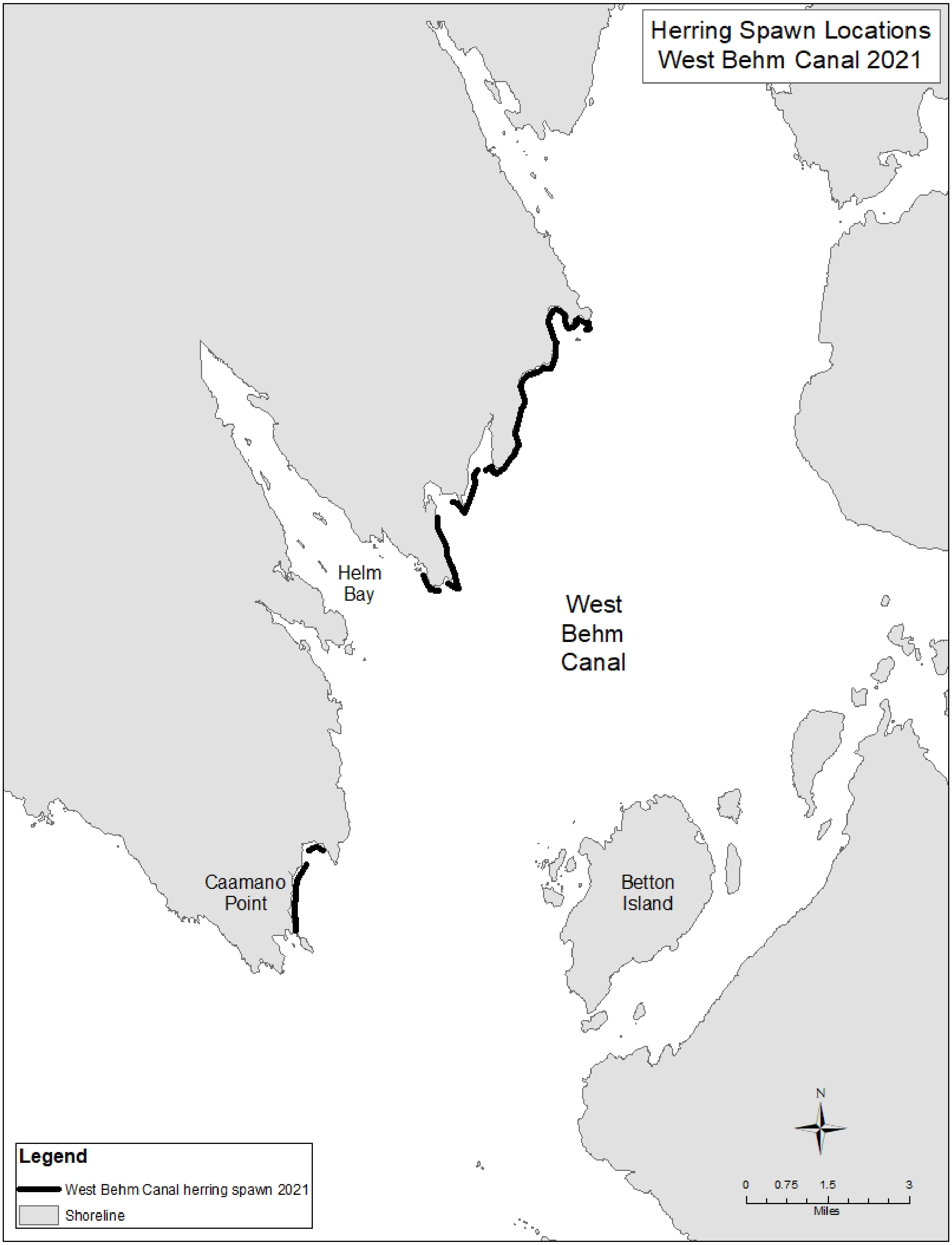

Figure 28.–Locations of herring observed for the West Behm Canal herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

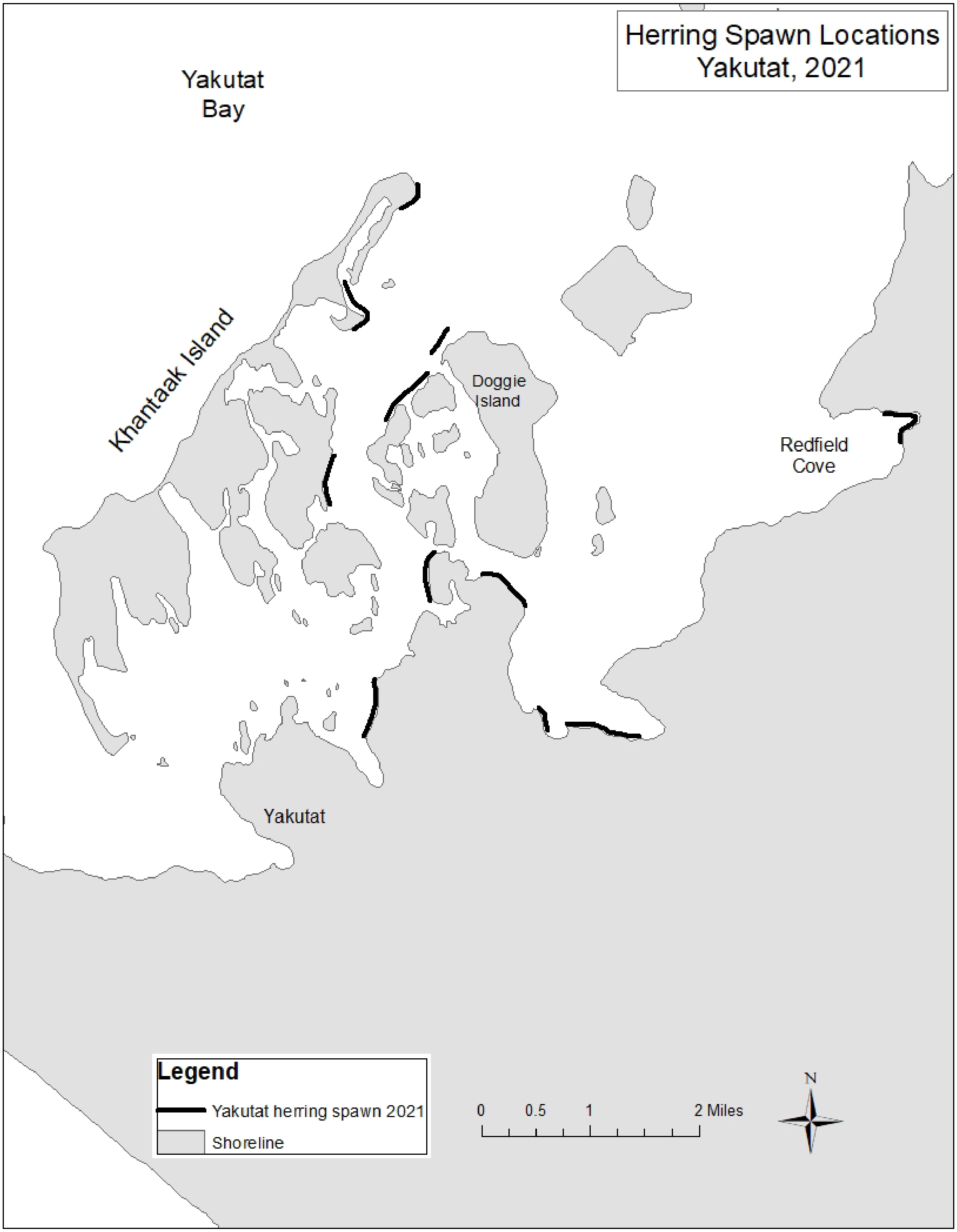

Figure 29.–Locations of herring observed for the Yakutat Bay herring stock for the 2020–21 season. Cumulative herring spawn denoted by thick black line along shoreline.

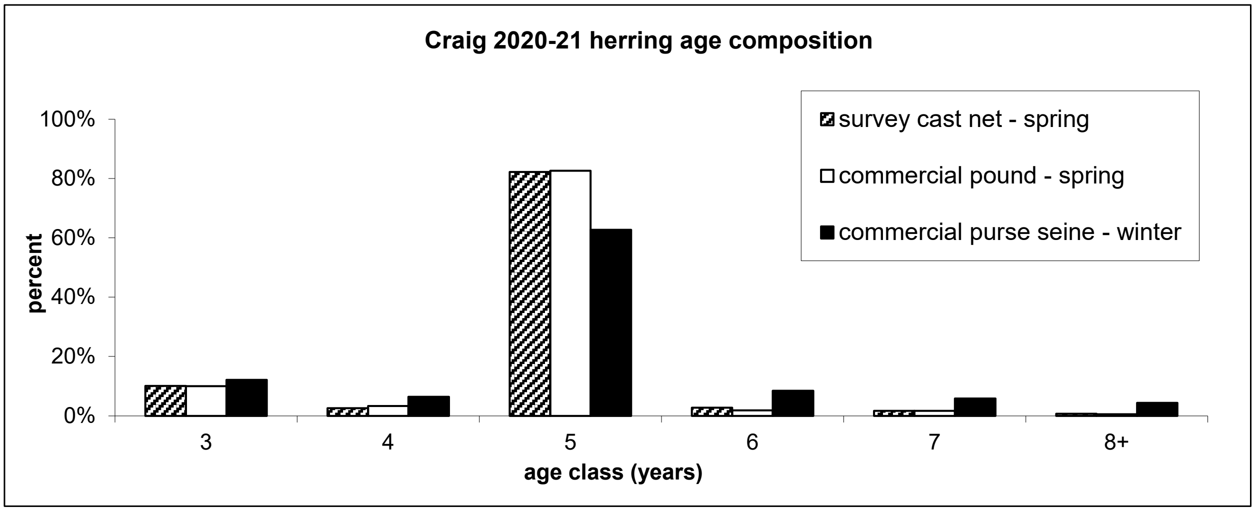

Figure 30.–Observed age composition for Craig herring stock in 2020–21.

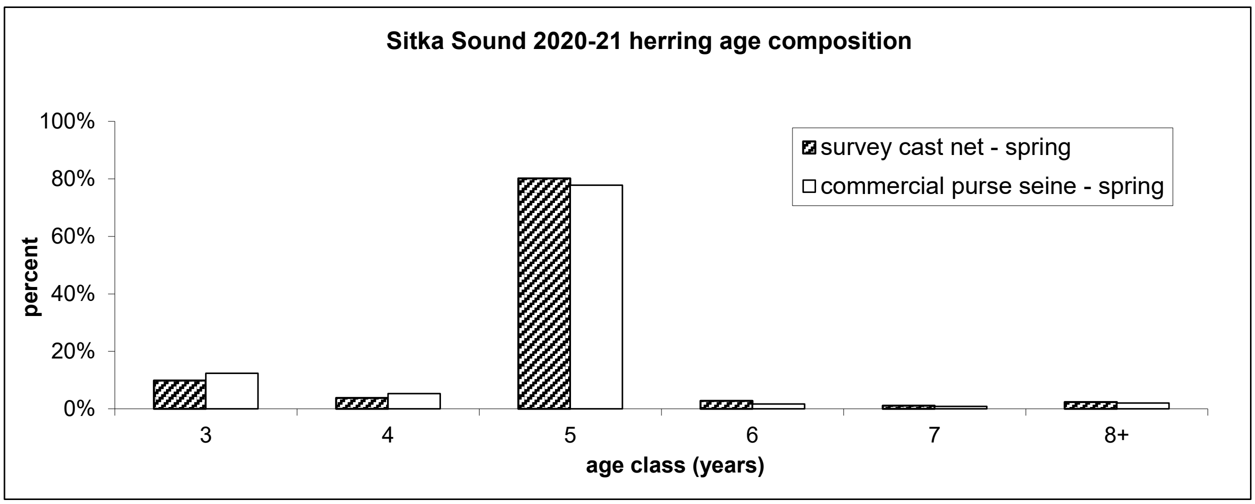

Figure 31.–Observed age composition for Sitka herring stock in 2020–21.

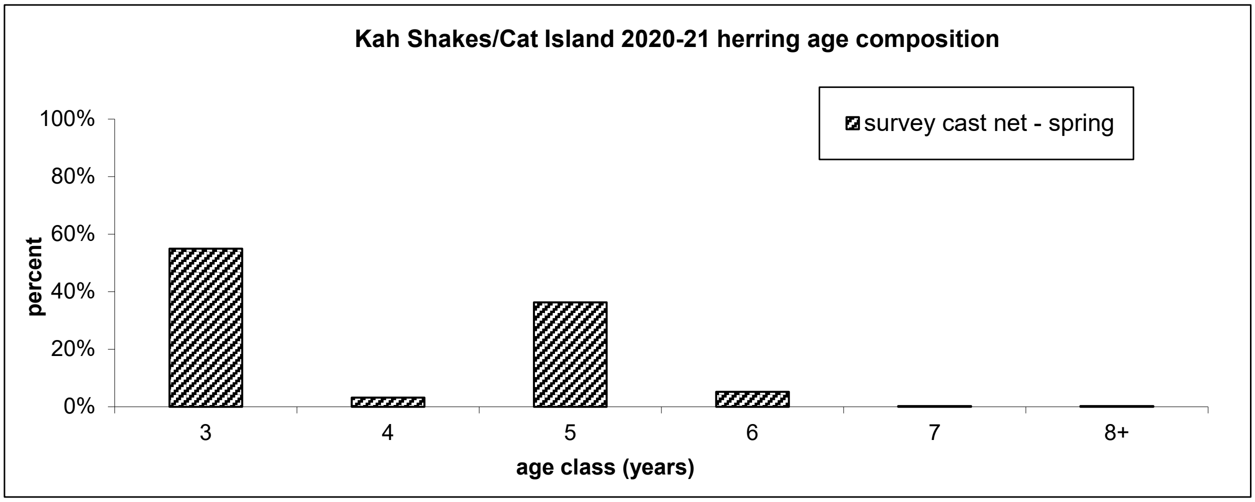

Figure 32.–Observed age composition for Kah Shakes–Cat Island (Revilla Channel) herring stock in 2020–21.

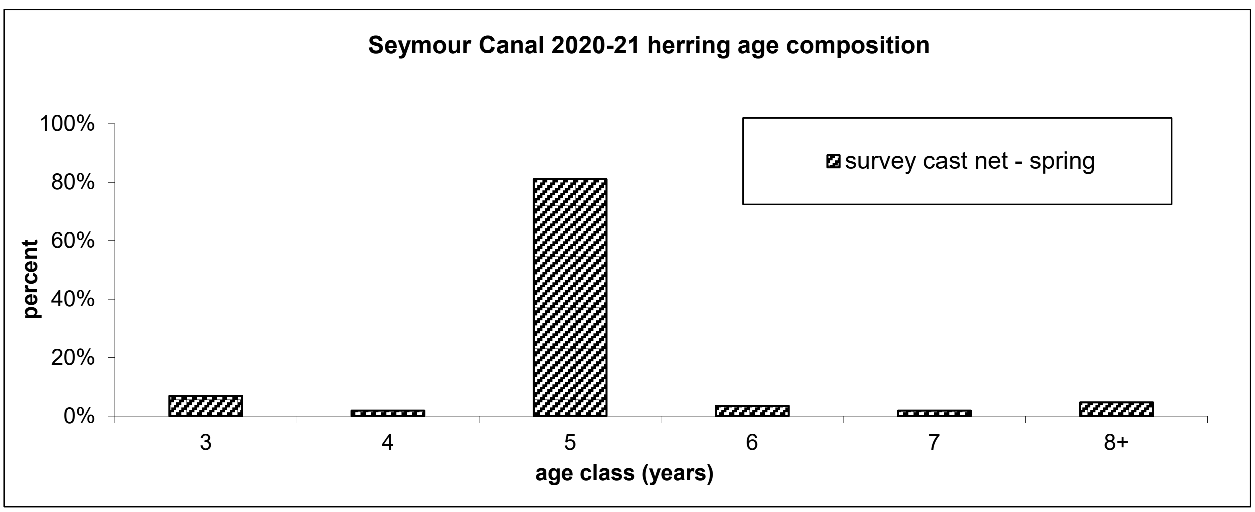

Figure 33.–Observed age composition for Seymour Canal herring stock in 2020–21.

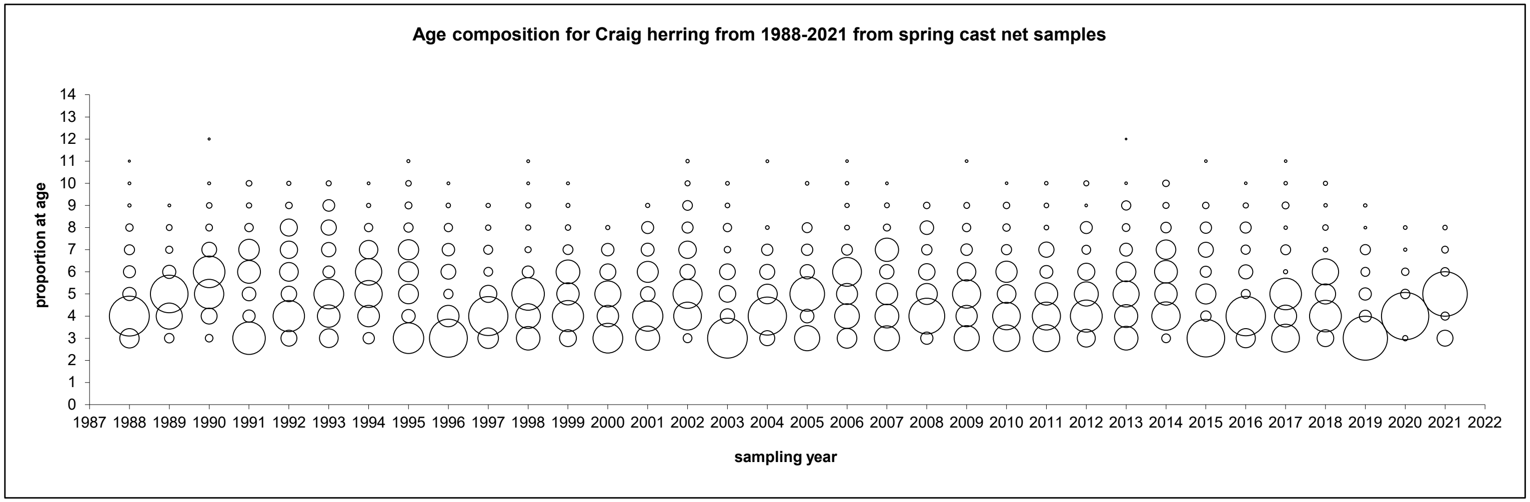

Figure 34.–Observed age compositions from sampling data for the Craig herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For reference, the largest circle represents 93%.

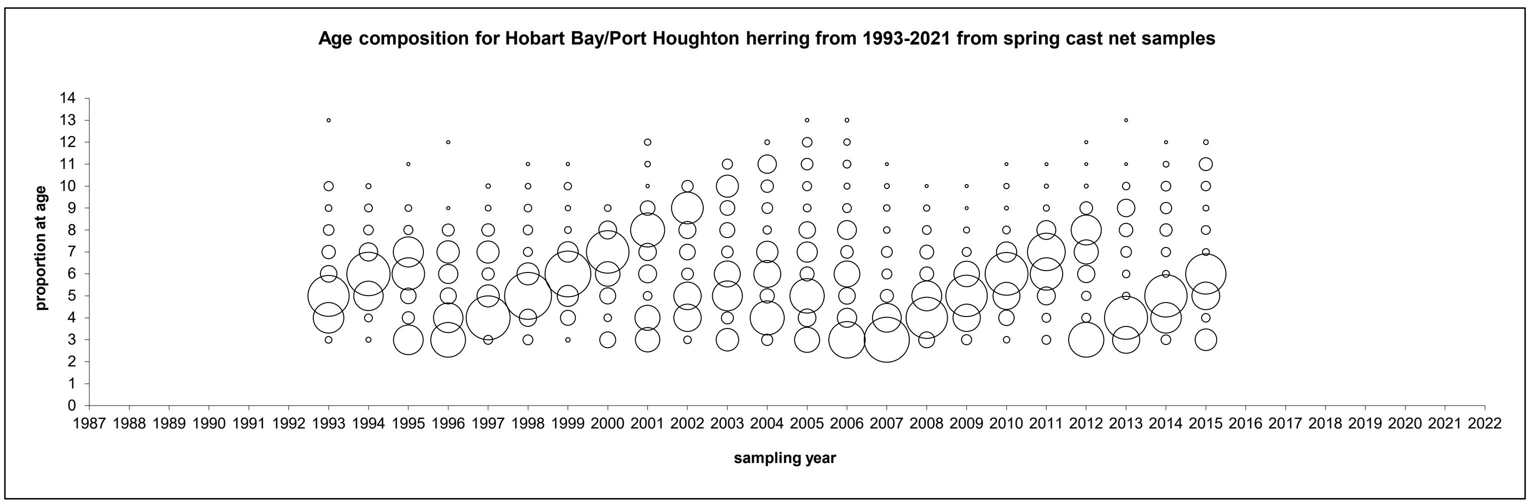

Figure 35.–Observed age compositions from sampling data for the Hobart Bay–Port Houghton herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 67%.

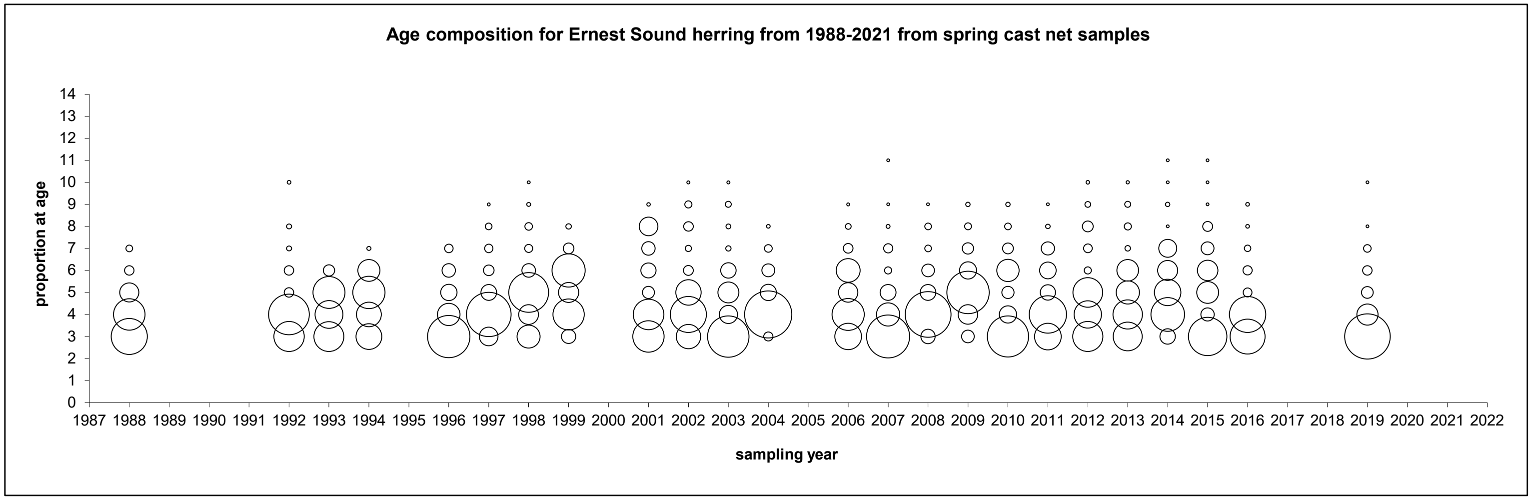

Figure 36.–Observed age compositions from sampling data for the Ernest Sound herring stock. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 80%.

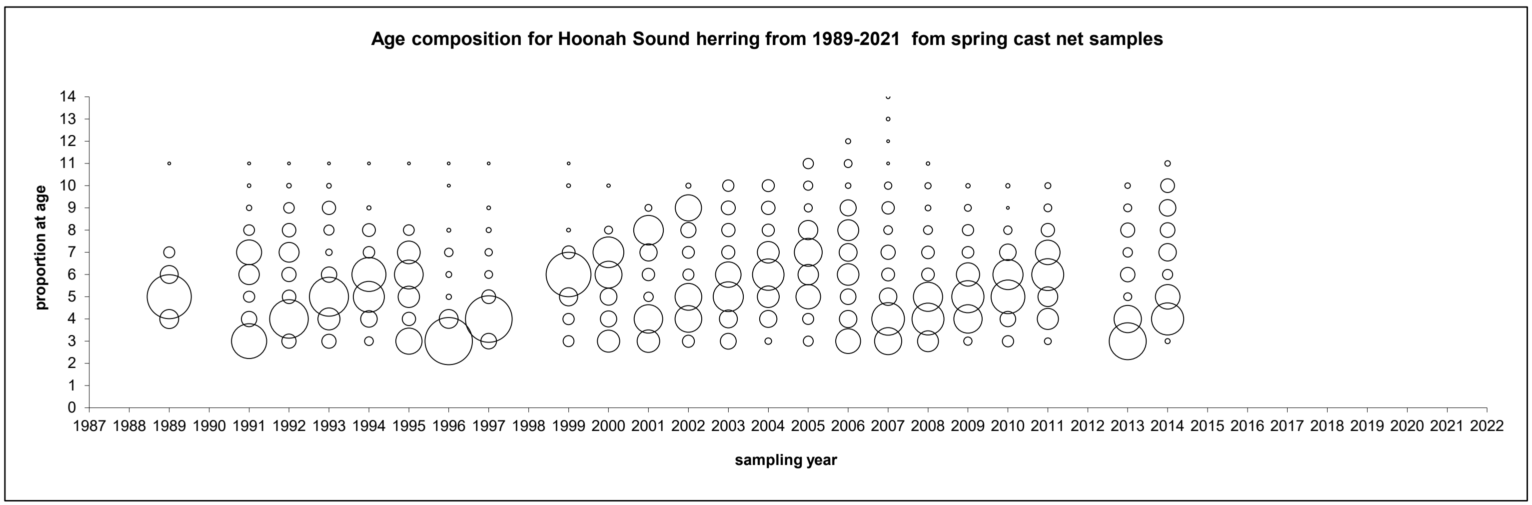

Figure 37.–Observed age compositions from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 82%.

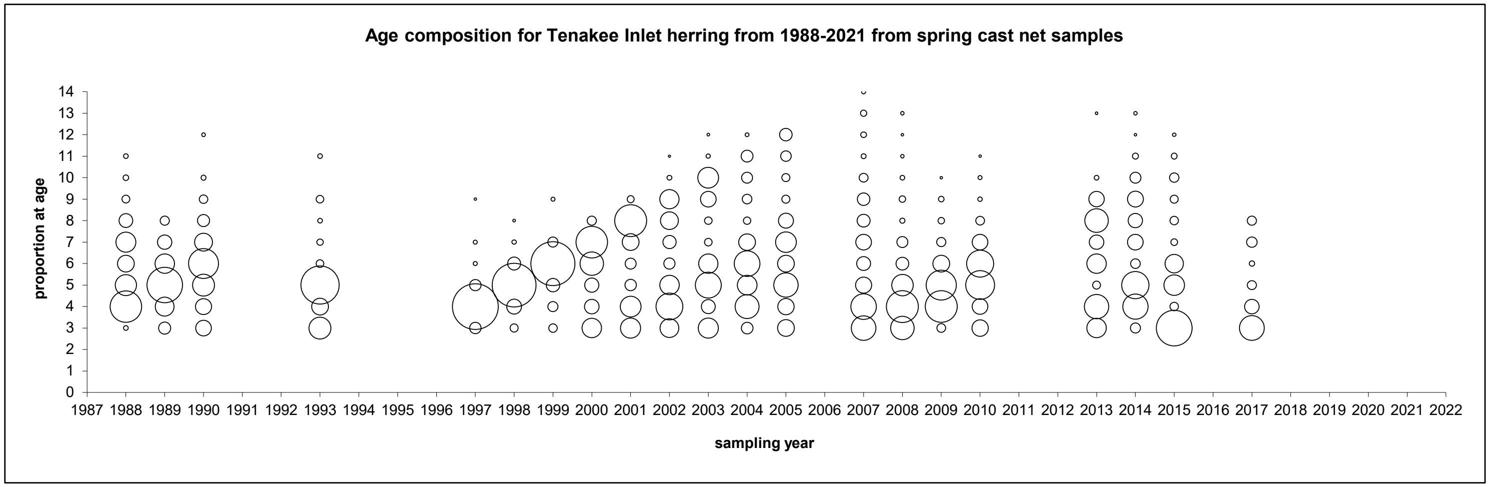

Figure 38.–Observed age compositions from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 88%.

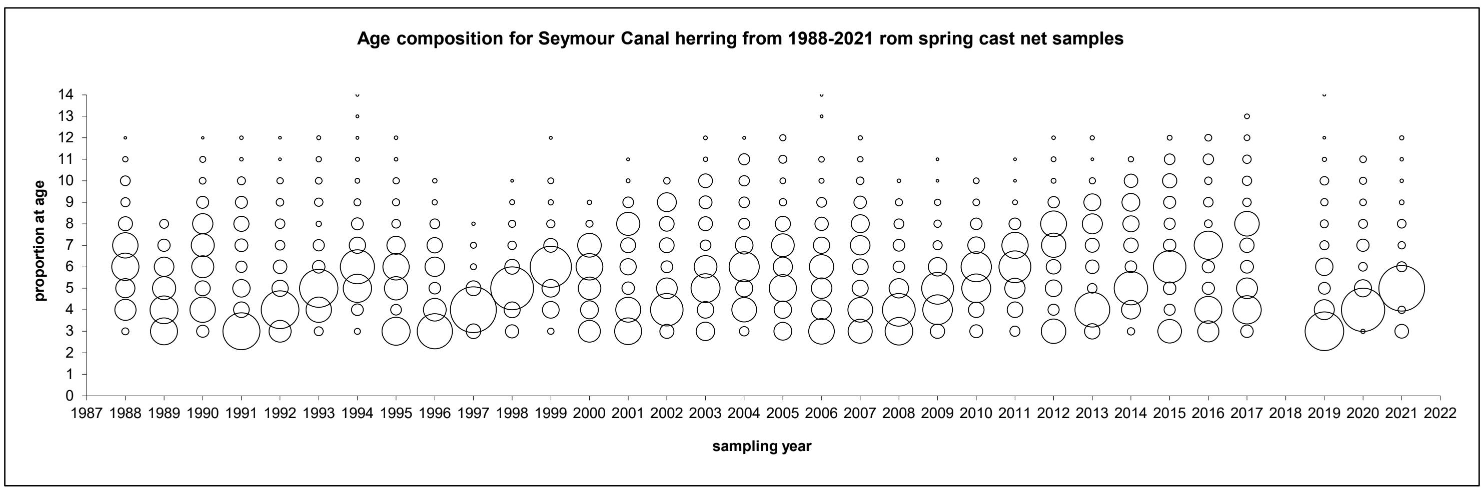

Figure 39.–Observed age compositions from sampling data for the Seymour Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 81%.

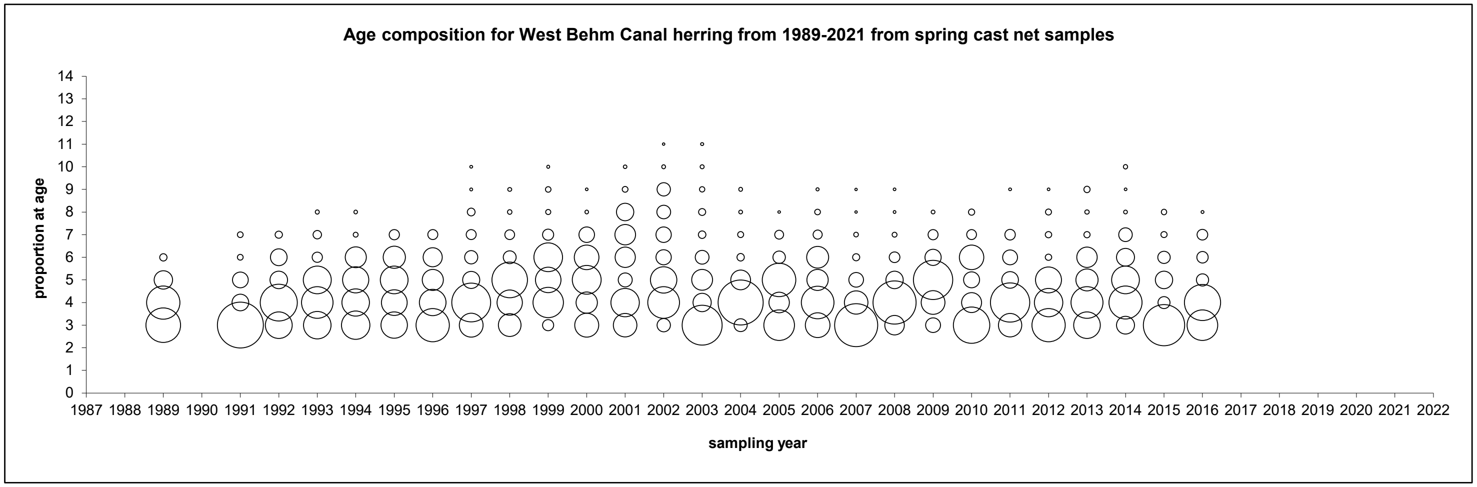

Figure 40.–Observed age compositions from sampling data for the West Behm Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 76%.

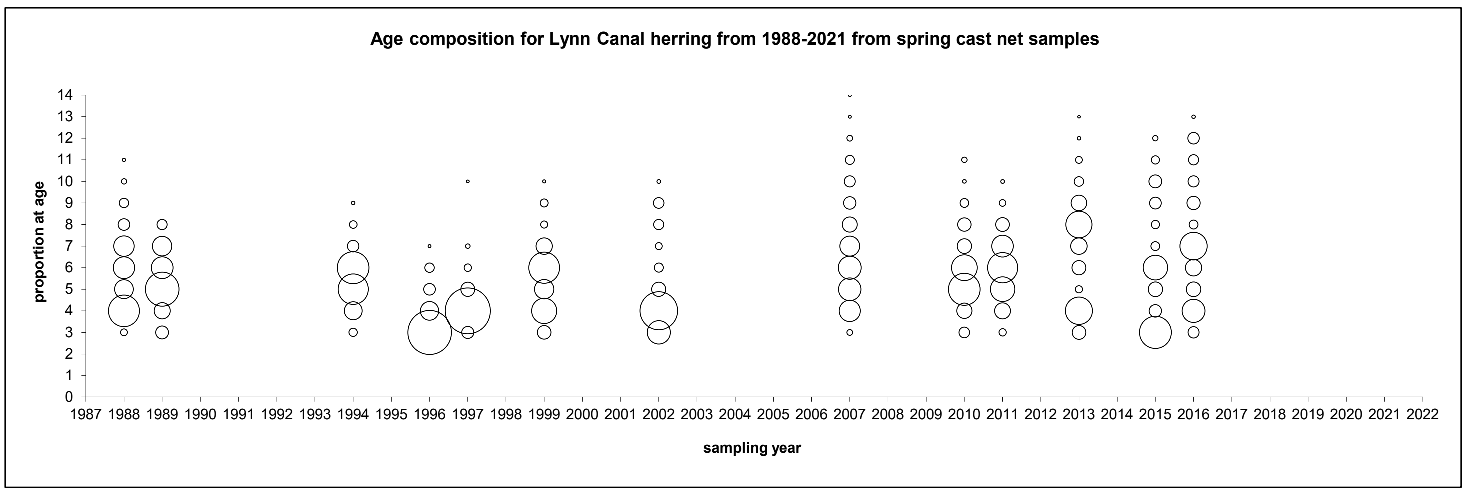

Figure 41.–Observed age compositions from sampling data for the Lynn Canal herring stock. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 79%.

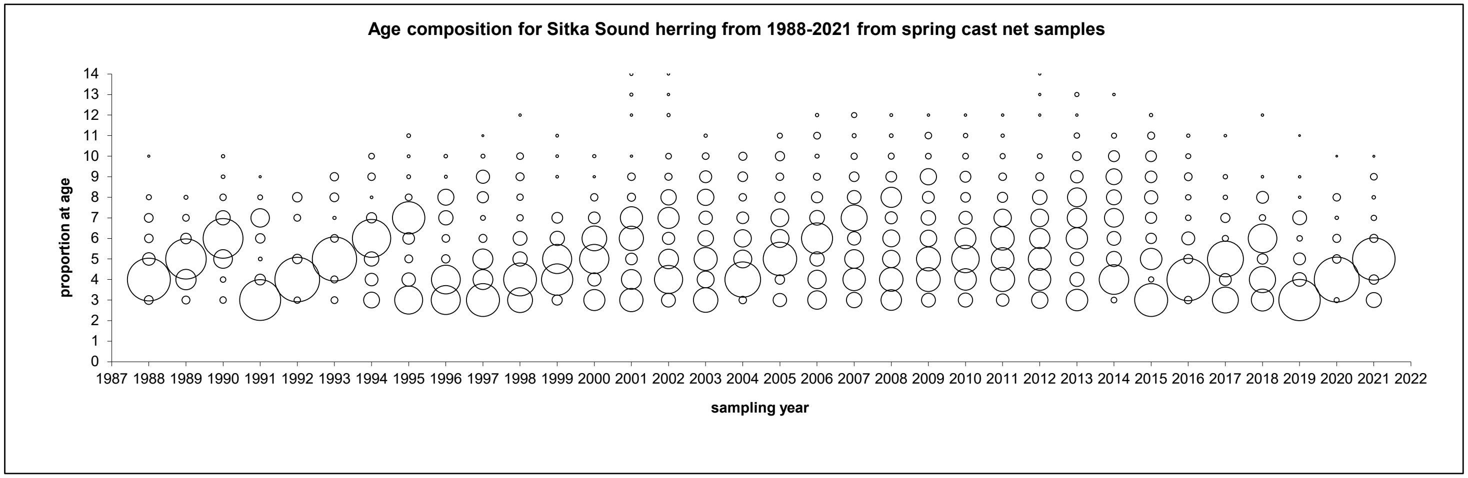

Figure 42.–Observed age compositions from sampling data for the Sitka Sound herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For reference, the largest circle represents 89%.

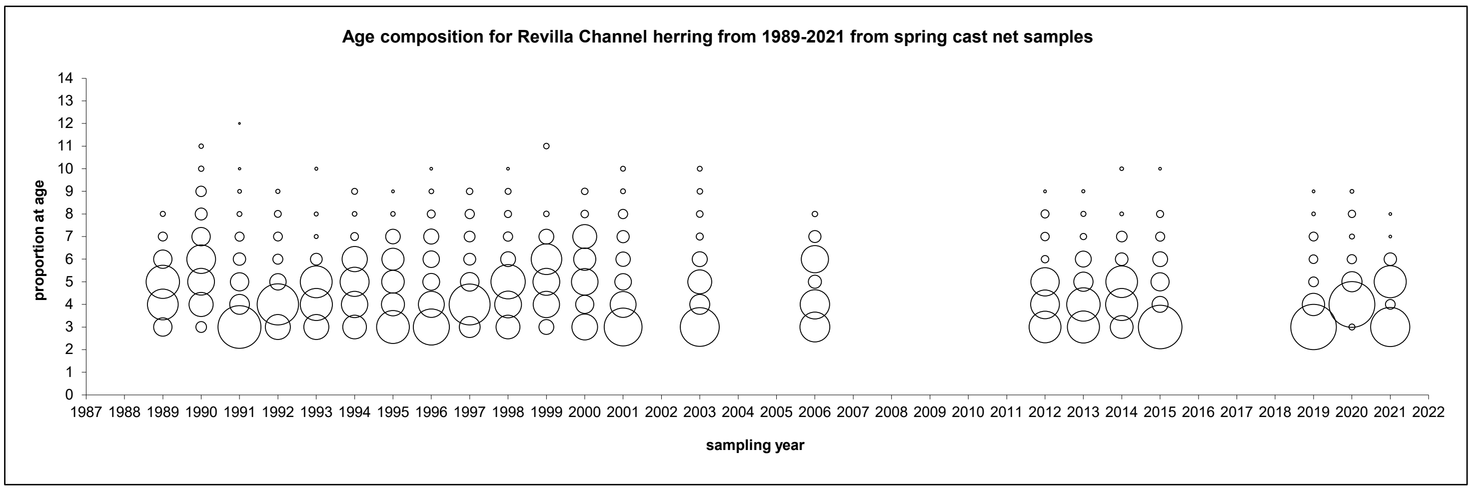

Figure 43.–Observed age compositions from sampling data for the Revilla Channel herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available. For reference, the largest circle represents 89%.

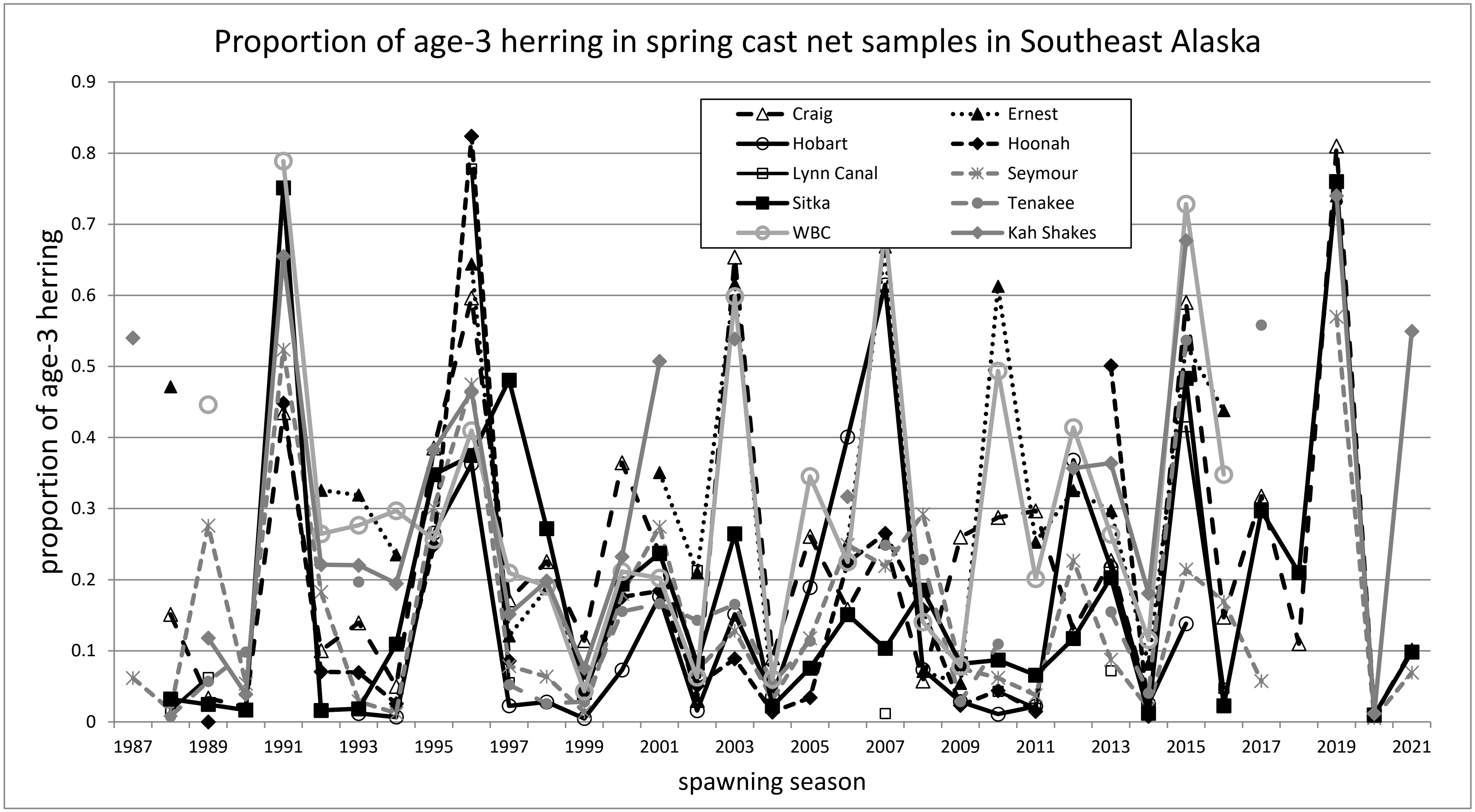

Figure 44.–Proportions of observed age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

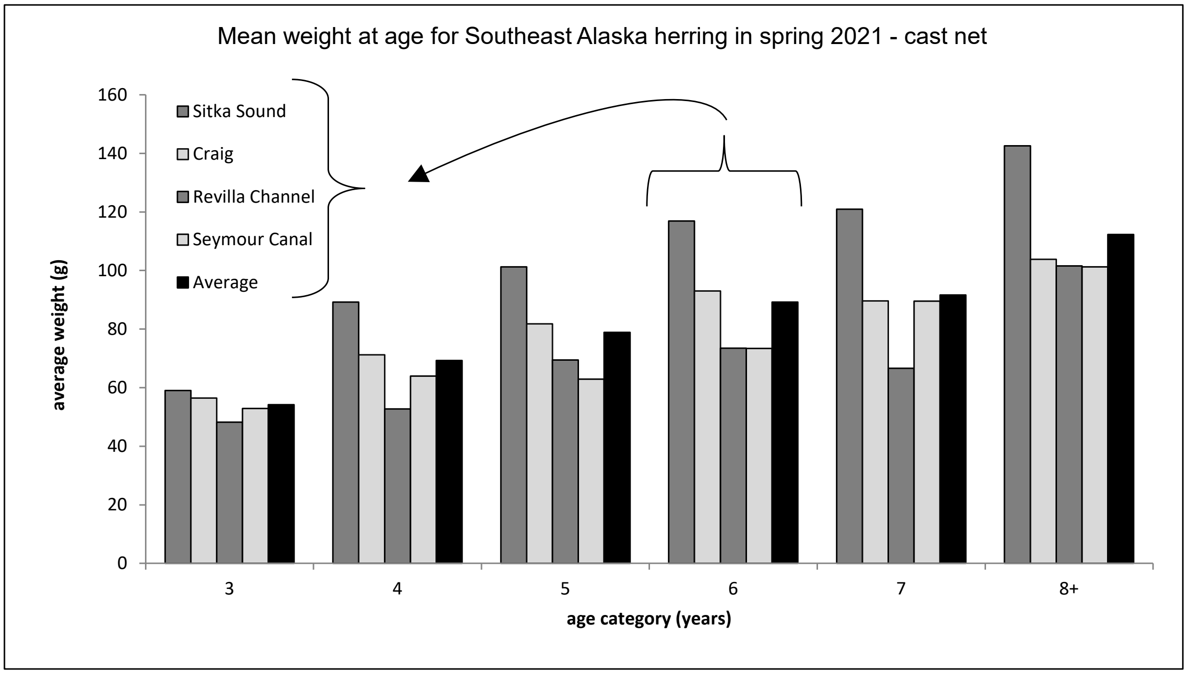

Figure 45.–Mean observed weight-at-age for Southeast Alaska herring stocks surveyed in spring 2021, sorted by age-6. The order of bars within age (left to right) is the order of the list of stocks and shade of bars is only to aid in visual separation of stocks.

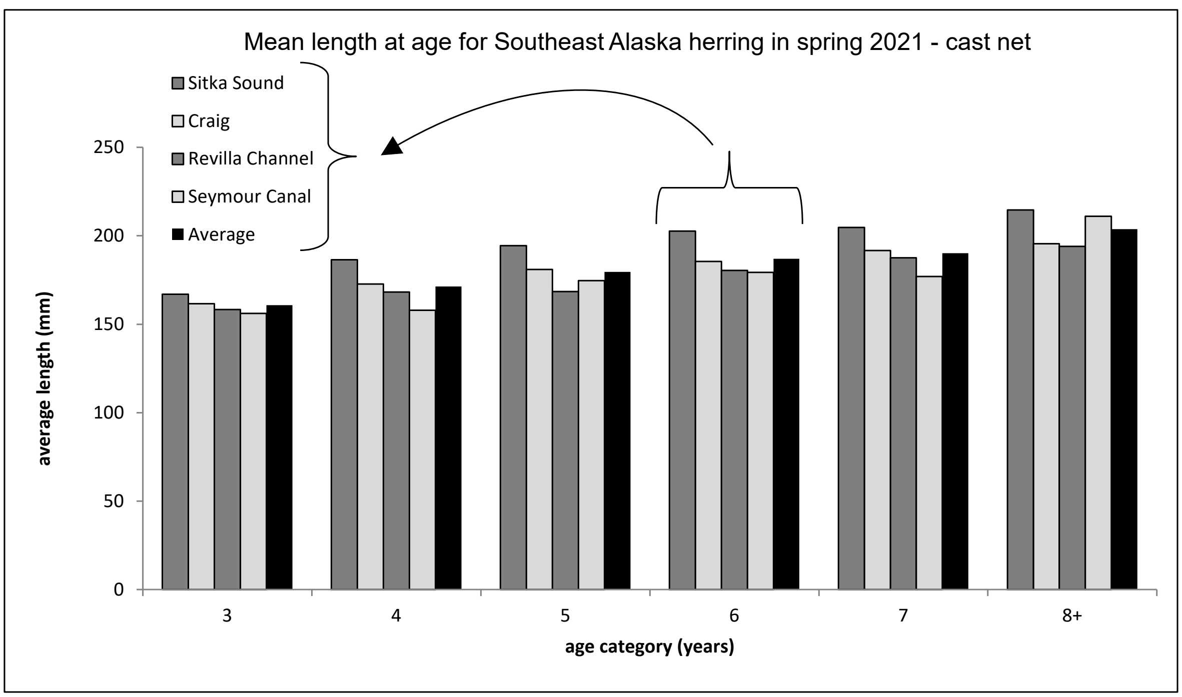

Figure 46.–Mean observed length-at-age for Southeast Alaska herring stocks surveyed in spring 2021, sorted by age-6The order of bars within age (left to right) is the order of the list of stocks and shade of bars is only to aid in visual separation of stocks.

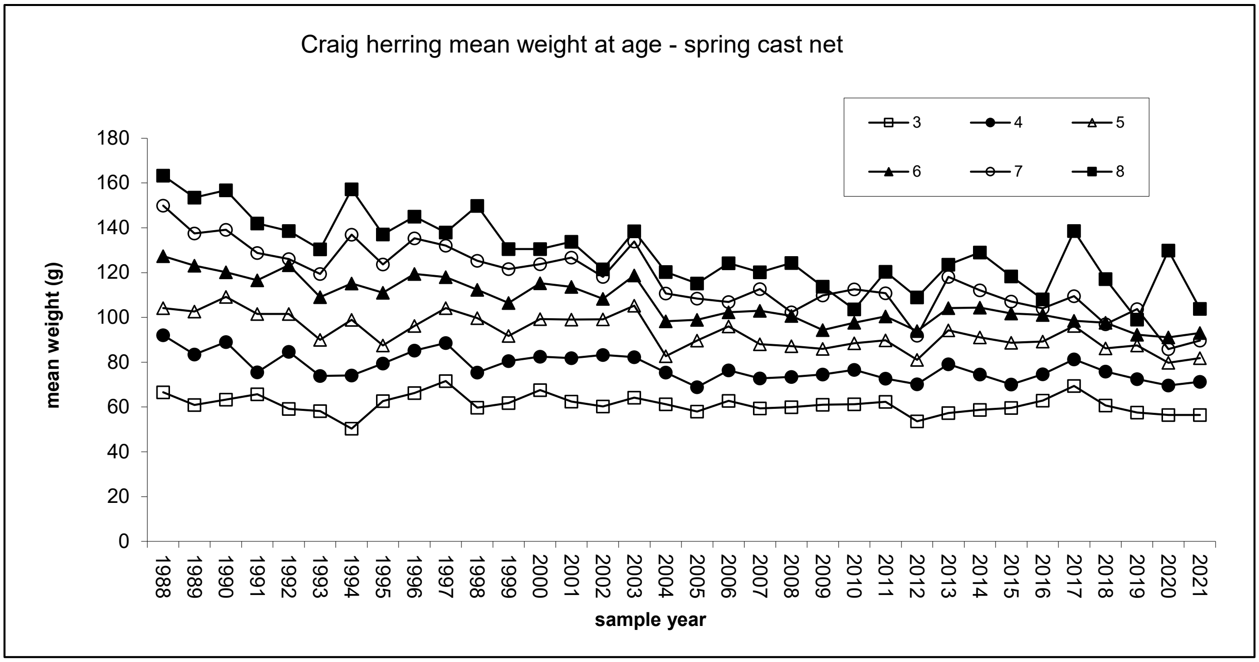

Figure 47.–Mean observed weight-at-age of the Craig herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

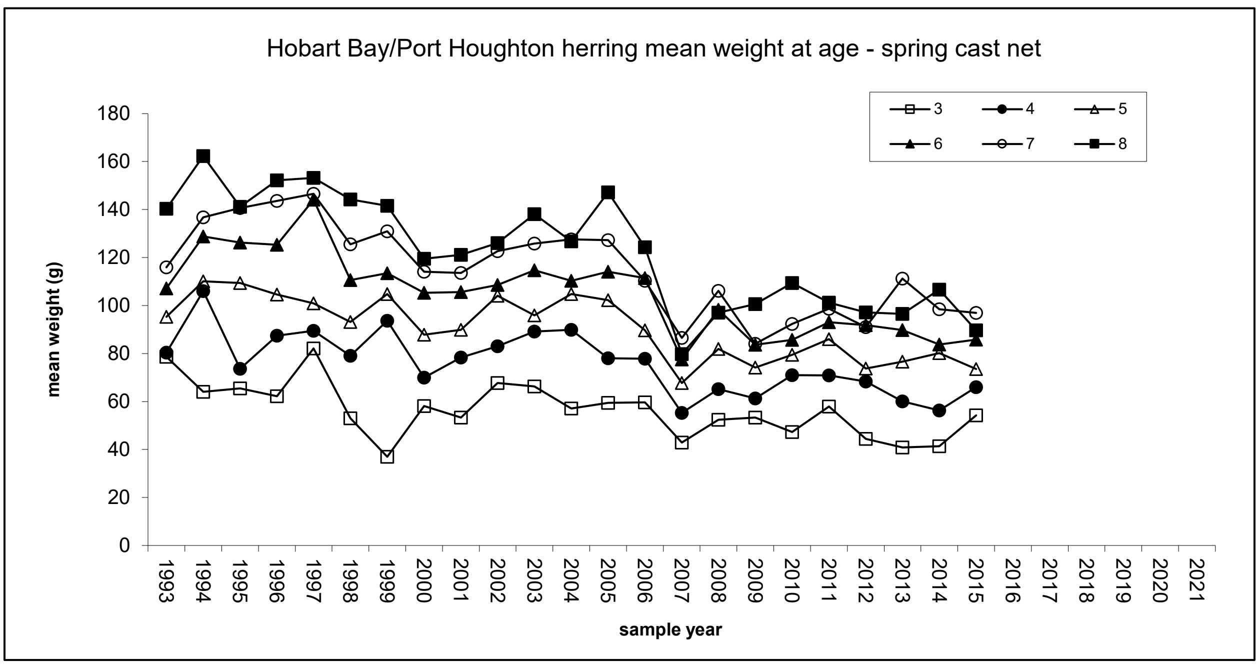

Figure 48.–Mean observed weight-at-age of the Hobart Bay–Port Houghton herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available.

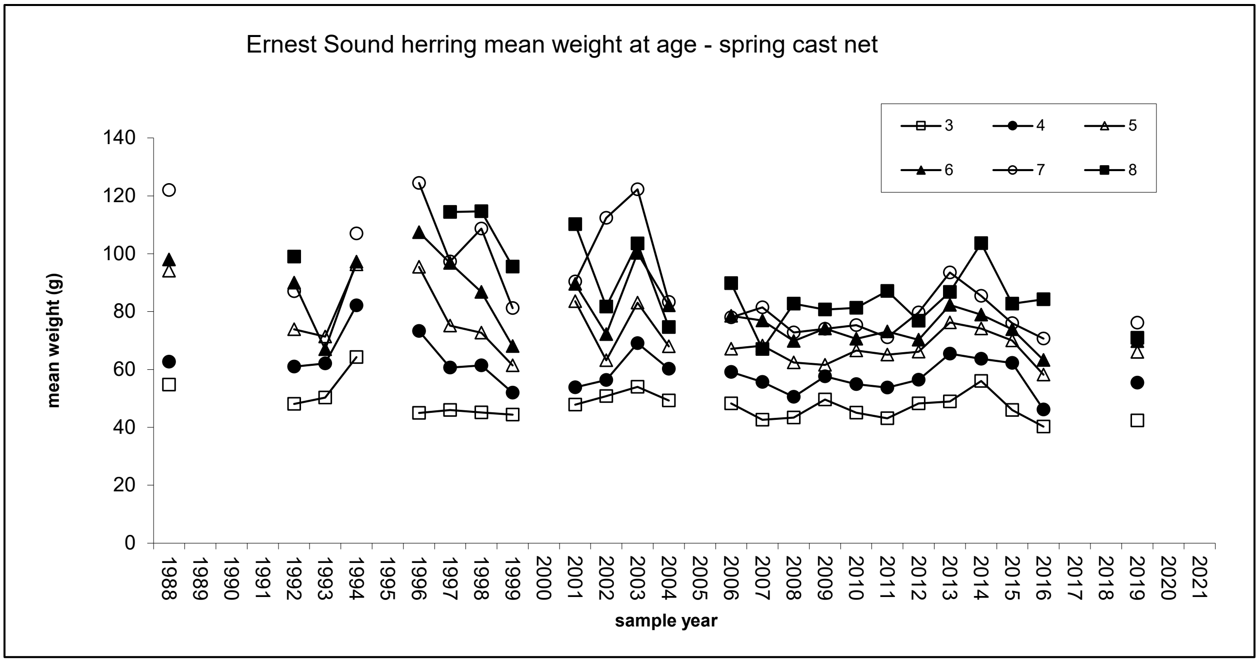

Figure 49.–Mean observed weight-at-age for the Ernest Sound herring spawning population. For years with blanks, data either were not collected or are not available.

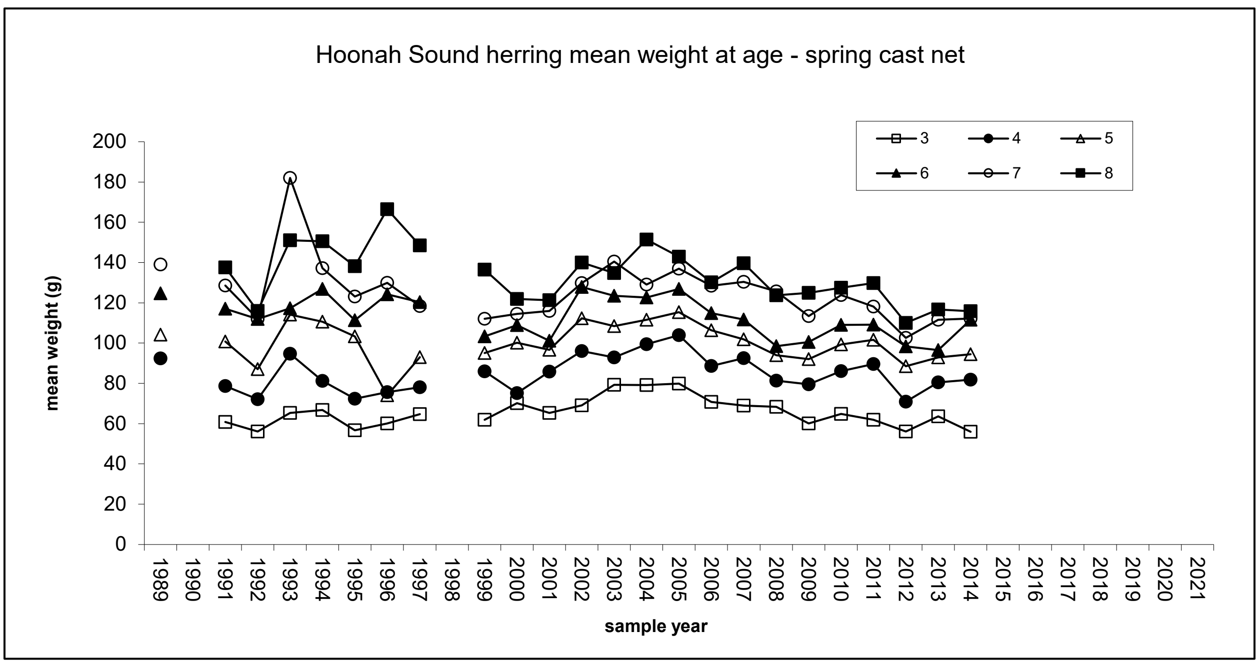

Figure 50.–Mean observed weight-at-age for the Hoonah Sound herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available.

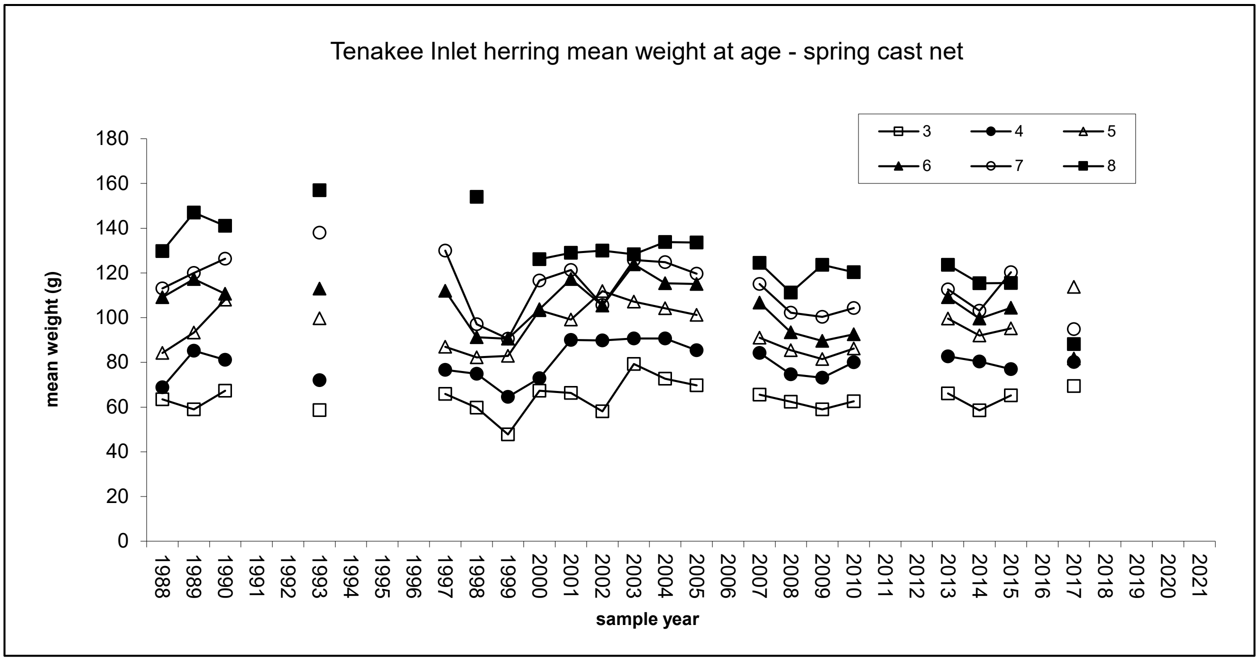

Figure 51.–Mean observed weight-at-age for the Tenakee Inlet herring stock. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available.

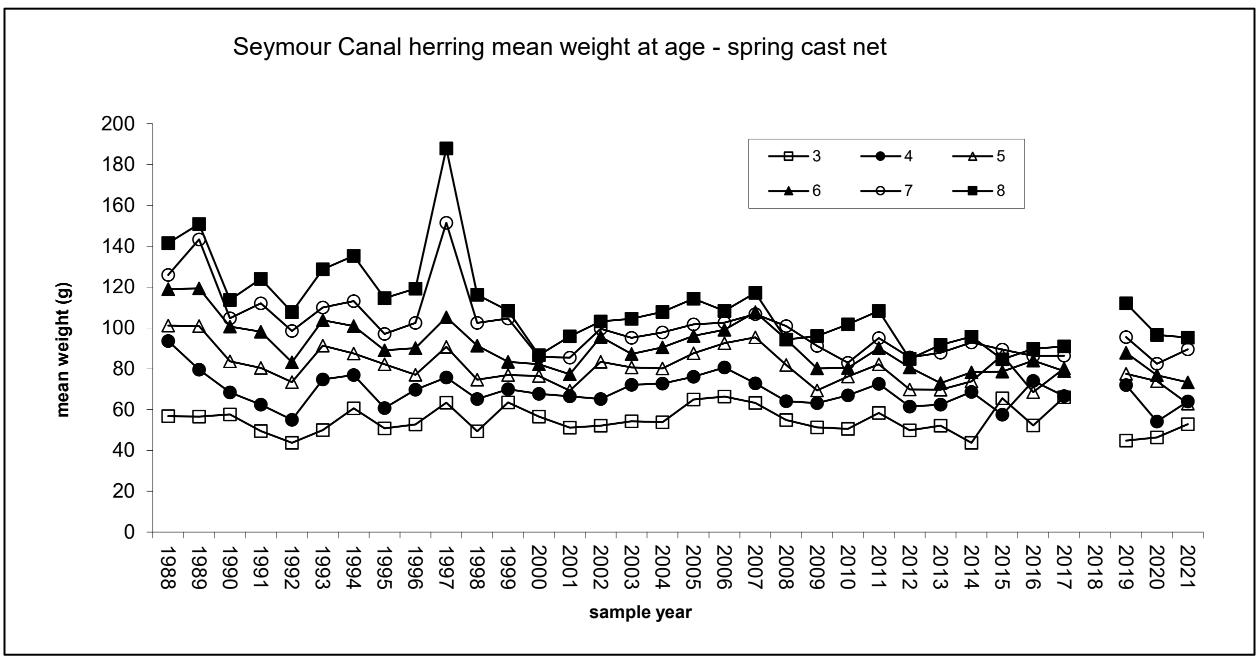

Figure 52.–Mean observed weight-at-age for the Seymour Canal herring stock. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available.

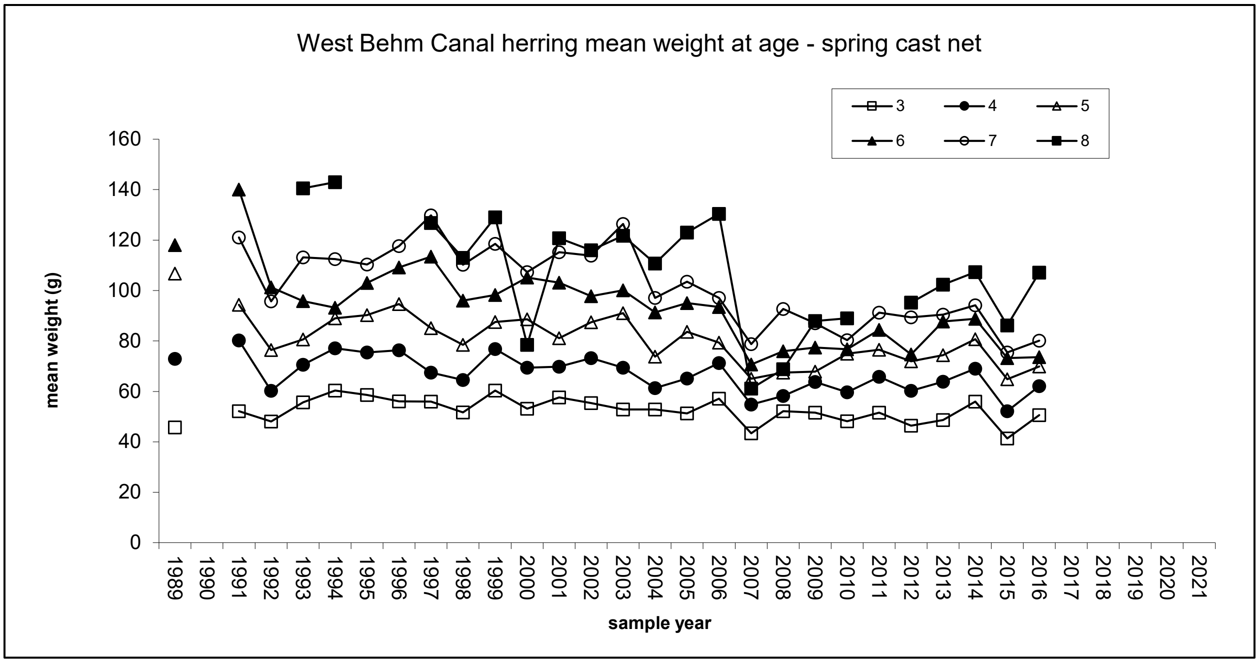

Figure 53.–Mean observed weight-at-age for the West Behm Canal herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. 2015 weights are likely biased low due to required additional sample handling that resulted in loss of weight. For years with blanks, data either were not collected or are not available.

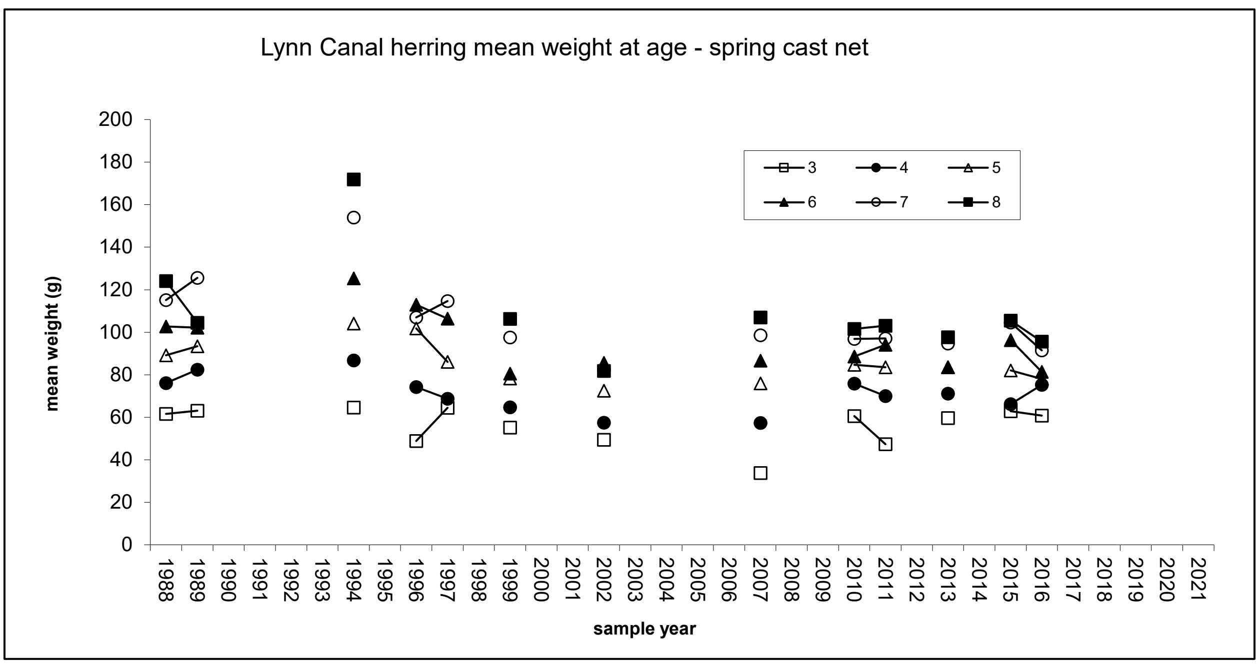

Figure 54.–Mean observed weight-at-age for the Lynn Canal herring spawning population. For years with blanks, data either were not collected or are not available.

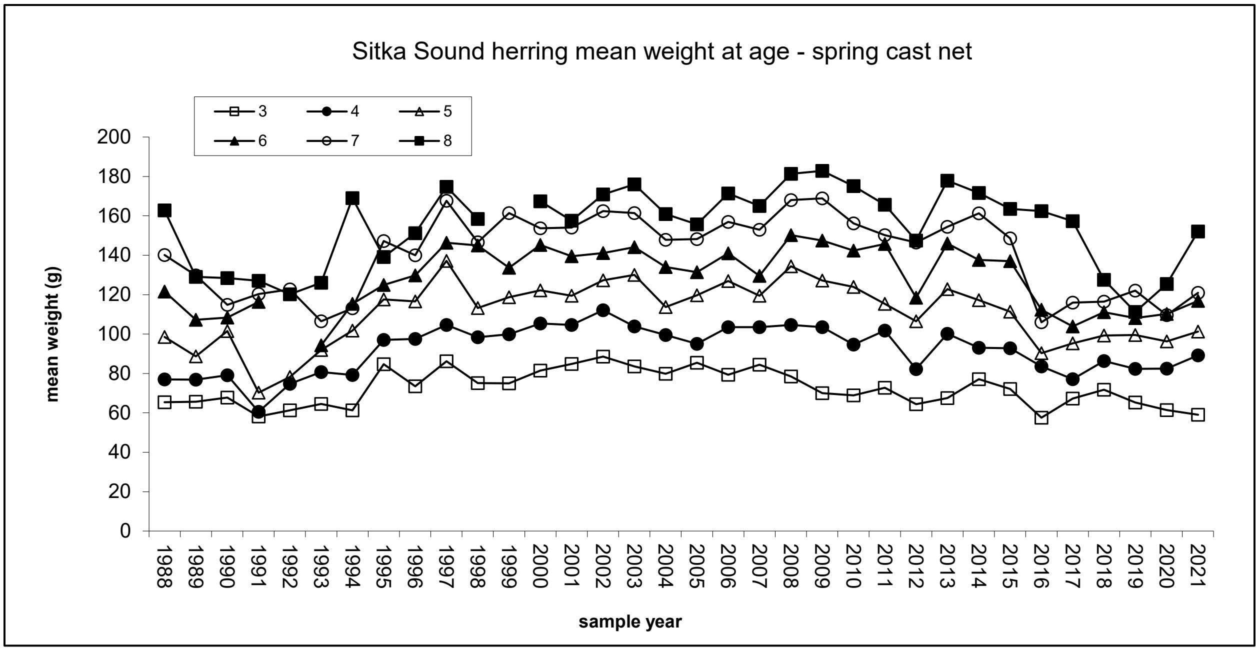

Figure 55.–Mean observed weight-at-age for the Sitka Sound herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

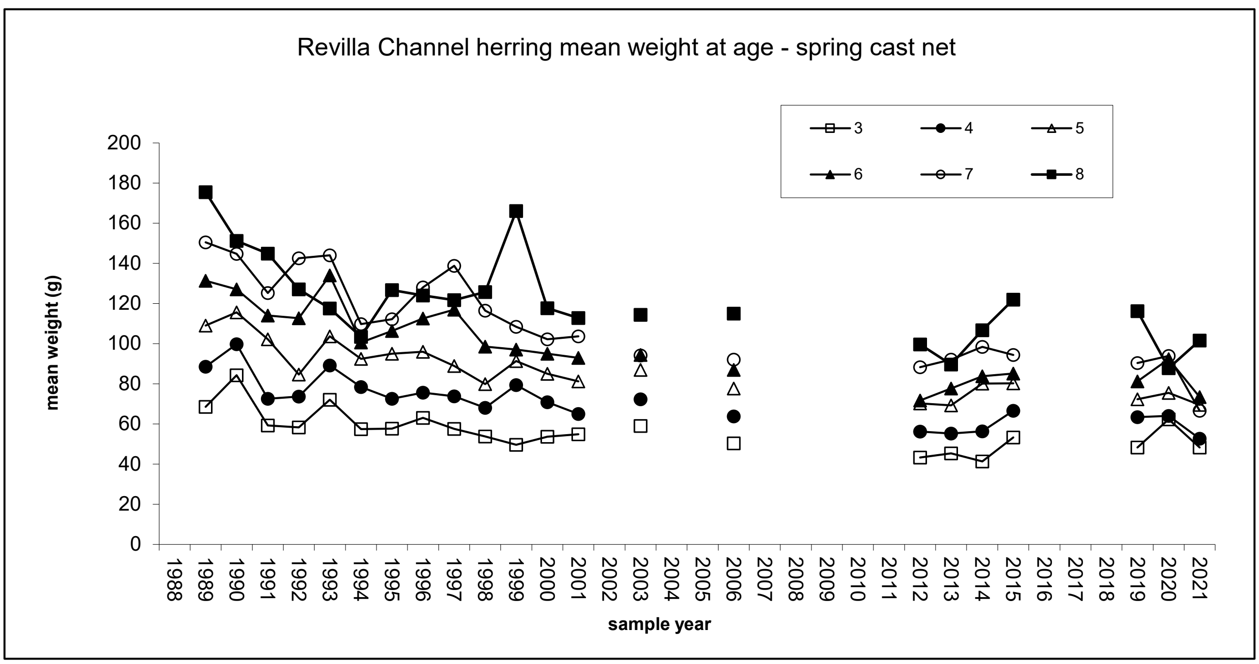

Figure 56.–Mean observed weight-at-age for the Revilla Channel herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data either were not collected or are not available.

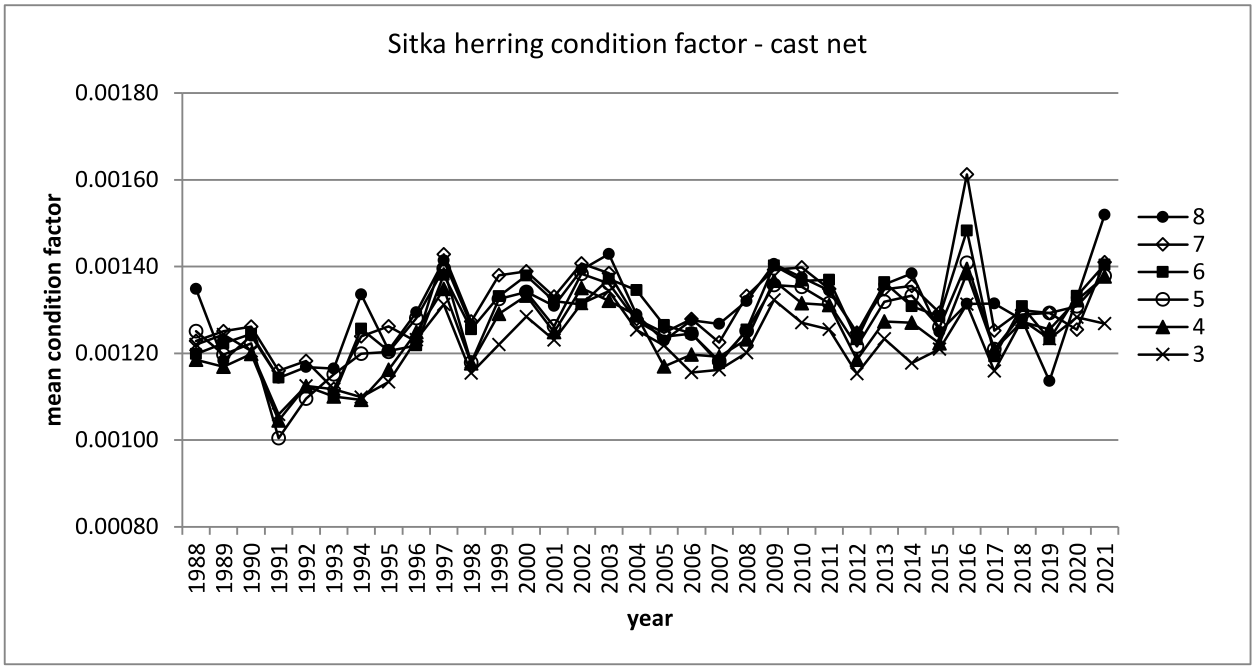

Figure 57.–Mean condition factors of age-3 through age-8 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning. 2016 values may be biased high due to length measurements that were likely underestimated.

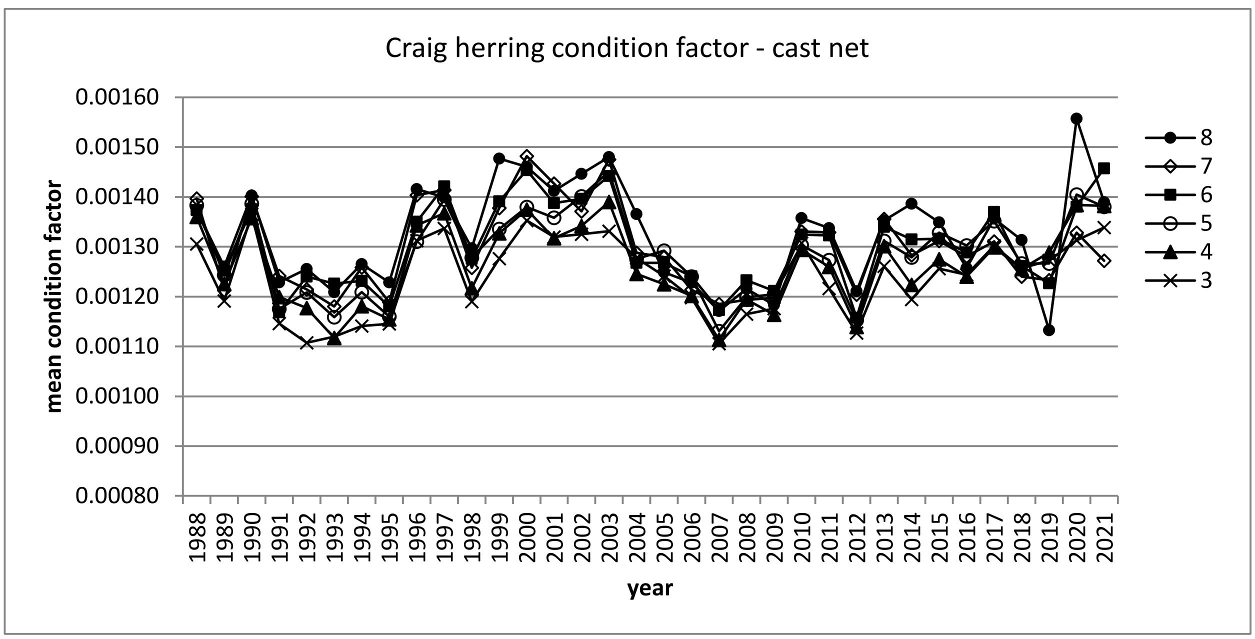

Figure 58.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

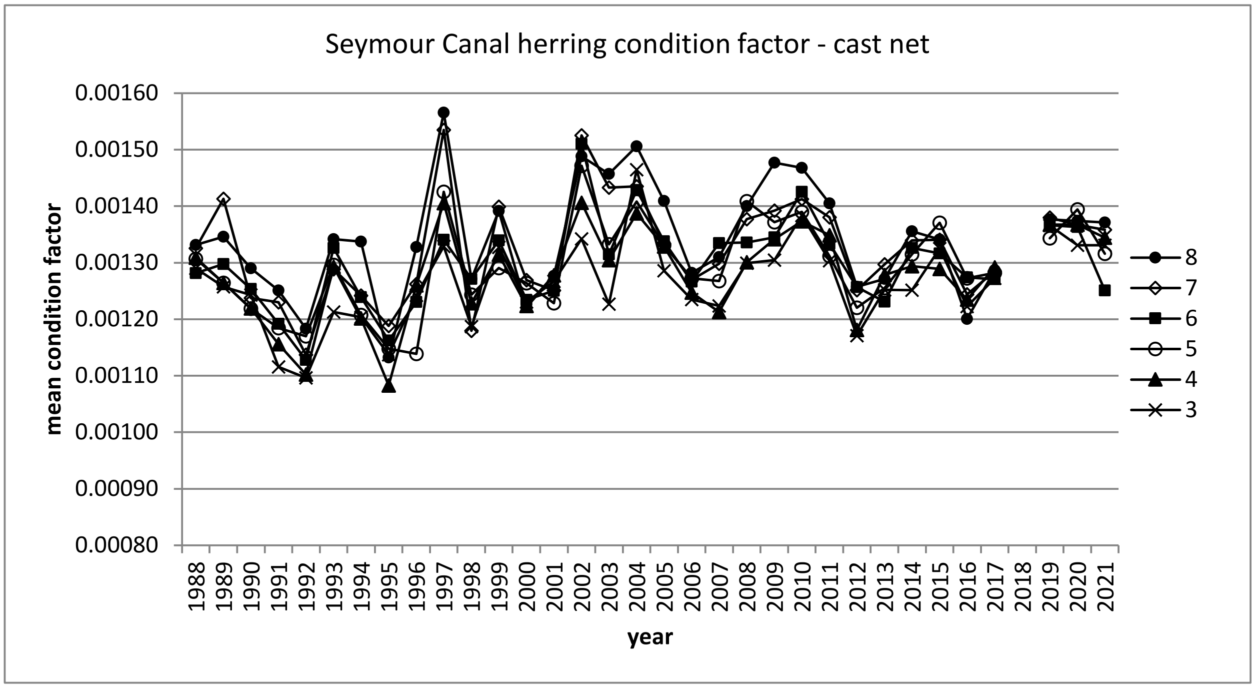

Figure 59.–Mean condition factors of age-3 through age-8 herring for the Seymour Canal spawning population, based on spring cast net samples taken during active spawning.

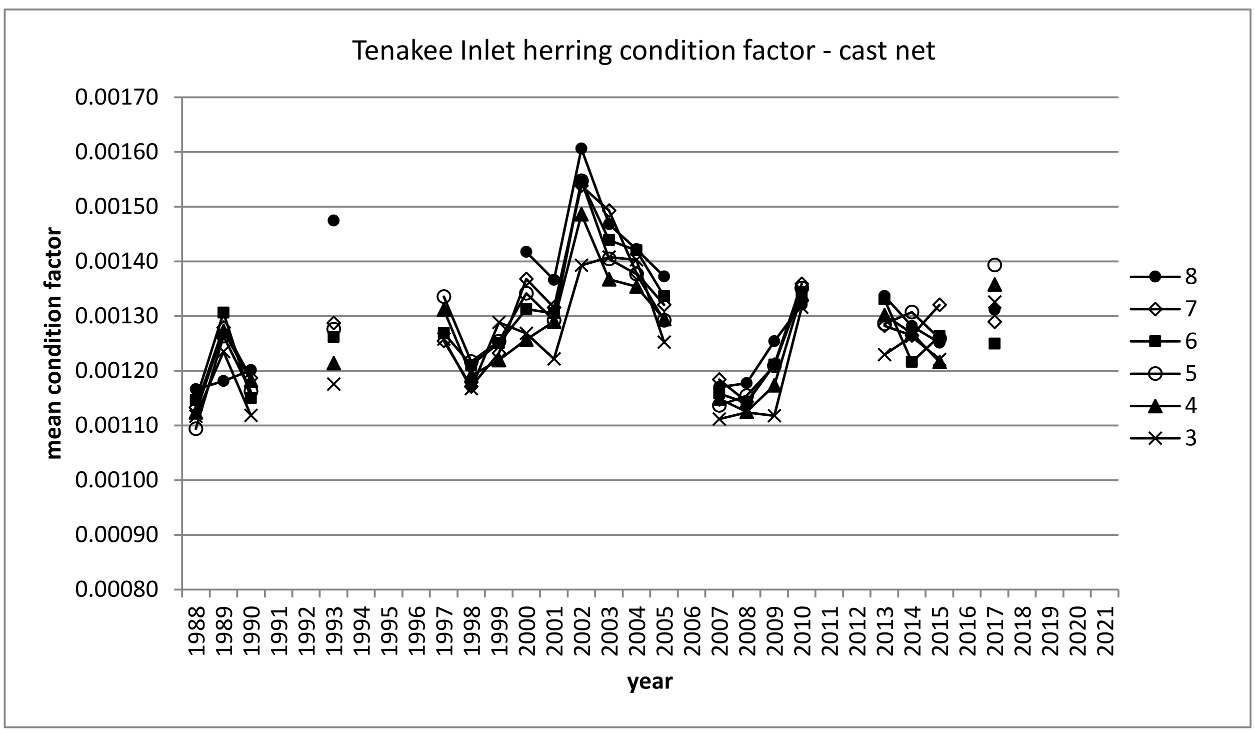

Figure 60.–Mean condition factors of age-3 through age-8 herring for the Tenakee Inlet spawning population, based on spring cast net samples taken during active spawning.

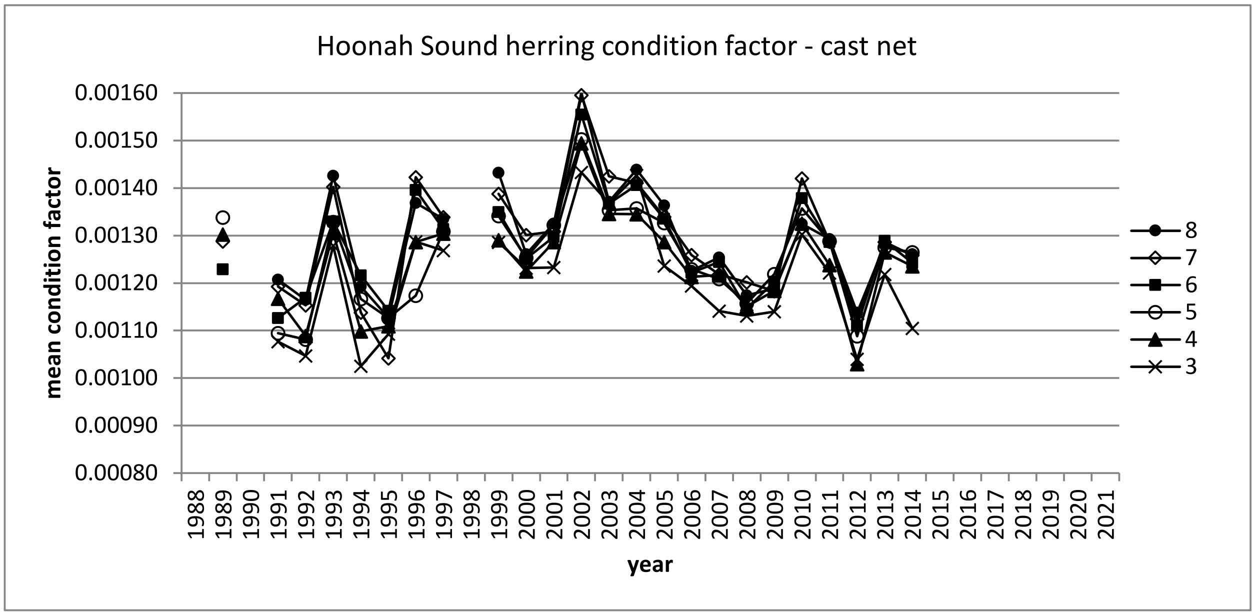

Figure 61.–Mean condition factors of age-3 through age-8 herring for the Hoonah Sound spawning population, based on spring cast net samples taken during active spawning.

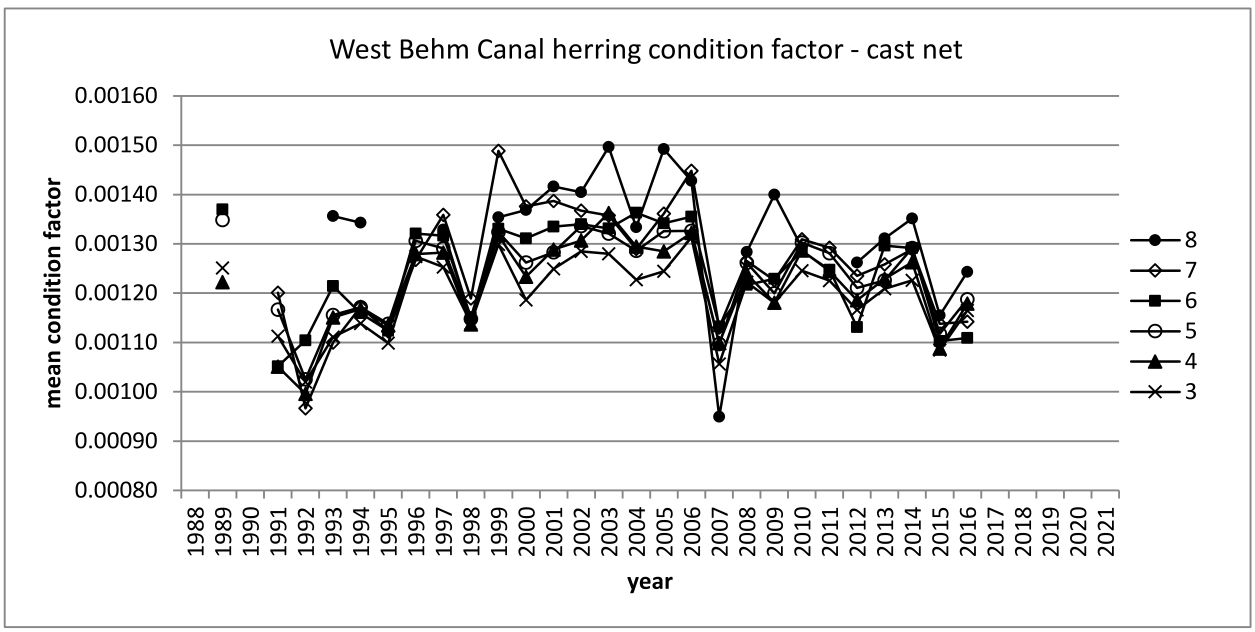

Figure 62.–Mean condition factors of age-3 through age-8 herring for the West Behm Canal spawning population, based on spring cast net samples taken during active spawning. 2015 condition factors are probably biased low due to required additional sample handling that resulted in loss of weight.

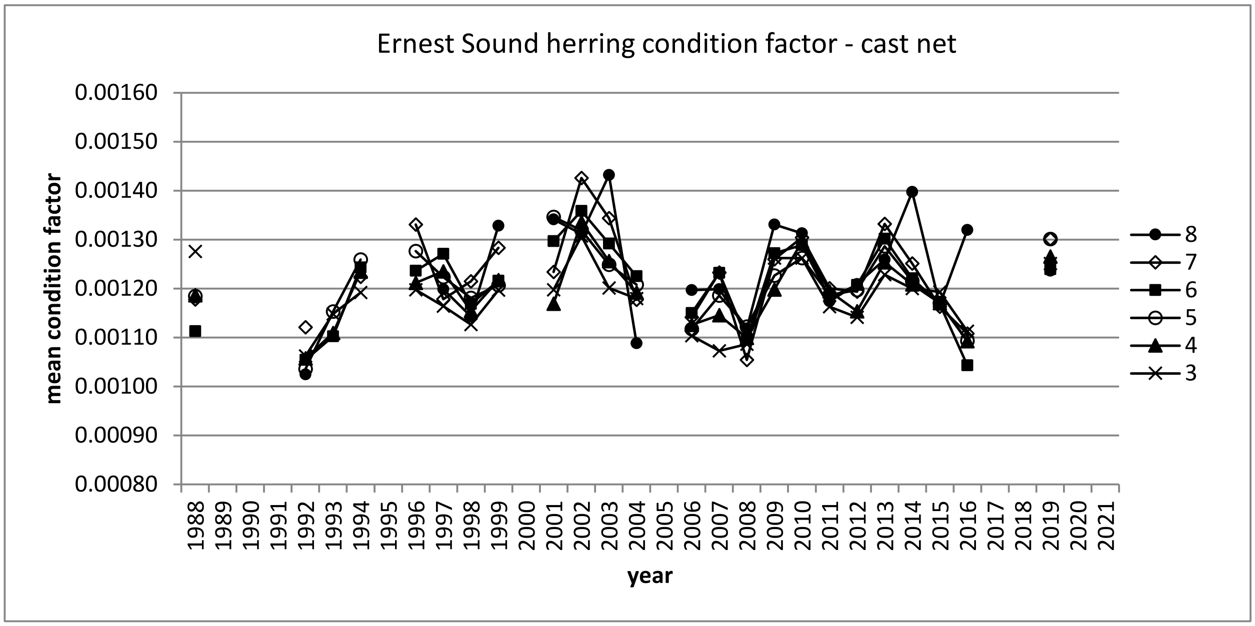

Figure 63.–Mean condition factors of age-3 through age-8 herring for the Ernest Sound spawning population, based on spring cast net samples taken during active spawning.

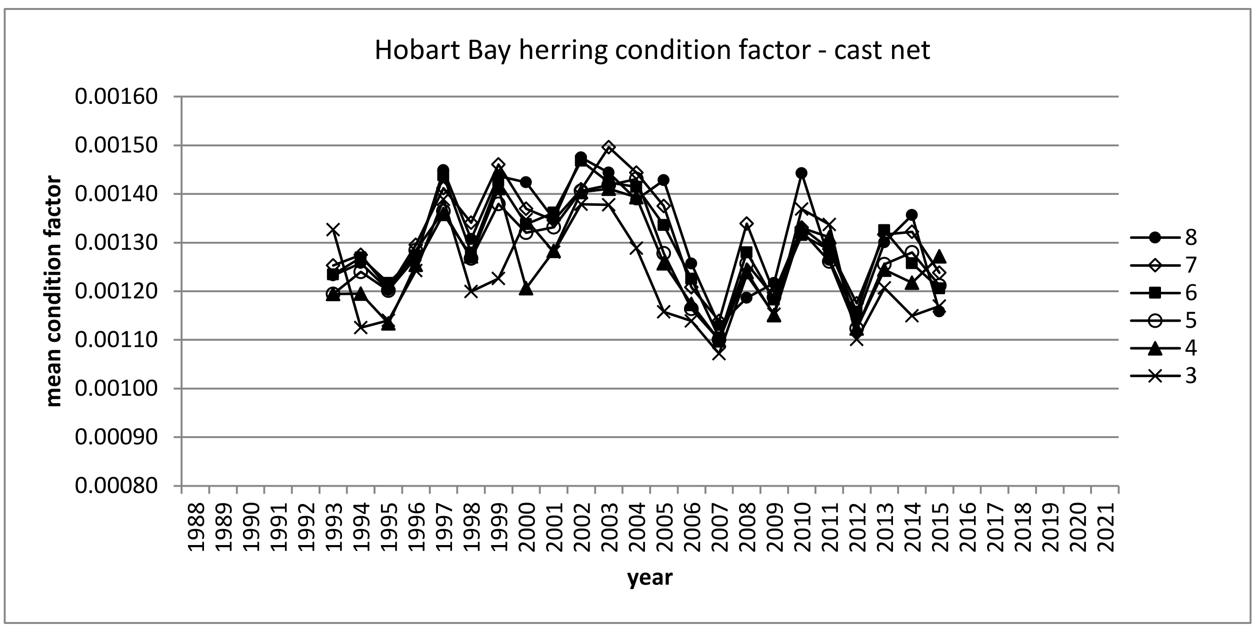

Figure 64.–Mean condition factors of age-3 through age-8 herring for the Hobart Bay spawning population, based on spring cast net samples taken during active spawning.

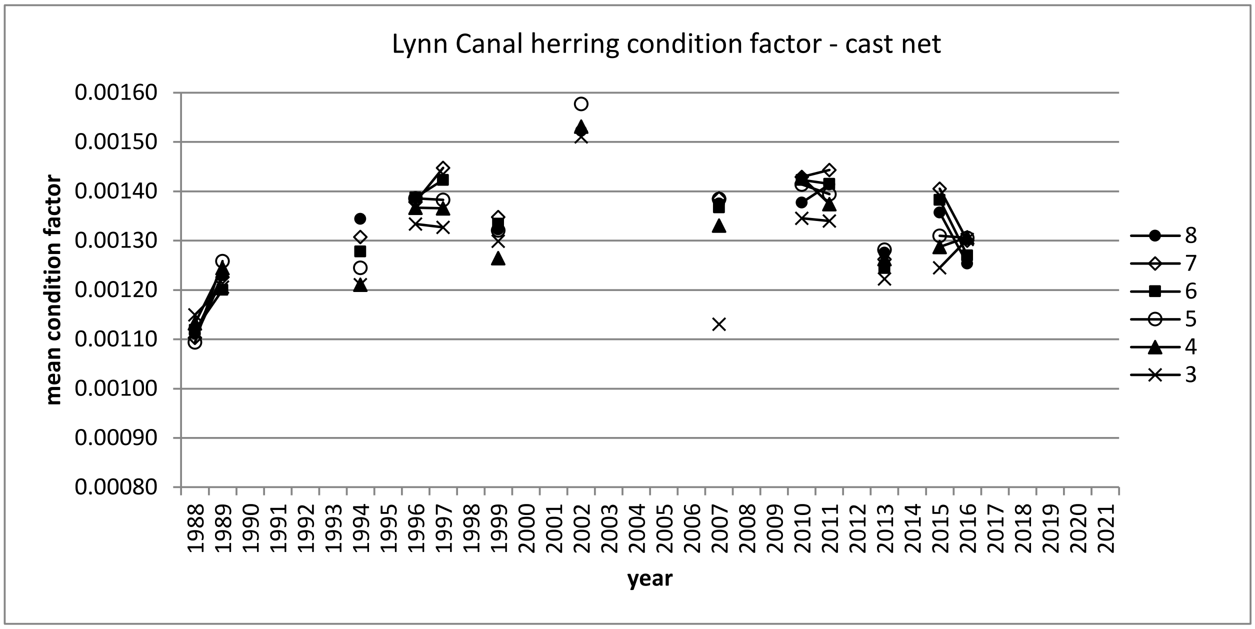

Figure 65.–Mean condition factors of age-3 through age-8 herring for the Lynn Canal spawning population, based on spring cast net samples taken during active spawning.

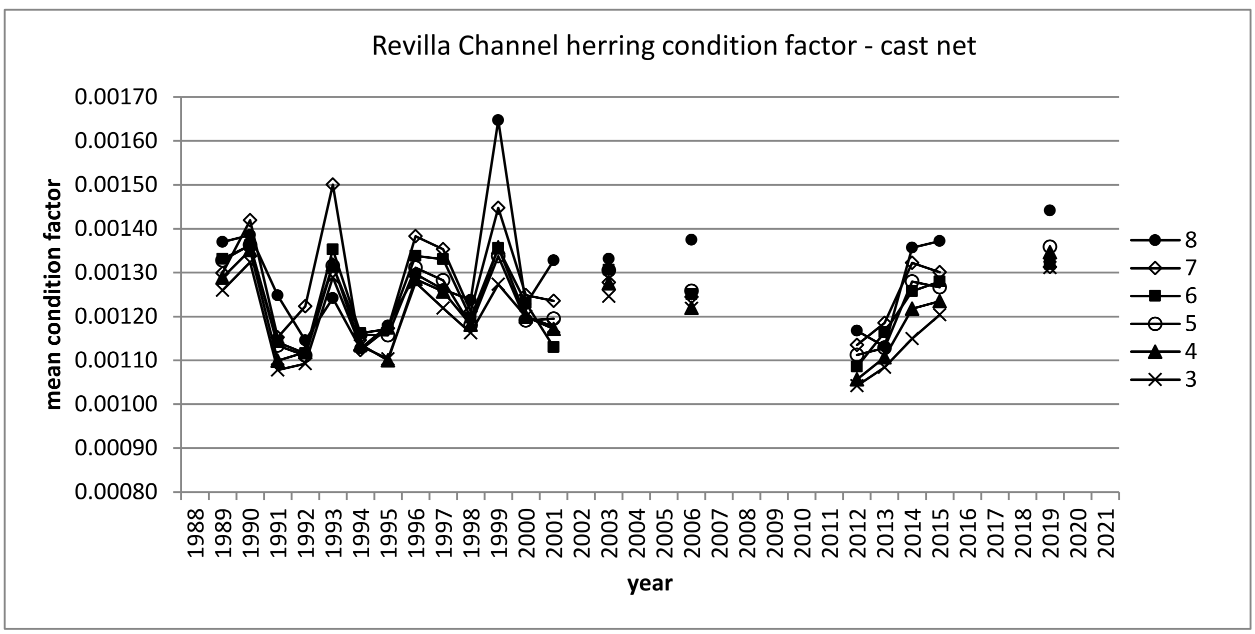

Figure 666.–Mean condition factors of age-3 through age-8 herring for the Revilla Channel spawning population, based on spring cast net samples taken during active spawning.

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

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

Code	Expanded code	Species included	Latin names
AGM	Agarum	Sieve kelp	*Agarum clathratum*
ALA	Alaria	Ribbon kelps	*Alaria marginata*, *A. nana*, *A. fistulosa*
ELG	Eel grass	Eel grass, surfgrasses	*Zostera marina*, *Phyllospadix serrulatus*, *P. scouleri*
FIL	Filamentous algae	Sea hair	*Enteromorpha intestinalis*
FIR	Fir kelp	Black pine, Oregon pine (red algae)	*Neorhodomela larix*, *N. oregona*
FUC	Fucus	Rockweed	*Fucus gardneri*
HIR	Hair kelp	Witch's hair, stringy acid kelp	*Desmarestia aculeata*, *D. viridis*
LAM	Laminaria	split kelp, sugar kelp, suction-cup kelp	*Laminaria bongardiana*, *L. saccharina*, *L. yezoensis* (when isolated and identifiable)
LBK	Large/leafy brown kelps	Five-ribbed kelp, 3-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* spp.
NER	Nereocystis	Bull kelp	*Nereocystis leutkeana*
RED	Red algae	All red leafy algae (red ribbons, red blades, red sea cabbage, Turkish washcloth)	*Palmaria mollis*, *P. hecatensis*, *P. callophylloides*, *Dilsea californica*, *Neodilsea borealis*, *Mastocarpus papillatus*, *Turnerella mertensiana*
ULV	Ulva	Sea lettuce	*Ulva fenestrata*, *Ulvaria obscura*
COR	Coralline algae	Coral seaweeds (red algae)	*Bossiella*, *Corallina*, *Serraticardia*

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

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

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

APPENDIX C: SPAWN SURVEYS BY DATE

Appendix C1.–Aerial and skiff herring spawn surveys by date, in Craig, West Behm Canal, Revilla Channel, and other areas (Ketchikan Management Area), Southeast Alaska in 2021.

Craig

Date	Activity
March 18, 2021	Limited predator activity.
March 22, 2021	Limited predator activity.
March 25, 2021	Slight increase in predator activity.
March 29, 2021	Reduced predator activity.
April 3, 2021	Slight increase in predator activity.
April 5, 2021	0.2 nmi of spawn on Fish Egg Island. Fisherman actively filling pounds. ~50 pounds filled.
April 6, 2021	1.0 nmi of spawn on Fish Egg Island. Fisherman actively filling pounds. ~55 pounds filled.
April 7, 2021	2.6 nmi of spawn on Fish Egg, Ballenas, Wadleigh and Alberto Islands. ~60 pounds filled.
April 8, 2021	8.7 nmi of spawn on Fish Egg, Ballenas, Wadleigh and Alberto Islands. ~70 pounds filled.
April 9, 2021	10.5 nmi of spawn on Fish Egg, Ballenas, Wadleigh, Alberto, and Abbess Islands. ~70 pounds filled.
April 10, 2021	15.5 nmi of spawn on Fish Egg, Ballenas, Wadleigh, Alberto, Clam, Rosary, & Abbess Islands.
April 11, 2021	22.0 nmi of spawn on Fish Egg, Ballenas, Wadleigh, Alberto, Clam, Rosary, & Abbess Islands.
April 12, 2021	12.4 nmi of spawn on Fish Egg, Ballenas, Wadleigh, Alberto, Clam, Rosary, San Juan Batista, Balandra, & Abbess Islands.
April 13, 2021	1.5 nmi of spawn on Fish Egg, Cape Suspiro, and Ballenas Islands.
April 14, 2021	1.1 nmi of spawn in Port Bagial, outer Alberto and San Juan Bautista Islands, and Blanquizal Point.
April 15, 2021	No activity. Spawn dive deposition survey begins.

West Behm Canal

Date	Activity
April 5, 2021	No predator activity.
April 8, 2021	Limited predator activity.
April 9, 2021	Limited predator activity.
April 12, 2021	1.3 nmi of spawn just north of Raymond Cove.
April 13, 2021	5.7 nmi of spawn from Pt. Francis to Helm Point.
April 14, 2021	5.2 nmi of spawn around Pt. Francis, Wadding Cove, and Bond Bay.
April 15, 2021	2.7 nmi of spawn around Helm Pt., Raymond Cove, and Bond Bay.
April 16, 2021	No activity.

-continued-

Revilla Channel (State waters)

Date	Activity
March 18, 2021	No predator activity.
March 22, 2021	No predator activity.
March 25, 2021	No predator activity.
March 26, 2021	~.5 nmi of spawn on Double Island. Based on verbal communication with Annette Island Reserve biologist.
March 27, 2021	unknown
March 28, 2021	~3 nmi of spawn on Double, Village, and Cat Islands.
March 29, 2021	5.8 nmi of spawn observed on Cat, Dog, Village, Double, and Mary Islands. Based on verbal communication with Annette Island Reserve biologist.
March 30, 2021	3.3 nmi of spawn observed on Cat, Dog, Village, and Double Islands.
April 3, 2021	Limited predator activity.
April 5, 2021	0.3 nmi of spawn on Mary Island.
April 6, 2021	0.1 nmi of spawn on Mary Island.
April 7, 2021	No activity.
April 11, 2021	Spawn dive deposition survey begins.

Revilla Channel (State waters)

Date	Activity
March 29, 2021	.3 nmi of spawn at Moss Point
March 30, 2021	1.1 nmi of spawn around Moss Point
April 5, 2021	0.7 nmi of light spawn just north of Crab Bay
April 6, 2021	1.0 nmi of spawn near Crab and Kwain Bay

Kasaan Bay

Date	Activity
April 15, 2021	3.1 miles of spawn around Sandy Point.
April 16, 2021	5.1 nmi of spawn around Sandy Point and near Kasaan village.

Sea Otter Sound

Date	Activity
April 6, 2021	1.0 nmi of spawn north of Camp Island
April 7, 2021	2.1 nmi of spawn from Camp Island to Gas Rock
April 8, 2021	Poor weather. Could have been huge.
April 9, 2021	Poor weather. Could have been huge.
April 17, 2021	2.5 nmi of spawn from Gas Rock to Port Alice.

Appendix C2.–Aerial and skiff herring spawn surveys by date, in Sitka Sound and Hoonah Sound (Sitka Management Area), Southeast Alaska in 2021.

March 09: Dupuis. 0900-1030. Today's aerial survey covered Sitka Sound from Biorka to Hayward Strait. Weather was good with calm winds and fair skies. No herring or herring spawn was observed. The highest concentration of herring predators was observed between Bieli Rock, Inner Point, and Hayward Strait; numerous whales were seen working in deeper waters west of Bieli Rock and numerous sea lions were observed in several large groups holding off the rock piles. The rocks on the coast near Biorka Island still held several hundred sealions.

March 12: Jones. 1000-1130. Today's aerial survey covered Sitka Sound from Crawfish Inlet to Hayward Strait. Weather was good with calm winds and fair skies. No herring or herring spawn was observed. The highest concentration of herring predators was observed between Bieli Rock, Inner Point, Hayward Strait and near middle island; numerous whales were seen working in deeper waters west of Bieli Rock and near Middle Island. Numerous sea lions were observed in several large groups holding off the rock piles. The rocks on the coast near Biorka Island and Crawfish Inlet still held several hundred sealions.

March 14: Dupuis/Jones. 0930-1530. Today's vessel survey covered Sitka Sound from Vitskari Rocks to Hayward Strait. Weather was good with calm winds and fair seas. Large schools of herring were located near Middle Island, west of Bieli Rock, and east of Vitskari Rocks. Small scattered schools were also located in Deep Inlet. Numerous whales were observed in the vicinity of the herring schools. The herring were still in very deep water.

March 15: Dupuis. 1330-1430. Today's aerial survey covered Sitka Sound from Eastern Channel to Hayward Strait. Weather during the flight was poor with fog, rain, snow, and 15 knot winds. No herring or herring spawn was observed. The highest concentration of herring predators was observed west of Bieli Rock, near Big Gavanski Island, and east of Vitskari Rocks. Several whales were seen working in deeper waters near Bieli Rock and Vitskari Rocks. Large groups of sea lions were observed holding off Vitskari Rocks, Low Island, Inner Point, and Bieli Rock. South of Sitka, no whales and or sea lions were observed in Eastern Channel.
A vessel survey conducted on March 14 identified large schools of herring in the deeper waters west of Bieli Rocks, east of Vitskari Rocks, and east of Middle Island.

March 16: Dupuis. 1000-1130. Today's aerial survey covered Sitka Sound from Crawfish Inlet to Krestof Sound. Weather during the flight was satisfactory with low clouds, snow, and 5-knot winds. No herring or herring spawn was observed. The highest concentration of herring predators was observed west of Bieli Rock, east of Big Gavanski Island, and east of Vitskari Rocks. Several whales were seen working in deeper waters near Bieli Rock, Big Gavanski Island, and Vitskari Rocks. Large groups of sea lions were observed holding off Vitskari Rocks, Inner Point, Bieli Rock, and east of Big Gavanski Island. South of Sitka, one whale and no sea lions were observed in Eastern Channel. Sea lions were still present hauled out on rocks near Biorka Island and Crawfish Inlet, but in smaller numbers than noted on previous flights. Approximately 10 gray whales were observed west of Biorka Island.

-continued-

March 18: Dupuis. 0830-0930. Today's aerial survey covered Sitka Sound from Eastern Channel to Hayward Strait. Weather during the flight was good with clear skies and fair winds. No herring or herring spawn were observed. The highest concentration of herring predators was observed west of Bieli Rock, east of Middle Island, and east of Vitskari Rocks. Several whales were seen working in deeper waters between Bieli Rock and Inner Point, near Middle Island, and east of Vitskari Rocks. Large groups of sea lions were observed holding off Inner Point, Bieli Rock, and east of Middle Island. South of Sitka, 2 whales and no sea lions were observed near Eastern Channel. Predator numbers and locations are normal for this time of year.

The Sitka Sound herring sac roe fishery will be placed on 2-hour notice effective 8:00 a.m., Saturday, March 20, 2021.

- *F/V Perseverance*; Inner Point; 30-ton set, mature roe (8.0%), immature roe (1.7%), average weight (111g), and (43%) females.

The *R/V Kestrel* will be arriving the morning of March 20 and will immediately conduct a vessel survey.

March 19: Dupuis. 1030-1115. Today's aerial survey covered Sitka Sound from Redoubt Bay to Hayward Strait. Weather during the flight was poor with snow squalls and 25-knot winds. A small school of herring was spotted near Bieli Rocks and no herring spawn was observed. The highest concentrations of herring predators were observed west of Bieli Rock, east of Middle Island, and east of Vitskari Rocks. Several whales were seen working in deeper waters near Middle Island and Vitskari Rocks. Large groups of sea lions were observed holding off Inner Point, Bieli Rock, and east of Middle Island. South of Sitka, one whale and no sea lions were observed near Eastern Channel. Predator numbers and locations are normal for this time of year.

March 20: Dupuis. 0800-0900. Today's aerial survey covered Sitka Sound from Povorotni Point to Hayward Strait. Weather during the flight was good with high overcast and 5-knot winds. No herring were observed. A small **spot spawn** was observed near Fred's Creek. The highest concentrations of herring predators were observed near of Vitskari Rocks and St. Lazaria Island. Numerous whales were seen working in deeper waters near Vitskari Rocks and St. Lazaria Island. Large groups of sea lions were observed holding off Vitskari Rocks and Shoals Point. A small number of whales were observed east of Middle Island. South of Sitka, one whale and five sea lions were observed near Eastern Channel. The herring predators that have been near Bieli Rock appear to have shifted south to Vitskari Rocks.

Vessel surveys showed a very large biomass of herring in the vicinity of Vitskari Rocks. Additionally, schools of herring were also observed near Bieli Rock, in Eastern Channel, and east of Middle Island.

One test set was conducted today near Vitskari Rocks but failed to produce a sample.

The Sitka Sound herring sac roe fishery has been placed on 2-hour notice effective 8:00 a.m., Saturday, March 20, 2021.

-continued-

March 21: Jones. 0800-0900. Today's aerial survey covered Sitka Sound from Eastern Channel to Krestoff Sound. Weather during the flight was fair to poor with a low cloud ceiling, fog, and rain with 10-knot south winds. No herring or herring spawn were observed. The highest concentrations of herring predators, including whales and sea lions were observed between Vitskari Rocks and St. Lazaria Island. A few sealion rafts of were also observed between Inner Point and Bieli Rocks.

A survey conducted by department vessels located numerous herring schools southwest of Bieli Rock, near Lisianski Point, east of Middle Island, and Eastern Channel.

Three successful test sets were conducted today, the results are as follows:

- *F/V Sitkanak*; southwest of Bieli Rock, 30-ton set, mature roe (7.7%), immature roe (2.7%), average weight (101g), females (44%).
- *F/V Hukilau*; Lisianski Point, 100-ton set, mature roe (9.2%), immature roe (2.7%), average weight (113g), females (48%).
- *F/V Chelsea Dawn*; Eastern Channel, 30-ton set, mature roe (11.9%), immature roe (0.9%), average weight (122g), females (52%).

March 22: Jones. 0830-0930. Today's aerial survey covered Sitka Sound from Redoubt Bay out to Cape Edgecumbe and north to Krestof Sound. Weather during the flight was good with low overcast, 15-knot winds, and occasionally snow flurries. No herring or herring spawn were observed. The highest concentrations of herring predators were observed from the Vitskari Rocks to Cape Edgecumbe. 20+ whales were seen working the deeper waters along the southern Kruzof Island shoreline. A few whales were also observed west of Crow Island and a large group of sea lions was observed off Inner Point.

A boat survey conducted by department vessels located numerous herring schools southeast of Kresta Point, near Lisianski Point, east of Middle Island, and near Inner Point. Additionally, industry vessels noted numerous schools of herring near Eastern Channel.

Three successful test sets were conducted today, the results are as follows:

- *F/V Perseverance*; south of Kresta Point, 210-ton set, mature roe (7%), immature roe (1.6%), average weight (111g), and females (37%).
- *F/V Defiant*; Inner Point, 80-ton set, mature roe (7.9 %), immature roe (1.43%), average weight (107g), and females (37%).
- *F/V Hukilau*; Inner Point, 75-ton set, mature roe (9.4%), immature roe (2%), average weight (110g), and females (48%).

-continued-

March 23: Today's aerial survey was cancelled due to poor weather.

A boat survey conducted by department vessels located large schools of herring southeast of Middle Island, near Bieli Rock, and east of Vitskari Rocks. Small schools were observed in Promisla and Eastern bays. Industry vessels noted several scattered schools in Eastern Channel and some larger schools east of the Siginaka Islands. No test sets were conducted today.

March 24: Jones. 0800-0900. Today's aerial survey covered Sitka Sound from Redoubt Bay to Shoals Point and north to Krestof Sound. Weather during the flight was poor with 20-knot winds, low overcast, and occasional snow flurries. No herring or herring spawn were observed. The highest concentrations of herring predators were observed near Vitskari Rocks, Bieli Rock, and east of Middle Island. Numerous whales were seen working the deeper waters east of Vitskari Rocks and near Bieli Rock. 2 whales were also observed east of Middle Island. Groups of sea lions were observed off Shoals Point and near Bieli Rock.

A boat survey conducted by department vessels located large schools of herring east of Middle Island and west of Bieli Rock. Industry vessels noted several scattered schools south of Sitka in Eastern Channel and Deep Inlet.

One successful test set was conducted today, the results are as follows:

- *F/V Perseverance*; Bieli Rock, 100-ton set, mature roe (6.8%), immature roe (1.1%), average weight (101g), and (33%) female.

March 25: Jones. 0800-0930. Today's aerial survey covered Sitka Sound with an area ranging from Walker Channel to the south, out to St. Lazaria Island, and north to Salisbury Sound. Weather during the flight was good with 15-knot winds, overcast skies. No herring or herring spawn were observed. The highest concentrations of herring predators were observed near Vitskari Rocks, Bieli Rock, and west of Middle Island. Numerous whales were seen working the deeper waters east of Vitskari Rocks, near Bieli Rock, and west of Middle Island. Several individual scattered whales and sea lion groups were also observed south of Sitka Sound near Crawfish Inlet.

A boat survey conducted by department vessels located multiple large schools of herring east of Middle Island, west of Bieli Rock, near Inner Point, and by Vitskari Rocks. Industry vessels noted several scattered schools south of Sitka in Eastern Channel and Deep Inlet.

Four successful test sets were conducted today, the results are as follows:

- *F/V Perseverance*, southwest of Bieli Rock, 20-ton set, mature roe (8%), immature roe (0.7%), average weight (102g), and (37%) female.
- *F/V Hukilau*, Inner Point, 20-ton set, mature roe (9.3%), immature roe (0.3%), average weight (112g), and (38%) female.
- *F/V Sitkanak*, Inner Point, 1-ton set, mature roe (9.4%), average weight (104g), and (37%) female.
- *F/V Shadowfax*, Fred's Creek, 200-ton set, mature roe (9.3%), average weight (109g), and (37%) female.

-continued-

March 26: Today's aerial survey was cancelled due to poor weather.

A boat survey conducted by department vessels located numerous large schools of herring east of Middle Island, west of Bieli Rock, and from Shoals Point to Mountain Point. Industry vessels noted several scattered schools south of Sitka in Eastern Channel and Deep Inlet.

Four successful test sets were conducted today, the results are as follows:

- *F/V Sitkanak*, Inner Point, 150-ton set, mature roe (9.6%), immature roe (1.3%), average weight (94g), and (45%) female.
- *F/V Ace*, Fred's Creek, 40-ton set, mature roe (9.1%), immature roe (0.7%), average weight (101g), and (40%) female.
- *F/V Chelsea Dawn*, Mountain Point, 5-ton set, mature roe (7.1%), average weight (82g), and (39%) female.
- *F/V Shadowfax*, Shoals Point, 250-ton set, mature roe (8.4%), immature roe (0.5%), average weight (117g), and (39%) female.

March 27: Today's aerial survey was cancelled due to poor weather.

Boat surveys conducted by department vessels located a large biomass of herring in the regulatory closed waters extending from Watson Point to Halibut Point and numerous large schools from Lisianski Point to Hayward Strait.

Four successful test sets were conducted today, the results are as follows:

- *F/V Nicholas Michael*, Magoun Islands, 75-ton set, mature roe –11.7%, average weight – 117 g, and 49% female.
- *F/V Defiant*, Lisianski Point, 75-ton set, mature roe – 11.3%, average weight–123 g, and 43% female.
- *F/V Chelsea Dawn*, Hayward Strait, no set size estimate, mature roe – 8.2%, average weight – 111 g, immature roe – 1.4%, and 37% female.
- *F/V Defiant*, Eastern Bay, 250-ton set, mature roe – 7.8%, immature roe – 0.9%, average weight – 103 g, and 39% female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 10:30-18:30. Open waters for this fishery included the area south of 57°10.78′ N lat, north of 57°08.47′ N lat, and west of 135°23.65′ W long.

-continued-

March 28: Jones. 0715-0815. Today's aerial herring survey in Sitka Sound had good weather with excellent visibility, 15-knot winds, and clear skies. The survey stretched from Redoubt Bay to Krestof Sound and west to St. Lazaria Island. Herring predators were scattered throughout Sitka Sound, with concentrations including within the closed commercial waters east of Middle Island, along the southern Kruzof Island shoreline, and in Hayward Strait and Krestof Sound. A large school of herring was observed in northern Krestof Sound. No herring spawn was observed.

Boat surveys conducted by department vessels located a large biomass of herring in the regulatory closed waters extending from Watson Point to Halibut Point. Numerous large schools were observed on sonar at Lisianski Point, Hayward Strait, the Magouns, and Krestof Sound.

Three successful test sets were conducted today; the results are as follows:

- F/V Rose Lee, Lisianski Point, 50-ton set, mature roe (10.3%), average weight (114g), immature roe (0.3%), and (47%) female.
- F/V Emily Nicole, Hayward Strait, 50-ton set, mature roe (10.2%), average weight (110g), and (50%) female.
- F/V Shadowfax, Krestof Sound, 75-ton set, mature roe (11.8%), immature roe (0.6%), average weight (108g), and (49%) female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 10:45 a.m. until 6:00 p.m. Open waters for this fishery included the area south of 57°10.78′ N lat, north of 57°08.47′ N lat, and west of 135°23.65′ W long, and waters of Krestof Sound north of the latitude of Partof Point at 57°13.69′ N lat.

March 29: Jones. 0730-0815. Today's aerial herring survey in Sitka Sound had 15-knot winds, overcast skies with snow and rain showers, and poor visibility. The survey covered Eastern Channel to Krestof Sound and west to Low Island. Herring predators were concentrated around Hayward Strait/Krestof Sound, including groups of whales and sea lions. Large schools of herring were observed in the Magoun Islands and smaller schools were observed in Krestof Sound. No herring spawn was observed.

Department vessel survey located large biomass of herring in the regulatory closed waters extending from Eliason Harbor to Starrigavan Bay. Numerous large schools from Lisianski Point to Dog Point, in Hayward Strait, and in the Magoun Islands.

Two successful test sets were conducted today, the results are as follows:

- *F/V Hukilau*, Lisianski Point, 20-ton set, mature roe (12.3%), average weight (120g), and (56%) female.
- *F/V Alinchak*, Hayward Strait, 100-ton set, mature roe (11.7%), average weight – (118g), and (54%) female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 9:45 a.m. until 4:30 p.m. Open waters for this fishery included the area south of 57°10.78′ N lat, north of 57°08.40′ N lat, and west of 135°23.41′ W long.

-continued-

March 30: Jones. 0730-0830. Today's aerial herring survey of Sitka Sound had 20-knot winds, overcast skies with rain showers and poor to fair visibility. The survey covered an area from Eastern Channel to the Magoun Islands and west to Shoals Point. Herring predators were observed around Hayward Strait, Inner Point, and Lisianski Point. A large group of sea lions were seen off Inner Point. Whales continue to be seen in Hayward Strait and Lisianski Point. Large schools of herring were observed from the air around Eastern Channel, Lisianski Point, and around the Magoun Islands. A **small amount of herring spawn** was observed by Brent's Beach. Boat surveys conducted by department vessels located numerous large schools of herring extending from Sandy Beach to Starrigavan Bay, from Lisianski Point to Dog Point, in Hayward Strait, and near Deep Inlet. A large biomass of herring was observed from Crescent Harbor to Thimbleberry Bay.

Three successful test sets were conducted today; the results are as follows:

- *F/V Alinchak*, Hayward Strait, 20-ton set, mature roe (10.3%), immature roe (0.3%), average weight (105g), and (49%) female.
- *F/V Shadowfax*, Indian River, 200-ton set, mature roe (11.2%), average weight (112g), and (50%)) female.
- *F/V Freedom*, Deep Inlet, 75-ton set, mature roe (12.2%), immature roe (0%), average weight (127g), and (52%) female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 9:30 a.m. until 6:30 p.m. Open area for this fishery included the waters of Hayward Strait south of 57°09.40′ N lat and north of 57°08.40′ N lat, and the waters south of 57°10.78′ N lat, north of 57°08.40′ N lat, west of 135°23.41′ W long, and east of 135°26.18′ W long.

March 31: Dupuis. 1400-1500. Today's aerial survey of Sitka Sound was delayed until the afternoon due to foul weather and covered Sitka Sound from Eastern Channel, West Crawfish Inlet, and north to Middle Island. Visibility was poor with passing showers and 20-knot winds. Large schools of herring were seen in Leesoffskaia Bay and near Magic Island. No herring spawn was observed. Herring predators, including whales and sea lions, were widely distributed throughout Sitka Sound; however, numerous sea lions and whales were observed in Windy Passage.

-continued-

Boat surveys conducted by department vessels located several large schools of herring within the regulatory closed waters extending from Sandy Beach to Old Sitka Rocks and near Whiting Harbor. Large schools of herring were also observed south of town from Crescent Harbor to Thimbleberry Bay and in Deep Inlet.

Two successful test sets were conducted today, the results are as follows:

- *F/V Nickolas Michael*, Indian River, 20-ton set, mature roe (11.6%), average weight (116g), and (55%) female.
- *F/V Little Lady*, Aleutkina Bay, 20-ton set, mature roe (10.2%), average weight (113g), and (46%) female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 1045-1830. Open areas for this fishery included the waters south of 57°02.88′ N lat, north of 57°01.95′ N lat, west of 135°16.61′ W long, and east of 135°20.21′ W long, and the waters south of 57°00.81′ N lat and east of 135°21.93′ W long.

April 1: Jones. 0715-0815. Today's aerial herring survey of Sitka Sound covered an area from Redoubt Bay to the Magoun Islands and from Silver Bay to Low Island. Visibility was mostly good with mostly cloudy skies, passing snow squalls, and 5-10 knot winds. Herring predators were scattered throughout Sitka Sound with whales and sea lions concentrated close to the shorelines. Whales were seen feeding by the Siganaka Islands, at Whiting Harbor, and near Vitskari. Schools of herring were observed at Whiting Harbor, by Jamestown Bay, and Deep Inlet. Two very small areas of **spot spawn** were seen along the eastern shoreline of Kruzof Island. Boat surveys conducted by department vessels located numerous large schools of herring south of town from Crescent Harbor to Thimbleberry Bay and in Deep Inlet. A comprehensive vessel survey was not conducted north of Watson Point this morning, however, numerous large schools of herring were observed in the regulatory closed waters extending from Eliason Harbor to Makhnati Island, near Whiting Harbor. In the afternoon, large schools of herring were observed close to the shoreline on the eastern side of the Siginaka Islands and from Lisianski Point to Watson Point.

Two successful test sets were conducted today, the results are as follows:

- *F/V Emily Nicole*, Indian River, 50-ton set, mature roe (12.1%), average weight (112g), and (53%) female.
- *F/V Nicholas Michael*, Aleutkina Bay, 5-ton set, mature roe (10.0%), average weight (117g), and (46%) female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 9:45 a.m. until 6:30 p.m. Open areas for this fishery included the waters south of 57°02.88′ N lat, north of 57°01.95′ N lat, west of 135°16.61′ W long, and east of 135°20.21′ W long, and the waters south of 57°00.81′ N lat and east of 135°21.93′ W long.

-continued-

April 2: Jones. 0700-0830. Today's aerial survey of Sitka Sound covered an area from Windy Passage to St. John Baptist Bay and from Silver Bay to Shoals Point. Weather and visibility were good with cloudy skies, occasional snow flurries, and 10-knot winds. Herring predators were scattered throughout the area with whales and sea lions mostly concentrated close to shore from Shoals Point to the Siganaka Islands. Whales were seen bubble-net feeding near Jamestown Bay. Large schools of herring were seen from the air outside of Deep Inlet and by Whiting Harbor. No significant spawning was seen in the area aside from a **small spot spawn** along the eastern shoreline of Kruzof Island.

Boat surveys conducted by department vessels located numerous large schools of herring south of town from Crescent Harbor to Entry Point. A comprehensive vessel survey was not conducted north of Watson Point this morning, however, numerous large schools of herring were observed in the regulatory closed waters extending from Eliason Harbor to Makhnati Island. Smaller scattered schools were noted in Redoubt Bay and Windy Passage. In the afternoon, scattered schools of herring were observed close to the shoreline from Halibut Point to Watson Point and large schools were located near Battery Island and within Whiting Harbor.

One successful test set was conducted today; the results were:

- *F/V Freedom*, Indian River, 100-ton set, mature roe – 9.6%, average weight–112 g, and 44% female.

An opening of the Sitka Sound herring sac roe fishery occurred today from 9:30 a.m. until 1:30 p.m. in 2 areas: 1) the waters south of 57°02.88′ N lat, north of 57°01.95′ N lat, west of 135°16.61′ W long, and east of 135°20.21′ W long.; and 2) the waters south of 57°00.81′ N lat and east of 135°21.93′ W long.

April 3: Jones. 0800-1000. Today's aerial survey of Sitka Sound covered an area ranging south to Lodge Island, north to Sukoi Inlet, and west to St. Lazaria Island. Weather and visibility were excellent with partly cloudy skies, and 5-knot winds. Herring predators were scattered throughout the area with whales and sea lions mostly concentrated close to shore along the southern and eastern shores of Kruzof Island, and south of St. Lazaria Island. In addition, whales were seen bubble-net feeding near Jamestown Bay. A number of large herring schools were seen from the air south of town around Deep Inlet and near West Crawfish Inlet. No significant spawning was seen in the area; however, a small area of **spot spawn** was seen along the eastern shoreline of Kruzof Island at Mountain Point. A second aerial survey was conducted in the afternoon to investigate additional spawn near the earlier observed spot spawn. The spot spawn observed earlier had expanded but was still confined to Mountain Point and no additional spawn was observed. Numerous large schools of herring were observed from Shoals Point to Brent's Beach, in Promisla and Eastern bays, and in the Siginaka Islands. Whales and sea lions were observed scattered through this area in shallow water actively feeding.

-continued-

Boat surveys conducted by department vessels located a very large biomass of herring south of town from Crescent Harbor to Entry Point. Numerous large schools of herring were also observed in Aleutkina Bay. A comprehensive vessel survey was not conducted north of Watson Point this morning. Numerous large schools of herring were observed in the state and federal regulatory closed waters extending from Eliason Harbor to Makhnati Island, west of the airport, and beyond into the islands south of the airport. In the afternoon, the vessel survey observed a large biomass of herring in shallow waters from Fred’s Creek to Brent’s Beach and extending into Hayward Strait.

One successful test set was conducted today; the results were:

- 9:30 a.m., Indian River, 100-ton set, mature roe (9.6%), average weight (106g).

An opening of the Sitka Sound herring sac roe fishery occurred today from 1130-1400 in the waters south of 57°02.88′ N lat, north of 57°01.95′ N lat, west of 135°16.61′ W long, and east of 135°18.86′ W long, and from 11:30 a.m. until 3:45 p.m. in the waters south of 57°00.81′ N lat and east of 135°21.93′ W long.

April 4: Jones. 0800-1000. Today’s aerial survey of Sitka Sound covered an area ranging south to Povorotni Point, north to Salisbury Sound, and west to Shoals Point. Weather and visibility were poor with overcast skies, rain and snow showers, and 15-knot winds. Herring predators were scattered throughout the area with whales and sea lions mostly concentrated close to shore along the eastern shores of Kruzof Island, and south of Kasiana Island. Approximately **6.5 nmi of spawn** was observed today along the Kruzof Island shoreline from Shoals Point to Rob Point, near Kresta Point, and on Gagarin and Crow Islands. Schools of herring were observed in Promisla Bay and Jamestown Bay.

Boat surveys conducted by department vessels located a very large biomass of herring south of town from Crescent Harbor to Entry Point and south to Whale Island. A comprehensive vessel survey was not conducted north of Kasiana Island this morning; however, numerous large schools of herring were observed in the state and federal regulatory closed waters extending from Eliason Harbor to the southern end of Kasiana Island, near Apple Island, in the Parker Group, west of the airport, and beyond into the islands south of the airport. In the afternoon, the vessel survey observed multiple schools of herring near Middle Island and Crow Island.

No test sets were conducted today.

An opening of the Sitka Sound herring sac roe fishery occurred today from 1030-1530 in the waters south of 57°02.60′ N lat, north of 57°01.15′ N lat, west of 135°16.61′ W long, and east of 135°20.85′ W long and the waters south of 57°00.81′ N lat and east of 135°21.93′ W long.

-continued-

April 5: Dupuis. 0800-0945. Today's aerial survey of Sitka Sound covered an area ranging south to West Crawfish Inlet, north to Krestof Sound, and west to Cape Edgecumbe. Weather and visibility were poor with overcast skies, rain and snow showers, and 15-knot winds. Approximately **14.9 nmi of spawn** was observed today along the Kruzof Island shoreline from Shoals Point to Rob Point, from Point Brown to Kresta Point, and on Gagarin and Crow Islands. Smaller areas of spawn were observed on Middle Island, the Chaichei Islands, Pirates Cove, and near Golf Island. Schools of herring were observed along the beach near Watson Point and in Eliason Harbor.

The *R/V Kestrel* departed Sitka Sound this morning at 5:00 a.m.

The Sitka Sound herring sac roe fishery will remain open from 0800-1800 daily beginning today, April 5, 2021, until closed by field or advisory announcement in the waters of Deep Inlet and Aleutkina Bay south of 57°00.81′ N lat and east of 135°21.93′ W long, and the waters south of the latitude of Povorotni Point at 57°00.81′ N lat and north of the latitude of Aspid Cape at 57°41.75′ N lat, except for the waters of Whale and Necker Bays.

April 6: Dupuis. 0800-0955. Today's aerial survey of Sitka Sound covered an area ranging south to West Crawfish Inlet, north to Krestof Sound, and west to Cape Edgecumbe. Weather and visibility were fair with overcast skies, rain and snow showers, and 10-knot winds. Approximately **20.0 nmi of spawn** was observed today along the Kruzof Island shoreline from Lava Island to Rob Point, the Magoun Islands, from Point Brown to Kresta Point, Promisla and Eastern Bays, on Gagarin, Crow, and Middle Islands, Whiting Harbor, near Indian River, Pirates Cove, and around Golf Island. Through April 6, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 22.5 nmi.

The Sitka Sound herring sac roe fishery will continue to be open from 0800-1800 daily until closed in the waters of Deep Inlet and Aleutkina Bay south of 57°00.81′ N lat and east of 135°21.93′ W long, and the waters south of the latitude of Povorotni Point at 56°57.13′ N lat and north of the latitude of Aspid Cape at 56°41.75′ N lat, except for the waters of Whale and Necker Bays.

April 7: Jones. 0800-1000. Today's aerial survey of Sitka Sound covered an area ranging south to West Crawfish Inlet, north to Krestof Sound, and west to Cape Edgecumbe. Weather and visibility were good with partly cloudy skies and 5-knot winds. Approximately **28.3 nmi of spawn** was observed today along the Kruzof Island shoreline from Lava Island to Rob Point, the Magoun Islands, from Point Brown to Kresta Point, Promisla and Eastern Bays, on Gagarin, Crow, and Middle Islands, Whiting Harbor, near Indian River, Pirates Cove, and around Golf Island. Through April 7, the cumulative estimate of herring spawn in Sitka Sound is approximately 33.3 nmi.

The Sitka Sound herring sac roe fishery continues to be open from 0800-1800 daily until closed in the waters of Deep Inlet and Aleutkina Bay south of 57°00.81′ N lat and east of 135°21.93′ W long, and the waters south of the latitude of Povorotni Point at 56°57.13′ N lat and north of the latitude of Aspid Cape at 56°41.75′ N lat, except for the waters of Whale and Necker Bays.

-continued-

April 8: Today's aerial survey was canceled due to poor weather.

The Sitka Sound herring sac roe fishery continues to be open from 0800-1800 daily until closed in the waters of Deep Inlet and Aleutkina Bay south of 57°00.81′ N lat and east of 135°21.93′ W long, and the waters south of the latitude of Povorotni Point at 56°57.13′ N lat and north of the latitude of Aspid Cape at 56°41.75′ N lat, except for the waters of Whale and Necker Bays.

April 9: Dupuis. 0800-1100. Today's aerial survey of Sitka Sound covered an area ranging south to West Crawfish Inlet, north to Salisbury Sound, and west to Cape Edgecumbe. Weather and visibility were poor with partly cloudy skies, numerous snow squalls, and 10-knot winds. Approximately **18.4 nmi of spawn** was observed today in the Magoun Islands, Degroff Bay, Promisla and Eastern Bays, the Siginaka Islands, on Little Gavanski, Gagarin, Crow, and Middle Islands, the Kasiana Islands, Whiting Harbor, along the Sitka road system near Halibut Point, near Indian River, Pirates Cove, Samsing Cove, Redoubt Bay, and Hot Springs Bay. Through April 9, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 48.8 nmi.

The fishery remained open daily from 0800-1800 until closed, in the waters of Deep Inlet and Aleutkina Bay south of 57°00.81′ N lat and east of 135°21.93′ W long, and the waters south of the latitude of Povorotni Point at 56°57.13′ N lat and north of the latitude of Aspid Cape at 56°41.75′ N lat, except for the waters of Whale and Necker Bays.

The Sitka Sound herring sac roe fishery closed today, April 9, at 6pm.

April 10: Jones. 1045-1315. Today's aerial survey of Sitka Sound covered an area ranging south from Walker Channel and north to Krestof Sound. Weather and visibility were fair with cloudy skies, rain and snow showers, and 10-knot winds. Approximately **24.2 nmi of spawn** was observed today in the Magoun Islands, Promisla and Eastern Bays, the Siginaka Islands, Gagarin, Crow, and Middle Islands, the Kasiana Islands, Pirates Cove, Samsing Cove, Redoubt Bay, Hot Springs Bay, Walker Channel, Jamboree Bay, Whiting Harbor, and along the Sitka road system including Halibut Point, and near Indian River. Through April 10, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 62.5 nmi.

April 11: Dupuis. 0800-1030. Today's aerial survey of Sitka Sound covered an area ranging south from Walker Channel and north to Salisbury Sound. Weather and visibility were fair with cloudy skies and 10-knot winds. Approximately **25.7 nmi of spawn** was observed today in Eastern Bay, Middle Island, the Kasiana Islands, from Silver Point to Pirates Cove, Redoubt Bay, Hot Springs Bay, Elovoi, Golf, and Gornoi Islands, Walker Channel, Jamboree Bay, Whiting Harbor, Jamestown Bay, and along the Sitka road system from Sandy Beach to Eliason Harbor. Through April 11, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 77.1 nmi.

-continued-

April 12: Jones. 0800-1000. Today's aerial survey of Sitka Sound covered an area ranging south from Walker Channel and north to Neva Strait. Weather and visibility were fair to poor with cloudy skies, rain/snow, a low cloud ceiling, and 15-knot winds. Approximately **12.5 nmi of active spawn** was observed today, mostly concentrated at Windy Passage, Dorothy Narrows, Hot Springs Bay, and outside Deep Inlet in Pirate, Samsing, and Sandy Coves. Through April 12, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 83.2 nmi.

April 13: Jones. 0900-0930. The aerial survey conducted today was aborted early due to foul weather, therefore, a comprehensive survey was not conducted but a small amount of active spawn was seen near Povorotni Point.

April 14: Jones. 1145-1345. Today's aerial survey of Sitka Sound covered an area ranging south from Jamboree Bay and north to Salisbury Sound. Weather and visibility were good with cloudy skies, light rain, and 20-knot winds. Aside from a small **spot spawn** in Windy Passage, no other active herring spawn was observed today.

A vessel survey was conducted today to locate areas of herring spawn missed during days aerial surveys could not be flown and after the aerial surveys were completed for the day. The vessel survey added approximately 6.3 nmi of spawn area to the cumulative total. Through April 14, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 90.4 nmi.

This was the last public fishery update of the 2021 season.

April 15: Jones. 1345-1500. Today's aerial survey of Sitka Sound covered an area ranging south from Jamboree Bay and north to Salisbury Sound. No active spawn was located.

A vessel survey was conducted today to locate areas of herring spawn missed during aerial survey weather days or spawn that appeared after the aerial surveys were completed for the day. This survey concentrated around Middle, Crow, Siganaka Islands and surrounding nearby islets. The vessel survey added approximately 7.3 nmi of spawn area to the cumulative total. Through April 15, the cumulative estimate of observed herring spawn in Sitka Sound is approximately 97.7 nmi.

April 16: Jones. 1300-1415. Today's aerial survey of Sitka Sound covered an area ranging south from Jamboree Bay and north to Salisbury Sound. Seven **small areas of active spawn** were located on the outer islands between West Crawfish and Crawfish Inlets, totaling 0.4 nmi.

A vessel survey was conducted in Sitka Sound to locate areas of herring spawn missed during aerial survey weather days or spawn that appeared after the aerial surveys were completed for the day. The area covered from the Causeway on Japonski Island and outside of Deep Inlet in southern Sitka Sound. The vessel survey added approximately 3.4 nmi of inactive spawn, marked as new areas to the cumulative total.

-continued-

April 17: Jones. 0800-0915. Today's aerial survey of Sitka Sound covered an area ranging south from Jamboree Bay and north to Salisbury Sound. Nine small areas of active spawn were located outside West Crawfish and Crawfish Inlets, and Hot Springs Bay. The total amount of **active spawn was 0.9 nmi**.

April 19: Jones. A vessel survey was conducted south of Sitka Sound to locate areas of herring spawn missed during aerial survey weather days or spawn that appeared after the aerial surveys were completed for the day. The vessel survey added approximately 0.7 nmi of spawn area to the cumulative total.

Spawn lines were reviewed and edited to more accurately depict the shoreline polygons, bringing the cumulative spawn total to 102.7 nmi. (The official cumulative spawn estimate is 102.3 nmi)

April 23: Dave Harris from the JNU office flew an aerial survey of Hoonah Sound. No herring spawn was observed. Small school in S Arm, no spawn. 1W. excellent vis.

Appendix C3.–Aerial and skiff herring spawn surveys by date, at Bradfield Canal, Ernest Sound, Ship Island, Zimovia Strait and Eastern Passage, Bear Creek, Hobart Bay, and other areas within Petersburg–Wrangell Management Area in Southeast Alaska, 2021.

Bradfield Canal
Not surveyed in 2021.

Vixen Inlet/Union Bay/Emerald Bay
Total miles of spawn: unknown
Spawning dates: sometime between 4/14 and 4/15
Peak spawning: unknown
4/11 No herring spawn or schools observed
4/14 Spot spawn and small schools, few predators or birds
4/15 0.5 nmi of active herring spawn or schools observed, 27 sea lions, 500 scoters, 200 gulls
4/16 No herring spawn or schools observed, 13 sea lions, 500 scoters,1,000 gulls.
4/19 No herring spawn or schools observed, 3 sea lions, 1,000 scoters 1,000 gulls.

Onslow/Stone/Brownson Island/Canoe Pass
Total miles of spawn: None
4/15 No herring spawn or schools observed, no predators or birds.
4/16 No herring spawn or schools observed few predators or birds.
4/19 No herring spawn or schools observed, 3 sea lions.

Ship Island
Not surveyed in 2021.

Zimovia St. and Eastern Passage
Not surveyed in 2021.

Bear Creek
Not surveyed in 2021.

Farragut Bay
Total miles of spawn: unknown
Spawning dates: possibly 5/2-5/3
Peak spawning: unknown
4/21 No herring spawn or schools observed, 15 sea lions.
4/23 No herring spawn or schools observed, 9 sea lions, very few birds
4/26 No herring spawn or schools observed, 5 sea lions.
4/27 No herring spawn or schools observed.
4/28 No herring spawn or schools observed, 15 sea lions, 1 whale
4/29 No herring spawn or schools observed.
5/2 No herring spawn observed, numerous schools on beach, 2 whales, 15 sea lions.
5/4 No herring spawn observed, 4 schools of herring, 3 whales, 13 sea lions, 200 scoters.
5/8 No herring spawn or schools observed, 500 scoters, 200 gulls.
5/9 No herring spawn or schools observed, 1,000 scoters.
5/10 No herring spawn or schools observed, 5 sea lions, 1 whale, 1,400 scoters.

-continued-

Hobart Bay
Total miles of spawn: 3.5 nm
Spawning dates: 4/26 to 4/28, 5/8-5/10
Peak spawning: 5/8

4/21	No herring spawn or schools observed, 2 sea lions
4/23	No herring spawn or schools observed, 1 sea lion.
4/26	~1.4 miles of active spawn, 1 school of herring, 12 sea lions, 2,000 birds.
4/27	~2.3 miles of active spawn, numerous schools, 10 sea lions, 1 whale.
4/28	~1.1 miles of active spawn, 1 school, 50 sea lions.
4/29	No herring spawn or schools observed, 25 sea lions.
5/2	No herring spawn observed, 3 schools of herring, 1 whale, 100 gulls.
5/4	No herring spawn or schools observed, 25 sea lions.
5/8	~2.5 miles of active spawn, 4 schools of herring, 300 gulls, 4 humpback whales.
5/9	~2.3 miles of spawn, 2 schools of herring, 33 sea lions.
5/10	~1 mile of active spawn, 1 whale, 60 sea lions, 200 scoters.
5/11	No herring spawn or schools observed, 25 sea lions, 1 whale, 1,000 scoters.
5/12	No herring spawn or schools observed, 1 whale, 6 sea lions, 1,225 scoters, 100 gulls.

Port Houghton
Total miles of spawn: ~0.5 nm
Spawning dates: 5/9-5/11
Peak spawning: 5/11

4/21	No herring spawn or schools observed.
4/23	No herring spawn or schools observed, 16 sea lions.
4/26	No herring spawn, numerous schools of herring, 3 sea lions, 2,500 birds, 1 whale.
4/27	No herring spawn, 2 schools of herring, 1 whale, 500 gulls.
4/28	No herring or herring spawn observed, 3 sea lions, 1000 gulls, 500 scoters.
4/29	No herring spawn or schools observed, 15 sea lions.
5/2	No herring spawn or schools observed, 500 gulls.
5/4	No herring spawn or schools observed, 35 sea lions.
5/8	No herring spawn or schools observed, 5 sea lions, 150 gulls.
5/9	~0.25 miles of active spawn, 6 schools of herring, 11 sea lions, 1,000 gulls.
5/10	No herring spawn or schools observed.
5/11	~0.3 miles of spawn, 2 schools of herring, 18 sea lions, 100 scoters, 1,500 gulls.
5/12	No herring spawn or schools observed, 10 sea lions, 100 gulls, 300 scoters.

Sunset Cove/Windham Bay

4/21	No herring spawn or schools observed, 10 sea lions
4/23	No herring spawn or schools observed, 10 sea lions, 1 whale.
4/26	No herring spawn or schools observed, 8 sea lions, 2 whales, few birds.
4/27	No herring spawn or schools observed, 2 sea lions.
4/28	No herring spawn or schools observed, 13 sea lions, 50 gulls.
4/29	No herring spawn or schools observed, 5 sea lions
5/2	No herring spawn or schools observed, 40 sea lions, light bird activity both gull and scoter.
5/8	No herring spawn or schools observed.
5/9	No herring spawn or schools observed, 5 sea lions.
5/10	No herring spawn or schools observed, 25 sea lions, 1 whale.
5/11	No herring spawn or schools observed, 4 sea lions.

-continued-

5/12 No herring spawn or schools observed, 13 sea lions, 1 whale.

Gambier Bay/Pybus Bay

5/4 ~.10 miles of possible spawn, 17 sea lions, 1,130 scoters.

Port Camden

5/4 No herring spawn or schools observed, 20 sea lions, 1,000 scoters

Tebenkof Bay

Not Surveyed in 2021.

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Juneau Management Area, in Southeast Alaska, 2021.

Seymour Canal

Number of times surveyed: 19
Total miles of spawn: 3.1 nmi
Spawning dates: 5/18-5/25
Peak spawn: 5/19; 5/25

4/16: No herring or herring spawn; 32 SL 0W Excellent vis.
4/20: No herring or herring spawn; 41 SL 4W Excellent vis.
4/23 No herring or herring spawn; 12 SL, 4W. Good vis.
4/26: Industry Pilot reported schools on the beach along the Big Bend shoreline; spot spawn on top of submerged rock inside of #9 rock. 41SL 3W. Excellent vis.
4/29: No herring or herring spawn; 51SL 0W. Poor vis
5/2: No herring or herring spawn; 71SL 11W. Excellent vis.
5/5: No herring or herring spawn; 64SL 5W. Good vis.
5/8: No herring or herring spawn; 18SL 0W. Good vis
5/11: No herring or herring spawn; 100SL 1W. Good vis.
5/14: No herring or herring spawn; 48SL 2W. Good vis.
5/17: No herring or herring spawn; 58SL 5W. Excellent vis.
5/18: Industry pilot reported 0.3 nmi of spawn Twin Islands and south.
5/19: 1.3 nmi light discontinuous spawn between Twin Islands and Pt Hugh, small spot at Cloverleaf Rocks. Numerous SL 3W at Pt Hugh. Excellent vis.
5/20: <0.1nmi spawn in 3 spots, several schools on the beach. 188 SL, many active at Pt Hugh. Excellent vis.
5/21: <0.1nmi spawn in 3 spots. Some schools. 4W 20 SL. Vis fair.
5/23: 0.3 nmi active spawn between Rock Garden and Sorethumb, with schools on beach nearby. 20 SL 1W. Excellent vis.
5/24: 0.5 nmi active spawn in Sorethumb Cove, small schools on beach north of Sorethumb. Few SL 0W. Good vis.
5/25: 0.9 nmi active spawn at Sorethumb Cove, no herring schools. 20SL 1W. excellent vis.
5/26: No herring or herring spawn; few predators. Good vis.

Tenakee Inlet

Number of times surveyed: 9
Total miles of spawn: 0
Spawning dates: n/a
Peak spawn: n/a
4/16: No herring or herring spawn; 2 SL 1W. Some fog, but excellent vis.
4/20: No herring or herring spawn; 7 SL 0W. Excellent vis.
4/23: No herring or herring spawn; 2SL 0W. Excellent vis.
4/26: No herring or herring spawn; 4SL 0W. Excellent vis.
4/29: No herring or herring spawn; 36 SL 0W. Poor vis
5/2: No herring or herring spawn; 10 SL 2W. Excellent vis.
5/5: No herring or herring spawn; 22SL 1W. excellent vis.
5/8: No herring or herring spawn; 4SL 0W. Good vis.
5/17: No herring or herring spawn; 8SL 3W. Excellent vis.

-continued-

Chatham Strait (Tenakee area/stock)
Number of times surveyed: 9
Spawn dates: 4/20, 4/21, 4/23
Total miles of spawn observed: 1.0 nmi
4/16: No herring or herring spawn; 2 SL 0W Excellent vis.
4/20: 1nm discontinuous spawn N of Basket Bay, no other herring schools; 6SL 0W excellent vis
4/21:0.1 nmi spawn at mouth of Basket Bay. 10 SL 1 W. vis good.
4/23: 0.1 nmi spawn north of Don's Creek 26 SL 0W. Excellent vis.
4/26: No herring or herring spawn; 47SL 0W. Excellent vis.
5/2: No herring or herring spawn; 17SL 0W. Excellent vis.
5/5: No herring or herring spawn; 13SL 0W. Good vis.
5/8: No herring or herring spawn; 4SL 0W. Good vis.
5/17: No herring or herring spawn; 1SL 0W. Excellent vis.

Lower Peril Strait (considered Tenakee stock)
Number of times surveyed: 1
Total miles of spawn observed: 0.7 nmi
4/23: Spawn at Pt Craven. Excellent vis

-continued-

Lynn Canal

Number of times surveyed: 10
Total miles of spawn: 0.9
Spawning dates: 5/5, 5/6, 5/8
Peak spawn: 5/5, 5/8
4/16: No herring or herring spawn; 20 SL 1W. Excellent vis.
4/20: No herring spawn; I school by Auke Rec; 36 SL 0W. Excellent vis.
4/23: No herring or herring spawn; 16 SL north of Pt St Mary. 0W. Excellent vis
4/26: No herring or herring spawn; 45 SL 2W. Excellent vis.
5/2: No herring or herring spawn; 20SL 0W. Excellent vis.
5/5: 0.4 nmi spawn, numerous schools and herring lining the beach around Pt Sherman; 5SL 3W. Fair vis.
5/6: Two spot spawns near Pt Sherman. Herring schools and fish lining the beach north of Comet. 1SL 1W. Fair vis.
5/8: 0.3 nmi light spawn in Lena Cove. Herring schools in Indian Cove. 3SL 0W. Fair vis.
5/11: Looked at Lena Cove no herring or herring spawn. 1W. Great vis.
5/17: No herring or herring spawn; 15SL 0W. Excellent vis.

Oliver Inlet and northern Stephens Passage

Number of times surveyed: 20
Spawning dates: 5/19-5/22
Peak Spawn: 5/20-5/21
Total miles of spawn: 2.9 nmi
4/16: No herring or herring spawn; 1 SL 0W. Excellent vis.
4/20: No herring or herring spawn; 0 SL 0W. Excellent vis.
4/23: No herring or herring spawn; 30 SL 0W. Excellent vis.
4/26: No herring or herring spawn; 8SL 0W. Excellent vis.
4/29: No herring or herring spawn; 12SL 0W. Poor vis.
5/2: No herring, herring spawn, or predators. Excellent vis.
5/5: No herring, herring spawn, or predators. Good vis.
5/6: No herring, herring spawn, or predators. Good vis.
5/8: No herring or herring spawn; 1SL 0W. Good vis.
5/11: No herring, herring spawn, or predators. Good vis.
5/14: No herring or herring spawn; 0SL 1W. Good vis.
5/17: No herring or herring spawn; 3SL 1W. Excellent vis.
5/19: 0.3 nmi active intense spawn w of Oliver Inlet, associated herring schools. 1W. excellent vis.
5/20: 1.2 nmi active spawn, schools leading the beach and in the mouth of Oliver Inlet. Excellent vis.
5/21: 1.7 nmi active spawn, with fish lining the beach and in the mouth of Oliver Inlet. Fair vis.
5/22: 0.3 nmi spawm E of Stink Creek and E of mouth of Oliver Inlet. No herring schools, few predators.
5/23: no spawn, or herring, several SL and one whale.
5/24: No herring, herring spawn, or predators. good vis.
5/25: No herring, herring spawn, or predators. Excellent vis.
5/26: No herring or herring spawn; 2W. good vis.

-continued-

Port Frederick

Number of times surveyed: 7
Spawn dates: 4/23
Total miles of spawn observed: 0.1 nmi
4/20: numerous schools in front of town, no herring spawn; 4SL 0W excellent vis.
4/23: 0.1 nmi spawn off Game Creek flats. Large school of herring in Hoonah Harbor, small school off Cannery Point. 2 SL 0W. Excellent vis.
4/26: A multitude of small herring schools offshore from the Narrows to Hoonah, schools on beach N of Seagull Creek; no spawn or predators. Excellent vis.
4/29: 2 nice herring schools in Hoonah Harbor, and a smaller one near Burnt Point. No spawn; 15 SL 0W. Poor vis.
5/2: Several small schools of herring, no spawn or predators. Excellent vis.
5/8: School near Hoonah, several schools n of Narrows, and in salt chuck. No spawn or predators. Good vis.
5/17: Schools in Hoonah Harbor, Burnt Point, Narrows and Salt Lake Bay. 7SL 0W. Excellent vis.

Funter Bay

Number of times surveyed: 4
Total miles of spawn observed: 0.2 nmi
5/20: 0.2 nmi in 2 spawns in n cove of the bay. Schools on the beach.
5/21: no spawn, several good schools on beach in N cove.
5/22: no spawn, schools in coves outside Funter, by the Kittens.
5/23: no spawn, schools in coves outside Funter, by the Kittens.

Appendix C5.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2021.

Yakutat Bay

Boat surveys were conducted every other day starting on April 28, 2021 and ending on May 6, 2021. Cumulative spawn mileage totaled 3.5 nmi and documented spawning mileage by day was as follows:

April 28 – 0.3 nmi
April 30 – 1.1 nmi
May 2 – 3.0 nmi
May 4 – 1.7 nmi
May 6 – 1.0 nmi