MEMORANDUM State of Alaska

DEPARTMENT OF FISH AND GAME

TO: Distribution

DATE: December 19, 2023

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SUBJECT: 2021 Region 1 Herring Stock Assessment Survey Summary

This memorandum provides a summary of results of Southeast Alaska herring stock assessment surveys conducted by the Alaska Department of Fish and Game during the 2020/21 fishery season. This summary is intended to provide only a brief recap of the primary data collection for herring egg deposition, age, and size. To view data collection methods and to provide context for these results, full reports of previous years should be read, such as "Southeast Alaska 2020 Herring Stock Assessment Surveys" (Fishery Data Series No. 22-21). Results are presented only for herring stocks for which data was collected in 2021 (Figure 1). Estimates of biomass reported in this memo are based on spawn deposition estimates (i.e. not model-based) and therefore are intended only to provide the general magnitude of stock size and depict trends. In general, survey results indicate that outer coastal stocks (Sitka and Craig) remain at the highest levels observed since the inception of stock assessment surveys in the late 1970s, and all stocks found in inside waters remain at low or very low levels.

Aerial and Spawn Deposition Surveys

Aerial and skiff surveys of herring activity, herring spawn, and marine mammal/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. Surveys or observations were conducted by ADF&G 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.

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. 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 (Table 1).

During spring 2021, scuba dive surveys to estimate egg deposition 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.

Due to low levels of observed spawning and funding constraints, spawn deposition dive 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. Although aerial surveys were conducted in several other minor spawning areas, no spawn deposition dive surveys were completed in these areas (Figure 2).

In the Sitka Sound and Craig areas, egg deposition estimates in 2021 were relatively similar to those from 2020, although notable differences were evident (Figures 3 and 4). 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.

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 exclusion of fish that could not be aged, regenerated scales, or data that was 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 spawning, and throughout the duration of spawning, 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.

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.

The minimum sample goal of 500 aged fish per sampling event (gear-fishery combination) was exceeded for every area/fishery where samples were obtained. Although age and size samples were not obtained for several other traditionally sampled stocks, aerial surveys were completed.

Age Composition

Age composition data from spawning populations were obtained for only four 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 funding, low levels of observed spawn, or inability to sample due to weather or other circumstances.

Observed age distributions for most sampled areas were similar in that age-5 herring dominated the spawning populations (Figures 5-6). 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.

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 from 7-55%, compared to 1% or less observed in 2020. 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, except for Revilla Channel.

Size at Age

Based on cast net samples in 2021, weight at age was similar as in 2020. Trends in weight-at-age over time are variable among stocks. 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 (Figures 7 and 8). The decline appears to be more pronounced for the oldest age classes. The current range of mean weight among age classes appears narrower than what it was three 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”. The data presented here only date back to the late 1980s, which coincided with the period of low weight and low condition 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, condition factors were calculated to roughly gauge herring health using the physical dimensions of herring (i.e., weight-to-length ratio) over time. 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. Mean condition factors of herring from most stocks on Southeast Alaska continue to follow the same general pattern observed over the last two decades: relatively low in the early 1990s, peaking in the early 2000s, followed by a decline until about 2007. Starting in 2008, condition factors for most stocks increased sharply, peaking in 2010 and then declining sharply to 2012. The condition factors calculated for 2021 for stocks where data was available are not notably different from those observed over the past 3 decades.

Table 1. Summary of results of herring aerial and spawn deposition surveys in Southeast Alaska and Yakutat 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	--	--	--	--
post survey[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: En 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 was conducted due to low observed mileage in traditional spawning areas and reduced funding.

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

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

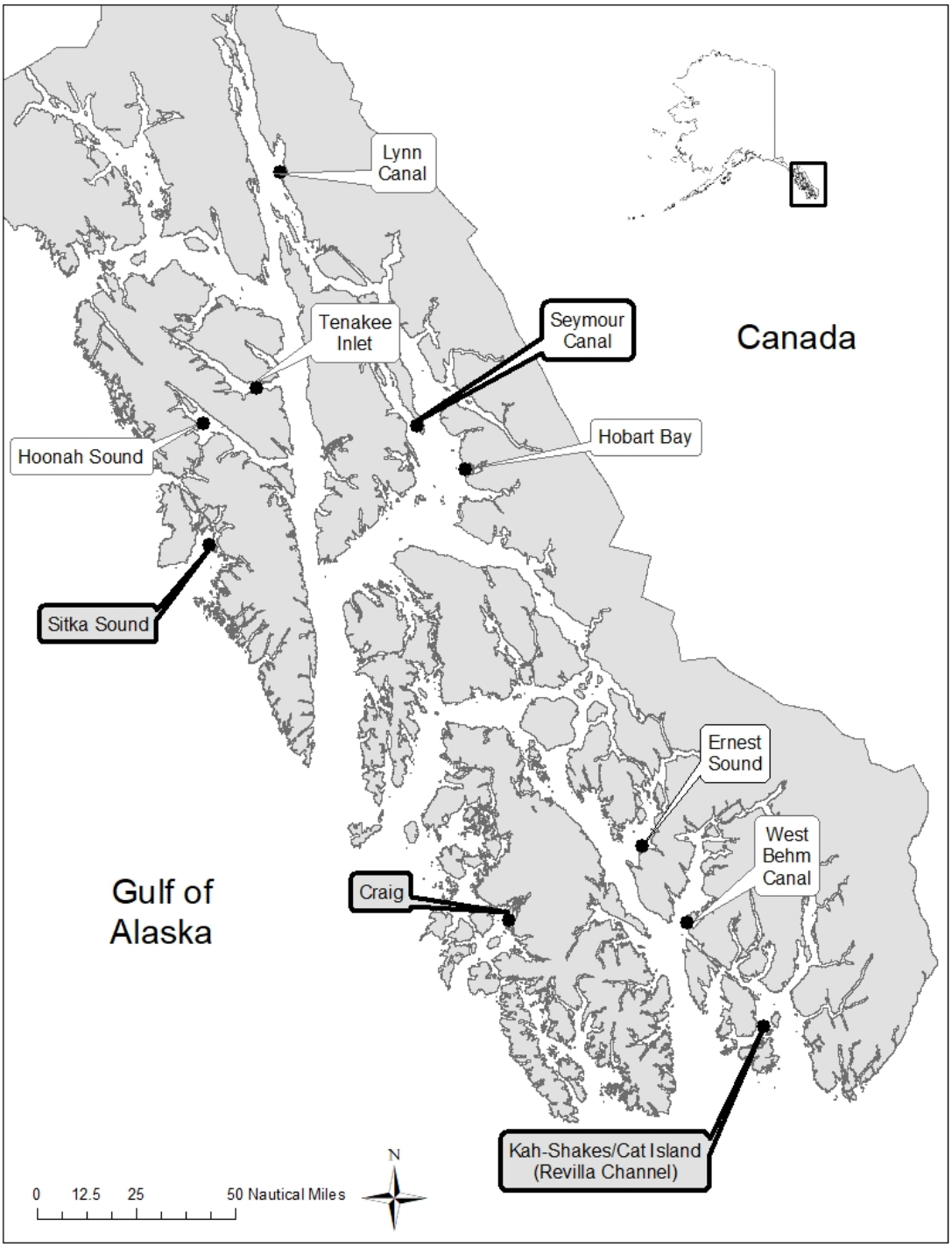


Figure 1. - Locations of major herring spawning areas in Southeast Alaska. Labels with shading and bold outline indicate areas where spawn deposition surveys and age-size sampling were conducted during the 2021 spawning season; labels with only bold outline indicate only age-size sampling of herring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

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 2. - 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.

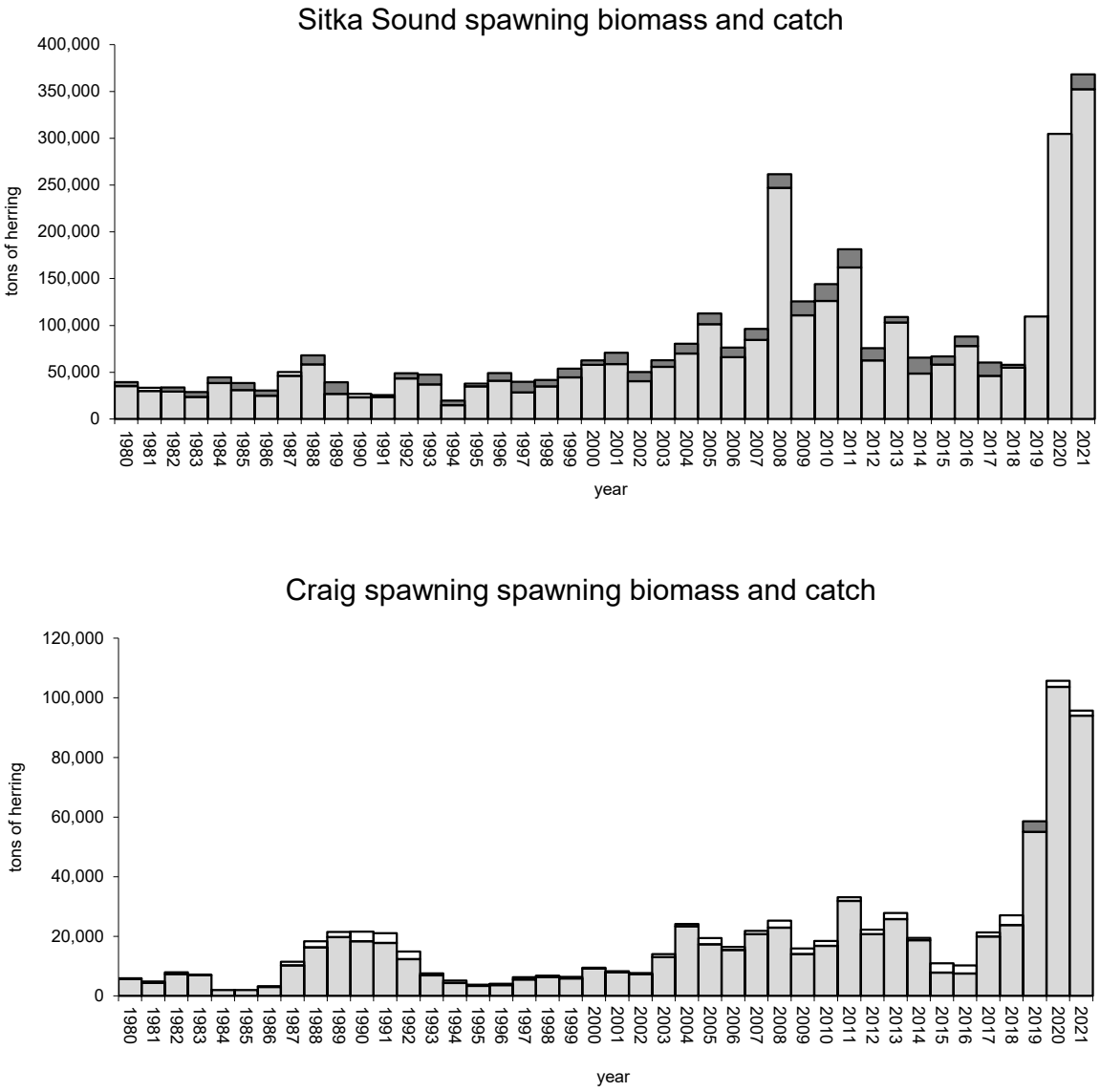


Figure 3. - Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Sitka and Craig areas, during 1980–2021.

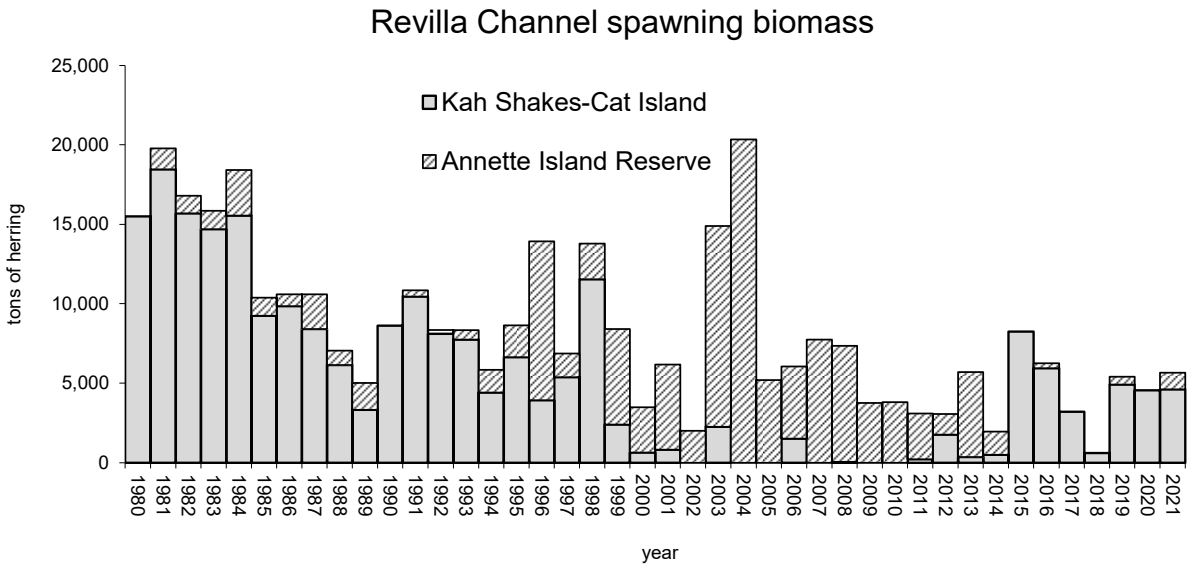
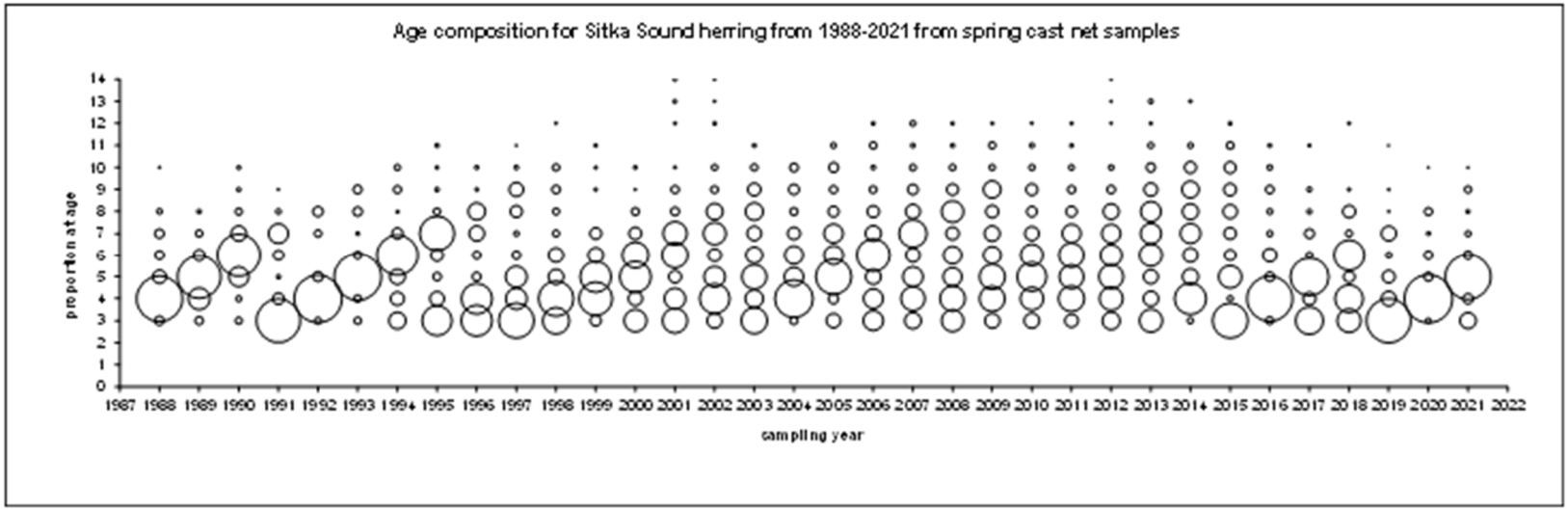


Figure 4. - Observed herring post-fishery spawning biomass, based on spawn deposition surveys or hydroacoustic surveys for stocks in the West Behm Canal and Revilla Channel (Kah Shakes–Cat Island–Annette Island) areas, during 1980–2021. Annette Island spawning biomass estimates between 1981 and 2016 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.



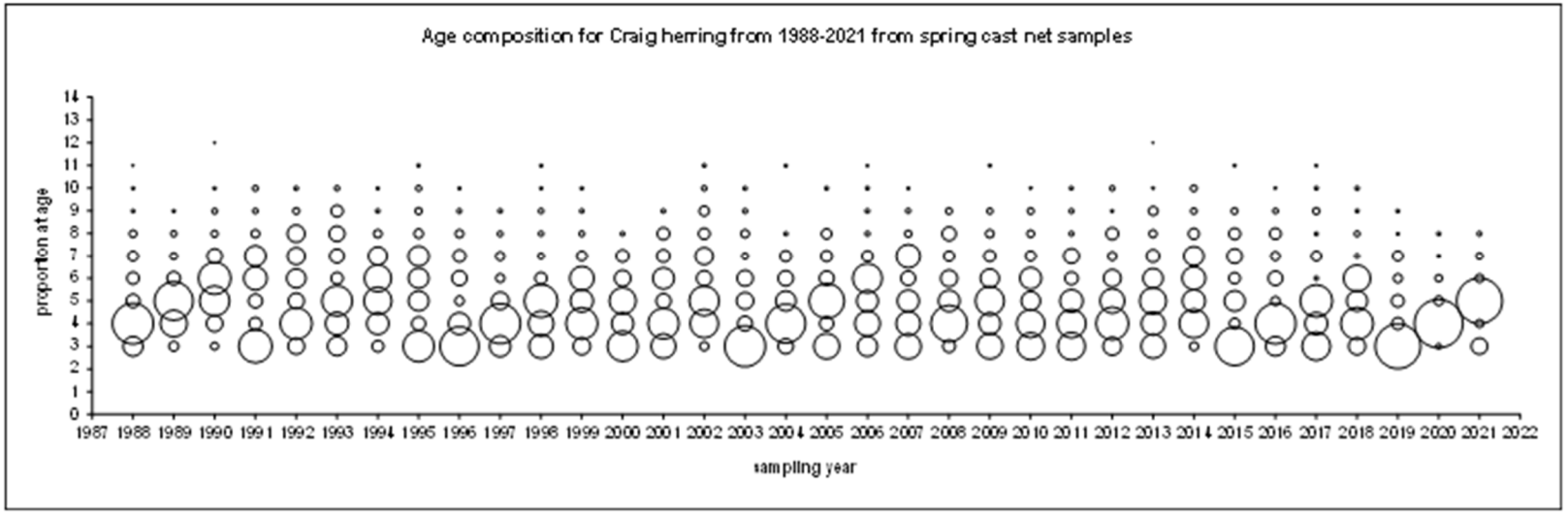


Figure 5. - Observed age compositions from sampling data for the Sitka Sound and Craig herring stocks. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data was either not collected or is not available. For reference, Sitka's largest circle represents 89% and Craig's largest circle represents 93%.

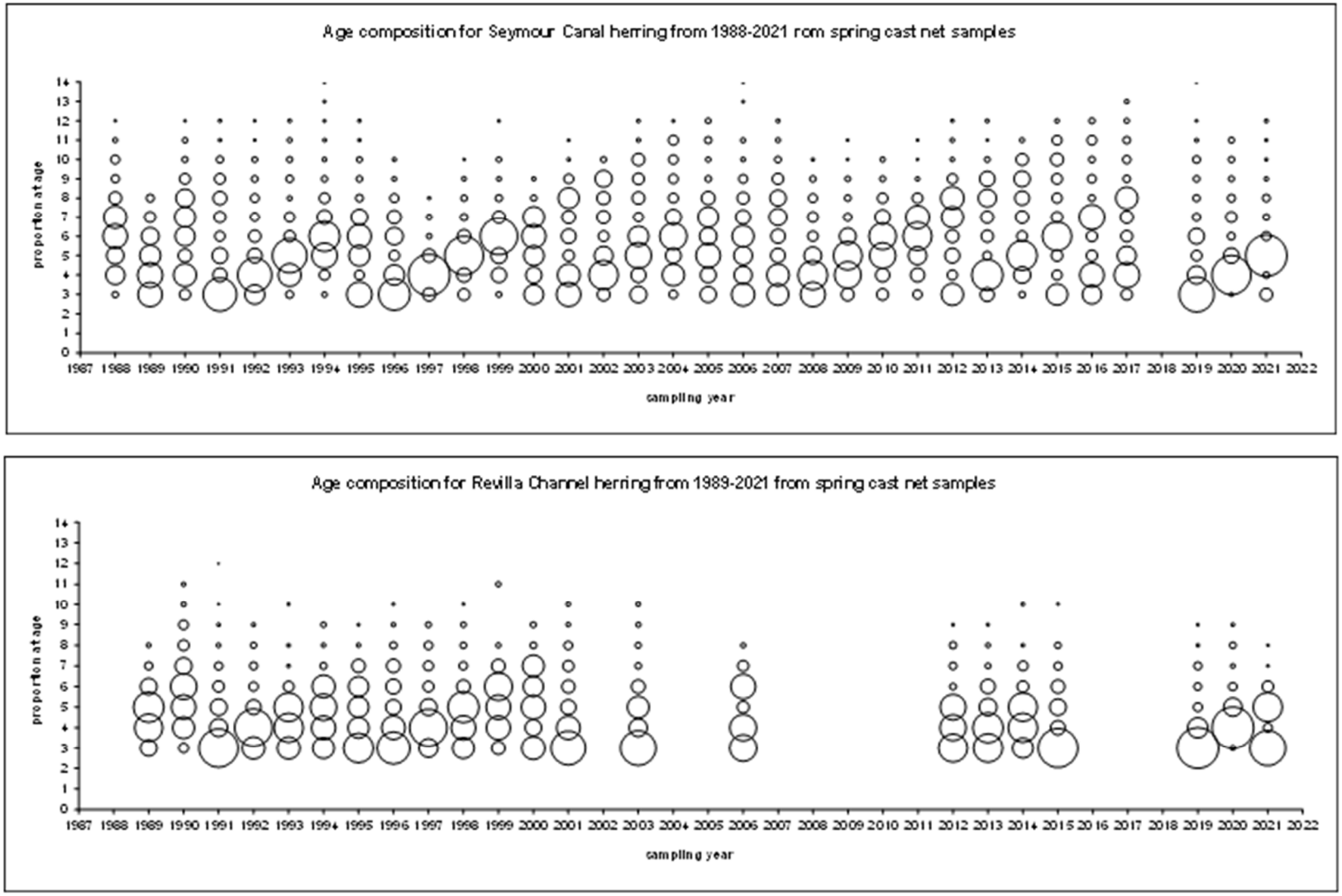


Figure 6. - Observed age compositions from sampling data for the Seymour Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data was either not collected or is not available. For reference, Seymour Canal's largest circle represents 81% and Revilla Channel's largest circle represents 89%.

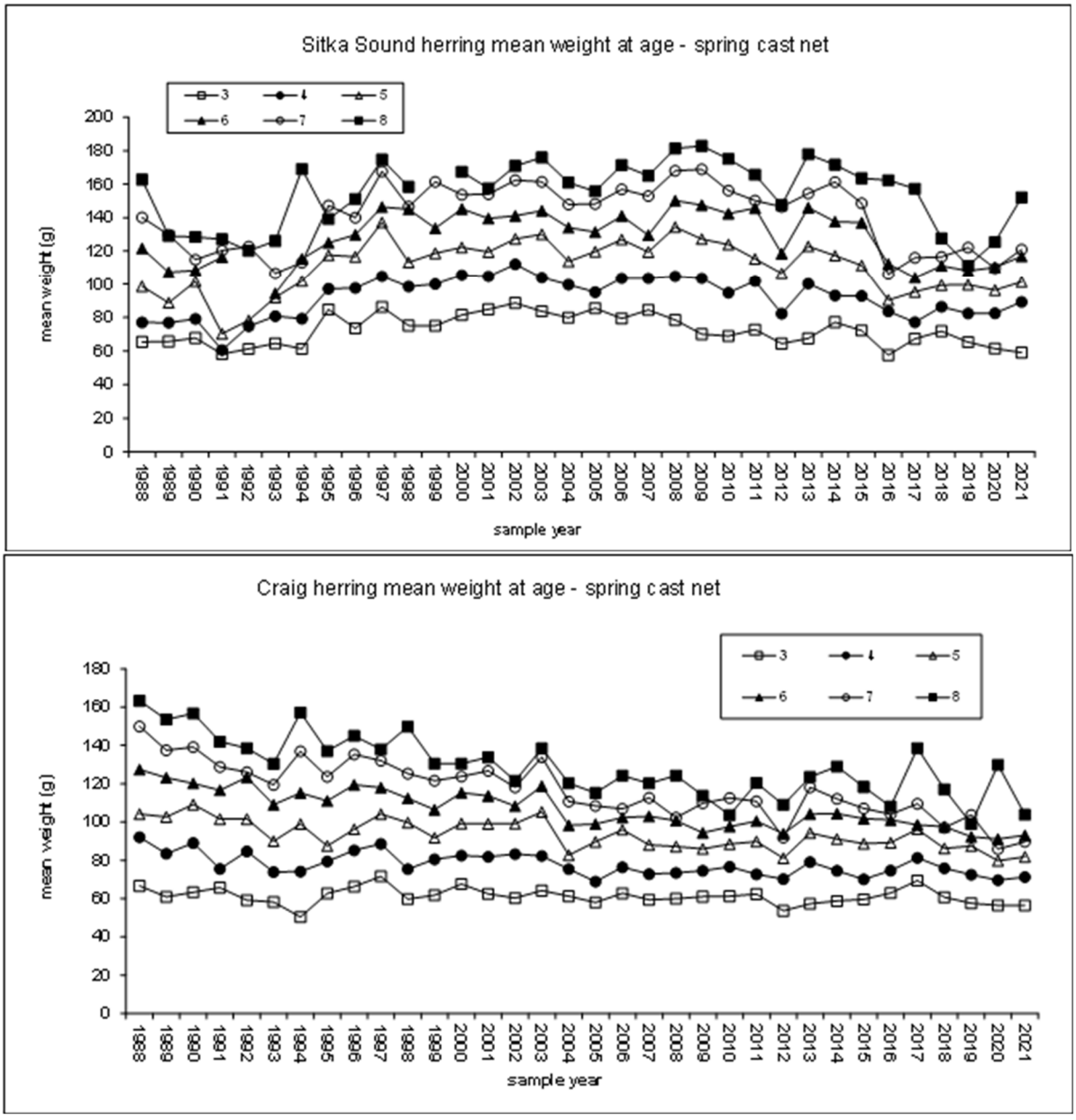


Figure 7. - Mean observed weight-at-age of the Sika and Craig herring spawning populations, from cast net samples. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

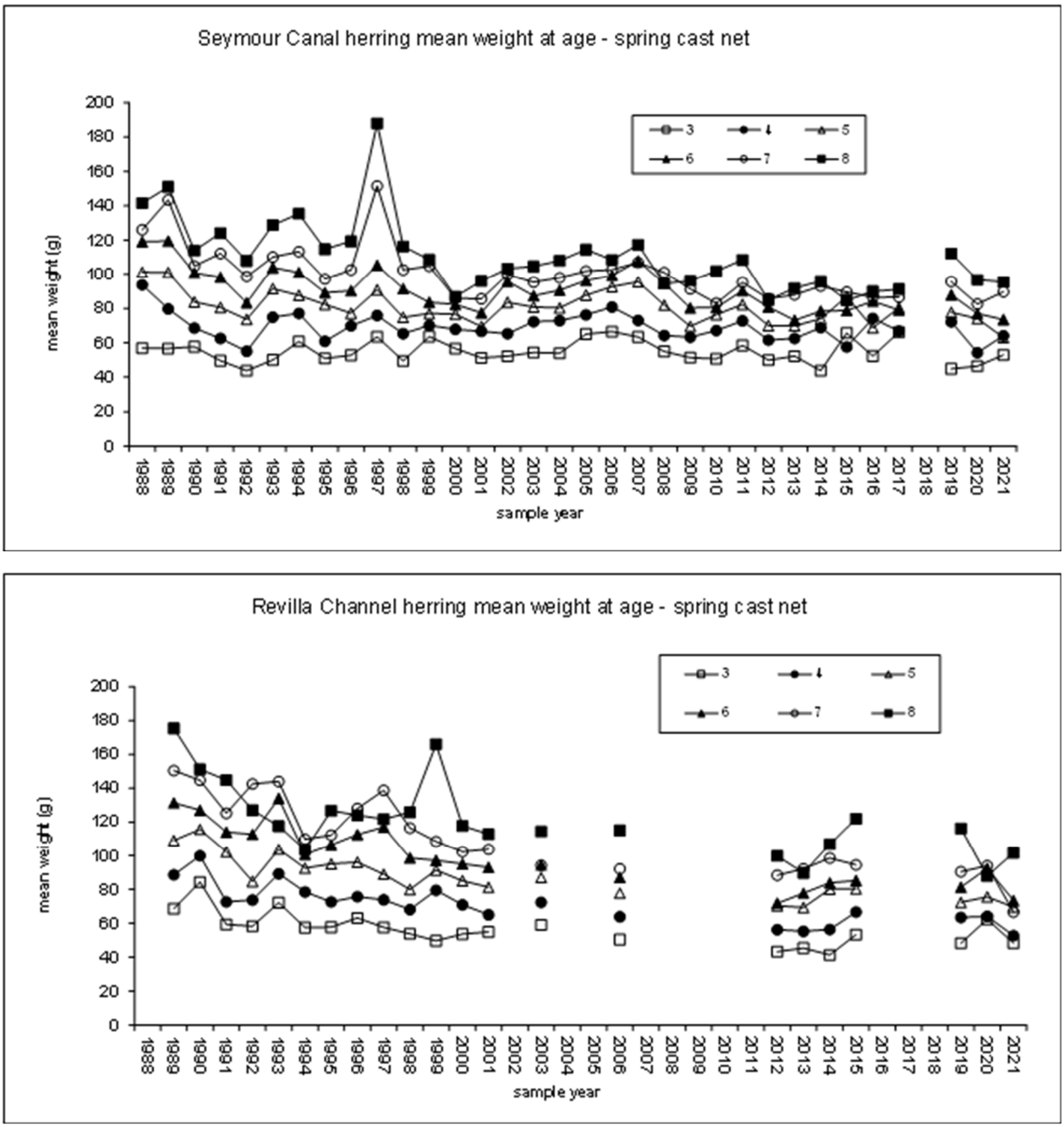


Figure 8.- Mean observed weight-at-age for the Seymour Canal and Revilla Channel herring spawning populations, based on cast net samples. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data was either not collected or is not available.