Technical Paper No. 480

The Subsistence Harvest of Pacific Herring Spawn in Sitka Sound, Alaska, 2020

by

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and

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October 2021

Alaska Department of Fish and Game **Division of Subsistence**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the reports by the Division of Subsistence. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

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The Division of Subsistence Technical Paper series was established in 1979 and represents the most complete collection of information about customary and traditional uses of fish and wildlife resources in Alaska. The papers cover all regions of the state. Some papers were written in response to specific fish and game management issues. Others provide detailed, basic information on the subsistence uses of particular communities which pertain to a large number of scientific policy questions.

Technical Paper series reports are available through the Alaska Resources Library and Information Services (ARLIS), the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and professional review.

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ABSTRACT

The subsistence fishery for the spawn of Pacific herring *Clupea pallasii* in Sitka Sound was historically, and remains, important to Alaska residents. Alaska Department of Fish and Game (ADF&G) Division of Subsistence research on the contemporary subsistence fishery reveals that harvesting herring spawn is a specialized activity in which a relatively small number of Southeast Alaska residents harvest and distribute herring spawn widely. Annual subsistence harvest monitoring surveys began in 2002 in response to concerns from subsistence harvesters that the commercial sac roe herring fishery was negatively affecting subsistence harvesting success. This report presents the results of the 19th annual harvest survey conducted in Sitka and neighboring communities in 2020. The survey generated data used to calculate estimates of the subsistence harvest of herring spawn on various substrates, including hemlock branches, kelp, and other seaweed in Sitka Sound. The average annual harvest from 2010–2019 was 92,116 lb. In 2020, an estimated total of 21,926 lb of herring spawn was harvested; this was the lowest estimated harvest over the course of the project. Approximately 94% of the harvest was shared with other households within Sitka as well as other communities in the state and beyond. The 2020 harvest year was unusual because the COVID-19 pandemic declared in early 2020 altered harvesting practices, precluding individuals from other communities coming to Sitka to harvest and reducing the number of households working together to harvest.

Key words: Pacific herring, *Clupea pallasii*, herring spawn, subsistence fishing, harvest estimate, subsistence, Sitka, Sitka Tribe of Alaska

1. INTRODUCTION

The spawn of Pacific herring *Clupea pallasii*, generally known as "herring eggs," is a traditional food of great cultural importance for indigenous coastal communities throughout the Pacific Northwest and Southeast Alaska (Moss 2016). Although herring spawn is consumed throughout this region, only a small number of people have the time, equipment, skills, and knowledge required to harvest it. This report presents findings of the 19th annual harvest assessment, which occurred in the spring of 2020, designed to document subsistence harvests of herring spawn in Sitka Sound (see Holen et al. [2011], Sill and Lemons [2012; 2014a; 2014b; 2015; 2017; 2020; 2021] and Sill and Cunningham [2017; 2019] for discussion of the previous study years).

Pacific herring return annually to spawn in locations throughout Alaska and the Pacific Northwest, but the abundance of herring and herring spawn and the length of the spawning period has set Sitka Sound apart from these other areas (Schroeder and Kookesh 1990). Herring harvesters have taken advantage of this unique harvest opportunity during both historical and contemporary periods (Schroeder and Kookesh 1990). In the 19th century, Sitka was a center for Tlingit from all over Southeast Alaska to harvest herring and herring spawn (Emmons 1991; Pierce 1972). Herring spawn was traditionally exchanged for specialized foods, such as eulachon *Thaleichthys pacificus* oil and dried eulachon, berries, dried seaweed, and mountain goat *Oreamnos americanus* meat. It was also traded for raw materials and handicrafts. Recently, herring eggs from Sitka Sound have been documented as being shared throughout Southeast Alaska and beyond to as far north as Utqiaġvik (formerly Barrow) and Kotzebue and as far south as California (Sill and Cunningham 2017).

The primary method of the contemporary harvest is to submerge branches of the western hemlock *Tsuga heterophylla* in salt waters just outside the intertidal zone before spawning takes place. Herring spawn is also collected on other substrates such as giant kelp *Macrocystis pyrifera*, hair seaweed *Desmarestia* spp., and rockweed *Fucus* spp. (Schroeder and Kookesh 1990). The herring deposit their eggs on the branches of the hemlock or other substrate which are then removed from the water. Historically, herring spawn was consumed either fresh or air-dried, or was packed in salt for later use and distribution. As freezers became more common in households in the 1940s and 1950s, freezing became the preferred method of preserving herring spawn.

At its February 1989 meeting, the Alaska Board of Fisheries (BOF) made a positive customary and traditional use determination for the harvest of herring spawn in the Sitka area. State regulations in the Sitka Sound area allow the subsistence harvest of herring and herring spawn in sections 13A and 13B north of Aspid Cape on Baranof Island (5 AAC 01.716 (a) (7)) as well as the limited noncommercial exchange of subsistence-harvested herring spawn on kelp for customary trade (5 AAC 01.717). In September 2001, the Sitka Tribe of Alaska (STA) met with representatives from the Alaska Department of Fish and Game (ADF&G) to discuss tribal members' difficulty in meeting their subsistence needs for herring spawn in Sitka Sound during the spring 2001 season. They cited the intensive commercial harvest of herring in the sac roe fishery in the Middle, Crow, and Kasiana islands areas as affecting the subsistence users' ability to successfully harvest herring spawn on hemlock branches.

At the January 2002 BOF meeting, STA submitted an unsuccessful proposal requesting recognition of the geographically and historically important areas used for the subsistence herring spawn harvest. During this meeting, the BOF also considered but did not adopt a permit program for the subsistence fishery.[1] As a

1. Subsistence fisheries throughout the state of Alaska have varying requirements for harvest reporting: the majority do not require a permit. Based on salmon permit programs, permits can underestimate the actual harvest (Conitz 2010; Walker 2009). In addition, permit data decouple harvest from the broader context in which the resource is harvested. For example, permits do not document information about household demographics, sharing practices, or qualitative assessments about the harvests which

consequence of these proposals, the BOF requested that the ADF&G Division of Subsistence work with STA to develop a harvest monitoring program based on in-person harvest surveys. This method of data collection provides a way to increase community buy-in and participation, build capacity within the community and STA, and provide consistent data. The BOF also made a determination that the amount reasonably necessary for subsistence[2] (ANS) was between 105,000 and 158,000 lb of herring spawn harvested from Section 13A and that portion of Section 13B that is north of the latitude of Aspid Cape (5 AAC 01.716 (b)). This finding was based upon the best harvest estimates of ADF&G, including results from a 1996 household harvest survey[3] and a 1989 harvest estimate (Schroeder and Kookesh 1990). At its 2009 meeting, the BOF revised the ANS to 136,000–227,000 lb, based on the mean estimated harvest from 2002–2008, as determined through the annual herring spawn harvest survey conducted by ADF&G and STA (Holen et al. 2011). Beginning in 2012, STA has successfully proposed several closures to other fisheries in areas of Sitka Sound that have historically been used for the subsistence harvest of herring spawn (referred to as the "core" area) (see Appendix A). In 2012, a compromise version of an STA proposal was adopted by the BOF, resulting in approximately 10 square nautical miles of Sitka Sound being closed to the commercial herring sac roe fishery. In 2015, the Federal Subsistence Board approved a proposal submitted by STA that closed approximately two square miles of federal waters around Makhnati Island (see Appendix A). In 2018, the BOF adopted Proposal 106 which expanded the state closed waters in the District 13 commercial fishery by approximately 6.5 square nautical miles.

Monitoring the subsistence harvest of herring spawn in Sitka Sound is an ongoing project. ADF&G participation in the annual harvest monitoring program is partially supported by a reimbursable services agreement (RSA) from the Division of Commercial Fisheries to the Division of Subsistence as well as by the Division of Subsistence general funds. STA provides its own funding for the project and is also supported by a cooperative agreement with ADF&G. STA and ADF&G collaborate on survey design and data collection. ADF&G provides technical consultation and, when possible, field survey and interviewing support for the project and STA provides ADF&G with completed surveys.

PROJECT OBJECTIVES

The goal of the harvest monitoring program is to annually document the subsistence harvest of herring spawn through household surveys with all harvesters who participate in the fishery in Sitka Sound. The objectives of the project in 2020 were to:

1. Conduct in-person interviews with household members in Sitka and surrounding communities who were identified as likely subsistence harvesters of herring spawn from Sitka Sound;
2. Produce estimates of the total pounds of herring spawn harvested on hemlock branches, giant kelp, hair seaweed, and other substrates; and
3. Identify locations where herring spawn were harvested.

METHODS

Estimates of the subsistence herring spawn harvest in Sitka Sound have been produced for 2002–2019 by systematically identifying and surveying households that harvest herring spawn. For the 2010 study year, STA and ADF&G refined the project methods to improve the accuracy of the household list and the conversion factors used for harvest amounts. Holen et al. (2011) detail the changes made. This annual

provide important explanatory context needed for sensitive allocation issues. A permit is required to subsistence harvest herring spawn on kelp in Southeast, but no other subsistence herring egg fisheries in the state require a permit.

2. Pursuant to Alaska Statute 16.05.258, the Alaska Board of Fisheries and the Alaska Board of Game are charged with identifying the fish stocks and game populations that are customarily and traditionally taken or used for subsistence, and with determining the amount of the harvestable portion that is reasonably necessary for subsistence uses.
3. The results from this study are published in the Community Subsistence Information System: http://www.adfg.alaska.gov/sb/CSIS/

project is guided by the research principles outlined in the *Alaska Federation of Natives Guidelines for Research*[4] and by the National Science Foundation, Office of Polar Programs in its *Principles for the Conduct of Research in the Arctic*[5], the *Ethical Principles for the Conduct of Research in the North* (Association of Canadian Universities for Northern Studies 2003), as well as the Alaska confidentiality statute (AS 16.05.815). These principles stress community approval of research designs, informed consent, anonymity of study participants, community review of draft study findings, and the provision of study findings to the study community upon completion of the research.

Survey Plan and Implementation

The COVID-19 pandemic in the spring of 2020 prevented STA and ADF&G from meeting in person. The survey instrument was approved and reviewed through email communications and phone calls. STA staff with experience administering this project's survey were engaged to administer them again in 2020 and no official training occurred. As closely as possible, the methods outlined in this section followed previous years' methods and are a collaborative effort between ADF&G and STA. STA staff conducted the majority of the household surveys; ADF&G staff administered a few surveys to households residing outside of Sitka. All surveys in 2020 were conducted telephonically.

Development of the Household Survey List

To meet Objective 1, STA updated the list of known and likely harvesters for the 2020 season. Using the 2019 household list as a starting point, new harvesters were added and non-harvesters were removed, following the methods revised in 2010, which are discussed below and in more detail in Holen et al. (2011). Outreach by STA and a chain referral method were employed to expand the list. Harvesting is a highly visible activity; therefore, it was assumed that active harvesters would be aware of other harvesters. Based on the knowledge of active harvesters identified through STA outreach efforts, additional potential harvesting households were added to the household list. The household list also included households from other communities who harvested herring spawn in Sitka Sound as identified through STA outreach efforts and knowledge of the surveyors and STA and ADF&G staff.

For this annual survey program, once added to the household list, an identified household remains on the list unless one of three situations occurs:

1. If the household is surveyed for three consecutive years and has not attempted to harvest within that time, it is removed; or
2. If a household is unable to be contacted for three consecutive years, it is removed from the list; or
3. If the household identifies that it no longer plans to harvest, it is removed from the list.

Once removed from the list, the household identification (ID) number is retired. Should a retired harvester become active again, the same household ID number would be re-assigned to the harvester. Prior to the beginning of the 2020 survey administration, staff from STA and ADF&G reviewed the household master list to ensure these parameters were satisfied.

The Survey Instrument

Objectives 2 and 3 were addressed using a household survey. The survey instrument was designed to collect information about:

4. Alaska Federation of Natives. 2013. *Alaska Federation of Natives Guidelines for Research*. Alaska Native Knowledge Network. http://www.ankn.uaf.edu/IKS/afnguide.html (accessed March 4, 2020).
5. National Science Foundation Interagency Arctic Research Policy Committee (IARPC). 2018. *Principles for Conducting Research in the Arctic*. http://www.nsf.gov/geo/opp/arctic/conduct.jsp (accessed March 4, 2020).

4. Whether respondents harvested, attempted to harvest, used, received, or gave away herring spawn.
5. The amount of herring spawn harvested.
6. The kind of substrate used.
7. Whether respondents harvested on their own or in collaboration with other households.
8. The amount of herring spawn respondents kept for their own use, gave away locally, or shipped out of Sitka, and the communities with which they shared the harvest.
9. The location of respondents' harvests.
10. Survey respondents' qualitative assessments of the study year's herring spawn harvest.
11. Survey respondents' qualitative descriptions of their participation in the harvest.

There were few changes made to the 2020 survey instrument from the 2019 instrument. The core questions were unchanged between the two years. In 2019, an additional 2-page module about barter and exchange was included at the request of researcher Dr. Thomas Thornton for a study he was conducting about the distribution of subsistence herring eggs from Sitka Sound (Thornton 2019). By including these additional questions, both ADF&G and Dr. Thornton were able to meet their research needs while reducing the survey burden placed upon the subsistence herring harvesters. This module was removed in 2020 because Dr. Thornton's research was complete. A copy of the 2020 instrument can be found in Appendix B.

Survey Implementation

The STA created a list of 51 potential harvesting households for 2020. An interview was attempted for each household on the list; 15 households were successfully interviewed, 35 households were unable to be contacted, and one household declined to participate. STA Cultural Coordinator Tammy Young conducted the majority of the surveys in May and June 2020 after the herring spawn activity ended; ADF&G staff Lauren Sill also administered surveys. Four of the 15 surveys were administered over fall and winter of 2020. Completed surveys were sent to ADF&G for coding and analysis. Completed surveys were given a code (see Appendix C for code book) based on user status: 1) individual harvester, 2) non-harvester, or 3) community harvest boat. The latter code encompasses boats, such as STA's traditional foods boat or non-local individuals that harvest herring for community-wide distribution in Sitka or another Southeast Alaska community. These community boats are considered a "household" for the purposes of this report and are part of the 15 households interviewed. For survey methods, the skipper or owner of the boat is surveyed about the entire harvest brought in by that boat. Crew on board who take home any of the boat's harvest are not considered harvesting households but as receivers of herring spawn.

Update of the 2020 Conversion Factors

In previous years of the project, prior to beginning the household survey, conversion factors to estimate the weight of herring spawn in common storage containers were created following the methods established in 2010 (Holen et al. 2011). In 2020, COVID-19 precautions restricted the ability of STA to harvest and process as usual. STA engaged two boats, each boat maintaining its own COVID bubble, to harvest the spawn. Once delivered, a different group of individuals processed the harvest for delivery, while attempting to maintain six feet of distance between themselves. Staff were unable to weigh eggs, either as they were unloaded or during processing. Staff delivered eggs to elders' doors. During coding of the surveys, any storage containers used to provide harvest amounts were converted to pounds using the recent 5-year average of the conversion factors.

DATA ANALYSIS

ADF&G Information Management staff analyzed the data from the 2020 survey to produce estimates of the total harvest of herring spawn on all substrates. For 2020, the surveys were coded for data entry by

ADF&G staff in Douglas using the conversion factors that were determined as described above. ADF&G staff also created codes for responses given to assessment questions (see Appendix C for the 2020 code book). Responses were coded following standardized conventions used by ADF&G. ADF&G Information Management staff in Anchorage set up database structures within a Microsoft SQL Server[6] database. The database structures included rules, constraints, and referential integrity to ensure that data were entered completely and accurately. Data entry screens were developed in Microsoft Access and made available on a secure network. Daily incremental backups of the database occurred, and transaction logs were backed up hourly. Full backups of the database occurred twice weekly. This ensured that no more than one hour of data entry would be lost in the unlikely event of a catastrophic failure. All survey data were entered twice and reviewed so as to minimize data entry errors.

Once data were entered and quality-control checked using standardized procedures employed by ADF&G Information Management staff, the information was processed using the Statistical Package for the Social Sciences (SPSS), Version 20. Initial processing included performing standardized logic checks of the data, which are often needed in complex datasets where rules, constraints, and referential integrity do not capture all the possible inconsistencies that may appear.

Data analysis also included review of raw data frequencies, cross tabulations, table generation, estimation of population parameters, and calculation of confidence intervals for the estimates. Missing information was dealt with in a manner appropriate to each situation, following such standardized practices as minimal value substitution or the use of an average response for similarly characterized households (mean replacement). Typically, missing data are an uncommon, randomly occurring phenomenon in ADF&G household surveys. In unusual cases, where a substantial amount of survey information is missing, the household survey is treated as a "non-response" and not included in community estimates. All adjustments were documented.

ADF&G applied the weighted means method (Cochran 1977) to generate harvest estimates for herring spawn from an interviewed sample of households drawn from a list of households known to harvest herring spawn in Sitka during the study year. These households were further divided into groups, or strata, by harvester, and community boats. Valid responses for each group were used to develop averages for invalid or missing responses within the same group, and the same averages were extended to all uncontacted households in the group. In cases where a household was known to be an active harvester during one year, but the harvest was unknown that year, the mean household harvest of that year was used as an estimate of that household's actual harvest. These totals were then summed to provide a community-wide estimate:

$$H = \sum_{k=1}^{K} N_k \left(\frac{\sum x_k}{n_k} \right) \qquad (1)$$

Where

H = total estimated harvest,

N_k = total number of households identified for strata-group 'k',

n_k = number of sampled households in strata-group 'k',

x_k = reported harvest for household within strata group 'k',

k = strata group, and

K = total strata groups.

6. Product names are given because they are established standards for the State of Alaska or for scientific completeness; they do not constitute product endorsement.

In this approach, each strata group is estimated separately and thus percentages are derived from the estimated values rather than samples. This assumes that the un-contacted households within each strata group are, on average, the same as those contacted and also that each strata group has different harvest patterns.

Since the mean is the primary statistic used to develop the estimates, Information Management staff produced a 95% confidence interval (CI), represented as a percentage, to measure the relative precision of the mean. The CI can also be applied to the total estimated harvest to obtain a likely upper and lower range for the estimate. The following formula was applied to create the CI percentage:

$$CI\% = \frac{t_{\propto/2} \times \sqrt{\frac{1}{N}\sum_{k=1}^{K} N_k(N_k - n_k)\frac{s_k^2}{n_k}}}{H} \quad (2)$$

Where

s_k = sample standard deviation for strata group ‘k’,

n_k = sampled households for strata group ‘k’,

N_k = total households identified for strata group ‘k’,

N = total households identified in the community,

$t_{\alpha/2}$ = student’s *t* statistic for alpha level ($\alpha = 0.05$) with n–1 degrees of freedom,

H = total estimated community harvest,

k = strata group, and

K = total strata groups.

A small CI percentage indicates low variance in household harvest amounts and that the actual mean is likely very close to the sampled mean. A larger CI percentage would indicate that there is a larger variance between household harvest amounts and an increased likelihood that the actual mean differs, possibly substantially, from the sampled harvest mean.

DISSEMINATION OF SURVEY RESULTS

The written report is reviewed within ADF&G as well as by the Southeast Alaska Herring Conservation Alliance and STA. The preliminary results from 2020 were presented at a virtual preseason meeting conducted by ADF&G in March 2021. Results from 2019 and 2018 study years were presented at the same time. The final report, once published, is available on the ADF&G website. Hard copies are distributed to STA.

2. 2020 RESULTS

In 2020, of 51 households identified as potential harvesters of herring spawn, 15 were interviewed (29%), including the STA boat and four other community harvester boats (Table 1). Data from all years of the annual monitoring program, as well as household surveys conducted in 1983, 1987, and 1996, are presented in Table 2, including confidence intervals for the harvest estimates (excluding 1983, for which the confidence interval is not available). As reported in Table 2, in 2020 an estimated 11 households attempted to harvest herring spawn and 9 were successful.

The second objective of the project was to estimate the total subsistence harvest of herring spawn in Sitka Sound during 2020. Table 3 presents the total estimated harvest (21,926 lb) of herring spawn by harvester type and substrate for all of Sitka Sound. As has been seen in prior years of study, the majority of harvesters were Sitka residents. However, whereas in past years the individual Sitka harvesters accounted for less than half of the total harvest, this year they contributed the majority to the harvest estimate. In prior survey years, the community harvest boats had made up over half of the total harvest. In 2020, STA operated the only community harvester boat in Sitka Sound. Most of the herring egg harvest was on hemlock branches, with a small portion on hair seaweed and an even smaller portion on kelp (Figure 1; Table 4). Of the estimated harvest, 96% (21,183 lb) occurred on hemlock branches, while just over 3% was harvested on hair seaweed (601 lb), and 1% was herring eggs harvested on kelp (142 lb).

As follow-up to questions about harvest amounts, harvesting households were asked how their harvest compared to other years (a time frame for comparison was not provided). Not all households responded to these follow-up questions, but eight did. Approximately 38% of the eight responding households felt they harvested about the same amount of herring eggs as in other years, 38% reported they harvested more, and 25% reported harvesting less (Table 5). Households that indicated a change in harvest (either more or less) were asked about the reasons for the change. More households (40%) gave “it was a good harvest year” as a reason than any other (Table 6). The same percentage of households (20%) gave the reason as the resource being less available, a change in harvest effort, and work conflicts. Harvesting households were asked if they got enough herring spawn in 2020 for themselves as well as to share with others. In 2020, 67% of the nine responding households reported that they got enough for themselves and 100% of the seven responding households reported that they had enough to share (Table 7). This question differs from the one that asked if the household shared their harvest in that it specifically asks if the household had enough to share. Based on past surveys and discussions with harvesters, even in poor harvest years, people will share some amount of herring eggs with a core set of relationships; in better harvest years, more will be shared and with more people.

As seen in previous years, the majority of the 2020 harvest was shared with other households in the community of Sitka and beyond. Of the surveyed households that harvested herring spawn in 2020, 73% shared at least some of their harvest (Table 2). Of the total estimated amount of herring spawn that was harvested, only 6% was kept for use by the harvesting household; the remainder was given away—40% of the pounds harvested remained in Sitka and 54% was shipped outside of Sitka (Figure 2; Table 4). The usually substantial portion of the total harvest that is taken by the community harvester boats influences these percentages as nearly all of their harvest is shared either in town or out of town. As seen in Table 3, individual respondents harvested that majority of the weight in 2020 and the percentages of spawn that were kept versus shared are similar to previous years. Spawn on hemlock branches composed most of the harvest, by weight (72%), kept for the harvester’s personal use, but the majority of the spawn-on-branches harvest was shared, with only about 4% kept for personal use. In contrast, 35% of all the spawn on hair seaweed harvested was kept for personal use; the rest was shared. All of the spawn on kelp harvest was kept for personal use. Out of eight harvesting households (including the STA community boat) that indicated they usually harvest for other households, 63% indicated they usually harvest for two to five households, 25% harvest for 11 to 50 households, and 13% harvest for over 100 households (Table 8). In 2020, herring spawn from Sitka Sound was shared with residents of at least the following communities:

Anchorage, Angoon, Bethel, Hoonah, Hydaburg, Fairbanks, Juneau, Kake, Kotzebue, Nome, Saint Marys, Saxman, Sitka, Utqiaġvik, as well as with communities in Washington.

Not all potential harvesters contacted for this survey attempted to harvest herring eggs in 2020. Of the six households contacted who reported that they did not attempt to harvest eggs in 2020, the most common reason given was COVID-19. Following that, personal reasons, working during the harvest, the spawn was too far away, and being out of town were all reasons given by an equal percentage of responding households (Figure 3). With regards to the spawn being too far away, there are several factors that likely inform that decision, including the time required and the fuel costs. Additionally, the type of boat used to harvest can affect a harvester's ability to get to where the spawn is occurring. Larger boats permit safe travel to more distant harvesting sites and in a wider variety of weather. In 2020, the majority of harvesters (67%) used a vessel less than 20 feet in length, 22% used a vessel between 20 and 24 feet, and 11% harvested from shore (Table 9). One strategy subsistence harvesters employ to overcome a variety of harvesting challenges is to harvest with other households, thereby sharing the costs of fuel, maintenance, and time. In 2020, 43% of responding households harvested with other families (Table 10).

Table 1.–Sampling characteristics for the 2020 herring spawn harvester survey.

Sampling characteristics	Sitka households	Community harvester boats
Herring spawn harvesting households		
Surveyed	10.0	5.0
Total	44.0	7.0
Sampling fraction	22.7%	71.4%
Population of herring spawn harvesting households		
Surveyed	28.8	13.3
Estimated total	126.5	18.7
Average household size	2.88	2.7
Tribal affiliation of sampled households[a]		
Sitka Tribe		
Number	4.0	1.0
Percentage	40.0%	20.0%
Other Southeast		
Number	0.0	3.0
Percentage	0.0%	60.0%
Other AK		
Number	2.0	0.0
Percentage	20.0%	0.0%
None		
Number	4.0	0.0
Percentage	40.0%	0.0%
Missing		
Number	2.0	1.0
Percentage	20.0%	20.0%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2020.

a. Percentages may not add to 100%. Households may have more than one tribal affilation.

Table 2.–Estimated subsistence harvest of herring spawn in Sitka Sound, 1983, 1987, 1996, 2002–2020.

		Percentages based on surveyed households				Estimated values					
Year	Total number of surveyed households	Percentage of households attempting to harvest	Percentage of households harvesting	Percentage of harvesting households giving away herring spawn	Percentage of harvesting households receiving herring spawn	Estimated number of households attempting to harvest	Estimated number of households harvesting	Estimated harvest, all substrates, pounds	95% confidence interval (± %)	Range: low[b]	Range: high
For the following 3 years, the data pertain to the entire population of Sitka, based on a random sample.											
1983	139	n/a	24.0%	n/a	n/a	n/a	586	42,000[a]	n/a	n/a	n/a
1987	296	n/a	9.0%	n/a	n/a	n/a	261	20,494[a]	91%	1,755	39,235
1996	150	16.0%	15.0%	n/a	20.0%	476	464	127,174	72%	35,131	219,217
For the following 15 years, the data pertain to only those Sitka households identified as potential participants in the subsistence herring spawn fishery.											
2002	86	n/a	71.0%	95.0%	40.0%	n/a	77	151,717	23%	116,701	186,734
2003	118	72.0%	71.0%	88.0%	30.0%	117	116	278,799	19%	225,704	331,895
2004	144	61.0%	60.0%	93.0%	17.0%	120	118	381,226	18%	312,224	450,229
2005	159	61.0%	52.0%	82.0%	13.0%	111	95	79,064	9%	72,272	85,856
2006	127	58.0%	55.0%	91.0%	27.0%	93	88	219,356	20%	176,484	262,228
2007	126	55.0%	48.0%	89.0%	43.0%	92	81	87,211	22%	67,702	106,720
2008	128	45.0%	41.0%	73.0%	52.0%	59	54	71,936	6%	67,764	76,108
2009	150	48.0%	48.0%	89.0%	79.0%	91	91	213,712	9%	193,623	233,801
2010	132	30.0%	30.0%	85.0%	12.5%	40	40	154,620	10%	139,872	169,367
2011	109	38.5%	35.4%	94.0%	35.0%	57	53	83,443	5%	79,719	87,166
2012	75	45.0%	43.2%	84.0%	88.0%	50	47	115,799	12%	102,332	129,265
2013	59	64.4%	62.7%	86.1%	27.7%	52	50	78,090	10%	70,075	86,106
2014	60	68.3%	67.8%	87.5%	31.7%	68	68	154,412	13%	135,054	173,769
2015	58	67.2%	65.5%	56.9%	17.2%	52	51	106,998	21%	84,664	129,333
2016	64	40.4%	37.2%	74.8%	0.0%	38	35	84,554	41%	50,028	119,079
2017	36	60.6%	49.8%	73.7%	0.0%	53	44	65,691	25%	49,268	82,114
2018	47	48.7%	36.2%	94.0%	5.8%	39	29	25,862	71%	17,914	44,148
2019	36	41.8%	39.0%	100.0%	14.2%	27	25	51,687	99%	26,447	102,764
2020	15	71.8%	63.1%	72.7%	41.0%	11	9	21,926	307%	8,051	89,128

-continued-

Table 2.–Page 2 of 2.

Source CSIS; Brock and Turek 2007; Sitka Tribe of Alaska household surveys, as summarized in Gmelch and Gmelch 1985.

a. Harvest estimates for 1983 and 1987 are likely low due to the small size of the random sample, which might have failed to include high harvesting households that specialize in harvesting herring spawn.

b. Confidence intervals falling below the reported harvest have been adjusted to the reported value.

n/a = data were not collected during the study year.

Table 3.–Subsistence harvest of herring spawn by type of harvester and total estimated harvest, Sitka area, 2020.

Resource	Percentage of potential participant		Estimated pounds	Confidence interval		
	Attempted	Harvested	Total	CI %	Low[b]	High
Sitka households (n=10)						
Herring spawn on hemlock branches	60.0%	40.0%	14,883.0	738.0%	3,382.5	124,712.3
Herring spawn on kelp	20.0%	20.0%	142.1	684.1%	32.3	1,114.3
Herring spawn on hair seaweed	30.0%	30.0%	600.6	591.7%	136.5	4,154.4
Subtotal, herring spawn, all types	*80.0%*	*70.0%*	*15,625.7*	*700.8%*	*3,551.3*	*125,132.8*
Community harvester boats (n=5)						
Herring spawn on hemlock branches	20.0%	20.0%	6,300.0	207.8%	4,500.0	19,389.5
Herring spawn on kelp	0.0%	0.0%	0.0	0.0%	0.0	0.0
Herring spawn on hair seaweed	0.0%	0.0%	0.0	0.0%	0.0	0.0
Subtotal, herring spawn, all types	*20.0%*	*20.0%*	*6,300.0*	*207.8%*	*4,500.0*	*19,389.5*
Total	**71.8%**	**63.1%**	**21,925.7**	**306.5%**	**8,051.3**	**89,128.2**

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence household surveys, 2020.

a. Based on the total number of surveyed households (n=15; community harvester boats are each treated as an individual household for the purpose of this analysis.

Table 4.–Distribution of subsistence herring spawn harvest, Sitka area, 2020.

Resource	Estimated harvest: *Kept for own use* Pounds	Percentage of substrate harvest	Percentage of kept harvest	Percentage of total harvest
Herring spawn on hemlock branches	915.6	4.3	72.3	4.2
Herring spawn on kelp	142.1	100.0	11.2	0.5
Herring spawn on hair seaweed	208.1	34.7	16.4	0.9
Herring spawn - all types	1,265.9		100.0	5.8

	Shared within Sitka Pounds	Percentage of substrate harvest	Percentage of Sitka shared harvest	Percentage of total harvest
Herring spawn on hemlock branches	8,747.6	41.3	98.5	39.9
Herring spawn on kelp	0.0	0.0	0.0	0.0
Herring spawn on hair seaweed	132.0	22.0	1.5	0.6
Herring spawn - all types	8,879.6		100.0	40.5

	Shared outside of Sitka Pounds	Percentage of substrate harvest	Percentage of harvest outside Sitka	Percentage of total harvest
Herring spawn on hemlock branches	11,519.8	54.4	97.8	52.5
Herring spawn on kelp	0.0	0.0	0.0	0.0
Herring spawn on hair seaweed	260.5	43.4	2.2	1.2
Herring spawn - all types	11,780.2		100.0	53.7

	Total Pounds	Percentage of substrate harvest	Total percentage kept/ shared[a]	Percentage of total harvest
Herring spawn on hemlock branches	**21,183.0**	**100**	**4.3 / 95.6**	**96.6**
Herring spawn on kelp	**142.1**	**100**	**100.0 / 0.0**	**0.6**
Herring spawn on hair seaweed	**600.6**	**100**	**34.7 / 65.3**	**2.7**
Herring spawn - all types	**21,925.7**	**100**	**5.8 / 94.2**	**100.0**

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence household surveys, 2020.

Note Due to rounding considerations, total percentages may not appear to exactly sum 100%.

a. "Shared" includes herring spawn shared both within and outside Sitka.

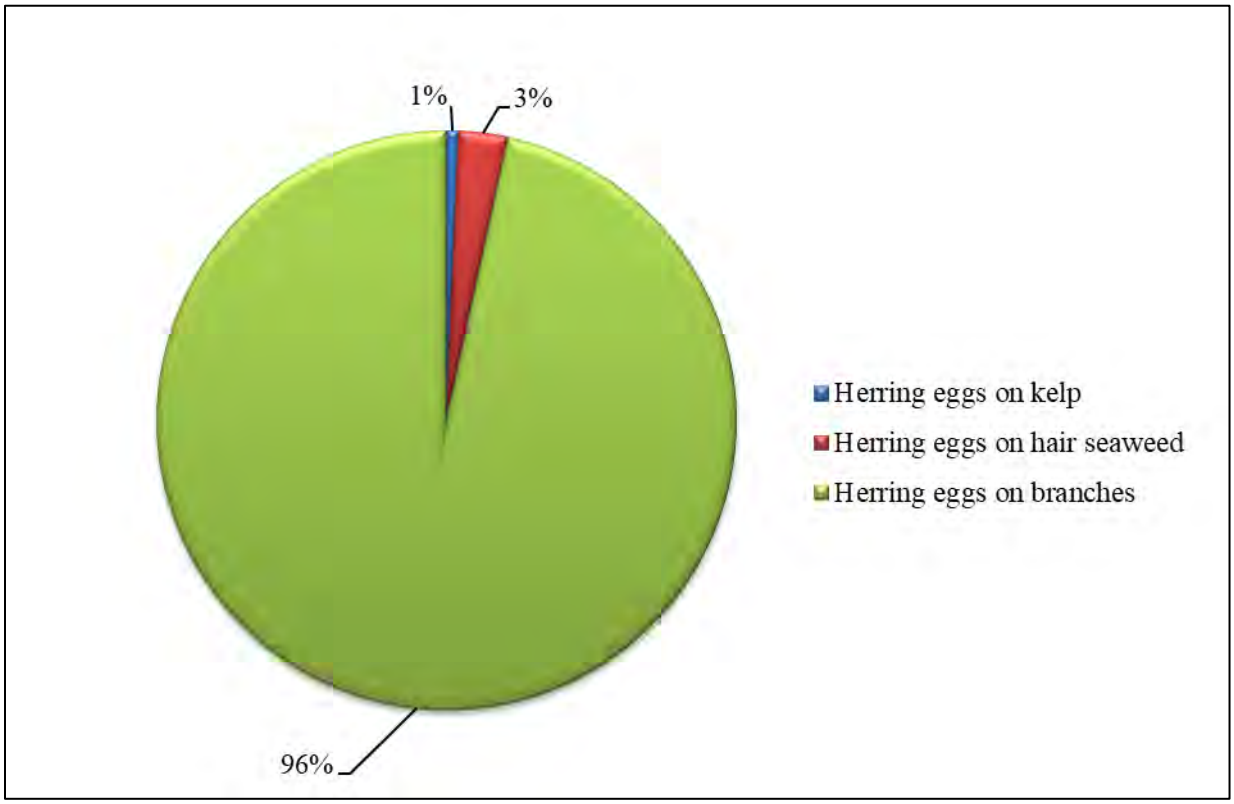

Figure 1.–Distribution of subsistence herring spawn harvest by substrate, Sitka area, 2020.

Table 5.–Harvesting households' perception of herring spawn harvest compared to previous years, Sitka area, 2020.

	Household comments		
Number of households responding	Less	Same	More
8	25.0%	37.5%	37.5%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household survey, 2020.

Table 6.–Reasons given by Sitka Sound harvesters for why their household harvests were different in 2020 than in other recent years.

	Household comments				
Number of households responding	Resource less available	More effort or less effort than previous years	Working/no time	It was a good harvest year	Total
5	20.0%	20.0%	20.0%	40.0%	100.0%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household survey, 2020.

Table 7.–Harvesting households' description of whether they got enough herring spawn to meet their households needs and their sharing needs, Sitka area, 2020.

For their household *(n=9)*		To share *(n=7)*	
Yes	No	Yes	No
66.7%	33.3%	100.0%	0.0%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household survey, 2020.

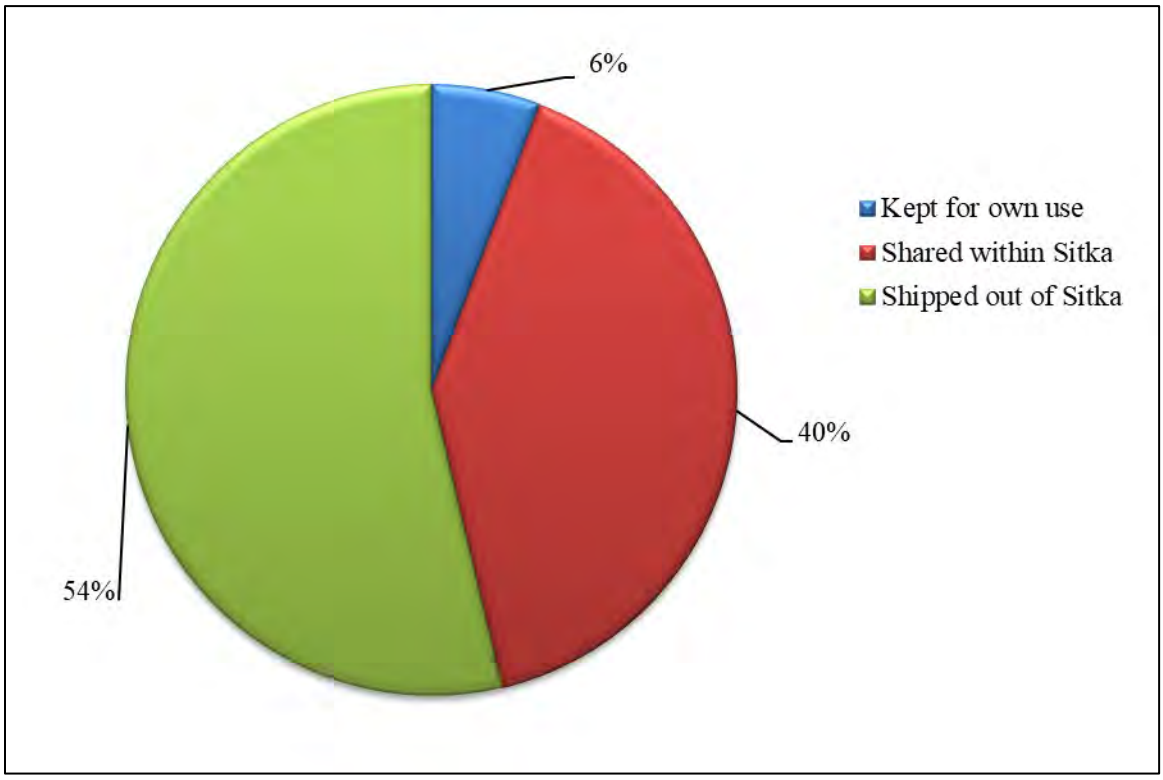

Figure 2.–Percentage of total Sitka Sound subsistence harvested herring spawn that was shared, 2020.

Table 8.–Percentage of harvesting households that harvest for other households, Sitka area, 2020.

	Percentage of responding households					
Number of households responding	One	Two to five	Six to ten	Eleven to fifty	Fifty-one to one hundred	Over one hundred
8	0.0%	62.5%	0.0%	25.0%	0.0%	12.5%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household survey, 2020.

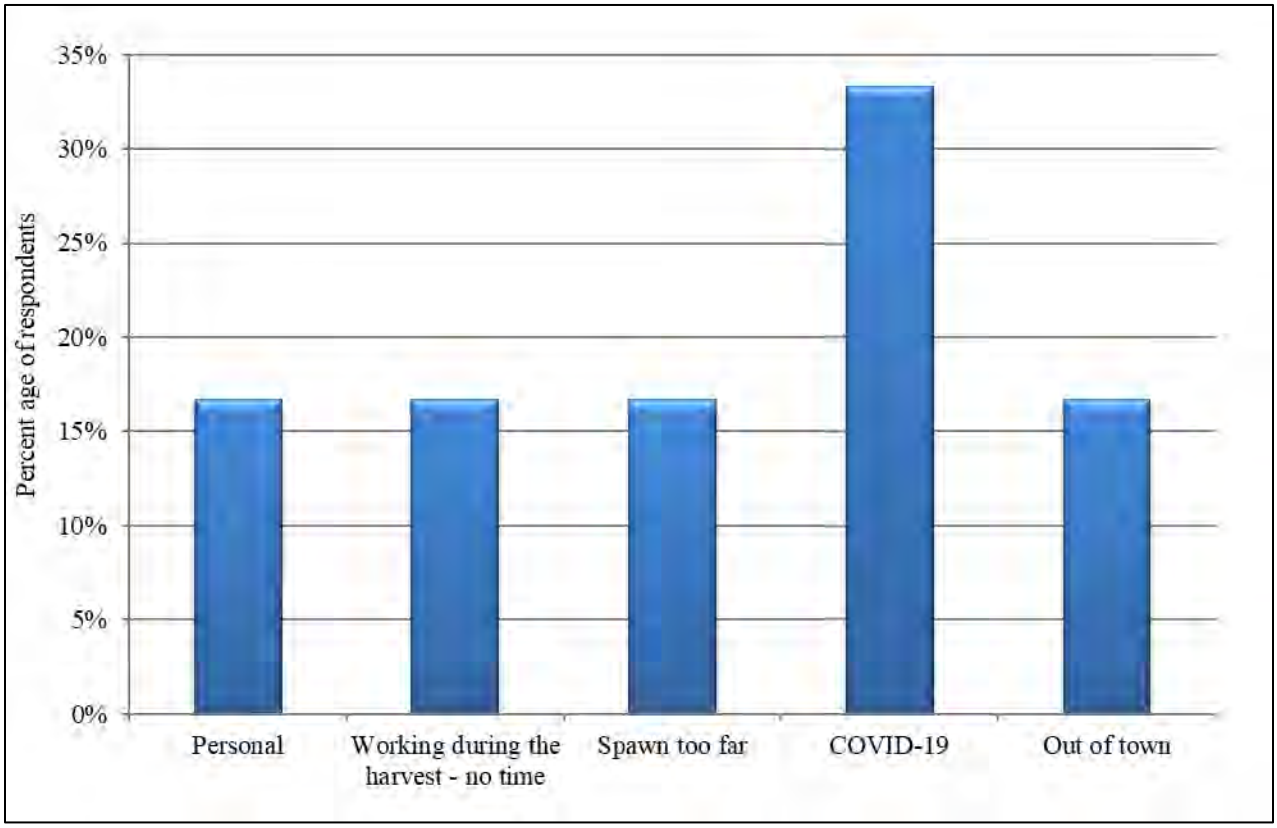

Figure 3.–Reported reasons households did not attempt to harvest herring spawn, Sitka area, 2020.

Table 9.–Size of vessel used to harvest herring spawn in Sitka Sound, 2020.

	Percentage of responding households					
Number of households responding	less than 20 feet	20–24 feet	Over 24 feet	Commercial vessel	Other	No boat used - harvested from shore
9	66.7%	22.2%	0.0%	0.0%	0.0%	11.1%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household survey, 2020.

Table 10.–Percent of households harvesting with other households, Sitka Sound, 2020.

Number of households responding	Percentage of responding households	
	Yes	No
	%	%
7	100.0	0.0

Source: Sitka Tribe of Alaska and ADF&G Division of Subsistence, household survey, 2020.

CONVERSION FACTORS

During survey administration, surveyors ask respondents to estimate the processed weight of their harvests. Project staff assume that experienced harvesters were knowledgeable about harvest weights through handling, packaging, and shipping herring spawn (Schroeder and Kookesh 1990). If respondents have difficulty estimating the weight of their harvests, they are asked for the volume which can then be converted into pounds using a conversion factor. From 2002 through 2009, this factor was static and was based on the weight of an equivalent volume of water. Beginning in 2010, project staff developed a more rigorous method for gauging harvest weights based on weighing each year's harvest in commonly used containers. In any year, respondents provide the majority of the harvest weight in estimated pounds with small amounts being converted from volume to weight. Table 11 presents the conversion factors for 2010 through 2020. As discussed above, due to STA's inability to weigh the harvest in 2020 because of COVID-19 complications, conversion factors were not created. Instead, the previous five-year average was used to convert gallons of harvested eggs into pounds on the survey. Conversion factors have been calculated every year for 50- and 25-lb wetlock boxes and gallon-sized zip-top bags; they have not been calculated for quart-sized ziptop bags or various container sizes of herring spawn on kelp every year. Generally, a small proportion of the total harvest weight derives from quart-sized bags or herring eggs on kelp or hair seaweed. In past project years, researchers documented a slight decrease in weight between primarily processed (from tote to wetlock box) and secondarily processed (from box to bag) weights due to the removal of branches during processing. Since 2016, due to the unavailability of dock space at the winch, raw weights of branches off the boat could not be taken.

Table 11.–Conversion factors for 2010–2020.

	Estimated average weight (pounds)										
Container type, spawn on branches	2020[a]	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
Large (50 lb) wetlock box	54.5	53.9	57.1	51.9	55.5	54.0	48.9	53.0	59.1	53.3	57.8
Small (25 lb) wetlock box	25.5	28.0	24.1	24.8	25.2	25.6	24.7	22.8	28.5	24.9	25.5
Zip-top gallon bag	3.7	3.5	4.0	4.2	3.4	3.7	4.1	3.9	4.4	3.9	4.1
Zip-top quart bag	n/a	n/a	1.5	1.4	1.1	n/a	n/a	1.4	1.4	1.5	1.4
Container type, spawn on kelp	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
Zip-top gallon bag	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.7	n/a	n/a
5-lb bucket	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	23.9	n/a	n/a
Small (25 lb) wetlock box	n/a	n/a	n/a	n/a	n/a	n/a	n/a	16.7	n/a	n/a	n/a

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence household surveys, 2019; Holen et al. (2011); Sill and Lemons (2012; 2014a; 2014b; 2015; 2017; 2020; 2021); and Sill and Cunningham (2017; 2019).

Note n/a indicates conversion factors were not calculated for these years.

a. The conversion factor for spawn on branches in 2020 reflects the previous 5-year average, 2015–2019.

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HARVEST LOCATIONS

The final project objective was to document where the herring spawn harvest took place. Table 12 and Figure 4 show the locations of harvest effort and reported harvest amounts. Note that not every surveyed household shared their harvest location data or the amounts harvested at each location. In 2020, most of the surveyed households traveled to the northern portion of the sound to harvest: five households traveled to the Eastern/Promisla bays area, two went to the Magoun Island/Hayward Strait area, and one traveled to the Siginaka Islands (Table 12). Unsurprisingly, harvesters reported the majority of the spawn harvest from these same locations. The other reported locations included the Kruzof Island shoreline and the road-accessible shoreline of Baranof Island.

Table 12.–Reported locations of subsistence herring spawn sets and harvest, Sitka Sound, 2020.

Location	Reported households using each location	Percentage of reporting households using each location[a]	Reported pounds harvested at each location
Eastern/Promisla Bay	5	45.5%	5,241
Magoons/Hayward	2	18.2%	1,590
Siginaka Islands	1	9.1%	1,000
Other	3	27.3%	210

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2020.

a. Percentages are based on the total number of locations reported by 9 harvesting households.

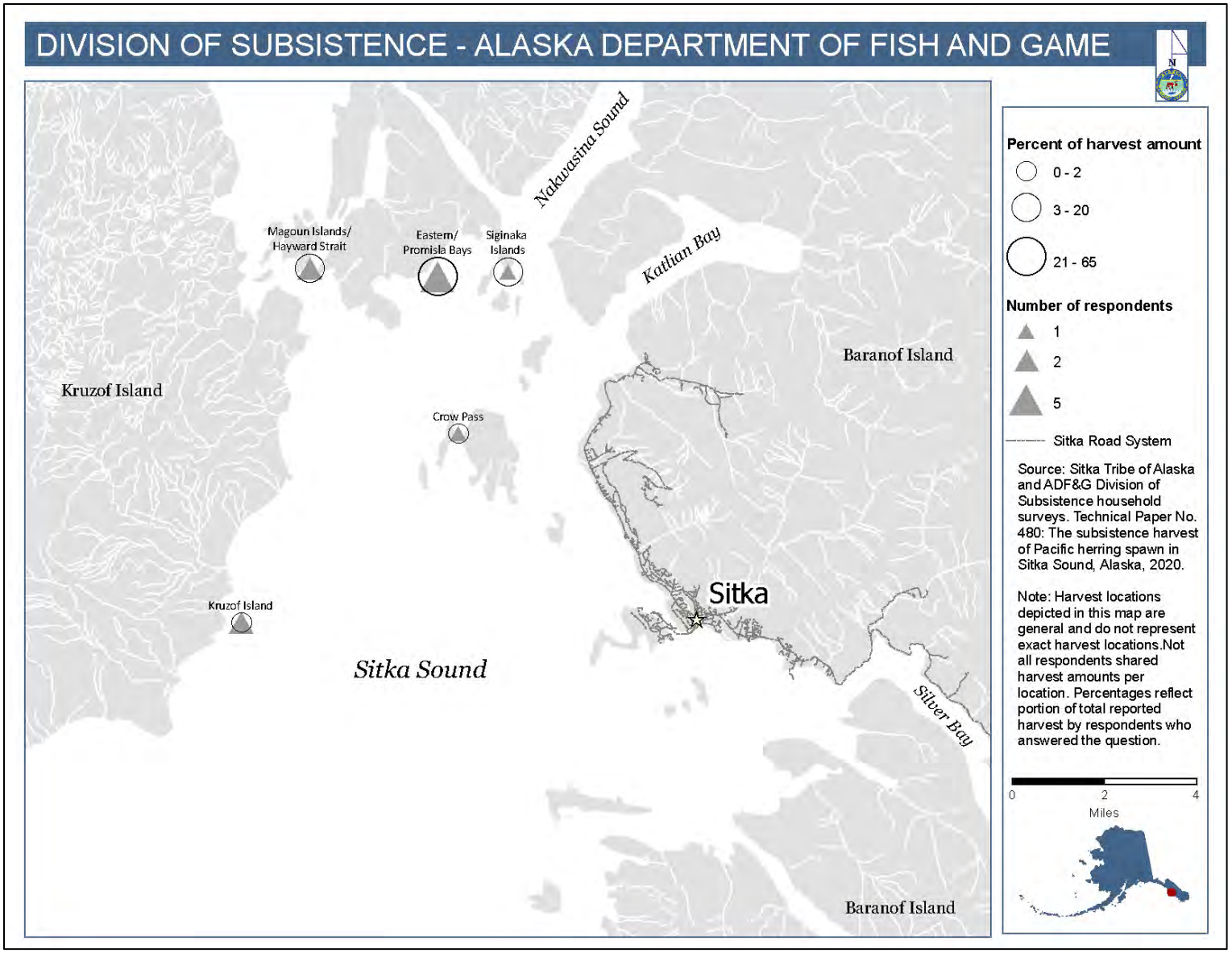

Figure 4.–Reported harvest locations and percent of harvest weight per location of herring spawn for subsistence use, 2020.

3. DISCUSSION

OVERVIEW OF 2020 HARVEST SEASON

Before beginning a discussion of the 2020 harvest year in comparison with past years, it is important to note at the outset the unusual circumstances of 2020 and to provide some discussion about the 2020 sample. In March of 2020, COVID-19 was officially declared as a global pandemic. Governor Dunleavy issued a health mandate on March 27 requiring most individuals to remain at their place of residence and practice social distancing.[1] At the time, there were many unknowns and rapidly changing information about the novel disease, its effects, and what activities and behaviors were safe to engage in. The herring spawning event occurred between March 25 and April 18 so the 2020 subsistence herring fishery took place in this context. While researchers did not attempt to identify specific changes that occurred in 2020 directly because of the pandemic, some relevant information is available from the surveys as well as anecdotally. Some of the regular community boats that travel to Sitka Sound did not come, either because of logistical challenges stemming from COVID-19, or out of concern for spreading the disease. While not related to COVID-19, the commercial sac roe herring fishery did not occur in 2020.[2] As a result, the commercial boats that would have also participated in the subsistence fishery were not in town for it, affecting the structure of the subsistence harvest as well which is discussed in more detail below. A smaller than usual percentage of responding households said that they harvested with other families; although surveyors did not ask follow-up questions, general health guidelines at the time were to keep contact with people outside one's own household to a minimum. Anecdotal information lends support to the idea that some households were less comfortable sharing harvest efforts. In terms of the sample, 2020 was an unusual year. The estimates developed for the 2020 fishing season were calculated from a stratified random sample. While an adequate number of 'community' boats were contacted (71% of potential community boats), the number of household contacts (10 of 44 potential households or 23%) was below the threshold to reliably develop an estimate. Typically, 30 households are required as the minimum, with 60% of all households for communities smaller than 50 households. The estimates presented in this report are the best possible given the data available but are not statistically rigorous. While the number of households surveyors contact has varied over the study years, 2020 had the fewest households successfully contacted than any other year. This could be related to the pandemic or to the challenge faced by every harvest assessment program of finding good contact information for potential harvesters and successfully connecting with harvesters. The 2020 study year will likely be seen as an anomalous year: the lack of community harvester boats and the changes resulting from the COVID-19 pandemic are circumstances unlikely to occur again during a non-pandemic study year.

CHARACTERISTICS OF HERRING SPAWN SHARING, HARVEST AREAS, AND PARTICIPATION, 2020

Over the course of this harvest monitoring program, several characteristics of the subsistence herring egg harvest have remained consistent, regardless of the overall magnitude of the harvest. The majority of harvesters share a portion of their harvest every year, and the harvest is widely shared, both in quantity and in geographic breadth. Harvesters usually focus their efforts on the islands just offshore Sitka, but when there is quality spawn elsewhere in the sound, some harvesters travel farther from town. The majority of the subsistence herring egg harvest is taken on hemlock branches, secondarily on kelp, with small amounts

1. Alaska Department of Health and Social Services, "COVID-19 Health Mandate 11," March 27, 2020. Accessed October 6, 2021. https://content.govdelivery.com/accounts/AKDHSS/bulletins/283a713
2. According to an advisory announcement released on February 28, 2020 all processors with a known interest in the Sitka Sound sac roe herring fishery indicated to ADF&G that they did not intend to purchase herring due to market requirements and the forecasted age composition of the herring return. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1135496187.pdf

on hair seaweed. Conflicts with work schedules and receiving eggs from others are the main reasons that surveyed households do not attempt to harvest herring eggs. The 2020 harvest shared many of these characteristics, but several measures set 2020 apart as well.

Sharing of resources is a characteristic of subsistence economies. In specialized harvests, such as of herring eggs, where specific knowledge and skills are required for a successful harvest, sharing is even more profound. The pattern of a small number of households ("super-households") harvesting and then distributing a unique resource is common because these "super-households" have the time, ability, knowledge, and equipment necessary to successfully harvest (Wolfe et al. 2010). Specialized harvesters provide the resource, in this case herring eggs, to a much larger percentage of households. In 2020, despite being the smallest harvest on record, 73% of harvesters shared some of their harvest and shared the harvest widely (Table 2; Table 4). Because this project specifically targets only potential herring harvesters, inferences about overall use and sharing of herring eggs cannot be made from these results.[3] However, household surveys in Sitka and elsewhere have shown that households further share received resources, and it is likely that herring eggs are shared through multiple households. Additionally, comprehensive surveys recently administered in seven Southeast Alaska communities show herring eggs are widely used in these communities (Sill et al. 2017; Sill and Koster 2017a–b; see further discussion to follow in section "Changes in Use of Herring Spawn.")

It might be expected that with lower harvest amounts, the amount any harvester shares would also decrease. While harvesters clearly are continuing to share their harvest even at low community harvest totals (Table 2), the survey does not track amounts shared so further insight into sharing patterns cannot be answered without additional research. When harvesters were asked if they had enough herring eggs, 100% said they had enough to meet their needs for sharing, and 67% said they had enough for their household. One caveat to these responses is that the survey was conducted shortly after the harvest and harvesters may not yet have been aware of unmet needs they would be asked to fulfill. Additionally, how needs are defined is subjective and can vary among households and between years. These surveys have shown that no matter how little may be harvested, the sharing of herring eggs is fundamental and will occur. In higher productivity years, sharing patterns often expand so that more is shared with more people (Thornton 2019; pgs 109-110). The lower percentage of households meeting their own needs could indicate that sharing obligations to family and friends take precedence over the harvester's own usage needs. Most households harvesting in 2020 indicated that they usually harvest for two to five other households; no household indicated only harvesting for their household, one-quarter said they harvest for 11 to 50 other households, and 13% said they harvest for over 100 households.

In addition to harvesters who share their eggs with other households, community boats usually come to Sitka to harvest eggs for their communities. Sometimes, these are commercial boats that are already in Sitka Sound for the commercial sac roe fishery. In other cases, communities may sponsor a boat to help defray the expense of harvesting, and still other boats use personal connections with Sitka residents to facilitate their community harvest. Beginning in 2009, the Southeast Herring Conservation Alliance (SHCA) has sponsored a vessel (in some years more than one) to harvest herring eggs and distribute them within Sitka or more broadly throughout Southeast Alaska. This practice continued until 2019, when the boats were asked to stop fishing due to law enforcement investigations.[4] In most years, the community boats have been responsible for well over half of the total pounds of harvest documented. In 2020, STA's traditional foods program was the only one to harvest herring eggs. Some boats were kept in port because of concerns with or logistical problems due to COVID-19. Additionally, there was no commercial season in 2020, so many commercial fishers were not in Sitka for the spawn. As a consequence of that lack of participation, the 2020

3. Thornton (2019) delves into the topic of the distribution of herring eggs from Sitka Sound through interviews with users and harvesters of herring spawn around Southeast Alaska and an additional module that was added to the ongoing herring egg harvester surveys in 2018. He discusses different patterns of exchange of herring eggs, including sharing, barter, and trade.
4. Sergeant Cody Litster, AWT, Petersburg, personal communication with Lauren Sill, ADF&G, September 2021.

harvest from community harvest boats was only one-third of the total harvest. Given that 2020 was an unusual year in many ways, it is difficult to discern from these results what, if any, changes may have occurred in individual harvesting behavior based on the loss of community boats, either temporarily such as was the likely case in 2020, or permanently as has happened with the loss of the SHCA-sponsored boat.

The 2020 survey documented the fewest successful harvesters since the monitoring program began as well as the lowest number of households attempting a harvest (Table 2). Although the survey sample size in 2020 was also the lowest achieved for any study year, a trend of decreasing harvesters has been seen since 2015. The low number of harvesters in 2020 may be an outlier due to the unusual circumstances of 2020; subsequent study years will put the 2020 study year into better context. Most households that attempted to harvest in 2020 were successful, a change from recent prior years. Harvester numbers vary from year to year due to a variety of reasons, including difficulty in finding time to participate, receiving herring eggs from others, or the cost of fuel or boat maintenance. One strategy to share the costs associated with harvesting is for harvesters to work together. In 2019, 92% of households indicated that they harvested with at least one other household, whereas in 2020 only 43% of harvesters did the same, which may be a short-lived effect of COVID-19. In most years, working during the harvest or receiving eggs from someone else have been the two main reasons potential harvesters gave for not participating in the harvest. In 2020 (and in 2019), a small percentage of households indicated that work schedules interfered with the harvest; no households reported that they did not harvest because they received eggs from elsewhere. The annual presence of the STA Traditional Foods program and, in years past, the SHCA-sponsored boat has provided some assurance that eggs would be available to those who could not or did not harvest, but as mentioned above, the estimated community boat harvest totals have been low compared to previous years. Instead, the distance to where spawn could be found and potential harvesters being out of town or working were reasons provided for not harvesting (in addition to the main reason of the pandemic). Traditionally, there is a "core" harvest area around the islands offshore from town. This area has historically been important to the subsistence herring egg harvest and was the focus of STA's efforts to set aside an area of the sound off limits to commercial herring fishing. The core area has traditionally had dependable spawn, good quality substrate, and somewhat protected waters—all factors that contribute to its importance for the harvest. Since 2017, the majority of the spawning activity has occurred along the outer edges of Sitka Sound. In 2020, herring spawned through more of the core area than in 2019 or 2018, and for a longer period of time. Still, most of the harvest effort, and most of the harvest weight, occurred in the Eastern/Promisla bays area, which, depending on where a boat launches from, can be relatively far from town.

The locations where herring spawned in 2020 likely contributed to the low overall harvest of herring spawn because fewer people were able or willing to travel so far. Not all harvesters have access to a boat that they feel comfortable taking far from town; nearly all the harvesting households indicated that they used a vessel 24 feet in length or smaller to harvest herring eggs. Some harvesters use larger vessels in some years, but the size of vessels used in 2020 is typical. Harvesters also consider weather conditions and fuel costs in determining how far they are willing to travel. Subsistence harvesting of herring eggs is a time-consuming process, requiring multiple trips to look for potential harvest sites, setting branches, checking the quality, and then harvesting them. The farther away from town harvest sites are located, the greater the investment of time and money required to access them.

Herring spawned in similar locations in 2020 as in 2018 and 2019, but the harvest was more similar to the low 2018 harvest than the much higher 2019 harvest. The unusual social conditions of spring 2020 were likely stronger contributing factors to this low harvest amount than resource availability, since nearly three-quarters of the households that did harvest said their harvest was the same as or better than recent years. Of those households that harvested less or more than usual, most felt the reason why was that it was a good harvest year. Additionally, it is important to note that there are substantial confidence intervals surrounding the 2020 harvest estimate, making it not statistically different from the previous several years of harvest estimates (Figure 5). Following a trend since 2015, the 2020 estimated harvest did not exceed the lower end of the ANS range. In addition to the social and ecological factors discussed below, the lack of community

boats harvesting in 2020 contributed to the low overall harvest amounts. As noted previously, in other project years, community boats have harvested over half of the total community harvest.

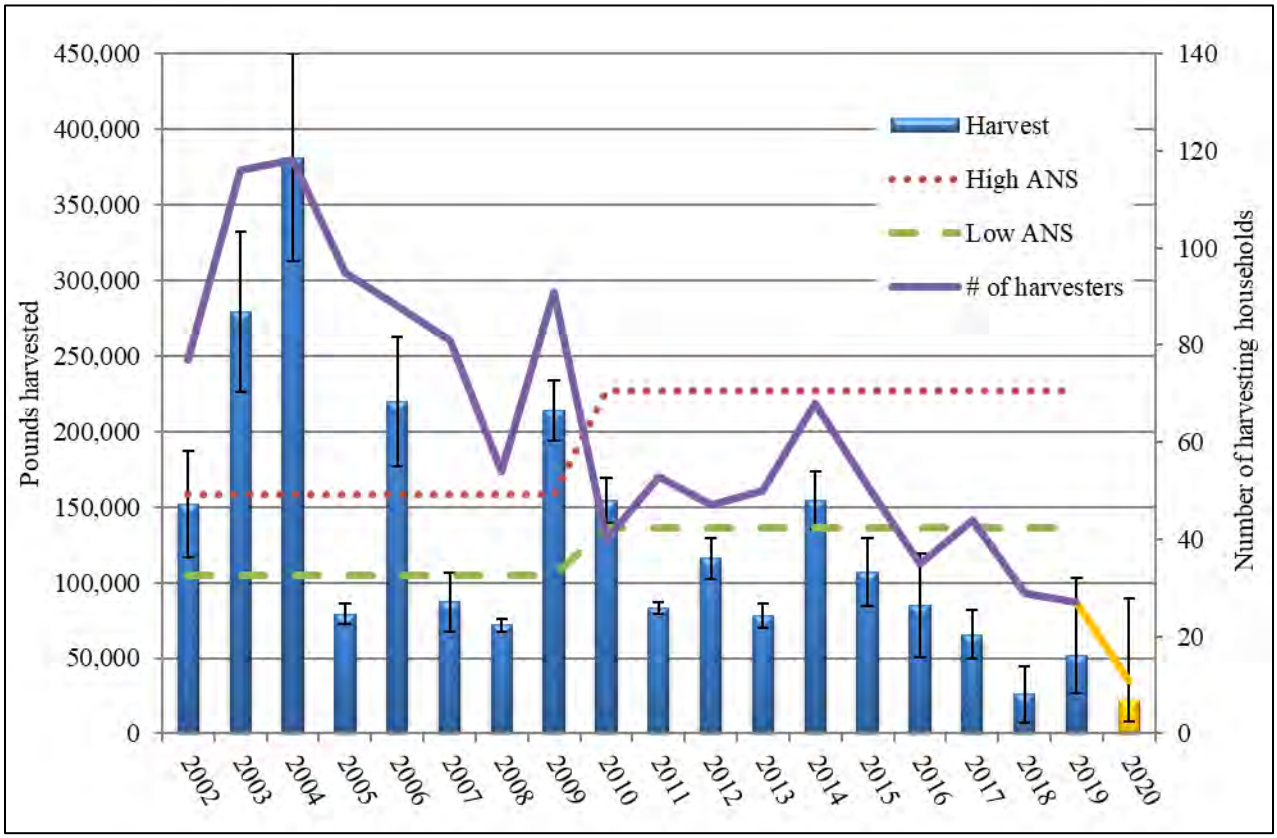

Figure 5.–Total pounds usable weight of herring spawn harvested, number of harvesting households, and amount reasonably necessary for subsistence (ANS) of herring spawn on all substrates in Sitka Sound, 2002–2020. The 2020 harvest is shown in yellow to reflect an atypical harvest year, perhaps due to the COVID-19 pandemic.

Delving further into the harvest success of any given year (as defined in relation to the ANS), it is clear that the amount of mature biomass returning does not have a direct correlation with harvest amounts (Figure 6). Some years with increased biomass estimates[5] were years with decreased harvests and vice versa. Since 2010, mature biomass estimates have been high compared to ADF&G estimates prior to 2010, but subsistence harvests show almost an inverse trend, with generally lower harvest estimates from 2010 to present than pre-2010 estimates. There may be finer details within the run size composition, apart from total estimated mature biomass, that may correlate with subsistence harvests, but such investigations are beyond the scope of this project. Shewmake (2013) argues that successful harvests in Sitka Sound are predicated on two groups of factors, broadly categorized as social opportunity and ecological opportunity. On the social side are issues like sufficient time, resources, knowledge, and skills to engage in harvesting activities. Within the ecological grouping the main factor is the quality of the eggs, which is influenced by timing, duration, location, and weather. Good quality eggs cover the substrate several layers deep and lack impurities, such as sand. According to local respondents, the thickness of deposition is related to the number of days of the spawning activity, as well as other factors such as the size or density of the spawning school of herring (Shewmake 2013). Shewmake (2013) found that mean consecutive spawning days in subsistence

5. Sherrie Dressel, ADF&G Fisheries Scientist, email, May 21, 2021.

use areas of Sitka Sound can be a reasonably good predictor of harvest success (also see Sill and Lemons [2014a] for a further discussion of the relationship between harvest success and multi-day spawning events).

The ADF&G Division of Commercial Fisheries documents total days of spawning activity and the number of miles of shoreline with active spawn but does not analyze how many days of spawning activity each section of shoreline receives.[6] Using the daily aerial mapped spawn coverage from the Division of Commercial Fisheries, the Division of Subsistence created a map showing numbers of days of spawn throughout Sitka Sound (Figure 7). In 2020, a total of 58.5 nautical miles of spawn were recorded by ADF&G during aerial surveys conducted between March 14 and April 20, which is slightly less than the 20-year (2000–2019) average. The majority of shoreline that received spawn only experienced one or two days of spawning activity. Fewer areas received three or more days of spawn;[7] these were almost exclusively outside of the subsistence "core" area, instead being documented in the northern portions of the sound. According to ADF&G herring egg deposition surveys,[8] egg deposition was very high throughout most of Sitka sound and exceptionally high along the Kruzof Island shoreline. It is not an area with high harvester use, but some harvesters did successfully harvest eggs there in 2020. A harvester's assessment of the length of the spawn and quality of the season is more likely localized to areas that are accessible to that harvester and therefore may not align with the ADF&G-documented duration or total coverage of the spawn. Although there was more spawning activity in the core area than there was in the previous several years, only one surveyed harvester reported setting branches there. Most of the harvesters set branches in the Magoun Island/Hayward Strait are and Eastern/Promisla bays, and most of the harvest was taken from these locations as well as Siginaka Islands.

It makes sense that the areas with more harvesters would produce more harvest weight, but that is not always the case, as was seen in 2018 (Sill and Lemons 2020). Harvest "effort" is difficult to compare within and between years, beyond the metric of number of households at any location, because there is no standard size of a subsistence herring egg "set." A set can vary dramatically between harvesters, based on the size of vessel, hydraulics on board, time available, and harvester intent. The harvest survey asks respondents how many sets are made and pulled in each area, but it does not ask the harvester to define a "set." Being able to track harvest per unit effort would likely give more insight into the effect of the spatial closures to commercial fishing in the core area since 2012. Without this scale of analysis, the closures do not seem to have had a clear or demonstrable effect on herring egg harvest totals. However, in nearly half of the years since the first closure went into effect, there has been unusual spawning activity generally bypassing the core area. With additional years of data, trends may become apparent.

6. Alaska Department of Fish and Game Division of Commercial Fisheries, "2020 Southeast Alaska Herring Summary," advisory announcement, May 21, 2020. Available online: http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1032212824.pdf (accessed May 17, 2021).
7. Three days is used as the reference point because that length of time is often mentioned by survey respondents as being the minimum threshold for reasonable opportunity ((Thornton et al. 2010); Shewmake 2013).
8. Alaska Department of Fish and Game Division of Commercial Fisheries, "2020 Southeast Alaska Herring Summary," advisory announcement, May 21, 2020. Available online: http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1032212824.pdf (accessed May 17, 2021).

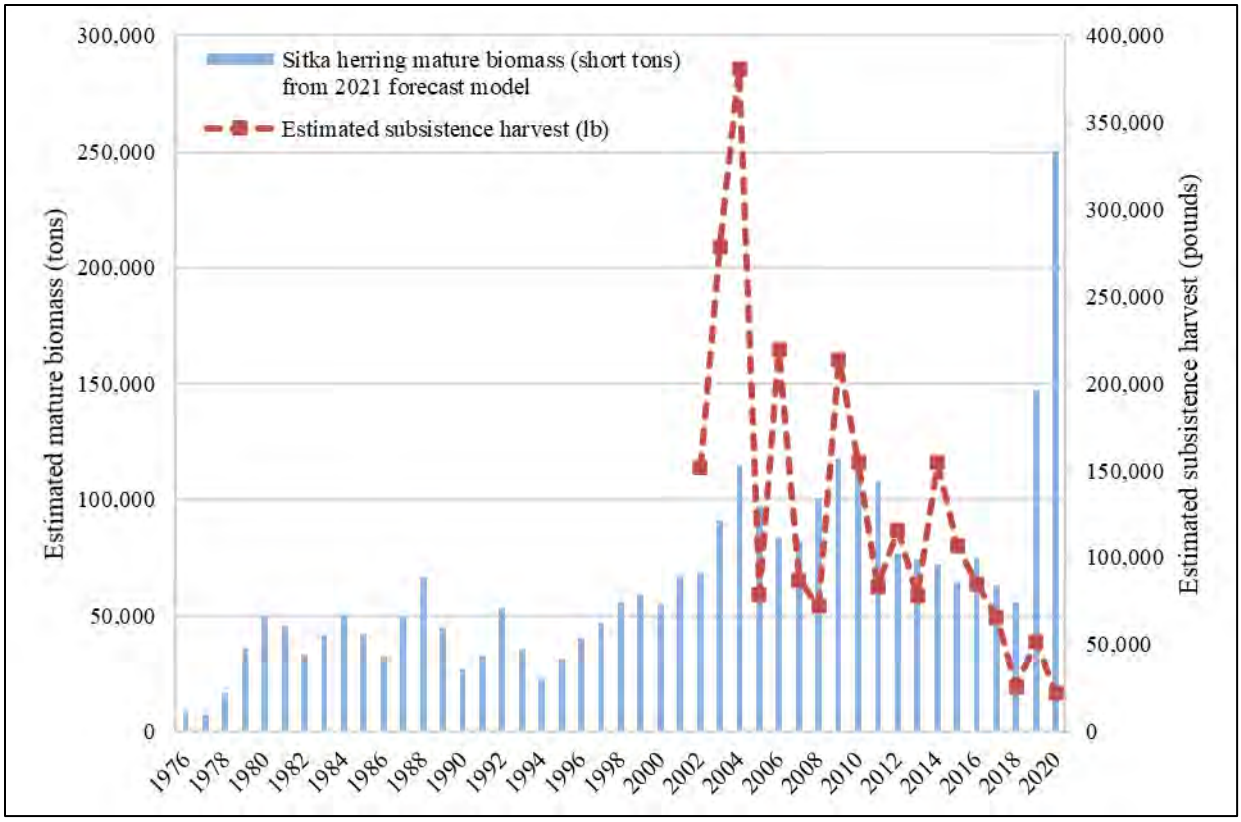

Figure 6.–Estimated mature biomass of Sitka Sound herring, 1976–2020 (based on the ADF&G 2020-forecast age-structured assessment model for Sitka Sound herring) and estimated subsistence harvest of herring eggs from Sitka Sound, 2002–2020.

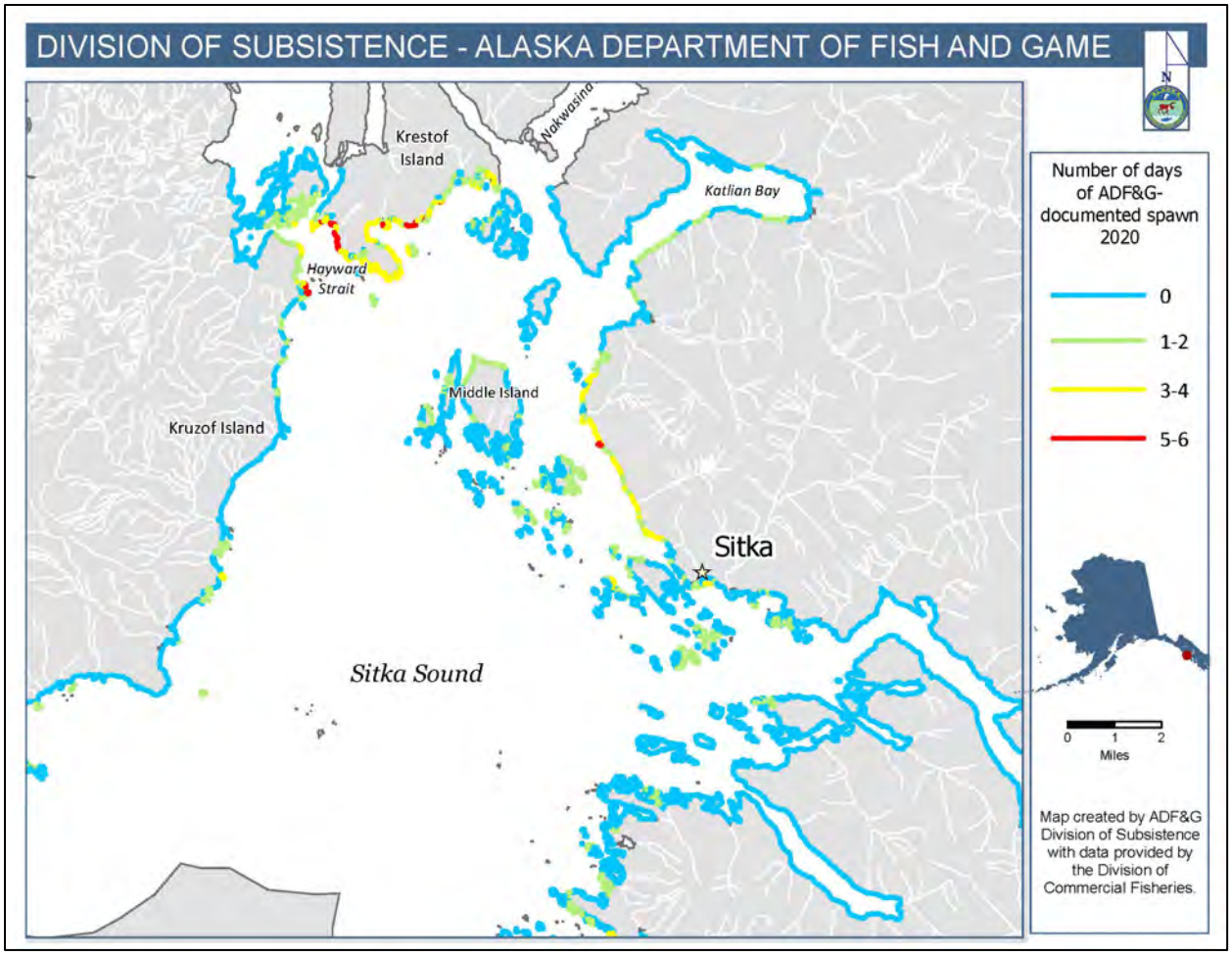

Figure 7.–Cumulative days of recorded herring spawn, Sitka Sound, 2020.

CHANGES IN USE OF HERRING SPAWN

As stated above, this research project targets herring egg harvesters, so it does not allow for analysis of the wider use of herring eggs within Sitka or other communities. The study has been able to document a general decrease in the participation of the subsistence herring egg harvest over the last 20 years, but there are few data available to speak to changes in overall use of the resource, either within Sitka or in other Southeast Alaska communities, or overall participation in the processing of herring eggs. In 2013, 2014, and 2016, several comprehensive subsistence harvest and use studies were conducted in Southeast Alaska communities. The use of herring eggs was documented in Hydaburg, Hoonah, Haines, Angoon, Sitka, and Yakutat; Whale Pass was surveyed, but no herring eggs were used in 2012 (Sill et al. 2017; Sill and Koster 2017; "The Harvest and Use of Wild Resources in Haines, Hoonah, Angoon, Whale Pass, and Hydaburg, Alaska, 2012" 2017). Sharing in all of these communities is widespread and varied: the percentage of households using herring eggs on hemlock branches ranged from 15% in Haines to 77% in Hydaburg, while the percentage of households harvesting eggs on hemlock branches was much lower, ranging from 0% in Angoon to 23% in Hydaburg (Figure 8). The majority of respondents indicated that the eggs they used or harvested came from Sitka, with the exception of Hydaburg residents who also harvested and used eggs from the Craig/Klawock area (Table 13); the Yakutat survey did not ask respondents to identify where herring eggs used and harvested came from, but some volunteered that herring eggs were shared or bartered for from Sitka and also harvested locally. In this limited sample of communities in Southeast Alaska, the use of herring eggs from Sitka Sound remains high, and patterns of sharing remain evident and of importance. A broader survey looking specifically at the use and receipt of herring eggs from the general populace would be necessary to fully discuss changes in the use of herring eggs over time.

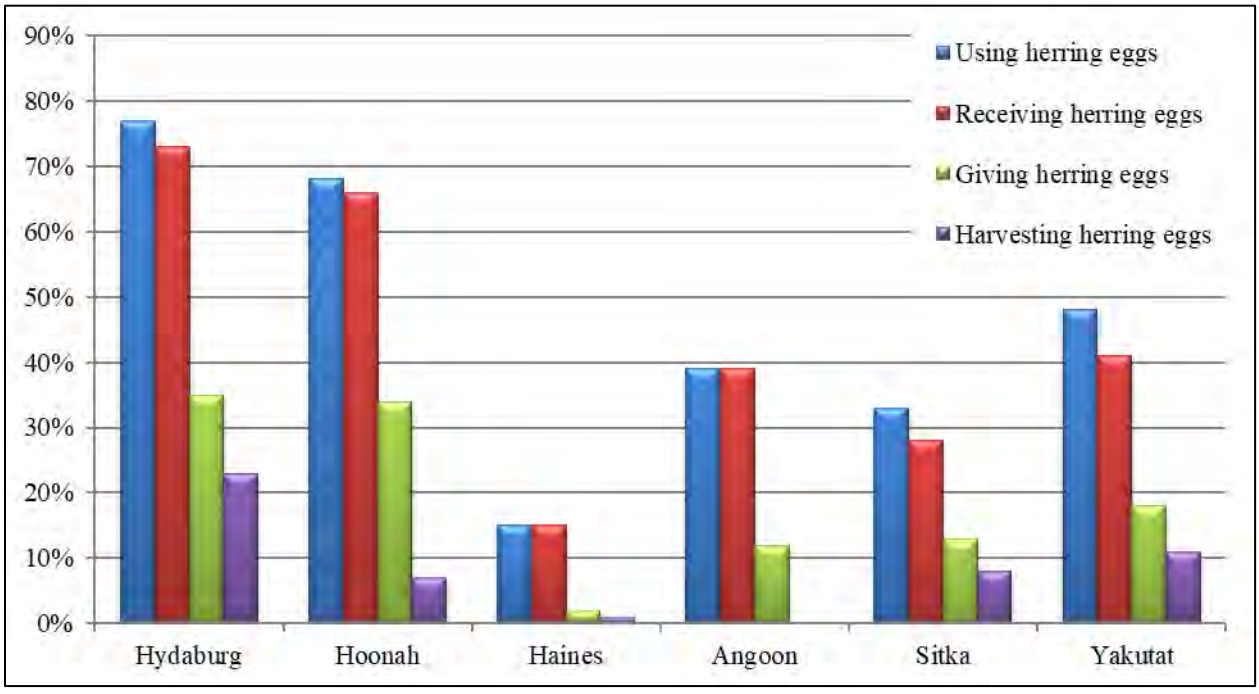

Figure 8.–Percentage of households using, receiving, giving, and harvesting herring eggs, Hydaburg, Hoonah, Haines, and Angoon 2012, Sitka 2013, and Yakutat 2015.

Table 13.–Locations where residents reported herring eggs were sourced, Angoon, Haines, Hoonah, Hydaburg, and Whale Pass, 2012.

	Valid responses									
	Angoon		Haines		Hoonah		Hydaburg		Whale Pass	
Source	No.	%	No.	%	No.	%	No.	%	No.	%
Craig	0	0.0%	0	0.0%	1	1.7%	21	51.2%	0	0.0%
Haines	0	0.0%	1	8.3%	0	0.0%	0	0.0%	0	0.0%
Hoonah	0	0.0%	0	0.0%	1	1.7%	0	0.0%	0	0.0%
Sitka	20	100.0%	11	91.7%	57	96.6%	20	48.8%	0	0.0%
Total	**20**	**100.0%**	**12**	**100.0%**	**59**	**100.0%**	**41**	**100.0%**	**0**	**0.0%**

Source ADF&G Division of Subsistence household surveys, 2013.

Note Includes only valid responses containing a named city; households were permitted to identify multiple sources.

CONVERSION FACTORS

Creating annual conversion factors is useful for two reasons.

12. Annual conversion factor summaries give researchers a more accurate estimate of herring egg harvests because individuals often report their harvest in number of boxes/bags, rather than total pounds harvested. With an average weight determined for storage containers for that year, researchers can convert the entire reported harvest into pounds with greater accuracy.
13. The other aspect of conversion factors is their potential insight into the effect of egg density on the success of the overall harvest. From Shewmake's (2013) work, according to local respondents, the number of consecutive spawning days is important to overall success. From this perspective, more spawning days should lead to thicker egg deposition and heavier branches. One way the project can potentially investigate egg density is through the creation of annual conversion factors.

Assuming that the herring spawn processors are relatively consistent in how they process branches for packing containers during the conversion factor updates, the average weight of a wetlock box should vary annually with spawn density—less in years with low density and more in high-density years. However, other factors, such as seawater content of the set, may also affect the weights of the processed spawn. Until more work is done to identify other factors potentially affecting the weight of wetlock boxes of processed spawn, year-to-year variations in conversion factors cannot be taken as an accurate indicator of herring spawn densities.

LOCATION OF HARVESTS

The final aspect of the subsistence herring harvest that the project attempted to understand was the location of harvests. Harvest location data has been documented during every study year except for 2007 and 2008. According to these data, harvesters clearly use a core area, which is also where the frequency of herring spawn has usually been highest (Figure 9). Continuing a trend begun in 2017, 2020 was another unusual year due to the small amount of spawning activity within this area. There is inter-annual variability in the locations used for the harvest within the broader core area; this variability occurs for several reasons. Within limits, harvesters will go where the herring are spawning (Figure 7). Herring do not exhibit site fidelity in spawn locations like salmon; therefore, the specific beaches and coves where they spawn each year can change. Harvesters look for areas they feel are most likely to produce high-quality spawn based on factors such as geography, substrate, and protection from wind and waves. Some harvesters do not have access to a boat, so they need to harvest in locations accessible by the road system, regardless of where the herring are spawning. Skiffs and other small boats are commonly used by herring harvesters and wind and rough seas can become dangerous; therefore, protected areas are sought. Protected areas are also favored for their

likelihood of high-quality spawn because ocean surge can stir up sand on the seafloor, thus degrading the quality of the herring spawn harvest. As Sitka has developed, and concerns for water quality have grown, harvesters have also tried to ensure that the area they harvest from is not negatively affected by development. In 2020, the harvesters who went out largely traveled to the outer edges of the sound and did not attempt putting branches in the core area, so despite more spawning activity in the core area in 2020 than in 2017–2019, there was no harvest there.

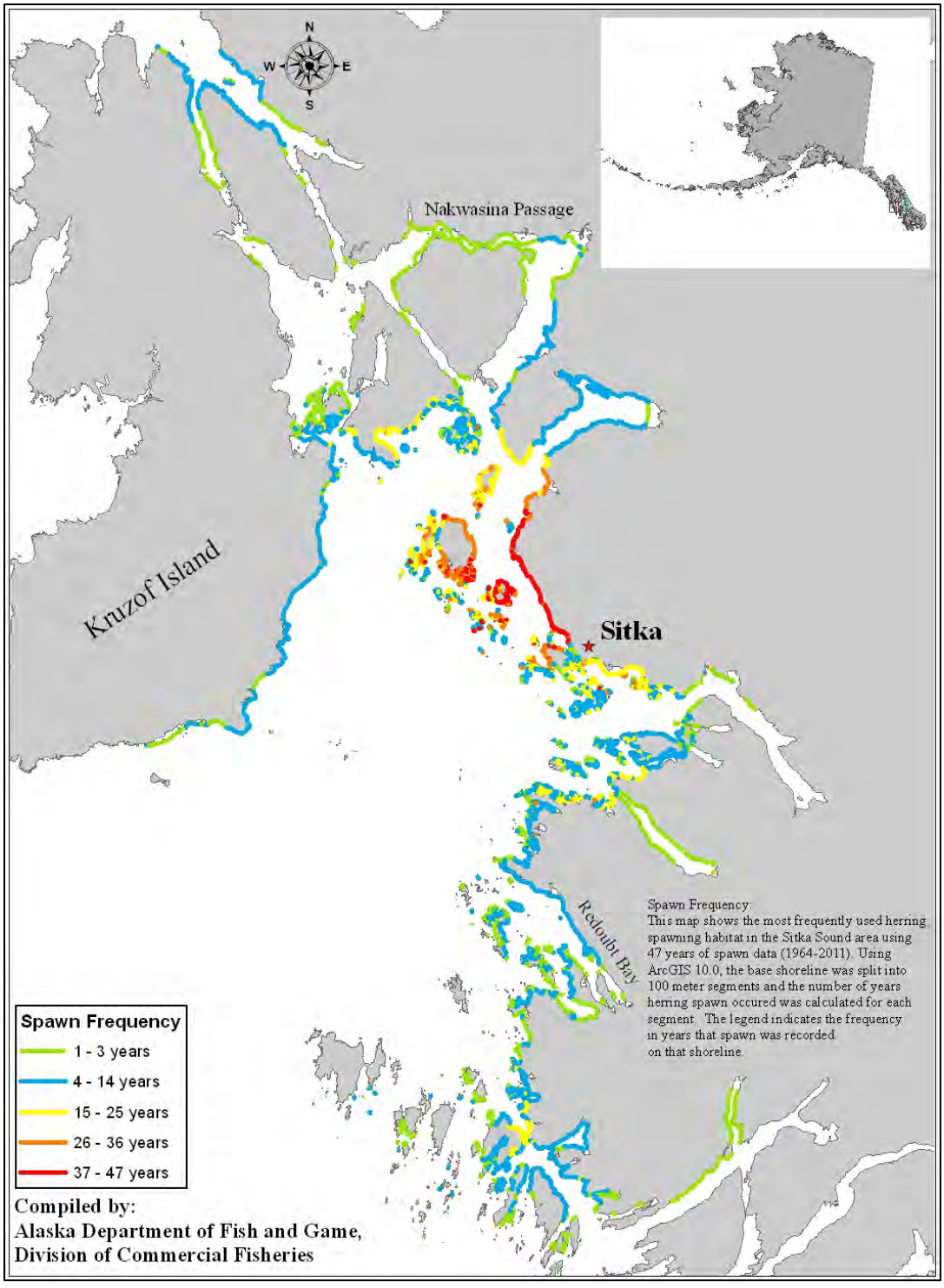

Figure 9.–Frequency of recorded spawn in Sitka Sound, 1964–2011.

SPAWN-ON-KELP FISHERY

In addition to further investigating the role of spawn deposition on weight conversion measurements, another aspect of the herring spawn fishery that researchers will continue to explore is the spawn-on-kelp fishery. While surveys are attempted with all harvesters of herring spawn, regardless of the substrate they

use to harvest, herring spawn on branches accounts for the majority of the harvest and has therefore received the most attention. Often, the amounts of spawn on kelp documented by the survey have been less than those recorded on the permits (a permit is necessary to harvest spawn-on-kelp in Sitka Sound; a second permit may be issued, limiting a household harvest to 316 lb in total). Beginning in 2012 and continuing through 2015, researchers concentrated additional effort on identifying and contacting spawn-on-kelp harvesters. In 2020, the harvest survey estimated 142 lb of spawn of kelp harvest (Table 4), while the expanded permit data show a harvest of 1,790 lb.[9] Additional efforts to identify and survey spawn-on-kelp harvesters is warranted since the survey effort is likely underestimating the spawn-on-kelp harvest recently. Additionally, further study of spawn-on-kelp harvesters to compare differences in participation, harvest, and uses to that of egg-on-branches harvesters would be useful. Because spawn-on-kelp harvesters already need to obtain a permit and report their harvest, they may feel they do not have to participate in the survey project. Comparisons of success rates and responses to annual changes in geographic spawn distribution between both sets of harvesters could also be investigated.

9. Data provided by the Alaska Department of Fish and Game Division of Commercial Fisheries to the Division of Subsistence.

4. CONCLUSION

Although participation in the subsistence harvest of herring spawn from Sitka Sound has generally dropped since the early 2000s, and more recently since 2014, harvesting and sharing eggs remain important cultural activities for Southeast Alaska residents. There is no simple measure of whether Alaska residents are meeting their needs for herring spawn. One metric the Board of Fisheries uses to assess this is the ANS, which has been achieved only once since 2010. Overall harvest amounts are influenced by the amount of harvest effort, but also by weather and the opportunity for quality spawn in accessible locations. The herring spawn harvest continues to be shared extensively throughout Sitka, Southeast Alaska, and beyond. Future years of this project will continue to investigate the spawn-on-kelp harvest and comparisons with permit data for that fishery. In addition, the variations in spawn density and identifying accurate ways to track and correlate density with the harvest will be explored. Expanding on the work Shewmake (2013) did, correlations between harvester success and spawn duration by location could provide further insight into harvester success and perhaps provide a more useful metric for gauging subsistence harvest opportunity than total nautical miles of spawn. Finally, a broader effort to look at overall harvest and use of herring eggs including changes over time, would provide needed additional information to evaluate this important fishery.

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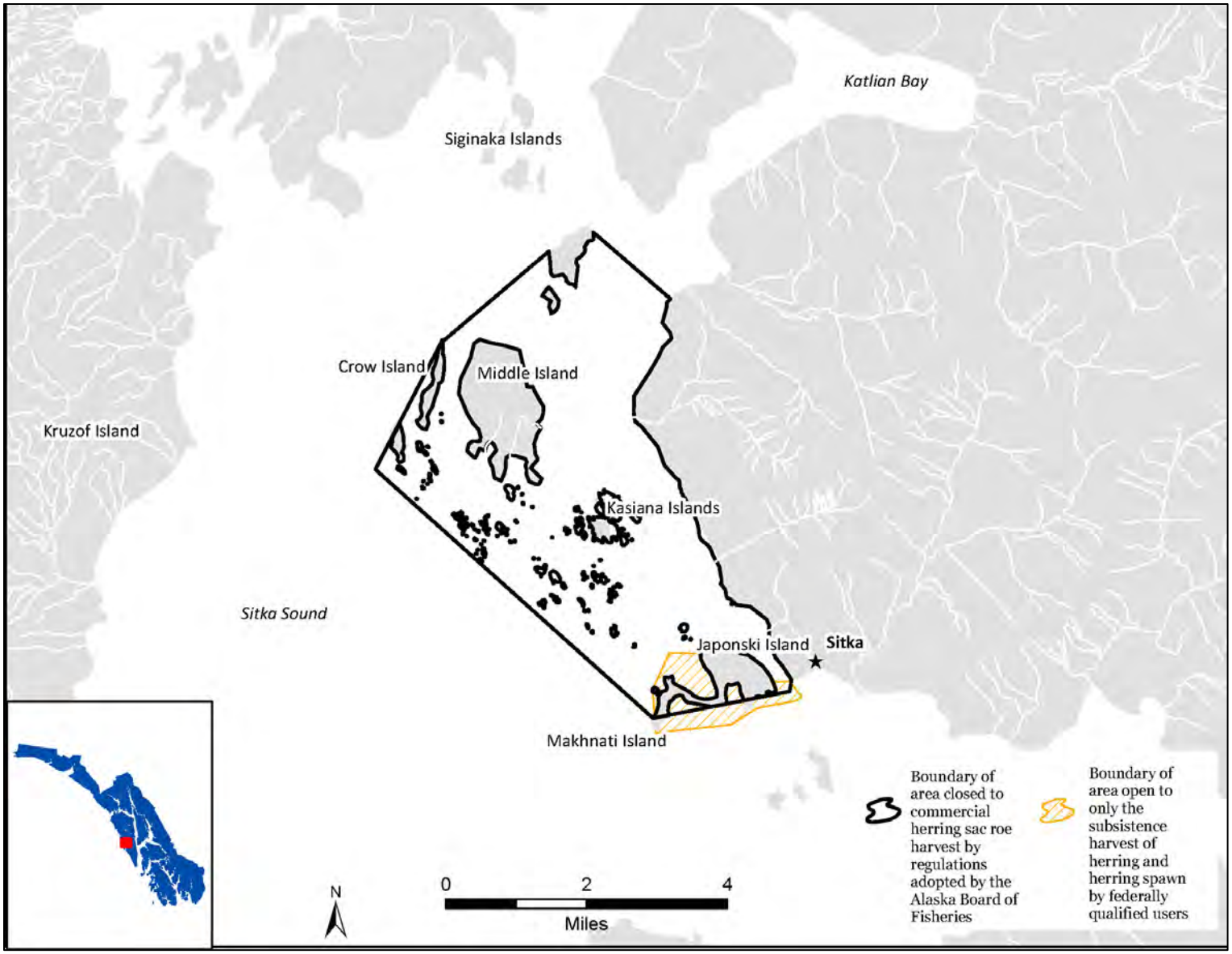
APPENDIX A: MAP OF AREAS OF SITKA SOUND WITH FISHING RESTRICTIONS



Appendix Figure A-1.–Waters of Sitka Sound with limitations on the harvest of herring and/or herring spawn.

APPENDIX B: SITKA SOUND SUBSISTENCE HERRING EGG HARVEST SURVEY, 2020

HERRING EGG SUBSISTENCE HARVEST SURVEY
SITKA, ALASKA
2020

This survey is used to estimate subsistence harvests of herring eggs from Sitka Sound and to describe community subsistence economies. We will publish a summary report which will be available to all households in your community. We share this information with the Sitka Tribe of Alaska, the Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service and the National Park Service. We work with the Federal Regional Advisory Councils and with local Fish and Game Advisory Committees to better manage subsistence, and to implement federal and state subsistence priorities.

This project is guided by the research principles adopted by the Alaska Federation of Natives in 1993. We will NOT identify your household. We will NOT use this information for enforcement. Participation in this survey is voluntary. Even if you agree to be surveyed, you may stop at any time.

HOUSEHOLD ID:		
COMMUNITY ID:	Sitka	313
INTERVIEWER:		
INTERVIEW DATE:		
	DATA CODED BY:	
	DATA ENTERED BY:	
	SUPERVISOR:	

COOPERATING ORGANIZATIONS

RESOURCE PROTECTION DEPARTMENT
SITKA TRIBE OF ALASKA
429 KATLIAN STREET
SITKA, AK 99835
907-747-7168

DIVISION OF SUBSISTENCE
ALASKA DEPT OF FISH & GAME
802 3RD STREET
JUNEAU, AK 99801
907-465-3617

HARVESTS: HERRING EGGS

HOUSEHOLD ID

Do members of your household USUALLY harvest HERRING EGGS for subsistence? ..... Y N

In 2020...
...Did members of your household TRY TO HARVEST herring eggs? ..... Y N

If NO... why not? _____

How many people lived in your household in 2020? ..... ____

Is anyone in the household enrolled in a tribe? ..... Y N

If YES, which one? ..... _____

If the household did not attempt to harvest herring eggs, stop the survey here. If the household attempted to harvest, continue to next page.

Please estimate how many herring eggs ALL MEMBERS OF YOUR HOUSEHOLD HARVESTED for subsistence use this year. INCLUDE herring eggs you gave away, ate fresh, lost to spoilage, or got by helping others. If fishing with others, report ONLY YOUR SHARE of the catch.

	IN 2020 DID MEMBERS OF YOUR HH...			IN 2020, HOW MANY {_____} DID YOUR HOUSEHOLD HARVEST...?			
	...HARVEST _____?	...GIVE _____?	...RECEIVE _____?	...FOR PERSONAL USE	...TO GIVE AWAY IN SITKA	...TO SHIP OUT OF SITKA	Units
	(circle)			*(amount used for each purpose)*			
Herring eggs on hemlock branches	Y N	Y N	Y N				LB
Herring Eggs							
Herring eggs on kelp	Y N	Y N	Y N				LB
Herring Eggs							
Herring eggs on hair seaweed {né}	Y N	Y N	Y N				LB
Herring Eggs							

These columns should include all the herring eggs harvested by members of this household in 2020.

If you shared with others, how many households did you share with?

COMMUNITY	

NOTES: _____

HARVESTS:

HOUSEHOLD ID

Where did you harvest your herring eggs in 2020 - set branches, harvest seaweed, macrocystis kelp?

	Location	# of sets... made	# of sets... harvested	Amount harvested	Quality (coverage, thickness)	Soak time	Comments
1	Kasiana Islands Group						
2	North Middle Island						
3	South Middle Island						
4	Crow/Gagarin islands						
5	Big/Little Gavanski islands						
6	Siginaka Islands						
7	North Japonski/Whiting Harbor						
8	South Japonski/Mermaid Cove						
9	Causeway Islands						
10	South Halibut Point Road						
11	North Halibut Point Road						
12	Eastern/Promisla Bay						
13	Magoons/Hayward						
14	Katlian Bay						
15	Apple/Parker Group						
16	Crescent/Jamestown Bay						
17	Southern Sitka Sound						
18	Other:						

LOCATION

SITKA: 313

HARVESTS: HERRING EGGS **HOUSEHOLD ID**

ASSESSMENT: HERRING EGGS

What size vessel(s) did you use to harvest herring eggs in 2020?..... ____

In 2020...

Did your household get enough eggs for...

...your personal consumption?.....Y N

...to share or exchange with others?.....Y N

How do you feel your 2020 HARVEST was compared to other years?..... X L S M

If LESS or MORE, why was your harvest different?

_____

_____

_____

_____

If you HARVESTED LESS herring eggs in 2020, what was the last year you remember having a good harvest? _____

How many households do you typically harvest for?..... ____

Do you harvest with other households?..... Y N

NOTES: _____

COMMENTS

DO YOU HAVE ANY QUESTIONS, COMMENTS, OR CONCERNS ABOUT THE 2020 SUBSISTENCE HERRING EGG HARVEST?

_____

_____

_____

_____

_____

_____

_____

OTHER FISH: 06 **SITKA: 313**

APPENDIX C: 2020 CODE BOOK

Subsistence Herring Egg Harvest Survey 2020

Herring Spawn User Status	Code
Individual Harvester	1
Non-Harvester	2
Community boat	3

Page 1: Harvests

If household did not try to harvest herring eggs in 2020, why not?	Code
Harvester - no response necessary	Blank
Personal	1
Working during the harvest/no time	2
Spawn too far	3
Covid-19	4
Out of town	5

If enrolled in a tribe, which one?	
Sitka Tribe of Alaska	1
Organized Village of Kake	2
Metlakatla Indian Community	3
Hoonah Indian Association	4
Hydaburg Cooperative Association	5
Native Village of Savoonga	6
Angoon Community Association	7
Central Council of Tlingit and Haida Indian Tribes of Alaska	8

What size vessel did you use to harvest herring eggs?	Code
less than 20 feet	1
20-24 feet	2
over 24 foot pleasure cruiser	3
commercial vessel	4
other	5
no boat used – harvested from shore	6

Page 2: Assessments

If less or more HARVEST, why?

Non-harvester - no response necessary	Blank
Work conflicts	1
More effort/less effort	2
Better than last year	3

Last good harvest year?

2011-2019	1
2000-2010	2
1990s	3
1980s	4
1970s	5

How many households usually harvest for?

1	1
2-5	2
6-10	3
11-50	4
51-100	5
100+	6