Technical Paper No. 492

The Subsistence Harvest of Pacific Herring Spawn in Sitka Sound, Alaska, 2022

by

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and

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February 2023

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

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

The subsistence fishery for the spawn of Pacific herring *Clupea pallasii* in Sitka Sound was historically, and remains, important to Alaska residents. Harvesting herring spawn is a specialized subsistence activity in which a relatively small number of Southeast Alaska residents harvest and distribute herring spawn widely throughout the state and beyond to relatives and other social relations. 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 21st annual harvest survey conducted with households that harvest subsistence herring eggs in Sitka Sound. 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 most recent 10-year average (2012–2021) estimated annual harvest was 75,197 lb. In 2022, an estimated total of 135,231 lb of herring spawn was harvested; this level of harvest was nearly three times the estimated harvest of 2021 and is the largest estimated harvest since 2014. A combination of factors, including effort, the location of spawning activity, the quality of spawn deposition, and opportunity to fulfill latent need for herring spawn, contributed to the higher estimated harvest. Approximately 96% of the harvest was shared with other households within Sitka or in other communities in the state and beyond.

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). Herring spawn is consumed throughout this region; however, only a small number of people have the time, equipment, skills, and knowledge required to harvest it. The harvest is then shared widely. This report presents findings of the 21st annual harvest assessment, which occurred in the spring of 2022, designed to document subsistence harvests of herring spawn in Sitka Sound (see Brock and Turek [2007], Holen et al. [2011], Sill and Lemons [2012; 2014a; 2014b; 2015; 2017; 2020; 2021] and Sill and Cunningham [2017; 2019; 2021a; 2021b] 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; Thornton and Moss 2021). In the 19th century, Tlingit from all over Southeast Alaska gathered in Sitka to harvest herring and herring spawn (Emmons 1991; Pierce 1972). The primary method of harvest has changed little over time; harvesters in both historical and contemporary times 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. The harvest of herring eggs is a specialized activity in which a relatively small number of harvesters provide the resource to many users. The most active harvesters in Sitka Sound, those who supply many households with herring eggs, set up to 80 small hemlock trees in sets of two to 10 trees. In contrast, less active harvesters may set a small number of hemlock branches in just a few sets. During the harvest, small branches can be pulled directly onboard the boat, but trees are usually cut into more manageable pieces since entire trees, laden with herring eggs, are heavy and can be difficult to maneuver. 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. Today, people tend to vacuum seal and freeze herring eggs for use throughout the year.

For subsistence resources in general, not all households participate equally in the harvest of resources, though most households do use a variety of subsistence resources. Distribution networks allow for efficiency in production and access to resources that a household does not harvest (Wolfe and Ellanna 1983). The reciprocal sharing of resources is a primary characteristic of subsistence economies. In Alaska Native communities, while the practice of sharing resources is often conducted through complex kinship responsibilities, it can also extend to unrelated households to strengthen relationships and foster community health by supporting those in need (Brown et al. 2017). The relationships between exchange partners, the timeframe of the exchange, and the different requirements for reciprocation are among several factors that help define an exchange. Sahlins (1972) identified three modes of reciprocity, two of which are relevant to a discussion of Sitka Sound herring eggs. Generalized reciprocity, or what would be considered simply sharing, is characterized by the lack of acknowledged expectation of a return gift. Although there may be an implied expectation of return, failure to reciprocate does not result in the giver ceasing to give. Balanced or delayed reciprocity almost always requires the recipient to return a gift of equal or near-equal value, although when and how the gift is returned can be negotiated and may take place over seasons or over many years. Most trade and exchange in Tlingit society was balanced or delayed reciprocity (Langdon and Worl 1981; Schroeder and Kookesh 1990); but, with herring eggs, traditionally, and contemporarily, both generalized and balanced reciprocity have been the primary forms of exchange (Thornton 2019). Prior to Russian contact, there were extensive trade networks throughout Southeast Alaska, and herring eggs were

among the items widely traded by Sitka Tlingit peoples (Schroeder and Kookesh 1990). 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. The distribution of herring eggs today is often conducted under the rubric of generalized reciprocity, where harvesters share when and what they can, with the expectation that at some point in the future, they will be on the receiving end of sharing. Trading herring eggs for other subsistence resources (balanced reciprocity) or for cash (customary trade) also occurs, but the social and cultural benefits of the exchange to the trading relationship is the point, not to realize a profit or advantage (Thornton 2019). The intensity of sharing distributions is dictated by social ties; for example, the prevalence of clan and family ties between Sitka residents and those of Hoonah, Angoon, and Juneau result in a greater amount of herring eggs being shared with those communities. Herring eggs are delivered to local recipients in grocery bags, while harvesters may pack eggs into different-sized wetlock boxes for shipment on the ferries or airlines. Recently, herring eggs from Sitka Sound have been documented as being shared throughout Southeast Alaska and beyond: within the state, eggs have been shared as far away as St. Lawrence Island, Utqiaġvik (formerly Barrow), and Akiachak (Sill and Lemons 2015; 2021). Beyond state borders, eggs have been sent to family living as far away as Florida and California (Sill and Lemons 2015).

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 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 in harvest reporting, build capacity within the community and STA, and provide consistent harvest data. At this same meeting, 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 available harvest data, including results from a 1996 household harvest survey[3] and a 1989 harvest estimate range (Schroeder and Kookesh 1990). At its 2009 meeting, the BOF revised the ANS to 136,000–227,000 lb,

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 that 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/

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).

In 2012, a compromise version of an STA proposal was adopted by the BOF, resulting in a closure of approximately 10 square nautical miles of Sitka Sound 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. 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 (see Appendix A). Several proposals were submitted to the board for its 2022 Southeast meeting concerning subsistence regulations for herring egg harvests, but during the meeting the proponents withdrew their support for most of the proposals. The only action taken by the board concerning subsistence harvest of herring eggs was to increase the possession limit for subsistence spawn-on-kelp harvests from 32 lb to 75 lb for an individual and from 158 lb to 325 lb for a household.[4]

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 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 Pacific herring spawn through household surveys with all harvesters who participate in the fishery in Sitka Sound. The objectives of the project in 2022 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

This annual project is guided by the research principles outlined in the *Alaska Federation of Natives Guidelines for Research*[5] and by the National Science Foundation, Office of Polar Programs in its *Principles for Conducting Research in the Arctic*[6], the *Ethical Principles for the Conduct of Research in the North* (ACUNS 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.

4. Alaska Department of Fish and Game. 2022. "Alaska Board of Fisheries Southeast and Yakutat Finfish and Shellfish, March 10–22, 2022, Preliminary Summary of Actions." Accessed January 2023. http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2021-2022/se/soa.pdf
5. Alaska Federation of Natives. "Alaska Federation of Natives Guidelines for Research." Alaska Native Knowledge Network. Accessed November 1, 2021. https://uaf.edu/ankn/indigenous-knowledge-syst/alaska-federation-of-nati/
6. National Science Foundation Interagency Arctic Research Policy Committee (IARPC). 2018. "Principles for Conducting Research in the Arctic." Accessed March 4, 2020. https://www.nsf.gov/geo/opp/arctic/conduct.jsp

Survey Plan and Implementation

STA and ADF&G met virtually in March 2022 to discuss the upcoming season and review the updated survey list. Division staff traveled to Sitka in April to participate in the annual update of weight conversion factors, the process for which is described in greater detail below. During this visit, STA and division staff reviewed the revised survey instrument for 2022. Surveys were administered by two STA staff who had experience administering these surveys during previous project years. 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 nearly all surveys (ADF&G staff administered one telephonically), and the majority were done telephonically.

Development of the Household Survey List

Prior to the start of the Pacific herring spawning season, STA staff update the previous year's survey list. Households that meet criteria for removal, which are outlined below (and provided in greater detail in Holen et al. [2011]), are removed from the survey list. After updating the 2021 survey list to remove 18 households, the initial 2022 list contained 51 households to be surveyed. Any new households planning to harvest that STA is aware of, usually through word-of-mouth, are added to the survey list prior to the season, but are not assigned a household identification (ID) number until they harvest eggs and are surveyed. Harvesting is a highly visible activity; therefore, it was assumed that active harvesters would be aware of other harvesters and new harvesters can be added to the survey list throughout the season.

Researchers have noted the declining number of households included in the survey universe. To ensure that researchers are reaching the majority of active harvesters, STA staff implemented a more formal and robust outreach effort in 2021 than had been attempted during previous project years. In 2022, STA posted announcements of spawning activity on the tribe's Facebook[7] page and asked harvesters to contact the tribe and respond to a short online survey concerning locations of herring sets. Through STA outreach efforts, coupled with word-of-mouth and chain referrals, there were 11 households added to the survey list for a total of 62 households. The household list was not limited to Sitka residents. Harvesting households from other communities, identified mainly through word-of-mouth and chain referrals, were also included.

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 will be re-assigned to the harvester.

The Survey Instrument

The primary method of data collection is the household survey. The survey instrument was designed to collect information about:

1. Whether respondents harvested, attempted to harvest, used, received, or gave away herring spawn.

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

2. The amount of herring spawn harvested.
3. The kind of substrate used.
4. Whether respondents harvested on their own or in collaboration with other households.
5. 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.
6. The location of respondents' harvests.
7. Survey respondents' qualitative assessments of the study year's herring spawn harvest.
8. Survey respondents' qualitative descriptions of their participation in the harvest.

The 2022 survey was similar to the 2021 survey. All questions from the 2021 survey were retained, but two question groups were modified. In 2021 and previous years, surveyors asked respondents, "How do you feel your harvest was compared to other years?" On the 2022 survey, this question was rephrased as, "In 2022, did you harvest less, same, or more herring eggs than in recent years?" The change in wording was intended to more directly elicit assessment responses of the study year in comparison to recent harvest years. The second modified question group concerned whether the respondent's needs for herring eggs were met. In 2021, respondents were asked if their household got enough herring eggs for their personal consumption and to share or exchange with others. In 2022, these questions were modified so that they concerned the previous year and a question was added to determine if the harvester knew of additional needs for herring eggs in the community. These modifications were made based on discussion among project staff, subsistence harvesters, and Board of Fisheries members. Because the survey is administered directly after the harvest, respondents may not be able to accurately answer if their needs were met for the year. A retrospective question concerning the previous year (2021) allows for a more realistic response. How harvesters define their needs may vary among respondents, especially when needs concern sharing. As Thornton (2019) found, harvesters make determinations about with whom and how much they share each year based on the harvest. While a harvester may feel his needs for sharing have been met because he has taken care of the priority recipient people and relationships, that does not inherently mean that there were not people wanting eggs with whom the harvester could not share. The needs of the herring egg-consuming population are not the same as the needs of the harvesters; while this survey effort cannot address the question of broader need among consumers of herring eggs, it can seek proxy information that speaks to that broader need. A copy of the 2022 instrument can be found in Appendix B.

Survey Implementation

Surveyors attempted to interview each of the 62 households on the survey list: 39 households were successfully interviewed (63%), two households chose to not participate in the survey, and 21 households were unable to be contacted. STA staff conducted the majority of the surveys in May 2022 after the herring spawn activity ended and all surveys were complete by June 2022. Completed surveys were sent to ADF&G for coding and analysis (see Appendix C for code book). For analysis, surveys were grouped into two strata: individual harvester or community harvest boat. The latter stratum 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 39 households interviewed. In 2022, STA resumed operation of its traditional foods boat after a hiatus in 2020 and 2021 due to the COVID-19 pandemic. 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 are not part of the skipper's household who take home any of the boat's harvest are not considered harvesting households but as receivers of herring spawn.

Update of the 2022 Conversion Factors

Prior to beginning the household survey effort, 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). On April 4 and April 5, STA staff processed 2,180 lb of their harvest of herring spawn on hemlock branches to create conversion factors. This was a portion of the total egg-on-branches harvest of the season for STA. The harvest was conducted by STA staff. Throughout the spawning period, STA staff set hemlock branches in Sitka Sound. The locations of the sets were determined by the harvesters based on active spawning conditions, their knowledge of herring spawn events, and past experience with the harvest.

Based on the plan devised by STA and ADF&G, the following steps were taken to measure weights in the field in 2022.

1. STA staff checked all herring sets and pulled those that were ready.
2. Once the boat returned to the harbor after pulling a set, STA staff offloaded the branches from the boat and into a pickup truck for transfer to the processing site located in front of the STA Resources Protection Department office. The method of processing spawn depended on how the final product was to be stored. For distribution in boxes or grocery bags, processors used pruning shears to remove the larger branches (usually anything larger than approximately one-half-inch in diameter) and the poorly covered branches. For storage in gallon-sized bags or vacuum-sealed bags, the more rigid branches were discarded, leaving only the pliable branches and needles that would not tear the bags.
3. The processed spawn was placed in containers identified by STA as common containers used to store, move, and ship herring spawn. The container types reflected the units harvesters might be familiar with and able to report on rather than having to estimate total pounds harvested for the survey. In 2022, containers used were 25 lb and 50 lb wetlock boxes—a type of waxed cardboard box commonly used for shipping seafood—as well as plastic zip-top gallon-sized bags.
    a. Each wetlock box from a herring set was placed in a plastic tote and weighed from a calibrated hanging scale. The gross weight of each tote was recorded by hand (weight of the plastic tote plus the weight of the wetlock box plus the weight of the spawn).
    b. Weights were taken for each box of processed spawn in order to understand variability between boxes. An average weight of each type of box was established.
4. A few wetlock boxes from each set were taken into the STA offices and further processed into gallon-sized zip-top plastic bags. Weights of filled bags were measured by a desktop digital scale and recorded by hand.
    a. During the processing, some of the plastic bags did not get filled to the 100% mark. These bags were included in the total weight calculations, but not included in mean bag weight calculations.

DATA ANALYSIS

ADF&G Information Management staff analyzed the data from the 2022 survey to produce estimates of the total harvest of herring spawn on all substrates. For 2022, 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 2022 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 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 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 27 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 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: 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:

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

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.

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 indicates 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 BOF rescheduled its Southeast meeting originally planned for Ketchikan in 2021 due to the COVID-19 pandemic and met instead in Anchorage in early March 2022. At the board meeting, division staff presented an overview of this collaborative harvest monitoring program and results from the 2021 season. Written copies of the 2021 report (Sill and Cunningham 2021b) were distributed to all board members and physical copies were available in the meeting room; the BOF also included the report with meeting documents posted online.[8] Additionally, division staff presented results of the 2021 study year at the meeting held by ADF&G to announce the beginning of the 2-hour notice period for the commercial sac roe herring fishery. The written report is reviewed within ADF&G as well as by the Southeast Alaska Herring Conservation Alliance and STA. The final report, once published, is available on the ADF&G website. Hard copies are distributed to STA.

8. Alaska Department of Fish and Game. 2022. "Alaska Board of Fisheries Meeting Information: Southeast and Yakutat Finfish and Shellfish, March 20 – 22, Meeting Documents, Additional Reports, The Subsistence Harvest of Pacific Herring Spawn in Sitka Sound, Alaska, 2021." Accessed January 2023. http://www.adfg.alaska.gov/index.cfm?adfg=fisheriesboard.meetinginfo&date=03-10-2022&meeting=anchorage

2. 2022 RESULTS

SAMPLE ACHIEVEMENT

As detailed in the methods, through STA's outreach efforts, 11 households were added to the survey list in 2022 compared to 2021, and 18 households were removed due to consecutive years of no participation, an inability for surveyors to contact the households, or deceased households. As a result, 62 households were identified as potential harvesters of herring spawn in 2022, compared to 69 in 2021 and 51 in 2020 (Sill and Cunningham 2021a:8; 2021b:10). Of these 62 households, 39 were interviewed (63%), including STA and four other community harvester boats (Table 1). More individual harvesters claimed tribal affiliation with the Sitka Tribe of Alaska (44%) than any other, but 38% claimed no tribal affiliation. All of the community harvester boats were affiliated with Southeast Alaska tribal organizations. Based on sampled households, an estimated 39 households attempted to harvest herring spawn in 2022 and 38 were able to do so (Table 2). 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).

HARVEST ESTIMATES

Households and community harvester boats harvested an estimated 135,231 lb of herring spawn on any substrate in Sitka Sound during 2022 (Table 2). Individual Sitka households, which composed the majority of the survey respondents, harvested 10% of the total harvest (Table 3). The remainder of the harvest was conducted by individuals or groups harvesting herring eggs from Sitka Sound for general distribution to a community, including Sitka, Kake, and Hoonah.

Among the community boats, 80% harvested herring spawn on hemlock branches and 40% harvested spawn on kelp. Among the individual households, 47% harvested spawn on branches, 41% harvested spawn on kelp, and 3% harvested spawn on hair seaweed (Table 3). By weight, the majority of the herring egg harvest was on hemlock branches (97%; 131,638 lb), with a small portion on kelp (3%; 3,589 lb), and an even smaller portion on hair seaweed (<1%; 3 lb) (Figure 1; Table 4).

Sharing of herring eggs continues to be an important aspect of the harvest. The majority (88%) of survey respondents who harvested herring eggs gave away some portion of their harvest (Table 2). Considering all of the herring eggs that were harvested on any substrate in 2022, only 4% of the harvest weight was kept for the harvesting household and the remainder was given away (Figure 2; Table 4). An estimated 47% of the total pounds harvested remained in Sitka, 47% was shipped outside of Sitka, and 2% was shared with households in unspecified locations. Table 4 presents greater detail on the harvest and sharing of herring eggs by substrate and by destination. Because of the overall larger amounts of herring spawn on branches harvested, that substrate composes the largest percentages of the estimated amounts kept for the harvesters' own use (90%), shared within Sitka (95%), or shipped outside of Sitka or to unspecified locations (100% of each). Approximately equal percentages of the herring spawn on hemlock branches were shared within Sitka and beyond Sitka (47% and 49%, respectively) with 3% retained for the harvesters' own use. In contrast, harvesters shared more of the spawn-on-kelp harvest with Sitka households (83%) than households outside of Sitka (3%) or kept for their own use (14%). The small harvest of spawn on hair seaweed was wholly kept for the harvester's personal use. Out of 22 harvesting households (including the community harvester boats) that indicated they usually harvest for other households, 41% indicated that they usually harvest for 2–5 households, 23% harvest for 6–10 households, 23% harvest for more than 100 households, 5% harvest for 11 to 50 households, and 5% harvest for 51 to 100 households (Table 5). In 2022, harvesters shared herring spawn with residents of at least the following communities: Anchorage, Angoon, Bethel, Hoonah, Hydaburg, Igiugig, Juneau, Kake, Ketchikan, Klawock, Kotzebue, Mountain Village, Nome, Petersburg, Saxman, Sitka, Toksook Bay, and Wrangell, as well as with communities in other states.

As follow-up to questions about harvest amounts, harvesting households were asked how their harvests compared to other years (a timeframe for comparison was not provided). Not all households responded to these follow-up questions. Approximately 46% of the 24 responding households thought that they harvested fewer herring eggs compared to other years, 29% reported harvesting the same amount, and 25% harvested more than other years (Table 6). Households that indicated a change in harvest (either more or less) were asked about the reasons for the change. Of the households that indicated harvesting more eggs, the main reason provided was that they were a new harvester (67%) followed by the reason that the household needed more eggs (33%) (Table 7). Households that harvested fewer eggs provided more reasons for why that was so. The most common response, by 27% of households that harvested fewer eggs, was that the weather was difficult. Six other reasons were provided by equal percentages of harvesters (18%): personal reasons, stolen sets, spawn was too far away, the availability of the resource was lacking, and it was too expensive to harvest (Table 8).

Harvesting households were asked if they got enough herring spawn in 2021 for themselves as well as to share with others. Compared to other survey questions, this question asked specifically about the prior year because harvesters do not always know whether or not they had enough eggs when these surveys are asked so close to the end of the harvesting period. A retrospective look at the previous year allows a fuller picture of whether needs were met. 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 individuals; in better harvest years, more will be shared and with more people. For 2021, 90% of the 20 responding households reported that they got enough for themselves and 79% of 19 responding households said they had enough to share with others (Table 9). Harvesters were also asked if in 2021 they were asked for eggs by other households that they could not supply. Most households responded in the negative (76% of 21 responding households) but nearly one-quarter of harvesters said they experienced the inability to provide eggs when asked (Table 10).

Not all potential harvesters contacted for this survey attempted to harvest herring eggs in 2022 (Figure 3). Of the 14 households contacted that reported that they did not attempt to harvest eggs in 2022, the most common reason given was the household lacked transportation, meaning either access to a working vessel, or that fuel costs were too great (43%). Following that, potential harvesters were working during the harvest (29%) or were out of town (21%).

Several more questions on the survey were included in order to understand certain characteristics of the harvest effort and to contextualize harvester activity. In many years, transportation issues—e.g., a lack of transportation, challenges in affording equipment repairs or fuel, or weather/distance concerns—factor into potential harvesters' decision making for whether or not to participate in the fishery and how they will participate. Survey respondents were asked the size of the vessel used during the fishery and whether they harvested with others. The latter question was asked to quantify how many households employ that strategy to share the costs of fuel, maintenance, and time. The question about the size of the vessel used provides information about potential limitations a harvester may have in terms of where to go, and how many sets can be put out and the size of the set, among other considerations. In 2022, a majority of responding harvesters (54%) used a vessel less than 20 feet in length, 33% used a vessel between 20 and 24 feet, and 21% used a commercial vessel (Table 11). In 2022, 71% of responding households harvested with other families (Table 12).

Table 1.–Sampling characteristics for herring spawn harvester survey, Sitka Sound, 2022.

Sampling characteristics	Individual households	Community harvester boats
Herring spawn harvesting households		
Surveyed	34	5
Total	55	7
Sampling fraction	61.8%	71.4%
Population of herring spawn harvesting households		
Surveyed	109	n/a
Estimated total	176.8	n/a
Average household size	3.2	n/a
Tribal affiliation of sampled households[a]		
Sitka Tribe		
Number	15	2
Percentage	44.1%	40.0%
Other Southeast		
Number	4	3
Percentage	11.8%	60.0%
Other Alaska		
Number	1	0
Percentage	2.9%	0.0%
None		
Number	13	0
Percentage	38.2%	0.0%
Missing		
Number	5	0
Percentage	14.7%	0.0%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Note n/a = no population data available because harvester boats are not a household and represent a community.

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

Table 2.–Estimated subsistence harvest of herring spawn, Sitka Sound, 1983, 1987, 1996, 2002–2022.

		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 (±) harvest	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 21 years, the data pertain to only those 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%	84,913	129,333
2016	64	40.4%	37.2%	74.8%	0.0%	38	35	84,554	41%	64,850	119,079
2017	36	60.6%	49.8%	73.7%	0.0%	53	44	65,691	25%	52,348	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

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Table 2.–Page 2 of 2.

		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 (±) harvest	Range: low[b]	Range: high
2020	15	71.8%	63.1%	72.7%	41.0%	11	9	21,926	307%	8,051	89,128
2021	55	71.7%	69.9%	100.0%	12.4%	49	48	46,950	33%	35,856	58,045
2022	39	63.8%	61.2%	87.5%	20.8%	39	38	135,231	81%	95,282	244,768

Sources Sitka Tribe of Alaska household surveys, as summarized in Gmelch and Gmelch (1985) and Schroeder and Kookesh (1990); CSIS; Brock and Turek (2007); Holen et al. (2011); Sill and Lemons (2012; 2014a; 2014b; 2015; 2017; 2020; 2021); and Sill and Cunningham (2017; 2019; 2021a; 2021b); and Sitka Tribe of Alaska and Division of Subsistence, household surveys, 2022.

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

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.

Table 3.–Estimated subsistence harvest of herring spawn by type of harvester, Sitka Sound, 2022.

Resource	Estimated percentage of potential participant households		Estimated pounds harvested	Confidence interval (CI)		
	Attempted	Harvested	Total[b]	CI %	Low[c]	High[d]
Individual households[a]						
Herring spawn on hemlock branches		47.1%	12,938	67%	7,998	21,636
Herring spawn on kelp		41.2%	705	69%	436	1,192
Herring spawn on hair seaweed		2.9%	3	203%	2	10
Subtotal, herring spawn, all types	*61.8%*	*58.8%*	*13,646*	*66%*	*8,436*	*22,653*
Community harvester boats[a]						
Herring spawn on hemlock branches		80.0%	118,700	124%	84,786	265,889
Herring spawn on kelp		40.0%	2,884	202%	2,060	8,710
Herring spawn on hair seaweed		0.0%	0	n/a	n/a	n/a
Subtotal, herring spawn, all types	*80.0%*	*80.0%*	*121,584*	*122%*	*86,846*	*269,917*
Total[b]	**63.8%**	**61.2%**	**135,231**	**81%**	**95,282**	**244,768**

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Note Blank cells indicate that the survey did not ask which type of substrate was used during attempted harvest.

Note n/a = no CI value is available because there was no reported harvest.

a. Participation characteristics are based on the total number of surveyed households by type of harvester: for individual households n=34, and for community harvester boats n=5.

b. Based on the total number of surveyed households (n=39; community harvester boats are each treated as an individual household for the purpose of this analysis.)

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

d. Each CI value, including for the subtotal and total rows, is the high range amount for each specific type of harvester and substrate combination.

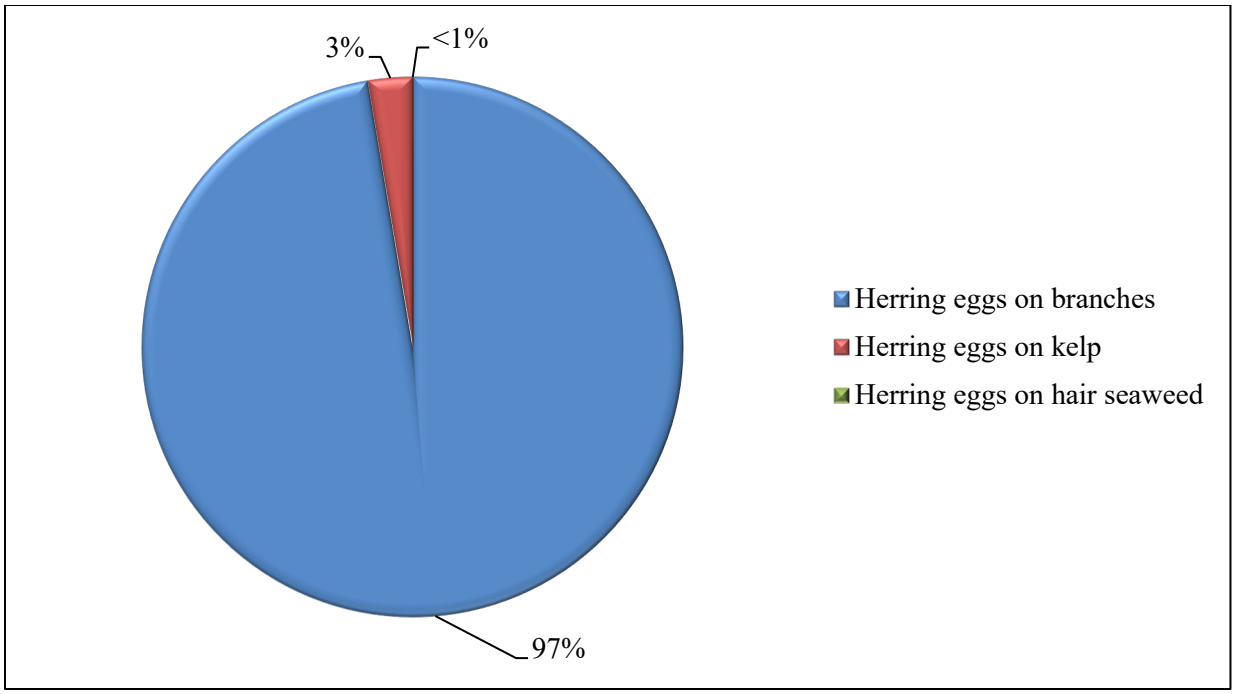


Figure 1.–Distribution of subsistence herring spawn harvest by substrate, Sitka Sound, 2022.

Table 4.–Distribution of subsistence herring spawn harvest, Sitka Sound, 2022.

Resource	Pounds	Percentage of substrate harvest	Percentage of kept harvest	Percentage of total harvest
	Estimated harvest: *Kept for own use*			
Herring spawn on hemlock branches	4,375	3.3%	89.6%	3.2%
Herring spawn on kelp	506	14.1%	10.4%	0.4%
Herring spawn on hair seaweed	3	100.0%	0.1%	0.0%
Herring spawn, all types	*4,884*		*100.0%*	*3.6%*
	Shared within Sitka			
	Pounds	Percentage of substrate harvest	Percentage of Sitka shared harvest	Percentage of total harvest
Herring spawn on hemlock branches	61,188	46.5%	95.3%	45.2%
Herring spawn on kelp	2,991	83.3%	4.7%	2.2%
Herring spawn on hair seaweed	0	0.0%	0.0%	0.0%
Herring spawn, all types	*64,179*		*100.0%*	*47.5%*
	Shared outside of Sitka			
	Pounds	Percentage of substrate harvest	Percentage of harvest outside Sitka	Percentage of total harvest
Herring spawn on hemlock branches	63,973	48.6%	99.9%	47.3%
Herring spawn on kelp	93	2.6%	0.1%	0.1%
Herring spawn on hair seaweed	0	0.0%	0.0%	0.0%
Herring spawn, all types	*64,065*		*100.0%*	*47.4%*
	Shared unspecified location			
	Pounds	Percentage of substrate harvest	Percentage of harvest unspecified location	Percentage of total harvest
Herring spawn on hemlock branches	2,103	1.6%	100.0%	1.6%
Herring spawn on kelp	0	0.0%	0.0%	0.0%
Herring spawn on hair seaweed	0	0.0%	0.0%	0.0%
Herring spawn, all types	*2,103*		*100.0%*	*1.6%*
	Total			
	Pounds	Percentage of substrate harvest	Total percentage kept/ shared[a]	Percentage of total harvest
Herring spawn on hemlock branches	131,638	100.0%	3.3%/96.7%	97.3%
Herring spawn on kelp	3,589	100.0%	14.1%/85.9%	2.7%
Herring spawn on hair seaweed	3	100.0%	100.0%/0.0%	0.0%
Herring spawn, all types	**135,231**	**100.0%**	**3.6%/96.4%**	**100.0%**

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

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.

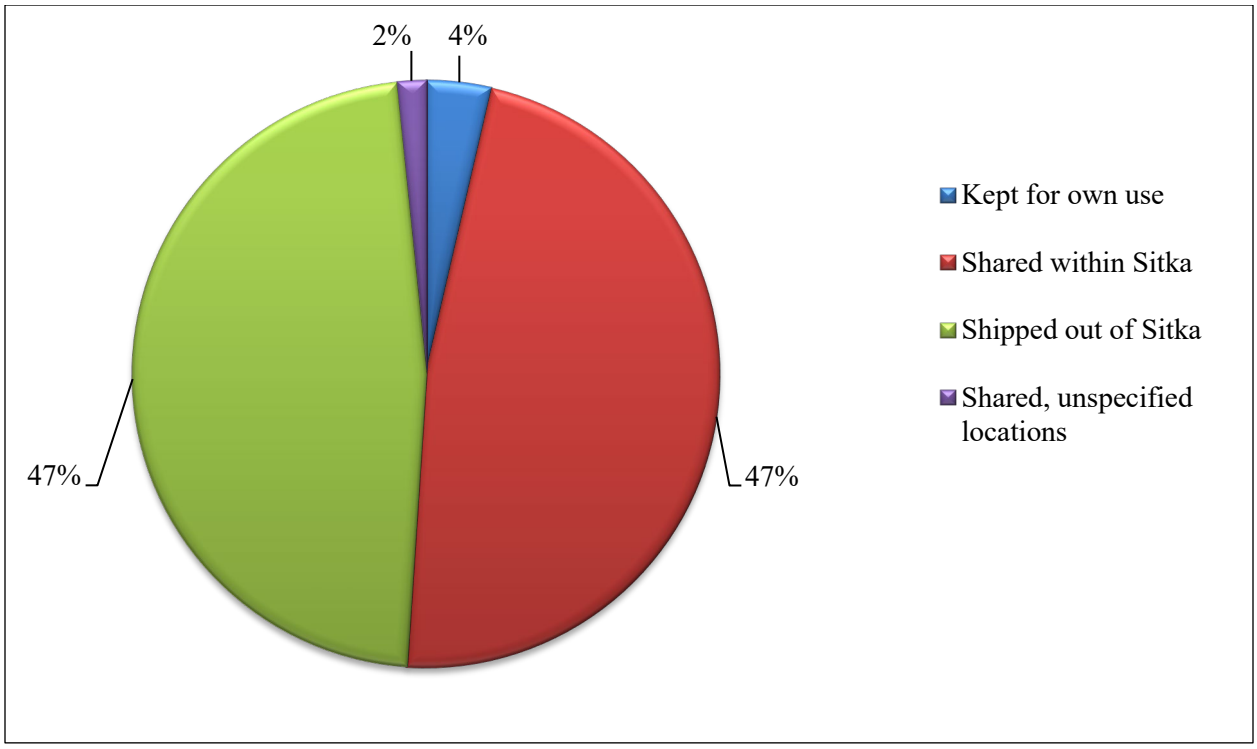


Figure 2.–Percentage of total subsistence-harvested herring spawn that was shared, Sitka Sound, 2022.

Table 5.–Percentage of responding households that usually harvest for other households, Sitka Sound, 2022.

Number of households responding	Number of households for which harvesters usually harvest					
	1	2–5	6–10	11–50	51–100	More than 100
22	0.0%	40.9%	22.7%	4.5%	4.5%	22.7%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Table 6.–Harvesting households' perception of herring spawn harvest compared to recent years, Sitka Sound, 2022.

Number of households responding	Harvest amount assessment		
	Less	Same	More
24	45.8%	29.2%	25.0%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Table 7.–Reported reasons for why household harvests were more than in other years, Sitka Sound, 2022.

Number of households responding	Reported reasons	
	New harvester	Needed more
6	66.7%	33.3%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Note Percentages may not add to 100%. Households may provide more than one response.

Table 8.–Reported reasons for why household harvests were less than in other years, Sitka Sound, 2022.

Number of households responding	Reported reasons								
	Personal reasons	Stolen sets	Other	Too far	Equipment issues	Availability of resource	Location	Weather	Too expensive
11	18.2%	18.2%	18.2%	18.2%	9.1%	18.2%	9.1%	27.3%	18.2%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Note Percentages may not add to 100%. Households may provide more than one response.

Table 9.–Harvesting households' description of whether they got enough herring spawn to meet their households' needs and their sharing needs, Sitka Sound, 2021.

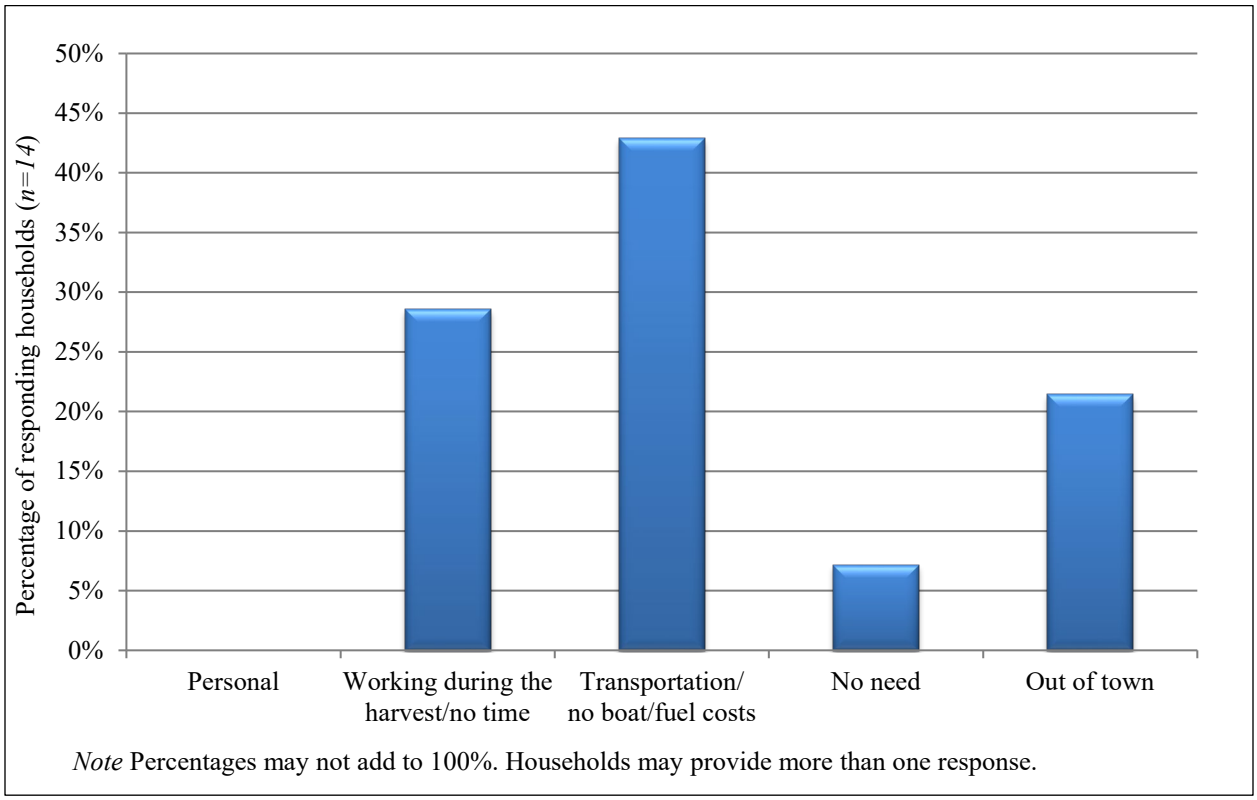
Households got enough herring spawn (____).	Yes	No
For own household *(n=20)*	90.0%	10.0%
To share *(n=19)*	78.9%	21.1%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Table 10.–Harvesting households that were asked to share eggs but they could not share, Sitka Sound, 2021.

Number of households responding	Respondents could not fulfill requests for herring spawn	
	Yes	No
21	23.8%	76.2%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.



Note Percentages may not add to 100%. Households may provide more than one response.

Figure 3.–Reported reasons households did not attempt to harvest herring spawn, Sitka Sound, 2022.

Table 11.–Size of vessel used to harvest herring spawn, Sitka Sound, 2022.

Number of households responding	Reported vessel size					
	Less than 20 feet	20–24 feet	More than 24 feet	Commercial vessel	Other	No boat used (harvested from shore)
24	54.2%	33.3%	4.2%	20.8%	0.0%	0.0%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Note Percentages may not add to 100%. Households may provide more than one response.

Table 12.–Percentage of responding households harvesting with other households, Sitka Sound, 2022.

Number of households responding	Respondents harvested with other households	
	Yes	No
24	70.8%	29.2%

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

Conversion Factors

During survey administration, surveyors ask respondents to estimate the processed weight of their harvests. Project staff assumed 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, where a gallon of water equals approximately 8 lb. Beginning in 2010, project staff developed a more rigorous method for gauging harvest weights based on weighing a portion of STA'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 13 presents the conversion factors for 2010 through 2022. STA was unable to weigh the harvest in 2020 because of logistics complications caused by the COVID-19 pandemic, so the previous 5-year average of conversion factors was used. 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 zip-top 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 13.–Conversion factors for 2010–2022.

	Estimated average weight (pounds)							
	2022	2021	2020[a]	2019	2018	2017	2016	2015
Container type, spawn on branches								
Large (50 lb) wetlock box	51.5	50.4	54.5	53.9	57.1	51.9	55.5	54.0
Small (25 lb) wetlock box	25.2	26.9	25.5	28.0	24.1	24.8	25.2	25.6
Zip-top gallon bag	3.7	3.5	3.7	3.5	4.0	4.2	3.4	3.7
Zip-top quart bag	n/a	1.4	n/a	n/a	1.5	1.4	1.1	n/a
Container type, spawn on kelp								
Zip-top gallon bag	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5-lb bucket	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Small (25 lb) wetlock box	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

-continued-

	Estimated average weight (pounds)				
	2014	2013	2012	2011	2010
Container type, spawn on branches					
Large (50 lb) wetlock box	48.9	53.0	59.1	53.3	57.8
Small (25 lb) wetlock box	24.7	22.8	28.5	24.9	25.5
Zip-top gallon bag	4.1	3.9	4.4	3.9	4.1
Zip-top quart bag	n/a	1.4	1.4	1.5	1.4
Container type, spawn on kelp					
Zip-top gallon bag	n/a	n/a	3.7	n/a	n/a
5-lb bucket	n/a	n/a	23.9	n/a	n/a
Small (25 lb) wetlock box	n/a	16.7	n/a	n/a	n/a

Sources Holen et al. (2011); Sill and Lemons (2012; 2014a; 2014b; 2015; 2017; 2020; 2021); and Sill and Cunningham (2017; 2019; 2021a; 2021b); and Sitka Tribe of Alaska and Division of Subsistence, household surveys, 2022.

Note n/a = 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.

HARVEST LOCATIONS

The final project objective was to document where the herring spawn harvest took place. Table 14 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 2022, surveyed households used multiple harvesting locations spread throughout the areas of Sitka Sound that have historically been used for the subsistence harvest of herring spawn (referred to as the "core" area) and into the northern portion of Sitka Sound. Eleven households traveled to Crow/Gagarin islands, 10 went to the Eastern/Promisla bays area, and nine traveled to the Kasiana Islands Group. Five or fewer households harvested from South Middle Island, North Middle Island, the Magoun Islands/Hayward Strait area, the northern end of Halibut Point Road and the Apple Islands/Parker group area (Table 14). The highest reported harvest came from the Kasiana Islands Group, followed by South Middle Island and the Magoun Islands/Hayward Strait area, but this may be more a consequence of harvesters not providing harvest amounts by location than an actual indication of how productive an area was.

Table 14.–Reported locations of subsistence herring spawn sets and harvest, Sitka Sound, 2022.

Location	Reported households using each location	Percentage of reporting households using each location[a]	Reported pounds harvested at each location
Crow/Gagarin islands	11	23.4%	678
Eastern/Promisla bays	10	21.3%	609
Kasiana Islands Group	9	19.1%	21,045
South Middle Island	5	10.6%	1,427
North Middle Island	4	8.5%	243
Other	4	8.5%	153
Magoun Islands/Hayward Strait	2	4.3%	1,327
North Halibut Point Road	1	2.1%	0
Apple Islands/Parker Group	1	2.1%	0

Source Sitka Tribe of Alaska and ADF&G Division of Subsistence, household surveys, 2022.

a. Percentages are based on the total number of locations reported by 23 harvesting households.

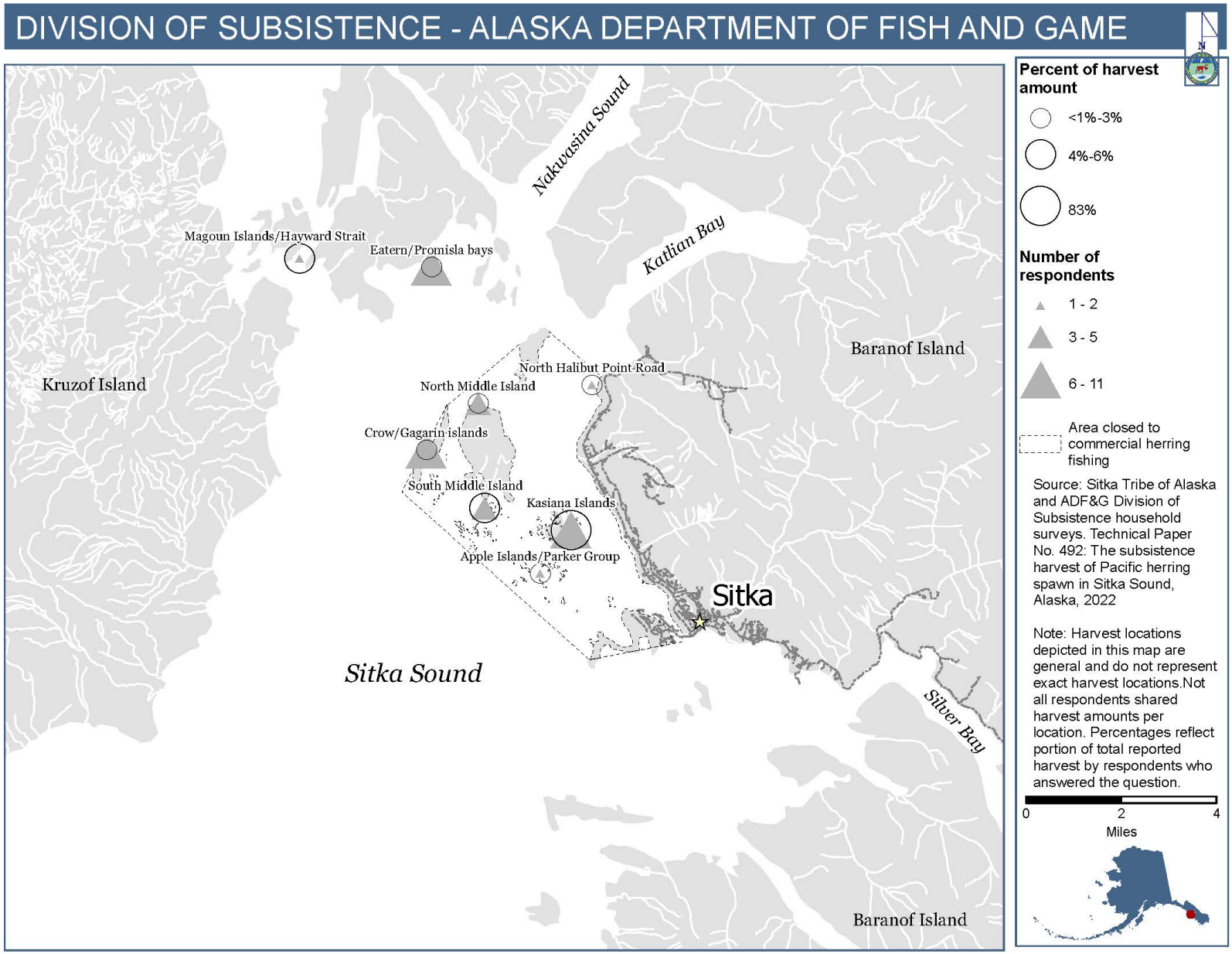


Figure 4.–Reported harvest locations and percent of harvest weight per location of herring spawn for subsistence use, Sitka Sound area, 2022.

3. DISCUSSION

OVERVIEW OF 2022 STUDY YEAR

Subsistence herring egg fishing in 2022 appeared to continue a return to harvesting patterns seen before the harvest disruptions caused by the COVID-19 pandemic that started in 2020. Households harvested together, community boats returned to the community to harvest, and herring eggs were shared far and wide. Compared to recent previous years, the estimated harvest was higher, nearly meeting the lower end of the ANS range—something that has not occurred since 2014 (Figure 5). Several circumstances in 2022 were different than in previous years and will be discussed below, including poor weather, a diesel spill at the beginning of the season, new harvesters, and a planned *koo.eex'* (or potlatch) occurring in the community.

After several years of a decreasing sample, staff recognized in 2021 the need to ensure that the survey sample was robust. As such, STA engaged in outreach activities to increase knowledge of the household survey effort in the community and among tribal members and to encourage participation in the survey by all harvesters. The result of these efforts was 21 new households added to the survey list and a high (80%) survey achievement (Sill and Cunningham 2021b). In 2022, less effort was spent on outreach methods, but 11 new households were added to the survey list. Sample achievement declined to 63% in 2022, highlighting the continued importance of active outreach about the importance of the survey. More households were removed from the sample at the beginning of the 2022 season than were added to the sample; households were removed due to harvest inactivity, persistent unavailability, or because households told surveyors they would no longer be harvesting. The prevalence of households that cannot be contacted due to nonexistent or outdated contact information raises a concern that active harvesters may be getting missed; however, it is unlikely that missed harvesters would be large-scale harvesters because, as stated before, herring harvesting is a highly visible activity. The result of missing harvesters due to contact inability likely has a small effect on the estimated harvest total, but may contribute to an underestimation of harvest effort, as measured in number of harvesters.

2022 HARVEST YEAR CHARACTERISTICS

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. Most harvesters share the majority 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 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 2022 harvest shared most of these characteristics. To further contextualize 2022 patterns, the remainder of this section includes summaries or comparisons to previous harvest estimates and spawning event assessments presented in earlier reports (Brock and Turek 2007; Gmelch and Gmelch 1985; Holen et al. 2011; Schroeder and Kookesh 1990; Sill and Cunningham 2017; 2019; 2021a; 2021b; Sill and Lemons 2012; 2014a; 2014b; 2015; 2017; 2020; 2021).

Sharing of Herring Spawn

Sharing resources is an integral characteristic of subsistence economies. In specialized harvests, such as of herring eggs, where specific knowledge and skills and equipment 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 prevalent within subsistence-based communities where a portion of the population has 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. This is true of herring eggs in the community of Sitka, where an estimated 32% of households used herring eggs in 2013 but only 8% harvested them (Sill and Koster 2017a). Because

Sitka remains one of the best places to harvest herring eggs, harvesters send eggs well beyond Sitka households, reaching far throughout the state of Alaska.

In 2022, 88% of the surveyed households shared some of their harvest and the majority (96%) of the total harvest was shared, either with other Sitka households or with non-local households (Table 2; Figure 2). Because this project specifically targets only potential herring harvesters, inferences about overall use and sharing of herring eggs cannot be made from these results. However, comprehensive household surveys in Sitka and elsewhere have shown that households share received resources in addition to resources they themselves harvested, and 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; 2017b; see further discussion to follow in section "Changes in Use of Herring Spawn"). 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 through the results of a barter-and-trade module that was added to the ADF&G–STA household subsistence herring harvest monitoring survey for 2018. The module included questions about whether the herring harvester shares, barters, or trades herring eggs, and, if so, collected information about the nature of relationships with recipients and where they live, if and how recipients contribute to the production of herring eggs, items that are exchanged, and how the quality of the herring egg harvest affects sharing and trade. The distribution network Thornton describes is extensive and resilient, consistently moving thousands of pounds of herring eggs to dozens of communities and thousands of recipients. He documented multiple types of exchange, including generalized reciprocity, balanced reciprocity, and customary trade for small amounts of cash. He also documented the prevalence of individuals establishing themselves as part of the production unit for herring eggs, providing labor, materials, storage capacity, or cash. The distribution of herring eggs touches every Alaska Native community in Southeast Alaska, and many Native and non-Native communities beyond the region. Primary distribution of herring eggs has reached at least 41 communities, and secondary sharing likely reaches at least 8–15 additional communities. Estimating the number of people receiving eggs is difficult because of this secondary sharing, but Thornton believes distribution chains may reach thousands of people. Numerous of Thornton's interviewees suggested they would like to have more eggs if they could.

Reviewing past project years, it is clear that the majority of the harvest is shared every year, regardless of the overall magnitude of the harvest is for the year, how many community boats are harvesting, or how many participants there are in the fishery. Since 2010, the percentage of the harvest that has been kept for the harvester's own use has ranged from 3% (in 2016) to 10% (in 2013). There is greater variability in where the harvest is shared: from 28% (2019) to 71% (2012) has been shared within Sitka and from 22% (2012) to 63% (2019) has been shared outside of Sitka. Through the survey, more than 40 communities have been documented as recipients of herring eggs. Because not every harvester is surveyed every year, and not all harvesters choose to share this information with the surveyors, these 40 communities are a minimum; this breadth of sharing speaks to the importance of Sitka as a source of herring eggs for the entire state.

To further investigate the role of sharing in herring egg harvest patterns, survey respondents have been asked, since 2007, some version of a question about whether their need for herring eggs was met. Originally, harvesters were only asked if their needs were met for the year; after review of the responses and further discussions among project staff, the question was changed in 2019 to a two-part question asking about whether the harvester's need for eggs for themselves and their need for eggs to share were met during the study year. In 2022, discussions among project staff and harvesters led to additional changes. The first change was the addition of a third sub-question to ask if harvesters were asked for eggs that they could not provide. While similar to the question about harvester needs for eggs to share, harvesters may not consider providing eggs to everyone who asks as part of how they define "need." Many harvesters have a set of recipients with whom they share eggs that constitute their "need" for eggs, and if the harvest is productive, they may share with more people, but not being able to share with those people does not mean the

harvester's needs were not met. This additional question tried to ascertain community need outside of harvesters' own social obligations. The second change to the question was to ask about the previous calendar year, rather than the current harvest year. The surveys are conducted shortly after the harvest concludes and harvesters may not yet be aware of unmet needs they would be asked to fulfill. Asking harvesters to think back on the previous year removes that temporal obstacle. Although it is too early to fully evaluate these changes, the initial assessment is positive. A few respondents indicated that they could not fulfill requests for eggs that were made well after the spawning season was over; without the changes made to the survey, this relevant information would not have been captured. One caveat to this series of questions is that how needs are defined is subjective and can vary among households and between years. In 2022, 90% of harvesters fulfilled their own household's needs and 79% fulfilled their sharing needs (Table 9). Compared to the prior three years, 2022 is the first year in which more households met their own needs than met their needs for sharing. It is also the only year when the harvest began to approach previous years' levels. Thornton (2019:109–110) has shown that in years with higher harvest levels, sharing patterns often expand so that more is shared with more people, which may be why some households felt their needs for sharing were not met. Additionally, 24% of households were asked for eggs that they could not supply, which could also contribute to a perception that their sharing needs were not met (Table 10).

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 have been commercial boats that were 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. In most years since 2010, the community harvester boats have been responsible for more than one-half of the total pounds of harvest estimated. In both 2020 and 2021, the harvest by individuals composed a greater proportion of the total harvest than community harvester boats, but the 2022 harvest was more similar to past patterns with community boats harvesting well more than one-half of the total harvest weight. Because of the COVID-19 pandemic during 2020, community boats did not travel to Sitka to harvest. In 2021, there were at least an equal number of community boats harvesting as in 2022, but these boats were able to harvest much larger amounts in 2022.

Harvest Participation and Success

Compared to the most recent 10-year average of 41 participants, there were fewer harvesters in Sitka Sound in 2022, but more than the previous five-year average of 31 participants (Table 15). In 2022, the total estimated harvest from Sitka Sound was substantially more than in recent years, more than tripling the five-year average harvest and exceeding the 10-year average harvest. While not among the historically higher harvests, the 2022 estimate is in line with the historical average harvest.

Creating a traditional catch per unit effort (CPUE) metric is challenging for this fishery because of the variability in what constitutes a unit of effort (e.g., whether branches or trees are used, the size of tree or branch, the number used in a set). A similar, but less informative, metric is the harvest per fishery participant, but this metric does not account for the variability in effort among harvesters and as such it cannot provide a complete picture of inter-annual variability within the subsistence herring spawn fishery. In terms of harvest weight per harvester, the 2022 estimate far exceeded all past averages.

It is possible that the survey failed to capture some of the newer or smaller-scale harvesters who were captured during the 2021 survey, or it is possible that long-standing harvesters harvested more herring eggs because of resource availability, location of the spawning activity, increased effort, or recognized need. For example, a koo.éex' was held in 2022 for which harvesters needed to harvest herring eggs for distribution. Coming out of the pandemic years, there could have been greater demand for eggs or a greater desire to reconnect and share eggs with people. Changes in the harvest amounts of the community-based boats was also a driver, since together those boats harvested substantially more eggs than in 2020 or 2021. Without additional analysis into individual harvesting patterns over time, more in-depth discussion with harvesters than what occurs during the standard survey is necessary to contextualize this finding.

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. The pandemic year of 2020 drastically reduced the percentage of households harvesting together: 92% of responding households (n=12) in 2019, but in 2020 only 43% (of 7 responding households) did (Sill and Cunningham 2021a; Sill and Lemons 2021). By 2021, 74% of responding households (n=38) indicated that they harvested with at least one other household, which is similar to 71% of responding households (n=24) that harvested with others in 2022 (Sill and Cunningham 2021b; Table 12). In most years since 2010, 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. From 2017 through 2021, working during the period of spawning activity was not provided as a main reason; from 2017 through 2019 resource availability or the distance to the spawn were among the top reasons and in 2020 the pandemic was the main reason. In 2021, the most common reason given was that the household did not have a need for eggs because the household got eggs from someone else. For 2022, the most common reason households did not harvest was the cost of fuel or otherwise lacking transportation, followed by working or no time to harvest (Figure 3). Fuel prices rose rapidly through the end of 2021 and much of 2022. In March 2022, marine fuel cost $3.69/gallon, compared to $2.44/gallon in March 2021. By April 2022, prices rose to $4.32/gallon.[1]

Among the many factors harvesters must consider, where the herring are spawning is an important one. Compared to recent years, herring spawned for more consecutive days closer to town and in what would be considered the core area for harvest, as well as through northern stretches of the sound. These more accessible locations likely contributed to the highest harvest estimated in several years. The proximity of quality harvestable spawn to Sitka was likely even more important during the 2022 harvest because of the poor weather conditions experienced in the middle of the spawn. On April 4, the peak[2] of herring spawning activity in 2022, researchers noted that the National Oceanic and Atmospheric Administration (NOAA) issued a small craft advisory warning of high winds and seas up to 7 feet. Adverse weather conditions make boating riskier, especially in relatively open water and in a vessel burdened with a full load of herring branches. As noted above, slightly more than one-half of harvesters in 2022 used a skiff shorter than 20 feet in length. In addition, such weather conditions can ruin sets by pushing them up onto the beach or stirring up sand from the ocean floor that mixes into the set. The community harvester boat from STA experienced damage to some sets in 2022 because of these weather conditions. One event of note in 2022 was a diesel spill that occurred in Neva Strait on March 21, 2022, when the tug *Western Mariner* ran aground. Although the spill was contained and oil sheens were not seen near spawning herring, some harvesters still expressed concern about food safety and potential effects to their harvest. The Alaska Department of Environmental Conservation issued a seafood safety advisory on March 26, 2022, encouraging people not to harvest herring eggs from Neva Strait or St. John Baptist Bay.[3]

Nearly one-half of responding harvesting households said that their harvest was poorer in 2022 than in recent years (note that the survey form did not define a timeframe for "recent"), with about equal percentages saying it was the same or more (Table 6). For those households that harvested less in 2022, weather was the most common reason given, suggesting that the adverse weather conditions discussed

1. EFIN Monthly Marine Fuel Prices, s.v. "[Table of Contents] Data; [Fuel Survey Data, States Sampled, Alaska, Download Data] MS Excel Format" (by Fisheries Economics Data Program). Accessed January 2023. https://www.psmfc.org/efin/data/fuel.html#FUEL_AK
2. Alaska Department of Fish and Game Division of Commercial Fisheries, "Advisory Announcement, May 5, 2022: Sitka Sound Herring Fishery Summary," Accessed December 22, 2022. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1370633863.pdf
3. Staff from federal and state agencies are conducting a preliminary Natural Resource Damage Assessment to determine if impacts to fish, wildlife, their habitats, and the human uses of these natural resources have occurred and if it is appropriate to proceed with restoration planning. As part of this process, samples of mussels and bivalves were taken and analyzed for several petroleum hydrocarbons. Results of these samples and information on the NRDS can be found online: https://dec.alaska.gov/spar/ppr/spill-information/response/2022/01-tug-western-mariner-grounding/#gsc.tab=0

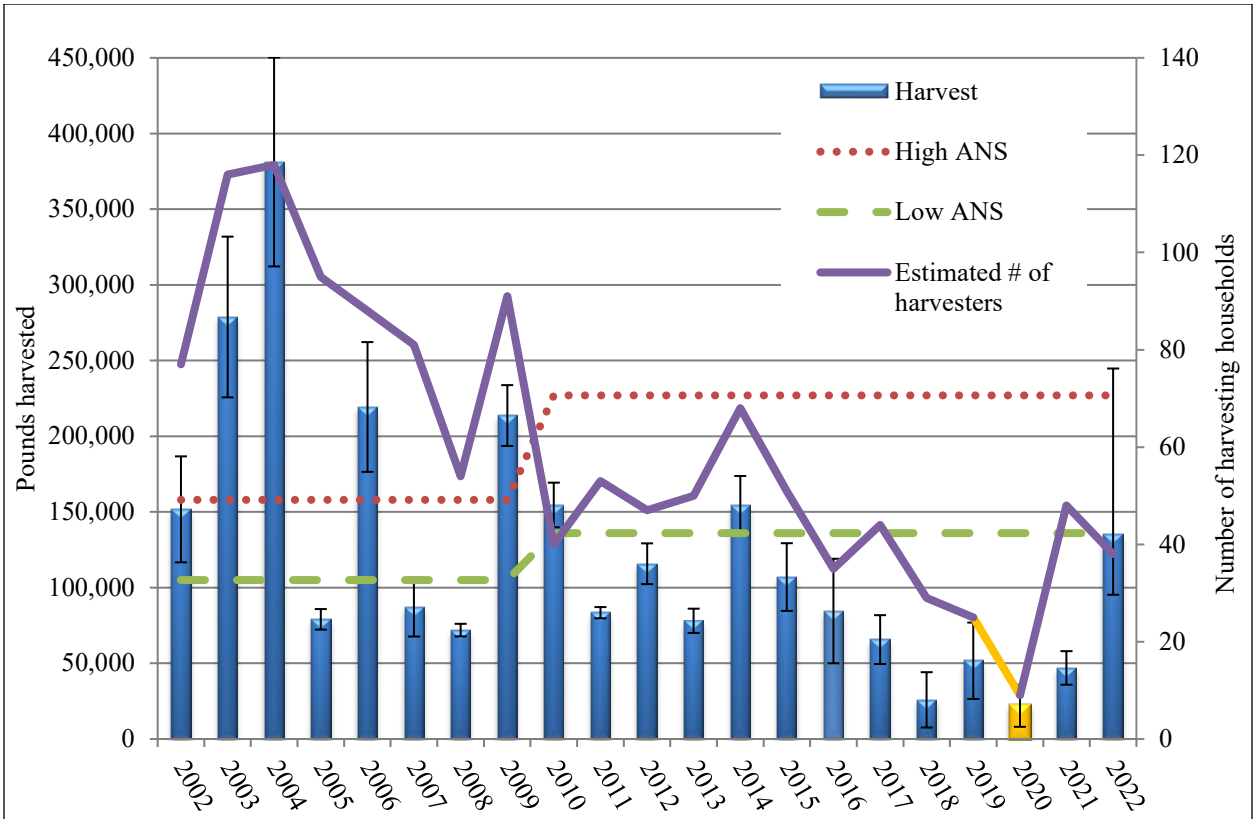
above hampered some harvesters' efforts (Table 8). For households that harvested more than recent years, reasons provided were either that the household was new to harvesting or that the household needed more (Table 7). Despite a near-majority of harvesters feeling that their harvest was less than in recent years, the overall community harvest was much higher than previous years, and the harvest amount per harvester was also much higher (Table 15). To reconcile these circumstances, it may be necessary to consider that the aggregate response to a survey can obscure important differences among harvesters. Without doing a household-level analysis of changes over time, it is difficult to assess these differences; however, it is possible that households responding that their harvest was worse than in previous years were relatively small-scale harvesters, while the high-harvesting community boats may have been more likely to have said their harvest was more, and they accounted for much of the increase in the overall community harvest.

Table 15.–Estimated subsistence herring spawn harvests and number of harvesting households, Sitka Sound, 2002–2022.

Year	Estimated number of households harvesting[a]	Estimated harvest, all substrates, in pounds	Pounds per harvester
2002	77	151,717	1,970
2003	116	278,799	2,403
2004	118	381,226	3,231
2005	95	79,064	832
2006	88	219,356	2,493
2007	81	87,211	1,077
2008	54	71,936	1,332
2009	91	213,712	2,348
2010	40	154,620	3,866
2011	53	83,443	1,574
2012	47	115,799	2,464
2013	50	78,090	1,562
2014	68	154,412	2,283
2015	51	106,998	2,101
2016	35	84,554	2,441
2017	44	65,691	1,493
2018	29	25,862	906
2019	25	51,687	2,067
2020	9	21,926	2,315
2021	48	46,950	973
2022	38	135,231	3,559
5-year average (2017–2021)	31	42,423	1,366
10-year average (2012–2021)	41	75,197	1,855
Historical average (2002–2021)	61	123,653	2,030

Sources Brock and Turek (2007); Holen et al. (2011); Sill and Lemons (2012; 2014a; 2014b; 2015; 2017; 2020; 2021); and Sill and Cunningham (2017; 2019; 2021a; 2021b); and Sitka Tribe of Alaska and Division of Subsistence, household surveys, 2022.

a. The number includes community harvester boats, which are treated as an individual household for the purposes of this analysis.



Note The line and bar depicting change in "estimated number of harvesters" between 2019 and 2020 and the 2020 harvest are yellow because the 2020 harvest year was affected by the COVID-19 pandemic.

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, 2002–2022.

Delving further into the harvest success of any given year, there does not appear to be a correlation between the amount of mature herring biomass returning to the sound and resulting harvest amounts (Figure 6). Some years with increased biomass estimates[4] 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. 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 that affect participation in the subsistence fishery, like sufficient time, resources, knowledge, and skills to engage in harvesting activities. Ecological opportunity factors center on the quality of the eggs, which is influenced by timing, duration, location, and weather. 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.

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).

4. Sara Miller, ADF&G Biometrician 3, personal communication, email, December 22, 2022.

Shewmake (2013) found that mean consecutive spawning days in subsistence use areas of Sitka Sound can be a reasonably good predictor of harvest success (see also Sill and Lemons [2014a] for 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.[5] Using the daily aerial mapped spawn coverage from the Division of Commercial Fisheries, the Division of Subsistence created a map[6] showing numbers of days of spawn activity throughout Sitka Sound (Figure 7). In 2022, ADF&G flew aerial surveys between March 8 and April 28 to document herring spawning activity. Between March 27 and April 28, a total of 91.5 nautical miles of spawn were recorded by ADF&G, which is higher than the 40-year average (1982–2021) of 60.2 nautical miles. Compared to recent years, in 2022 more days of multiple spawn deposition occurred in more locations within the subsistence core area, especially around Middle Island, Crow Pass, and the Kasiana Islands Group. The majority of the northern part of Sitka Sound, from Hayward Strait to the Siginaka Islands, received multiple spawn deposition days. According to herring egg deposition surveys[7] by ADF&G, egg deposition was very high throughout much of the survey area, particularly around Middle/Crow/Kasiana islands, Halibut Point Road, Siginaka Islands, Hayward Strait, and Kruzof Island. In a shift from previous years, substantially more eggs were observed in the northern and eastern areas of Sitka Sound than along the Kruzof Island shoreline. 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. Harvester effort was documented throughout the core area islands and a lesser amount in the more northern areas of the sound, including Hayward Strait and Eastern/Promisla bays. Harvester locations correspond to where spawning occurred for multiple days, with the exception of Kruzof Island. Some harvesters will set branches along Kruzof Island, but, with closer areas of quality spawn in 2022, none did.

It makes sense that the areas with more harvesters would produce more harvest weight, but that is not always the case, as was seen particularly in 2018 (Sill and Lemons 2020). As discussed above, 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 subsistence herring egg harvest totals. However, in approximately one-third 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.

5. Alaska Department of Fish and Game Division of Commercial Fisheries, "Sitka Sound Herring Fishery Summary," advisory announcement, May 5, 2022. Accessed December 22, 2022. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1370633863.pdf
6. To create the map, the base shoreline was divided into segments of various lengths and the maximum number of days of spawn along any portion of that segment was calculated and attributed to the whole segment. Due to inclement weather, there were days during the spawn when surveys of the entire sound were not performed.
7. Alaska Department of Fish and Game Division of Commercial Fisheries, "Sitka Sound Herring Fishery Summary," advisory announcement, May 5, 2022. Accessed December 22, 2022. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1370633863.pdf

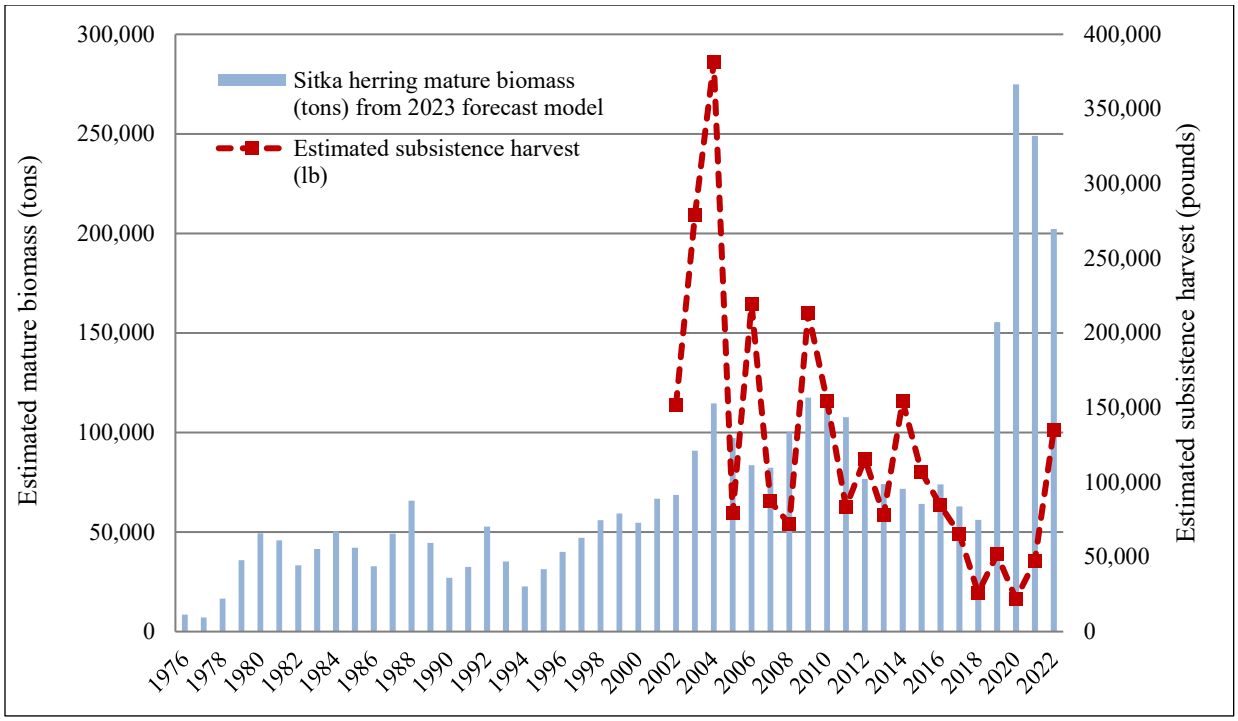


Figure 6.–Estimated mature biomass of Sitka Sound herring, 1976–2022 (based on the ADF&G 2023 forecast age-structured assessment model for Sitka Sound herring) and estimated subsistence harvest of herring eggs from Sitka Sound, 2002–2022.

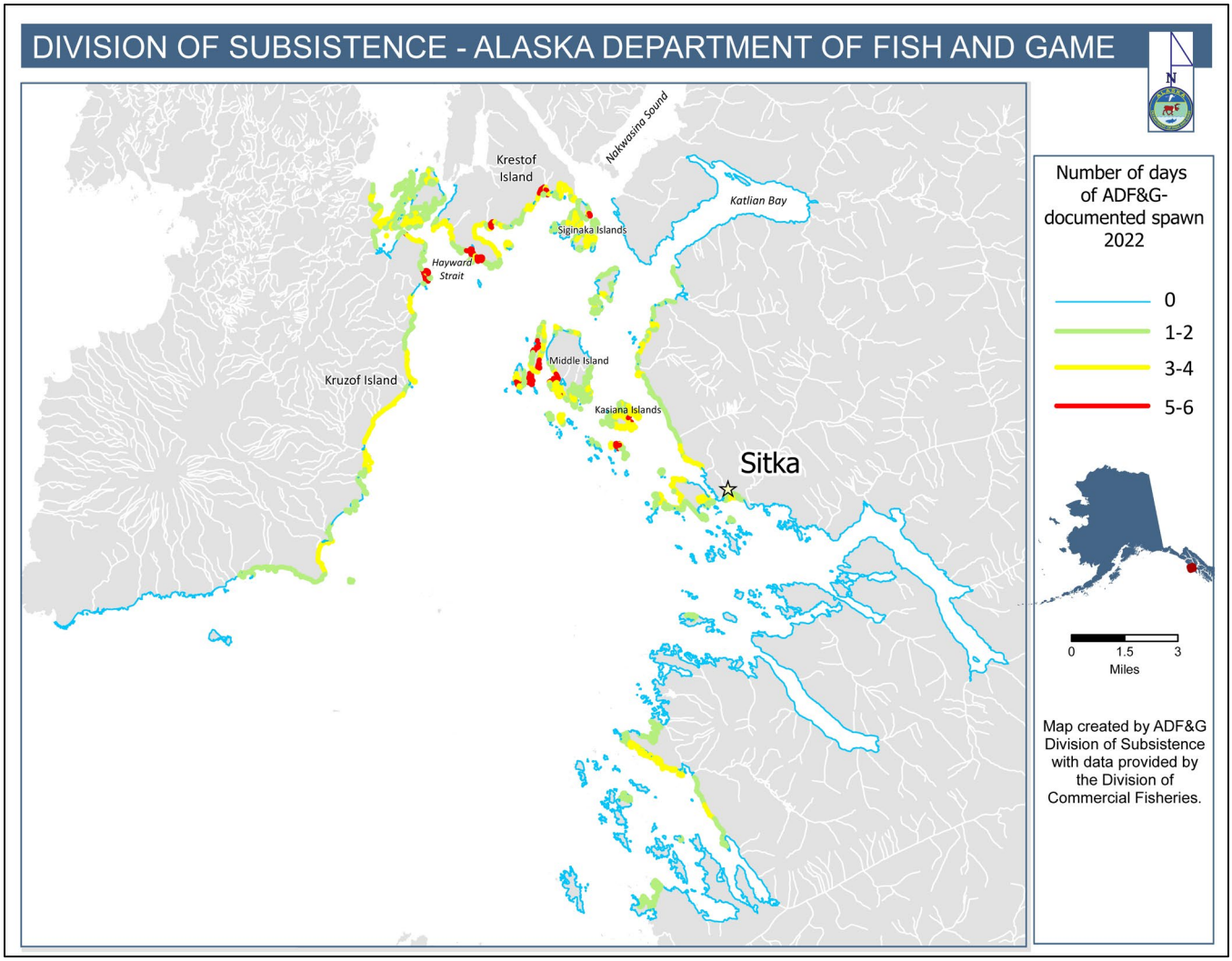


Figure 7.–Cumulative days of recorded herring spawn, Sitka Sound area, 2022.[8]

8. Aerial or skiff surveys were conducted on April 8, 9, 14, and 16, 2022. Note that no surveys were conducted on March 18 and April 11 due to inclement weather.

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 2017b; 2017a). Sharing in all of these communities is widespread and varied: the percentage of households harvesting eggs on hemlock branches ranged from 0% in Angoon to 23% in Hydaburg, while the percentage of households using herring eggs on hemlock branches was much higher, ranging from 15% in Haines to 77% 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 16); 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.

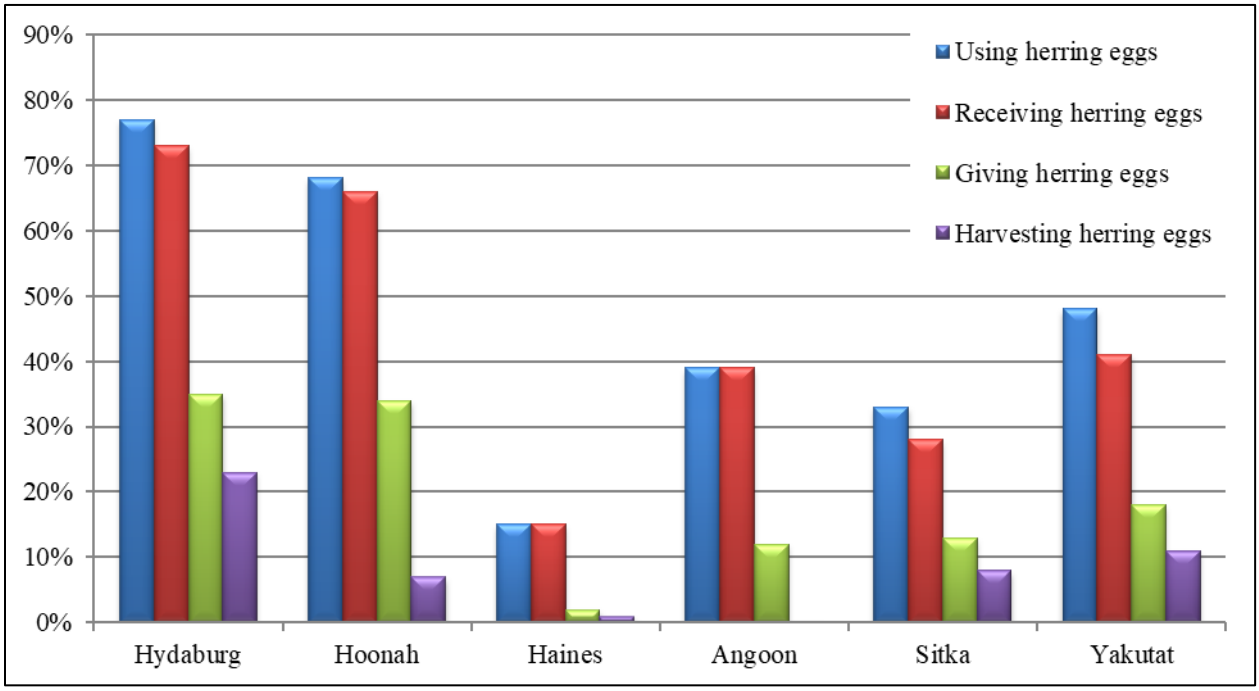


Figure 8.–Percentage of households using, receiving, giving, and harvesting herring eggs, Hydaburg, Hoonah, Haines, and Angoon 2012, Sitka 2013, and Yakutat 2015.

Table 16.–Locations from where residents reported receiving herring eggs, Angoon, Haines, Hoonah, Hydaburg, and Whale Pass, 2012.

	Valid responses									
	Angoon		Haines		Hoonah		Hydaburg		Whale Pass	
Source	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
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.

1. 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.
2. 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, it can be seen that the number of consecutive spawning days is important to overall success. 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 have 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). From 2018 through 2020, there was a small amount of spawning activity within this area (Sill and Cunningham 2019; Sill and Lemons 2020; 2021). Spawning activity in 2021 was more similar to the years prior to 2017 with increased spawning activity in the core area, a trend that continued into 2022. 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 believe 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 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 2022, harvesters put more effort into the core area locations than they had in recent years, but some effort in areas such as Eastern/Promisla bays were rewarded with substantial harvests.

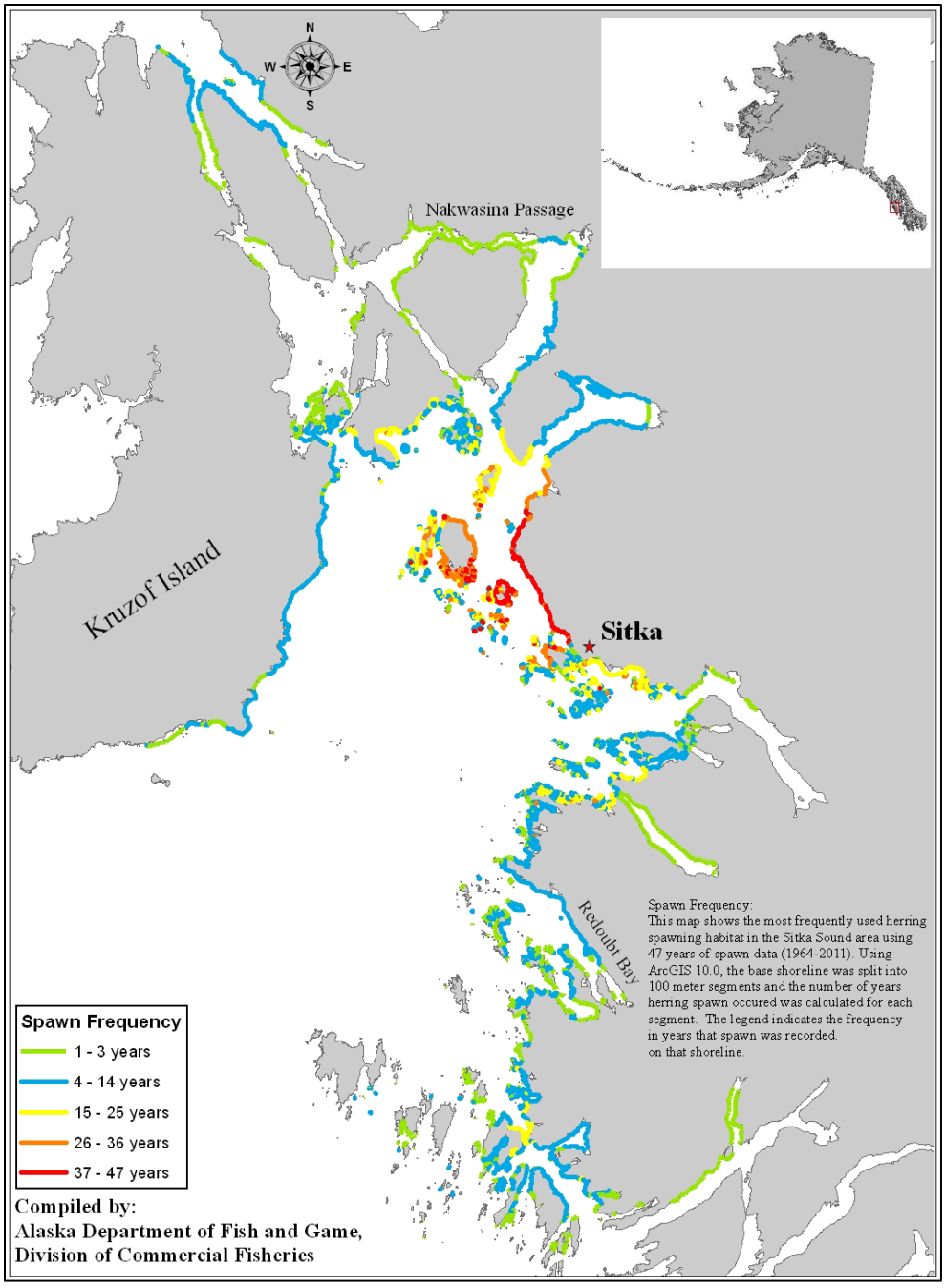


Figure 9.–Frequency of spawn recorded during ADF&G surveys, Sitka Sound area, 1964–2011.

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 2022, the harvest survey estimated 3,589 lb of spawn on kelp were harvested (Table 4), while expanded permit data show a harvest of 5,373 lb.[9] Additional efforts to identify and survey spawn-on-kelp harvesters is warranted since the survey effort has likely underestimated 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 ADF&G Division of Commercial Fisheries, Aaron Dupuis, Fishery Biologist, personal communication, December 22, 2022.

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. Local concerns for the subsistence harvest of herring eggs prompted this collaborative harvest monitoring program 20 years ago. Residents continue to express similar concerns, highlighted by the proposals submitted to the 2021 Southeast meeting of the BOF that echo proposals submitted within the last 20 years. Although the proponents withdrew support and no action was taken on most of these proposals, because of the participation of the subsistence community in the harvest monitoring program, the BOF has many years of consistent data about the nature of subsistence herring egg harvests to inform its decision-making process. There is no simple measure of whether Alaska residents are meeting their needs for herring spawn. One metric the BOF considers in determining whether reasonable opportunity to harvest herring spawn is being provided is the ANS, which has been achieved only once since 2010 (Figure 5). The reasons for the ANS not being achieved are likely multifaceted. 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 subsistence fishery in Sitka Sound is unique in terms of the importance of this one small geographic area to subsistence users throughout the state. Because of that, the herring spawn harvest continues to be shared by a small number of local harvesters 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 Shewmake (2013), 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. Exploring the potential to create a CPUE for this fishery is also a worthwhile endeavor to provide another metric for understanding harvest effort and changes over time. A state-waters closed area has been in place in some form since 2012, but formal analysis of any effects of that closure on subsistence harvests has not been conducted. While outside the scope of this annual report on subsistence harvest monitoring activities, such an analysis could provide the BOF with additional useful information for managing this fishery. Finally, a broader effort to look at overall use of herring eggs beyond Sitka, and changes in harvest effort at the household level, would provide needed additional information to evaluate changes and trends documented through the harvest survey.

ACKNOWLEDGMENTS

The ADF&G Division of Subsistence would like to thank the staff of the Sitka Tribe of Alaska for their hard work and dedication to this project: in particular, we thank Jeff Feldpausch, Kyle Rosendale, and Tammy Young. The survey would not have been possible without their leadership and cooperation. We would like to thank the STA Tribal Council and Herring Committee members for their support of the project. Within the Division of Commercial Fisheries, we appreciate the assistance from and review of this project provided by Aaron Dupuis. Input into the final draft of the report was also gratefully received from Chip Treinen with Southeast Alaska Herring Conservation Alliance, and Jeff Feldpausch and Kyle Rosendale with STA. There are many subsistence harvesters and commercial fishers who contributed to the success of this project by taking the time to speak to researchers, and we would like to take this opportunity to thank them as well.

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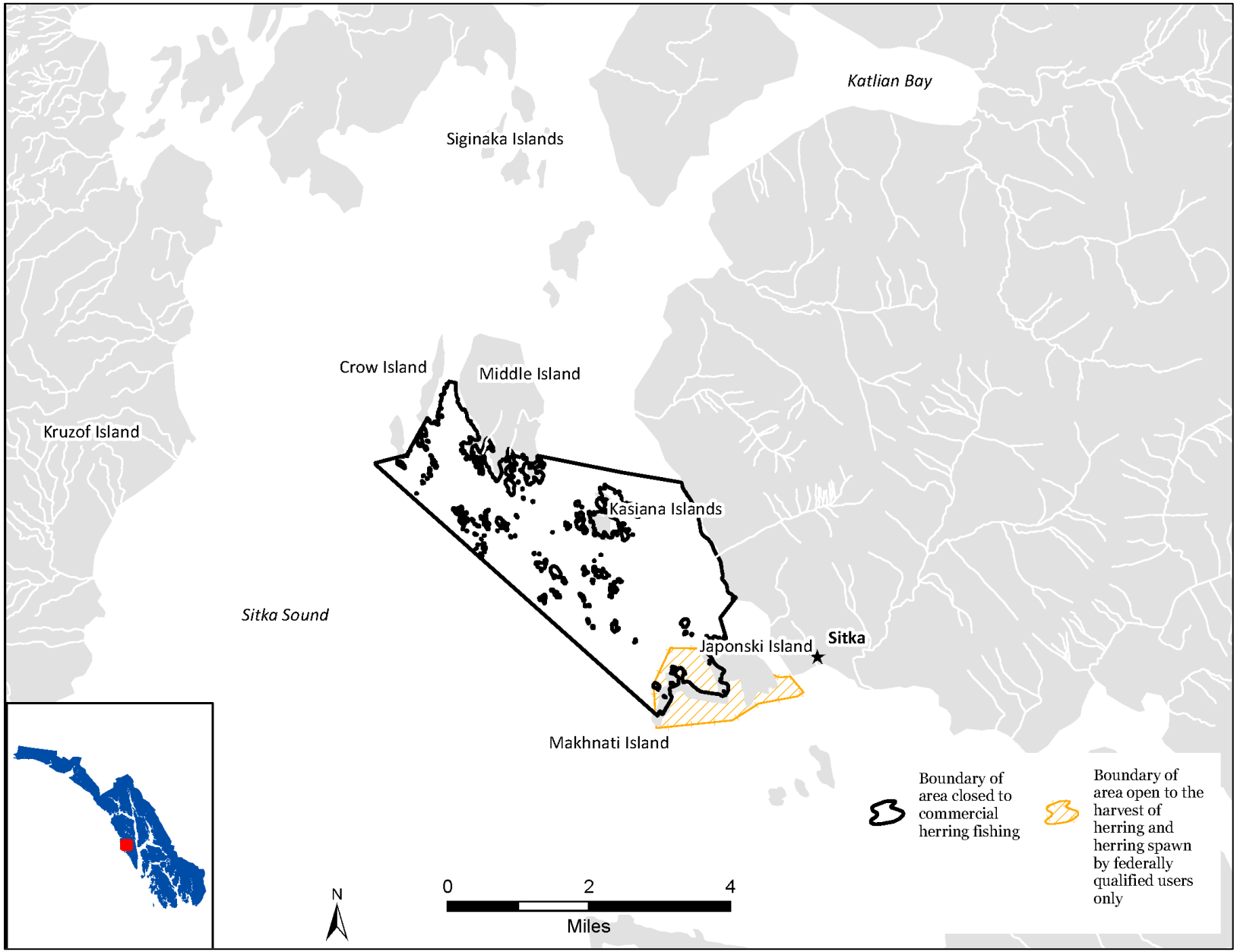
APPENDIX A: MAP OF AREAS OF SITKA SOUND WITH FISHING RESTRICTIONS



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, 2022

HERRING EGG SUBSISTENCE HARVEST SURVEY

SITKA, ALASKA

2022

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 2022...
...Did members of your household TRY TO HARVEST herring eggs? ..... Y N

If No, why not? ..... _____

How many people lived in your household in 2022? ..... ____

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

If YES, which tribe(s)? ..... _____

_____

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 2022 DID MEMBERS OF YOUR HH...			IN 2022, 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
120310000							
Herring eggs on kelp	Y N	Y N	Y N				LB
120306000							
Herring eggs on hair seaweed (né)	Y N	Y N	Y N				LB
120308000							

These columns should include all the herring eggs harvested by members of this household in 2022.

If you shared with others, which communities did you share with and how many households in each community?

# OF HOUSEHOLDS	COMMUNITY	

NOTES: _____

HARVESTS:

HOUSEHOLD ID

Where did you harvest your herring eggs in 2022 (set branches, harvested eggs on seaweed, or macrocystis kelp)?

	Location	# of sets... made	# of sets... harvested	Amount harvested (lbs)	Quality (coverage, thickness)	Soak time (days)	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 2022?..... _____
_____
_____

In 2022, did you harvest LESS, SAME, or MORE herring eggs than in recent years?..... X L S M

If LESS or MORE, why was your harvest different?

_____
_____
_____

If you HARVESTED LESS herring eggs in 2022, 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: _____

We know that herring eggs are used and shared through the year. Thinking back after last year's egg harvest, for all of 2021...

Did your household get enough eggs to meet your needs...

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

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

Were you asked for eggs that you could not supply?..... Y N

Are you aware that ADF&G publishes daily maps of spawn observed during their aerial surveys?..... Y N

If yes, did you use those maps in 2022?..... Y N

Do you have any comments about the maps? _____

COMMENTS

DO YOU HAVE ANY QUESTIONS, COMMENTS, OR CONCERNS ABOUT THE 2022 SUBSISTENCE HERRING EGG HARVEST?

_____
_____
_____
_____
_____

OTHER FISH: 06 **SITKA: 313**

APPENDIX C: 2022 CODE BOOK

Subsistence Herring Egg Harvest Survey 2022

Herring Spawn User Status	Code
Individual Harvester	1
Community boat	2

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
boat/mechanical	3
no need	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
Angoon Community Association	6
Central Council of Tlingit and Haida Indian Tribes of Alaska	7
Ketchikan Indian Community	8
Yakutat Tlingit Tribe	9
Other AK	10

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 HARVEST, why?

Non-harvester - no response necessary	Blank
Personal	1
stolen sets	2
other	3
resource too far to harvest	4
equipment	5
resource availability	6
location of the spawn (unsuccessful?)	7
	8
weather	9
expense	10

If MORE HARVEST, why?

Non-harvester - no response necessary	Blank
new harvester	1
needed more	2

Last good harvest year?

2020-2021	1
2011-2019	2
2000-2010	3
1990s	4
1980s	5
1970s	6

How many households usually harvest for?

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