Regional Operational Plan CF.1J.13-02

Operational Plan: Southeast Alaska Herring Stock Assessment Surveys and Sampling, 2013

by

Kyle Hebert

March 2013

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

Symbols and Abbreviations

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

Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

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

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

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

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

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

REGIONAL OPERATIONAL PLAN CF.1J.13-02

OPERATIONAL PLAN: SOUTHEAST ALASKA HERRING STOCK ASSESSMENT SURVEYS AND SAMPLING, 2013

by

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Alaska Department of Fish and Game
Division of Commercial Fisheries

March 2013

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Signature Page

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Project leader(s):	Kyle Hebert
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Approval

Title	Name	Signature	Date
Project leader	Kyle Hebert	Kyle P. Hebert	3/7/13
Research Coordinator	Kyle Hebert	Kyle P. Hebert	3/7/13

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PURPOSE

The primary purpose of this project is to collect the data necessary for stock assessment and forecast of herring spawning populations in Southeast Alaska, with the ultimate goal of setting appropriate guideline harvest levels. To conduct stock assessments using the established methods, it is critical to obtain estimates of egg deposition (i.e. "spawn deposition") within each spawning area, estimates of age composition of the spawning population, and estimates of age composition of harvested herring. This information, along with estimates of fecundity relationships and amount harvested are direct inputs for models used to forecast the biomass and age composition of herring spawning populations in the ensuing year.

Keywords: Pacific herring, spawn deposition, dive survey, *Clupea pallasi*, stock assessment, Southeast Alaska

OBJECTIVES

1. Estimate total spawn deposition (total number of herring eggs), for each major herring spawning area, to provide input for both the ASA and biomass accounting models.
2. Estimate age compositions of mature (spawning) herring for each major spawning area, by using cast nets to collect a minimum of 525 herring per spawning area.
3. Estimate age compositions of commercial catch for each commercial herring fishery, by collecting a minimum of 525 herring per gear type used for each stock.
4. Estimate mean weight-at-age and mean length-at-age for herring within each spawning area, and for herring in commercial catch for each fishery. The same fish sampled for age composition estimates are used to estimate mean weights-at-age.
5. Periodically, estimates of fecundity are made, which are used with spawn deposition estimates to determine absolute abundance of herring populations. Typically an estimate of the fecundity-to-weight relationship is made for one or more of the four major herring spawning areas (Sitka, Craig, Revillagigedo Channel, and Seymour Canal) by sampling female herring distributed among ten 20-g weight classes. No fecundity sampling is expected during 2013.

BACKGROUND

In 1971 the Alaska Department of Fish and Game (ADF&G) instituted a herring research program to evaluate Pacific herring stocks in Southeast Alaska. Visual estimates, hydroacoustic surveys, and spawn deposition surveys using scuba diving have been used to assess stocks, particularly in areas judged to support significant herring populations. This Project Operational Plan (POP) describes the data required for assessing the abundance and condition of herring populations in Southeast Alaska and the methods and rationale for collecting those data. Data generated during these stock assessment programs are used directly in the management of all commercial herring fisheries conducted in Southeast Alaska.

Data described in this POP are used as input into two different stock assessment models to determine abundance and forecast future abundance of herring populations. These models include an age-structured analysis (ASA) model and a biomass accounting model.

Historically biomass estimates and abundance forecasts of mature herring in Southeast Alaska were either developed from hydroacoustic surveys or the product of estimates of egg density and area of spawn deposition (called "spawn deposition" method). Presently the ASA model is used for herring populations with longer (i.e. > 10 years) time-series of stock assessment data and the biomass accounting model is used for all other populations. The two methods are not mutually exclusive. Spawn deposition data is an important element of ASA and biomass accounting models. A primary difference between the two models is the amount of data needed to conduct the respective analyses. Spawn deposition is estimated using only the most recent spawn deposition data, and no specific age composition or weight data, to yield an estimate of current biomass. A standard number of eggs per ton (based on data specific for that area, when available, or the closest area when not available) of herring is applied to the total egg estimate to compute spawning escapement. In contrast, the ASA uses a time series of age compositions and weights-at-age in conjunction with spawn deposition to estimate biomass. Biomass accounting is based on spawn deposition estimates adjusted for natural mortality, age-specific growth, and recruitment. Beginning in 1993 ASA, with auxiliary information, has been used to estimate the abundance of herring for up to five major Southeast Alaskan herring fishery populations: for the 1994 season in Sitka, Seymour Canal, Revillagigedo Channel (Kah Shakes/Cat Island), and Craig/Klawock, with Tenakee Inlet added for the 2000 season. These five potential commercial harvest areas or spawning populations have a sufficiently long time series of data to permit the use of ASA for estimating historical and forecasting future biomass. Other areas, which may support significant herring fisheries but lack time-series data suitable for ASA, are candidates for biomass accounting. This approach began in 1996 and biomass accounting forecasts have been made for West Behm Canal, Ernest Sound, Hobart Bay/Port Houghton, and Hoonah Sound.

The principal outputs from all models are forecasts of mature herring biomass for the ensuing year. These forecasts are compared to stock-specific threshold biomass levels to determine whether a fishery will be allowed in a particular area. This biomass forecast is coupled with the appropriate exploitation rate to determine the commercial fishing guideline harvest level.

STUDY SITE

Surveys or sampling will be conducted at several major herring spawning areas throughout Southeast Alaska (Figure 1). Spawning events may be expected in most years at each of these areas; however in some years spawning may not occur at some areas, or the amount of spawn deposition may be so low that a survey or sampling is not warranted or is impossible. In some years, the magnitude of spawning may be high in areas that are typically considered minor spawning areas, which are not show in Figure 1, and occasionally surveys or sampling will be conducted in these areas.

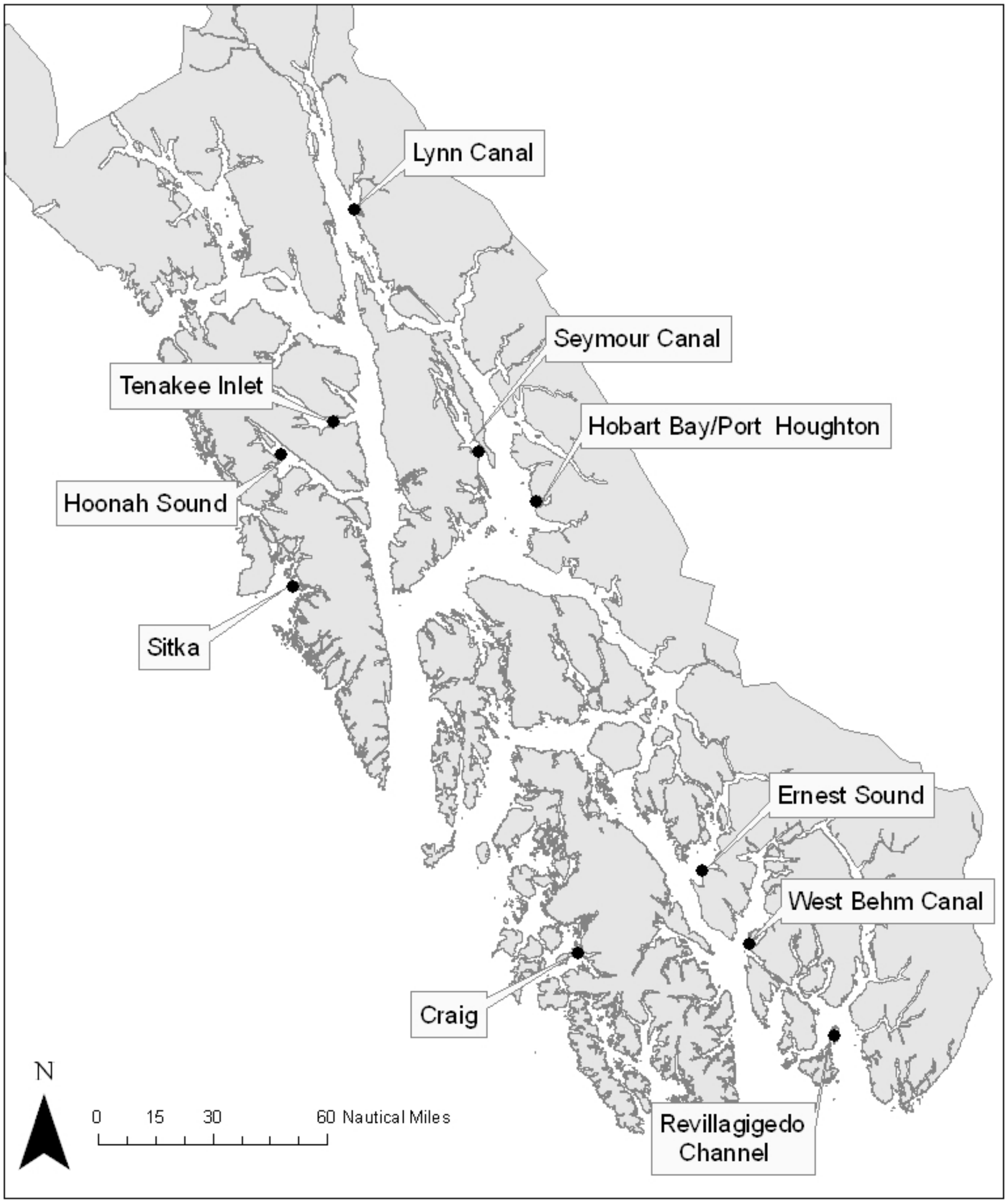

Figure 1.– Locations of major herring stocks in Southeast Alaska where stock assessment surveys or sampling is expected to occur in 2013.

METHODS

DIVE OPERATIONS

An ADF&G research vessel (e.g. *R/V Kestrel*) will be on site during spawn deposition surveys of each area and serve as the support vessel and base for all dive operations. The only exceptions anticipated are the possible use of skiffs for day trips 1) near Ketchikan for the Kah-Shakes/Cat Island spawning area, or 2) for secondary spawn surveys in Sitka Sound if necessary. The *R/V*

Kestrel will accommodate all members of the dive team (usually six divers) in addition to vessel officers (usually three Boat Officers) for extended periods. Typically, the support vessel remains in a location central to dive activity throughout the survey.

Actual diving will be conducted from 19-foot outboard powered aluminum skiffs. Three-person dive teams will be assigned to each skiff. All dives will be conducted in pairs, with the third team member remaining in the skiff to monitor surface traffic and provide support and assistance to the dive team. Team members will rotate diving/tending responsibilities. Equipment required for dive surveys, such as scuba gear and sampling/data collection equipment, is assembled on-board the support vessel to reduce unnecessary trips between support vessel and dive site. While conducting surveys teams may be separated from the support vessel by as much as five nautical miles, although actual distances will be kept at a minimum and are usually within one mile. All dive operations will be done in compliance with the department's current Dive Safety Manual (Hebert 2012). All dives are limited to a maximum of 21 m (70 fsw) because deeper dives severely limit total bottom times for scuba divers and pose safety risks when done repetitively over several days.

SPAWN DEPOSITION

Aerial Surveys

Beginning in mid-to-late March, the historical start of herring spawning in some areas, fixed-wing aerial surveys will be conducted in locations where spawning is anticipated. Flights will be coordinated within each management area by the local Area Management Biologist.

During aerial surveys ADF&G personnel indicate on a chart the shoreline where active spawning occurs. Additionally, indications of herring schools, presence of recent or old milt, presence and numbers of seabirds and marine mammals, and other information relevant to herring spawning is noted. On occasion the aircraft will land to collect herring samples for estimates of age, weight, and length, using a cast net. Aerial surveys will continue until active spawning is no longer observed in an area.

Upon completion of an aerial survey notes will be transcribed and presented, with charts indicating spawn activity, to the herring research biologist. Spawn data from charts will be transferred to GIS to calculate final spawn mileage estimates and help to determine position of transects used for spawn deposition dive surveys.

Sampling Design

A two-stage sampling design, similar to that of Schweigert et al. (1985), is used to estimate the density of herring eggs at selected spawning locations in Southeast Alaska. The field sampling procedure entails two-person scuba teams swimming along transects and recording visual estimates of the number of eggs within a 0.10 m^2 square sampling frame placed on the bottom at fixed distances along the transects.

The specific approach is as follows: diver 1 holds a 0.10 m^2 sampling quadrate (frame) with an attached compass. Diver 2 holds an underwater writing slate with an attached diving computer for depth and dive time at depth, along with an attached data sheet for recording distance covered, depth, bottom type, percent vegetative cover, most prevalent vegetation type, number of herring eggs observed, and other comments. Diver 1 sets a compass course perpendicular from the beach. Starting at a point approximately 2.5 m inside any intertidal spawn, or at the water line if no intertidal spawn is observed, divers swim along the pre-determined course, and place the sampling frame systematically (to avoid biased placement of the frame) every five meters. As an option, divers may swim until they first encounter eggs before placing the quadrate. This has the benefit of more accurately estimating the spawn width if initial, shallower depths are devoid of eggs (i.e. spawning occurred at low tide but the transects are completed at high tide and no eggs are present in the intertidal or shallow sections of the transect.) Distance is measured using a 5 m line tied to the sampling frame. Divers stop every 5 m. If eggs are not present the estimate is entered as "0". When eggs are present, diver 1 visually estimates the number of eggs observed within the entire water column defined by the frame. Often the frame cannot be placed on the bottom without displacing eggs and vegetation and must be held in mid-water column. This may require estimating numbers of eggs both above and below the frame as they occur on the substrate. Diver 1, using hand signals, indicates his estimate to diver 2 to record. Diver 2 also records depth, distance covered, bottom type, percent vegetative cover, vegetative type, and any additional observations. Vegetative type will be coded using a key that groups various algae and marine and intertidal plants species into categories (Appendix A). Similarly, bottom type will be coded according to Appendix B. Since frames are spaced equidistant along transects, the number of frames is also used to compute individual transect length.

Starting points for transects are located randomly along the shore within areas where aerial or skiff surveys indicated probable spawn deposition. Transects are placed no closer than 0.1 nmi and are oriented perpendicular to the shoreline.

Upon completion of a survey dive all data will be entered into a database on-board the supporting research vessel. When possible, the collector of the data will complete data entry.

Diver Calibration

Since visual estimates, rather than complete counts of eggs within the sampling frames are recorded, measurement error occurs. To minimize the influence of this measurement error on final estimates of total egg deposition diver-substrate-specific correction coefficients (c_h) are used to adjust estimates of egg density. Correction coefficients are estimated by double sampling (Jessen 1978) frames independent of those estimates obtained along regular spawn deposition transects. This involves visually estimating the number of eggs within a sampling frame and then collecting all of the eggs within the frame for later enumeration in the laboratory. Divers will carefully collect all of the kelp containing eggs located within the frame and place the samples in collection bags. Eggs that are attached to rocks and other uncollectable substrates remaining within the frame are not part of the estimate. All samples will be preserved in a 100% salt brine solution until laboratory analysis. A detailed description of the processing and counting of collected eggs in the laboratory is provided in Blankenbeckler (1987). In addition to diver estimates when conditions permit (e.g. proper substrate, visibility) samples will be photographed prior to estimates and collection. A photographic record may allow for later comparison of diver to lab estimates. Photographs may also provide a venue for future training both in herring egg estimation and kelp identification.

Given the visual estimates and actual counts of eggs, the diver-specific correction factors are estimated as:

$$c_{ih} = \frac{\bar{r}_{hk}}{\bar{v}_{hk}} \quad (1)$$

where c_{ih} is the estimated correction factor for diver h, v_{hk} is the mean visual estimate of egg numbers for diver h, *and* $\bar{r}_{hk}$ is the mean laboratory count of egg numbers for diver h.

Estimates of Total Egg Deposition

For each spawning area, i, total egg deposition is estimated as:

$$t_i = a_i \bar{d}_i, \tag{2}$$

where t_i is the estimated total deposition of eggs for spawning area i, a_i is the estimated total area (m^2) on which eggs have been deposited at spawning area i, and $\bar{d}_i$ is the estimated mean density of eggs ($eggs/m^2$) at spawning area i.

The total area on which eggs have been deposited is estimated as:

$$a_i = l_i w_i, \tag{3}$$

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

The mean density of eggs/m^2 at area i ($\bar{d}_i$) is estimated as:

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

where v_{hij} is the visual estimate of egg numbers by diver h, at area i, quadrate j, on kelp type k. The c_{hk} term refers to a diver-specific, kelp-specific correction factor to adjust visual estimates made by diver h on kelp type k, and m_{hi} is the number of quadrates visually estimated by diver h at area i. Divers visually estimate egg density within 0.1 m quadrates. Multiplying by 10 expands the mean density from a 0.1 m^2 to a 1.0 m^2.

Sample Size

The statistical objective of spawn deposition sampling is to estimate herring egg densities (per quadrate) so the lower bound of the one-sided 90% confidence interval is within 30% of the mean density. This will also achieve the objective of estimating the total spawn deposition at a particular location with the specified precision. A one-sided confidence interval is used because we are concerned more with avoiding overestimating, rather than avoiding underestimating the densities of spawn deposition. Since spawn deposition surveys are conducted as two-stage sampling, target precision can be achieved by changing the number of transects per nautical mile of shore and/or by changing the number of quadrates within transects per nautical mile of shore. Sampling optimization, which accounts for both the costs and variances specific to sampling, could be used to obtain optimum estimates of egg density given constraints on precision and cost. This approach would necessitate some flexibility in varying both the transect density (i.e. number of transects per nautical mile of shore) and quadrate density (i.e. number of quadrates per meters of transect) at the various spawning areas. Since a length of line is now used to measure inter-quadrate distances, it would be practical to optimize the spawn deposition sampling by varying not only the number of transects per nautical mile, but also the number of quadrates per transect specific to each spawning area. But to simplify the sampling and reduce chances of error a standard quadrate spacing of one quadrate every 5 m of transect will be maintained. This standardization simplifies estimation of desired sample.

The desirable number of transects is estimated as:

$$n = \frac{\left(S_b^2 - \frac{S_2^2}{\overline{M}} + \frac{S_2^2}{\overline{m}} \right)}{\left(\frac{x\overline{d}}{t_\alpha} \right)^2 + \frac{S_b^2}{N}}, \quad (5)$$

where:

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

These preliminary estimates may be obtained from the prior year's spawn deposition surveys, or may be obtained from preliminary sampling from the current years' sampling and updated as the current years' survey proceeds (Table 1). The latter approach is preferred but current available resources preclude obtaining sample size estimates from recent data; sample sizes calculated from 2000 data will be used in 2013. From a practical standpoint, the number of transects located in an area will be set as a minimum of 20 and a maximum of 50.

Transect Location

Once the desired number of transects per nautical mile of spawn is determined, transect location is decided through a process of measuring the distance of shoreline that received spawn and then randomly selecting locations. The final mileage is obtained using GIS software.

Shoreline measurement and transect placement can be subjective and depend on the location of spawn deposition relative to the shoreline, bottom contour and depth, and map resolution. Fine measurement of a convoluted shoreline may substantially increase distance but may not be appropriate for instances when spawn deposition does not closely follow the shoreline. In such situations, less resolution is used for measurements and transects are placed perpendicular to a "theoretical" shoreline so they intersect the spawn in a meaningful way. Conversely, spawn may closely follow a convoluted shoreline, requiring finer resolution of measurements, and transects are placed perpendicular to the actual shoreline contingent upon physical features such as depth, bottom slope, and distance to the opposite shore. For example, a steep sloped shore with a narrow band of spawn habitat (e.g. Sitka) requires much finer shoreline mapping as opposed to an area with broad shallow waters (e.g. Cat Island) interspersed with rocks and reefs at some distance from shore.

The product of the total measured shoreline and the estimated optimal number of transects per nautical mile (Table 1) determines the minimum number of transects to be surveyed in an area. Total measured shoreline that received spawn is divided into tenths of a nautical mile and each of these segments becomes a candidate for transect location. The location of transects to be surveyed are then selected from these segments using a random number generator.

FECUNDITY

Due to resource limitations, it is unlikely there will be an opportunity for herring fecundity sampling in 2013. But if the opportunity develops, the following general protocol will be followed:

Sampling Design

Estimates of fecundity are used with spawn deposition estimates to determine absolute abundance of herring populations. Sufficient samples of female herring, distributed among 20-g weight classes will be collected to promote estimates of fecundity-at-weight. In 1995, 1996, 1998, and 2005 fecundity-at-weight estimates were obtained for the four major herring spawning areas: Sitka (1995, 1996, 1998, 2005), Craig, Kah Shakes/Cat Island (1996), and Seymour Canal (1996). Sampling will be conducted so that regression estimates of fecundity as a function of weight can be obtained.

Herring samples must be obtained as close to spawning as possible though sampling should not occur during spawning (to prevent sampling of partially spent females). Sample timing is crucial to provide real time estimates of potential egg deposition. Sampling procedures may occur in conjunction with herring sampling prior to the sac roe fishery using purse seines; samples from multiple locations are preferred.

Sample Size

In Southeast Alaska weights of mature herring may range from approximately 40g for an age-3 fish to over 200g for an age-10 fish. Given this range of weights and the need to sample for a possible nonlinear relationship, sampling will be conducted equally within this weight range.

Sampling will be conducted by selecting a minimum of 10 reproductively mature female herring from each of the following 20g weight categories: <80, 80-99, 100-119, 120-139, 140-159, 160-179, 180-199, 200-219, ≥220 grams. This will yield a minimum of 90 herring to define the fecundity relationship. This total sample size is dictated largely by limitations on the number of fish that can reasonably be processed given available resources. This sample size is also consistent with previous fecundity sample sizes. All herring collected for potential fecundity sampling will be individually bagged to prevent cross contamination and to make it readily apparent if a herring is losing eggs.

Ovary Removal

Appropriate size females will be selected and weighted to the nearest gram. The standard length (tip of snout to posterior margin of the hypural plate) of each fish will be measured to the nearest millimeter. Using a sharp dissecting knife or scissors, a shallow incision will be made from the vent to the gill cage, exposing the skeins.

Fecundity Estimate

The skein will be carefully removed and eggs separated from the membrane (removing as much membrane and "non-skein" tissue as possible without losing or breaking any eggs). The skein's weight will be recorded to the nearest 0.01 gram. The skein/eggs will then be placed into a suitable container or on weight paper. Three skein sub samples will be weighted to the nearest 0.01 gram. The number of eggs in each sub sample will be counted. Each sub sample should contain approximately 300 - 500 eggs. All weights and counts will be recorded and identified with that fish's total weight and length. There is still some concern about counting eggs and herring egg "stickiness". If eggs are too sticky to accurately count, they may be boiled or washed in either a brine or KOH solution prior to counting. Other reagents and methods may be investigated as needed. As sub sample weight has already been obtained, the wash procedure will not alter the sub sample weight though care must be taken to avoid loss or destruction of eggs in the sub sample. This procedure is designed to avoid using caustic preservatives and reagents such as Gilson's solution.

Data Collected

When completed, the data collected shall include:

Spawning Stock (e.g. Sitka Sound)

Collection Date, Sample Date

Location (e.g. Old Sitka Rocks)

Gear (e.g. purse seine)

length (mm)

weight (grams)

sub samples weights (x3)

sub samples counts (x3)

sampler (technician(s) completing project).

A separate data sheet can be used for each weight category to more easily keep track of the number of herring sampled in each category.

Data will be entered into a spreadsheet but preferably, if available, into the department's herring database. Once entered average number of eggs per gram will be calculated and extrapolated to estimate the number of eggs for the individual herring.

CATCH AGE COMPOSITION

Sampling Design

Samples will be collected from at least three different vessels participating in each of the commercial herring fisheries. Apportioning samples among vessels and positions within sets is intended to promote more representative estimates of age composition. Sampling from tenders at the processing plants may be required for the winter bait fishery but is not preferred due to scale loss. Samples will be stored in plastic bags (large garbage bag) in 5-gallon buckets and shipped to the Juneau tag lab for processing at the earliest convenience. Information with each sample will include: date of set, location of set, name of vessel making the set, name of person collecting the sample, commercial gear used in making the set and if available, the approximate size of the set. Samples will be collected from all commercial fisheries conducted during the year. Labels will be included both inside and outside each bucket.

Sample Size

Based on multinomial sampling theory (Thompson, 1987), a sample size of 511 ages is sufficient to assure age composition estimates that deviate no more than 5% (absolute basis) from the true value, 90% of the time. To achieve a sample size of approximately 500 ages and promote adequate sampling from a cross section of the commercial catch, approximately 100 herring will be taken from each of at least five different vessels participating in the commercial fishery, with a total goal of 525 fish. Fish sampled beyond the goal of 500 ages are to ensure samples to replace unusable scales due to scale regeneration.

MATURE AGE COMPOSITION

Sampling Design

Cast net samples will be collected annually from major spawning areas that have historically been sampled and/or which have significant pre-spawning and spawning activity.

Sample Size

It is a goal to sample several different times and/or sites within the general spawning locale prior to or during the onset of the major spawning event (total sample size is 525 fish). Sampling gillnet sac roe fishery areas should be completed prior to the onset of any commercial fishery in the area.

AGE-SPECIFIC WEIGHT AND LENGTH

Sampling Design

The sampling design for estimating age-specific weight and length is dictated by the design used to estimate mature and catch age compositions, since the same fish are used for estimating age, weight, and length.

Sample Size

The precision of the estimates of mean weights and lengths-at-age will vary depending upon age composition of populations, as will the numbers of herring within the various age classes among the 500 ages sampled. In addition, precision will vary depending upon inherent variability in weights among fish within the various age classes.

SCHEDULE AND DELIVERABLES

SCHEDULES

Spawn deposition surveys will conducted from approximately the first week of April through mid-May, depending on actual herring spawn timing. A goal is to begin dive surveys about 10 days after the peak of the spawning event. Collection of age, weight, length samples will occur during spawning events from late-March through mid-May, and during commercial fisheries, which may occur from October 2012 through mid-May. Processing of herring samples by laboratory staff is expected to be complete by June 2013. Data preparation and basic analysis is expected to be completed by September 2013, and forecast modeling will be conducted during fall/winter 2013/14.

DATA ENTRY / DATABASE AND SOFTWARE REQUIREMENTS

All spawn deposition data will be entered into the "portable ZANDER" data entry form (i.e Integrated Fisheries Database or "IFDB") by a designated dive team member within the same day of data collection to maximize recall of dives. Ideally, the collectors of the data will enter data. Upon completion of the cruise, data will be uploaded to the IFDB master database.

OTHER NECESSARY RESOURCES

The *R/V Kestrel*, based in Petersburg, will be used as the support research vessel and base dive platform for herring spawn deposition cruises. This is a live-aboard 105-foot vessel capable of accommodating up to nine divers in addition to three vessel officers. It is equipped with compressors for on-board filling of scuba tanks with air and Nitrox. A 36% Nitrox breathing mixture will be used for all dives to enhance safety. All diving will adhere to guidelines and procedures outlined in the department's Dive Safety Manual (Hebert 2012) and emergency response to dive accidents will follow the 2012 dive safety plan.

Two 19-foot aluminum skiffs that have been enhanced for diving purposes will accompany the support research vessel and all diving will be conducted directly from these skiffs.

DELIVERABLES

Survey results are summarized in Excel spreadsheet tables and figures that are provided to biometrics staff by July/August to begin review and stock assessment. Tables include summaries for spawn deposition results, calibration factors, and age/length/weight data. Stock assessments and forecasts are provided to area management biologists in the form of email memo with supporting Excel spreadsheets between November and January. A report of the stock assessment survey results is published annually in the ADF&G Fishery Data Series.

RESPONSIBILITIES

Kyle Hebert, Herring/Dive Research Project/Program Leader, Fishery Biologist IV. Oversight of all aspects of the project and vessel operation, including planning, budgeting, sample design, field work, personnel; analyzes data and reports project results; conducts stock assessment/forecast for areas where biomass accounting used for forecast; participates in dive surveys.

Jeff Meucci, Dive Research Project, Fish and Wildlife Technician V. Assists with operational planning, oversees dive operations and safety as dive master, emergency medical technician, maintenance of skiffs and dive gear/equipment, data entry, participates in dive surveys.

Sherri Dressel, Herring Fisheries Scientist I. Assists with/recommends survey design; overall scientific review; conducts stock assessment and forecast for Sitka Sound; participates in dive surveys

Kray Van Kirk, Regional Biometric Supervisor, Biometrician III. Assists with/recommends survey design; overall scientific review; conducts stock assessment and forecast for areas where age-structured assessment model used other than Sitka Sound.

Scott Kelley, Regional Supervisor, Region I. participates in dive surveys; provides overall guidance as needed.

Dave Gordon, Sitka Area Management Biologist, Fishery Biologist III. Participates in dive surveys; aerial spawn surveys, AWL sample collection; provides guidance on local level as needed.

Eric Coonradt, Sitka Area Assistant Management Biologist, Fishery Biologist II. Participates in dive surveys; aerial spawn surveys, AWL sample collection; provides guidance on local level as needed.

Troy Thynes, Petersburg Area Management Biologist, Fishery Biologist III. Participates in dive surveys; aerial spawn surveys, AWL sample collection; provides guidance on local level as needed.

Scott Walker, Ketchikan Area Management Biologist, Fishery Biologist III. Participates in dive surveys; aerial spawn surveys, AWL sample collection; provides guidance on local level as needed.

Bo Meredith, Ketchikan Area Assistant Management Biologist, Fishery Biologist II. Participates in dive surveys; aerial spawn surveys, AWL sample collection; provides guidance on local level as needed.

Justin Breese, Ketchikan Area Assistant Management Biologist, Fishery Biologist II. Participates in dive surveys; aerial spawn surveys, AWL sample collection; provides guidance on local level as needed.

Kevin Kivisto, Captain of *R/V Kestrel*, Boat Officer IV. Command of dive research vessel and overall responsibility of vessel operations, safety and conduct aboard the vessel.

Joselito Skeek, Chief Engineer of *R/V Kestrel*, Boat Officer III. Operation and maintenance of engine room, safety systems, davits/cranes and hydraulic deck gear, assists with operation of vessel, operates dive cylinder air/Nitrox compressor.

Erin Kandoll, Deck Mate and Cook of *R/V Kestrel*, Boat Officer I. Galley operations/cook, operation of davits/cranes, assists engineer, assists with dive compressor.

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