

Regional Information Report No. 1J08-13

**Project Operational Plan for the 2008 Southeast
Alaska Herring Stock Assessment**

by

Marc Pritchett

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Alaska Department of Fish and Game

Division of Commercial Fisheries



Symbols and Abbreviations

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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative Code	AAC	fork length	FL
deciliter	dL			mid-eye-to-fork	MEF
gram	g	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	mid-eye-to-tail-fork	METF
hectare	ha			standard length	SL
kilogram	kg			total length	TL
kilometer	km	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.		
liter	L	at	@	Mathematics, statistics <i>all standard mathematical signs, symbols and abbreviations</i>	
meter	m	compass directions:		alternate hypothesis	H _A
milliliter	mL	east	E	base of natural logarithm	<i>e</i>
millimeter	mm	north	N	catch per unit effort	CPUE
		south	S	coefficient of variation	CV
Weights and measures (English)		west	W	common test statistics	(F, t, χ^2 , etc.)
cubic feet per second	ft ³ /s	copyright	©	confidence interval	CI
foot	ft	corporate suffixes:		correlation coefficient (multiple)	R
gallon	gal	Company	Co.	correlation coefficient (simple)	r
inch	in	Corporation	Corp.	covariance	cov
mile	mi	Incorporated	Inc.	degree (angular)	°
nautical mile	nmi	Limited	Ltd.	degrees of freedom	df
ounce	oz	District of Columbia	D.C.	expected value	<i>E</i>
pound	lb	et alii (and others)	et al.	greater than	>
quart	qt	et cetera (and so forth)	etc.	greater than or equal to	≥
yard	yd	exempli gratia (for example)	e.g.	harvest per unit effort	HPUE
		Federal Information Code	FIC	less than	<
Time and temperature		id est (that is)	i.e.	less than or equal to	≤
day	d	latitude or longitude	lat. or long.	logarithm (natural)	ln
degrees Celsius	°C	monetary symbols (U.S.)	\$, ¢	logarithm (base 10)	log
degrees Fahrenheit	°F	months (tables and figures): first three letters	Jan, ..., Dec	logarithm (specify base)	log ₂ , etc.
degrees kelvin	K	registered trademark	®	minute (angular)	'
hour	h	trademark	™	not significant	NS
minute	min	United States (adjective)	U.S.	null hypothesis	H ₀
second	s	United States of America (noun)	USA	percent	%
		U.S.C.	United States Code	probability	P
Physics and chemistry		U.S. state	use two-letter abbreviations (e.g., AK, WA)	probability of a type I error (rejection of the null hypothesis when true)	α
all atomic symbols				probability of a type II error (acceptance of the null hypothesis when false)	β
alternating current	AC			second (angular)	"
ampere	A			standard deviation	SD
calorie	cal			standard error	SE
direct current	DC			variance	
hertz	Hz			population	Var
horsepower	hp			sample	var
hydrogen ion activity (negative log of)	pH				
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

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HERRING STOCK ASSESSMENT**

By

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ABSTRACT

Herring in Southeast Alaska are harvested for commercial bait, commercial sac roe, commercial spawn-on-kelp, subsistence spawn-on-kelp, personal use, and department test fisheries. The Southeast Alaska Herring Management plan (5 AAC 27.190.(3)) requires that the department shall assess the abundance of mature herring for each stock before allowing fishing to occur. This Project Operation Plan outlines the 2008 monitoring program for herring spawning stocks in Southeast Alaska and data collection needed for herring spawn biomass estimates and forecast modeling.

Key words: Southeast Alaska, herring spawn, spawning biomass, dive survey.

INTRODUCTION

In 1971 the Alaska Department of Fish and Game (ADF&G) instituted a herring research program to evaluate herring stocks in Southeast Alaska. Visual estimates, hydroacoustic surveys, and spawn deposition surveys using scuba diving have been used for biomass assessment, 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 appropriate exploitation rates to determine the commercial fishing quota.

OBJECTIVES

The ASA model uses a least-squares procedure to yield estimates of historical abundance that are as consistent as possible with the objective estimates listed below. In the context of a least squares procedure, the objective estimates may be thought of as the “observed” data, and the ASA model estimates, derived to be as close to the “observed” data as possible, as the “expected” values. The biomass accounting model uses estimates of natural mortality, age-specific maturity, and growth to forecast mature biomass. These parameter estimates are obtained from ASA outputs from other stocks.

Both forecasting models are currently deterministic models. That is, the error structure of parameter estimates used as input into the models are not expressly accounted for in the models, nor do the models provide variances for resulting parameter estimates, such as abundance of age-3 herring. If the models were stochastic, the desired precision of input parameter estimates (e.g. catch-at-age compositions) might be dictated partly by the desired precision of output parameter estimates. Until the ASA model is sufficiently refined to account for variability in both input and output parameters, sampling design criteria related to sample sizes and variance estimation will be determined individually for each of the objective estimates listed below, and largely independent of the influence of the estimates on the ASA model. Sampling designs for each objective estimate will account for the usual tradeoffs between the costs of acquiring the data and the precision of resultant estimates.

A more detailed explanation of the ASA and biomass accounting models and how the objective estimates are used in these models are provided by Carlile et al. (1996).

Objective 1—Estimate annual herring spawn deposition.

Estimate spawn deposition (total numbers of herring eggs), in conjunction with information on fecundity, yield estimates of escapement or absolute abundance for use in both the biomass accounting and ASA models. Egg density is sampled on transects by scuba divers. Estimated lengths of beach with herring spawn, the second critical component for abundance estimates, will be determined with aerial and skiff surveys.

Objective 2—Estimate age composition of herring in commercial catches.

To estimate the historical abundance and forecast future abundance of herring, the ASA model uses catch and weight-at-age data to produce estimates of abundance, commercial gear selectivity, and natural mortality. Where commercial harvest is expected, a minimum target of 500 ages of individual herring will be set to estimate catch age composition.

Objective 3—Estimate age composition of mature herring populations.

Age compositions of mature herring populations are obtained through cast net sampling of pre-spawning and spawning herring or trawl sampling of pre-spawning herring, and are inputs to the ASA and biomass accounting models. The ASA model estimates age-3 abundance, maturity-at-age, natural mortality, and estimates of catch-at-age to yield model estimates of mature age composition as close to the observed estimates of age composition as possible. The biomass

accounting model forecasts abundance of age 4 to 8+ mature herring. Target sampling for estimates of mature age composition is the same as for catch age compositions.

Objective 4—Estimate age-specific weights and lengths of mature herring.

Age specific weights are necessary to monitor and estimate growth and to convert numbers of fish to biomass. The same fish sampled for age composition estimates are used to estimate mean weights-at-age.

Objective 5—Estimate fecundity of herring in S.E. Alaska

As indicated under Objective 1, estimates of fecundity are used with spawn deposition estimates to determine absolute abundance of herring populations. In 1995, 1996, 1998 and 2005 fecundity-at-weight estimates were obtained for one or more of the four major herring spawning areas (Sitka, Craig, Revillagigedo Channel, and Seymour Canal). This procedure requires sufficient samples of female herring distributed optimally among ten 20-g weight classes to promote estimates of fecundity-at-weight at the extremes of the weight range that are within +/- 30% of the predicted fecundity, 90% of the time. No additional fecundity-at-weight estimates are expected to be obtained in 2008 due to resource limitations.

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 exception anticipated is the possible use of skiffs for day trips: near Ketchikan for the West Behm Canal stock, post primary spawn surveys in Sitka Sound, and north of Juneau in the Lynn Canal area (i.e. Berners Bay). 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 during the survey.

Actual diving will be conducted from outboard powered skiffs. Three-person dive teams will be assigned to a 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 diving members of the 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 5 nmi though actual distances will be kept at a minimum. All dive operations will conform to procedures described in the department's current Dive Safety Manual. 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 m² 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 m² sampling quadrat (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 quadrat. 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:

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

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:

$$t_i = a_i \bar{d}_i, \quad (2)$$

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:

$$a_i = l_i w_i, \quad (3)$$

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/m² at area i (\bar{d}_i) is estimated as:

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

where v_{hij} is the visual estimate of egg numbers by diver h , at area i , quadrat 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 quadrats visually estimated by diver h at area i . Divers visually estimate egg density within 0.1 m quadrats. Multiplying by 10 expands the mean density from a 0.1 m² to a 1.0 m².

Sample Size

The statistical objective of spawn deposition sampling is to estimate herring egg densities (per quadrat) 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 quadrats 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 quadrat density (i.e. number of quadrats per meters of transect) at the various spawning areas. Since a length of line is now used to measure inter-quadrat 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 quadrats per transect specific to each spawning area. But to simplify the sampling and reduce chances of error a standard quadrat spacing of one quadrat every 5 m of transect will be maintained. This standardization simplifies estimation of desired sample.

The desirable number of transects is estimated as:

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

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,
\bar{M}	=	estimated mean width of spawn,
\bar{m}	=	estimated mean number of 0.1 m quadrates per transect,
x	=	specified precision, expressed as a proportion (i.e. 0.3 = 30%),
\bar{d}	=	overall estimated mean egg density,
t_a	=	critical t value for a one-sided, 90% confidence interval,
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 2008. From a practical standpoint, the number of transects located in an area will be set as a minimum of 20 and will not to exceed 40.

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 2008. 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 120 herring will be taken from each of at least five different vessels participating in the commercial fishery, for a total of 600 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 and/or seine samples will be collected annually from areas that have historically been sampled and/or which have significant pre-spawning and spawning activity.

Sample Size

A minimum of 150 fish will be taken from at least four 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 600 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 and therefore the numbers of herring within the various age classes among the total of 500 ages sampled. In addition, precision will vary depending upon inherent variability in weights among fish within the various age classes.

SPECIAL PROJECTS

Photographic Training Aids

When conditions permit underwater photos of herring spawn will be taken prior to collecting calibration samples and while conducting standard transects. These photos can be used as a training aid for both algae identification as well as herring spawn estimates. Calibration samples and photos will later be combined with lab estimates for comparison.

SCHEDULES

Herring stock assessment data collection schedule, 2008: Dates of spawn deposition surveys are approximately April and May. Actual survey dates are dependent on herring spawn timing.

Surveys are anticipated to be conducted in the following locations and sequence (Appendix C):

Sitka Sound

Craig

Kah Shakes / Cat Island (dependent on spawn mileage, this area has not been surveyed since 2001)

West Behm Canal

Ernest Sound

Tenakee Inlet

Hoonah Sound

Hobart Bay / Port Houghton

Seymour Canal

Berners Bay (Lynn Canal).

PARTICIPATING DIVERS

The following department divers are scheduled for either one or both herring spawn deposition dive surveys: Marc Pritchett, Jeff Meucci, Kyle Hebert, William Bergmann, Zac Hoyt, Dave Gordon, Troy Thynes, Justin Breese, Sherri Dressel, Scott Walker, and Bo Meredith.

DATA ENTRY / DATABASE AND SOFTWARE REQUIREMENTS

All spawn deposition data will be entered into the “portable ALEX” database 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 files will be imported into the ALEX 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 105-foot vessel capable of accommodating six 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 2007) and emergency response to dive accidents will follow the 2008 dive safety plan.

Two aluminum skiffs that have been enhanced for diving purposes will accompany the support research vessel.

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- Jessen, R. J. 1978. Statistical survey techniques. John Wiley & Sons. New York.
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Table 1.–Estimated number of samples required to achieve statistical objective.

	Estimated target transects/nmi		
	Based on 1994 analysis	Based on 1997 analysis	Based on 2000 analysis
Sitka	0.2	0.6	0.3
Revilla Channel	1.0	1.8	3.4
Seymour Canal	2.8	2.4	1.2
Craig	0.8	3.1	1.3
Hobart/Houghton	4.5	1.7	3.6
Vixen Inlet (Ernest Sound)	1.9	5.0	3.5
Hoonah Sound	2.9	1.0	0.7
Tenakee Inlet	5.1	1.2	1.6
West Behm Canal	-	0.4	1.7

APPENDICES

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

CODE	EXPANDED CODE	SPECIES INCLUDED	LATIN NAMES
AGM	Agarum	Sieve kelp	<i>Agarum clathratum</i>
ALA	Alaria	Ribbon kelps	<i>Alaria marginata</i> , <i>A. nana</i> , <i>A. fistulosa</i>
ELG	Eel grass	Eel grass, surfgrasses	<i>Zostera marina</i> , <i>Phyllospadix serrulatus</i> , <i>P.</i> <i>scouleri</i>
FIL	Filamentous red algae	Sea brush, poly, black tassel	<i>Polysiphonia pacifica</i> , <i>P.</i> <i>hendryi</i> , <i>Pterosiphonia</i> <i>bipinnata</i>
FIR	Fir kelp	Black pine, Oregon pine (red algae)	<i>Neorhodomela larix</i> , <i>N. oregona</i>
FUC	Fucus	Rockweed or popweed	<i>Fucus gardneri</i>
HIR	Hair kelp	Witch's hair, stringy acid kelp	<i>Desmarestia aculeata</i> , <i>D.</i> <i>viridis</i>
LAM	Laminaria	split kelp, sugar kelp, suction- cup kelp	<i>Laminaria bongardiana</i> , <i>L.</i> <i>saccharina</i> , <i>L. yezoensis</i> (when isolated and identifiable)
LBK	Large Brown Kelps	Five-ribbed kelp, three-ribbed kelp, split kelp, sugar kelp, sea spatula, sieve kelp, ribbon kelp	<i>Costaria costata</i> , <i>Cymathere triplicata</i> , <i>Laminaria</i> spp., <i>Pleurophycus gardneri</i> , <i>Agarum</i> , <i>Alaria</i> spp.
MAC	Macrocystis	macrocystis	<i>Macrocystis integrifolia</i>
NER	Nereocystis	Bull kelp	<i>Nereocystis leutkeana</i>
RED	Red algae	All red leafy algae (red ribbons, red blades, red sea cabbage, Turkish washcloth)	<i>Palmaria mollis</i> , <i>P.</i> <i>hecatensis</i> , <i>P.</i> <i>callophyloides</i> , <i>Dilsea</i> <i>californica</i> , <i>Neodilsea</i> <i>borealis</i> , <i>Mastocarpus</i> <i>papillatus</i> , <i>Turnerella</i> <i>mertensiana</i>
ULV	Ulva	Sea lettuce	<i>Ulva fenestrata</i> , <i>Ulvaria</i> <i>obscura</i>
COR	Coralline algae	Coral seaweeds (red algae)	<i>Bossiella</i> , <i>Corallina</i> , <i>Serraticardia</i>

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

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

Appendix C.–Southeast Alaska traditional herring spawning locations.

