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A Program for Improving Management and Research of Fisheries in the Southeast Region—Herring

by

Kyle Hebert

February 2010

Alaska Department of Fish and Game **Division of Commercial Fisheries**

Symbols and Abbreviations

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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	use 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

REGIONAL INFORMANTION REPORT 1J10-01

A PROGRAM FOR IMPROVING MANAGEMENT AND RESEARCH OF FISHERIES IN THE SOUTHEAST REGION—HERRING

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The Regional Information Report Series was established in 1987 and was redefined in 2007 to meet the Division of Commercial Fisheries regional need for publishing and archiving information such as project operational plans, area management plans, budgetary information, staff comments and opinions to Board of Fisheries proposals, interim or preliminary data and grant agency reports, special meeting or minor workshop results and other regional information not generally reported elsewhere. Reports in this series may contain raw data and preliminary results. Reports in this series receive varying degrees of regional, biometric and editorial review; information in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author or the Division of Commercial Fisheries if in doubt of the level of review or preliminary nature of the data reported. Regional Information Reports are available through the Alaska State Library and on the Internet at: http://www.sf.adfg.ak.us/statewide/divreprots/htlm/intersearch.cfm.

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TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

ABSTRACT

This report summarizes research and management information gaps and projects to address those gaps for herring in Southeast Alaska. Projects identified in this document are currently unfunded or under funded. If fully funded these projects would contribute to the knowledge base for the species associated with each project and in many cases facilitate management of abundance based fisheries that exploit those stocks.

Key words: Herring, funding, spawn-on-kelp, purse seine, gillnet, subsistence, biometrics, Blue Book

INTRODUCTION

OVERVIEW OF SOUTHEAST ALASKA COMMERCIAL FISHERIES

The Southeast/Yakutat Region, stretching south from Cape Suckling to the Canadian border at Dixon Entrance, is divided into two registration areas. Registration Area A, the Southeast Alaska area, extends from Dixon Entrance to Cape Fairweather. Area D, the Yakutat area, extends from Cape Fairweather to Cape Suckling. Pacific herring stocks are found throughout the region. The stocks vary greatly in size and productivity. Herring are harvested in the region in commercial bait, sac roe, spawn-on-kelp and bait pound fisheries. In the Yakutat area the only commercial herring fishery allowed by regulation is a winter bait fishery. Subsistence and personal use harvesting of herring and herring spawn-on-kelp and spawn-on-branches occurs in both areas.

Prior to 1967 most of the region's harvest was taken in a commercial reduction fishery with a historic peak harvest of 79,700 tons in 1929; this fishery typically harvested mixed stocks of feeding herring during the summer months for reduction to meal and oil. A commercial winter bait fishery has occurred annually since the turn of the century and has historically supplied most of the bait for Alaskan commercial longline and pot fisheries. Harvests in this fishery are taken by purse seine gear during the fall and winter months, when bait quality is best, on discrete wintering schools in major bays and inlets. Since statehood, annual winter bait harvests have ranged from 460 tons to 6,400 tons.

Sac roe fisheries began to dominate the Southeast industry beginning in 1971. Sac roe fisheries are held in the spring immediately prior to spawning when egg maturity is highest. Southeast Alaska commercial sac roe fisheries are limited entry fisheries, with two exclusive purse seine areas (Sitka Sound and Lynn Canal), two exclusive set gillnet areas (Kah Shakes/Cat Island and Seymour Canal), and the Hobart Bay/Port Houghton fishery area where a herring gillnet sac roe fishery is allowed if the winter bait fishery does not harvest the entire guideline harvest level (GHL). The Sitka Sound purse seine sac roe fishery is the largest herring fishery in the region, with annual harvests during the 1980–2009 seasons ranging from 1,900 tons to 14,750 tons, and exvessel values for the 50 permit holders as high as $14.3 million. During the January 2003 meeting, the Board of Fisheries adopted regulations allowing a sac roe fishery in West Beam Canal, near Ketchikan. This fishery is unique to Southeast herring fisheries because allowable gear types will alternate between purse seine and set gillnet each fishery. The first year of the fishery was scheduled to occur in 2004 using gillnets, however due to a very poor return of spawning biomass the fishery was not conducted. The West Behm Canal fishery has not opened since 2004 because the spawning biomass threshold has not been reached. The Lynn Canal purse seine fishery has been closed since 1982 due to low stock abundance. Since 1980, sac roe harvests in the combined gillnet areas have ranged from 300 tons to 3,300 tons, and exvessel values for the approximately 120 permit holders have been as high as $3.2 million. Two herring

spawn-on-kelp pound fisheries developed in the early 1990s in the Hoonah Sound and Craig/Klawock areas. The spawn-on-kelp fisheries became limited entry fisheries in 1995. In January 2003, the Board of Fisheries adopted regulations creating spawn-on-kelp fisheries in Tenakee Inlet and Ernest Sound. Herring mortality in spawn-on-kelp fisheries is probably lower than other fisheries, as herring are released after spawning and the value of the fishery is derived from eggs deposited on suspended kelp blades. Annual exvessel value for the Northern Southeast Alaska permitted areas (Hoonah Sound and Tenakee Inlet fisheries) has ranged from $169,000 to almost $4.5 million. Exvessel value for the Southern Southeast permitted areas (Craig and Ernest Sound fisheries) has ranged from $69,000 to about $1.3 million. Fresh bait and tray pack bait pounds are allowed under a permit system in Southeast, but very little harvest has occurred in these fisheries during the last two decades (0 to 80 tons annually). Growing interest in bait pound fishing opportunities lead the Board of Fisheries to modify regulations during the January 2003 meeting, by combining fresh bait and tray pack seasons, quotas and use descriptions to allow greater flexibility to participate in these fisheries.

MANAGEMENT OF SOUTHEAST ALASKA HERRING FISHERIES

Southeast Alaska commercial herring fisheries are managed according to the Herring Management Plan for Statistical Area A, adopted by the Board of Fisheries in 1994. This plan directs the department to manage herring stocks on a spawning area basis, to establish minimum spawning biomass thresholds below which fishing is not allowed, to assess abundance of mature herring for each stock before allowing fishing to occur, to allow herring harvests at exploitation rates between 10% and 20% of the estimated spawning biomass when the biomass exceeds the minimum threshold level, to identify and consider other sources of mortality in setting harvest guidelines, and to modify fishing periods to minimize incidental mortalities during commercial fisheries.

Threshold levels represent a minimum herring biomass needed to allow commercial harvest, and have been established for each area where winter bait, sac roe, and spawn-on-kelp pound fisheries exist. In areas where spawning biomass meets or exceeds the threshold level, guideline harvest levels (GHLs) are established based on a graduated scale that allows for higher harvest rates as the herring population increases, reaching a maximum of 20% when the population is six-times the threshold level.

Herring populations are assessed annually to estimate herring spawning biomass. The department estimates spawning biomass using miles of shoreline receiving spawn (as documented using aerial and skiff surveys) and diver estimates of herring egg deposition on the spawning grounds. Spawning biomass is estimated as the product of estimated egg density and spawn mileage, with adjustments made for age composition and fecundity. For most major stocks, forecasts of the following year's spawning biomass are made using an age-structured analysis (ASA). This method applies estimates of recruitment, growth, maturation, and natural mortality to an estimate of spawning escapement from one year to forecast herring biomass for the next year.

Management of sac roe fisheries is very demanding due to short intense fishing periods during which the GHL can be taken in less than one hour. Harvests are timed to coincide with the brief period when roe quality and value is the highest. For this reason management is very intensive, and relies on frequent aerial and sonar surveys of schooling fish, test fishing, as well as close contact with industry to assess product quality prior to fishing. In years when demand for bait exceeds the GHLs, intensive on-the-grounds management can also be necessary in winter bait

fisheries. Bait fisheries occur at night and close contact with industry is maintained via radio to assess harvest rates. Management of spawn-on-kelp pound fisheries also requires significant staff time and effort to monitor all aspects of the fishery. Due to the intensive nature of the fisheries and the need for extended periods of on-the-grounds management, costs of managing herring fisheries are frequently substantial.

EFFECTS OF GENERAL FUND REDUCTIONS

General fund support for herring fisheries management and stock assessment in Southeast Alaska, including such basic tools as aerial surveys and management vessel expenses, has fluctuated substantially in recent years. Additionally, during the January 2003 Board of Fisheries meeting, the Board approved several new herring fisheries, including an annually alternating purse seine-gillnet sac roe fishery in West Behm Canal, and spawn-on-kelp fisheries in Tenakee Inlet and Ernest Sound. The department has not received an increased allocation to support these fisheries. In response to declining budgets and new fisheries, and after consulting with industry, the department has implemented new or expanded herring test fisheries in the region to support some of the most critical functions of the program. Test fishing is not the department's preferred method of funding important research and management programs because of the need to harvest fish and because of logistical and administrative difficulties associated with oversight of test fish contracts and conducting test fishing operations. Funding essential herring management and assessment programs through more secure funding sources that do not require resource extraction is desired.

PROPOSED PROJECTS

This document contains a list of projects proposed for increased funding. The projects described are either not conducted due to a lack of funding, are currently operated at levels insufficient to meet management objectives, or a reduction in our reliance on test fish revenue is sought. Projects are grouped into three categories (Table 1). The first category (A) covers replacing five test fisheries currently operated in the region with a more stable funding source. This is a high priority for the department. The second category (B) covers improvements needed in the region's herring stock assessment program. Within the stock assessment category projects are listed in order of priority. The third category (C) covers funding surveys to estimate subsistence harvest, particularly harvest of eggs on branches in the Sitka Sound area.

Table 1.–Summary of proposed projects and estimated costs (thousands of dollars).

Project	Estimated First-Year Cost	Estimated Annual Continuing Cost	Duration
A. Fishery Management			
A.1. Herring Fishery Management	$115.0	$115.0	Long Term
B. Stock Assessment Projects			
B.1. Herring Biometrics Support	$110.0	$110.0	Long Term
B.2. Herring Research Fishery Biologist II	$80.0	$80.0	Long Term
B.3. Movement, Migration, Stock Identification*	$80.0	$90.0	5 Years
B.4. Maturation Study*	$15.0	$15.0	5 Years
B.5. Survey Methods Improvement for Macrocystis Kelp*	$20.0	$20.0	3 Years
B.6. Juvenile Index Survey Pilot*	$75.0	$75.0	2 Years
B.7. Fecundity Estimates	$15.0	$15.0	Long Term
B.8. Calibration Factors	$28.0	$28.0	Long Term
B.9. Expanded Herring Spawn Deposition Surveys	$20.0	$20.0	Long Term
C. Subsistence Harvest Estimates			
C.1. Sitka Sound Subsistence Herring Roe Fishery Harvest Assessment	$23.0	$23.0	Long Term
Total	$501.0	$511.0	

*signify projects that also require the addition of a Fishery Biologist II position.

A. FISHERY MANAGEMENT PROJECTS

Herring test fisheries provide funding for many of the region's essential herring management and stock assessment activities. Test fisheries are conducted in the Ketchikan, Petersburg, Sitka, and Juneau management areas, with revenues used to support management and assessment activities in each of the respective areas. Revenues from several of these test fisheries are substantial when compared to the value of associated commercial fisheries. Test fishing is not the department's preferred method of funding important research and management programs because of the need to harvest fish and because of logistical and administrative difficulties associated with oversight of test fish contracts and conducting test fishing operations.

Project A.1. Herring Fishery Management

Location: Southeast Alaska.

Primary Objective: To provide biological samples and revenue to support herring management and assessment programs in Southeast Alaska.

Description: Gillnet sac roe test fisheries have been conducted in West Behm Canal in the Ketchikan management area, Hobart Bay/Port Houghton in the Petersburg management area, and Seymour Canal in the Juneau management area. Purse seine sac roe and winter bait test fisheries have been conducted in the Sitka management area. Spawn-on-kelp test fisheries have been conducted in Section 3-B, Ernest Sound, Hoonah Sound, and Tenakee Inlet. Biological samples gathered from the fisheries provide age, sex, and size data, weight-at-age, and fecundity data that are used in generating biomass forecasts used to set following year's GHLs. Revenues from the

fisheries are used to conduct aerial surveys, charter vessels, and help cover costs of managing fisheries in these management areas.

Duration: A long-term stable funding source is desired.

Estimated Annual Cost: $115.0k.

B. Stock Assessment Projects

Management of the region's herring stocks relies heavily on monitoring and analysis of spawning biomass. The first project in this category is increased biometric support for the herring research program, which is badly needed to deal with a backlog of stock assessment, modeling, and analysis needs to address trends of biomass and age composition. Funding of the next four ranked projects in this section could help improve understanding of life-history patterns and ultimately improve the department's abilities to estimate current-year spawning biomass and forecast biomass. Some of these projects would require relatively large-scale efforts over a short period to complete. Projects that would require a substantial short-term investment in time and funding include Movement and Migration, Maturation Study, and Juvenile Index Survey Pilot. The last two projects listed in Table 1 (Fecundity Estimates and Calibration Factors) would require less upfront funding and time investment, but would continue annually. The intent of these projects are not to answer major questions, but rather to supplement annual data collection with regular updates of fecundity estimates and increased sample size for calibration factors to more precisely estimate spawn deposition. The addition of new projects, particularly large or complicated projects, may require additional support staff, such as project biologists or technicians, to carry out or assist with implementation.

Project B.1. Herring Biometrics Support

Location: Southeast Alaska.

Primary Objective: To improve the region's herring stock assessment program through increased biometric support.

Description: Additional biometric support is needed for the herring program in Southeast Alaska. Currently one biometrician position is funded to provide biometric support for all herring and most groundfish project needs in the Southeast and Yakutat areas. Because that position also supervises all biometrics projects in the region (herring, shellfish, groundfish, salmon), the time available for herring analysis is limited to only conducting annual stock assessments. A backlog of stock assessment modeling, analyses, and reporting has accumulated and there is no additional time for additional analyses that may improve stock assessments. We are requesting funds to hire a permanent full-time Biometrician II in order to improve management and assessment of herring fisheries.

There are numerous biometric improvements that need to be made to improve the region's herring stock assessment program. Refinement and sensitivity analyses of ASA models used to forecast and evaluate herring biomass are needed. External estimates of age-specific survival would improve the model and provide more accurate forecasts of spawning biomass. Although it is understood that survival rate varies considerably throughout the herring life cycle a constant (average) survival rate is currently used in the modeling process for all age classes because empirical estimates have not been made for Southeast Alaska stocks. Age specific estimates

could be obtained using currently-available age data, additional empirical studies, and modeling. Another improvement to the ASA model would be incorporating bootstrapping to estimate confidence intervals for ASA model parameter estimates such as biomass. There is a long list of other analyses to explore including, estimating variability in age composition, incorporating a miles of milt index and addressing weighting concerns with egg index in the ASA model, incorporating a temperature time series into the model, applying the ASA model to additional stocks, re-evaluating biomass thresholds for all areas, migrating the ASA model from Excel spreadsheets to AD Model Builder software, and re-evaluating sampling rate for spawn deposition survey transects. The above list of analyses represent potentially significant improvements to stock assessments for herring, but do not include the addition of any major new projects, which follow below.

Duration: A long-term stable funding source is desired.

Estimated Annual Cost: $110.0k.

Project B.2. Herring Research Fishery Biologist II

Location: Southeast Alaska.

Primary Objective: To improve the region's herring stock assessment program through stable research staff support.

Description: Through 2005 the region had two Fishery Biologist IIs and one Fish and Wildlife Technician to assist with coordination and implementation of herring stock assessment projects in Southeast Alaska. One of the Fishery Biologist II positions was deleted when the incumbent accepted another position within the region. The funds associated with the position were reprogrammed to provide stable funding for the remaining two positions. Those two remaining positions had been funded by a wide variety of short term projects which have since lapsed or been significantly reduced.

Although regular stock assessment survey and sampling needs are being met with current staff, if new projects are added (signified with asterisk in Table 1), a new Fishery Biologist II position will be necessary to assist with, and/or implement field work, data management, and report writing.

Duration: A long-term stable funding source is desired.

Estimated Annual Cost: $80.0k.

Project B.3. Movement, Migration, and Stock Identification

Location: Southeast Alaska Area.

Primary Objective: To improve understanding of herring stock structure.

Description: Of primary consideration when assessing and managing herring stocks is an understanding of population structure and having some knowledge about whether there exists spawning site fidelity and stock discreteness. Debate about how to define herring stocks continues at many levels from scientific researchers to local resource users. In Southeast Alaska, herring are assessed based on areas where spawning is recurrent annually and is spatially or

temporally separated from other spawning areas. To improve or verify delineation of herring stocks in Southeast Alaska, an understanding of movement or migration patterns would be highly valuable. Herring in Southeast Alaska, and elsewhere, may be distributed broadly across areas, and exhibit seasonal movement/migration, and even mix with other stocks during summer feeding or over-wintering months. In addition, age, size, or maturity classes may have different distributions over the course of a year. The extent of movement, mixing, and "straying" to other spawning areas is unknown in Southeast Alaska. In some areas, the rate of exchange between areas is suspected to be at high levels. In the Ketchikan area, herring abundance around Kah-Shakes, Cat Island, Annette Island, and West Behm Canal, has fluctuated so much that movement between areas is highly suspected. Other areas where significant exchange may occur are Hobart Bay-Port Houghton and Seymour Canal. Additionally, there have been questions raised about whether herring in Salisbury Sound are discreet from herring in the Sitka Sound spawning area.

The most direct way to estimate the extent of movement is to conduct tagging studies. Very limited tagging studies have been conducted in Southeast Alaska in the past, during the 1930s herring reduction fisheries. These studies used internal tags and focused on movement between Sitka Sound and Craig. British Columbia has had a successful tagging program in more recent years using external tags. Other non-tagging studies are have been conducted or are on-going to attempt stock differentiation using genetics, fatty acid composition, or analysis relating otolith chemistry to water chemistry in the vicinity of spawning grounds.

A full-scale tagging program would require significant funding and time, as it should involve several areas/stocks and several years of release and recovery. A smaller pilot project involving two spawning areas should be done to evaluate feasibility of tagging and recovery methods. Such a project would require a large vessel platform, potential contracting with commercial purse seine vessels, and use of herring pound structures. It is expected that herring would be captured during spawning season, stored in submerged pound structures while tagging, and then recaptured during subsequent commercial fisheries at processing plants.

Duration: Five years.

Estimated Annual Cost: $90.0k.

Project B.4. Maturation Study

Location: Sitka Sound or other spawning areas in Southeast Alaska Area.

Primary Objective: Explore validity of assumption that immature age-3+ herring exist.

Description: Traditionally in Southeast Alaska, age-3 herring was the first age class to be observed in samples of spawning herring and were an indication of recruitment to the spawning population. In recent years very few or zero age-3 herring have been observed in samples taken from the spawning population, in several areas. However, samples taken the following year revealed age-4 fish, or age-5 fish after two years. This suggests that age-3 fish did exist in the population as a whole, but do not enter the spawning population until they are older. Age-structured analysis models suggest that there has been a change in maturity schedule (i.e. proportion of mature herring at each age) for herring in Sitka Sound, possibly due to shifts in ocean conditions. Models estimate that even though age-3 herring are not observed in samples of mature fish, they exist in the population but as immature fish, resulting in greater biomass

estimates than otherwise would occur. Based on histological studies, some researchers in British Columbia found that all age-3 herring in that region are maturing, and contend that there are no large concentrations of immature age-3 herring, even though stock assessments reveal lower proportions of age-3 fish than age-4 fish one year later. Although observations of age-4+ fish a year after observing no age-3 fish is a compelling indication that herring are maturing later in life, it is worth exploring other methods to determine if results corroborate or contradict this contention. A study to determine maturity based on ovarian histology would require significant funding for laboratory time and sample collection. One or two spawning areas should be chosen for collection of herring and herring ovaries over a period of years, and samples would be processed in a laboratory by examining and measuring individual oocytes under a microscope.

Duration: Five years.

Estimated Annual Cost: $15.0k.

Project B.5. Survey Methods Improvement for Macrocystis Kelp

Location: Sitka Sound in Southeast Alaska Area.

Primary Objective: Develop spawn deposition survey method specific for Macrocystis kelp.

Description: Spawn deposition surveys are conducted throughout Southeast Alaska annually to provide a basis for estimating and forecasting herring biomass. The method involves following transects across the width of egg deposition and estimating the number of eggs within a sampling frame every five meters. The habitat encountered along transects is variable and kelp forms may range from carpet-like algae to towering Macrocystis kelp that form a canopy "forest". The survey method works well for low-lying kelp forms that are within 2-3 feet of the bottom. However, because individual Macrocystis stipes may be 20-40 feet tall and often extend from the bottom to the surface, it is a challenge to obtain a reasonably precise estimate of the number of eggs within the sampling frame, which is set on the bottom. Herring egg estimates are commonly found on Macrocystis kelp and at times in great numbers. During years when significant herring eggs are spawned on Macrocystis kelp, estimates of total egg deposition for an area may be highly variable. This is because egg estimates of one Macrocystis plan may be highly variable, and one, or very few, transects that cross Macrocystis kelp beds could result in very high egg estimates relative to other transects, resulting in high uncertainty around total estimate egg deposition. A method for use specifically when Macrocystis beds are encountered may result in lower variability of total estimates. Macrocystis kelp is found mainly in spawning grounds around Sitka Sound and Craig. A method would be developed in one of these two areas and then, pending results, applied within annual spawn deposition surveys.

Duration: Three years.

Estimated Annual Cost: $20.0k.

Project B.6. Juvenile Survey Index Pilot

Location: Sitka Sound in Southeast Alaska Area.

Primary Objective: To ultimately predict strength of recruitment to spawning populations.

Description: In Southeast Alaska, the department's herring stock assessment program focuses on sampling during egg and mature (typically age-3+) herring stages. There is a poor understanding of herring ecology, abundance, and distribution during larval through age-2 or age-3. The department's stock assessment methods estimate age-3 herring after they join the mature population, but not before entering the mature population. Currently, forecasts of age-3 herring have been based on assuming the median number of estimated age-3 herring from past years, or more recently for age-structured modeled areas, based on a spawner-recruitment relationship. These methods have been used because there is no sampling on which to base estimates. A method to forecast recruitment to the mature population may be beneficial by potentially allowing more accurate forecasting of overall return, and if so, more appropriate harvest levels.

Surveys designed to index and forecast strength of recruitment (age-3 herring) have been conducted in British Columbia with some success, at least since 1991. These surveys are comprised of conducting several transects within bays using purse seine, and data are used to determine the relative amount of herring in their first and second year. Those young herring are then compared to estimates of herring of the same cohort 1-3 years later to develop a statistical relationship. A survey of similar design could be explored and potentially initiated in the Sitka Sound area to better forecast recruitment.

Duration: Ten years.

Estimated Annual Cost: $75.0k.

Project B.7. Fecundity Estimates

Location: Various herring spawning areas in Southeast Alaska.

Primary Objective: To provide estimates of fecundity by size.

Description: Accurate and regular estimates of fecundity are important for ground truthing assumptions used for spawner-recruitment relationships that are incorporated into estimates and forecasts of herring biomass. In addition, fecundity estimates are used to convert estimates of herring egg deposition into biomass of the mature component of the population. This project would estimate fecundity to establish a relationship between egg number and weight of fish. Sample collection would rotate among several stocks so that estimates of fecundity would be updated every few years, particularly for stocks with existing long survey data time series.

Duration: Long-term.

Estimated Annual Cost: $15.0k.

Project B.8. Herring Diver Calibration Studies

Location: Entire Southeast Alaska Area.

Primary Objective: To improve accuracy of divers' estimates of herring egg deposition.

Description: Calibration factors are used to compensate for estimator error while visually assessing herring eggs during spawn deposition surveys. Divers estimate the number of eggs on kelp within a fixed area and then collect those eggs and kelp for later laboratory counts. Correction factors are then developed for each diver by kelp type, and directly applied to their

visual estimates made during surveys. For several years calibration factors have been relatively low (close to one) and consistent among divers and years. Individual calibration factors can have a potentially large impact on spawn deposition estimates of biomass because typically 5–6 divers' estimates comprise most of the data. In recent years the ratios have become variable and inconsistent. Recent variable and very high calibration factors have raised concerns about using the data because the reason for the change is unknown. During this time several changes in the assessment program have occurred. For example, there have been fewer samples collected each year, a different laboratory is used for processing, a different egg preservative is used to store eggs, and estimator experience level has changed with new personnel.

A directed study of the several steps involved in producing calibration factors may help determine the underlying cause of recent changes in the ratios. Specifically, there is a need to investigate: appropriate sample size, estimator feedback from laboratory, differences among areas, differences among years, field sample collection procedure, preservative type, laboratory sample processing, and data analysis. This study would require vessel time and staff time (estimators, lab, and biometrician), and some travel and equipment.

Duration: Three years.

Estimated Annual Cost: $28.0.

Project B.9. Expanded Herring Spawn Deposition Studies

Location: Lynn Canal, Lisianski Inlet, and other areas of Southeast Alaska.

Primary Objective: To expand spawn deposition surveys to cover additional spawning stocks.

Description: Starting in the mid-1970s major herring stocks in Southeast Alaska have been assessed using a combination of aerial surveys of spawn and subsequent spawn deposition dive surveys. Direct estimate of herring egg density, which is obtained from the dive surveys, has been a useful tool for determining herring spawning biomass and forecasting returns. Continuation of this method for all currently exploited stocks is desirable and expansion to other recovering or low-level stocks in anticipation of future exploitation would improve the modeling process used to determine forecasts. Where spawn deposition data exists for an adequate time series, Age Structured Analysis (ASA) is the preferred model and it has been used to forecast herring returns for Sitka Sound, Craig, Tenakee Inlet, Kah-Shakes/Cat Island, and Seymour Canal stocks. For acceptable model goodness of fit a ten-year continuous minimum is required for spawn deposition records. A more general model is applied to data from other major stocks that have fewer than ten years of spawn deposition data. For those stocks where no spawn deposition data exists, spawning biomass is estimated as the product of shoreline miles of spawn (from aerial surveys) and an average biomass-per-mile conversion factor.

Several herring stocks that once supported (or currently support) fisheries are at low levels, including Lynn Canal, Lisianski, Ernest Sound, Kah-Shakes/Cat Island and Hobart Bay/Port Houghton. During years when relatively little spawning occurred the practice has been to forego a spawn deposition estimate with the assumption that the biomass estimate will fall below the threshold to conduct a fishery. Mainly, this has been a means to preserve funds for herring surveys in more promising areas. Although this assumption may be true, it extinguishes the possibility of maintaining continuous data time series for these stocks. For some stocks (e.g. Lynn Canal and Lisianski), initiation of spawn deposition surveys would begin a data time series

that would anticipate use of the ASA model, even if fisheries were not conducted for several years. The alternative is waiting until the stock size has returned to threshold levels before conducting surveys and possibly exploiting for years before having the necessary data to take advantage of the preferred forecast model. For stocks where harvest has been intermittent over recent years (e.g. Ernest Sound and Kah-Shakes), conducting continuous annual surveys, regardless of threshold size, would maintain ASA requirements and may improve the Department's understanding of those stocks.

Duration: A long-term funding source is desired.

Estimated Annual Cost: $20.0.

C. SUBSISTENCE HARVEST ESTIMATES

Project C.1. Sitka Sound Subsistence Herring Roe Fishery Harvest Assessment

Location: Sitka Sound, Sitka (Southeast Alaska).

Primary Objective: The primary objective of this research project is to produce estimates of subsistence herring eggs-on-hemlock-branch harvests by harvesters fishing in Sitka Sound using a face-to-face interview methodology.

Description: Current regulations allow the subsistence harvest of herring and herring spawn in Districts 13(A) and 13(B) north of Latitude of Aspid Cape (5AAC 01.716(7)) and limits on customary trade in herring roe on kelp (5AAC 01.717). There are no regulations regarding subsistence reporting requirements, or specific allocations for subsistence. At the Alaska Board of Fisheries meeting in January 2002 the board made a finding for the amount reasonably necessary for subsistence herring roe in Sitka Sound, Section 13-B: 105,000 to 158,000 lbs. The Sitka Tribe of Alaska and ADF&G agreed that the Tribe will provide ADF&G with harvest data each year and this raw data will be analyzed by ADF&G, Subsistence Division using standard statistical techniques. ADF&G may publish the results in their Statewide Subsistence Harvest Database. The Tribe and ADF&G will collaborate to improve the survey and interview reporting system and survey methodology, with ADF&G providing technical consultative work and, when possible, field survey/interview project support.

Duration: A long-term funding source is desired.

Estimated Annual Cost: $23.0k.