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PACIFIC HERRING (*Clupea harengus pallasi*) RESEARCH IN SOUTHEASTERN ALASKA, 1982-1983

By:
Dennis Blankenbeckler
and
Robert Larson

March 1985

ALASKA DEPARTMENT OF FISH AND GAME
P.O. Box 3-2000, Juneau, Alaska 99802

Don W. Collinsworth
Commissioner

ADF&G TECHNICAL DATA REPORTS

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PACIFIC HERRING *(Clupea harengus pallasi)* RESEARCH IN SOUTHEASTERN ALASKA, 1982-1983[1]

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Dennis Blankenbeckler

and

Robert Larson

Alaska Department of Fish and Game
Division of Commercial Fisheries
Ketchikan, Alaska

March 1985

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ABSTRACT

The Alaska Department of Fish and Game conducted surveys to assess herring *(Clupea harengus pallasi)* for abundance, distribution, presence of other species, and size of concentrated herring schools by means of hydroacoustical equipment and subsequent midwater trawling. Priority survey areas were established by action of the Alaska Board of Fisheries. Pre-spawning concentration in potential sac roe fishing areas were surveyed for abundance to establish quotas and set the management strategy. Areas surveyed included Hoonah Sound, Ketchikan area, Juneau area, Tenakee Inlet, Sitka Sound, Boca de Quadra, and Seymour Canal. Herring samples were collected from the commercial catch and project sampling for age and growth and length frequency information. Samples were taken from either the spawning grounds, the commercial fisheries, or from midwater trawling. Laboratory analysis of a portion of samples taken in the winter and spring sac roe fishery were also processed. Baseline information was collected to determine the feasibility for developing a survey method for annually assessing herring escapements and documenting spawning ground conditions. Total biomass of herring was computed from estimates of egg densities related to the area receiving spawn. A percentage of the estimated biomass was predicted as an aid in setting season openings. Visual estimates of density showed promise for developing a fast method for evaluating spawning success. A large variation in density was observed as the result of the extent of egg deposition and substrate availability. A large variation in suitable substrate (kelp and sea grasses) available was noted in different spawning areas. Quotas and commercial fishery openings, based on available information, were established and on-the-ground monitoring by aerial and vessel surveillance of winter bait and food and spring sac roe harvests was conducted.

KEY WORDS: Pacific herring, *Clupea harengus pallasi*, biology, abundance, distribution, hydroacoustical equipment and sampling, midwater trawling.

INTRODUCTION

Abundance of herring *(Clupea harengus pallasi)* in Southeastern Alaska exhibit wide fluctuations from year to year. In order to monitor these changes a data base reflecting abundance, age structure, and spawning success is required to manage the resource.

The goal of this project is to provide biological data necessary for the scientific management of herring stocks by the Alaska Department of Fish and Game (ADF&G) throughout Southeastern Alaska. Objectives required to accomplish this goal are as follows:

1) Refine and develop hydroacoustical equipment to make reliable herring biomass estimates on a real-time basis;

2) Conduct and evaluate hydroacoustical assessments of major herring stocks in Southeastern Alaska with emphasis on the months of November and February;

3) Conduct biological sampling in Southeastern Alaska for age and growth analysis as an indicator of stock condition;

4) Develop, conduct, and evaluate spawning ground studies to provide life history information and spawner numbers to use as a comparison to hydroacoustical estimates and as a basis for quotas where reliable acoustical estimates cannot be made, and

5) Carry out in-season management responsibilities.

This report covers the period 1 January 1983 through 30 June 1983, therefore, it covers only a portion of the total fiscal year program, targeting on the spawning ground segment of the project. Data analysis is also not complete for the field sampling conducted because of the limited reporting period.

JOB 1. HYDROACOUSTICAL ASSESSMENT OF SOUTHEASTERN ALASKA HERRING STOCKS.

Objective

Refine and develop hydroacoustic equipment to make reliable herring biomass estimates on a real-time basis.

Procedures

Negotiations with the University of Washington for service contracts to computer analyze acoustical data, provide technical and maintenance services, and assist in calibration of acoustical systems were conducted.

Major stocks of herring were assessed from three ADF&G support vessels during wintering and pre-spawning concentration periods. Acoustical systems capable of assessing biomass are installed on the ADF&G support vessels in Southeastern

Alaska. The acoustic systems consists of a Ross 200A echo sounder modified for collection of data on magnetic tape. These systems operate at 105 KHz with 7° circular transducers. These systems are fully calibrated. Parameters calibrated include source level, transducer receiving response, receiver gain, receiver linearity, time-varied gain, and pulse length. Parameters, except receiver time-varied gain, are reasonably stable and are calibrated once each year. These measurements are conducted with a specialized field calibration system developed and built under contract by the Applied Physics Laboratory, University of Washington. The calibration system includes a calibrated standard hydrophone on a frame which is attached by a diver to a special mounting plate to the transducer on the ship's hull.

Hydroacoustical surveys are conducted to known herring concentration areas from October through May. November and March are target time periods when herring are distributed normally for best results. In September, prior to the field season, calibration of all acoustical systems is accomplished. Service contracts are entered into at this time with the University of Washington for computer data analysis and technical, calibration, and maintenance services during the field season. Two biologists working full time, plus support from Area Management Biologists, are required to conduct the surveys.

Surveys include defining an area encompassing a herring concentration. This is accomplished by previous experience, or searching with sonar. All vessels are equipped with Wesmar side scanning sonars or Sea Tec Omni sonars.

A series of assessment surveys are then conducted on the area of herring concentration. A series of transects spaced evenly over the area is conducted to determine the density. During surveys, midwater trawl samples are also conducted to determine species composition of acoustical targets observed. ADF&G presently has one midwater trawl with a 20 x 20 foot spread equipped with a Furuno Model FNR-200 Mark II net recorder. After the surveys are completed, the magnetic tapes are sent to the University of Washington. The magnetic tapes are analyzed and results submitted to ADF&G. It is possible to have complete analysis in 1 to 2 days after the survey. Data analysis is by echo integration using the University of Washington's data analysis system; a PDP 11/45 computer with special software and hardware modifications. In certain instances where accurate computer analyzed surveys are not possible because of herring distribution, visual estimates are made by experienced observers.

A series of surveys were conducted aboard the R/V KITTIWAKE, in Tenakee Inlet, using a Bio Sonics on-board integrator. Results were compared to computer analysis conducted by the University of Washington of magnetic tapes from the same data.

Results

Acoustical surveys were conducted in the Ketchikan area, Hoonah Sound, the Juneau area, Tenakee Inlet, Sitka Sound, Boca de Quadra, and Seymour Canal for the reporting period. Locations of survey areas are shown in Figure 1.

In Seymour Canal and Hoonah Sound herring were not distributed to allow accurate computer surveys for determination of biomass. Herring were either

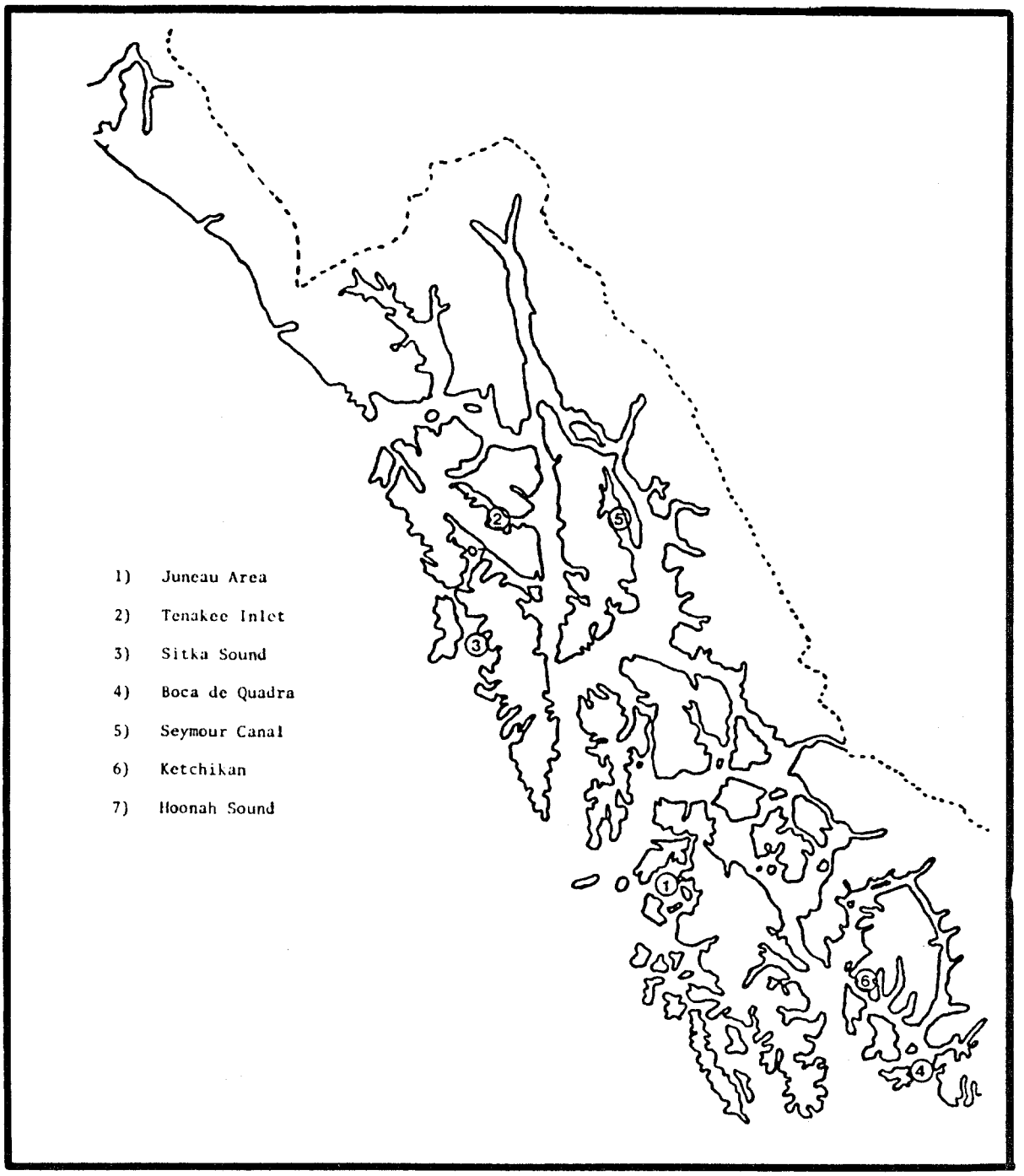

Figure 1. Southeastern Alaska study areas, Herring Research, January 1 through June 30, 1983.

in broken schools or not present in traditional areas. Visual estimates of biomass were made by an experienced observer.

Results of computer analyzed surveys from Tenakee, Sitka, Juneau, and Boca de Quadra are summarized in Table 1. The biomass ranged from approximately 11.7 million kg (Old Sitka Rocks) to 0.76 million kg (Katlian Bay).

On-board integration was done at Tenakee Inlet during the January surveys using a Bio Sonic integrator. On-board estimates provided accurate results. The advantage of the integrator was immediate results requiring no turn around time analysis.

JOB 2. COLLECTION OF AGE AND GROWTH, AND LENGTH FREQUENCIES FROM SOUTHEASTERN HERRING STOCKS.

Objective

Conduct biological sampling on herring in Southeastern Alaska for age and growth analysis as indicators of stock condition.

Procedures

Herring samples were collected from commercial seine and gillnet vessels and from processing plants in Southeastern Alaska. Also, herring samples were collected from ADF&G purse seines, variable mesh gillnets, and midwater trawls. Scale samples were mounted and read in Ketchikan for analysis.

Collection of Herring:

Herring samples for age and growth analysis were collected by either sampling the commercial catch, project trawling, variable mesh gillnets, or with a small project purse seine on the spawning grounds. The commercial catch was sampled either on the grounds from several sets or at the processor from tenders. The trawl samples were obtained from the State Fish and Game R/V STELLER. These samples are generally from more than one drag on a herring concentration. When the variable mesh gillnet was used, it was set for a very short period of time to help prevent saturation of any particular mesh size. When possible, repeated sets were made until a sufficient sample was obtained. The small project purse seine was utilized when fish were in the shallows during spawning. Samples or age and growth analysis were taken from several sets, and separated either spatially or chronologically whenever possible. All fish were either processed fresh or frozen for later examination in the laboratory. A target of 600 herring for each stock and commercial fishery was set as a goal following a Statewide herring sampling standard.

Laboratory Methods:

In the laboratory, herring were thawed immediately prior to examination. The standard length of each fish, from the tip of the snout to the caudal peduncle, was recorded to the nearest whole millimeter on a caliper measuring board. The weight was taken from an electronic balance to the nearest whole gram.

Table 1. Computer estimates of herring biomass by area and date conducted in Southeastern Alaska.

Date	Area	Survey Number	Biomass in Kilograms
1/28/83	Tenakee Inlet	1	4,024,092
1/29/83	Tenakee Inlet	1	1,741,274
1/29/83	Tenakee Inlet	2	870,637
1/17/83	Sitka (Katlian)	1	762,339
2/16/83	Sitka (Old Sitka Rocks)	1	11,707,351
2/25/83	Stephens Passage	1	1,637,485
3/19/83	Boca de Quadra	1	3,675,564

Sex was determined by dissection, and a readable (non-regenerated) scale was selected for age determination.

Scales were cleaned and dipped in a solution of 10% mucilage glue and water and placed unsculptured side down for permanent mounting on glass slides. Aging was conducted using a dissecting microscope, varying the light source for optimum image of annuli. Scale reading results were spot-checked by a second reader for verification. The fish were assigned an anniversary date for each complete growing season. All samples collected were taken before growth had resumed in the spring. For example, if a herring was hatched in the spring of 1976 and collected in the fall of 1977, two growing seasons had occurred (age two). If the herring had been collected in the spring of 1978 (before growth had resumed), it was still recorded as age two. All scales and original data are filed and available for review upon request.

In order to supply rapid age frequency analysis, a field method utilizing plastic mylars was used. Approximately 100 herring were placed on a mylar sheet and standard lengths marked with a soft lead pencil. By calculating lengths versus age from previous analyses an overlay was prepared. This served as a rapid means of evaluating recruitment. An example of mylars and overlays is illustrated in Figure 2. The original mylars are on file in the Ketchikan office.

Results

Samples were taken from the Tenakee Inlet, Seymour, Sitka, Juneau, and Boca de Quadra stocks during the reporting period. Approximately 2,000 herring were analyzed for age and growth in the laboratory. The Sitka area sampling showed a strong year class of the 3 year old herring entering the spawning stock. The Seymour area showed an older age stock consisting of strong 6 year old herring.

The Juneau area showed a similar trend to Seymour indicating strong showings of 5 and 6 year old herring. The Quadra area had a balanced age composition of 3, 4, 5, and 6 year old herring. Laboratory processing of data completed during the reporting period illustrating area, date sampled, number sampled, age composition by numbers, and average length is shown in Table 2.

JOB 3. CONDUCT SURVEYS ON HERRING SPAWNING GROUNDS TO ASSESS SUCCESS OF SPAWNING.

Objective

Develop, conduct, and evaluate spawning ground studies on herring to provide: (1) life history information, (2) a comparison to hydroacoustical estimates, and (3) a basis for quotas where reliable acoustical estimates cannot be made.

Procedures

Aerial surveys were conducted to provide an index of spawning success in terms of beach area receiving spawn. Intensive ground surveys utilizing SCUBA transects determined substrate type, egg densities, and predator relationships of Southeastern herring stocks.

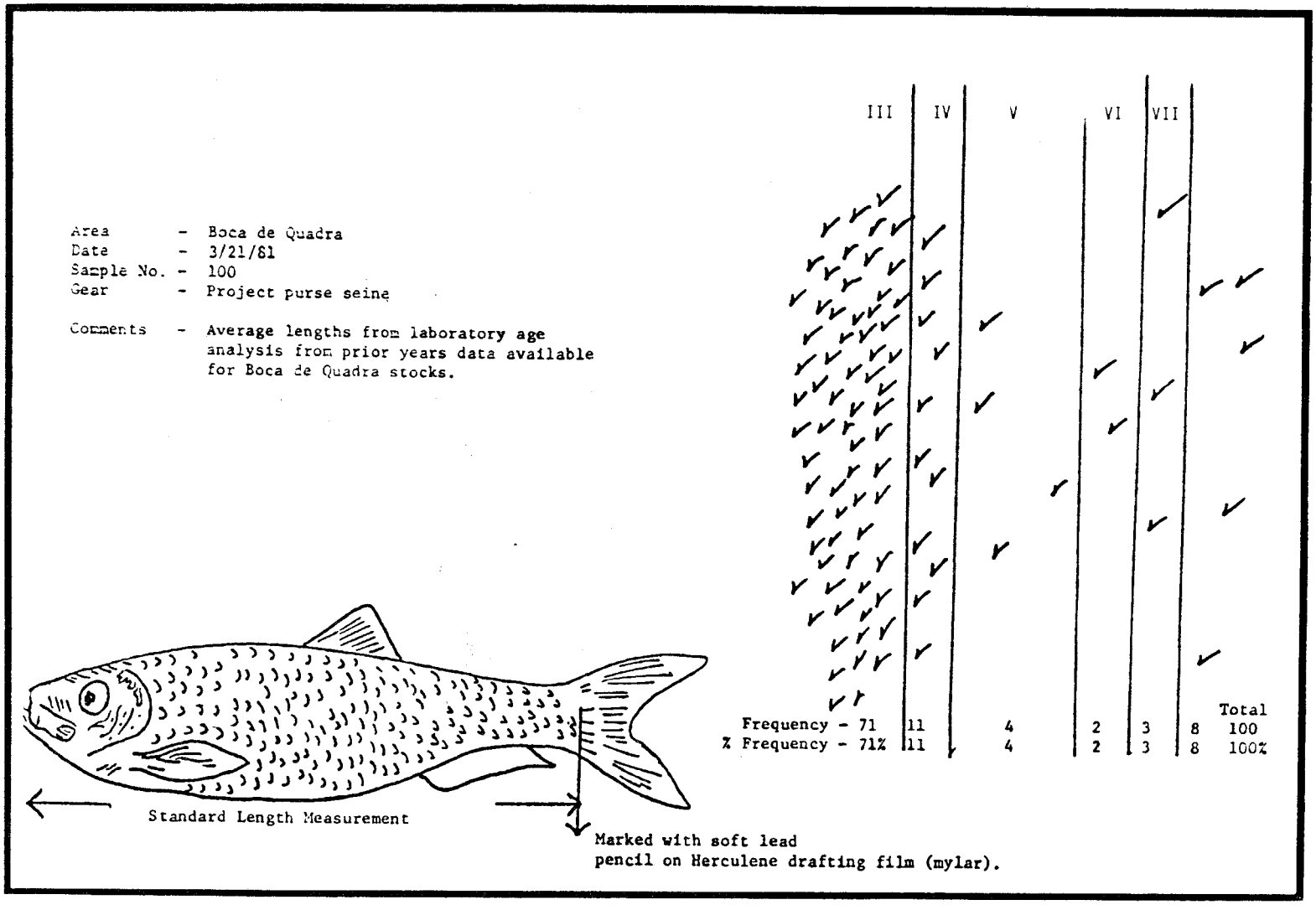

Figure 2. Illustration of mylar field method of age analysis.

Table 2. Summary of herring scale analysis performed during reporting period and area sampled by date.

AREA	DATE	N	% Age Composition By Numbers II	III	IV	V	VI	VII	VIII	Mean Standard Length in mm
Sitka Long Is.	4/05/83	50	8	85	0	0	0	7	0	181.3
Sitka Galanikin Is.	4/05/83	50	2	94	2	0	0	2	0	181.0
Sitka Samsing Cove	4/05/83	50	2	83	8	0	0	6	0	178.9
Sitka Pirates Cove	4/05/83	50	2	84	5	0	0	9	0	186.5
Sitka Galanikin Is. #2	4/05/83	50	4	85	4	2	2	2	0	182.9
Sitka Pirates Cove #2	4/05/83	50	0	90	2	0	0	8	0	184.7
Sitka Cannon Is.	4/21/83	50	0	98	2	0	0	0	0	178.1
Sitka Dog Point	4/07/83	50	2	71	7	0	5	15	0	190.6
Sitka Boat Hbr.	4/07/83	50	0	95	5	0	0	0	0	179.3
Sitka Starrigavan Bay	4/07/83	50	0	91	4	0	0	4	0	180.2
Seymour Canal	5/01/83	156	0	13	3	5	67	8	4	189.0
Seymour Canal	5/02/83	185	0	15	6	11	66	1	1	189.0
Juneau (Fishery 82) #1	4/20/82	106	0	9	7	50	29	3	2	203.7
Juneau (Fishery 82) #2	4/20/82	106	0	0	4	61	28	4	3	206.3
Juneau (Lynn Canal)	4/15/83	122	2	38	3	7	35	13	3	184.9
Tenakee Inlet	11/03/82	76	0	11	9	4	28	47	1	214.7
Scow Bay	5/06/82	99	0	9	45	18	12	8	7	216.0
Quadra (Slate Is.)	3/23/83	79	0	14	18	16	48	3	1	204.8
Quadra (Slate Is.)	4/07/83	173	6	38	26	7	23	1	1	188.2
Quadra (Slate Is.)	3/23/83	101	0	13	27	15	44	2	0	202.1
Quadra (Kirk Pt.)	3/22/83	181	1	18	29	7	43	2	1	196.7
Quadra (Kirk Pt.)	3/22/83	132	0	14	30	11	39	2	3	195.0
TOTAL		2,016								

The following methods were used in the estimation of egg deposition.

Index of Beach Receiving Spawn:

An index reported as linear miles of beach receiving spawn was determined by aerial and boat surveys in Southeastern Alaska.

Aerial surveys were conducted on a periodic schedule to document presence of eggs on intertidal kelp, milt present in the water, herring schools, and bird and sea mammal activity. Most types of small aircraft were acceptable, with a Cessna 180 or 185 type airplane ideal, allowing for greater range over a Super Cub (traditional fish spotting airplane). In certain areas skiffs were used to monitor the coastline to collect the same information.

Favorable weather conditions, experienced observers, and low tidal conditions were pre-requisites to collecting meaningful data.

Comprehensive Spawning Ground Surveys:

SCUBA divers were used to collect samples and to document biological and physical parameters on established transect lines.

Spawning study areas were delineated by systematic aerial and boat surveys. Once the spawning area was defined, transects were established at 400 to 800 m (1/4 to 1/2 mi) intervals along the beach. Transect lines or compass courses were set perpendicular to the shore, measured at 5 m intervals. Divers followed the transect line or compass heading until spawn or vegetation disappeared. Data collected included depth, temperature, substrate type, egg layers, visual estimates of eggs in a 0.1 square meter frame, and subsequent collection of eggs and kelp from the frame. Sampling equipment used was as follows:

1) 100 m 6.35 mm (1/4 in) nylon line graduated at 5 m intervals with fluorescent orange surveyor tape and weighted at each end. The line was coiled into a garbage can and laid by skiff, perpendicular to the shore.

2) 0.1 square meter sample frame made from perforated 18.30 mm (3/4 in) plastic pipe. A pocket meat thermometer and photograph index reference was permanently mounted on the sample frame.

3) Small sample bags (approximately 2 liter, 0.5 gallon capacity) and larger diver collection bag to hold individual samples.

4) Standard diving equipment including depth gauge, compass, and underwater timer.

Kelp and egg samples were transferred from the divers bag to 4 liter (1 gallon) size water tight zip lock bags and preserved in Gilson fluid for later laboratory analysis. Only a small amount, 1/4 to 1/2 liter (1/2 to 1 pint), of Gilson fluid was added to the sample for preservation. Preserved samples were then taken to the laboratory for chemical separation and counting. The following is a detailed procedure for determining egg densities from collected samples:

1) Decant the Gilson fluid from the sample bags.

2) Add 1 normal KOH to the sample bag and thoroughly mix through the sample. Allow the sample to soak for 1.5 hours in KOH digestive hydrolysis. Placing the sample bag in a hot water bath accelerates digestion (eel grass can stand a strong digestion, while other kelps disintegrate quickly, impeding egg sortings).

3) Drain off KOH and place sample in a 4 liter (1 gallon) plastic bucket.

4) Repeated cold water washes of the sample will loosen many of the attached eggs. Decant and filter each wash through a fine mesh sieve. Majority of the eggs in the sample can be removed and collected from the filtrate.

5) The remaining eggs must be cleaned from the substrate by careful manual scraping. The loose eggs must be clean of kelp debris for accurate volumetric analysis.

6) Hand count and record all eggs that are lost or cannot be cleaned from the substrate.

7) The loose egg sample must be allowed to soak in 1.0 Normal buffered formal saline solution for approximately 24 hours to assure a standardized volumetric displacement.

8) The preliminary step in quantitative analysis is to determine the standard displacement of 1,000 eggs. This is done by handcounting 1,000 eggs from a number of samples and determining the average displacement.

9) Hand count totals are added to the sample displacement and this figure is expanded by a factor of 10 to determine eggs/m^2 at each sample station. One technician can work up approximately six samples per day at a chemical cost of approximately $2.00 per sample.

Results

The majority of the work accomplished during the reporting period was focused on spawning ground assessment.

Comprehensive spawning ground surveys utilizing SCUBA were conducted at Boca de Quadra, Sitka, Juneau, and Seymour Canal. A summary of data collected is presented in Table 3.

Boca de Quadra:

A total of 30 transects was sampled in Boca de Quadra to determine egg density, areas of spawn, vegetation utilized for spawning, temperature, and depth of spawn. By calculating estimate of total eggs present to required spawners, a preliminary biomass of 14.11×10^6 kilograms of herring escaped in 1983 to spawn.

Table 3. Summary of data collected in research studies on Southeastern Alaska spawning grounds, January 1 through June 30, 1983.

AREA	YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	PRELIMINARY HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	PRELIMINARY HERRING AVERAGE WEIGHT IN KILOGRAMS	AVERAGE FECUNDITY	PRELIMINARY INDEX OF ESCAPEMENT IN KILOGRAMS X 10^6
Boca de Quadra	1983	3/22 - 4/07	4/06 - 4/11	15.0	212.0	0.17	29,415	14.11
Sitka	1983	3/21 - 4/24	4/13 - 4/17	68.0	193.0	0.11	22,585	30.39
Seymour	1983	5/06 - 5/11	5/09 - 5/11	10.0	190.0	0.11	22,585	4.22
Juneau	1983	4/24 - 4/26	5/06 -	6.0	190.0	0.11	22,585	0.45

YEAR	COMMERCIAL HARVEST IN KILOGRAMS X 10^6	PRELIMINARY INDEX OF TOTAL HERRING BIOMASS AVAILABLE IN KILOGRAMS X 10^6	% HARVEST OF BIOMASS	KILOGRAMS OF HERRING PER LINEAR MILE X 10^6	RANGE IN DEPTH IN FEET SPAWN OBSERVED	TEMPERATURE RANGE FOR SPAWNING °F	PLANKTON BLOOM OBSERVED	PREDATOR BIRD ACTIVITY OBSERVED
1983	2.90	7.94	17%	0.93	+10 to -30'	N/A	Moderate	Heavy
1983	4.99	35.38	14%	0.44	+13 to -38'	44-45°	Moderate	Light
1983	0.00	4.22	0%	0.46	+11 to -37'	45-48°	Moderate	Moderate
1983	0	1.00	0%	0.16	+ 7 to -30'	44°	Moderate	Heavy

Sitka:

A total of 63 transects was sampled in Sitka. By back-calculating estimates of total eggs present to required spawners, a preliminary biomass of 30.39 x 10^6 kilograms of herring escaped in 1983 to spawn.

Seymour Canal:

A total of 18 transects was sampled in Seymour Canal. By back-calculating estimates of total eggs present to required spawners, a preliminary biomass of 4.22 x 10^6 kilograms of herring escaped in 1983 to spawn.

Juneau Area:

A total of 10 transects was sampled in the Juneau area. By back-calculating estimates of total eggs present to required spawners, a preliminary biomass of 0.45 x 10^6 kilograms of herring escaped in 1983 to spawn.

JOB 4. GROUND MANAGEMENT OF SOUTHEASTERN HERRING STOCKS.

Objective

Carry out in-season management responsibilities.

Results

In-season management assistance was provided during March and early April for the Kah Shakes and Sitka herring sac roe fisheries. Pre-fishery sampling, industry meetings, and monitoring of effort and catch were duties accomplished. Pre-fishery sampling included aerial surveillance of herring schools and spawning activity, workup of test fishery results for size, age, and degree of egg maturity, and sonar abundance estimates from State vessels.

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