Regional Operational Plan CF.2A.2016.02

Operational Plan: Abundance, Age, Sex, and Size Sampling of Herring in Togiak District

by

Greg Buck

and

Charles Brazil

February 2016

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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by

Greg Buck and Charles Brazil

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February 2016

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Signature Page

Project Title:	Togiak Herring Catch Sampling, 2016
Project leader(s):	*Greg Buck*
Division, Region and Area	Commercial Fisheries, Region 2, Anchorage
Project Nomenclature:	FM-20457
Period Covered	2016
Field Dates:	Late April-Late May
Plan Type:	Category I

Approval

Title	Name	Signature	Date
Project leader	Greg Buck		2-17-2016
Biometrician	Xinxian Zhang		2/17/2016
Research Coordinator	Jack Erickson		2-17-2016

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PURPOSE

The Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries, annually monitors abundance/biomass of Pacific herring *Clupea pallasi* in Togiak District of Bristol Bay, Alaska. Herring are sampled for age, length, and sex composition from commercial purse seine and gillnet harvests. Aerial survey abundance/biomass estimates and age composition are used for the inseason management of the commercial herring fishery in Togiak District. This report provides operational guidelines for the Togiak herring catch sampling project, sampling procedures, abundance/biomass estimate, and general camp policies.

Key words: Togiak, Bristol Bay, Pacific herring *Clupea pallasi*, commercial herring fishery, sac roe, spawning biomass, escapement, age composition, sex composition, length, weight, fisheries management, Dutch Harbor, food and bait, operational plan

BACKGROUND

The largest commercial fishery for herring in Alaska occurs in Togiak District of Bristol Bay (Figure 1) and is conducted on fish that overwinter near the Bering Sea shelf and move inshore to spawn in early spring. The sac roe of pre-spawning females are targeted in this fishery, primarily for the Japanese market. Commercial fishing for herring in Togiak District began in 1968 and expanded rapidly through the mid-1980s, and currently harvests around 21,000 tons of a 144,000 ton biomass annually (10-year mean).

Herring that spawn in Togiak District are managed as a distinct population with a maximum exploitation rate set at 20% of the available spawning biomass (5AAC 27.865). The existing management plan allocates 1,500 tons to a spawn-on-kelp fishery (not currently prosecuted) and reserves 7% of the remaining available harvest for a food and bait fishery conducted out of Dutch Harbor on herring that have migrated through Togiak District, along the coast and clockwise down the Alaskan Peninsula. The remaining harvest is reserved for the Togiak sac roe fishery with 30% allocated to the gillnet fleet and 70% to the purse seine fleet.

An accurate measure of abundance (biomass) is essential to the proper management of this fishery. Forecasting future biomass is accomplished using an age-based model (Funk and Rowell 1995) and therefore it is critical that we have an estimate of the age composition of the biomass present and harvested each year. Tracking the biomass and age composition of the Togiak herring population began in 1976 and has continued annually since 1978 (McBride et al. 1981; McBride and Whitmore 1981; Fried et al. 1982a, 1982b, 1983a, 1983b, and 1984; Lebida et al. 1985a, 1985b; Lebida 1987; Sandone and Brannian 1988; Lebida and Sandone 1990; Rowell et al. 1991; Rowell 1995, 2002a, 2002b; West 2002; West et al. 2003; Schwanke 2003a, 2003b; Brazil 2007a, 2007b, 2007c; Brazil et al. 2009; and Buck 2010a, 2010b, 2012, 2013a, 2013b, 2014, 2015).

OBJECTIVES

Objectives for the Togiak Herring Catch Sampling project are to

1. Sample the commercial herring harvest in Togiak District with respect to time periods, fishing sections, and gear types to accurately estimate age composition of such that the estimates are within +/- 10% of the true value 90% of the time:
    a. Available spawning biomass, and
    b. Commercial harvest by gear type.
2. Collect the following biological information on each fish sampled such that the estimates are within +/- 10% of the true value 90% of the time:

a. Sex,
b. Length,
c. Weight,
d. Gonad Condition,
e. Age, and
f. Catch information (date, location, processor, and gear type).

METHODS

STUDY DESIGN

Study Site

Historically, catch sampling has been accomplished with a crew based at Togiak Fisheries International (TFI), located on Togiak Bay and drawing samples from floating processors and TFI itself. In 2014 we shifted our operation to King Salmon and currently draw all our samples from local shore plants. Only fish landed at shore plants in Naknek and King Salmon are sampled at this time.

Age, Sex, and Length Composition

Age, sex, and size information will be collected from herring captured in the commercial fishery. This information is used by management and research biologists to:

1) forecast herring abundance,
2) monitor harvest levels,
3) determine run timing, entry patterns, and distribution of herring arriving on the spawning grounds,
4) estimate in-season run strength,
5) monitor sexual maturity and age composition,
6) determine optimal spawning goals, and
7) gain a better understanding of the biology of this stock. The usefulness of age-sex-length (ASL) data depends on its accuracy.

DATA COLLECTION

Herring Sampling

Pacific herring samples will be obtained from the commercial catch during fishery openings. Herring will be sampled across gear type and fishing section as much as is practical. Furthermore, samples will be collected from multiple vessels when possible to sample multiple schools of fish as much as is practical. For detailed data collection procedures refer to the HandheldPC sampling instructions provided (Appendix A.1). The Project or Crew leader is responsible for coordinating with ADF&G Togiak herring district fishery managers to ensure adequate coverage.

Length Measurement

Standard length from the anterior most extremity of the herring (tip of the lower jaw) to the edge of the hypural plate at the base of the tail will be measured to the nearest millimeter. Measurements will be taken for every herring sampled unless the specimen has been mutilated.

Sex and Gonad Maturity

Sex and maturity will be determined for each herring by visual examination of the gonads. Maturity of both male and female herring will be rated by a shortened version of the eight-scale guideline outlined in Barton and Steinhoff (1980). Categories used are: unknown (1), immature-green or not ready to spawn (3), ripe or ready to spawn (5), and spent or already spawned (7 or 8). Refer to Gonad Maturity Index (Appendix A.1).

Weight

Each herring sampled will be weighed to the nearest gram using an electronic scale. The scale will be calibrated with a known weight prior to each sampling session.

Scale Collection

The desired sample size of a multinomial population results in an estimate whereby each category simultaneously falls within 5% (α =0.05) of the true population age proportions 90% of the time (Thompson 1987). A sample size of 400 herring from the commercial purse seine fishery provides this level of precision and accuracy. A sampling goal of 400 fish per 3-day strata, or 134 fish per day will be utilized. A sampling goal of 150 herring per section per day will be utilized for the gillnet fishery.

A scale, for age determination, will be removed from the left side of each fish approximately 2.5 cm behind the operculum and 2.5 cm below the lateral line. There are 5 body areas on the left side to remove preferred scales (Appendix A1). If scales are absent from a preferred area, a scale will be removed from the right side of the fish in the same location; one of the other preferred areas, or anywhere a readable scale is present. Removed scales will be dipped in 10% mucilage solution and mounted sculptured side up on the glass microscope slides. A second slide is taped over the first once 10 scales have been mounted to protect the mounted scales. Scales will be aged using a 10x dissecting microscope post season.

Age Composition

Inseason age composition will be estimated daily from length data collected from sampled herring from each management section using average length-at-age data and available aged fish. Postseason age composition will be estimated from the complete scale collection and applied to the commercial harvest and total run biomass estimate.

Sampling Log

A sampling log will be maintained to keep track of the number of samples collected by gear type, location, and date. This log will also be used to track samples and slides. It is the responsibility of the sampling crew to accurately log samples and label slides. It is the responsibility of the Project or Crew leader to ensure the sample log is updated and accurate, and that scale slides correspond to the log.

Commercial Harvest

Inseason commercial harvest will be estimated by processors and reported to ADF&G fisheries management staff in Dillingham. Postseason commercial harvest will be calculated from fish tickets (sales receipts) completed by processing companies and buyers. Estimates of waste or discarded herring will be obtained from aerial survey estimates of discarded herring or processor reports. Estimated waste will be included in the fish ticket database and included in the

commercial harvest. It is the responsibility of the ADF&G fishery managers in Dillingham to calculate the commercial herring harvest inseason and postseason. Bristol Bay research staff will use this data to estimate age composition of the commercial harvest and total run biomass.

Biomass Estimate

Herring biomass for Togiak District will be estimated using aerial survey assessment procedures outlined by Lebida and Whitmore (1985). Weather permitting, aerial surveys will be flown daily by management staff at low tide to estimate herring abundance. Togiak District is divided into index areas to facilitate survey documentation. Estimates for each index area will be summed to provide biomass estimates for each management section by day.

DATA REDUCTION AND ANALYSIS

Age, Weight, and Length Data

Age, weight, and length data will be collected on a handheld PC and stored in a corresponding ACCESS database. Inseason age composition will be estimated from historical weight-at-age information. Postseason, scales from collected samples will be aged using a microfiche reader. Scales are aged by counting the annuli formed at the end of winter prior to spawning (Shaboneev 1965). The outer edge of the scale is counted as an annulus. Age, sex and size data are applied to the commercial catch for each fishery type (test purse seine, commercial purse seine, and gillnet) and each sub-district and finale biomass estimates by age will be calculated in Excel and applied to the total run biomass or preseason forecast if a reliable biomass estimate is not made.

The percent age composition by number, for each age class P_a, will be estimated for each gear-time-area as

$$P_a = \frac{n_a}{n} \tag{1}$$

where

n_a = the number of herring in the sample that were age *a*, and

n = the total number of herring in the sample.

The mean weight-at-age, $\overline{W}_a$, for herring will be estimated for each gear-time-area stratum by

$$\overline{W}_a = \frac{\sum_{i=1}^{n_a} W_{ai}}{n_a} \tag{2}$$

where

W_{ai} = the individual weight of herring in sample *n* that were age *a*.

The mean length-at-age will be calculated by substituting the individual length L_{ai} of herring for the individual weight W_{ai}.

Biomass Estimation

Age information from the herring samples collected by nonselective gear (commercial purse seine and test purse seine) are examined across management sections and catch date to detect temporal and spatial trends in age composition, which would indicate immigration of new herring or emigration of herring from the fishing district after spawning.

Age composition, by weight, of the commercial harvest and of the appropriate daily biomass data for each age class is estimated as:

$$B_a = \left[\frac{n_a \overline{W}_a}{\sum_{a=1}^{\max_a} (n_a \overline{W}_a)} \right] B, \tag{3}$$

where

B_a = the biomass of the harvest for age *a*,

n_a = the number of herring in the sample that were age *a*,

$\overline{W}_a$ = the mean weight for herring of age *a*, and

B = the total estimated harvest expressed as biomass or daily biomass estimate.

Age composition of the waste, or deadloss (i.e., herring that were caught but not sold), will be assigned the same age composition for the same gear type and harvest date.

The number of fish for each age class, N_a, will be calculated by

$$N_a = \frac{B_a}{\overline{W}_a}. \tag{4}$$

The run biomass, B_{tot}, will be calculated by summing the biomass by each age class and management section from the selected daily aerial surveys:

$$B_{tot} = \sum_{i=1}^{n} B_i \quad (5)$$

where *i* is the aerial survey estimate in each survey section (Figure 2).

The inshore escapement biomass, E_{tot}, is the summation of the difference between the run biomass, M_a, for each age and the combined purse seine and gillnet harvest for each age, C_a:

$$E_{tot} = \sum_{a=1}^{maz} (M_a - C_a) \quad (6)$$

It is the responsibility of the ADF&G fishery managers in Dillingham to calculate the commercial herring harvest inseason and postseason. It is the responsibility of Bristol Bay research staff to estimate a revised total run biomass from all available aerial survey estimates. It is the responsibility of the Project Leader to apply age composition, by weight, to calculate daily biomass data for each age class and apply it to the total run biomass estimate or preseason forecast if a reliable biomass estimate is not available.

SCHEDULE AND DELIVERABLES

Project operation dates are determined by the fishery with start dates ranging from late April to late May. While our ability to forecast the timing of this fishery is limited, it is believed that the timing of this migration is driven by sea surface temperature and sea ice conditions. Sampling will continue for the duration of the fishery, typically 10-14 days. There is currently no budget to operate this project but to cover this project with permanent full-time staff would cost approximately $4,000 in travel and per diem (Table 1). Data collected inseason will be analyzed and archived by December 31st and reported in an annual ADF&G peer reviewed Fisheries Data Series report prior to the start of the following season.

RESPONSIBILITIES

Greg Buck, Research Project Leader, ADF&G.

Duties: Oversees project and serves as budget manager. Responsible for the project operational plan. Assist with the collection of data and responsible for data accuracy. Age herring scales. Author final technical report. Provide forecast and forecast summary to other ADF&G staff. Assist with management outlook and postseason summary.

Xinxian Zhang, Biometrician, ADF&G.

Duties: Provide statistical supervision and assists in project design. Review and provide statistical support for the data analysis and reports as required.

Charles Brazil, Area Research Project Leader, ADF&G.

Duties: Assist in preparation of the project operational plan. Review and approve progress and final report.

Tim Sands, Area Management Biologist, ADF&G.

Duties: Togiak District commercial fishery manager. Conducts aerial surveys to estimate herring biomass and collect harvest data. Provide logistical support. Provide management outlook and postseason summary news releases to the public.

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Table 1.– Projected expenses for Togiak herring catch sampling, Bristol Bay Research.

Staff	Personnel Cost (Per Diem)	Travel
Chuck Brazil	$840.00	$300.00
Greg Buck	$840.00	$400.00
Fred West	$840.00	$600.00
Total	$2,520.00	$1,300.00

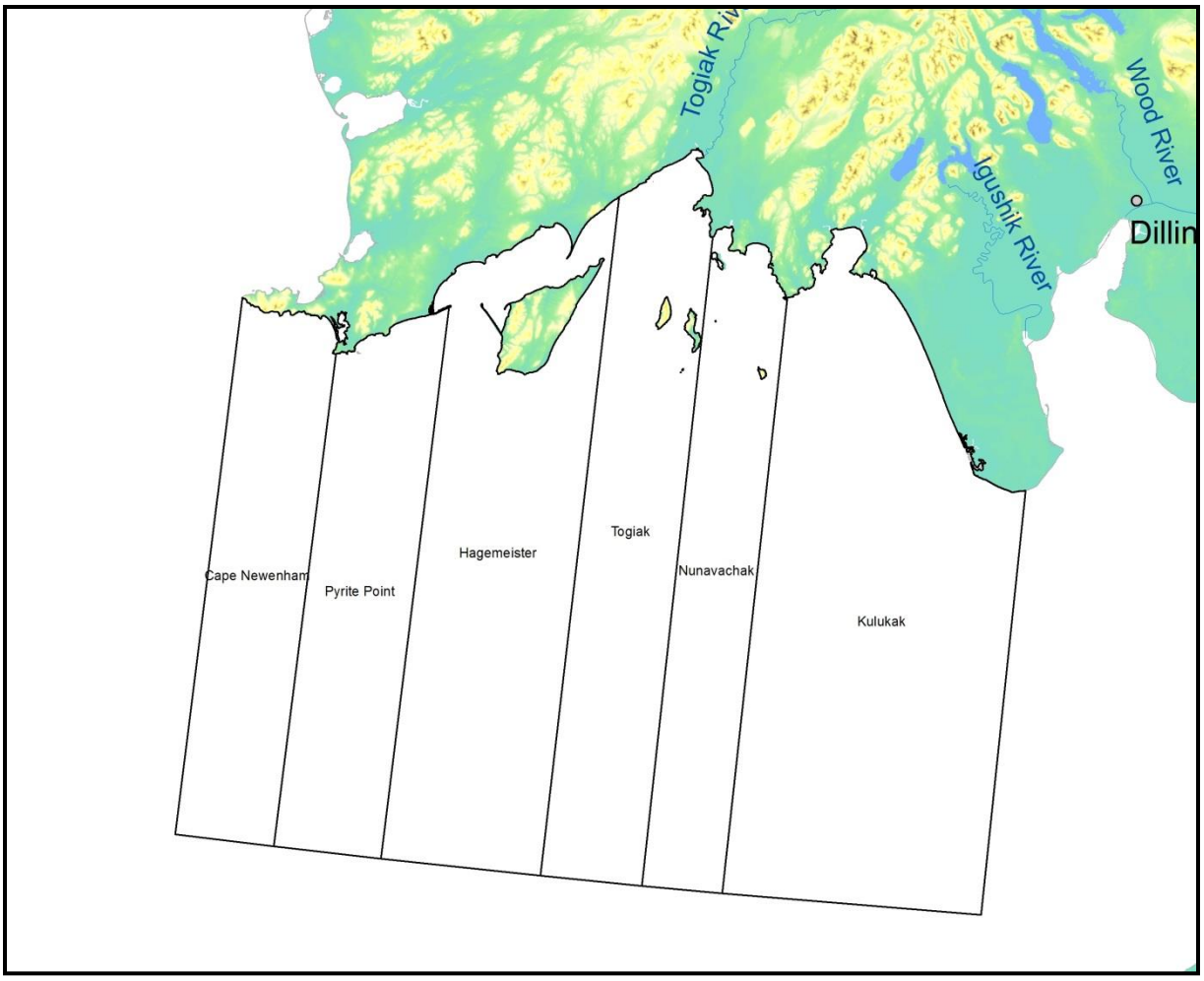


Figure 1.–Fishing management sections with Togiak District, Bristol Bay, Alaska.

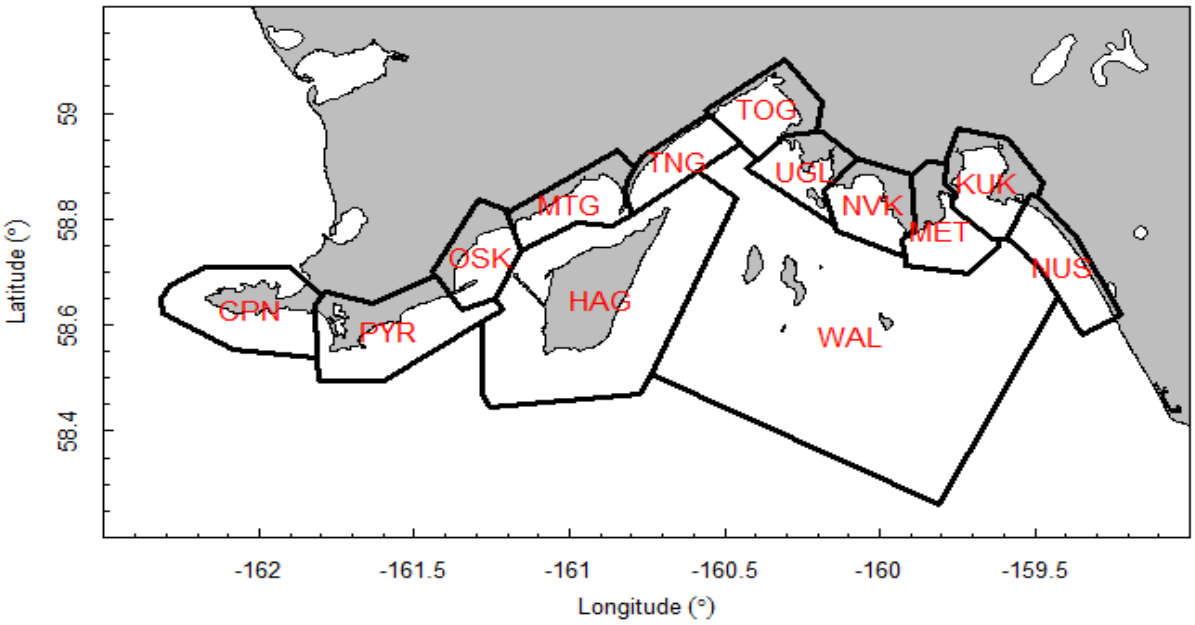


Figure 2.–Togiak aerial survey sections, Bristol Bay.

Note: Survey sections abbreviated as NUS - Nushagak Peninsula; KUK - Kulukak; MET - Metervik; NVK - Nunavachak; UGL - Ungalikthluk/Togiak; TOG - Togiak; TNG - Tongue Pt.; MTG - Matogak; HAG - Hagemeister; OSK - Osviak; PYR - Pyrite Point; CPN - Cape Newenham; WAL - Walrus Islands.

Organizing the sample

Lay out the fish from a sample on to cookie trays covered in plastic. Arrange herring in columns of 10 (This is the number of scales that can be mounted on a slide. Lay each herring on its right side with its snout facing left. Slides should be labeled with species, catch date and sample ID (time + device name) and fish numbers within that sampling session. Sample ID is generated by the sampling program outlined below when the sampler begins a sampling session. Print labels for slides using template provided (SlideLabel.xls). Once scales are collected they are mounted as shown:

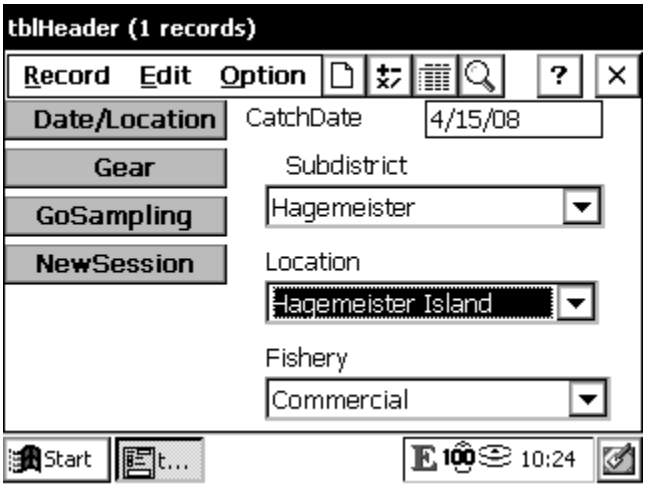
HERRING 4/9/08 15:05:09 AllegroCE_18722 FISH 1-11	1	2	3	4	5
	6	7	8	9	10

Organize trays such that one sampler can collect sex, length, gonad information on the handheldPC while the other sampler(s) collect scale samples.

Collecting Sex, Length and Gonad condition

Herring sampling on the Allegro handheld PC is accomplished using two tables (tblHeader and tblFish) on the handheld that are synched with corresponding tables the ACESS database located on the desktop (C:\TogHerring\TogHerringNew.mdb). Information collected on the allegro will be transferred automatically to the desktop database whenever the allegro is connected. Transferred records are not retained on the Allegro.

Each data table on the allegro has a data collection form (tblHeader.vce and tblFish.vce) located in the \My Documents directory on the handheld. Samplers initiate sampling using the tblHeader.vce form (link provided on desktop) to collect information about the sampling session and then 'jump' to the tblFish.vce to collect information on individual fish in that sampling session. Opening tblHeader.vce, the sampler sees:



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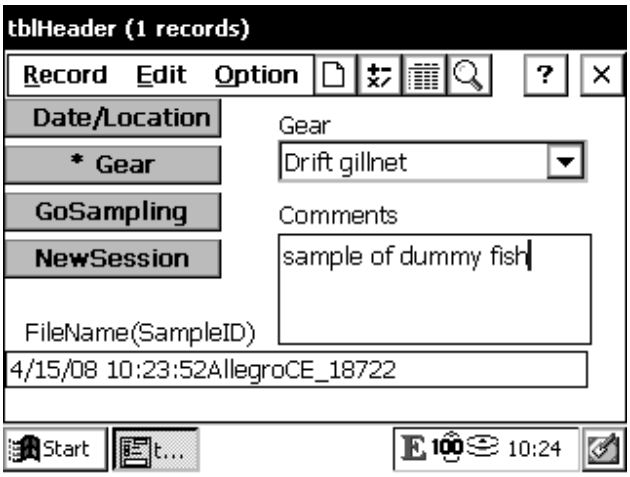
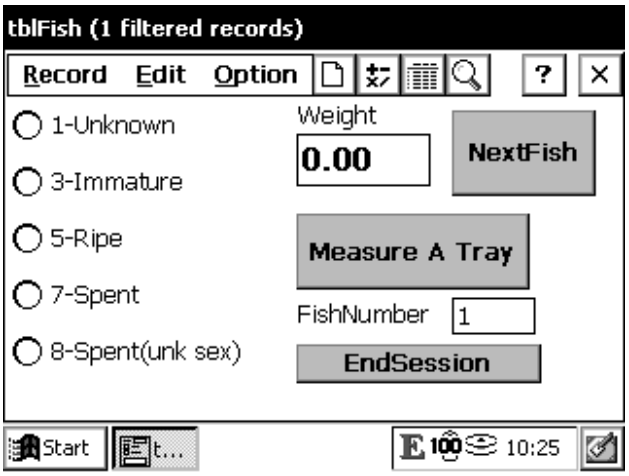
Control buttons are located on the left of the screen and data entry fields on the right. If there are no sampling sessions on the allegro all fields should be blank. If sampling sessions exist on the allegro, samplers should press 'New Session' to begin on a blank record.

Subdistrict and Location drop-down lists are populated from a copy of the table tblLocationnew in the ACCESS database. The Fishery drop-down list uses tblFishery as a lookup table. Catch date is entered using a 'calendar picker' type control. Once the sampler has filled out this screen press 'Gear" to go to this screen:



At this screen the sampler identifies Gear type (tblGears) and can add comments. Once this is done the sampler presses 'GoSampling' to jump to the main screen of the data collection form for tblFish:



This form is set up to sample fish in batches of 10 (tray). The sampler enters length and sex information on 10 fish using the Haglof Digitech calipers at which point the program returns to the first fish in the tray so gonad condition and weight for each fish can be added in turn. To initiate the sequence, the sampler pushes 'Measure a Tray'. This activates the antenna to receive incoming signals from the caliper (the antenna should be connected to COM1 on the top of the allegro and has a light that will blink red when activated).

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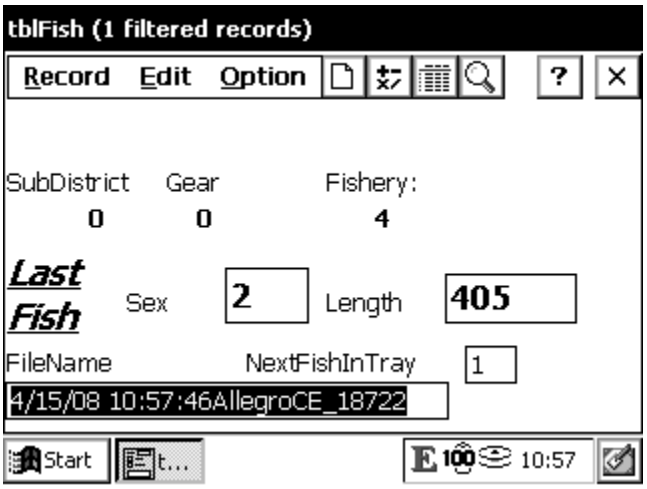
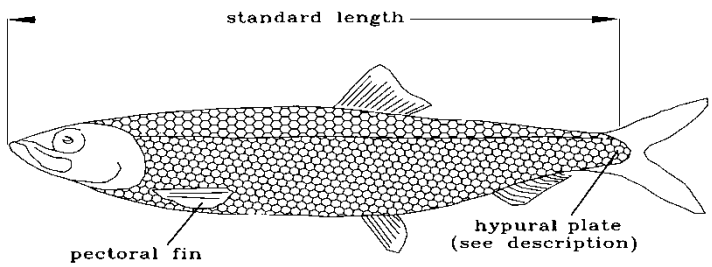
The length and sex entry screen looks like this:



Here the sampler sees some reference information (SubDistrict, Gear, Fishery) to ensure the sampler does not get out of order. They also see the sex and length of the last fish measured and which fish should be measured next ('NextFishInTray').

Sex and length information is collected on the caliper and transmitted to the handheldPC wirelessly. The Haglof digitech caliper display window holds 4 numbers with a decimal point after the 1st. That 1st number is used for the sex code (1=male, 2=female, 3=juvenile and 4=unknown) and is manipulated on the caliper using the left/right arrow buttons. The remaining three numbers display the last length transmitted (mm).

Measurements must be taken for every herring sampled unless the specimen has been too badly mangled or **THE HEAD OR LOWER JAW IS MISSING**. Length measurements require more time to gain consistency than the other tasks. Anyone tasked to measure lengths should be cross-checked by another crew member to ensure accurate measurements. Herring are measured using the Standard Length (SL) measurement, which is from the tip of the snout to the hypural plate (end of the vertebrate). Locate the area where the caudal (tail) fin rays meet the hypural plate—this can usually be felt as a slight bump when sliding the caliper jaw down the side of the fish until the edge of the hypural plate is detected. Pushing the large red 'E' key on the haglof digitech caliper sends both sex and length data to the handheldPC. Samplers will hear a beep when the allegro reads the caliper input and see the sex, length and fish number information update.



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Gonad condition and Weight measurements

Once ten fish have been measured, the program will move to the first fish in the tray just measured and return to the main screen. Here the sampler enters gonad condition and weight for each fish, using 'FishNumber' to keep in sequence and pushing 'NextFish' to advance one record. Gonad codes are:

Unknown (1)

Green (3)

Ripe (5)

Spent-sex known (7)

Spent-sex unknown (8)

Use the following descriptions to accurately describe the gonad condition:

1 **Unknown**

Gonads are very thin difficult or impossible to discern sex, usually small, juvenile herring. Body cavity clean, not bloody.

3 **Green or Immature**

Females - Eggs are opaque, considerable blood venation, usually gonads do not fill body cavity. Eggs do not flow when body cavity is gently pressed

Males - White full gonads with considerable venation from blood vessels.

Gonads in this condition do not fill body cavity.

5 **Ripe**

Females - Eggs are translucent, golden. Some blood vessels on skeins, slight pressure causes eggs to flow.

Males - White full gonads that fill the body cavity and are soft to flowing consistency are ripe males. Milt sac has little presence of blood vessels. Slight pressure causes milt to flow.

7 **Spawned out**

Gonads bloody, red and baggy for both sexes.

Residual milt may be present for males and eggs for females.

8 **Spawned out** Sex Unknown

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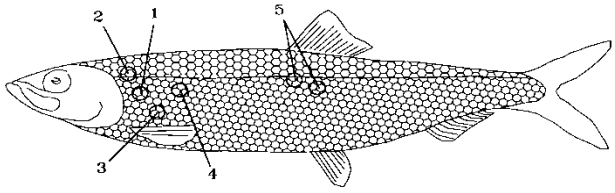
Weights are entered for each fish to the nearest gram using the Ohaus scales (calibrate daily). Collect data from as many trays of fish per sampling session as is desired. Once data are collected for all fish in a sample, push 'EndSession' button on the main screen to close the sampling session.

Scale sampling

Typically while one person collects weight/sex and gonad information on the handheldPC, other sampler(s) will collect scale samples. Use forceps to remove a scale from one of the **preferred body areas** on the left side of the fish (if necessary use the right side). Body area locations are numbered in order of preference (location 1 is most preferred; location 5 is least preferred).



If samples are scarce or a high percentage of samples have been de-scaled, check for scales behind the left pectoral fin. If no scales are present, check behind the right pectoral fin.

Only **one readable scale** will be taken from each herring with a maximum of 10 scales placed on each slide. Dip each scale in clean water, rub between thumb and forefinger to remove dirt and slime, then examine the scale (hold up to a light) for **regeneration** (regenerated scales appear blurred in the center). Discard scale if regenerated, and then repeat the procedure until a suitable scale is located.

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To **mount a scale** on the glass slide, dip the scale into the mucilage glue solution (1 part mucilage glue: 10 parts water), shake off the excess solution, and place the scale onto the labeled glass slide. To **orient the scale on the slide**, make sure that the unsculptured (concave) side of the scale is facing up and the anterior margin (portion of the scale embedded into the integument of the fish) is facing towards the top of the slide. The ridges on the scale can be felt with a fingernail or forceps. Make certain that scales are placed on the slides in a position that corresponds to the specimen number.

Press each scale firmly against the slide with a paper towel after mounting (this **removes excess glue** from underneath the scale). Set slide aside until it thoroughly dries. Place a plain slide on top of each frosted slide when all scales have been mounted. **Tape** both slides together with a piece of Scotch tape at the labeled end only. Make sure the tape does not cover any mounted scales. Always **check slide label against sample ID in the database (FileName)** when sampling is completed. **Store** completed scale mounts in slide boxes to avoid loss or breakage. **Label each slide box** with the district, subdistrict, gear type, range of slide numbers and box number for that gear type.