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Abundance, Age, Sex, and Size Statistics for Pacific Herring in Togiak District of Bristol Bay, 2010

by

Gregory B. Buck

April 2012

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

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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)

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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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The Pacific herring *Clupea pallasii* run in Togiak District of Bristol Bay was monitored for abundance/biomass and sampled for age, size, and sex composition in 2010. Abundance was estimated from aerial surveys with chartered aircraft. Commercial harvest was measured through landing reports filed by the commercial fish processors to the department. Samples were collected from commercial purse seine and gillnet harvests at the processors. The estimated 2010 run biomass was 146,913 short tons. Total commercial harvest was 28,296 tons (26,355 tons from the sac roe fisheries with 18,816 tons harvested by purse seine and 7,540 tons by gillnet and 1,941 tons harvested by the Dutch Harbor food and bait fishery). Final exploitation rate was estimated at 19%. A total of 8,130 herring were sampled for age, sex, length, weight and sexual maturity information between 10 May and 22 May 2010. The 2010 inshore herring ages ranged from 4 to 19 years, with purse seine caught fish dominated by age 5 (29%), 6 (24%), and 7 (13%) while gillnet fish were dominated by age 7 (22%), 8 (24%) and 9 (16%). Mean length and weight from the purse seine fishery samples were 285 mm and 338 grams, while fish sampled from the gillnet fishery averaged 300 mm and 394 grams.

Key words Pacific herring, *Clupea pallasii*, sac roe, abundance, spawning biomass, commercial herring fishery, Bristol Bay, Togiak District, age, length, weight, sex, Dutch Harbor, food and bait.

INTRODUCTION

Commercially exploited quantities (or stocks) of Pacific herring *Clupea pallasii* are found along the coast of Alaska from its southern boundary at Dixon Entrance to Norton Sound (Woodby et al. 2005). One of the most important of these exploited stocks is the Bristol Bay-Alaska Peninsula stock. The Bristol Bay-Alaska Peninsula herring stock has been managed as a single spawning population with a total allowable exploitation rate of 20% established by the *Bristol Bay Herring Management Plan*, 5 AAC 27.865.

Each spring, herring from the Bristol Bay-Alaska Peninsula stock migrate from their overwinter habitat north of the Pribilof Islands to spawning locations along the eastern Bering Sea coast, primarily in the Togiak region east of Cape Newenham (Figure 1). The shoreline in this region is characterized by a wide intertidal zone and shallow bays. Diurnal tidal ranges reach 4.6 m (Selkregg 1976). The primary marine vegetation consists of ribbon kelp *Laminaria* spp., rockweed *Fucus* spp., and eelgrass *Zostera* spp. Rockweed is the most visible species of aquatic vegetation because it grows on cobble substrate in intertidal areas and upon rocky outcroppings. Herring spawn throughout the fishing district, particularly in areas where eelgrass and rockweed are present.

Herring spawn within Togiak District from late April through early June. After spawning, herring continue their clockwise migration along the Alaska Peninsula to feeding areas near Unalaska Island. In August and September, these fish move north to over-wintering grounds north of the Pribilof Islands (Shaboneev 1965; Rumyantsev and Darda 1970; Wespestad and Barton 1981; Funk 1990; Tojo et al. 2007; Figure 1).

The commercial fishery for herring in Togiak District occurs as the fish move inshore at or near their time of spawning. The target of this harvest is the ripened ovaries, or egg skeins, referred to as sac roe. This product is primarily marketed in Japan. Commercial harvest of herring for sac roe was first documented in Togiak District in 1968. Passage of the Fisheries Conservation and Management Act in 1976 and the resulting inability of Japanese fishermen to harvest sac roe

from U.S. waters prompted increased interest in the Togiak fishery by U.S. fishermen. The 20-year mean sac roe harvest is presently 20,965 tons[1] (19,019 tonnes[2]; Table 1). During this period, the harvest has ranged from a high of 30,315 tons (27,502 tonnes) in 1994 to a low of 12,230 tons (11,095 tonnes) in 1990. The sac roe fishery uses gillnets and purse seines.

The herring fishery in Togiak District, which consists of all state waters between the longitude at the tip of Cape Constantine and the tip of Cape Newenham and extending south to the latitude of Cape Menshikof (approximately 4,116 km^2; Figure 2) occurs on the largest discrete spawning biomass of Pacific herring in Alaskan waters. Biomass estimates of this spawning aggregation have been conducted using aerial surveys since 1978. The largest estimated annual biomass was 239,022 tons (216,839 tonnes) in 1979, and has averaged 140,173 tons (127,164 tonnes) from 2000 through 2009 (Table 1).

Currently this fishery is managed under the *Bristol Bay Herring Management Plan* (5 AAC 27.865; Sands 2009). This plan, originally adopted in 1980, sets a 20% exploitation rate of the available spawning biomass as the management target. Of this potential harvest, a fixed allocation of 1,500 tons (1,361 tonnes) is set aside for a spawn-on-kelp harvest in Togiak District and 7% of the remaining available biomass for a food and bait fishery operated out of Dutch Harbor. All remaining available biomass is reserved for the Togiak sac roe fishery with an allocation target of 30% gillnet and 70% purse seine.

Wild spawn-on-kelp product has been historically harvested either by hand or by rake. This harvest, first documented in 1967, has been intermittent in recent years because of low demand, with no fishery occurring during the 1997, 1998, 2000, 2001 seasons, as well as from 2004 to the present (Table 1).

After leaving Togiak District, herring are susceptible to one other directed fishery during their post spawn migration. This is a food and bait fishery occurring mid to late summer around Unalaska Island with boats operating out of Dutch harbor. Harvests in this fishery began in 1929 and peaked at 3,006 tons (2,727 tonnes) in 1932 (Jackson 2008). The fishery declined and ended by 1938 because of poor market demand. This fishery was renewed in 1981 whereupon harvest quickly peaked in 1984 at 3,578 tons (3,246 tonnes) and has since trended down with the most recent 10-year average at 1,527 tons (1,385 tonnes; Table 1).

In addition to the managed harvest, Togiak herring occur as bycatch in fisheries targeting groundfish in the southeastern Bering Sea. Foreign vessels first developed this fishery but domestic fishermen have recently been more dominant. These fisheries occur in areas that include the migratory route of feeding herring (Rowell et al. 1991). In the Bering Sea and Aleutian Islands Management Area a 1% cap of available (forecasted) herring biomass has been established for this fishery (NPFMC 2009).

Stock assessments of the Togiak herring population began in 1976 and have been conducted 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

[1] The Alaska Board of Fisheries requires that inseason catch and aerial survey biomass estimates be calculated and reported in short tons. The English short ton = 2,000 lb or 907.2 kg.

[2] The metric tonne (1,000 kg or 2,205 lbs) = tons/1.1023

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).

OBJECTIVES

The specific objectives for assessing Togiak herring each year are to

1) Estimate the run biomass of spawning herring within Togiak District;
2) Document the commercial harvest (including dead loss and test fishing) of herring within Togiak District by time period (date), gear type, and district subsection;
3) Characterize the age composition as well as length and weight at age of the run, harvest (by gear type), and escapement; and
4) Estimate the total exploitation rate of herring in Togiak District.

METHODS

BIOMASS

Run biomass within Togiak District was estimated using aerial survey procedures outlined by Lebida and Whitmore (1985). Surveys were flown daily at low tide, weather permitting. The district was divided into 13 aerial survey sections (Figure 3). Daily biomass estimates were made by summing survey section estimates. Peak inseason biomass is the maximum daily estimate during the fishing season, whereas run biomass is the sum of all daily biomass estimates judged to be composed of fish not accounted for in any other survey plus any harvests that occurred prior to the first usable daily biomass estimate. In a typical fishing season, this will be the peak biomass estimate combined with an immediate postseason estimate.

HARVEST

Fish tickets (sales receipts) completed by buyers for each commercial delivery of herring were the primary source for documenting harvest. Fish ticket information included date of harvest, gear type, biomass (tons), and location by section. Estimates of waste and or discarded herring observed during aerial surveys or reported by fishermen or processors were added to the fish ticket database and counted as harvest when calculating exploitation rates.

AGE SIZE AND SEX COMPOSITION

We attempted to sample the commercial catch for age composition from each management section during every commercial fishing period (by day). Sampling staff collected samples at the close of each commercial fishing period from processors, tenders, or individual fishing vessels and labeled them by gear type, processor, and section. Attempts were made to collect samples from multiple vessels and or processors to ensure samples came from a maximum number of herring schools. Samples collected from each gear type were used to characterize the harvest of each gear type, while only fish captured by purse seine gear were used to characterize aerial survey biomass estimates because purse seines are less size-selective than gillnets.

To determine age, samplers removed a scale from the preferred left side of each fish approximately 2.5 cm behind the operculum and 2.5 cm below the lateral line for later interpretation. If scales were absent from this preferred area, a scale from the right side of the

fish in the same location or any other area readable scales were present. Removed scales were dipped in a 10% mucilage solution, mounted sculptured side up on glass slides, and read by annuli interpretation at low (~10x) magnification using a microfiche reader. Age was estimated by counting the compressed annuli formation at the end of winter prior to spawning (Shaboneev 1965). Because samples were collected during the spawning migration, the outer edge of the scale was considered an annulus.

In addition to age, the standard length (tip of snout to the hypural plate) of each fish was measured to the nearest millimeter. We weighed each herring to the nearest 0.5 g and determined sex and maturity for each herring by visually examining the gonads. We rated maturity using an abbreviated version of the 8-scale guideline outlined in Barton and Steinhoff (1980), combining categories as green (not ready to spawn), ripe (ready to spawn), or spent (already spawned).

Adequate sample sizes ensured that age composition estimates for a multinomial population resulted in a solution whereby each age category would simultaneously fall within 5% (δ =0.05) of the true population age proportions 90% of the time (Thompson 1987). A sample size of 400 herring provides this level of precision and accuracy. We attempted to collect samples daily from each section where commercial purse seine and gill net fisheries occurred.

Harvest sample group assignment was accomplished by considering the earliest samples and sequentially adding samples from subsequent days and or adjacent fishing sections if they did not differ significantly (χ^2, P<0.05) or if additional samples were needed in a step-wise process until the minimum sample size was achieved. The desired sample size for gillnet harvest groups was 400 and 200 for gillnet harvest groups. This process resulted in 8 sampling groups for the purse seine harvest (Table 2, Figure 4) and 2 for gillnet harvest; harvest on or before 17 May and harvest after that date (Figure 5).

If harvest and sampling was insufficient to characterize spawning biomass within the district, ADF&G can conduct test fishing with commercial purse seine gear to broaden coverage. Test fishing occurred during the 2010 season on 11 May in Nunavachak Section and on 23 and 24 May in Hagemeister Section.

Age composition and related information was calculated by matching sampling groups with corresponding harvest and serial survey biomass estimates. The mean weight-at-age, $\overline{W}_a$, for herring for each gear-time-area stratum is estimated as:

$$\overline{W}_a = \frac{\sum_{i=1}^{n_a} W_{ai}}{n_a}, \qquad (1)$$

where:

W_{ai} = the individual weight of herring in sample n of age a and

n_a = the number of herring in the sample of age a.

The mean length-at-age is calculated by substituting the individual length, L_{ai}, of herring for the individual weight, W_{ai}. Biomass by age, B_a, is estimated as

$$B_a = \left[\frac{n_a \overline{W}_a}{\sum_{a=1}^{\max_a} (n_a \overline{W}_a)} \right] B, \quad (2)$$

where:

B_a = the biomass for age a,

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

B = aerial survey or harvest biomass estimate.

The estimated run biomass is calculated by summing B_a for all ages. This can also be converted to numbers of fish for each age class, N_a, as:

$$N_a = \frac{B_a}{\overline{W}_a} . \quad (3)$$

The sum across all age classes of the difference between the run biomass at age B_a and the combined purse seine and gillnet harvests at age C_a which is defined as the escapement biomass, E_{tot}:

$$E_{tot} = \sum_{a=1}^{\max} (B_a - C_a) . \quad (4)$$

An age-structured analysis (ASA) model (Funk and Rowell 1995) is used to forecast the 2010 herring run (Appendix C). The latest biomass estimate included in the 2010 forecast model was for 2009.

EXPLOITATION RATE

The exploitation rate, U, is estimated as

$$U = \frac{C}{B}, \quad (5)$$

where:

C = total Togiak sac roe harvest and Dutch Harbor food and bait harvest and

B = run biomass.

RESULTS

BIOMASS

Aerial surveys in Togiak District began on 28 April (Table 3). Observers first spotted herring on 10 May during a survey that documented 2,371 tons (2,151 tonnes). Herring biomass increased steadily through 18 May to a peak inseason biomass of 98,290 tons (89,168 tonnes).

Herring concentrated their spawning biomass in the center of Togiak District (Figures 3 and 6). We estimated run biomass at 146,913 tons (133,279 tonnes) by combining the peak inseason biomass estimate on 18 May with the postseason aerial survey estimate from 2 June (assuming that spawning biomass in the district likely experienced a near complete turn-over in the interval between these 2 surveys) and harvest prior to the first survey used in this estimate. This estimate was 105% of the 10-year average and 104% of the 20-year average (Table 1).

Aerial survey conditions ranged from poor to excellent throughout the season, with excellent conditions during the peak inseason survey and good conditions during the 2 June survey (Table 3). Spawn occurred for 8.4 miles (13.5 km) along coastlines in Togiak District in 2009, with over half of it observed during the 18 May survey (Table 3). This represents 21% of the 10-year average and 16% of the 20-year average (Table 4).

HARVEST

Historically, this fishery commences around 6 May; however it has commenced as early as 25 April (in 2003) and as late as 16 May (in 2008 and 2009) within the last 10 years (Table 5). This temporal variation is largely a function of the spring ice break-up and related water temperatures in the eastern Bering Sea. In 2010, with the area experiencing a late spring, the department forecasted the first harvest on 11 May. Fishing opened on 11 May and ended on 27 May, making for a relatively long 17 day fishing season. Fishing with purse seine gear was initially open from Togiak Reef west to Cape Newenham and from Anchor Point to Right Hand Point while gillnet gear was allowed from Right Hand Point east to Egg Island (Figure 7). The gillnet area was extended to the west of Right Hand Point between 16 and 19 May and beyond 24 May to manage for gear allocation.

Commercial openings between 14 and 27 May produced a total harvest of 26,355 tons (23,909 tonnes) within Togiak District (Table 6) in 2010. The total commercial harvest in the Togiak District sac roe fishery of 26,355 tons (23,909 tonnes) represents 132% of the 10-year historical average and 126% of the 20-year average (Table 1). Catches from Hagemeister Section accounted for the largest percentage (46%) of the total commercial harvest, followed by Kulukak (26%), Nunavachak (23%), Togiak (6%), and Pyrite Point (1%) Sections (Table 6, Figure 8). No harvest was taken from the Cape Newenham Section.

Roe percentages ranged from 12.5% for herring harvested by gillnet in Kulukak Section on 26 May to 5.4% for herring harvested by purse seine in Nunavachak Section on 14 May (Table 6).

Purse Seine

There were 9 commercial purse seine openings totaling 268 hours in Togiak District between 11 May and 22 May, harvesting a total of 18,816 tons (17,070 tonnes) during 2010 (Table 6). The first opening that closed on 14 May experienced a 1,685 ton (1,529 tonnes) purse seine harvest concentrated in Hagemeister Section. Purse seine harvests peaked on 15 May with 4,630 tons

(4,200 tonnes) and ended on 22 May with a harvest of 1,886 tons (1,711 tonnes). Test fishing boats harvested an additional 279 tons (253 tonnes) postseason in Hagemeister Section on 23 and 24 May. A total of 64% of the harvest occurred in Hagemeister Section. No dead loss was reported or observed in 2010. Purse seine harvests averaged 2,060 tons (1,869 tonnes) per fishing period and excluding the initial 76 h opening the commercial purse seine fleet harvested 2,107 tons (1,911 tonnes) per day.

Roe accounted for 9.7% (by weight) of the commercial purse seine fishery and ranged from 5.4% in Nunavachak Section on 14 May to 12.2% in the same location on 15 May (Table 6). The total average roe percentage (weighted) for purse seine herring was 103% of the 10-year and 20-year average (Table 5).

Gillnet

Fourteen commercial gillnet openings totaling 388 hours were held between 14 May and 27 May, harvesting a total of 7,540 tons (6,840 tonnes), 89% from Kulukak Section and the remainder from Nunavachak Section. The first commercial harvest took 59 tons (54 tonnes). Harvest peaked on 18 May with a landing of 1,585 tons (1,438 tonnes) and ended on 27 May with a harvest of 266 tons (241 tonnes) (Table 6). Gillnet harvests averaged 539 tons (489 tonnes) per fishing period and excluding the initial 76 h opening the commercial gillnet fleet harvested 575 tons (522 tonnes) per day.

Roe accounted for 10.1% (by weight) of the commercial gillnet fishery. Roe percentages ranged from a low of 9.0% on 24 May in Nunavachak Section, to a high of 12.5% on 26 May in Kulukak Section (Table 6). The total average roe percentage (weighted) for gillnet harvested in 2010 was 94% of the 10-year and 20-year average (Table 5).

Spawn on Kelp

There was no commercial harvest for a spawn-on-kelp fishery in 2010 as there were no registered buyers (Table 1). The fishery last occurred in 2003.

AGE, SIZE, AND SEX COMPOSITION

A total of 6,430 samples collected from the commercial purse seine fishery (all sections) produced 5,560 readable scales (Table 7, Appendices B1–B3 and B5). A total of 3,410 samples were collected between 13 and 22 May in Hagemeister Section, producing 2,927 (42%) of the total readable scales (Appendices B1 and B5). A total of 2,150 samples were collected from catches on 14–20 and 22 May in Nunavachak Section, producing 1,897 (27%) of the total readable scales (Appendices B2 and B5). A total of 870 samples were collected from catches on 10, 14 and 15 May in Togiak Section producing 736 (11%) of the total readable scales (Appendices B3 and B5).

A total of 1,700 herring were sampled from the commercial gillnet fishery between 15 and 21 May from Kulukak Section producing 1,398 (20%) of the total readable scales (Table 7, Appendix B4).

Total Run

The 2010 biomass estimate was the sum of aerial survey estimates conducted on 18 May and 2 June, and all harvests occurring prior to the 18 May survey. The survey on 18 May recorded the largest biomass of the season; the only postseason survey was on 2 June. The age composition

of the peak biomass of 98,290 (89,168 tonnes) used 3,776 purse seine samples collected through 18 May. The age composition of biomass after the peak of 93,894 (85,180 tonnes) used 1,325 herring sampled from purse seine catches between 20 and 22 May.

Age classes composing more than 10% of the run either in abundance or run biomass were age-5, -6, -7, -8 and -9 fish, which comprised 16%, 18%, 13%, 13%, and 13% (respectively) of the run by weight and 24%, 22%, 13%, 11, and 9% by number (Table 8, Figure 9, Appendix A1). The mean lengths and weights of these important age classes were larger than historical means (Figures 10–11).

Similar to previous years, age composition of the run shifted from older fish to younger fish as the run progressed. Most (75%) fish surveyed at the peak of the run were age 9 or younger while 71% of the fish surveyed postseason were age 6 or younger.

Commercial Harvest

Age classes composing more than 10% of the harvest in abundance or harvest biomass were age-5, -6, -7, -8 and -9 fish, which comprised 14%, 16%, 15%, 15%, and 12% (respectively) of the harvest by weight and 24%, 20%, 15%, 13%, and 9% by number (Table 8, Appendix A1). The gillnet harvest was markedly older than the purse seine harvest (Figures 12–13).

The average length and weight of herring harvested in the commercial fishery was 288 mm and 350 g respectively. Samples collected from commercial purse seine and gillnet harvests were 49% male and 51% female (χ^2=4e^{-4}, P=0.98), varying in composition by time and location (Appendices B1–B5).

Purse Seine

Herring samples were collected from commercial purse seine openings between 14 and 22 May from Hagemeister, Nunavachak, and Togiak sections and from test fishing on 13 May in Hagemeister Section (Appendices B1–B3 and B5).

Herring sampled from the purse seine fishery ranged from age 4 to 19 (Table 8). Age-5, -6, -7 and -8 fish comprised 18%, 20%, 13%, and 12% of the commercial purse seine harvest by weight and 29%, 24%, 13%, and 10% by number (Table 8).

Herring sampled from the 2010 purse seine harvest had a mean length of 285 mm and mean weight of 338 g (Table 9). Purse seine harvest samples were 49.9% male and 50.0% female (χ^2=0.015, P=0.90), varying in composition by time and location (Appendix B5).

Gillnet

Herring sampled from the gillnet fishery ranged from age 4 to 16 (Table 8), with age-7, -8, and -9 fish representing 21%, 24%, and 17% of the commercial gillnet harvest by weight and 22%, 24% and 16% by number (Table 8, Appendices A2 and B4). Herring age 10 and older composed 30% of the gillnet harvest by weight and 26% by number while the contribution of herring age 6 and younger was 9% by weight and 12% by number (Table 8, Appendix A2).

Herring sampled from the 2010 gillnet harvest had a mean length of 300 mm and mean weight of 394 g (Table 9). Gillnet harvest samples were 44.5% male and 55.5% female (χ^2=14.1, P=1.7e^{-4}), varying in composition by time (Appendix B4).

EXPLOITATION RATE

We estimated a total exploitation rate of 19% by dividing the combined Togiak District commercial sac roe harvest of 26,355 tons (23,909 tonnes) and the Dutch Harbor food and bait harvest of 1,941 tons (1,761 tonnes) by the run biomass of 146,913 tons (133,279 tonnes) (Table 1). An estimated 120,558 tons (109,370 tonnes or 319 million herring) escaped harvest in the Togiak District fishery (Table 8).

DISCUSSION

The purpose of this report was to estimate run biomass (Objective 1), harvest biomass (Objective 2) and age, size (weight and length), and sex composition of herring in Togiak District (Objective 3) as well as the exploitation rate (Objective 4) of this fishery. This was achieved by stationing a sampling crew at the North Pacific Seafoods plant in Togiak to process samples collected throughout the district. This strategy provides managers with inseason age composition estimates in a timely and cost-effective manner.

The 2010 run biomass estimate (Objective 1) of 146,913 tons (133,279 tonnes) was 105% of the 10-year average and 104% of the 20-year average and 100% of the forecast of 146,775 tons (133,153 tonnes; Table 1, Appendix C1). The estimated spawning escapement of 120,558 tons (109,370 tonnes) represents approximately 319 million herring (Table 8). In total, surveyors observed 8.4 linear miles (13.5 km) of spawning herring. This represents only 21% of the 10-year average and 16% of the 20-year average (Table 4). Herring spawn was first documented during the survey on 18 May at 5.0 miles (8.0 km), the highest single spawn observed (Table 3).

The total commercial harvest (Objective 2) of 26,355 tons (23,909 tonnes) was 132% of the recent 10-year average and 126% of the 20-year average (Table 5). The commercial fishery started on 11 May, 4 days later than the average starting date over the last 20 years (Table 5). The late start was similar to 2009 and may be partially attributed to a colder than normal spring. The average roe percent was 9.8% for all harvested herring (Table 6).

At 17 days, the 2010 Togiak District herring fishery was 5 days longer than the most recent 10-year average and 6 days longer than the 20-year average (Table 5). Fishing effort, defined as the peak vessel count during aerial surveys, was up slightly for both gillnet and purse seiners over 2009 (Table 5). Effort for gillnet gear was 48% of the 10-year average and 67% for purse seine gear. This continued low effort was probably the result of depressed market conditions as well as fishing and processor co-ops, which first appeared in 2001 and focus on quality over quantity of harvest. This practice allows the purse seine fishermen to inspect their catches more closely, and harvest only the most valuable fish.

The commercial purse seine harvest of 18,816 tons (17,070 tonnes) of herring was 130% of the 10-year average and 120% of the 20-year average (Table 5). The average roe percentage of 9.7% was 103% of the 10-year and 20-year average. The commercial gillnet harvest of 7,540 tons (6,840 tonnes) was 138% of the 10-year average and 141% of the 20-year average while the average roe percentage of 10.1% was 9% of the 10-year and 20-year average.

Our sampling effort in 2010 was 156% of our effort in 2009 as we continued to improve logistics, coordination, and the efficiencies realized through sampling technology introduced in 2008. The number of readable scales (5,560) collected from the 2010 commercial purse seine fishery was more than the 4,012 readable scales collected in 2009, and the 3,999 readable scales

collected on average since 2000 (Brazil 2007a, 2007b, 2007c; Brazil et al. 2009; Schwanke 2003a, 2003b; West et al 2003). The number of readable scales (1,398) collected from the commercial gillnet fishery was more than the 844 collected in 2009, and more than the 796 readable scales collected on average since 2000 (Brazil 2007a, 2007b, 2007c; Brazil et al. 2009; Buck 2010a,b; Schwanke 2003a, 2003b; West et al. 2003). This sampling effort was sufficient to characterize the Togiak District herring spawning biomass.

Young fish dominated the 2010 Togiak inshore herring run (Objective 3). Herring of age 8 or younger made up 73% of the run biomass, 74% of the total harvest and 73% of the escapement. (Table 8, Appendix A1).

Age-5, -6, -7, and -8 herring were all more than 10% of the commercial purse seine biomass, accounting for 18%, 20%, 13% and 12% of the harvest biomass respectively (Table 8). Age-7, -8, and -9 herring were all more than 10% of the commercial gillnet biomass, accounting for 21 %, 24% and 17% of the harvest biomass respectively (Table 8).

The ages that composed more than 10% of the total run biomass (age-5, -6, -7, and -8), tended to be longer and heavier than the historical trend (Figures 10–11).

Again, we observed a shift in age composition from older to younger herring throughout the run, typical in this fishery, with herring of age 8 and younger comprising 65% of the biomass estimated at the peak of the fishery on 18 May and 90% of the biomass postseason on 2 June (Table 8).

A major problem with estimating recruitment in any given year is the lack of postseason sampling necessary to detect younger fish. In 2010, the lateness of the season and budget constraints precluded any sampling of fish caught after 22 May and only allowed one postseason survey (2 June). The younger recruit age classes, age-4 and age-5 herring, generally spawn later than older fish and are typically underrepresented when late-season sampling is curtailed. Nevertheless, age-4 and -5 herring were present at low levels and not at the elevated levels seen in 2008 and 2009, suggesting that the strong recruitment event observed over the past few years may be over (Table 8, Figure 13, Appendix C1). Togiak herring typically experience recruitment events every 8–10 years.

The total exploitation rate (Objective 4) of herring in Togiak District was 19% (Tables 1–2), higher than the 16% and 17% average rates over the last 10 and 20 years (Table 1).

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TABLES AND FIGURES

Table 1.–Historical run biomass and commercial harvests (tons) of herring returning to Togiak District, Bristol Bay, 1990–2010.

	Togiak		Spawn-on-Kelp			Dutch Harbor	
Year	Run Biomass (tons)	Sac Roe Harvest (tons)	Harvest (lbs)	Harvest (tons)	Herring Equivalent (tons)	Food and Bait Harvest (tons)	Exploitation Rate
1990	88,105	12,230	413,844	207	1,617	820	16.6%
1991	83,229	14,970	348,357	174	1,310	1,325	21.2%
1992	156,957	25,808	363,600	182	1,482	1,982	18.6%
1993	193,847	17,956	383,000	192	1,481	2,824	11.5%
1994	185,412	30,315	308,400	154	1,134	3,349	18.8%
1995	149,093 [a]	26,732	281,600	141	996	1,705	19.7%
1996	135,585 [a]	24,871	455,800	228	1,899	2,279	21.4%
1997	144,887	23,813				1,950	17.8%
1998	121,000 [a]	22,776				1,994	20.5%
1999	157,028	19,878	419,563	210	1,605	2,437	15.2%
2000	130,904 [a]	20,421				2,014	17.1%
2001	115,155	22,330				1,437	20.6%
2002	120,196 [a]	17,049	67,793	34	260	2,799	16.7%
2003	126,213 [a]	21,663	[b]	[b]	[b]	1,487	18.3%
2004	143,124 [a]	18,868				1,255	14.1%
2005	163,737 [c]	20,912				1,159	13.5%
2006	179,580 [c]	23,953				954	13.9%
2007	143,827 [c]	17,132				1,254	12.8%
2008	136,839 [c]	20,523				1,575	16.1%
2009	142,154 [c]	17,107				1,334	13.0%
2010	146,913	26,355				1,941	19.3%
2000-2009 Average	140,173	19,996	67,793	34	260	1,527	15.6%
1990-2009 Average	140,844	20,965	337,995	169	1,309	1,797	16.9%

Note: Blank cells indicate no fishery occurred that year.

Sources: Morstad et al. 2010; Poetter et al. 2009; ADF&G fish tickets.

[a] Total biomass estimate based on preseason forecast because inseason biomass could not be estimated due to poor aerial survey conditions during the season.

[b] Data confidential under Alaska Statute 16.05.815.

[c] Adjusted from previous reports in this series.

Table 2.–Herring samples with purse seine harvest and associated sampling groups. Togiak District, 2010.

	Available Samples				Purse Seine Harvest (tons)				Sample Group			
Date	Nunavachak	Togiak	Hagemeister	Pyrite Point	Nunavachak	Togiak	Hagemeister	Pyrite Point	Nunavachak	Togiak	Hagemeister	Pyrite Point
10 May		259								1		
11 May					30.0				2			
12 May												
13 May			81								1	
14 May	178	146	444		64.5	209.2	1,381.2		2	1	1	
15 May	334	331	358		381.7	524.0	3,545.0	179.7	2	2	3	3
16 May	324		148		886.3	67.1	673.5		6	6	3	
17 May	145		421		791.0	383.6	849.0		6	6	4	
18 May	225		444		1,361.8	121.3	621.8		7	7	4	
19 May	225		172		862.4		120.2		7		5	
20 May	238		257		344.2	31.5	1,616.7		8	5	5	
21 May			395		165.5		1,440.1				5	
22 May	228		207		227.4	141.7	1,487.1	29.5	8	5	5	5
23 May							173.7				5	
24 May							104.8				5	

Table 3.–Aerial survey estimates (tons) of herring by index area, Togiak District, 2010.

Date	Start Time	Survey Rating [b]	Spawn	Estimated Biomass by Index Area [a]													Daily Total
				NUS	KUK	MET	NVK	UGL	TOG	TNG	MTG	OSK	PYR	CPN	HAG	WAL	
28 Apr	10:00																
3 May	14:00																
5 May	13:00																
10 May	11:00	4.5						1,638	130						602		2,371
14 May	15:00	3.0		674	7,205	4,684	3,093	1,246	42,395	7,463	4,737	7,687					79,183
18 May	15:00	1.0	5.0	5,095	19,264	722	14,151	12,221	39,483	4,467	2,468	211	171		36		98,290
21 May	15:30	1.7	3.4		21,790	480	2,306	378	35,719	8,803	56	1,118			1,554	155	72,357
25 May	12:00	2.0		677	1,606	159	186	981	48,875	291		84				53	52,913
2 Jun	14:00	2.1			4,273	1,015	394	41	31,202								36,924
Total linear miles of spawn			8.4										Peak biomass estimate				98,290

Note: Blank cells represent nothing observed. Total Togiak herring biomass was estimated at 142,133 (tons). This was the sum of 16 May and 24 May surveys.

[a] Index areas: NUS - Nushagak Peninsula; KUK - Kulukak; MET - Metervik; NUK - Nunavachak; UGL - Ungalikthluk/Togiak; TOG - Togiak; TNG - Tongue Pt.; MTG - Matogak; HAG - Hagemeister; OSK - Osviak; PYR - Pyrite Point; CN - Cape Newenham.

[b] Average survey rating for all sections surveyed: 1= Excellent, 2 = Good, 3 = Fair, 4 = Poor, 5 = Unsatisfactory.

Table 4.–Aerial survey estimates of herring spawn deposition, Togiak District, 1990–2010.

	Spawn Estimates	
Year	Observations	Miles
1990	94	65.7
1991	90	69.5
1992	160	96.9
1993	76	53.4
1994	80	71.9
1995	70	58.7
1996	99	72.9
1997	79	59.1
1998	42	33.0
1999	33	56.0
2000	71	46.0
2001	100	57.0
2002	79	32.0
2003	182	94.7
2004	47	36.4
2005	106	27.6
2006	66	17.8
2007	43	18.9
2008	38	48.6
2009	32	15.3
2010	9	8.4
2000–2009 Average	76.4	39.4
1990–2009 Average	78.9	51.6

Table 5.–Sac roe herring industry participation, fishing effort and harvest, Togiak District, 1990–2010.

			Fishery Dates			Gillnet				
Year	Buyers	Daily Capacity[a]	Start	Close	Days	Effort[b]	Duration (hours)	Harvest[c]	CPUE	Roe %
1990	16	3,100	5/8	5/21	14	277	66	3,072	0.2	9.0
1991	16	3,350	5/10	5/17	8	170	14	3,182	1.3	8.5
1992	18	3,700	5/20	5/27	8	274	26	5,030	0.7	8.8
1993	12	2,500	4/27	5/12	16	75	145	3,564	0.3	10.1
1994	16	3,300	5/11	5/20	10	146	76	7,462	0.7	12.0
1995	22	4,350	5/7	5/15	9	250	34	6,995	0.8	12.0
1996	19	4,850	5/5	5/8	4	461	18	6,863	0.8	11.1
1997	18	4,200	5/2	5/6	5	336	24	5,164	0.6	11.8
1998	15	2,475	4/29	5/10	12	152	46	5,952	0.9	12.5
1999	12	2,400	5/18	5/26	9	171	28	4,858	1.0	11.5
2000	12	2,100	5/6	5/14	9	227	67	5,464	0.4	10.6
2001	11	2,255	5/6	5/13	8	96	84	6,481	0.8	10.6
2002	8	1,920	5/3	5/13	11	82	102	5,216	0.6	10.9
2003	7	1,920	4/25	5/7	13	75	142	6,505	0.6	10.9
2004	6	2,150	4/29	5/9	11	54	162	4,980	0.6	10.4
2005	8	2,330	4/30	5/8	9	56	149	5,841	0.7	11.2
2006	7	2,060	5/12	5/21	10	49	144	7,132	1.0	10.8
2007	5	1,420	5/10	5/25	16	25	366	4,012	0.4	11.2
2008	7	1,950	5/16	5/31	16	27	312	4,832	0.6	11.4
2009	6	2,015	5/16	5/29	14	32	338	4,140	0.4	9.7
2010	6	2,603	5/11	5/27	17	35	338	7,540	0.6	10.1
2000–2009 Average	8	2,012	5/6	5/17	12	72	187	5,460	0.6	10.8
1990–2009 Average	12	2,717	5/7	5/16	11	152	117	5,337	0.7	10.8

-continued-

Table 5.–Page 2 of 2.

Year	Purse Seine Effort[b]	Duration (hours)	Harvest[c]	CPUE	Roe %	Total Harvest[c]
1990	221	3	9,158	13.8	9.7	12,230
1991	200	3	11,788	19.6	10.0	14,970
1992	301	0	20,778	230.1	9.2	25,808
1993	140	34	14,392	3.0	9.6	17,956
1994	240	5	22,853	20.7	9.4	30,315
1995	254	12	19,737	6.4	10.1	26,732
1996	268	2	18,008	27.8	9.0	24,871
1997	231	6	18,649	12.6	9.4	23,813
1998	123	17	16,824	8.3	9.6	22,776
1999	96	5	15,020	33.3	9.2	19,878
2000	90	16	14,957	10.6	10.1	20,421
2001	64	26	15,849	9.5	9.2	22,330
2002	37	58	11,833	5.6	9.3d	17,049
2003	35	110	15,158	3.9	8.9d	21,663
2004	31	78	13,888	5.7	9.5	18,868
2005	33	83	15,071	5.5	9.6	20,912
2006	28	113	16,821	5.3	9.2	23,953
2007	21	244	13,120	2.6	10.0	17,132
2008	28	292	15,691	1.9	8.4	20,523
2009	21	226	12,967	2.7	9.2	17,107
2010	26	266	18,816	2.7	9.7	26,355
2000–2009 Average	39	125	14,536	5.3	9.4	19,996
1990–2009 Average	123	67	15,628	21.4	9.5	20,965

Note: Blank cells represent no data.

[a] Number of tons per day based on companies registered.

[b] Peak aerial survey count of fishing vessels. This occurred on 18 May 2010 for both the gillnet and purse seine fleet.

[c] Harvest total includes dead loss and test fish harvest.

Table 6.–Commercial herring harvest (tons) and roe (%) by fishing section and gear type, Togiak District, Bristol Bay, 2010.

			Kulukak		Nunavachak		Togiak		Hagemeister		Pyrite Point		Cape Newenham		Total		
Date	Duration	Period	Tons	Roe	Tons	Roe	Tons	Roe	Tons	Roe	Tons	Roe	Tons	Roe	Tons		Roe
							Purse Seine										
11 May					30										30	[a]	
14 May	76:00	1			64.5	5.4	209.2	9.6	1,381.2	9.9					1,654.9		9.7
15 May	24:00	2			381.7	12.2	524	10.5	3545	9.9	179.7	8.2			4,630.4		10.9
16 May	24:00	3			886.3	9.6	67.1	9.3	673.5	10.2					1,626.9		9.5
17 May	24:00	4			791	8.5	383.6	10.1	849	8.8					2,023.6		7.0
18 May	24:00	5			1,361.8	10.4	121.3	10.1	621.8	10					2,104.9		10.3
19 May	24:00	6			862.4	10.1			120.2	9.1					982.6		10.0
20 May	24:00	7			344.2	11	31.5	9.9	1,616.7	9.9					1,992.4		10.1
21 May	24:00	8			165.5	9.8			1,440.1	10					1,605.6		10.0
22 May	24:00	9			227.4	10	141.7	10.2	1,487.1	9.8	29.5	8.0			1,885.7		9.8
23 May									173.7						173.7	[a]	
24 May									104.8						104.8	[a]	
Subtotal	268:00				5,114.8	9.9	1,478.4	10.1	1,2013	9.6	209.2	8.2			18,815.5		9.7
							Gillnet										
11 May																	
14 May	76:00	1	59	11.4											59		
15 May	24:00	2	652.9	10.6											652.9		
16 May	24:00	3	212.3	10.8	431.2	11.1									643.5		11.0
17 May	24:00	4	188.7	11	189.5	10.5									378.2		10.7
18 May	24:00	5	1,409.3	11.9	175.5	12.2									1,584.8		11.9
19 May	24:00	6	919.4	11.3											919.4		
20 May	24:00	7	830.2	12.2											830.2		
21 May	24:00	8	853.9	11.9											853.9		
22 May	24:00	9	227.4	11.8											227.4		
23 May	24:00	10	424.4	11.8											424.4		
24 May	13:00	11	263.2	12.2											263.2		
25 May	24:00	12	261	11.5											261		
26 May	24:00	13	162	12.5	14.3	9.7									176.3		9.7
27 May	24:00	14	258.8	12.1	6.7	9									265.5		9.0
Subtotal	388:00		6,722.5	10.0	817.2	11.2									7,539.7		10.1

-continued-

Table 6.–Page 2 of 2.

Date	Duration	Period	Kulukak Tons	Kulukak Roe	Nunavachak Tons	Nunavachak Roe	Togiak Tons	Togiak Roe	Hagemeister Tons	Hagemeister Roe	Pyrite Point Tons	Pyrite Point Roe	Cape Newenham Tons	Cape Newenham Roe	Total Tons		Total Roe
								Combined									
11 May					30.0										30.0	[a]	
14 May			59.0	11.4	64.5	5.4	209.2	9.6	1,381.2	9.9					1,713.9		0.6
15 May			652.9	10.6	381.7	12.2	524.0	10.5	3,545.0	9.9	179.7	8.2			5,283.3		8.8
16 May			212.3	10.8	1317.5	10.1	67.1	9.3	673.5	10.2					2,270.4		9.9
17 May			188.7	11.0	980.5	8.9	383.6	10.1	849.0	8.8					2,401.8		7.6
18 May			1409.3	11.9	1537.3	10.6	121.3	10.1	621.8	10.0					3,689.7		11.0
19 May			919.4	11.3	862.4	10.1			120.2	9.1					1,902.0		10.6
20 May			830.2	12.2	344.2	11.0	31.5	9.9	1,616.7	9.9					2,822.6		10.7
21 May			853.9	11.9	165.5	9.8			1,440.1	10.0					2,459.5		10.6
22 May			227.4	11.8	227.4	10.0	141.7	10.2	1,487.1	9.8	29.5	8.0			2,113.1		8.3
23 May			424.4	11.8					173.7						598.1	[a]	11.8
24 May			263.2	12.2					104.8						368.0	[a]	12.2
25 May			261.0	11.5											261.0		11.5
26 May			162.0	12.5	14.3	9.7									176.3		12.3
27 May			258.8	12.1	6.7	9.0									265.5		12.0
Total			6,722.5	10.0	5,932.0	10.1	1,478.4	10.1	12,013.1	9.6	209.2	8.2	0.0	0.0	26,355.2		9.8

Note: Blank cells represent no data due to area closures or no fishing.

[a] Includes test fish harvest.

Table 7.–Number of herring samples for which age estimations were made by gear type, Togiak District, 2010.

Gear Type	Readable	Missing & Unreadable	Total	Percent unreadable
Commercial Purse Seine	5,560	870	6,430	13.5
Commercial Gillnet	1,398	302	1,700	17.8
Total	6,958	1,172	8,130	14.4

Table 8.–Herring harvest (biomass) by age and gear type for early season (16 May aerial survey), late season (24 May aerial survey), total run, and escapement from the herring sac roe fishery, Togiak District, 2010.

Purse Seine					Gillnet					Total Harvest				
	Biomass		Herring			Biomass		Herring			Biomass		Herring	
Age	ST	%	(x1000)	%	Age	ST	%	(x1000)	%	Age	ST	%	(x1000)	%
1	0	0.0	0	0.0	1	0	0.0	0	0.0	1	0	0.0	0	0.0
2	0	0.0	0	0.0	2	0	0.0	0	0.0	2	0	0.0	0	0.0
3	0	0.0	0	0.0	3	0	0.0	0	0.0	3	0	0.0	0	0.0
4	275	1.5	1,698	2.7	4	16	0.2	66	0.4	4	290	1.1	1,765	2.2
5	3,462	18.4	18,133	29.3	5	176	2.3	627	3.7	5	3,638	13.8	18,760	23.8
6	3,708	19.7	14,772	23.8	6	497	6.6	1,327	7.8	6	4,205	16.0	16,099	20.4
7	2,504	13.3	7,938	12.8	7	1,562	20.7	3,786	22.3	7	4,066	15.4	11,724	14.9
8	2,275	12.1	6,204	10.0	8	1,783	23.7	4,117	24.2	8	4,058	15.4	10,321	13.1
9	1,810	9.6	4,189	6.8	9	1,265	16.8	2,735	16.1	9	3,075	11.7	6,925	8.8
10	1,389	7.4	2,823	4.6	10	741	9.8	1,509	8.9	10	2,130	8.1	4,332	5.5
11	1,053	5.6	2,026	3.3	11	629	8.3	1,218	7.2	11	1,682	6.4	3,244	4.1
12	1,400	7.4	2,569	4.1	12	486	6.4	904	5.3	12	1,885	7.2	3,472	4.4
13	640	3.4	1,118	1.8	13	262	3.5	468	2.8	13	902	3.4	1,586	2.0
14	174	0.9	286	0.5	14	80	1.1	146	0.9	14	254	1.0	432	0.5
15	61	0.3	107	0.2	15	31	0.4	58	0.3	15	92	0.4	165	0.2
16	25	0.1	41	0.1	16	12	0.2	17	0.1	16	36	0.1	58	0.1
17	20	0.1	34	0.1	17	0	0.0	0	0.0	17	20	0.1	34	0.0
18	17	0.1	29	0.0	18	0	0.0	0	0.0	18	17	0.1	29	0.0
19	2	0.0	3	0.0	19	0	0.0	0	0.0	19	2	0.0	3	0.0
Total	18,816	100	61,971	100	Total	7,540	100	16,978	100	Total	26,355	100	78,949	100

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Table 8.–Page 2 of 3.

Peak (18 May)					Postseason (2 June)					Total Run				
Age	Biomass ST	%	Herring (x1000)	%	Age	Biomass ST	%	Herring (x1000)	%	Age	Biomass ST	%	Herring (x1000)	%
4	1,141	1.0	5,322	2.0	4	880	2.4	4,480	3.5	4	2,021	1.4	9,802	2.5
5	12,379	11.3	49,843	18.4	5	10,656	28.9	46,800	37.1	5	23,036	15.7	96,643	24.3
6	15,101	13.7	47,541	17.5	6	10,948	29.7	38,126	30.2	6	26,049	17.7	85,668	21.5
7	14,077	12.8	36,178	13.3	7	5,249	14.2	15,918	12.6	7	19,326	13.2	52,095	13.1
8	16,178	14.7	36,537	13.5	8	3,146	8.5	8,292	6.6	8	19,324	13.2	44,830	11.3
9	13,925	12.7	29,201	10.8	9	2,321	6.3	5,433	4.3	9	16,246	11.1	34,634	8.7
10	10,765	9.8	20,426	7.5	10	1,044	2.8	2,192	1.7	10	11,809	8.0	22,619	5.7
11	9,330	8.5	16,902	6.2	11	858	2.3	1,716	1.4	11	10,187	6.9	18,618	4.7
12	10,377	9.4	18,197	6.7	12	898	2.4	1,716	1.4	12	11,275	7.7	19,912	5.0
13	4,653	4.2	8,055	3.0	13	637	1.7	1,144	0.9	13	5,290	3.6	9,199	2.3
14	1,173	1.1	1,942	0.7	14	120	0.3	191	0.2	14	1,293	0.9	2,133	0.5
15	475	0.4	791	0.3	15	0	0.0	0	0.0	15	475	0.3	791	0.2
16	92	0.1	144	0.1	16	112	0.3	191	0.2	16	205	0.1	334	0.1
17	145	0.1	216	0.1	17	54	0.1	95	0.1	17	199	0.1	311	0.1
18	134	0.1	216	0.1	18	0	0.0	0	0.0	18	134	0.1	216	0.1
19	43	0.0	72	0.0	19	0	0.0	0	0.0	19	43	0.0	72	0.0
Total	109,989	100	271,583	100	Total	36,924	100	126,293	100	Total	146,913	100	397,876	100

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Table 8.–Page 3 of 3.

Escapement				
	Biomass		Herring	
Age	ST	%	(x1000)	%
4	1,731	1.4	8,038	2.5
5	19,397	16.1	77,883	24.4
6	21,844	18.1	69,569	21.8
7	15,259	12.7	40,371	12.7
8	15,266	12.7	34,509	10.8
9	13,170	10.9	27,709	8.7
10	9,678	8.0	18,286	5.7
11	8,506	7.1	15,374	4.8
12	9,390	7.8	16,440	5.2
13	4,389	3.6	7,614	2.4
14	1,039	0.9	1,701	0.5
15	383	0.3	626	0.2
16	168	0.1	276	0.1
17	179	0.1	277	0.1
18	116	0.1	187	0.1
19	41	0.0	69	0.0
Total	120,558	100	318,927	100

Table 9.–Mean length (mm), weight (g), and standard deviation by age for herring of the commercial harvest by gear type, Togiak District, 2010.

Inseason Biomass[a]						Purse Seine					
Age	Sample (n)	Mean Length (mm)	SD	Mean Weight (g)	SD	Age	Sample (n)	Mean Length (mm)	SD	Mean Weight (g)	SD
4	127	244	18.7	188	54.9	4	137	244	18.6	190	54.1
5	1,201	254	13.1	218	41.0	5	1315	254	12.9	218	40.4
6	1,075	271	16.1	278	60.1	6	1177	271	16.1	278	59.7
7	675	287	17.7	340	73.9	7	736	287	17.5	339	72.9
8	604	300	15.1	393	70.4	8	646	300	15.2	391	71.1
9	468	307	13.9	427	69.6	9	492	307	14.0	425	70.4
10	308	316	15.3	475	73.9	10	321	317	15.1	475	73.3
11	254	322	12.7	497	67.7	11	260	322	12.6	497	67.3
12	275	325	12.4	515	58.5	12	289	325	12.4	514	58.7
13	124	326	10.9	522	64.4	13	131	326	10.9	521	63.8
14	29	330	9.9	550	58.5	14	32	330	10.2	550	57.1
15	11	331	9.9	545	67.4	15	12	330	10.2	536	70.5
16	4	336	14.8	559	34.0	16	4	336	14.8	559	34.0
17	4	339	18.7	587	124.1	17	4	339	18.7	587	124.1
18	3	339	8.3	562	43.1	18	3	339	8.3	562	43.1
19	1	319	NA	546	NA	19	1	319	NA	546	NA
Average		285	14	340	64			285	14	338	64
Total	5,163						5,560				

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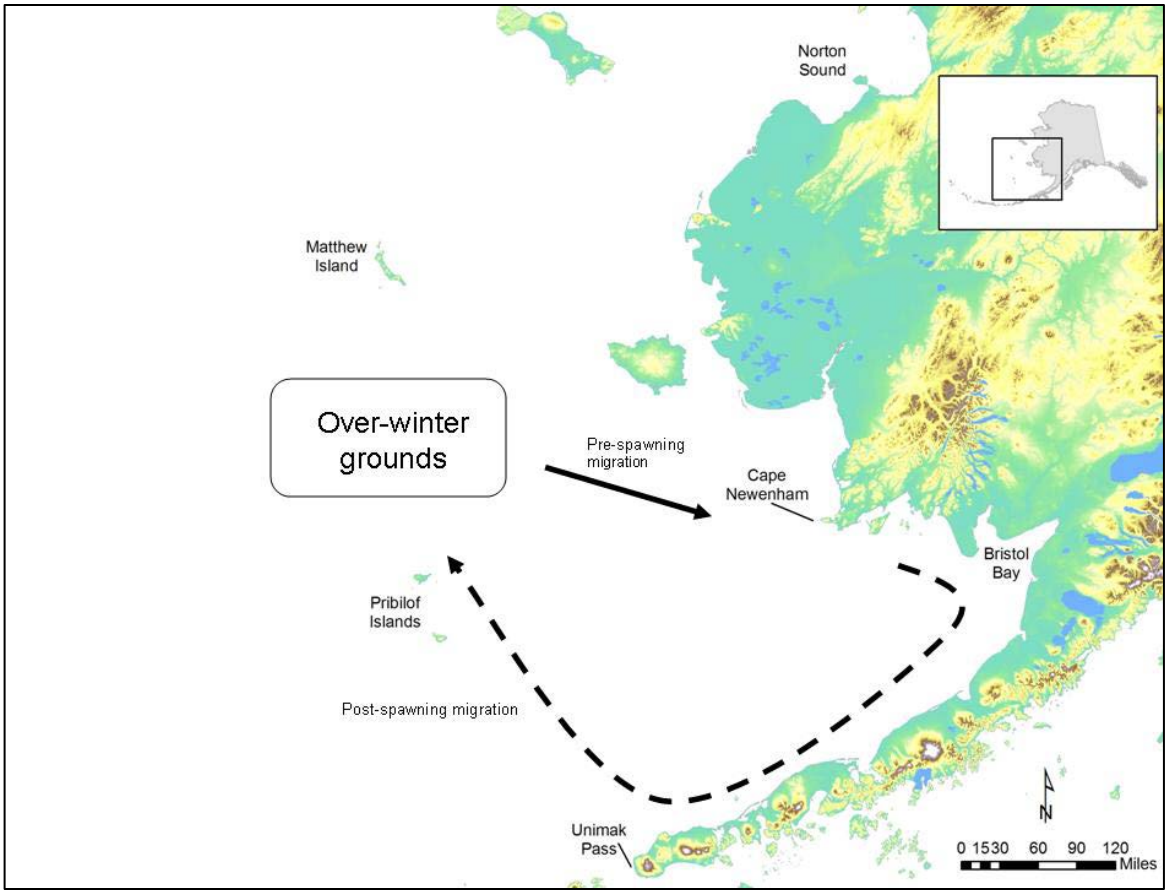
Table 9.–Page 2 of 2.

	Gillnet				
Age	Sample (n)	Mean Length (mm)	SD	Mean Weight (g)	SD
4	9	245	19.9	188	58.6
5	77	260	17.5	236	62.8
6	107	285	16.5	331	67.0
7	291	295	11.0	374	40.2
8	312	300	11.0	393	43.6
9	231	306	12.1	420	53.8
10	135	314	12.4	449	53.9
11	102	318	12.4	470	59.1
12	80	320	12.1	488	60.5
13	38	324	12.1	510	71.2
14	11	322	17.3	496	75.6
15	4	324	16.4	480	68.5
16	1	345	NA	616	NA
17	0	NA	NA	NA	NA
18	0	NA	NA	NA	NA
19	0	NA	NA	NA	NA
		300	14	394	60
	1,398				

[a] Purse seine samples applied to aerial survey biomass.



Source: Adapted from Tojo et al. (2007).

Figure 1.–Southeastern Bering Sea herring migration.

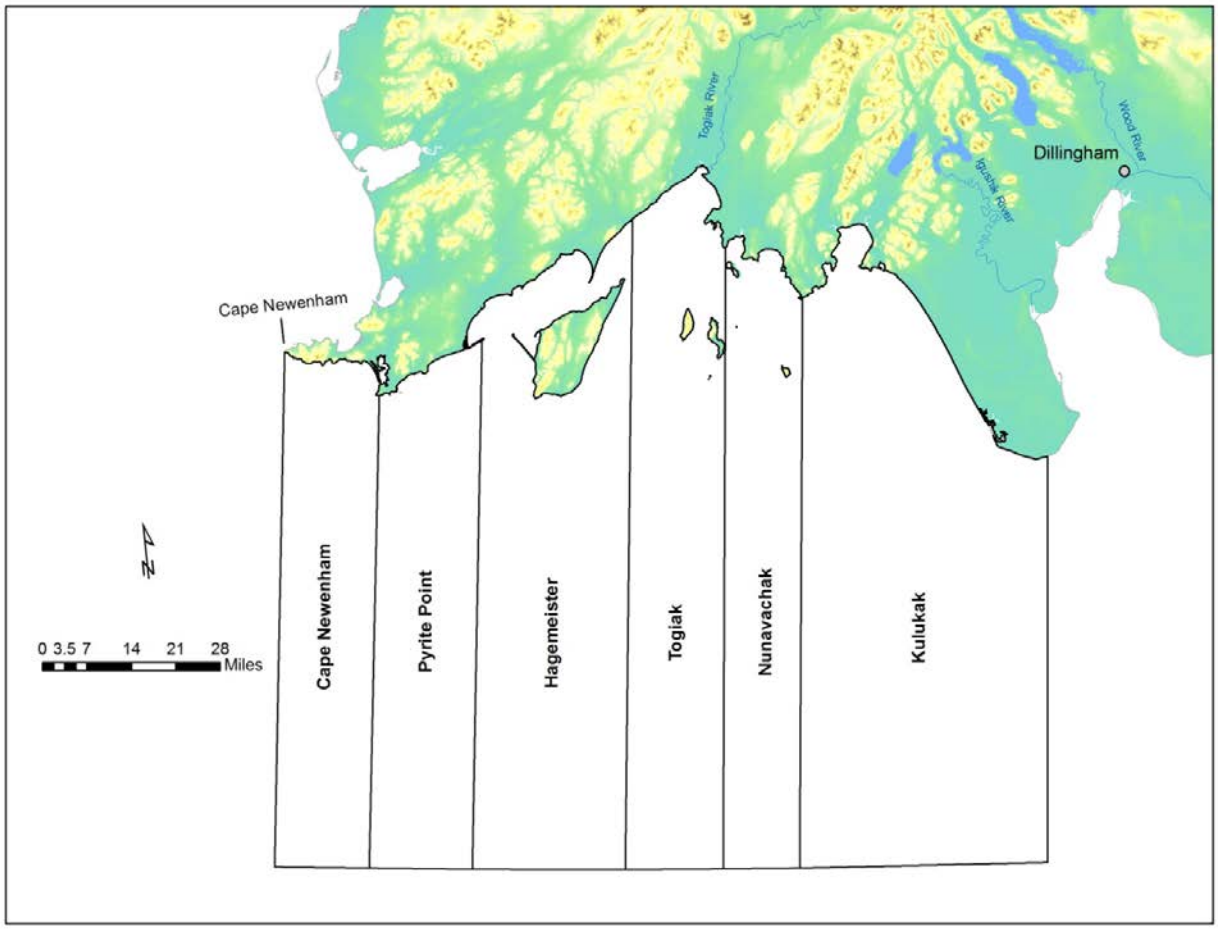
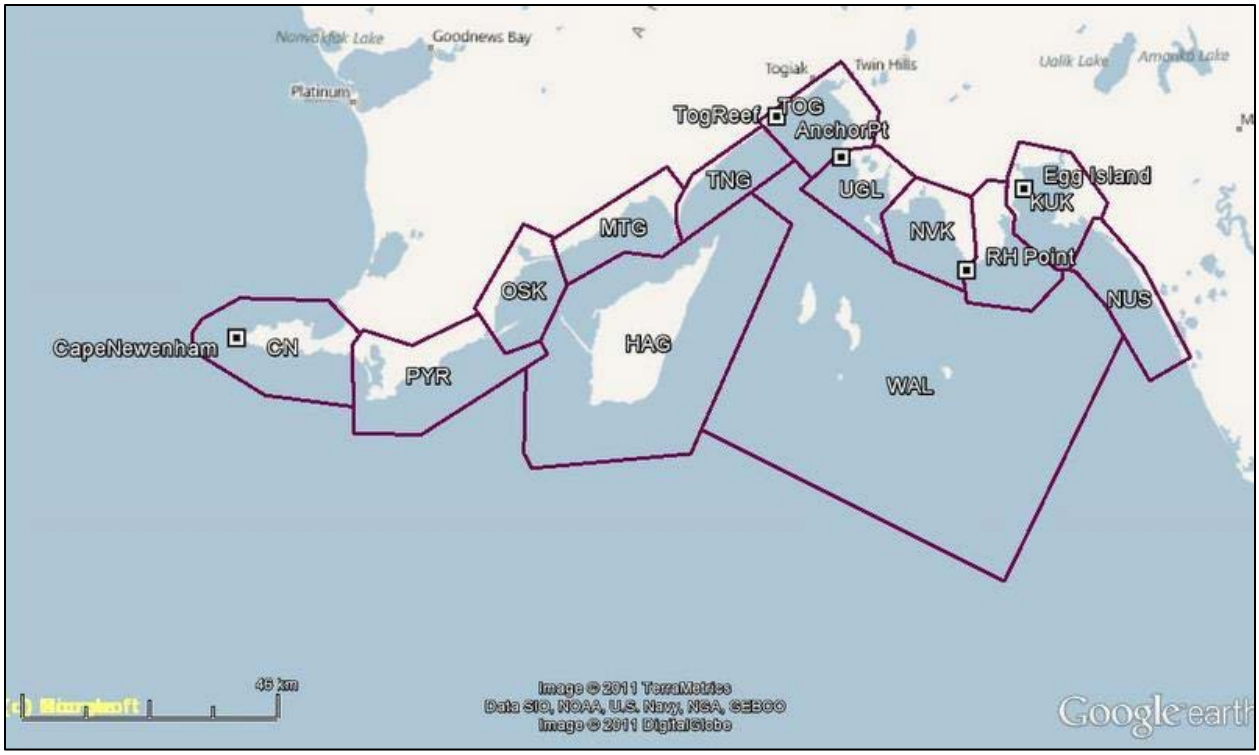


Figure 2.–Map of Togiak District and management sections, Bristol Bay.



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

Figure 3.–Togiak herring aerial survey sections, Bristol Bay.

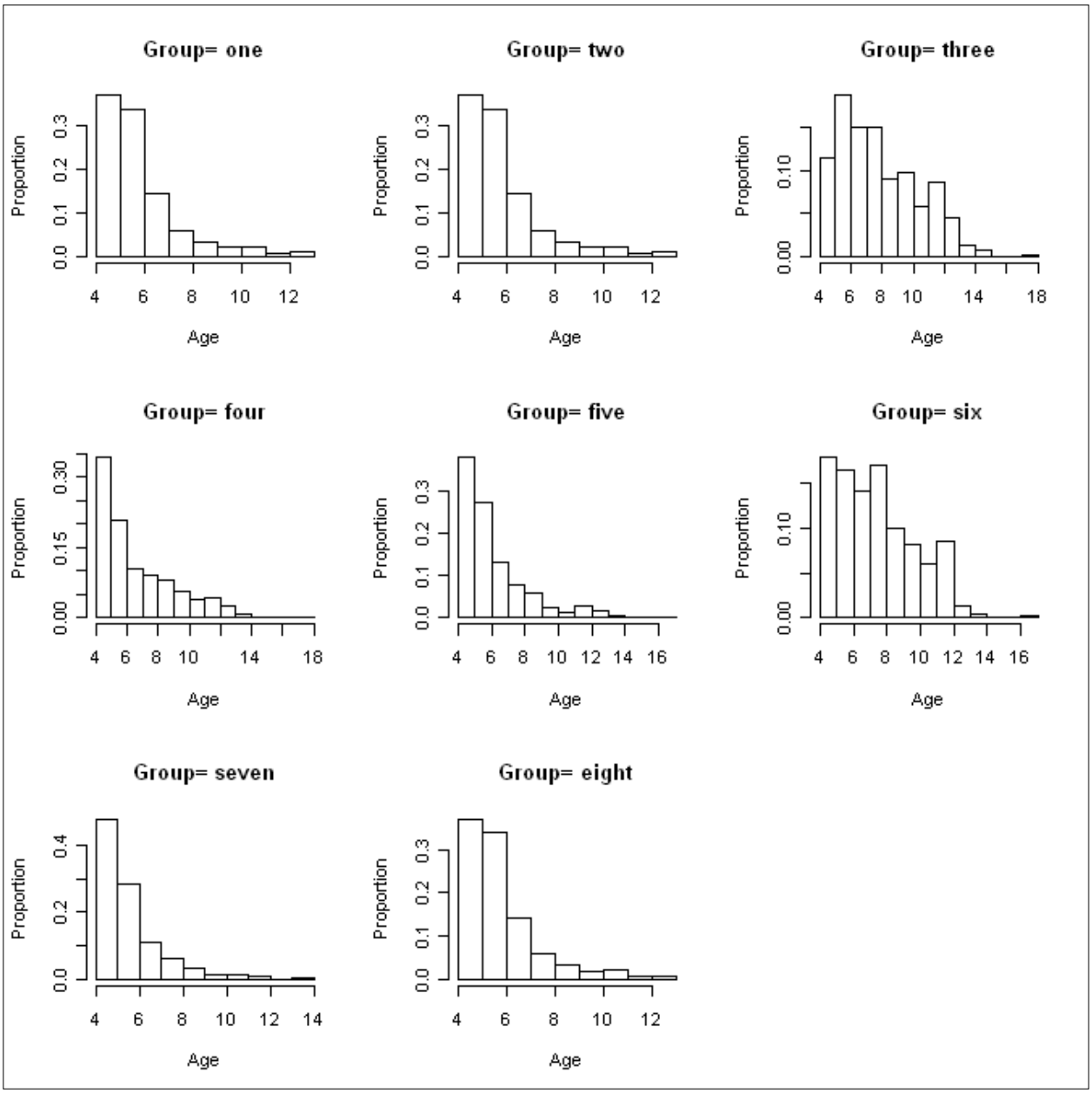


Figure 4.–Age composition of purse seine sample groups, Togiak District, 2010.

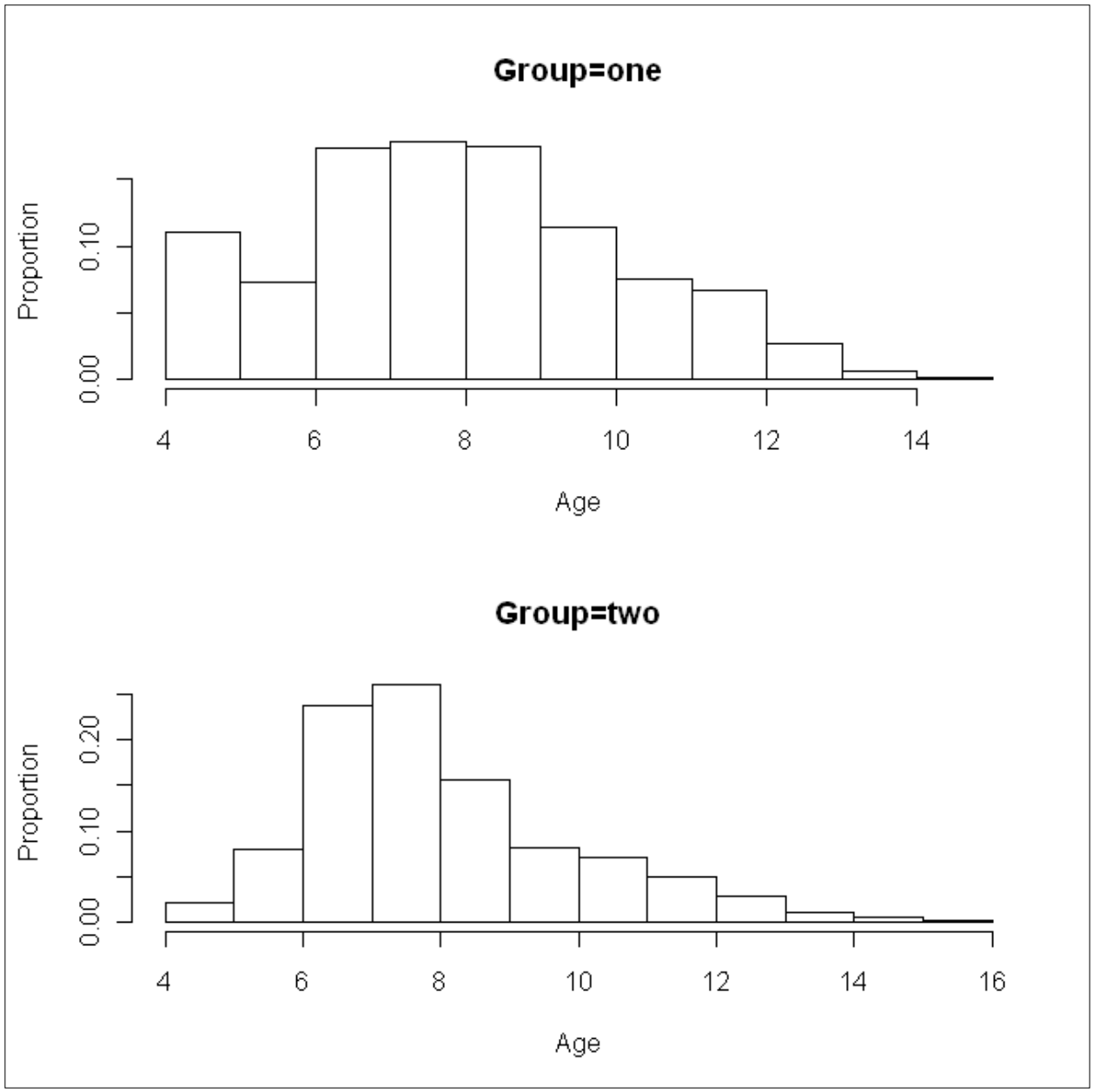


Figure 5.–Age composition of gillnet sample groups, Togiak District, 2010.

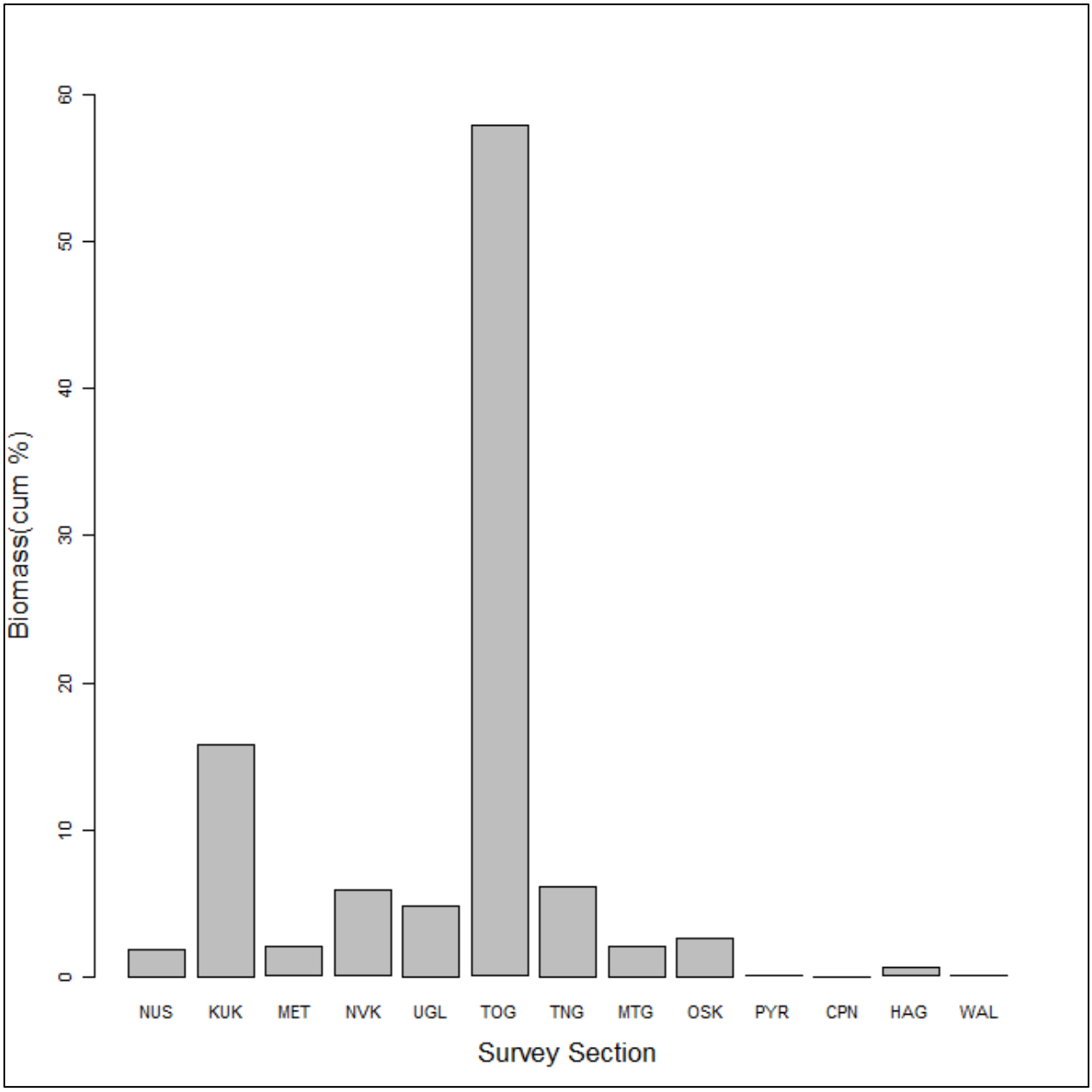
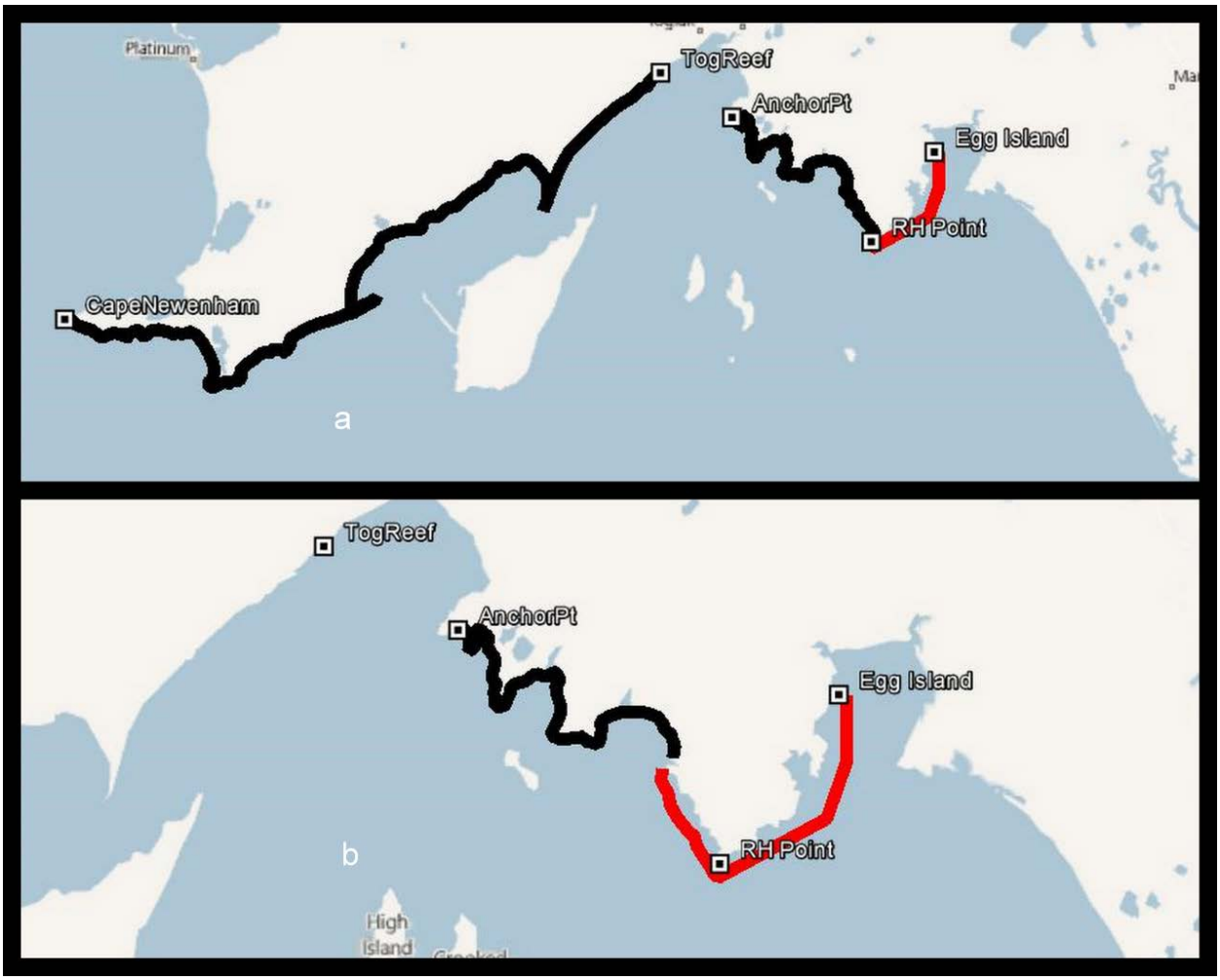
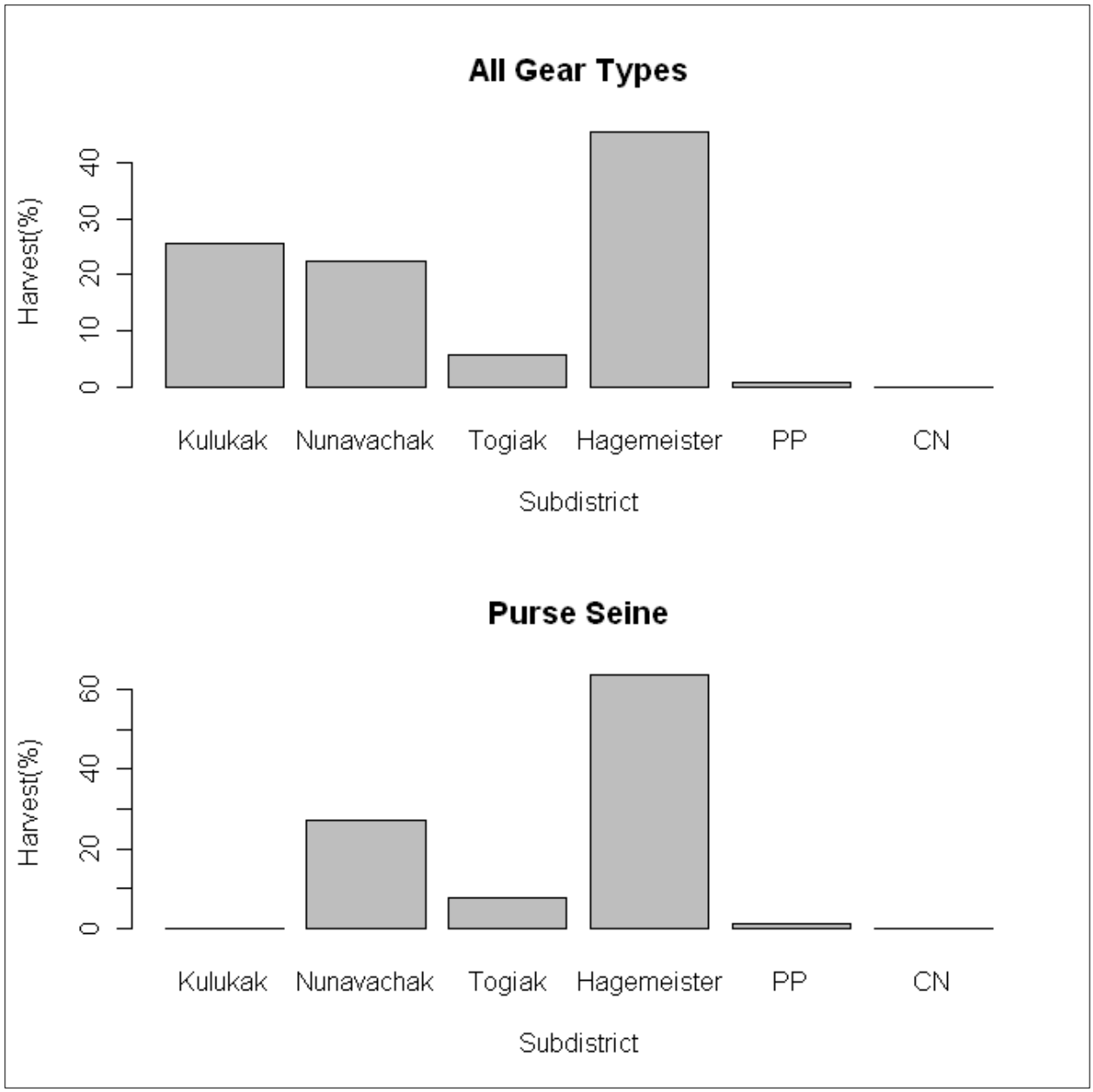


Figure 6.–Cumulative tons of herring estimated in each aerial survey section during all aerial surveys, Togiak District, 2010.



Note: Top panel (a) shows areas open to gillnet east of RH Point to Egg Island highlighted in red and areas open to purse seine to the west of RH Point highlighted in black. Lower panel (b) shows extension of gillnet area to the west of RH Point between 16–19 May and from 25 May through season end.

Figure 7.–Commercial herring harvest areas opened by gear type, Togiak District, 2010.



Note: (PP=Pyrite Point, CN=Cape Newenham).

Figure 8.–Commercial herring harvest by reporting section for all gear types (top) and for purse seine only (bottom), Togiak District, 2010.

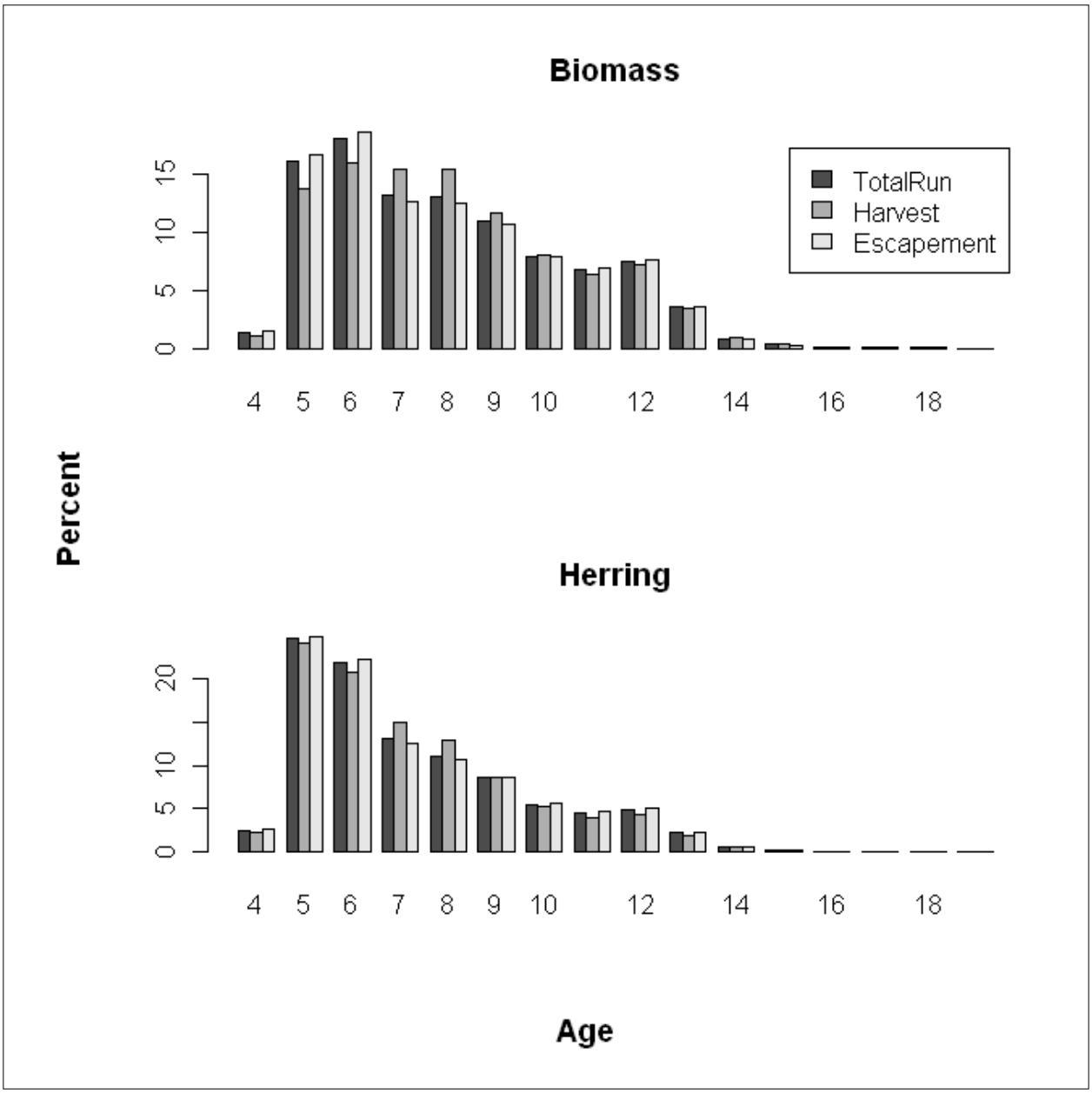


Figure 9.–Age composition of run, harvest and escapement by biomass (top) and numbers of fish (bottom), Togiak District, 2010.

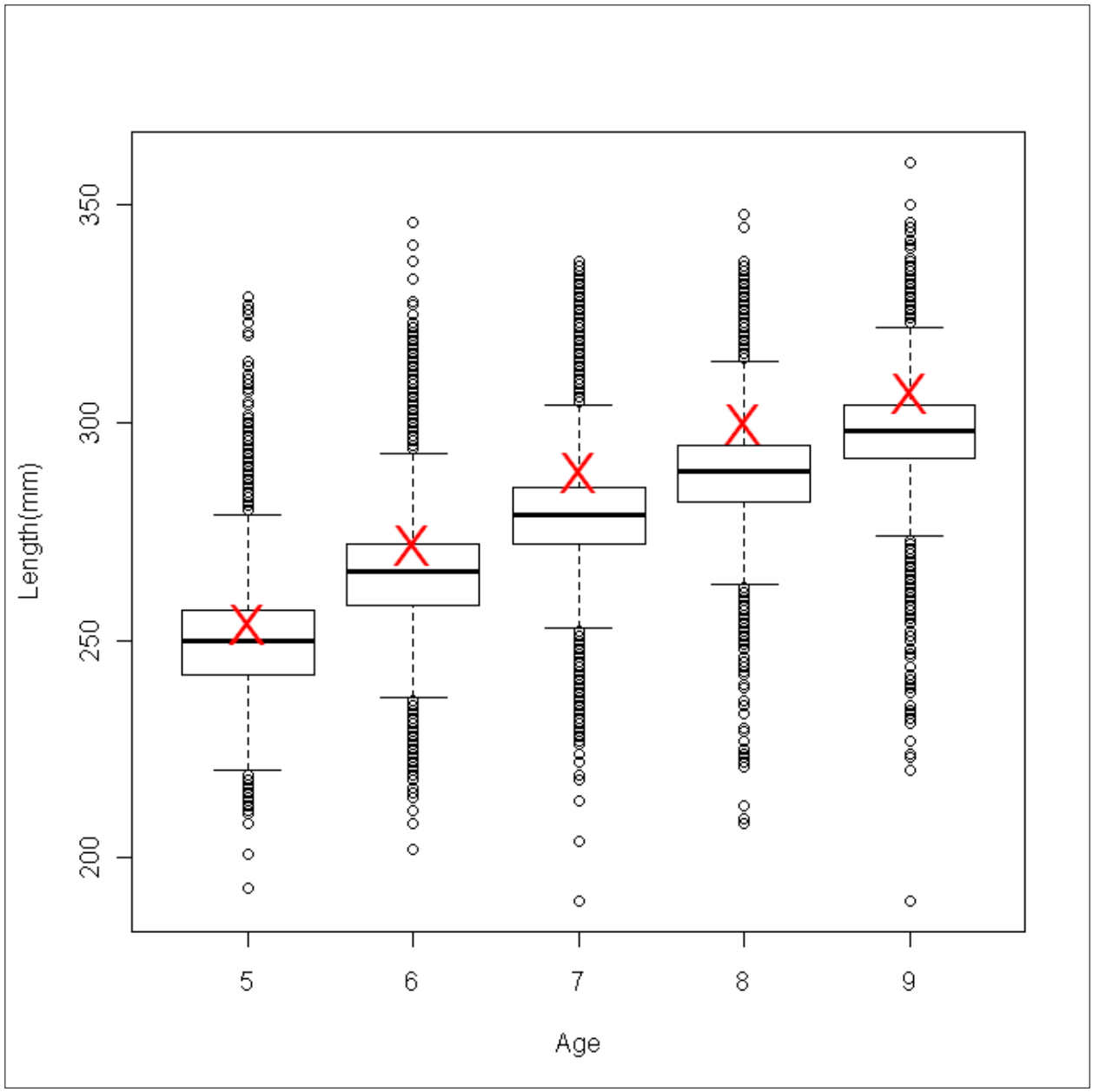


Figure 10.–Average length (denoted as ‘X’) of herring observed in 2010 and distribution of historical observations (1981–present).

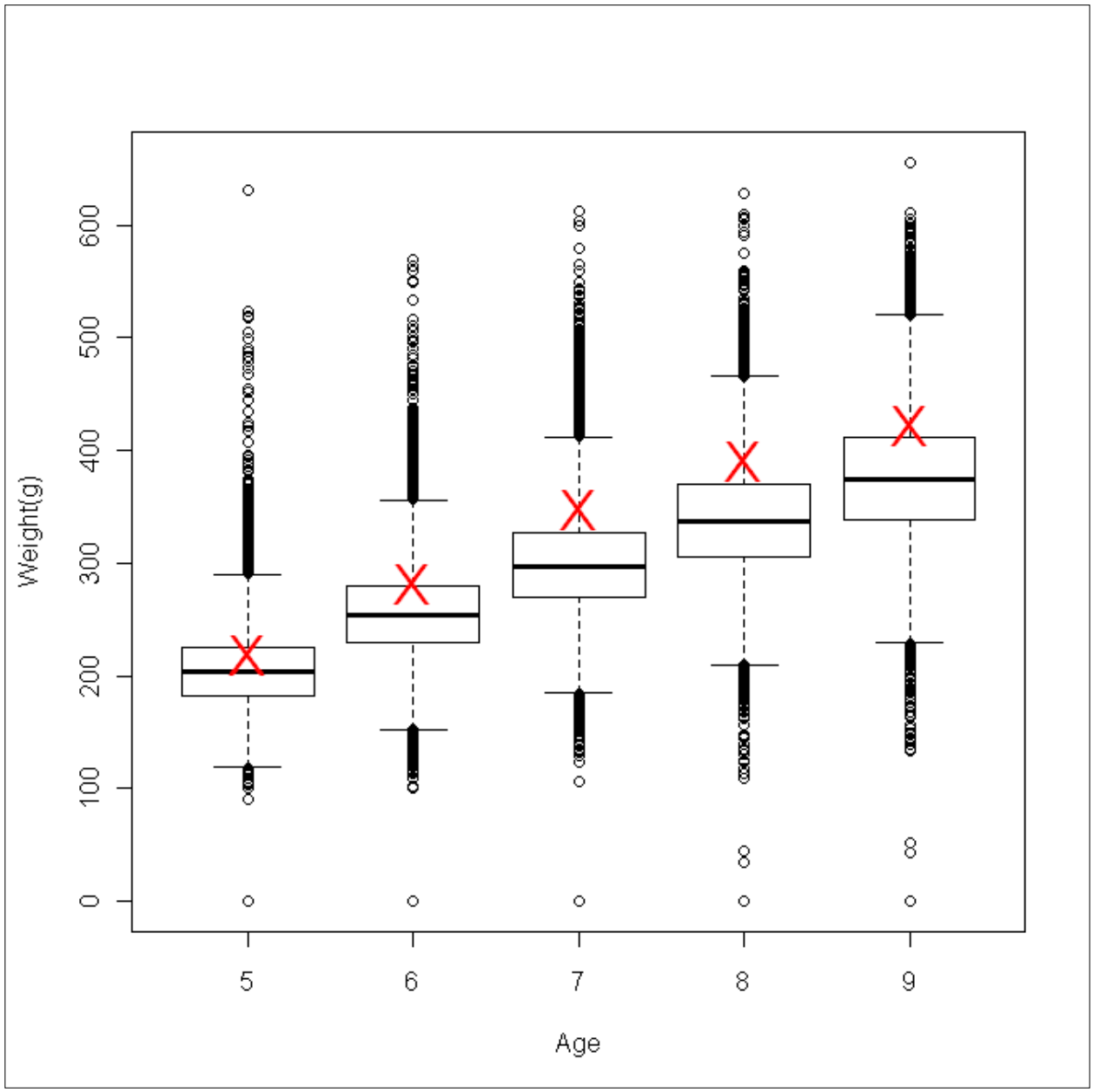
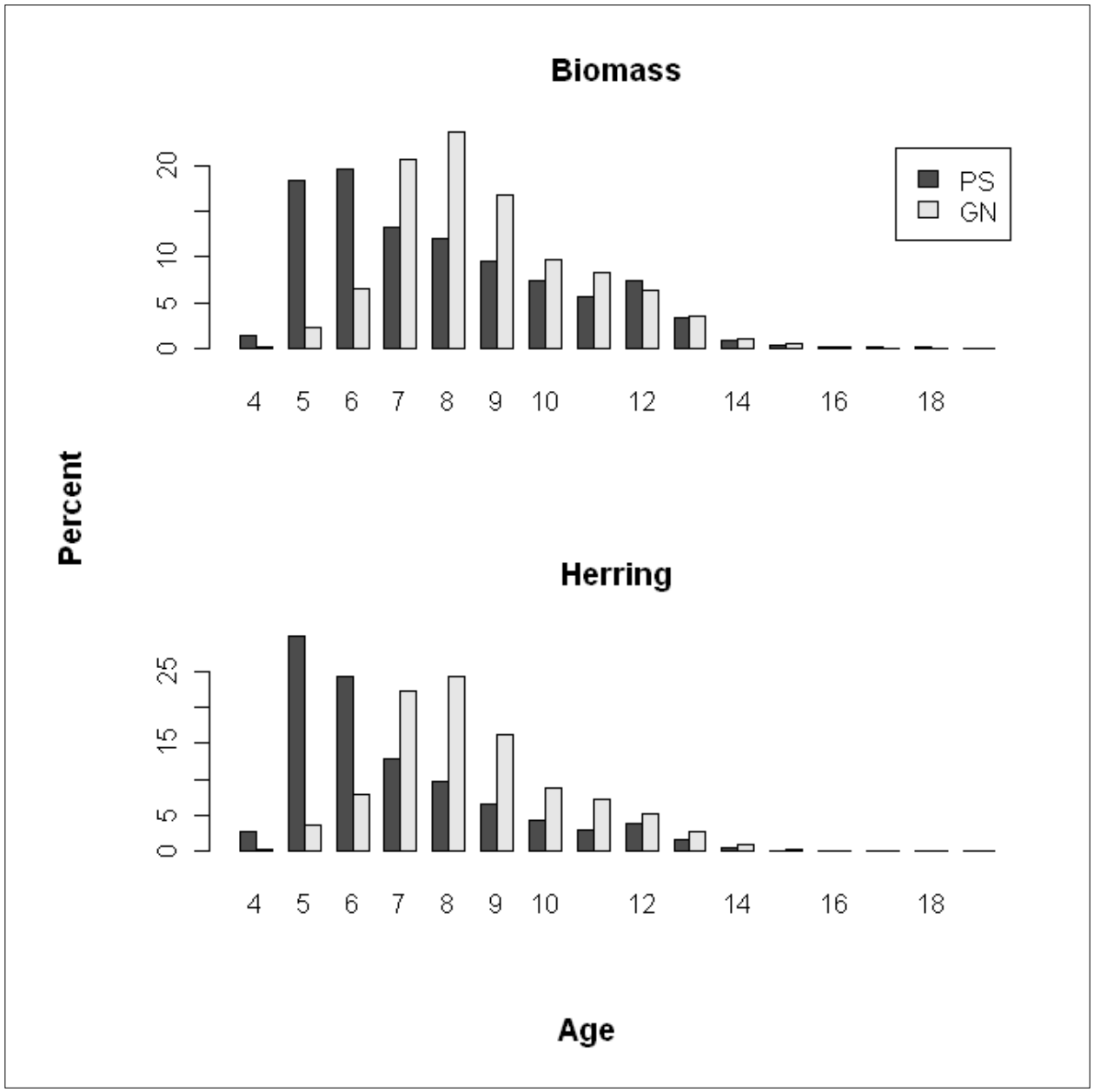


Figure 11.–Average weight (denoted as ‘X’) of herring observed in 2010 and distribution of historical observations (1981–present).



Note: Purse Seine=PS, Gillnet=GN.

Figure 12.–Percent age composition of the commercial herring harvest by gear type by biomass (top) and by numbers of fish (bottom), Togiak District, 2010.

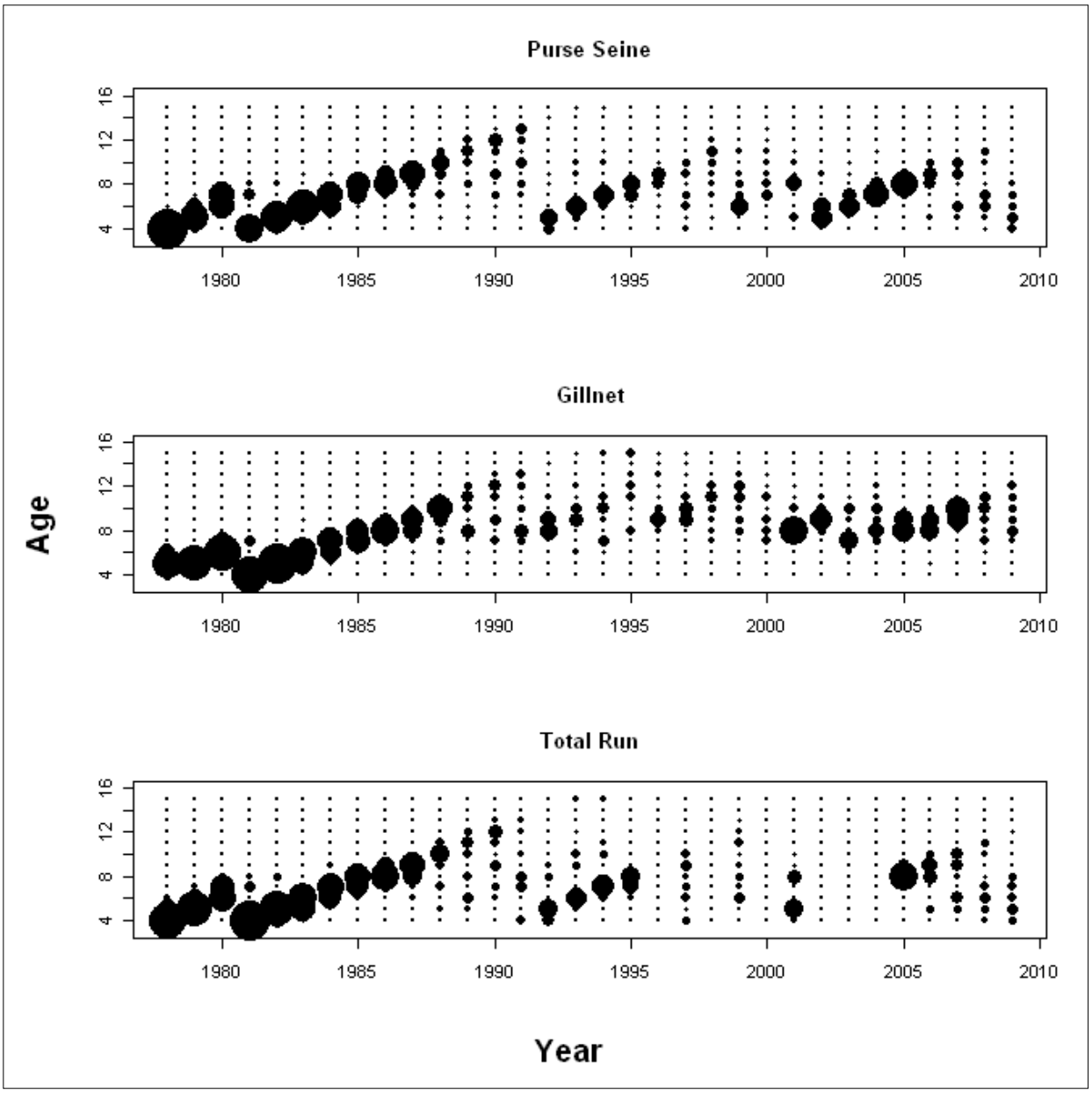


Figure 13.–Relative age class contribution of herring in the purse seine harvest, gillnet harvest and run, Togiak District, Bristol Bay, 1977–2010.

APPENDIX A

Appendix A1.–Estimated age composition of the herring run, by aerial survey date, Togiak District, 2010.

Survey Date		5/18/10	
Index Section(s):		NUN/HAG/TOG	
Survey Biomass:		109,989	
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	74	2.0	5,322
5	693	18.4	49,843
6	661	17.5	47,541
7	503	13.3	36,178
8	508	13.5	36,537
9	406	10.8	29,201
10	284	7.5	20,426
11	235	6.2	16,902
12	253	6.7	18,197
13	112	3.0	8,055
14	27	0.7	1,942
15	11	0.3	791
16	2	0.1	144
17	3	0.1	216
18	3	0.1	216
19	1	0.0	72
20	0	0.0	0
Total	3,776	100.0	271,583

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	14,393	1.0	1,141
5	156,146	11.3	12,379
6	190,475	13.7	15,101
7	177,556	12.8	14,077
8	204,061	14.7	16,178
9	175,638	12.7	13,925
10	135,780	9.8	10,765
11	117,678	8.5	9,330
12	130,893	9.4	10,377
13	58,693	4.2	4,653
14	14,795	1.1	1,173
15	5,993	0.4	475
16	1,166	0.1	92
17	1,834	0.1	145
18	1,685	0.1	134
19	546	0.0	43
20	0	0.0	0
Total	1,387,331	100.0	109,989

Survey Date		6/2/10	
Index Section(s):		NUN/HAG	
Survey Biomass:		36,924	
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	47	3.5	4,480
5	491	37.1	46,800
6	400	30.2	38,126
7	167	12.6	15,918
8	87	6.6	8,292
9	57	4.3	5,433
10	23	1.7	2,192
11	18	1.4	1,716
12	18	1.4	1,716
13	12	0.9	1,144
14	2	0.2	191
15	0	0.0	0
16	2	0.2	191
17	1	0.1	95
18	0	0.0	0
19	0	0.0	0
20	0	0.0	0
Total	1325	100.0	126,293

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	8,378	2.4	880
5	101,425	28.9	10,656
6	104,202	29.7	10,948
7	49,959	14.2	5,249
8	29,941	8.5	3,146
9	22,089	6.3	2,321
10	9,936	2.8	1,044
11	8,163	2.3	858
12	8,547	2.4	898
13	6,065	1.7	637
14	1,146	0.3	120
15	0	0.0	0
16	1,070	0.3	112
17	514	0.1	54
18	0	0.0	0
19	0	0.0	0
20	0	0.0	0
Total	351,435	100.0	36,924

Note: Sections refers to the following subdistricts within the Togiak District: TOG=Togiak, NUN=Nunavachak, HAG=Hagemeister, KUL=Kulukak, PYP=Pyrite Point and CN=Cape Newenham.

Appendix A2.–Estimated age composition of herring in the commercial purse seine harvest, by date and fishing section, Togiak District, 2010.

Sample Date(s)	14 May			Sample Date(s)	15–16 May		
Section(s):	TOG/HAG			Section(s):	NUN/TOG		
Harvest Biomass:	1,590			Harvest Biomass:	1,000		
Age	No.	Percent by No.	Numbers (x1,000)	Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0	1	0	0.0	0
2	0	0.0	0	2	0	0.0	0
3	0	0.0	0	3	0	0.0	0
4	0	0.0	0	4	14	1.7	42
5	17	4.2	60	5	168	19.9	509
6	49	12.1	172	6	169	20.0	512
7	57	14.1	200	7	137	16.3	415
8	76	18.8	267	8	109	12.9	331
9	67	16.5	235	9	86	10.2	261
10	32	7.9	112	10	48	5.7	146
11	47	11.6	165	11	39	4.6	118
12	37	9.1	130	12	42	5.0	127
13	19	4.7	67	13	20	2.4	61
14	1	0.2	4	14	7	0.8	21
15	1	0.2	4	15	3	0.4	9
16	0	0.0	0	16	0	0.0	0
17	1	0.2	4	17	0	0.0	0
18	1	0.2	4	18	0	0.0	0
Total	405	100	1,421	Total	843	100	2,556
		Percent Weighted by				Percent Weighted by	
Age	Weight	Weight	Biomass	Age	Weight	Weight	Biomass
1	0	0.0	0	1	0	0.0	0
2	0	0.0	0	2	0	0.0	0
3	0	0.0	0	3	0	0.0	0
4	0	0.0	0	4	3,173	1.1	11
5	11,948	2.9	46	5	39,978	13.4	134
6	28,824	7.0	111	6	50,342	16.8	168
7	44,844	10.9	173	7	48,186	16.1	161
8	71,799	17.5	278	8	42,742	14.3	143
9	71,195	17.3	275	9	36,588	12.2	122
10	51,354	12.5	199	10	21,998	7.4	74
11	52,934	12.9	205	11	18,889	6.3	63
12	50,395	12.3	195	12	20,695	6.9	69
13	22,136	5.4	86	13	10,391	3.5	35
14	2,279	0.6	9	14	3,961	1.3	13
15	1,670	0.4	6	15	1,728	0.6	6
16	0	0.0	0	16	0	0.0	0
17	1,372	0.3	5	17	0	0.0	0
18	559	0.1	2	18	0	0.0	0
Total	411,307	100.0	1,590	Total	299,217	100	1,000

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Sample Date(s)	15–16 May		
Section(s):	HAG/PYP		
Harvest Biomass:	4,398		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	2	0.4	40
5	56	11.1	1,132
6	95	18.8	1,921
7	76	15.0	1,537
8	76	15.0	1,537
9	46	9.1	930
10	49	9.7	991
11	29	5.7	586
12	44	8.7	890
13	23	4.5	465
14	6	1.2	121
15	3	0.6	61
16	0	0.0	0
17	0	0.0	0
18	1	0.2	20
Total	506	100	10,233

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	440	0.2	10
5	13,275	6.7	296
6	29,007	14.7	647
7	27,189	13.8	606
8	29,714	15.1	662
9	19,929	10.1	444
10	22,512	11.4	502
11	14,895	7.5	332
12	23,008	11.7	513
13	11,954	6.1	266
14	3,272	1.7	73
15	1,586	0.8	35
16	0	0.0	0
17	0	0.0	0
18	520	0.3	12
Total	197,301	100	4,398

Sample Date(s)	17–18 May		
Section(s):	HAG		
Harvest Biomass:	1,471		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	32	4.0	170
5	241	30.0	1,278
6	166	20.7	880
7	86	10.7	456
8	68	8.5	361
9	64	8.0	339
10	46	5.7	244
11	34	4.2	180
12	32	4.0	170
13	22	2.7	117
14	8	1.0	42
15	2	0.2	11
16	1	0.1	5
17	0	0.0	0
18	1	0.1	5
Total	803	100	4,259

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	5,978	2.4	35
5	51,871	20.6	303
6	44,354	17.6	259
7	27,955	11.1	163
8	26,100	10.4	153
9	25,579	10.2	150
10	20,388	8.1	119
11	15,914	6.3	93
12	16,130	6.4	94
13	10,935	4.3	64
14	4,157	1.7	24
15	1,009	0.4	6
16	585	0.2	3
17	0	0.0	0
18	606	0.2	4
Total	251,561	100	1,471

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Sample Date(s)	13–15 May		
Section(s):	HAG/PYP/TOG		
Harvest Biomass:	5,145		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	41	4.0	661
5	349	33.9	5,629
6	281	27.3	4,533
7	133	12.9	2,145
8	81	7.9	1,307
9	60	5.8	968
10	24	2.3	387
11	12	1.2	194
12	27	2.6	436
13	15	1.5	242
14	4	0.4	65
15	1	0.1	16
16	2	0.2	32
17	1	0.1	16
18	0	0.0	0
Total	1031	100	16,630

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	7,067	2.4	126
5	72,844	25.2	1,295
6	74,470	25.7	1,324
7	41,086	14.2	731
8	28,484	9.8	506
9	23,552	8.1	419
10	11,023	3.8	196
11	5,561	1.9	99
12	13,255	4.6	236
13	7,739	2.7	138
14	2,274	0.8	40
15	444	0.2	8
16	1,070	0.4	19
17	514	0.2	9
18	0	0.0	0
Total	289,383	100	5,145

Sample Date(s)	16–17 May		
Section(s):	NUN/TOG		
Harvest Biomass:	2,128		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	14	3.0	158
5	70	14.9	792
6	77	16.4	871
7	66	14.1	746
8	80	17.1	905
9	47	10.0	531
10	38	8.1	430
11	28	6.0	317
12	40	8.5	452
13	6	1.3	68
14	2	0.4	23
15	0	0.0	0
16	0	0.0	0
17	1	0.2	11
18	0	0.0	0
Total	469	100	5,303

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	2,553	1.5	32
5	16,094	9.4	201
6	21,706	12.7	271
7	23,094	13.5	288
8	31,645	18.5	394
9	19,394	11.4	242
10	18,299	10.7	228
11	13,353	7.8	166
12	19,717	11.5	246
13	3,277	1.9	41
14	1,126	0.7	14
15	0	0.0	0
16	0	0.0	0
17	462	0.3	6
18	0	0.0	0
Total	170,720	100	2,128

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Appendix A2.–Page 4 of 4.

Sample Date(s)	18–19 May		
Section(s):	NUN/TOG		
Harvest Biomass:	2,346		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	15	3.3	574
5	200	44.4	7,658
6	128	28.4	4,901
7	49	10.9	1,876
8	27	6.0	1,034
9	14	3.1	536
10	6	1.3	230
11	6	1.3	230
12	4	0.9	153
13	0	0.0	0
14	1	0.2	0
15	0	0.0	0
16	0	0.0	0
17	0	0.0	0
18	0	0.0	0
Total	450	100	17,191

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	1,170	2.1	49
5	22,980	41.4	970
6	16,242	29.2	685
7	6,288	11.3	265
8	2,061	3.7	87
9	2,963	5.3	125
10	1,229	2.2	52
11	1,693	3.0	71
12	948	1.7	40
13	0	0.0	0
14	0	0.0	0
15	0	0.0	0
16	0	0.0	0
17	0	0.0	0
18	0	0.0	0
Total	55,574	100	2,346

Sample Date(s)	20–24 May		
Section(s):	NUN		
Harvest Biomass:	737		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	8	1.7	34
5	165	35.4	963
6	158	33.9	843
7	67	14.4	353
8	27	5.8	141
9	15	3.2	82
10	9	1.9	47
11	10	2.1	48
12	3	0.6	16
13	4	0.9	22
14	0	0.0	0
15	0	0.0	0
16	0	0.0	0
17	0	0.0	0
18	0	0.0	0
Total	466	100	2,549

		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	1,670	1.1	8
5	43,728	29.5	218
6	48,809	32.9	243
7	23,561	15.9	117
8	10,598	7.2	53
9	6,889	4.7	34
10	4,171	2.8	21
11	4,909	3.3	24
12	1,548	1.0	8
13	2,274	1.5	11
14	0	0.0	0
15	0	0.0	0
16	0	0.0	0
17	0	0.0	0
18	0	0.0	0
Total	148,157	100	737

Note: Sections refers to the following subdistricts within the Togiak District: TOG=Togiak, NUN=Nunavachak, HAG=Hagemeister, KUL=Kulukak, PYP=Pyrite Point and CN=Cape Newenham.

Appendix A3.–Estimated age composition of herring in the commercial gillnet harvest, by date and fishing section, Togiak District, 2010.

Sample Date(s)	14–17 May		
Section(s):	KUL/NUN		
Harvest Biomass:	1,734		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	8	1.2	49
5	63	9.8	385
6	47	7.3	287
7	112	17.3	684
8	115	17.8	702
9	113	17.5	690
10	74	11.5	452
11	49	7.6	299
12	43	6.7	263
13	17	2.6	104
14	4	0.6	24
15	1	0.2	6
16	0	0.0	0
17	0	0.0	0
18	0	0.0	0
Total	646	100.0	3,945
		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	1,356	0.5	9
5	13,911	5.4	94
6	14,891	5.8	100
7	42,104	16.3	283
8	46,960	18.2	316
9	48,782	18.9	328
10	32,536	12.6	219
11	23,326	9.1	157
12	21,771	8.5	147
13	9,581	3.7	64
14	1,802	0.7	12
15	515	0.2	3
16	0	0.0	0
17	0	0.0	0
18	0	0.0	0
Total	257,535	100.0	1,734

Sample Date(s)	18–27 May		
Section(s):	KUL/NUN		
Harvest Biomass:	5,806		
Age	No.	Percent by No.	Numbers (x1,000)
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	1	0.1	17
5	14	1.9	243
6	60	8.0	1,040
7	179	23.8	3,102
8	197	26.2	3,414
9	118	15.7	2,045
10	61	8.1	1,057
11	53	7.0	919
12	37	4.9	641
13	21	2.8	364
14	7	0.9	121
15	3	0.4	52
16	1	0.1	17
17	0	0.0	0
18	0	0.0	0
Total	752	100.0	13,033
		Percent Weighted by	
Age	Weight	Weight	Biomass
1	0	0.0	0
2	0	0.0	0
3	0	0.0	0
4	339	0.1	6
5	4,329	1.4	83
6	20,776	6.8	397
7	66,929	22.0	1,279
8	76,795	25.3	1,467
9	49,038	16.1	937
10	27,334	9.0	522
11	24,681	8.1	472
12	17,756	5.8	339
13	10,312	3.4	197
14	3,565	1.2	68
15	1,441	0.5	28
16	616	0.2	12
17	0	0.0	0
18	0	0.0	0
Total	303,911	100.0	5,806

Note: Sections refers to the following subdistricts within the Togiak District: TOG=Togiak, NUN=Nunavachak, HAG=Hagemeister, KUL=Kulukak, PYP=Pyrite Point and CN=Cape Newenham.

APPENDIX B

Appendix B1.–Age, sex and size composition of herring caught by commercial purse seine, Hagemeister Section, 13–22 May, 2010.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
13 May	4	3	1	0	4	4.9	2.4	170	39.4	4	241	16.2	4
	5	10	11	0	21	25.9	4.9	218	32.9	21	257	10.0	21
	6	8	9	0	17	21.0	4.6	289	54.4	17	273	15.0	17
	7	6	12	0	18	22.2	4.6	383	83.1	18	297	19.0	18
	8	4	6	0	10	12.3	3.7	412	99.6	10	306	21.3	10
	9	3	1	0	4	4.9	2.4	470	35.7	4	316	12.8	4
	10	1	1	0	2	2.5	1.7	471	59.4	2	327	4.2	2
	11	1	0	0	1	1.2	1.2	540	NA	1	345	NA	1
	12	1	1	0	2	2.5	1.7	585	154.1	2	338	8.5	2
	13	0	1	0	1	1.2	1.2	573	NA	1	331	NA	1
	14	1	0	0	1	1.2	1.2	662	NA	1	338	NA	1
Sample Total		38	43	0	81	100.0		333	126.6	81	284	30.1	81
14 May	4	1	0	0	1	0.2	0.2	398	NA	1	307	NA	1
	5	7	4	0	11	2.5	0.7	304	71.0	11	276	17.7	11
	6	10	12	1	23	5.2	1.1	355	87.1	23	290	18.9	23
	7	26	15	1	42	9.5	1.4	415	61.5	42	302	12.2	42
	8	53	30	0	83	18.7	1.9	442	58.1	83	306	12.4	83
	9	51	33	0	84	18.9	1.9	473	69.4	84	313	13.7	84
	10	34	32	0	66	14.9	1.7	529	58.2	66	324	10.3	66
	11	31	22	0	53	11.9	1.5	528	58.2	53	324	12.0	53
	12	35	19	0	54	12.2	1.6	547	53.0	54	329	11.1	54
	13	11	10	0	21	4.7	1.0	536	64.8	21	324	10.3	21
	14	1	1	0	2	0.5	0.3	527	57.3	2	330	17.7	2
	15	1	1	0	2	0.5	0.3	584	10.6	2	336	7.1	2
	16	0	1	0	1	0.2	0.2	581	NA	1	352	NA	1
	17	0	1	0	1	0.2	0.2	739	NA	1	359	NA	1
Sample Total		261	181	2	444	100.0		480	87.3	444	314	17.7	444

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Appendix B1.–Page 2 of 5.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
	4	1	0	0	1	0.3	0.3	235	NA	1	260	NA	1
	5	14	9	1	24	6.7	1.3	244	54.0	24	261	15.0	24
	6	29	21	0	50	14.0	1.8	313	85.4	50	276	17.6	50
	7	32	21	0	53	14.8	1.9	358	64.8	53	291	14.7	53
	8	32	22	0	54	15.1	1.9	412	44.4	54	302	10.0	54
	9	18	19	0	37	10.3	1.6	431	65.7	37	306	11.7	37
	10	22	21	0	43	12.0	1.7	465	45.3	43	314	10.4	43
15 May	11	8	17	0	25	7.0	1.3	518	55.7	25	323	12.5	25
	12	11	28	0	39	10.9	1.6	527	48.3	39	325	9.3	39
	13	12	11	0	23	6.4	1.3	520	64.7	23	325	11.6	23
	14	2	3	0	5	1.4	0.6	566	46.7	5	328	10.7	5
	15	2	1	0	3	0.8	0.5	529	81.7	3	323	8.1	3
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	1	0	0	1	0.3	0.3	520	NA	1	336	NA	1
Sample Total		184	173	1	358	100.0		417	105.6	358	302	23.4	358
	4	0	1	0	1	0.7	0.7	205	NA	1	252	NA	1
	5	12	19	1	32	21.6	3.4	232	54.6	32	257	16.2	32
	6	16	28	1	45	30.4	3.8	297	64.1	45	277	17.3	45
	7	10	12	1	23	15.5	3.0	357	48.6	23	292	12.9	23
	8	14	8	0	22	14.9	2.9	340	68.8	22	289	17.7	22
16 May	9	3	6	0	9	6.1	2.0	441	53.6	9	314	8.3	9
	10	2	4	0	6	4.1	1.6	423	113.2	6	304	27.5	6
	11	1	3	0	4	2.7	1.3	486	80.3	4	324	6.3	4
	12	1	4	0	5	3.4	1.5	491	45.2	5	322	10.7	5
	13	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	14	1	0	0	1	0.7	0.7	444	NA	1	327	NA	1
Sample Total		60	85	3	148	100.0		324	94.9	148	283	24.9	148

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Appendix B1.–Page 3 of 5.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
	4	13	6	0	19	5.3	1.2	174	36.6	19	239	15.2	19
	5	55	66	0	121	33.7	2.5	212	38.4	121	250	12.0	121
	6	29	26	0	55	15.3	1.9	269	61.0	55	268	17.1	55
	7	21	20	0	41	11.4	1.7	337	63.0	41	287	13.7	41
	8	19	12	0	31	8.6	1.5	374	88.1	31	298	19.2	31
17 May	9	18	14	0	32	8.9	1.5	389	61.2	32	302	14.7	32
	10	14	10	0	24	6.7	1.3	437	73.0	24	315	11.5	24
	11	9	2	0	11	3.1	0.9	476	65.2	11	322	11.0	11
	12	7	5	0	12	3.3	0.9	488	82.1	12	320	19.1	12
	13	4	5	1	10	2.8	0.9	493	37.9	10	326	7.0	10
	14	1	2	0	3	0.8	0.5	535	57.6	3	329	8.1	3
Sample Total		190	168	1	359	100		305	114.4	359	277	30.7	359
	4	7	6	0	13	2.9	0.8	206	74.0	13	247	20.8	13
	5	66	53	1	120	27.0	2.1	219	38.1	120	253	12.8	120
	6	58	52	1	111	25.0	2.1	266	52.4	111	267	15.6	111
	7	22	22	1	45	10.1	1.4	314	56.4	45	279	14.3	45
	8	14	21	2	37	8.3	1.3	392	51.6	37	298	11.0	37
	9	22	9	1	32	7.2	1.2	410	72.7	32	304	12.3	32
	10	12	9	1	22	5.0	1.0	450	87.3	22	310	18.3	22
18 May	11	12	11	0	23	5.2	1.1	464	63.2	23	315	12.8	23
	12	8	11	1	20	4.5	1.0	514	55.0	20	326	10.1	20
	13	5	7	0	12	2.7	0.8	501	74.1	12	320	13.0	12
	14	0	5	0	5	1.1	0.5	511	85.1	5	324	6.6	5
	15	0	2	0	2	0.5	0.3	505	60.1	2	332	9.2	2
	16	0	1	0	1	0.2	0.2	585	NA	1	331	NA	1
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	0	1	0	1	0.2	0.2	606	NA	1	348	NA	1
Sample Total		226	210	8	444	100.0		320	115.5	444	280	28.9	444

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Appendix B1.–Page 4 of 5.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
19 May	4	2	0	0	2	1.2	0.8	224	1.4	2	263	4.2	2
	5	12	11	0	23	13.4	2.6	228	48.0	23	259	14.8	23
	6	21	18	0	39	22.7	3.2	297	61.6	39	278	15.1	39
	7	18	15	0	33	19.2	3.0	343	64.8	33	291	16.0	33
	8	11	10	0	21	12.2	2.5	368	61.8	21	296	13.2	21
	9	9	9	0	18	10.5	2.3	397	60.7	18	306	11.0	18
	10	5	4	1	10	5.8	1.8	472	56.8	10	325	9.3	10
	11	2	2	0	4	2.3	1.2	494	59.8	4	324	9.5	4
	12	4	8	0	12	7.0	1.9	503	69.1	12	326	10.6	12
	13	5	2	0	7	4.1	1.5	503	51.2	7	325	11.3	7
	14	1	1	0	2	1.2	0.8	564	66.5	2	338	19.1	2
	15	0	1	0	1	0.6	0.6	444	NA	1	318	NA	1
Sample Total		90	81	1	172	100.0		356	105.0	172	293	25.3	172
20 May	4	7	4	0	11	4.3	1.3	153	24.8	11	229	7.7	11
	5	48	63	0	111	43.2	3.1	202	29.0	111	250	10.0	111
	6	32	38	0	70	27.2	2.8	257	60.3	70	266	17.2	70
	7	13	10	0	23	8.9	1.8	294	66.5	23	278	19.9	23
	8	6	10	0	16	6.2	1.5	351	59.8	16	292	13.0	16
	9	5	9	0	14	5.4	1.4	412	55.9	14	308	12.7	14
	10	2	2	0	4	1.6	0.8	486	105.1	4	322	12.1	4
	11	2	0	0	2	0.8	0.5	384	112.4	2	317	29.7	2
	12	2	1	0	3	1.2	0.7	477	16.6	3	317	9.1	3
	13	1	0	0	1	0.4	0.4	533	NA	1	319	NA	1
	14	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	2	0	0	2	0.8	0.5	535	33.9	2	331	17.7	2
Sample Total		120	137	0	257	100.0		257	92.1	257	265	25.5	257

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Appendix B1.–Page 5 of 5.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
21 May	4	6	12	0	18	4.6	1.1	173	31.3	18	237	11.7	18
	5	60	83	1	144	36.5	2.4	207	28.3	144	251	11.1	144
	6	50	66	1	117	29.6	2.3	259	48.2	117	267	14.5	117
	7	22	28	0	50	12.7	1.7	297	74.8	50	277	20.0	50
	8	19	11	0	30	7.6	1.3	354	56.8	30	294	13.3	30
	9	10	5	0	15	3.8	1.0	396	62.4	15	302	17.0	15
	10	2	3	0	5	1.3	0.6	416	57.9	5	303	14.0	5
	11	4	1	0	5	1.3	0.6	451	88.4	5	318	12.1	5
	12	2	3	0	5	1.3	0.6	484	51.2	5	317	11.1	5
	13	1	2	0	3	0.8	0.4	550	48.8	3	336	2.3	3
	14	1	1	0	2	0.5	0.4	573	8.5	2	331	14.1	2
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	1	0	1	0.3	0.3	514	NA	1	336	NA	1
Sample Total		177	216	2	395	100.0		265	88.5	395	268	24.2	395
22 May	4	3	5	2	10	4.8	1.5	183	39.7	10	245	15.0	10
	5	36	30	5	71	34.3	3.3	216	33.0	71	258	12.3	71
	6	22	32	1	55	26.6	3.1	266	41.5	55	272	11.7	55
	7	10	16	1	27	13.0	2.3	301	58.7	27	281	15.9	27
	8	11	3	0	14	6.8	1.7	323	52.6	14	294	15.5	14
	9	8	5	0	13	6.3	1.7	362	63.6	13	297	15.9	13
	10	2	3	0	5	2.4	1.1	456	68.7	5	294	45.2	5
	11	0	1	0	1	0.5	0.5	566	NA	1	331	NA	1
	12	5	2	0	7	3.4	1.3	481	58.6	7	323	10.9	7
	13	2	2	0	4	1.9	1.0	510	50.2	4	331	6.1	4
Sample Total		99	99	9	207	100.0		277	89.6	207	274	23.8	207
Samples Combined		1,451	1,405	27	2,883			341	126.2	2,883	285	30.2	2,883

Appendix B2.–Age, sex and size composition of herring caught by commercial purse seine, Nunavachak Section, 14–20 May and 22 May, 2010.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
14 May	4	3	3	0	6	3.4	1.4	187	25.9	6	243	9.1	6
	5	34	34	0	68	38.2	3.7	229	48.1	68	256	14.0	68
	6	22	28	0	50	28.1	3.4	286	57.0	50	272	15.9	50
	7	10	9	0	19	10.7	2.3	365	77.5	19	290	14.4	19
	8	8	9	0	17	9.6	2.2	375	92.5	17	297	16.6	17
	9	9	3	0	12	6.7	1.9	413	67.7	12	305	14.8	12
	10	1	2	0	3	1.7	1.0	486	59.8	3	316	12.2	3
	11	0	1	0	1	0.6	0.6	607	NA	1	339	NA	1
	12	1	1	0	2	1.1	0.8	544	31.1	2	336	6.4	2
Sample Total		88	90	0	178	100.0		295	97.7	178	273	24.5	178
15 May	4	1	3	1	5	1.5	0.7	290	77.5	5	282	29.2	5
	5	23	19	0	42	12.6	1.8	252	59.8	42	264	17.9	42
	6	24	32	0	56	16.8	2.0	293	52.1	56	276	13.6	56
	7	25	29	4	58	17.4	2.1	352	77.6	58	291	18.4	58
	8	19	21	2	42	12.6	1.8	387	54.9	42	302	13.9	42
	9	17	15	2	34	10.2	1.7	415	64.6	34	309	14.7	34
	10	10	15	2	27	8.1	1.5	451	72.0	27	315	13.7	27
	11	10	11	1	22	6.6	1.4	463	54.0	22	320	7.5	22
	12	16	9	3	28	8.4	1.5	475	44.4	28	321	18.1	28
	13	2	10	0	12	3.6	1.0	504	60.3	12	328	9.5	12
	14	1	4	0	5	1.5	0.7	558	34.8	5	334	10.6	5
	15	1	1	0	2	0.6	0.4	524	19.8	2	331	3.5	2
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	19	0	1	0	1	0.3	0.3	546	NA	1	319	NA	1
Sample Total		149	170	15	334	100.0		375	101.0	334	297	25.4	334

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Appendix B2.–Page 2 of 4.

Sample Dates	Age	Sex (number) Male	Female	Unk.	Total	% of Total	SE	Weight Mean (g)	SD	Number Weighed	Length Mean (mm)	SD	Number Measured
16 May	4	1	0	0	1	0.3	0.3	162	NA	1	248	NA	1
	5	13	9	1	23	7.1	1.4	254	61.3	23	267	19.8	23
	6	25	21	3	49	15.1	2.0	297	51.3	49	278	14.3	49
	7	23	25	3	51	15.7	2.0	356	61.1	51	296	15.3	51
	8	22	39	5	66	20.4	2.2	406	65.8	66	305	13.4	66
	9	15	17	6	38	11.7	1.8	422	63.2	38	311	12.5	38
	10	10	19	3	32	9.9	1.7	497	63.2	32	324	12.6	32
	11	8	11	4	23	7.1	1.4	477	58.0	23	320	12.4	23
	12	10	17	7	34	10.5	1.7	494	62.4	34	326	14.9	34
	13	3	1	0	4	1.2	0.6	530	73.0	4	331	12.7	4
	14	1	1	0	2	0.6	0.4	563	60.8	2	338	13.4	2
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	1	0	1	0.3	0.3	462	NA	1	315	NA	1
Sample Total		131	161	32	324	100.0		398	99.8	324	303	23.5	324
17 May	4	5	6	2	13	9.0	2.4	184	29.3	13	240	9.7	13
	5	23	22	2	47	32.4	3.9	218	47.4	47	251	14.5	47
	6	10	17	1	28	19.3	3.3	256	41.2	28	264	12.5	28
	7	4	10	1	15	10.3	2.5	331	70.8	15	285	18.0	15
	8	9	5	0	14	9.7	2.5	348	57.2	14	292	17.7	14
	9	3	4	2	9	6.2	2.0	374	47.1	9	301	10.9	9
	10	2	4	0	6	4.1	1.7	401	102.6	6	299	23.5	6
	11	3	2	0	5	3.4	1.5	477	56.4	5	319	14.9	5
	12	4	2	0	6	4.1	1.7	487	32.5	6	320	9.8	6
	13	0	2	0	2	1.4	1.0	579	59.4	2	334	2.1	2
Sample Total		63	74	8	145	100.0		289	104.4	145	272	28.4	145

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Appendix B2.–Page 3 of 4.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
18 May	4	5	2	0	7	3.1	1.2	167	34.8	7	234	10.4	7
	5	45	63	1	109	48.4	3.3	211	28.0	109	249	9.9	109
	6	35	30	0	65	28.9	3.0	250	42.1	65	261	13.2	65
	7	10	11	0	21	9.3	1.9	299	44.5	21	273	12.9	21
	8	2	4	0	6	2.7	1.1	344	78.4	6	288	17.0	6
	9	5	3	0	8	3.6	1.2	370	56.9	8	300	9.1	8
	10	1	2	0	3	1.3	0.8	410	36.5	3	302	10.4	3
	11	2	2	0	4	1.8	0.9	423	40.4	4	313	7.7	4
	12	1	1	0	2	0.9	0.6	474	48.1	2	313	2.8	2
Sample Total		106	118	1	225	100.0		247	68.1	225	260	19.9	225
19 May	4	4	4	0	8	3.6	1.2	212	41.2	8	250	17.1	8
	5	47	44	0	91	40.4	3.3	217	29.1	91	253	9.1	91
	6	28	35	0	63	28.0	3.0	264	48.7	63	267	15.0	63
	7	18	10	0	28	12.4	2.2	308	50.1	28	280	12.8	28
	8	7	14	0	21	9.3	1.9	360	88.3	21	291	18.8	21
	9	3	3	0	6	2.7	1.1	333	90.6	6	291	18.9	6
	10	0	3	0	3	1.3	0.8	474	82.4	3	317	6.2	3
	11	0	2	0	2	0.9	0.6	494	61.5	2	315	15.6	2
	12	0	2	0	2	0.9	0.6	499	45.3	2	315	13.4	2
	13	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	14	0	1	0	1	0.4	0.4	534	NA	1	325	NA	1
Sample Total		107	118	0	225	100.0		268	80.1	225	267	20.7	225

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Appendix B2.–Page 4 of 4.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
20 May	4	0	2	0	2	0.8	0.6	272	154.1	2	266	38.9	2
	5	32	34	0	66	27.7	2.9	216	26.6	66	254	9.2	66
	6	43	39	0	82	34.5	3.1	276	49.7	82	272	13.5	82
	7	25	16	0	41	17.2	2.5	309	54.8	41	283	15.8	41
	8	6	6	0	12	5.0	1.4	348	69.3	12	292	14.0	12
	9	7	5	0	12	5.0	1.4	373	50.0	12	297	14.2	12
	10	6	2	0	8	3.4	1.2	390	72.8	8	303	13.4	8
	11	4	5	0	9	3.8	1.2	462	68.7	9	321	11.4	9
	12	3	0	0	3	1.3	0.7	443	36.5	3	320	6.4	3
	13	2	1	0	3	1.3	0.7	483	35.8	3	322	7.5	3
Sample Total		128	110	0	238	100.0		289	82.0	238	275	22.5	238
22 May	4	3	3	0	6	2.6	1.1	203	42.9	6	254	14.4	6
	5	39	58	2	99	43.4	3.3	197	26.9	99	251	10.0	99
	6	34	41	1	76	33.3	3.1	246	41.5	76	266	13.1	76
	7	7	18	1	26	11.4	2.1	289	48.9	26	279	15.8	26
	8	5	9	1	15	6.6	1.6	334	48.4	15	291	15.8	15
	9	1	2	0	3	1.3	0.8	402	61.5	3	300	9.1	3
	10	1	0	0	1	0.4	0.4	512	NA	1	326	NA	1
	11	0	1	0	1	0.4	0.4	419	NA	1	327	NA	1
	12	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	13	1	0	0	1	0.4	0.4	396	NA	1	316	NA	1
Sample Total		91	132	5	228	100.0		239	63.0	228	264	19.1	228
Samples Combined		863	973	61	1,897			310	106.3	1,897	279	27.9	1,897

Appendix B3.–Age, sex and size composition of herring caught by commercial purse seine, Togiak Section, 10, 14 and 15 May, 2010.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
10 May	5	10	3	0	13	5.0	1.4	239	40.6	13	262	12.9	13
	6	25	17	0	42	16.2	2.3	319	56.9	42	282	16.2	42
	7	21	27	0	48	18.5	2.4	352	70.1	48	289	16.2	48
	8	26	30	0	56	21.6	2.6	398	67.8	56	300	17.1	56
	9	24	23	0	47	18.1	2.4	426	39.7	47	306	10.9	47
	10	10	6	0	16	6.2	1.5	464	70.1	16	315	12.5	16
	11	9	9	0	18	6.9	1.6	489	50.6	18	318	16.5	18
	12	9	1	0	10	3.9	1.2	501	36.9	10	322	8.5	10
	13	2	5	0	7	2.7	1.0	506	40.2	7	317	8.5	7
	14	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	15	0	1	0	1	0.4	0.4	503	NA	1	324	NA	1
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	1	0	0	1	0.4	0.4	559	NA	1	332	NA	1
Sample Total		137	122	0	259	100.0		392	88.4	259	298	20.7	259
14 May	5	4	0	0	4	2.7	1.4	229	22.0	4	256	6.5	4
	6	5	2	0	7	4.8	1.8	338	58.0	7	286	12.9	7
	7	3	6	0	9	6.2	2.0	407	110.0	9	300	20.1	9
	8	17	3	0	20	13.7	2.9	434	58.2	20	308	12.5	20
	9	12	8	0	20	13.7	2.9	479	65.3	20	316	13.4	20
	10	14	2	0	16	11.0	2.6	505	47.3	16	320	10.5	16
	11	16	13	0	29	19.9	3.3	538	68.4	29	328	13.3	29
	12	18	9	0	27	18.5	3.2	543	45.8	27	329	8.6	27
	13	7	5	0	12	8.2	2.3	565	43.4	12	334	9.1	12
	14	0	1	0	1	0.7	0.7	564	NA	1	328	NA	1
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	1	0	1	0.7	0.7	633	NA	1	347	NA	1
Sample Total		96	50	0	146	100.0		490	94.9	146	318	19.9	146

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Appendix B3.–Page 2 of 2.

Sample Dates	Age	Sex (number) Male	Female	Unk.	Total	% of Total	SE	Weight Mean (g)	SD	Number Weighed	Length Mean (mm)	SD	Number Measured
15 May	4	3	0	0	3	0.9	0.5	201	59.3	3	253	17.4	3
	5	35	23	0	58	17.5	2.1	238	41.6	58	259	12.8	58
	6	31	32	0	63	19.0	2.2	311	60.0	63	278	15.3	63
	7	26	34	0	60	18.1	2.1	348	78.8	60	286	18.7	60
	8	22	28	0	50	15.1	2.0	402	68.5	50	299	14.1	50
	9	20	19	1	40	12.1	1.8	438	71.1	39	306	14.5	39
	10	8	10	0	18	5.4	1.2	465	53.2	18	316	12.2	18
	11	8	8	0	16	4.8	1.2	507	68.6	16	322	12.6	16
	12	3	9	0	12	3.6	1.0	525	44.9	12	325	9.7	12
	13	3	5	0	8	2.4	0.8	544	103.1	8	331	13.8	8
	14	0	2	0	2	0.6	0.4	587	23.3	2	332	18.4	2
	15	0	1	0	1	0.3	0.3	680	NA	1	351	NA	1
Sample Total		159	171	1	331	100.0		367	111.4	330	290	25.8	330
Samples Combined		392	343	1	736			400	110.6	735	298	25.2	735

Appendix B4.–Age, sex and size composition of herring caught by commercial gillnet, Kulukak Section, 15–21 May, 2010.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
15 May	5	0	0	1	1	0.3	0.3	NA	NA	0	NA	NA	0
	6	0	2	3	5	1.7	0.7	400	71.4	2	297	25.5	2
	7	9	7	21	37	12.4	1.9	382	26.0	16	294	4.9	16
	8	8	16	41	65	21.8	2.4	423	31.7	24	303	9.1	24
	9	11	11	48	70	23.5	2.5	439	43.3	22	307	9.2	22
	10	5	4	36	45	15.1	2.1	429	56.1	9	303	12.6	9
	11	4	5	20	29	9.7	1.7	475	64.1	9	312	10.5	9
	12	6	1	21	28	9.4	1.7	512	70.1	7	322	14.0	7
	13	1	3	9	13	4.4	1.2	567	111.0	4	323	19.0	4
	14	2	0	2	4	1.3	0.7	451	27.6	2	316	9.2	2
	15	0	0	1	1	0.3	0.3	NA	NA	0	NA	NA	0
Sample Total		46	49	203	298	100.0		438	63.5	95	306	12.7	95
16 May	5	2	1	0	3	1.5	0.9	322	89.6	3	278	27.5	3
	6	11	10	0	21	10.8	2.2	362	44.8	21	291	11.0	21
	7	24	34	0	58	29.7	3.3	380	34.0	58	296	10.4	58
	8	15	22	0	37	19.0	2.8	402	42.5	37	299	9.1	37
	9	13	20	0	33	16.9	2.7	426	50.8	33	307	12.0	33
	10	10	12	0	22	11.3	2.3	455	47.2	22	314	9.9	22
	11	4	8	0	12	6.2	1.7	481	59.0	12	322	12.4	12
	12	4	3	0	7	3.6	1.3	485	57.4	7	321	14.8	7
	13	1	1	0	2	1.0	0.7	479	41.0	2	322	6.4	2
Sample Total		84	111	0	195	100.0		409	58.6	195	303	14.6	195

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Appendix B4.–Page 2 of 4.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
17 May	4	5	3	0	8	5.2	1.8	170	16.7	8	239	9.3	8
	5	25	28	6	59	38.6	3.9	214	33.1	59	256	12.0	59
	6	7	13	1	21	13.7	2.8	252	50.9	21	267	15.6	21
	7	6	11	0	17	11.1	2.5	348	66.2	17	294	17.3	17
	8	6	7	0	13	8.5	2.3	356	63.2	13	298	15.6	13
	9	6	4	0	10	6.5	2.0	403	99.1	10	303	19.9	10
	10	5	1	1	7	4.6	1.7	456	72.7	7	324	13.0	7
	11	2	5	1	8	5.2	1.8	472	67.3	8	324	11.5	8
	12	3	3	2	8	5.2	1.8	506	73.6	8	328	8.7	8
	13	0	2	0	2	1.3	0.9	625	40.3	2	335	15.6	2
Sample Total		65	77	11	153	100.0		301	120.0	153	279	30.8	153
18 May	5	1	1	0	2	0.9	0.7	404	51.6	2	306	2.1	2
	6	5	10	0	15	7.0	1.8	355	57.6	15	295	11.1	15
	7	20	28	0	48	22.5	2.9	388	46.9	48	303	11.9	48
	8	23	36	0	59	27.7	3.1	399	41.0	59	305	11.7	59
	9	11	23	1	35	16.4	2.5	436	47.5	35	312	10.1	35
	10	8	13	0	21	9.9	2.0	463	63.1	21	321	11.4	21
	11	11	8	0	19	8.9	2.0	483	51.7	19	323	10.7	19
	12	4	4	0	8	3.8	1.3	471	42.9	8	316	9.9	8
	13	1	4	0	5	2.3	1.0	449	44.9	5	324	13.9	5
	14	0	1	0	1	0.5	0.5	657	NA	1	355	NA	1
Sample Total		84	128	1	213	100.0		418	62.3	213	309	14.1	213

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Appendix B4.–Page 3 of 4.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
19 May	5	1	2	0	3	2.0	1.1	364	37.7	3	292	2.5	3
	6	5	5	1	11	7.3	2.1	362	50.3	11	289	8.4	11
	7	19	20	0	39	25.8	3.6	367	31.6	39	291	8.5	39
	8	16	23	0	39	25.8	3.6	382	31.4	39	294	8.5	39
	9	11	11	0	22	14.6	2.9	415	46.4	22	304	9.7	22
	10	8	6	0	14	9.3	2.4	443	47.8	14	312	10.4	14
	11	6	5	0	11	7.3	2.1	488	44.0	11	321	12.8	11
	12	7	2	0	9	6.0	1.9	487	54.0	9	317	10.9	9
	13	0	2	0	2	1.3	0.9	553	54.4	2	335	0.7	2
	14	1	0	0	1	0.7	0.7	478	NA	1	329	NA	1
Sample Total		74	76	1	151	100.0		404	59.5	151	300	14.3	151
20 May	5	1	0	1	2	1.0	0.7	236	26.9	2	260	6.4	2
	6	10	8	0	18	8.9	2.0	330	57.1	18	283	16.6	18
	7	19	30	0	49	24.3	3.0	361	40.4	49	291	9.0	49
	8	32	24	0	56	27.7	3.2	387	46.2	56	298	10.5	56
	9	13	17	0	30	14.9	2.5	400	59.6	30	301	13.8	30
	10	8	7	0	15	7.4	1.8	445	52.4	15	312	12.7	15
	11	4	8	0	12	5.9	1.7	424	61.1	12	309	12.2	12
	12	5	5	0	10	5.0	1.5	489	64.0	10	319	12.3	10
	13	2	3	0	5	2.5	1.1	499	44.5	5	323	5.6	5
	14	2	1	0	3	1.5	0.9	445	27.1	3	307	11.4	3
	15	2	0	0	2	1.0	0.7	515	46.7	2	331	17.7	2
Sample Total		98	103	1	202	100.0		392	66.7	202	299	15.7	202

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Appendix B4.–Page 4 of 4.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
21 May	4	0	1	0	1	0.5	0.5	339	NA	1	293	NA	1
	5	2	5	0	7	3.8	1.4	280	82.0	7	266	25.2	7
	6	5	11	0	16	8.6	2.1	346	59.5	16	288	13.7	16
	7	15	28	0	43	23.2	3.1	379	28.6	43	294	8.6	43
	8	20	23	0	43	23.2	3.1	389	42.0	43	300	11.4	43
	9	10	21	0	31	16.8	2.8	409	42.9	31	303	10.6	31
	10	6	5	0	11	5.9	1.7	430	43.9	11	310	12.1	11
	11	7	4	0	11	5.9	1.7	459	59.6	11	313	9.5	11
	12	6	4	0	10	5.4	1.7	472	67.3	10	319	14.1	10
	13	3	6	0	9	4.9	1.6	497	45.9	9	319	12.1	9
	14	0	2	0	2	1.1	0.8	548	2.1	2	330	3.5	2
	15	1	0	0	1	0.5	0.5	411	NA	1	312	NA	1
	16	0	1	0	1	0.5	0.5	616	NA	1	345	NA	1
Sample Total		75	111	0	186	100.0		401	66.7	186	301	16.4	186
Samples Combined		526	655	217	1,398			394	81.8	1,195	300	19.7	1,195

Appendix B5.–Age, sex and size composition of herring caught by commercial purse seine, all sections, 10 May and 13–22 May, 2010.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
10 May	5	10	3	0	13	5.0	1.4	239	40.6	13	262	12.9	13
	6	25	17	0	42	16.2	2.3	319	56.9	42	282	16.2	42
	7	21	27	0	48	18.5	2.4	352	70.1	48	289	16.2	48
	8	26	30	0	56	21.6	2.6	398	67.8	56	300	17.1	56
	9	24	23	0	47	18.1	2.4	426	39.7	47	306	10.9	47
	10	10	6	0	16	6.2	1.5	464	70.1	16	315	12.5	16
	11	9	9	0	18	6.9	1.6	489	50.6	18	318	16.5	18
	12	9	1	0	10	3.9	1.2	501	36.9	10	322	8.5	10
	13	2	5	0	7	2.7	1.0	506	40.2	7	317	8.5	7
	14	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	15	0	1	0	1	0.4	0.4	503	NA	1	324	NA	1
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	1	0	0	1	0.4	0.4	559	NA	1	332	NA	1
Sample Total		137	122	0	259	100.0		392	88.4	259	298	20.7	259
13 May	4	3	1	0	4	4.9	2.4	170	39.4	4	241	16.2	4
	5	10	11	0	21	25.9	4.9	218	32.9	21	257	10.0	21
	6	8	9	0	17	21.0	4.6	289	54.4	17	273	15.0	17
	7	6	12	0	18	22.2	4.6	383	83.1	18	297	19.0	18
	8	4	6	0	10	12.3	3.7	412	99.6	10	306	21.3	10
	9	3	1	0	4	4.9	2.4	470	35.7	4	316	12.8	4
	10	1	1	0	2	2.5	1.7	471	59.4	2	327	4.2	2
	11	1	0	0	1	1.2	1.2	540	NA	1	345	NA	1
	12	1	1	0	2	2.5	1.7	585	154.1	2	338	8.5	2
	13	0	1	0	1	1.2	1.2	573	NA	1	331	NA	1
	14	1	0	0	1	1.2	1.2	662	NA	1	338	NA	1
Sample Total		38	43	0	81	100.0		333	126.6	81	284	30.1	81

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Appendix B5.–Page 2 of 6.

Sample Dates	Age	Sex (number) Male	Female	Unk.	Total	% of Total	SE	Weight Mean (g)	SD	Number Weighed	Length Mean (mm)	SD	Number Measured
14 May	4	4	3	0	7	0.9	0.3	217	83.2	7	252	25.6	7
	5	45	38	0	83	10.8	1.1	239	56.3	83	259	15.7	83
	6	37	42	1	80	10.4	1.1	311	73.5	80	279	18.3	80
	7	39	30	1	70	9.1	1.0	400	75.5	70	299	14.8	70
	8	78	42	0	120	15.6	1.3	431	67.5	120	305	13.4	120
	9	72	44	0	116	15.1	1.3	468	70.5	116	313	14.0	116
	10	49	36	0	85	11.1	1.1	523	56.9	85	323	10.5	85
	11	47	36	0	83	10.8	1.1	532	62.0	83	325	12.6	83
	12	54	29	0	83	10.8	1.1	546	49.9	83	329	10.2	83
	13	18	15	0	33	4.3	0.7	546	58.9	33	328	10.9	33
	14	1	2	0	3	0.4	0.2	539	45.9	3	329	12.5	3
	15	1	1	0	2	0.3	0.2	584	10.6	2	336	7.1	2
	16	0	1	0	1	0.1	0.1	581	NA	1	352	NA	1
	17	0	2	0	2	0.3	0.2	686	75.0	2	353	8.5	2
Sample Total		445	321	2	768	100.0		439	120.9	768	305	26.6	768
15 May	4	5	3	1	9	0.9	0.3	254	75.9	9	270	26.8	9
	5	72	51	1	124	12.1	1.0	244	50.8	124	261	15.2	124
	6	84	85	0	169	16.5	1.2	306	66.5	169	277	15.5	169
	7	83	84	4	171	16.7	1.2	352	74.0	171	289	17.5	171
	8	73	71	2	146	14.3	1.1	401	57.1	146	301	12.7	146
	9	55	53	3	111	10.9	1.0	429	67.4	110	307	13.6	110
	10	40	46	2	88	8.6	0.9	460	56.0	88	315	11.8	88
	11	26	36	1	63	6.2	0.8	496	62.9	63	322	10.9	63
	12	30	46	3	79	7.7	0.8	508	52.1	79	323	13.1	79
	13	17	26	0	43	4.2	0.6	520	71.4	43	327	11.4	43
	14	3	9	0	12	1.2	0.3	566	37.3	12	331	11.0	12
	15	3	3	0	6	0.6	0.2	552	81.6	6	330	12.2	6
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	1	0	0	1	0.1	0.1	520	NA	1	336	NA	1
	19	0	1	0	1	0.1	0.1	546	NA	1	319	NA	1
Sample Total		492	514	17	1023	100.0		387	108.3	1022	296	25.3	1022

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Appendix B5.–Page 3 of 6.

Sample Dates	Age	Sex (number) Male	Female	Unk.	Total	% of Total	SE	Weight Mean (g)	SD	Number Weighed	Length Mean (mm)	SD	Number Measured
16 May	4	1	1	0	2	0.4	0.3	184	30.4	2	250	2.8	2
	5	25	28	2	55	11.7	1.5	241	58.0	55	261	18.4	55
	6	41	49	4	94	19.9	1.8	297	57.5	94	277	15.7	94
	7	33	37	4	74	15.7	1.7	356	57.2	74	295	14.6	74
	8	36	47	5	88	18.6	1.8	389	72.1	88	301	16.0	88
	9	18	23	6	47	10.0	1.4	425	61.4	47	312	11.8	47
	10	12	23	3	38	8.1	1.3	485	76.4	38	321	17.1	38
	11	9	14	4	27	5.7	1.1	478	60.0	27	321	11.7	27
	12	11	21	7	39	8.3	1.3	494	60.0	39	325	14.4	39
	13	3	1	0	4	0.8	0.4	530	73.0	4	331	12.7	4
	14	2	1	0	3	0.6	0.4	523	81.1	3	334	11.3	3
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	1	0	1	0.2	0.2	462	NA	1	315	NA	1
Sample Total		191	246	35	472	100		375	103.9	472	297	25.6	472
17 May	4	18	12	2	32	6.3	1.1	178	33.7	32	239	13.1	32
	5	78	88	2	168	33.3	2.1	214	41.1	168	251	12.7	168
	6	39	43	1	83	16.5	1.7	265	55.2	83	267	15.8	83
	7	25	30	1	56	11.1	1.4	335	64.6	56	286	14.8	56
	8	28	17	0	45	8.9	1.3	366	80.0	45	296	18.8	45
	9	21	18	2	41	8.1	1.2	386	58.2	41	302	13.8	41
	10	16	14	0	30	6.0	1.1	430	79.1	30	312	15.5	30
	11	12	4	0	16	3.2	0.8	476	60.7	16	321	11.9	16
	12	11	7	0	18	3.6	0.8	488	68.4	18	320	16.2	18
	13	4	7	1	12	2.4	0.7	507	51.2	12	327	7.1	12
	14	1	2	0	3	0.6	0.3	535	57.6	3	329	8.1	3
Sample Total		253	242	9	504	100.0		301	111.8	504	275	30.2	504

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Appendix B5.–Page 4 of 6.

Sample Dates	Age	Sex (number) Male	Female	Unk.	Total	% of Total	SE	Weight Mean (g)	SD	Number Weighed	Length Mean (mm)	SD	Number Measured
18 May	4	12	8	0	20	3.0	0.7	192	64.8	20	243	18.7	20
	5	111	116	2	229	34.2	1.8	215	33.9	229	251	11.6	229
	6	93	82	1	176	26.3	1.7	260	49.4	176	265	15.0	176
	7	32	33	1	66	9.9	1.2	310	53.0	66	277	14.1	66
	8	16	25	2	43	6.4	0.9	385	57.5	43	297	12.3	43
	9	27	12	1	40	6.0	0.9	402	71.0	40	303	11.7	40
	10	13	11	1	25	3.7	0.7	445	83.4	25	309	17.6	25
	11	14	13	0	27	4.0	0.8	458	61.5	27	314	12.1	27
	12	9	12	1	22	3.3	0.7	510	54.6	22	325	10.4	22
	13	5	7	0	12	1.8	0.5	501	74.1	12	320	13.0	12
	14	0	5	0	5	0.7	0.3	511	85.1	5	324	6.6	5
	15	0	2	0	2	0.3	0.2	505	60.1	2	332	9.2	2
	16	0	1	0	1	0.1	0.1	585	NA	1	331	NA	1
	17	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	18	0	1	0	1	0.1	0.1	606	NA	1	348	NA	1
Sample Total		332	328	9	669	100.0		295	107.6	669	273	27.7	669
19 May	4	6	4	0	10	2.5	0.8	215	36.7	10	253	16.1	10
	5	59	55	0	114	28.7	2.3	219	33.8	114	255	10.7	114
	6	49	53	0	102	25.7	2.2	277	56.0	102	271	15.9	102
	7	36	25	0	61	15.4	1.8	327	60.7	61	285	15.5	61
	8	18	24	0	42	10.6	1.5	364	75.4	42	293	16.2	42
	9	12	12	0	24	6.0	1.2	381	72.8	24	302	14.6	24
	10	5	7	1	13	3.3	0.9	473	59.6	13	323	9.1	13
	11	2	4	0	6	1.5	0.6	494	53.9	6	321	11.2	6
	12	4	10	0	14	3.5	0.9	503	64.8	14	324	11.2	14
	13	5	2	0	7	1.8	0.7	503	51.2	7	325	11.3	7
	14	1	2	0	3	0.8	0.4	554	50.1	3	333	15.3	3
	15	0	1	0	1	0.3	0.3	444	NA	1	318	NA	1
Sample Total		197	199	1	397	100.0		306	101.6	397	278	26.1	397

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Appendix B5.–Page 5 of 6.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
20 May	4	7	6	0	13	2.6	0.7	171	67.0	13	235	19.0	13
	5	80	97	0	177	35.8	2.2	207	28.9	177	251	9.9	177
	6	75	77	0	152	30.7	2.1	267	55.4	152	269	15.5	152
	7	38	26	0	64	12.9	1.5	304	59.2	64	281	17.4	64
	8	12	16	0	28	5.7	1.0	350	62.8	28	292	13.2	28
	9	12	14	0	26	5.3	1.0	394	55.8	26	303	14.4	26
	10	8	4	0	12	2.4	0.7	422	92.7	12	309	15.3	12
	11	6	5	0	11	2.2	0.7	448	77.8	11	321	14.0	11
	12	5	1	0	6	1.2	0.5	460	31.2	6	319	7.1	6
	13	3	1	0	4	0.8	0.4	495	38.6	4	322	6.4	4
	14	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	2	0	0	2	0.4	0.3	535	33.9	2	331	17.7	2
Sample Total		248	247	0	495	100.0		272	88.8	495	270	24.6	495
21 May	4	6	12	0	18	4.6	1.1	173	31.3	18	237	11.7	18
	5	60	83	1	144	36.5	2.4	207	28.3	144	251	11.1	144
	6	50	66	1	117	29.6	2.3	259	48.2	117	267	14.5	117
	7	22	28	0	50	12.7	1.7	297	74.8	50	277	20.0	50
	8	19	11	0	30	7.6	1.3	354	56.8	30	294	13.3	30
	9	10	5	0	15	3.8	1.0	396	62.4	15	302	17.0	15
	10	2	3	0	5	1.3	0.6	416	57.9	5	303	14.0	5
	11	4	1	0	5	1.3	0.6	451	88.4	5	318	12.1	5
	12	2	3	0	5	1.3	0.6	484	51.2	5	317	11.1	5
	13	1	2	0	3	0.8	0.4	550	48.8	3	336	2.3	3
	14	1	1	0	2	0.5	0.4	573	8.5	2	331	14.1	2
	15	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	16	0	0	0	0	0.0	0.0	NA	NA	0	NA	NA	0
	17	0	1	0	1	0.3	0.3	514	NA	1	336	NA	1
Sample Total		177	216	2	395	100.0		265	88.5	395	268	24.2	395

-continued-

Appendix B5.–Page 6 of 6.

Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
22 May	4	6	8	2	16	3.7	0.9	190	40.7	16	248	15.0	16
	5	75	88	7	170	39.1	2.3	205	30.9	170	254	11.6	170
	6	56	73	2	131	30.1	2.2	254	42.5	131	269	12.7	131
	7	17	34	2	53	12.2	1.6	295	54.0	53	280	15.7	53
	8	16	12	1	29	6.7	1.2	328	49.8	29	293	15.4	29
	9	9	7	0	16	3.7	0.9	370	63.2	16	298	14.7	16
	10	3	3	0	6	1.4	0.6	466	65.5	6	300	42.5	6
	11	0	2	0	2	0.5	0.3	493	103.9	2	329	2.8	2
	12	5	2	0	7	1.6	0.6	481	58.6	7	323	10.9	7
	13	3	2	0	5	1.1	0.5	487	66.9	5	328	8.5	5
Sample Total		190	231	14	435	100.0		257	79.1	435	269	22.1	435
Samples Combined		2,700	2,709	89	5,498			338	121.0	5,497	285	29.4	5,497

APPENDIX C

Appendix C1.–2010 Togiak Herring Forecast.

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF COMMERCIAL FISHERIES
NEWS RELEASE

Denby S. Lloyd, Commissioner
John R. Hilsinger, Director

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Greg Buck & Fred West, Asst. Area Research Biologists 333 Raspberry Road
Tim Baker, Area Research Biologist Anchorage, AK 99518
Phone: (907) 267-2355 Date Issued: November 12, 2010
Fax: (907) 267-2442 Time: 1:00 p.m.

2010 TOGIAK HERRING FORECAST

The 2010 Togiak herring forecast and harvest allocation is listed below for the Togiak District sac roe fishery and the Dutch Harbor food and bait fishery, given a maximum 20% exploitation rate of the projected run biomass:

Harvest Allocation of the 2010 Forecasted Pacific Herring Run Biomass, Togiak District, Bristol Bay

	Biomass (Short Tons)	Harvest (Short Tons)
Forecasted Biomass for 2010	146,775	
Total Allowable Harvest (20% exploitation rate)		29,355
Togiak Spawn-on-Kelp Fishery (Fixed Allocation)		1,500
Remaining Allowable Harvest		27,855
Dutch Harbor Food/Bait Allocation (7.0% of the remaining allocation)		1,950
Remaining Allowable Harvest for Togiak District Sac Roe Fishery:		25,905
Purse Seine Allocation 70.0%		18,134
Gill Net Allocation 30.0%		7,772

2010 Togiak Herring Forecast Summary

The Pacific herring population is forecasted to be 146,775 tons in Togiak District during 2010 (Figure 1). Herring returning from 2004 through 2006-year classes (ages 4–6) are expected to comprise 45.1% of the biomass (Figure 2) in 2010. Ages 7–8 are expected to comprise 24.5% of the population while ages 9–11 and 12+ are forecasted to comprise 16.8% and 13.6% of the population by weight, respectively. The forecasted individual average weight of herring in the harvest biomass is 330 g.

A run biomass of 146,775 tons would be ~5% more than the recent 10-year average observed biomass of 139,635 tons. A biomass of this size would potentially produce an overall harvest of 29,355 tons in all fisheries and 25,905 tons in the Togiak sac roe fisheries (purse seine and gillnet). A harvest of this size in the Togiak sac roe fisheries would be ~28% more than the recent 10-year average harvest of 20,212 tons.

We used an age-structured analysis (ASA) model to forecast the Togiak herring population using catch and age composition data and total run biomass estimates. The ASA model integrates data from purse seine fishery age compositions (1978–2009), total run age compositions (1978–1995, 1997, 1999, 2001, and 2005–2009), and aerial survey biomass estimates (1981, 1983, 1992–1994, 1997, 1999–2001, and 2005–2009). The model estimates were generated by comparing them to observed data. Samples from non-selective gear (commercial purse seine) were used to assess age composition of the total run biomass. Commercial purse seine catch samples ranged from age-3 to age-17. Age-4 herring average weight for 2010 was predicted using the recent 4-year average while simple linear regression models were used to forecast average weight of age-5 through age-15 herring based on their weight the previous year.

A temporal change in age composition from older to younger herring typically occurs during this fishery. A cohort of young herring (< age-7) and a cohort of older (ages 11–13) herring predominated in 2009, comprising 48.1% and 23.7% of the total commercial purse seine harvest by weight respectively. These 2 major age cohorts made up a significant portion of the observed biomass through 22 May, after which the older cohort had migrated through and the biomass came to be dominated by age-7 and younger herring after 22 May. The high abundance (15.4% by number of fish) of age-4 and age-3 herring (age classes that are typically not caught in significant numbers) in the purse seine harvest suggests very strong future year classes in years ahead. However, it should be noted that measuring contributions of younger age classes to the spawning biomass is difficult as they typically do not show up until late in the fishery and the department no longer conducts post-fishery sampling as was typical during the 1980s.

The biomass of the Togiak herring spawning population has been estimated with aerial surveys since the late 1970s, concurrent with development of the sac-roe fishery. Total run biomass for 2009 was estimated to be 142,133 tons. This was the sum of the peak aerial survey on 24 May (93,894 tons) and a survey on 16 May (48,239 tons). The time between these surveys leads us to believe that a near complete turnover of herring on the spawning grounds had occurred between these surveys. Herring were first observed in district on 13 May, when approximately 462 tons were documented in Togiak Bay. The biomass steadily increased through 16 May, with herring

concentrated in areas east of Togiak Bay (Figure 3). Spawning biomass had extended westward by the time of the peak survey on 24 May and was most heavily concentrated in Togiak Bay. Large recruitments in this population are typical every 8 to 10 years. The last such event occurred off the 1996 and 1997-year classes and another currently appears to be underway with strong returns from 2005 and 2006-year classes.

There is always uncertainty in forecasting the Togiak District herring biomass and predicting the 2010 run is no different. The performance of the ASA model has had a tendency to forecast low since its inception in 1993, under-forecasting the run in 2009 run (121,800 tons forecast and 142,133 tons observed). The mean percent error (MPE) was -22.2% for years with reliable total run biomass estimates (Figure 1). The accuracy or mean absolute percent error (MAPE) of the ASA model has been 20%. The forecast range for 2010 is from 117,460 tons to 176,090 tons based on a MAPE of 20%. We consider this population to be healthy and sustainable.

Greg Buck, Fred West and Tim Baker
Bristol Bay Fishery Research Staff
Anchorage

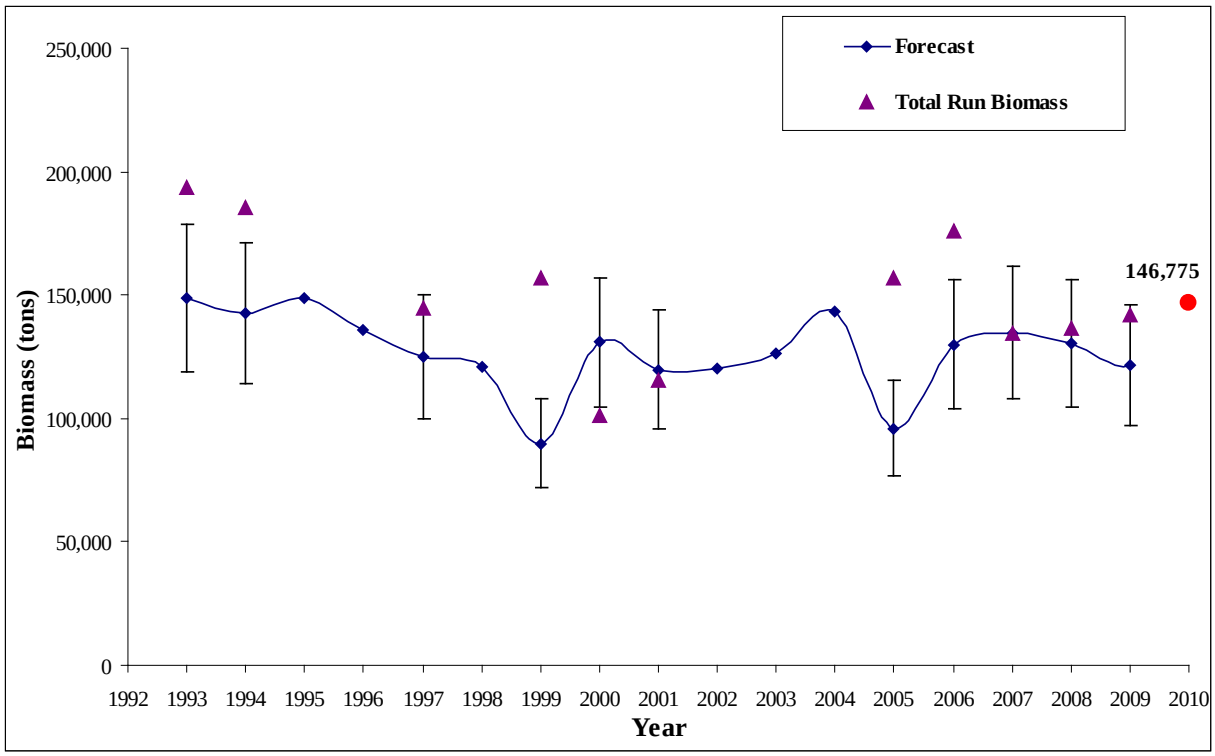

Figure 1- Annual observed Togiak herring total run biomass estimates and preseason forecasts based on the ASA model. Mean absolute percent error (MAPE) of 25% around the forecast is also shown for years with a reliable total run biomass estimate.

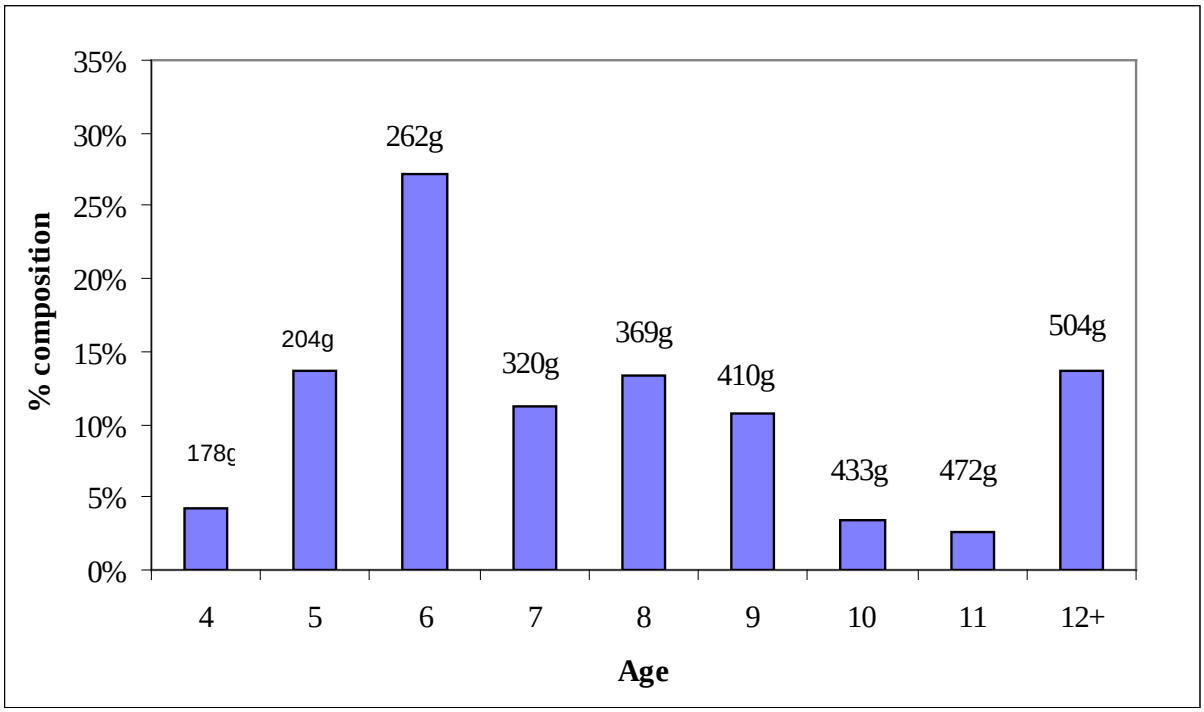

Figure 2- Forecasted age composition by weight for the 2010 Togiak herring return. Forecasted average weight (grams) shown for each age category.

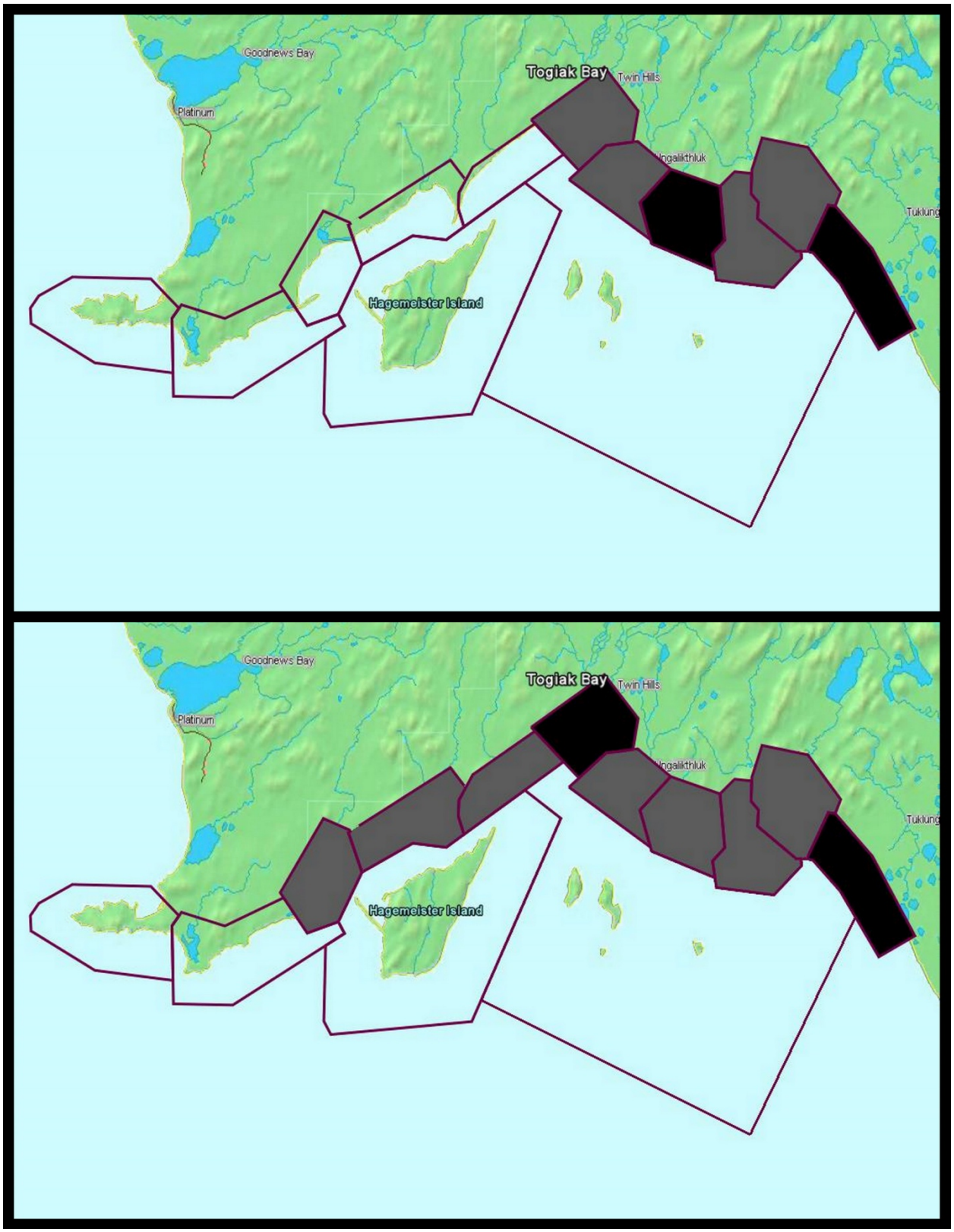

Figure 3- Herring spawning distribution observed during aerial surveys conducted on 16 May 2009 (top) and 24 May 2009 (bottom). Aerial survey sections outlined. Sections with measurable biomass are shaded. Sections with biomass >10,000 t shaded in black.