Fishery Data Series No. 14-40

Abundance, Age, Sex, and Size Statistics for Pacific Herring in Togiak District of Bristol Bay, 2013

by

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October 2014

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

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

FISHERY DATA SERIES NO. 14-40

ABUNDANCE, AGE, SEX, AND SIZE STATISTICS FOR PACIFIC HERRING IN TOGIAK DISTRICT OF BRISTOL BAY, 2013

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October 2014

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This document should be cited as:
Buck, G. B. 2014. Abundance, age, sex, and size statistics for Pacific herring in Togiak District of Bristol Bay, 2013. Alaska Department of Fish and Game, Fishery Data Series No. 14-40, Anchorage.

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ABSTRACT

The Pacific herring *Clupea pallasii* total run in Togiak District of Bristol Bay was monitored for abundance/biomass and sampled for age, size, and sex composition in 2013. Abundance was estimated from aerial surveys with chartered aircraft. Commercial harvest was measured through landing reports filed by commercial fish processors to the Alaska Department of Fish and Game. Samples were collected from commercial purse seine and gillnet harvests. The 2013 run biomass was estimated at 169,020 tons (153,334 tonnes). Total commercial harvest was 29,374 tons (27,610 tons from the sac roe fisheries with 19,366 tons harvested by purse seine and 8,244 tons by gillnet, and 1,764 tons harvested by the Dutch Harbor food and bait fishery). The preseason allowable exploitation rate is 20% by regulation, and the final exploitation rate was estimated at 17%. A total of 6,160 herring were sampled for age, sex, length, weight, and sexual maturity information between 11 May and 25 May 2013. The 2013 inshore herring ages ranged from 4 to 15 years, with purse seine harvest dominated by age-7 (28%), and -8 (30%) fish, whereas gillnet harvest was dominated by age-8 (29%), and -9 (19%) fish. Mean length and weight of herring from the purse seine fishery samples were 280 mm and 360 g, whereas fish sampled from the gillnet fishery averaged 293 mm and 412 g.

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

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 is managed as a single spawning population as established in the *Bristol Bay Herring Management Plan* (5 AAC 27.865). This plan, originally adopted in 1980, sets a maximum 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. Remaining available biomass is reserved for the Togiak sac roe fishery with a gear allocation target of 30% reserved for the gillnet fleet and 70% for the purse seine fleet (Sands 2009).

The primary commercial fishery targeting this stock occurs in the 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 1). This fishery occurs as fish move inshore prior to spawning and targets the ripened ovaries (sac roe) of female herring prior to spawning. Biomass estimates of this spawning aggregation have been conducted annually using aerial surveys since 1978. The largest was 239,022 tons (216,839 tonnes) in 1979 and has averaged 144,344 tons (130,948 tonnes) between 2002 and 2011 (McBride et al. 1981; McBride and Whitmore 1981; Fried et al. 1982a, 1982b, 1983a, 1983b, and 1984; Lebida et al. 1985a, 1985b; Lebida 1987; Sandone and Brannian 1988; Lebida and Sandone 1990; Rowell et al. 1991; Rowell 1995, 2002a, 2002b; West 2002; West et al. 2003; Schwanke 2003a, 2003b; Brazil 2007a, 2007b, 2007c; Brazil et al. 2009; and Buck 2010a, 2010b, 2012, 2013a, 2013b; Table 1).

Commercial harvest 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 United States (U.S.) waters prompted increased interest in the Togiak

fishery by U.S. fishermen. The 20-year mean sac roe harvest is presently 21,628 tons[1] (19,620 tonnes[2]; Table 1). During this period, the harvest ranged from a high of 30,315 tons (27,502 tonnes) in 1994 to a low of 17,021 tons (15,441 tonnes) in 2012. In addition to the sac roe fishery, wild spawn-on-kelp has historically been harvested as well either by hand or rake. First documented in 1967, this fishery has been intermittent in recent years because of low demand, and it did not occur in 1997, 1998, 2000, 2001, and from 2004 to the present (Table 1).

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 (Tojo 2007; Figure 2). The shoreline in this region is characterized by a wide intertidal zone and shallow bays with diurnal tidal ranges up to 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. Spawning occurs throughout the Togiak fishing district, particularly in areas where eelgrass and rockweed are present, and occurs from late April through early June. After spawning, the fish continue their clockwise migration along the Alaska Peninsula to feeding areas near Unalaska Island. In August and September, these fish move north to overwintering grounds north of the Pribilof Islands (Shaboneev 1965; Rumyantsev and Darda 1970; Wespestad and Barton 1981; Funk 1990).

After leaving Togiak District, fish from this stock are susceptible to one other directed fishery during their postspawn 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 1,433 tons (1,300 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).

OBJECTIVES

The specific objectives for assessing Togiak herring were to

1) Estimate the run biomass of spawning herring within Togiak District;
2) Document the commercial harvest (including deadloss 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 and the Dutch Harbor food and bait fishery.

[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.

METHODS

BIOMASS

Run biomass within Togiak District was estimated following aerial survey procedures outlined by Lebida and Whitmore (1985). Surveys were flown daily at low tide within the constraints of aircraft availability and weather. The district was divided into 13 aerial survey sections (Figure 3). Daily biomass estimates were made by summing survey section estimates. Peak inseason biomass was the maximum daily estimate during the fishing season, and run biomass was the sum of all daily biomass estimates judged to be composed of fish not accounted for in any other survey plus all harvest 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 combined with all pre-peak harvest.

HARVEST

Fish tickets (sales receipts) completed by buyers for each commercial delivery were the primary source for documenting harvest. Fish ticket information included date of harvest, gear type, biomass (tons), and location by management 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 (usually consisting of a single 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, location, and harvest date. Attempts were made to collect samples from multiple vessels and or processors to ensure that samples came from a maximum number of schools. Samples collected from each gear type were used to characterize the harvest of each gear type, but 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, they removed a scale from the right side of the fish in the same location or any other area where 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 (~10×) magnification using a microfiche reader or dissecting microscope. 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, 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 fish provides this level of precision and accuracy. We attempted to collect this amount daily from each section where commercial purse seine fishing occurred and every other day where gillnet fishing 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 stepwise process until the minimum sample size was achieved. This process resulted in 6 sampling groups for the purse seine harvest and 3 for gillnet harvest (Table 2; Figures 4 and 5).

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

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

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

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

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

$$N_a = \frac{B_a}{\overline{W}_a}. \tag{3}$$

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) was used to forecast the 2013 run (Appendix D). The most recent biomass estimate included in the 2013 forecast model occurred in 2012.

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 began on 28 April. Observers first spotted herring on 10 May during a survey that documented 43,170 tons. Biomass increased through 13 May when the inseason biomass peaked at 85,888 tons then fell to 75,547 tons on the final survey of 29 May (Table 3). Spawning was concentrated in the center of Togiak District (Figures 3 and 6).

Aerial survey conditions ranged from fair to excellent throughout the season, with good conditions during the peak inseason survey (Table 3). We estimated run biomass at 169,020 tons (153,334 tonnes) by combining the peak inseason biomass estimate of 13 May with the final biomass estimate from 29 May and all harvest that occurred prior to the peak biomass survey (Table 4). We assume that the spawning biomass in the district experienced a complete turnover between the 2 surveys used in this estimate. Spawn occurred for 47 miles (76 km) along the Togiak District coastline in 2013, with a little over one-third of it observed during the 24 May survey (Table 3).

HARVEST

Commercial openings between 11 May and 28 May produced a total harvest of 27,610 tons (25,048 tonnes) within Togiak District in 2013 (Table 5). Historically, this fishery commences around 7 May; however, there is annual temporal variation, with fishing commencing as early as 25 April (in 2003) and as late as 16 May (in 2008 and 2009) within the last 10 years (Table 6). This temporal variation is thought to be largely a function of the spring ice breakup and related water temperatures in the eastern Bering Sea (Tojo et al. 2007). Fishing opened on 11 May and ended on 28 May, making for a relatively late and long 17-day fishing season. Fishing was open continuously from 11 May through 20 May for purse seine gear and through 28 May for gillnet

gear. The total commercial harvest in the Togiak District sac roe fishery of 27,610 tons represents 134% of the 10-year average and 128% of the 20-year average (Table 1). Catches from Hagemeister Section accounted for the largest percentage (41%) of the total commercial harvest, followed by Nunavachak (32%), Kulukak (25%), Togiak (2%), and Pyrite Point (<1%) sections (Table 5; Figure 7). No harvest was taken in the Cape Newenham Section.

Roe percentages ranged from 13.2% for herring harvested by gillnet in Nunavachak Section on 25 May and Kulukak Section on 27 May to 8.2% for herring harvested by purse seine in Nunavachak Section on 11 May (Table 5).

Purse Seine

The Togiak purse seine fishery opened at 12:00 pm on 11 May. The Alaska Department of Fish and Game (ADF&G) initially opened the purse seine fishery for 82 hours. Commercial quality fish were available late on 11 May, and 606 tons of herring (Table 4) were harvested during the first day of fishing. Herring continued to be of marketable quality for the remainder of the purse seine fishery, and the department extended the fishery in 48-hour increments for the duration of the fishery. Although harvest was reduced due to poor weather on 16 and 17 May, the fishery progressed at a steady pace. Improved weather conditions on 18 May allowed the purse seine fleet to harvest 3,595 tons of herring (Table 4), the largest single day harvest in 2013. The fleet harvested an additional 2,429 tons the following day, 19 May. After the large harvests of 18 and 19 May, the fishery was allowed to close as scheduled so the department could evaluate the harvest and determine whether additional fishing time was warranted. The fleet was able to harvest 1,211 tons on Monday, 20 May (Table 4). The department determined that it would not be possible to conduct an orderly fishery for the small amount of remaining quota without the risk of significantly exceeding the quota. Therefore, the purse seine fishery remained closed for the rest of the season. The final harvest was 19,366 tons of herring (Table 4), equal to 92% of the quota.

There were 10 commercial purse seine openings totaling 328 hours in Togiak District between 11 and 20 May, harvesting a total of 19,366 tons during 2013 (Table 5). The first opening lasted 54 hours harvesting 606 tons, mostly in the Nunavachak Section. A total of 59% of the harvest occurred in Hagemeister Section. Purse seine harvests averaged 1,853 tons per fishing day.

Roe accounted for 9.0% (by weight) of the commercial purse seine fishery and ranged from 8.2% in Nunavachak Section on 11 May to 10.6% in the same section on 18 May (Table 5). The total average roe percentage (9.0%) for purse seine herring was 0.3% lower than the most recent 10-year average and 0.4% lower than the 20-year average (Table 6).

Gillnet

The Togiak gillnet fishery was opened at 12:00 pm 11 May until further notice with no prior test fishing. In 2013, there were 6 companies participating in the Togiak sac roe gillnet fishery (Table 5). Participation by fishermen also increased to 37 vessels, up from 18 in 2012. Although the season opened on May 11, the first day that all 6 companies purchased fish was 13 May. The combined harvest from 11 and 12 May was 345 tons of herring (Table 4). Harvest continued at a steady pace until May 17 and then slowed to 30 tons on 18 May (Table 4). Harvest increased again on 19 May to 439 tons (Table 4). The harvest was similar on 20 May, but deteriorating weather developing by the afternoon of 20 May essentially prevented fishing until 23 May. Fishing improved on 23 May and stayed good until 25 May when weather again deteriorated.

Weather improved on 26 May; however, abundance had diminished and fishing was slower. The fleet continued to fish until Monday, 27 May, but poor fishing and the decision of some processors to cease buying brought the season to a close at noon on 28 May, although the last delivery was made the morning of 27 May. The total gillnet harvest was 8,244 tons of herring (Table 4), representing 91% of the quota.

There were 15 commercial gillnet openings totaling 534 hours in Togiak District between 11 and 27 May, harvesting a total of 8,244 tons (Table 5). The first opening lasted 102 hours harvesting 345 tons in Kulukak Section. A total of 85% of the harvest occurred in Kulukak Section (Table 4). Purse seine harvests averaged 515 tons per fishing day (Table 4).

Roe accounted for 10.9% (by weight) of the commercial gillnet fishery and ranged from 9.0% on 19 May in Kulukak Section, to a high of 13.2% on 25 May in Nunavachak and 27 May in Kulukak Section (Table 4). The total average roe percentage (weighted) for gillnet harvested herring in 2013 was 0.1% below the 10-year and 20-year average (Table 5).

Spawn on Kelp

There was no commercial harvest for spawn on kelp in 2013 because there were no registered buyers (Table 1). This fishery last occurred in 2003.

AGE, SIZE, AND SEX COMPOSITION

A total of 4,620 samples collected from the commercial purse seine fishery (all sections) produced 4,052 readable scales of the 5,347 total readable scales from all gear types (Table 6; Appendices B1–B4). A total of 2,300 samples collected between 12 and 19 May in Hagemeister Section produced 1,993 (37%) of the total readable scales (Appendices B1 and B4). A total of 1,910 samples were collected from purse seine catches between 11 and 14 May in Nunavachak Section produced 1,694 (32%) of the total readable scales (Appendices B2 and B4). A total of 410 samples collected from catches on 11 and 15 May in Togiak Section produced 364 (8%) of the total readable scales (Appendices B3 and B4).

A total of 1,540 herring sampled from the commercial gillnet fishery between 11 and 19 May produced 1,295 (24%) of the total readable scales (Table 7; Appendices C1–C3). A total of 250 samples collected on 19 May in Nunavachak Section produced 198 (4%) of the total readable scales (Appendices C1 and C3). A total of 1,290 samples collected between 11 and 17 May from Kulukak Section produced 1,097 (21%) of the total readable scales (Appendices C2 and C3). Standard sampling protocol accounted for the typical percentage of non-readable scales and was designed to meet the sample size goal of readable scales.

Total Run

The 2013 biomass estimate was the sum of aerial survey estimates conducted on 13 and 29 May and all harvest occurring prior to the 13 May survey. The survey on 13 May recorded the largest biomass of the season, and by 29 May the fishery had ceased. We assume that fish present on 29 May arrived on the spawning grounds after 13 May, that no fish present during the 13 May survey were still present on the spawning grounds during the 29 May survey, and that the amount of fish arriving after the 13 May survey and harvested prior to 29 May was a negligible percentage of the total available. The age composition of the 93,473 tons that represent peak biomass and harvest up to that point in the run (Table 3 and 4) were characterized using all available 1,262 purse seine samples collected through 12 May. The age composition of the

75,583 tons estimated during the 29 May survey were characterized using 1,640 herring sampled from the purse seine harvest between 13 and 29 May in the Hagemeister section, which had the bulk of the post-peak biomass as evidenced by the harvests after 13 May (Table 4).

Age classes composing more than 10% of the run either in abundance or run biomass were age-6, -7, -8 and -9 fish, which composed 10%, 25%, 29% and 15% (respectively) of the run by weight and 12%, 27%, 29%, and 14% by number (Table 7; Figure 8; Appendix A1). The mean lengths were slightly below historical means (Figure 9), and weight classes were slightly higher than historical means (Figure 10).

Typically, the Bristol Bay–Alaska Peninsula herring stock biomass experiences a shift towards younger age classes as the season progresses. This did not occur in 2013, with age classes remaining relatively stable throughout the run. Age-8 was the dominant age class, composing 29% of the total run biomass (Table 7).

Commercial Harvest

Abundant age classes (>10% of the harvest in abundance or harvest biomass) were age-6, -7, -8, -9 and -10 fish, which composed 8%, 23%, 29%, 16% and 10% (respectively) of the harvest by weight and 10%, 26%, 30%, 15% and 9% by number (Table 7; Appendix A1). The gillnet harvest was markedly older than those in the purse seine harvest (Figures 11 and 12; Table 8).

The average length and weight of fish harvested in the commercial purse seine fishery was 280 mm and 360 g, whereas the average length and weight of fish in the commercial purse seine fishery was 293 mm and 412 g (Table 8). Samples collected from commercial purse seine and gillnet harvests were 46% male and 54% female, varying in composition by time ($\chi^2 = 24.0$, $P = 2.3e^{-3}$) and location ($\chi^2 = 30.5$, $P = 1.1e^{-6}$) (Appendix B4 and C3).

Purse Seine

Samples were collected from the commercial purse seine harvest between 11 and 25 May from Hagemeister, Nunavachak, and Togiak sections (Appendices B1–B4). Abundant age classes (>10% of the harvest in abundance or harvest biomass) were age-6, -7, -8 and -9 fish, which composed 10%, 26%, 30% and 14% respectively of the harvest by weight and 12%, 28%, 30% and 13% by number (Table 7; Appendix A2). Samples from the 2013 purse seine harvest had a mean length of 280 mm and mean weight of 360 g (Table 8), were 48% male and 52% female, and varied by harvest date ($\chi^2 = 17.4$, $P = 0.03$) and location ($\chi^2 = 6.6$, $P = 0.03$) (Appendix B4).

Gillnet

Samples were collected from the commercial gillnet harvest between 11 and 19 May from Nunavachak and Kulukak sections (Appendices C1–C3). Abundant age classes (>10% of the harvest in abundance or harvest biomass) were age-7, -8, -9 and -10 fish, which composed 17%, 27%, 19% and 15% respectively of the harvest by weight and 19%, 29%, 19% and 14% by number (Table 7; Appendix C3). Samples from the 2013 gillnet harvest had a mean length of 293 mm and mean weight of 412 g (Table 8). Herring sampled from the gillnet harvest were 39% male and varied by harvest date ($\chi^2 = 14.7$, $P = 0.01$) but not location ($\chi^2 = 0.83$, $P = 0.36$) (Appendix C3).

EXPLOITATION RATE

We estimate the 2013 exploitation rate of this stock at 17% by dividing the combined Togiak District commercial sac roe harvest of 27,610 tons and the Dutch Harbor food and bait harvest of 1,764 tons by the total run biomass estimate of 169,020 tons (Table 1).

DISCUSSION

The purpose of this report was to estimate total run biomass; spawning escapement; and age, size (weight and length), and sex composition of the Bristol Bay–Alaska Peninsula herring stock that spawn in Togiak District. A sampling crew located at the North Pacific Seafoods plant in Togiak processed samples from this fishery collected from processors throughout the district. This strategy provides managers with inseason age composition estimates in a timely and cost-effective manner.

We estimated the 2013 total run biomass to be 169,020 tons (Objective 1) based on aerial surveys conducted on 13 and 29 May and harvest prior to the 13 May survey (Table 1; Appendix A1). Herring were first observed on a survey conducted 10 May, and spawning activity was first detected on 12 May (Table 3).

The total Togiak sac roe commercial harvest (Objective 2) of 27,610 tons was approximately 134% and 125% of the 10- and 20-year average respectively (Table 1). The commercial fishery started 3 days later than the 10-year average, opening on 11 May. The average roe percent was slightly below average for both gillnet and purse seine harvest.

Over the last decade or so, changes in agency and industry management (processor co-ops) as well as global market conditions have driven several trends in this fishery. Beginning around the turn of the century, fishing seasons have become longer and daily fishing effort has declined. At 17 days, the 2013 fishery was 2 days longer than the recent 10-year average with effort at or slightly below average for both gear types (Table 5). These trends allow purse seine fishermen to inspect their catches more closely and harvest only the most valuable fish.

The commercial purse seine harvest of 19,366 tons was 128% of the 10-year average and 118% of the 20-year average, and the commercial gillnet harvest of 8,244 tons was 150% of the 10-year average and 145% of the 20-year average (Table 5).

The number of readable scales (5,347) collected from the 2013 commercial fishery was 96% of the 5-year average of readable scales (Table 6). This sampling effort was sufficient to characterize the Togiak District spawning biomass.

Age-8 fish dominated the total run and the harvest in 2013 (Objective 3), accounting for 29% of the total biomass harvested and 30% of the herring harvested (Table 7). The age composition of the 2013 run was steady over time.

A major problem with estimating recruitment in any given year is the lack of postseason sampling necessary to detect younger fish. The 2013 season was both longer than normal at 17 days and closed later (27 May) than the recent 10- to 20-year average. Personnel and budget constraints precluded any sampling of fish caught after 25 May, and no postseason survey or sampling was conducted. This makes the detection of younger recruit age classes, such as age-4 and age-5, difficult because they generally spawn later than older fish. Although age-4 and -5 herring were present at low levels, they were well below the elevated levels seen during the last

significant recruitment event experienced by this biomass that occurred in 2008 and 2009 (Figure 12). This population typically experiences a large recruitment event every 8–10 years.

The total exploitation rate (Objective 4) in Togiak District was 17% (Table 1), which was slightly higher than recent 10- to 20-year average but below the management target exploitation rate of 20%.

ACKNOWLEDGEMENTS

Thanks go to several ADF&G Division of Commercial Fisheries personnel for contributing to this report. Bristelle Larsen, Sandi Echuck, and Hannah Hilowitz collected the data contained in this report. Tim Sands and Matt Jones provided daily biomass estimates. Karen Brito and Phil Carpenter provided logistical and administrative support. Charles Brazil provided critical review of the manuscript. Thanks also go to North Pacific Seafoods at Togiak for hosting our sampling program and to the fishermen and processors who provided samples.

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TABLES AND FIGURES

Table 1.–Historical total run biomass and commercial harvests (tons) of herring returning to Togiak District, Bristol Bay, 1993–2013.

	Togiak		Spawn on Kelp			Dutch Harbor	
Year	Total Run Biomass (tons)	Sac Roe Harvest (tons)	Harvest (lbs)	Harvest (tons)	Herring Equivalent (tons)	Food and Bait Harvest (tons)	Exploitation Rate
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				2,437	21.5%
2002	120,196 [a]	17,049	67,793	34	260	2,014	16.1%
2003	126,213 [a]	21,663	[b]	[b]	[b]	1,332	18.2%
2004	143,124 [a]	18,868				1,038	13.9%
2005	163,737	20,912				1,159	13.5%
2006	179,580	23,953				952	13.9%
2007	143,827	17,132				1,248	12.8%
2008	136,839	20,523				1,536	16.1%
2009	142,154	17,107				1,310	13.0%
2010	146,913	26,355				1,941	19.3%
2011	140,860 [a]	22,877				1,795	17.5%
2012	167,738	17,021				1,807	11.2%
2013	169,020	27,610				1,764	17.4%
2003-2012 Average	149,098	20,641	NA	NA	NA	1,433	15%
1993-2012 Average	147,205	21,628	319,359	160	1,229	1,856	16%

Note: Blank cells indicate no fishery occurred that year.

Sources: Jones et al. 2012; Bernard 2011; ADF&G fish tickets.

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

[b] Data confidential under Alaska Statute 16.05.815.

Table 2.–Herring samples with harvest (including deadloss) by gear type and associated sampling groups, Togiak District, 2013.

	Available Samples					Harvest (tons)					Sample Group				
Date	KUK	NUN	TOG	HAG	PYR	KUK	NUN	TOG	HAG	PYR	KUK	NUN	TOG	HAG	PYR
5/11		415	143				606	203				1	1		
5/12		350		354			3,142	215	292			2	2	2	
5/13		183					1,840					3			
5/14		746					1,129		731			3		3	
5/15			221				598	220	960			3	3	3	
5/16				436					1,103					4	
5/17				461					893	35				5	5
5/18				388			164		3,595			6		6	
5/19				355					2,429					6	
5/20									1,211					6	
	Gillnet														
5/11	293					345					1				
5/12															
5/13	158					942					1				
5/14	282					785					2				
5/15						760					2				
5/16	155					524					3				
5/17	209					322					3				
5/18						30					3				
5/19		198				30	409				4	4			
5/20							526					4			
5/21						858	54				4	4			
5/22															
5/23						1,137					4				
5/24						693	186				4	4			
5/25						178	69				4	4			
5/26						242					4				
5/27						153					4				

Note: Fishing section abbreviations: KUK = Kulukak, NUN = Nunavachak, TOG = Togiak, HAG = Hagemeister, PYR = Pyrite Point.

Table 3.–Aerial survey estimates (tons) of herring by index area, Togiak District, 2013.

Date	Start Time	Survey Rating [b]	Miles of Spawn	Estimated Biomass by Index Area [a] NUS	KUK	MET	NVK	UGL	TOG	TNG	MTG	OSK	PYR	CPN	HAG	WAL	Daily Total
4/28	1230	2.0	0.0														0
5/3	1000	2.3	0.0														0
5/5	1100	3.0	0.0														0
5/7	1300	1.5	0.0														0
5/10	1100	1.5	0.0	3,001	1,574	375			460	56					37,208	496	43,170
5/12	0000	2.0	9.7	212	7,006	14,275	3,204	12,264	34,407	935	4,464	2,258			523		79,548
5/13	1400	2.1	7.7	53	12,564	11,361	14,296	16,407	9,167	2,058	16,656	3,025			301		85,888
5/14	1300	1.8	5.9	804	12,969	5,584	1,339	4,132	7,801	3,321	1,935	4,075	2,083	127			44,170
5/15	0900	2.9	7.1	99	4,423	1,802	3,578	6,221	18,880		2,975	65			980		39,023
5/19	1000	3.5	0.9	73	2,902	341	1,751	1,158	52,546		3,469	788			2,257		65,285
5/24	1000	3.5	15.6	9,583	26	30	5,073	818	14,670	1,630	543	202			2,348		34,923
5/29	1300	3.0	0.0	8,719	23,993	397			28,651	9,620	4,155				12		75,547
Total linear miles of spawn			46.9										Peak biomass estimate				85,888

Note: Blank cells represent no biomass observed.

[a] Index areas: NUS = Nushagak Peninsula; KUK = Kulukak; MET = Metervik; NVK = Nunavachak; UGL = Ungalikthluk/Togiak; TOG = Togiak; TNG = Tongue Pt.; MTG = Matogak; HAG = Hagemeister; OSK = Osviak; PYR = Pyrite Point; CPN = Cape Newenham; WAL = Walrus Islands.

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

Table 4.–Commercial herring harvest (tons) and roe (%) by fishing section and gear type, Togiak District, Bristol Bay, 2013.

			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 % [a]
							Purse Seine									
5/11	54:00	1			605.8	8.2	202.8	9.4							605.8	11.3
5/12	48:00	2			3,141.7	9.1	215.3	7.0	292.3	9.9					3,434.0	9.6
5/13	24:00	3			1,839.6	9.0									1,839.6	9.0
5/14	24:00	4			1,128.8	9.7			730.7	9.0					1,859.5	9.4
5/15	24:00	5			598.4	10.0	220.4	8.2	959.8	8.8					1,558.2	10.4
5/16	12:00	6							1,102.6	8.9					1,102.6	8.9
5/17	24:00	7							893.3	8.8	35.0	10.2			893.3	9.2
5/18	24:00	8			164.4	10.6			3,595.2	9.1					3,595.2	9.6
5/19	24:00	9							2,429.3	9.0					2,429.3	9.0
5/20	24:00	10							1,211.0	8.8					1,211.0	8.8
Subtotal [a]	328:00				7,478.7	9.2	638.5	8.2	11,214.2	9.0	35.0	10.2			19,366.4	9.0
							Gillnet									
5/11	102:00	1	345.4	11.3											345.4	11.3
5/13	24:00	2	942.4	11.2											942.4	11.2
5/14	24:00	3	784.6	11.1											784.6	11.1
5/15	24:00	4	760.4	10.7											760.4	10.7
5/16	24:00	5	523.7	10.4											523.7	10.4
5/17	24:00	6	321.5	10.7											321.5	10.7
5/18	24:00	7	29.9	11.2											29.9	11.2
5/19	24:00	8	29.9	9.0	408.6	10.6									438.5	10.5
5/20	24:00	9			526.3	10.2									526.3	10.2
5/21	24:00	10	858.3	11.0	53.8	11.4									912.1	11.0
5/23	24:00	11	1,136.5	11.1											1,136.5	11.1
5/24	24:00	12	693.3	9.5	185.9	12.8									879.2	10.2
5/25	24:00	13	178.3	10.6	69.1	13.2									247.4	11.3
5/26	24:00	14	242.2	12.2											242.2	12.2
5/27	120:00	15	153.4	13.2											153.4	13.2
Subtotal [a]	534:00		6,999.8	10.9	1,243.7	10.9									8,243.5	10.9

-continued-

Table 4.–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 % [a]
Combined																
5/11			345.4	11.3	605.8	8.2	202.8	9.4							1,154.0	9.3
5/12					3,141.7	9.1	215.3	7.0	292.3	9.9					3,649.3	9.0
5/13			942.4	11.2	1,839.6	9.0									2,782.0	9.7
5/14			784.6	11.1	1,128.8	9.7			730.7	9.0					2,644.1	9.9
5/15			760.4	10.7	598.4	10.0	220.4	8.2	959.8	8.8					2,539.0	9.6
5/16			523.7	10.4					1,102.6	8.9					1,626.3	9.4
5/17			321.5	10.7					893.3	8.8	35.0	10.2			1,249.8	9.3
5/18			29.9	11.2	164.4	10.6			3,595.2	9.1					3,789.5	9.2
5/19			29.9	9.0	408.6	10.6			2,429.3	9.0					2,867.8	9.2
5/20					526.3	10.2			1,211.0	8.8					1,737.3	9.2
5/21			858.3	11.0	53.8	11.4									912.1	11.0
5/23			1,136.5	11.1											1,136.5	11.1
5/24			693.3	9.5	185.9	12.8									879.2	10.2
5/25			178.3	10.6	69.1	13.2									247.4	11.3
5/26			242.2	12.2											242.2	12.2
5/27			153.4	13.2											153.4	13.2
Total [a]			6,999.8	10.9	8,722.4	9.4	638.5	8.2	11,214.2	9.0	35.0	10.2			27,609.9	9.6

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

[a] Weighted roe percentage used with this formula: (tons × roe % + tons × roe % + ….) / total tons.

Table 5.–Sac roe herring industry participation, fishing effort and harvest, Togiak District, 1993–2013.

			Fishery Dates			Gillnet				
Year	Buyers	Daily Capacity[a]	Start	Close	Days	Effort[b]	Duration (hours)	Harvest[c]	CPUE	Roe %
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
2011	6	2,413	5/8	5/31	24	25	601	5,907	0.4	12.1
2012	4	1,970	5/14	6/5	23	18	534	4,027	0.4	12.1
2013	6	2,775	5/11	5/27	17	37	534	8,244	0.4	10.9
2003-2012 Average	6	2,083	5/8	5/22	15	40	309	5,492	0.6	11.0
1993-2011 Average	10	2,646	5/7	5/17	12	132	160	5,697	0.6	11.0

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Table 5.–Page 2 of 2.

Year	Purse Seine Effort[b]	Duration (hours)	Harvest[c]	CPUE	Roe %		Total Harvest[c]
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	9.3	[d]	17,049
2003	35	110	15,158	3.9	8.9	[d]	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
2011	22	270	16,970	2.9	9.6		22,877
2012	16	328	12,994	2.5	9.4		17,021
2013	26	328	19,366	2.3	9.0		27,610
2003-2012 Average	26	201	15,150	3.6	9.4		20,641
1992-2011 Average	104	93	16,370	20	9.4		22,067

Note: Blank cells represent no data. CPUE is catch per unit effort.

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

[b] Peak aerial survey count of fishing vessels.

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

[d] Lower than inseason assessment due to more stringent postseason market scrutiny.

Table 6.–Number of herring samples for which age estimations were made by gear type, Togiak District, 2013.

Gear Type	Readable	Missing & Unreadable	Total	Percent unreadable
Commercial Purse Seine	4,052	568	4,620	12.3
Commercial Gillnet	1,295	245	1,540	15.9
Total	5,347	813	6,160	13.2

Table 7.–Herring harvest (biomass short tons) by age and gear type, Togiak District, 2013.

Purse Seine					Gillnet					Total Harvest				
Age	Biomass ST	%	Herring (x1000)	%	Age	Biomass ST	%	Herring (x1000)	%	Age	Biomass ST	%	Herring (x1000)	%
4	43	0.2	132	0.3	4	3	0.0	7	0.0	4	45	0.2	139	0.2
5	460	2.4	1,472	3.0	5	43	0.5	110	0.6	5	503	1.8	1,583	2.4
6	1,937	10.0	5,988	12.2	6	271	3.3	688	3.9	6	2,208	8.0	6,675	10.0
7	4,992	25.8	13,963	28.4	7	1,398	17.0	3,288	18.6	7	6,390	23.1	17,251	25.8
8	5,803	30.0	14,841	30.1	8	2,248	27.3	5,047	28.5	8	8,051	29.2	19,887	29.7
9	2,797	14.4	6,423	13.0	9	1,600	19.4	3,360	19.0	9	4,397	15.9	9,783	14.6
10	1,581	8.2	3,226	6.6	10	1,252	15.2	2,512	14.2	10	2,833	10.3	5,737	8.6
11	749	3.9	1,424	2.9	11	728	8.8	1,415	8.0	11	1,477	5.4	2,840	4.2
12	551	2.8	962	2.0	12	280	3.4	506	2.9	12	831	3.0	1,468	2.2
13	281	1.4	498	1.0	13	293	3.6	506	2.9	13	574	2.1	1,004	1.5
14	133	0.7	226	0.5	14	90	1.1	185	1.0	14	222	0.8	411	0.6
15	42	0.2	76	0.2	15	37	0.4	70	0.4	15	78	0.3	146	0.2
Total	19,366	100	49,230	100	Total	8,244	100	17,694	100	Total	27,610	100	66,924	100

Peak (22 May)					Postseason (31 June)					Total Run				
Age	Biomass ST	%	Herring (x1000)	%	Age	Biomass ST	%	Herring (x1000)	%	Age	Biomass ST	%	Herring (x1000)	%
4	112	0.1	346	0.2	4	136	0.2	482	0.2	4	248	0.1	827	0.2
5	1,562	1.7	4,666	2.1	5	1,824	2.4	5,900	3.0	5	3,386	2.0	10,565	2.5
6	8,367	9.0	23,675	10.9	6	7,920	10.5	25,043	12.7	6	16,288	9.6	48,718	11.7
7	23,230	24.9	60,137	27.6	7	18,466	24.4	52,976	26.8	7	41,696	24.7	113,113	27.2
8	26,300	28.1	63,075	28.9	8	22,329	29.6	58,755	29.8	8	48,629	28.8	121,830	29.3
9	14,881	15.9	31,624	14.5	9	11,095	14.7	26,488	13.4	9	25,976	15.4	58,112	14.0
10	8,259	8.8	16,071	7.4	10	6,549	8.7	13,966	7.1	10	14,808	8.8	30,037	7.2
11	5,422	5.8	9,677	4.4	11	3,051	4.0	6,261	3.2	11	8,473	5.0	15,938	3.8
12	3,074	3.3	5,184	2.4	12	1,786	2.4	3,130	1.6	12	4,861	2.9	8,315	2.0
13	1,450	1.6	2,246	1.0	13	1,160	1.5	2,288	1.2	13	2,609	1.5	4,534	1.1
14	645	0.7	1,037	0.5	14	714	0.9	1,204	0.6	14	1,360	0.8	2,241	0.5
15	171	0.2	346	0.2	15	515	0.7	963	0.5	15	687	0.4	1,309	0.3
Total	93,473	100	218,083	100	Total	75,547	100	197,456	100	Total	169,020	100	415,538	100

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Table 7.–Page 2 of 2.

Escapement				
	Biomass		Herring	
Age	ST	%	(x1000)	%
4	203	0.1	689	0.2
5	2,883	2.0	8,983	2.6
6	14,079	10.0	42,042	12.1
7	35,307	25.0	95,862	27.5
8	40,578	28.7	101,942	29.2
9	21,579	15.3	48,328	13.9
10	11,974	8.5	24,300	7.0
11	6,996	4.9	13,098	3.8
12	4,030	2.8	6,847	2.0
13	2,036	1.4	3,530	1.0
14	1,137	0.8	1,830	0.5
15	608	0.4	1,163	0.3
Total	141,410	100	348,615	100

Table 8.–Mean length (mm), weight (g), and standard deviation (SD) by age for herring of the commercial harvest by gear type, Togiak District, 2013.

Purse Seine						Gillnet					
Age	Sample (*n*)	Mean Length (mm)	SD	Mean Weight (g)	SD	Age	Sample (*n*)	Mean Length (mm)	SD	Mean Weight (g)	SD
4	11	256	76.9	273	22.1	4	1	290	NA	380	NA
5	125	262	43.5	284	13.2	5	9	270	12.8	321	55.2
6	503	265	52.7	296	14.8	6	68	282	12.2	366	47.5
7	1,134	273	54.1	330	13.7	7	275	285	11.6	377	44.7
8	1,219	280	62.2	357	14.7	8	406	289	11.7	399	50.4
9	525	288	78.0	397	17.2	9	241	296	12.5	423	54.7
10	263	298	80.6	444	17.2	10	151	302	13.1	449	57.5
11	126	306	87.9	477	18.5	11	74	309	13.1	476	57.2
12	76	315	72.6	518	11.7	12	33	307	19.4	484	79.4
13	40	312	110.0	525	18.9	13	22	314	13.2	509	63.0
14	20	316	96.6	538	19.1	14	8	307	12.8	488	74.9
15	10	306	142.1	478	26.4	15	5	314	5.1	525	60.3
16	0	NA	NA	NA	NA	16	2	328	0.7	539	39.6
Average		280	19.3	360	84.2			293	15.0	412	63.7
Total	4,052						1,295				

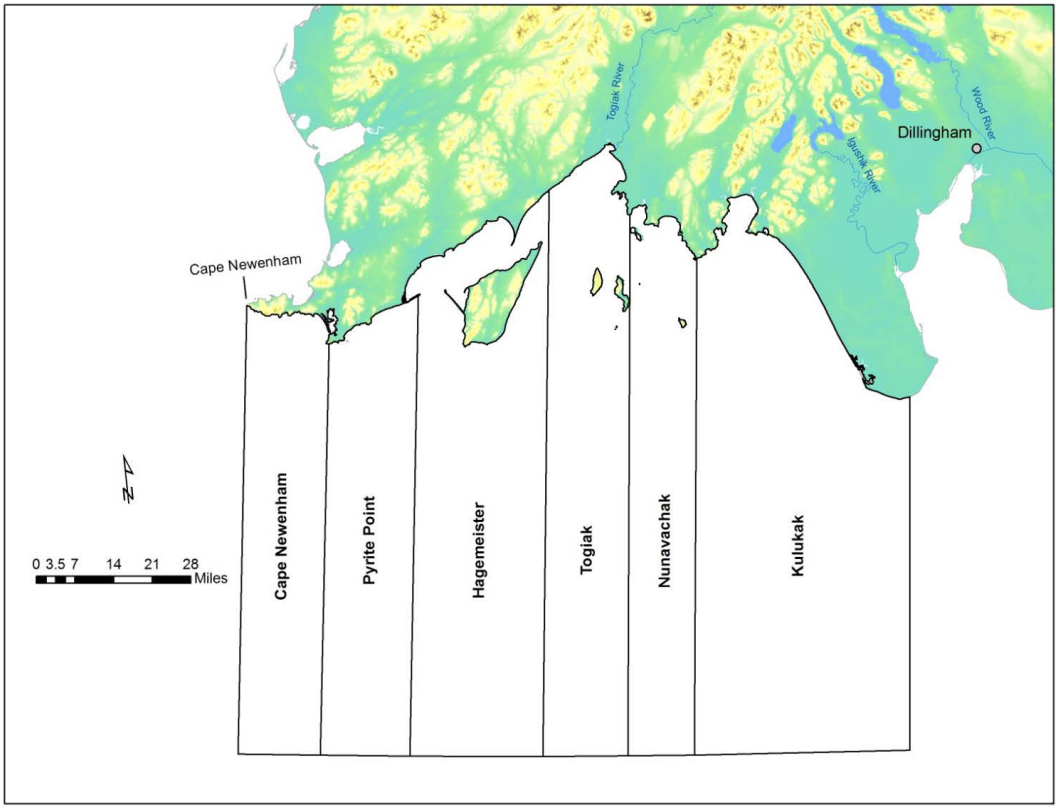

Figure 1.–Map of Togiak District herring management sections, Bristol Bay.

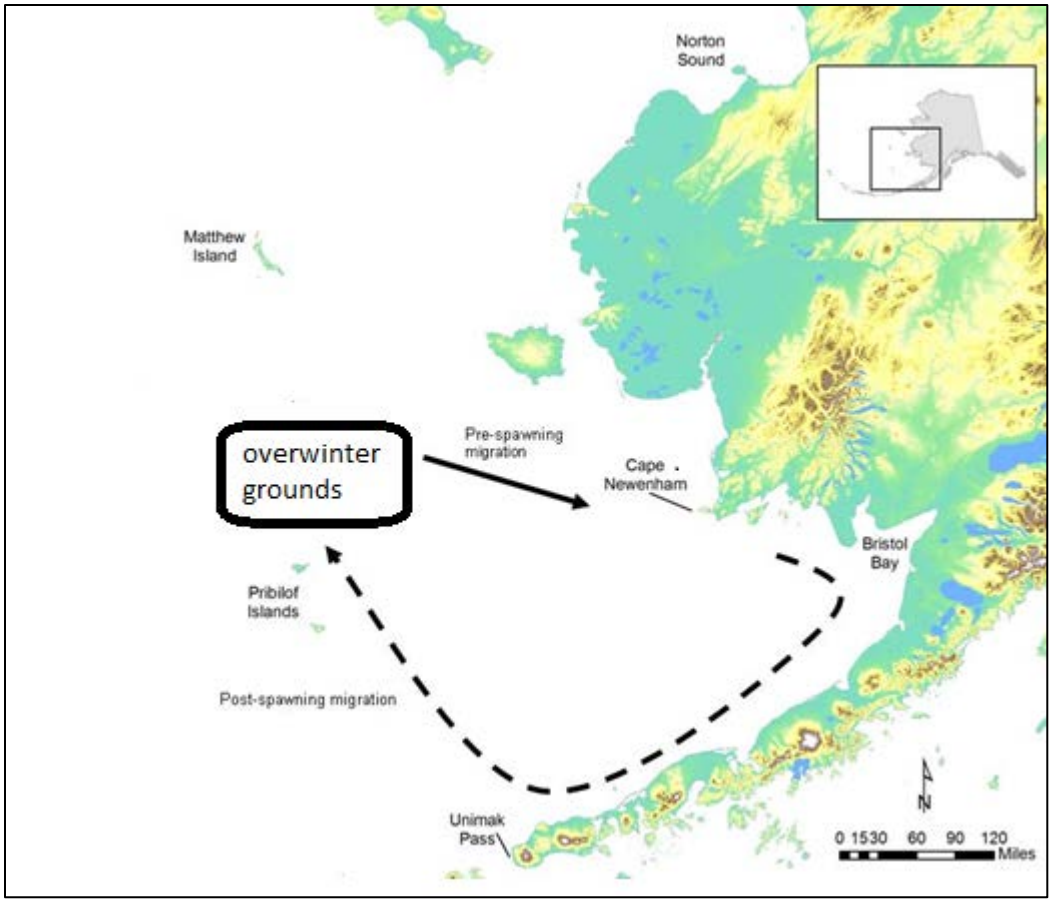

Figure 2.–Southeastern Bering Sea herring migration.

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

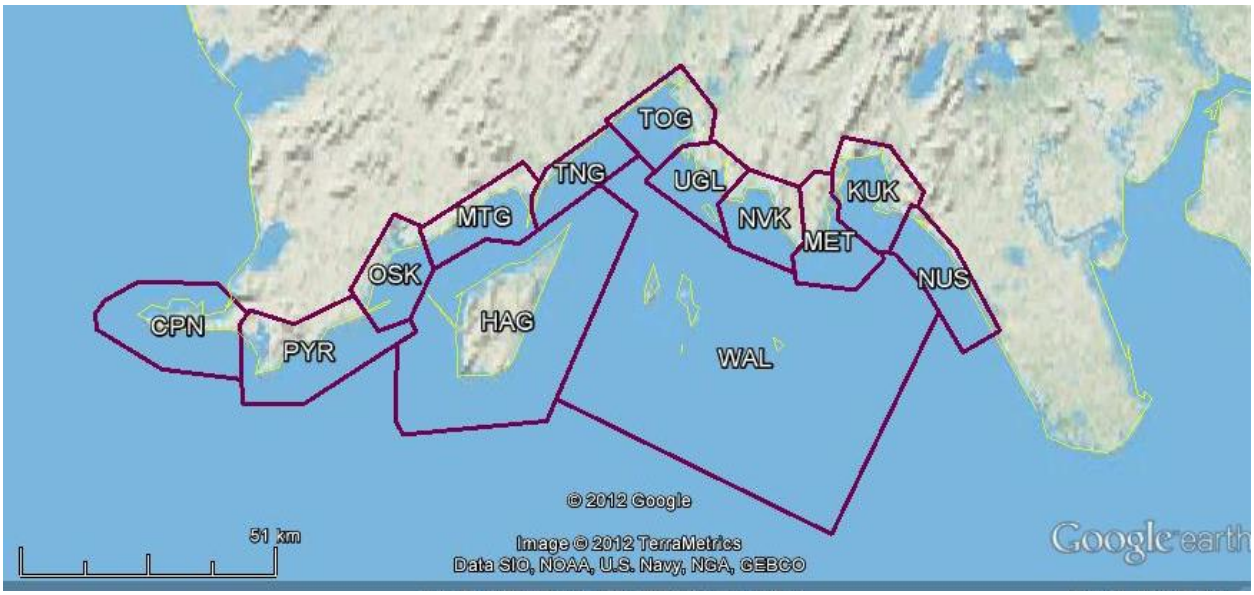

Figure 3.–Togiak herring aerial survey sections, Bristol Bay.

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

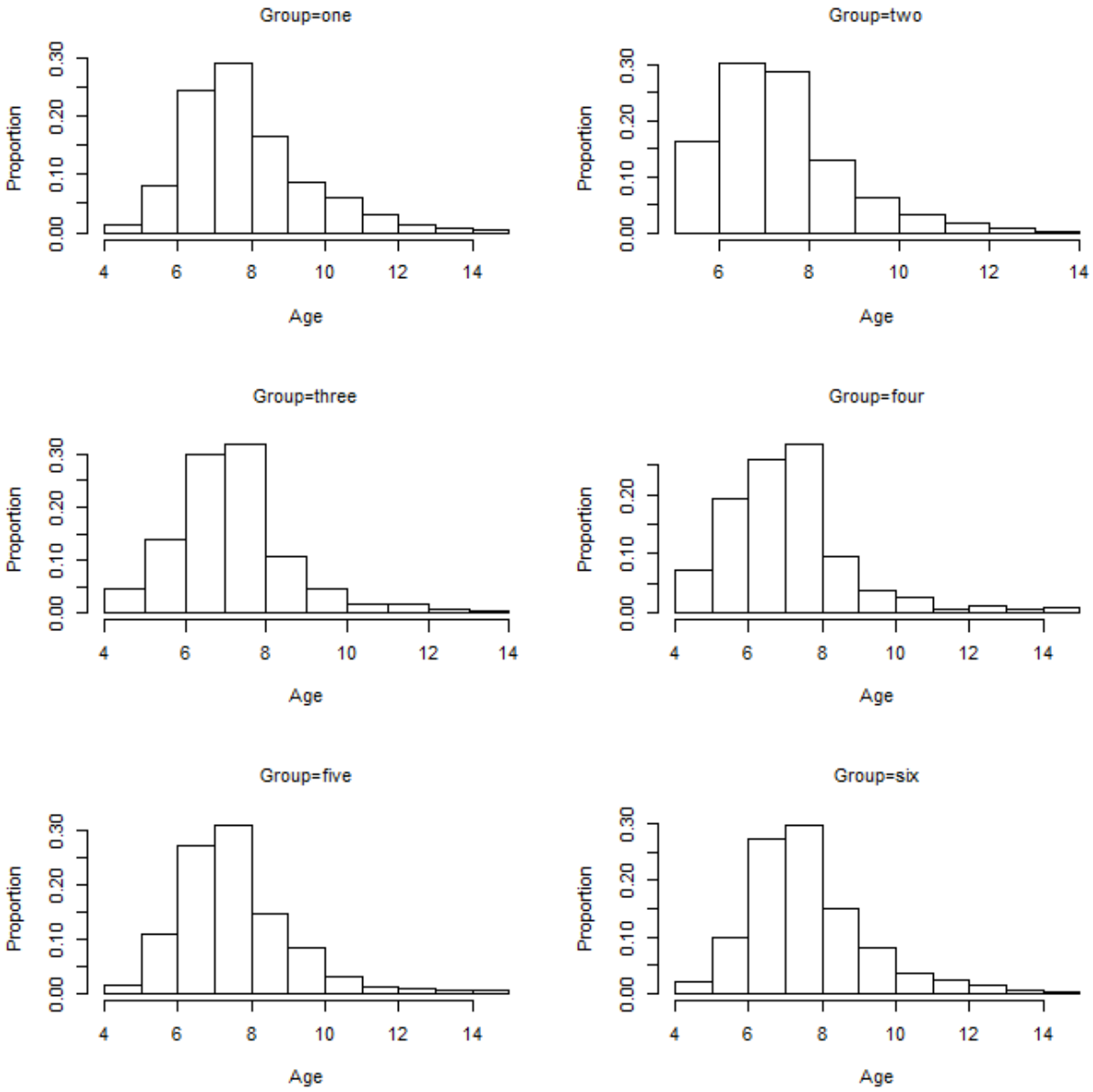

Figure 4.–Age composition of purse seine sample groups, Togiak District, 2013.

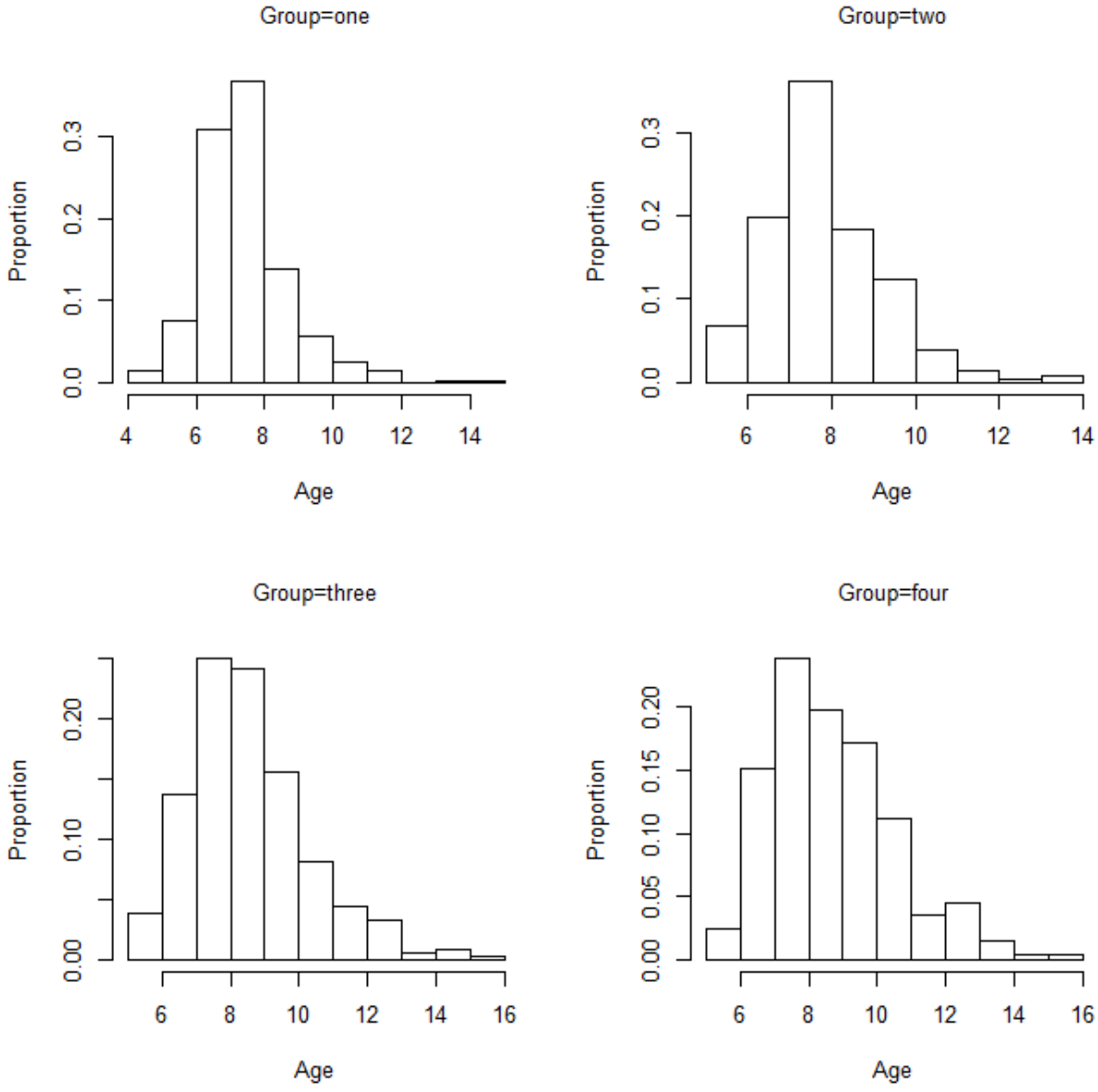

Figure 5.–Age composition of gillnet sample groups, Togiak District, 2013.

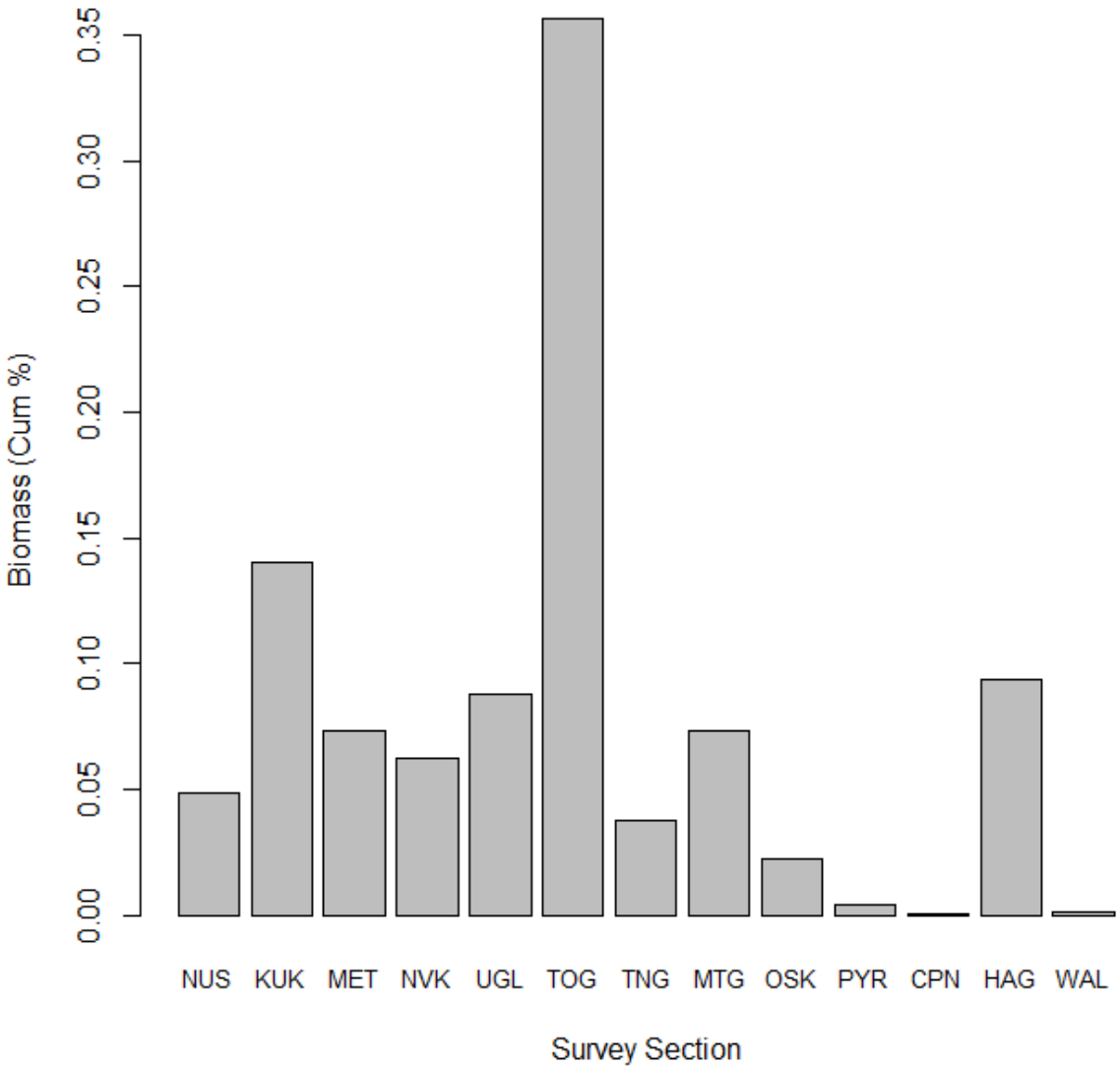

Figure 6.–Cumulative tons of herring estimated in each aerial survey section during all aerial surveys, Togiak District, 2013.

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

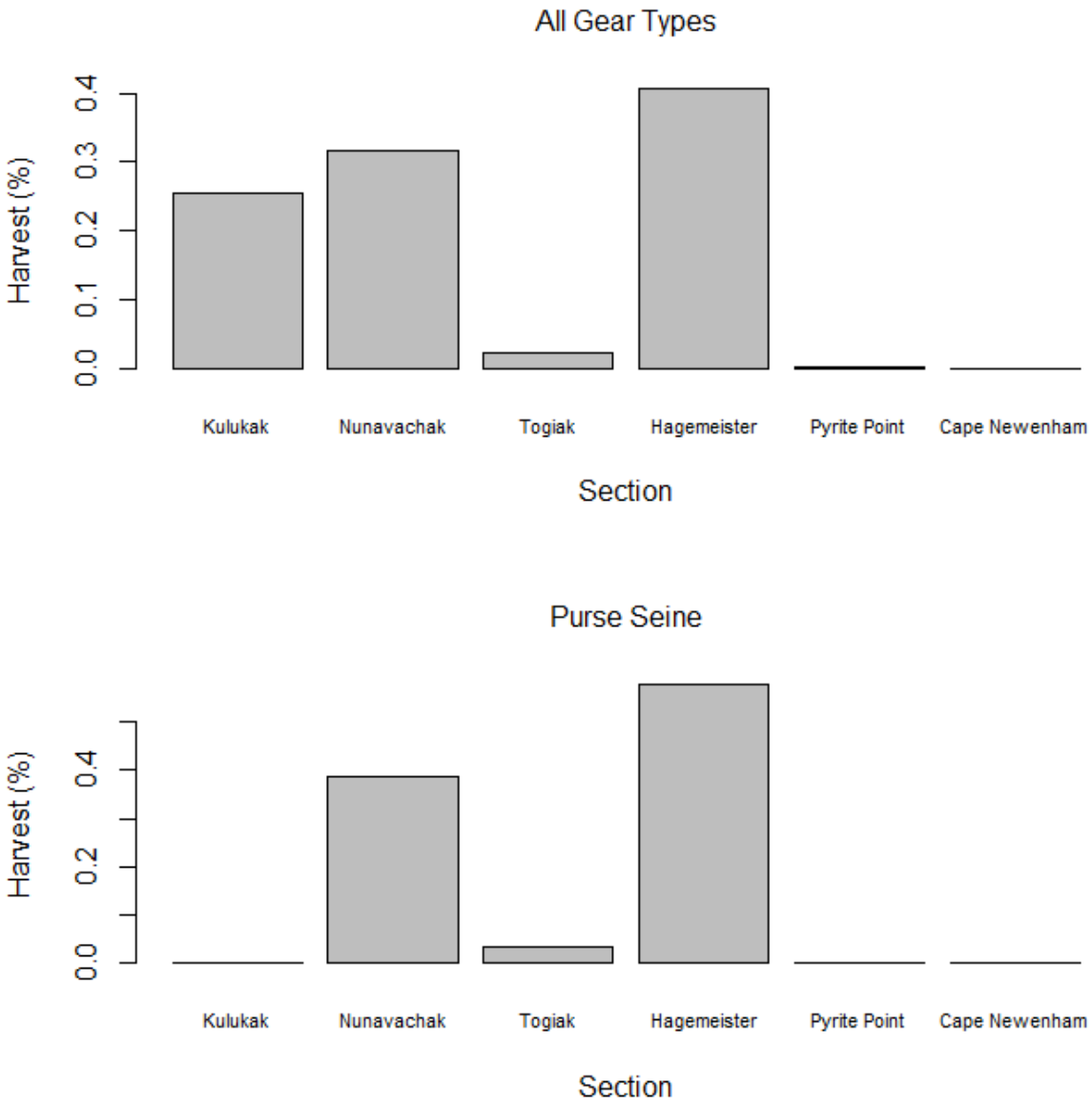

Figure 7.–Commercial herring harvest by reporting section for all gear types (top) and for purse seine only (bottom), Togiak District, 2013.

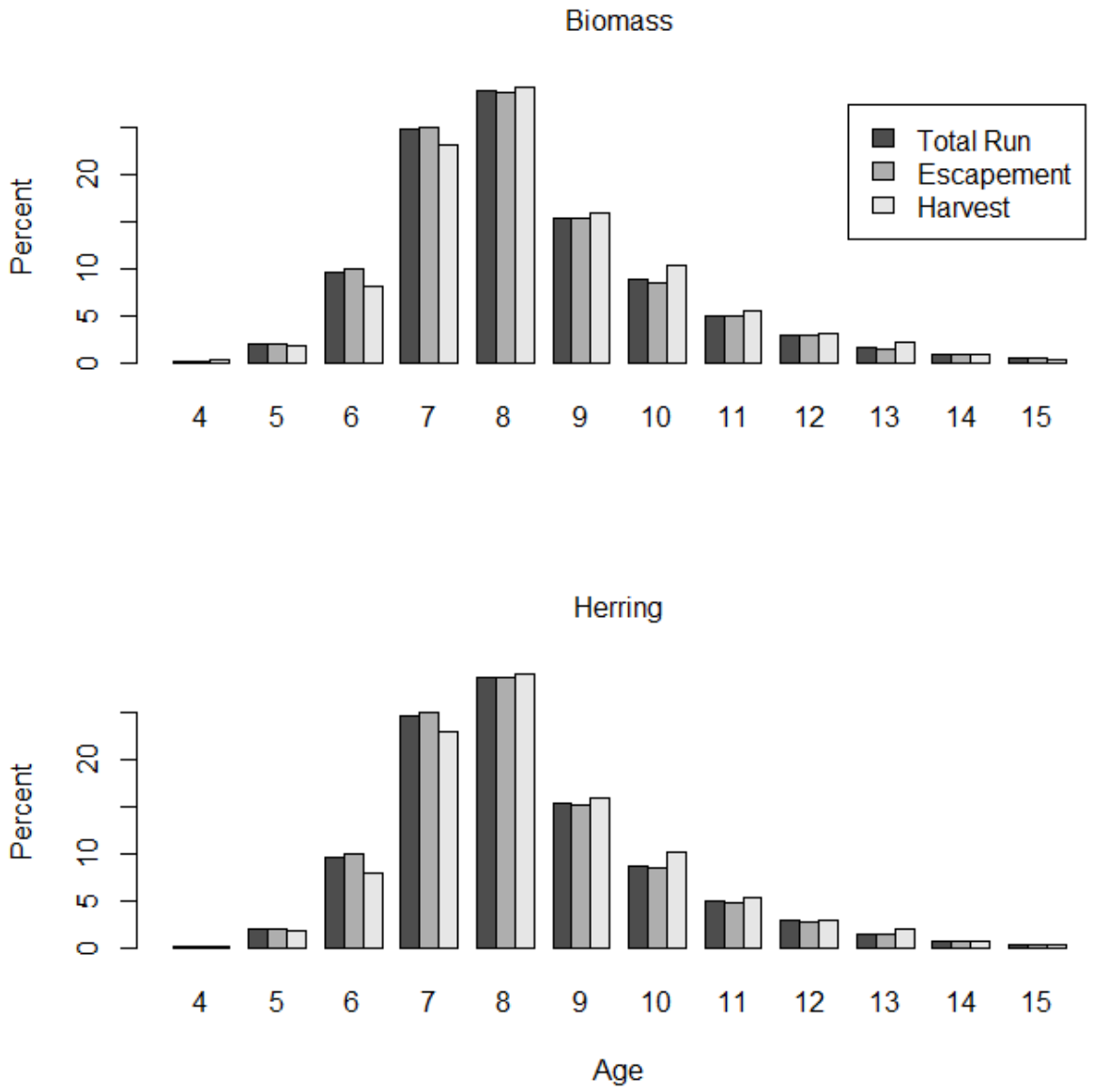

Figure 8.–Age composition of total run, escapement, and harvest by biomass (top) and numbers of fish (bottom), Togiak District, 2013.

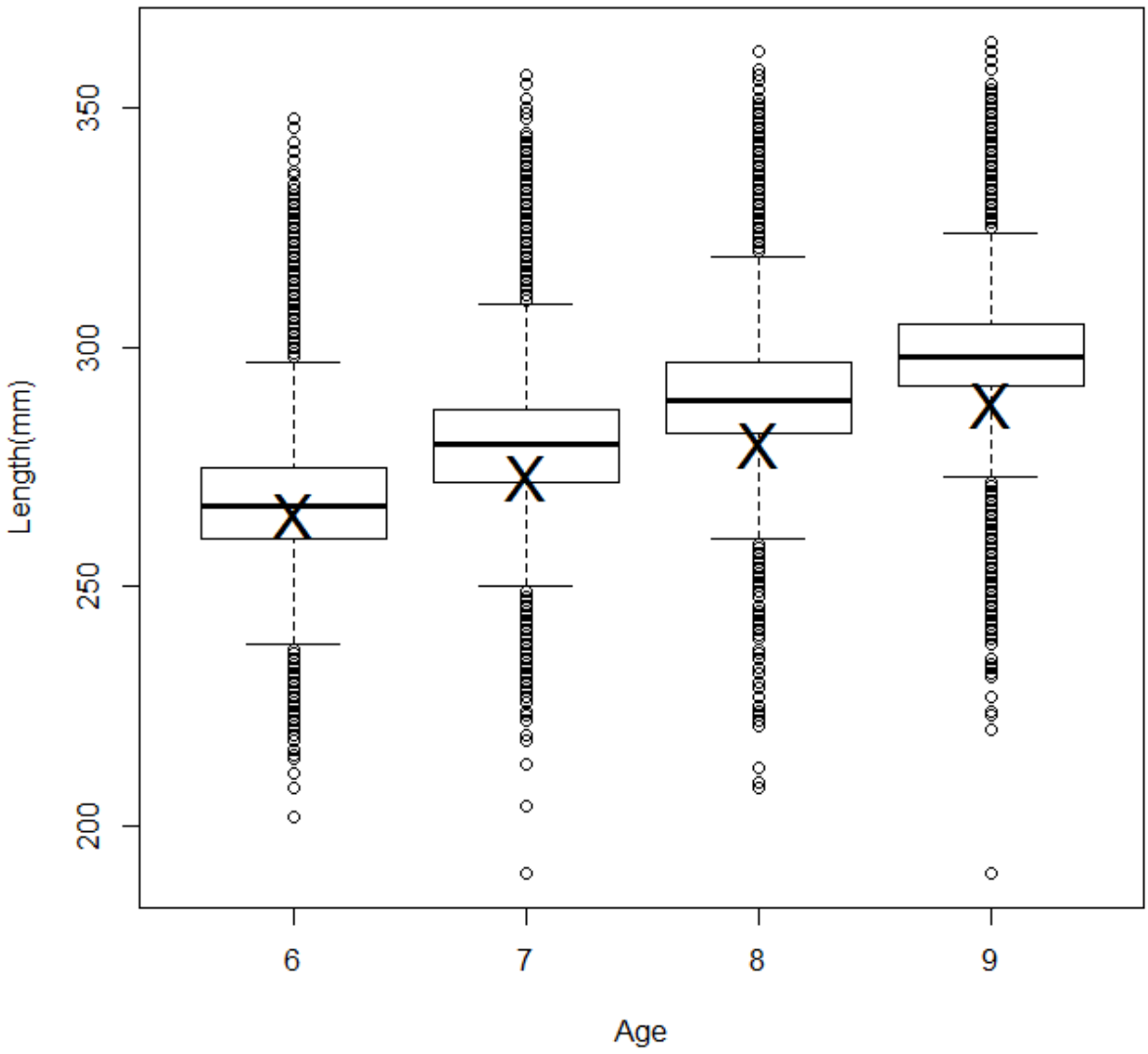

Figure 9.–Average length (denoted as 'X') of herring observed in 2013 age-6 through age-9 and distribution (box plot) of historical observations (1981–present).

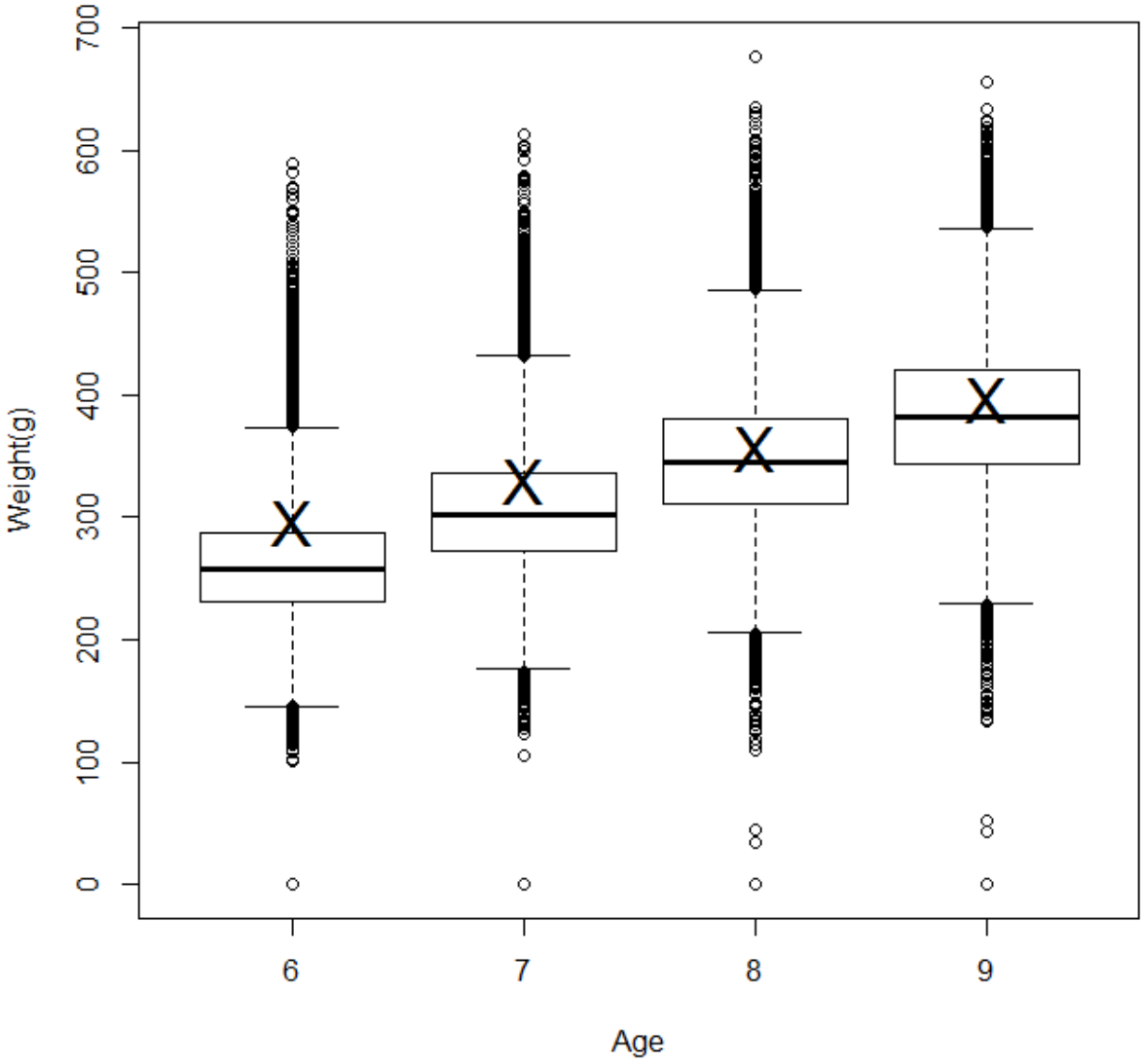

Figure 10.–Average weight (denoted as 'X') of herring observed in 2013 age-6 through age-9 and distribution (box plot) of historical observations (1981–present).

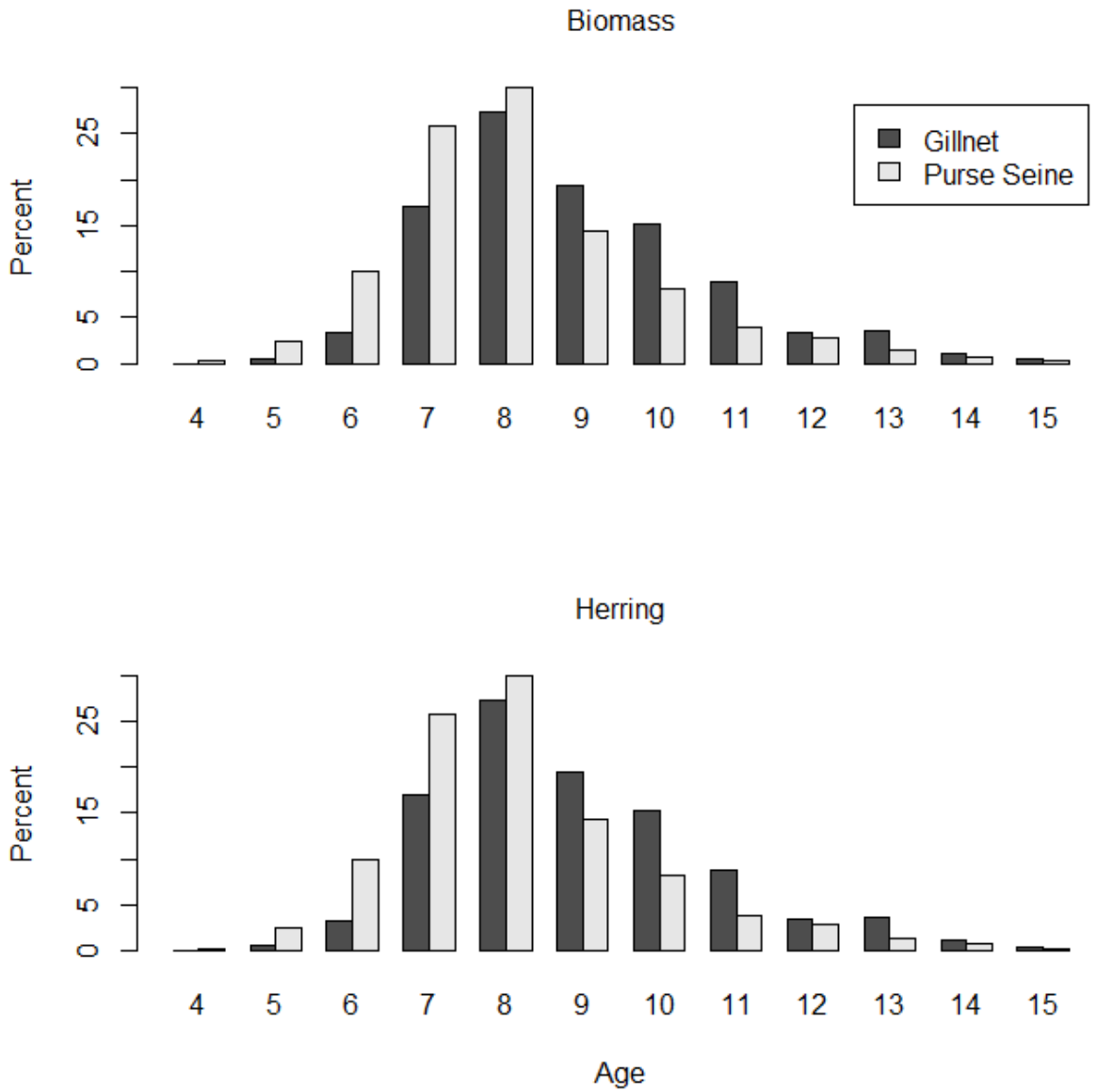

Figure 11.–Percentage composition of the commercial herring harvest by gear type, by biomass, and by numbers of fish, Togiak District, 2013.

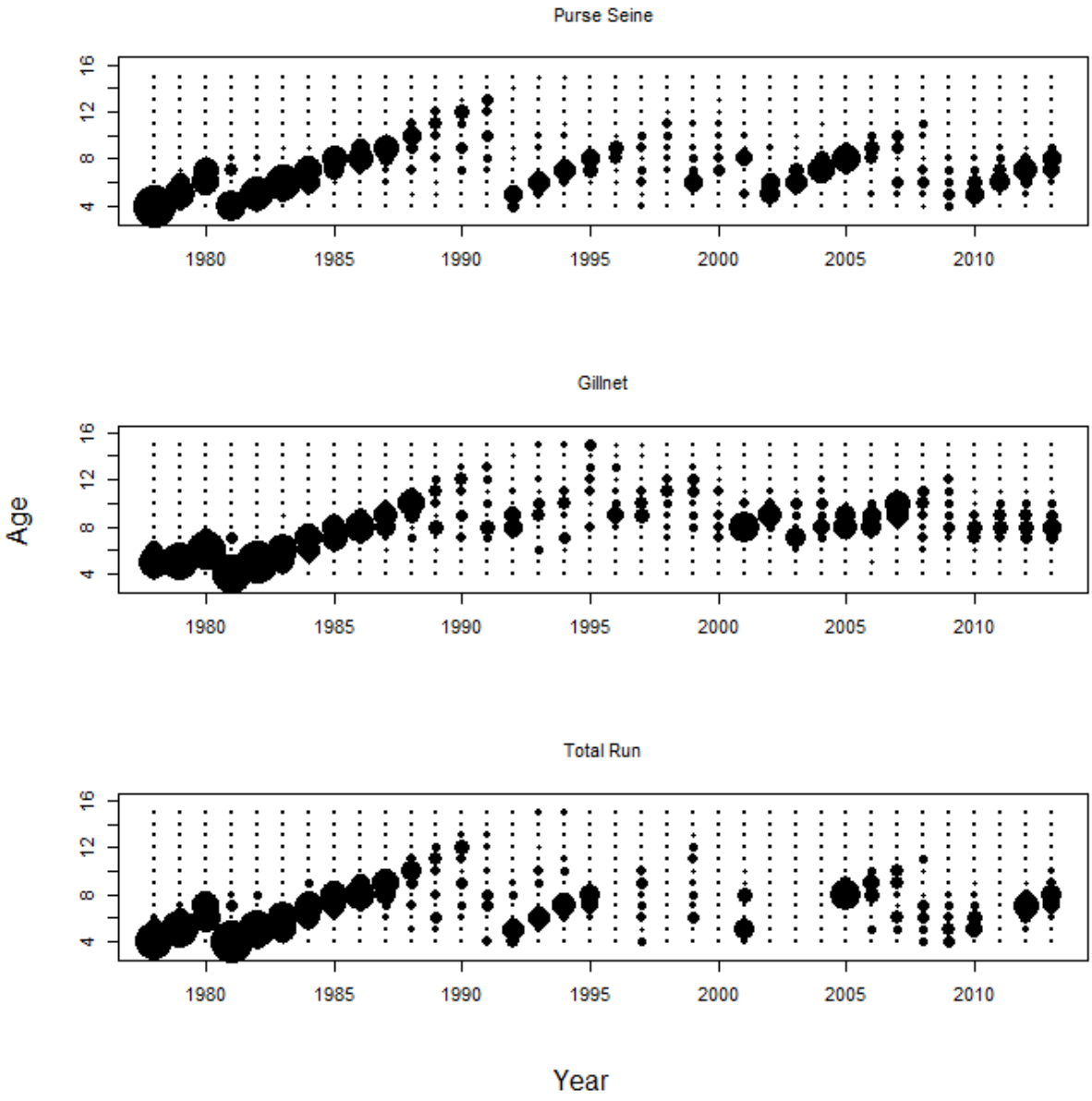

Figure 12.–Relative age class contribution of herring in the purse seine harvest, gillnet harvest, and total run, Togiak District, Bristol Bay, 1977–2013.

APPENDIX A:
ESTIMATED AGE COMPOSITION OF HERRING IN THE TOGIAK DISTRICT

Appendix A1.–Estimated age composition of the Togiak herring run by aerial survey date, Togiak District, 2013.

Survey Date		5/22		Survey Date		5/31	
Index Section(s):		NUN/HAG/TOG		Index Section(s):		HAG	
Survey Biomass:		93,473		Survey Biomass:		75,547	
Age	No.	Percent by No.	Numbers (x1,000)	Age	No.	Percent by No.	Numbers (x1,000)
4	2	0.2	346	4	4	0.2	482
5	27	2.1	4,666	5	49	3.0	5,900
6	137	10.9	23,675	6	208	12.7	25,043
7	348	27.6	60,137	7	440	26.8	52,976
8	365	28.9	63,075	8	488	29.8	58,755
9	183	14.5	31,624	9	220	13.4	26,488
10	93	7.4	16,071	10	116	7.1	13,966
11	56	4.4	9,677	11	52	3.2	6,261
12	30	2.4	5,184	12	26	1.6	3,130
13	13	1.0	2,246	13	19	1.2	2,288
14	6	0.5	1,037	14	10	0.6	1,204
15	2	0.2	346	15	8	0.5	963
Total	1,262	100.0	218,083	Total	1,640	100.0	197,456
		Percent Weighted by				Percent Weighted by	
Age	Weight	Weight	Biomass	Age	Weight	Weight	Biomass
4	587	0.1	112	4	1,028	0.2	136
5	8,198	1.7	1,562	5	13,743	2.4	1,824
6	43,926	9.0	8,367	6	59,678	10.5	7,920
7	121,951	24.9	23,230	7	139,142	24.4	18,466
8	138,069	28.1	26,300	8	168,248	29.6	22,329
9	78,120	15.9	14,881	9	83,602	14.7	11,095
10	43,358	8.8	8,259	10	49,343	8.7	6,549
11	28,465	5.8	5,422	11	22,988	4.0	3,051
12	16,140	3.3	3,074	12	13,459	2.4	1,786
13	7,610	1.6	1,450	13	8,738	1.5	1,160
14	3,388	0.7	645	14	5,382	0.9	714
15	899	0.2	171	15	3,884	0.7	515
Total	490,711	100.0	93,473	Total	569,235	100.0	75,547

Note: "Sections" refers to the following subdistricts within the Togiak District: TOG = Togiak, NUN = Nunavachak, HAG = Hagemeister.

Appendix A2.–Estimated age composition of herring in the commercial purse seine harvest by sample group, date and fishing section(s), Togiak District, 2013.

Sample Group	1
Sample Date(s)	5/11
Section(s):	NUN/TOG
Harvest Biomass:	809

Age	No.	Percent by No.	Numbers (x1,000)
4	2	0.4	7
5	5	0.9	16
6	45	8.1	148
7	136	24.4	449
8	162	29.0	534
9	93	16.7	307
10	49	8.8	162
11	34	6.1	112
12	18	3.2	59
13	8	1.4	26
14	4	0.7	13
15	2	0.4	7
Total	558	100.0	1,840

Age	Weight (total g)	Percent by Wt.	Biomass (tons)
4	587	0.3	2
5	1,457	0.7	5
6	14,078	6.3	51
7	48,641	21.9	177
8	61,395	27.6	223
9	39,014	17.5	142
10	22,679	10.2	82
11	17,382	7.8	63
12	9,495	4.3	35
13	4,609	2.1	17
14	2,201	1.0	8
15	899	0.4	3
Total	222,437	100.0	809

Sample Group	2
Sample Date(s)	5/12
Section(s):	NUN/TOG/HAG
Harvest Biomass:	3,649

Age	No.	Percent by No.	Numbers (x1,000)
4	0	0.0	0
5	22	3.1	271
6	92	13.1	1,135
7	212	30.1	2,616
8	203	28.8	2,505
9	90	12.8	1,111
10	44	6.3	543
11	22	3.1	271
12	12	1.7	148
13	5	0.7	62
14	2	0.3	25
15	0	0.0	0
Total	704	100.0	8,688

Age	Weight (total g)	Percent by Wt.	Biomass (tons)
4	0	0.0	0
5	6,741	2.5	92
6	29,848	11.1	406
7	73,310	27.3	997
8	76,674	28.6	1,043
9	39,106	14.6	532
10	20,679	7.7	281
11	11,083	4.1	151
12	6,645	2.5	90
13	3,001	1.1	41
14	1,187	0.4	16
15	0	0.0	0
Total	268,274	100.0	3,649

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Appendix A2.–Page 2 of 3.

Sample Group	3
Sample Date(s)	5/13-5/15
Section(s):	NUN/TOG/HAG
Harvest Biomass:	5,478

Age	No.	Percent by No.	Numbers (x1,000)
4	5	0.4	62
5	49	4.3	612
6	158	13.7	1,974
7	346	30.1	4,322
8	366	31.8	4,572
9	122	10.6	1,524
10	54	4.7	675
11	18	1.6	225
12	20	1.7	250
13	8	0.7	100
14	4	0.3	50
15	0	0.0	0
Total	1,150	100.0	14,366

Age	Weight (total g)	Percent by Wt.	Biomass (tons)
4	1,389	0.3	19
5	13,588	3.4	187
6	45,501	11.4	627
7	112,721	28.3	1,552
8	128,854	32.4	1,774
9	46,714	11.7	643
10	24,006	6.0	331
11	8,597	2.2	118
12	9,785	2.5	135
13	4,642	1.2	64
14	1,989	0.5	27
15	0	0.0	0
Total	397,786	100.0	5,478

Sample Group	4
Sample Date(s)	5/16
Section(s):	HAG
Harvest Biomass:	1,103

Age	No.	Percent by No.	Numbers (x1,000)
4	1	0.2	7
5	30	6.9	211
6	84	19.3	590
7	113	25.9	794
8	124	28.4	871
9	41	9.4	288
10	17	3.9	119
11	11	2.5	77
12	3	0.7	21
13	5	1.1	35
14	3	0.7	21
15	4	0.9	28
Total	436	100.0	3,063

Age	Weight (total g)	Percent by Wt.	Biomass (tons)
4	180	0.1	1
5	8,156	5.7	63
6	23,341	16.4	181
7	35,412	24.9	274
8	40,894	28.7	317
9	15,097	10.6	117
10	7,055	5.0	55
11	4,988	3.5	39
12	1,433	1.0	11
13	2,226	1.6	17
14	1,522	1.1	12
15	2,059	1.4	16
Total	142,363	100.0	1,103

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Sample Group	5
Sample Date(s)	5/17
Section(s):	HAG/PYR
Harvest Biomass:	928

Age	No.	Percent by No.	Numbers (x1,000)
4	1	0.2	5
5	6	1.3	31
6	50	10.8	259
7	125	27.1	647
8	143	31.0	740
9	67	14.5	347
10	39	8.5	202
11	15	3.3	78
12	5	1.1	26
13	4	0.9	21
14	3	0.7	16
15	3	0.7	16
Total	461	100.0	2,385

Age	Weight (total g)	Percent by Wt.	Biomass (tons)
4	169	0.1	1
5	1,983	1.2	11
6	15,492	9.5	88
7	41,020	25.2	234
8	50,325	30.9	287
9	24,942	15.3	142
10	15,803	9.7	90
11	5,655	3.5	32
12	2,555	1.6	15
13	1,822	1.1	10
14	1,739	1.1	10
15	1,283	0.8	7
Total	162,788	100.0	928

Sample Group	6
Sample Date(s)	5/18-5/20
Section(s):	NUN/HAG
Harvest Biomass:	7,400

Age	No.	Percent by No.	Numbers (x1,000)
4	2	0.3	51
5	13	1.7	330
6	74	10.0	1,881
7	202	27.2	5,135
8	221	29.7	5,618
9	112	15.1	2,847
10	60	8.1	1,525
11	26	3.5	661
12	18	2.4	458
13	10	1.3	254
14	4	0.5	102
15	1	0.1	25
Total	743	100.0	18,887

Age	Weight (total g)	Percent by Wt.	Biomass (tons)
4	679	0.3	19
5	3,604	1.4	101
6	20,845	7.9	584
7	62,710	23.7	1,757
8	77,029	29.2	2,158
9	43,563	16.5	1,221
10	26,485	10.0	742
11	12,345	4.7	346
12	9,471	3.6	265
13	4,690	1.8	131
14	2,121	0.8	59
15	542	0.2	15
Total	264,084	100.0	7,400

Note: "Sections" refers to the following subdistricts within the Togiak District: TOG = Togiak, NUN = Nunavachak, HAG = Hagemeister, and PYR = Pyrite Point.

Appendix A3.–Estimated age composition of herring in the commercial gillnet harvest by sample group, date and fishing section(s), Togiak District, 2013.

Sample Group	1		
Sample Date(s)	5/11-5/13		
Section(s):	NUN		
Harvest Biomass:	1,288		
Age	No.	Percent by No.	Numbers (x1,000)
5	5	1.1	33
6	34	7.5	224
7	139	30.8	917
8	166	36.8	1,095
9	62	13.7	409
10	25	5.5	165
11	11	2.4	73
12	6	1.3	40
13	0	0.0	0
14	1	0.2	7
15	1	0.2	7
Total	451	100.0	2,976
		Percent Weighted by	
Age	Weight	Weight	Biomass
5	1,525	0.9	11
6	12,501	7.1	91
7	51,293	29.0	373
8	65,079	36.8	473
9	26,062	14.7	190
10	11,222	6.3	82
11	5,210	2.9	38
12	2,702	1.5	20
13	0	0.0	0
14	538	0.3	4
15	557	0.3	4
Total	177,069	100.0	1,288

Sample Group	2		
Sample Date(s)	5/14-5/15		
Section(s):	NUN		
Harvest Biomass:	1,545		
Age	No.	Percent by No.	Numbers (x1,000)
5	2	0.7	24
6	17	6.0	204
7	56	19.9	673
8	102	36.2	1,226
9	52	18.4	625
10	35	12.4	421
11	11	3.9	132
12	4	1.4	48
13	1	0.4	12
14	2	0.7	24
15	0	0.0	0
Total	282	100.0	3,390
		Percent Weighted by	
Age	Weight	Weight	Biomass
5	762	0.7	10
6	6,300	5.4	83
7	21,394	18.3	283
8	40,907	35.1	542
9	22,989	19.7	305
10	15,599	13.4	207
11	5,133	4.4	68
12	2,010	1.7	27
13	455	0.4	6
14	1,056	0.9	14
15	0	0.0	0
Total	116,605	100.0	1,545

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Sample Group	3		
Sample Date(s)	5/16-5/17		
Section(s):	NUN		
Harvest Biomass:	875		
Age	No.	Percent by No.	Numbers (x1,000)
5	1	0.3	5
6	13	3.6	67
7	50	13.8	258
8	91	25.1	470
9	88	24.2	455
10	57	15.7	294
11	30	8.3	155
12	16	4.4	83
13	12	3.3	62
14	2	0.6	10
15	3	0.8	15
Total	363	100.0	1,875
		Percent Weighted by	
Age	Weight	Weight	Biomass
5	270	0.2	2
6	4,781	3.1	27
7	19,223	12.5	109
8	36,672	23.9	209
9	36,298	23.6	207
10	25,395	16.5	145
11	14,653	9.5	83
12	7,680	5.0	44
13	5,952	3.9	34
14	1,112	0.7	6
15	1,629	1.1	9
Total	153,665	100.0	875

Sample Group	4		
Sample Date(s)	5/19-5/27		
Section(s):	NUN/TOG		
Harvest Biomass:	4,536		
Age	No.	Percent by No.	Numbers (x1,000)
5	1	0.5	48
6	4	2.0	192
7	30	15.2	1,440
8	47	23.9	2,255
9	39	19.8	1,871
10	34	17.3	1,631
11	22	11.2	1,056
12	7	3.6	336
13	9	4.6	432
14	3	1.5	144
15	1	0.5	48
Total	197	100.0	9,453
		Percent Weighted by	
Age	Weight	Weight	Biomass
5	389	0.5	21
6	1,321	1.5	70
7	11,947	13.9	632
8	19,362	22.6	1,024
9	16,998	19.8	899
10	15,491	18.1	819
11	10,187	11.9	539
12	3,592	4.2	190
13	4,789	5.6	253
14	1,235	1.4	65
15	439	0.5	23
Total	85,750	100.0	4,536

Note: "Sections" refers to the following subdistricts within the Togiak District: TOG = Togiak and NUN = Nunavachak.

APPENDIX B:
AGE, SEX, AND SIZE COMPOSITION OF HERRING CAUGHT BY COMMERCIAL PURSE SEINE

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

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/12	4	0	0	0	0	0.0	0	297	52.9	0	264	15.9	0
	5	5	3	0	8	2.3	1	333	50.1	8	271	14.1	8
	6	19	11	0	30	8.5	1	355	50.6	30	276	12.3	30
	7	53	44	0	97	27.5	2	385	64.2	97	281	14.1	97
	8	39	62	0	101	28.6	2	451	84.3	101	294	17.0	101
	9	23	35	0	58	16.4	2	488	82.1	58	303	14.7	58
	10	14	17	0	31	8.8	2	523	72.0	31	308	10.9	31
	11	4	10	0	14	4.0	1	553	72.7	14	314	9.9	14
	12	4	5	0	9	2.5	1	600	50.4	9	315	6.8	9
	13	3	2	0	5	1.4	1	604	NA	5	318	NA	5
Sample Total		164	189	0	353	100.0		444	91.8	353	293	18.6	353
5/16	4	0	1	0	1	0.2	0	180	NA	1	231	NA	1
	5	14	16	0	30	6.9	1	272	37.5	30	259	13.0	30
	6	42	40	2	84	19.3	2	278	47.3	84	260	14.5	84
	7	51	61	1	113	25.9	2	313	60.5	113	270	14.2	113
	8	59	61	4	124	28.4	2	330	55.7	124	274	14.3	124
	9	24	16	1	41	9.4	1	368	72.0	41	283	17.0	41
	10	12	5	0	17	3.9	1	415	68.3	17	296	16.1	17
	11	7	4	0	11	2.5	1	453	69.7	11	304	17.2	11
	12	0	3	0	3	0.7	0	478	97.2	3	311	17.3	3
	13	3	2	0	5	1.1	1	445	48.0	5	311	8.9	5
	14	2	1	0	3	0.7	0	507	95.6	3	313	18.7	3
	15	3	1	0	4	0.9	0	515	179.6	4	311	32.3	4
Sample Total		217	211	8	436	100.0		327	77.0	436	273	19.4	436

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Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
	4	1	0	0	1	0.2	0	169	NA	1	226	NA	1
	5	4	2	0	6	1.3	1	331	49.6	6	275	8.9	6
	6	27	23	0	50	10.8	2	310	62.0	50	267	13.7	50
	7	63	62	0	125	27.1	2	328	64.4	125	272	15.8	125
	8	73	70	0	143	31.0	2	352	66.4	143	278	16.0	143
5/17	9	42	24	1	67	14.5	2	372	69.4	67	282	15.5	67
	10	13	26	0	39	8.5	1	405	83.2	39	289	17.7	39
	11	8	7	0	15	3.3	1	377	96.7	15	284	22.5	15
	12	3	2	0	5	1.1	1	511	56.0	5	315	3.8	5
	13	0	4	0	4	0.9	0	456	168.2	4	295	37.9	4
	14	2	1	0	3	0.7	0	580	99.7	3	318	24.6	3
Sample Total		237	223	1	461	100.2		353	79.5	461	276	18.3	461
	4	0	0	0	0	0.0	0	284	33.0	0	264	7.8	0
	5	3	3	0	6	1.6	1	292	56.2	6	262	15.9	6
	6	22	11	0	33	8.5	1	318	45.9	33	270	12.0	33
	7	55	46	0	101	26.1	2	354	55.8	101	277	13.6	101
	8	57	59	0	116	30.0	2	406	87.8	116	288	20.1	116
5/18	9	26	31	0	57	14.7	2	456	73.5	57	298	15.3	57
	10	19	18	0	37	9.6	1	466	111.7	37	302	22.4	37
	11	7	11	0	18	4.7	1	540	74.9	18	316	10.0	18
	12	4	6	0	10	2.6	1	479	73.3	10	308	10.9	10
	13	3	3	0	6	1.6	1	494	55.2	6	321	7.2	6
	14	1	2	0	3	0.8	0	542	NA	3	311	NA	3
Sample Total		197	190	0	387	100.0		407	89.5	387	289	20.0	387

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		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/19	4	0	1	0	1	0.3	0	340	7.8	1	273	5.7	1
	5	0	2	0	2	0.6	0	272	34.8	2	260	13.4	2
	6	7	0	0	7	2.0	1	273	48.6	7	259	14.4	7
	7	16	25	0	41	11.5	2	303	44.3	41	268	11.6	41
	8	53	48	0	101	28.4	2	343	60.0	101	277	14.2	101
	9	41	63	1	105	29.5	2	371	61.9	105	283	14.5	105
	10	27	28	0	55	15.4	2	418	88.1	55	292	19.8	55
	11	14	9	0	23	6.5	1	494	58.3	23	307	14.1	23
	12	1	7	0	8	2.2	1	509	85.6	8	310	11.4	8
	13	5	3	0	8	2.2	1	454	133.8	8	301	29.0	8
Sample Total		167	188	1	356	100.0		375	80.3	356	279	18.4	356
Samples Combined		982	1,001	10	1,993			357	87.2	1,993	278	19.4	1,993

Appendix B2.–Age, sex, and size composition of herring caught by commercial purse seine, Nunavachak Section.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/11	4	1	1	0	2	0.5	0.3	294	0.7	2	273	9.2	2
	5	0	1	0	1	0.2	0.2	220	NA	1	246	NA	1
	6	19	10	0	29	7.0	1.3	313	46.9	29	272	15.1	29
	7	53	44	0	97	23.4	2.1	356	57.0	97	281	15.1	97
	8	49	72	0	121	29.2	2.2	376	58.9	121	286	14.6	121
	9	35	41	0	76	18.3	1.9	423	73.4	76	296	15.6	76
	10	16	20	0	36	8.7	1.4	458	67.7	36	304	16.0	36
	11	13	15	0	28	6.7	1.2	505	71.2	28	313	13.6	28
	12	5	10	0	15	3.6	0.9	519	65.4	15	318	13.4	15
	13	2	4	0	6	1.4	0.6	567	127.8	6	314	21.2	6
	14	2	1	0	3	0.7	0.4	513	72.6	3	307	12.7	3
	15	1	0	0	1	0.2	0.2	534	NA	1	317	NA	1
Sample Total		196	219	0	415	100.0		400	86.3	415	291	19.4	415
5/12	5	6	8	0	14	4.0	1.0	312	41.3	14	271	12.3	14
	6	28	34	0	62	17.7	1.9	320	58.4	62	273	15.3	62
	7	48	66	1	115	32.9	2.3	338	46.9	115	278	13.1	115
	8	46	55	1	102	29.1	2.2	371	61.0	102	284	14.4	102
	9	13	19	0	32	9.1	1.4	405	73.3	32	291	16.7	32
	10	8	5	0	13	3.7	0.9	426	71.7	13	297	15.3	13
	11	5	3	0	8	2.3	0.7	470	54.1	8	309	13.1	8
	12	0	3	0	3	0.9	0.5	555	73.5	3	317	7.4	3
	14	1	0	0	1	0.3	0.3	583	NA	1	320	NA	1
Sample Total		155	193	2	350	100.0		358	69.7	350	281	16.6	350

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Sample Dates	Age	Sex (number) Male	Female	Unk.	Total	% of Total	SE	Weight Mean (g)	SD	Number Weighed	Length Mean (mm)	SD	Number Measured
	5	5	1	1	7	3.8	0.9	293	33.1	7	273	7.3	7
	6	10	6	1	17	9.3	1.4	295	44.9	17	271	11.4	17
	7	22	23	2	47	25.7	2.1	344	48.1	47	279	12.5	47
	8	37	26	2	65	35.5	2.4	372	57.2	65	287	12.9	65
5/13	9	9	13	0	22	12.0	1.6	436	69.6	22	301	14.7	22
	10	9	6	0	15	8.2	1.3	474	73.9	15	308	12.6	15
	11	2	2	0	4	2.2	0.7	525	27.0	4	319	5.1	4
	12	2	3	0	5	2.7	0.8	496	48.2	5	321	6.9	5
	13	0	1	0	1	0.5	0.4	616	NA	1	327	NA	1
Sample Total		96	81	6	183	100.0		379	81.0	183	288	18.0	183
	4	2	2	0	4	0.5	0.4	277	99.8	4	252	25.9	4
	5	13	14	1	28	3.8	0.9	281	44.7	28	260	13.5	28
	6	51	55	1	107	14.3	1.7	285	41.9	107	261	12.6	107
	7	104	126	1	231	31.0	2.3	325	47.7	231	273	12.4	231
	8	101	140	0	241	32.3	2.3	351	54.2	241	278	12.6	241
5/14	9	21	46	2	69	9.2	1.4	379	71.0	69	286	16.3	69
	10	9	22	0	31	4.2	1.0	439	83.0	31	298	18.4	31
	11	5	5	0	10	1.3	0.6	487	42.0	10	312	12.0	10
	12	7	8	0	15	2.0	0.7	487	70.1	15	311	14.9	15
	13	0	6	0	6	0.8	0.4	577	91.8	6	321	12.0	6
	14	3	1	0	4	0.5	0.4	497	151.0	4	311	35.0	4
Sample Total		316	425	5	746	100.0		344	74.5	746	276	18.1	746
Samples Combined		763	918	13	1,694			364	80.6	1,694	282	19.0	1,694

Appendix B3.–Age, sex, and size composition of herring caught by commercial purse seine, Togiak Section.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
	5	3	1	0	4	2.8	1.4	309	20.6	4	265	2.1	4
	6	9	6	1	16	11.2	2.6	312	48.1	16	267	14.9	16
	7	19	20	0	39	27.3	3.7	363	57.0	39	282	13.8	39
	8	22	19	0	41	28.7	3.8	387	77.5	41	285	15.9	41
	9	9	8	0	17	11.9	2.7	404	56.3	17	289	12.5	17
5/11	10	6	7	0	13	9.1	2.4	476	57.2	13	306	13.3	13
	11	2	4	0	6	4.2	1.7	539	50.4	6	314	14.9	6
	12	0	3	0	3	2.1	1.2	568	101.3	3	317	11.7	3
	13	1	1	0	2	1.4	1.0	605	47.4	2	327	0.0	2
	14	0	1	0	1	0.7	0.7	661	NA	1	328	NA	1
	15	1	0	0	1	0.7	0.7	365	NA	1	282	NA	1
Sample Total		72	70	1	143	100.0		395	90.7	143	287	19.3	143
	4	1	0	0	1	0.5	0.5	280	NA	1	261	NA	1
	5	8	6	0	14	6.3	1.6	263	40.2	14	255	11.1	14
	6	18	16	0	34	15.4	2.4	292	44.5	34	262	12.6	34
	7	31	37	0	68	30.8	3.1	315	38.8	68	269	10.3	68
5/15	8	28	32	0	60	27.1	3.0	334	66.9	60	274	15.3	60
	9	14	16	1	31	14.0	2.3	353	58.9	31	276	13.2	31
	10	3	5	0	8	3.6	1.3	411	83.7	8	291	20.8	8
	11	1	3	0	4	1.8	0.9	406	95.4	4	298	26.5	4
	13	1	0	0	1	0.5	0.5	564	NA	1	321	NA	1
Sample Total		105	115	1	221	100.0		325	64.0	221	271	15.8	221
Samples Combined		177	185	2	364			352	82.9	364	277	18.8	364

Appendix B4.–Age, sex, and size composition of herring caught by commercial purse seine, all sections.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/11	4	1	1	0	2	0.4	0.3	294	0.7	2	273	9.2	2
	5	3	2	0	5	0.9	0.4	291	43.7	5	261	8.5	5
	6	28	16	1	45	8.1	1.2	313	46.8	45	270	15.1	45
	7	72	64	0	136	24.4	1.8	358	56.9	136	281	14.7	136
	8	71	91	0	162	29.0	1.9	379	64.0	162	286	14.9	162
	9	44	49	0	93	16.7	1.6	420	70.7	93	295	15.3	93
	10	22	27	0	49	8.8	1.2	463	65.0	49	304	15.2	49
	11	15	19	0	34	6.1	1.0	511	68.6	34	314	13.6	34
	12	5	13	0	18	3.2	0.7	528	71.3	18	318	12.9	18
	13	3	5	0	8	1.4	0.5	576	110.9	8	317	19.0	8
	14	2	2	0	4	0.7	0.4	550	94.7	4	312	14.9	4
	15	2	0	0	2	0.4	0.3	450	119.5	2	300	24.7	2
Sample Total		268	289	1	558	100.0		399	87.4	558	290	19.4	558
5/12	5	11	11	0	22	3.1	0.7	306	45.2	22	268	13.7	22
	6	47	45	0	92	13.1	1.3	324	55.8	92	272	14.9	92
	7	101	110	1	212	30.1	1.7	346	49.1	212	277	12.7	212
	8	85	117	1	203	28.8	1.7	378	62.9	203	283	14.3	203
	9	36	54	0	90	12.8	1.3	435	83.1	90	293	16.9	90
	10	22	22	0	44	6.3	0.9	470	83.4	44	301	15.0	44
	11	9	13	0	22	3.1	0.7	504	69.8	22	309	11.4	22
	12	4	8	0	12	1.7	0.5	554	69.5	12	314	9.1	12
	13	3	2	0	5	0.7	0.3	600	50.4	5	315	6.8	5
	14	2	0	0	2	0.3	0.2	594	14.8	2	319	1.4	2
Sample Total		320	382	2	704	100.0		381	84.5	704	283	17.7	704

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Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
	5	5	1	1	7	3.8	1.4	293	33.1	7	273	7.3	7
	6	10	6	1	17	9.3	2.2	295	44.9	17	271	11.4	17
	7	22	23	2	47	25.7	3.2	344	48.1	47	279	12.5	47
	8	37	26	2	65	35.5	3.5	372	57.2	65	287	12.9	65
5/13	9	9	13	0	22	12.0	2.4	436	69.6	22	301	14.7	22
	10	9	6	0	15	8.2	2.0	474	73.9	15	308	12.6	15
	11	2	2	0	4	2.2	1.1	525	27.0	4	319	5.1	4
	12	2	3	0	5	2.7	1.2	496	48.2	5	321	6.9	5
	13	0	1	0	1	0.5	0.5	616	NA	1	327	NA	1
Sample Total		96	81	6	183	100.0		379	81.0	183	288	18.0	183
	4	2	2	0	4	0.5	0.3	277	99.8	4	252	25.9	4
	5	13	14	1	28	3.8	0.7	281	44.7	28	260	13.5	28
	6	51	55	1	107	14.3	1.3	285	41.9	107	261	12.6	107
	7	104	126	1	231	31.0	1.7	325	47.7	231	273	12.4	231
	8	101	140	0	241	32.3	1.7	351	54.2	241	278	12.6	241
5/14	9	21	46	2	69	9.2	1.1	379	71.0	69	286	16.3	69
	10	9	22	0	31	4.2	0.7	439	83.0	31	298	18.4	31
	11	5	5	0	10	1.3	0.4	487	42.0	10	312	12.0	10
	12	7	8	0	15	2.0	0.5	487	70.1	15	311	14.9	15
	13	0	6	0	6	0.8	0.3	577	91.8	6	321	12.0	6
	14	3	1	0	4	0.5	0.3	497	151.0	4	311	35.0	4
Sample Total		316	425	5	746	100.0		344	74.4	746	276	18.0	746

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Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/15	4	1	0	0	1	0.5	0.5	280	NA	1	261	NA	1
	5	8	6	0	14	6.3	1.6	263	40.2	14	255	11.1	14
	6	18	16	0	34	15.4	2.4	292	44.5	34	262	12.6	34
	7	31	37	0	68	30.8	3.1	315	38.8	68	269	10.3	68
	8	28	32	0	60	27.1	3.0	334	66.9	60	274	15.3	60
	9	14	16	1	31	14.0	2.3	353	58.9	31	276	13.2	31
	10	3	5	0	8	3.6	1.3	411	83.7	8	291	20.8	8
	11	1	3	0	4	1.8	0.9	406	95.4	4	298	26.5	4
	13	1	0	0	1	0.5	0.5	564	NA	1	321	NA	1
Sample Total		105	115	1	221	100.0		325	64.0	221	271	15.8	221
5/16	4	0	1	0	1	0.2	0.2	180	NA	1	231	NA	1
	5	14	16	0	30	6.9	1.2	272	37.5	30	259	13.0	30
	6	42	40	2	84	19.3	1.9	278	47.3	84	260	14.5	84
	7	51	61	1	113	25.9	2.1	313	60.5	113	270	14.2	113
	8	59	61	4	124	28.4	2.2	330	55.7	124	274	14.3	124
	9	24	16	1	41	9.4	1.4	368	72.0	41	283	17.0	41
	10	12	5	0	17	3.9	0.9	415	68.3	17	296	16.1	17
	11	7	4	0	11	2.5	0.8	453	69.7	11	304	17.2	11
	12	0	3	0	3	0.7	0.4	478	97.2	3	311	17.3	3
	13	3	2	0	5	1.1	0.5	445	48.0	5	311	8.9	5
	14	2	1	0	3	0.7	0.4	507	95.6	3	313	18.7	3
	15	3	1	0	4	0.9	0.5	515	179.6	4	311	32.3	4
Sample Total		217	211	8	436	100.0		327	77.0	436	273	19.4	436

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Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/17	4	1	0	0	1	0.2	0.2	169	NA	1	226	NA	1
	5	4	2	0	6	1.3	0.5	331	49.6	6	275	8.9	6
	6	27	23	0	50	10.8	1.4	310	62.0	50	267	13.7	50
	7	63	62	0	125	27.1	2.1	328	64.4	125	272	15.8	125
	8	73	70	0	143	31.0	2.2	352	66.4	143	278	16.0	143
	9	42	24	1	67	14.5	1.6	372	69.4	67	282	15.5	67
	10	13	26	0	39	8.5	1.3	405	83.2	39	289	17.7	39
	11	8	7	0	15	3.3	0.8	377	96.7	15	284	22.5	15
	12	3	2	0	5	1.1	0.5	511	56.0	5	315	3.8	5
	13	0	4	0	4	0.9	0.4	456	168.2	4	295	37.9	4
	14	2	1	0	3	0.7	0.4	580	99.7	3	318	24.6	3
	15	1	2	0	3	0.7	0.4	428	161.2	3	301	33.8	3
Sample Total		237	223	1	461	100.0		353	79.5	461	278	18.3	461
5/18	5	3	3	0	6	1.5	0.6	284	33.0	6	264	7.8	6
	6	22	11	0	33	8.5	1.4	292	56.2	33	262	15.9	33
	7	55	46	0	101	26.0	2.2	318	45.9	101	270	12.0	101
	8	57	59	0	116	29.9	2.3	354	55.8	116	277	13.6	116
	9	26	31	0	57	14.7	1.8	406	87.8	57	288	20.1	57
	10	19	18	0	37	9.5	1.5	456	73.5	37	298	15.3	37
	11	7	11	0	18	4.6	1.1	466	111.7	18	302	22.4	18
	12	4	6	0	10	2.6	0.8	540	74.9	10	316	10.0	10
	13	3	3	0	6	1.5	0.6	479	73.3	6	308	10.9	6
	14	1	2	0	3	0.8	0.4	494	55.2	3	321	7.2	3
	15	0	1	0	1	0.3	0.3	542	NA	1	311	NA	1
Sample Total		197	191	0	388	100.0		369	89.5	388	280	20.1	382

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		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	0	2	0	2	0.6	0.4	340	7.8	2	273	5.7	2
	5	7	0	0	7	2.0	0.7	272	34.8	7	260	13.4	7
	6	16	25	0	41	11.5	1.7	273	48.6	41	259	14.4	41
	7	53	48	0	101	28.5	2.4	303	44.3	101	268	11.6	101
	8	41	63	1	105	29.6	2.4	343	60.0	105	277	14.2	105
25 May	9	27	28	0	55	15.5	1.9	371	61.9	55	283	14.5	55
	10	14	9	0	23	6.5	1.3	418	88.1	23	292	19.8	23
	11	1	7	0	8	2.3	0.8	494	58.3	8	307	14.1	8
	12	5	3	0	8	2.3	0.8	509	85.6	8	310	11.4	8
	13	3	1	0	4	1.1	0.6	454	133.8	4	301	29.0	4
	14	0	1	0	1	0.3	0.3	639	NA	1	332	NA	1
Sample Total		167	187	1	355	100.0		341	80.3	355	276	18.4	355
Samples Combined		1,923	2,104	25	4,052			360	84.2	4,052	280	19.3	4,046

APPENDIX C:
AGE, SEX, AND SIZE COMPOSITION OF HERRING CAUGHT BY COMMERCIAL GILLNET

Appendix C1.–Age, sex, and size composition of herring caught by commercial gillnet, Nunavachak Section.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/19	5	0	1	0	1	0.5	0.5	389	NA	1	287	NA	1
	6	2	2	0	4	2.0	1.0	330	109.3	4	278	33.5	4
	7	11	19	0	30	15.2	2.6	398	54.0	30	288	11.8	30
	8	14	33	0	47	23.7	3.0	412	54.4	47	293	13.3	47
	9	12	27	0	39	19.7	2.8	436	46.3	39	301	10.0	39
	10	9	24	1	34	17.2	2.7	456	56.9	34	305	12.2	34
	11	10	11	1	22	11.1	2.2	463	58.7	22	309	13.9	22
	12	3	4	0	7	3.5	1.3	513	50.2	7	318	10.9	7
	13	6	3	0	9	4.5	1.5	532	53.5	9	316	9.1	9
	14	0	3	0	3	1.5	0.9	412	29.4	3	294	5.5	3
	15	1	0	0	1	0.5	0.5	439	NA	1	316	NA	1
	16	0	1	0	1	0.5	0.5	511	NA	1	327	NA	1
Sample Total		68	128	2	198	100.0		436	65.1	198	300	15.4	198
Samples Combined		68	128	2	198			436	65.1	198	300	15.4	198

Appendix C2.–Age, sex, and size composition of herring caught by commercial gillnet, Kulukak Section.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/11	4	1	0	0	1	0.3	0.3	380	NA	1	290	NA	1
	5	2	2	0	4	1.4	0.7	301	54.3	4	264	14.1	4
	6	10	11	0	21	7.2	1.5	360	46.2	21	282	12.7	21
	7	40	57	0	97	33.1	2.8	365	40.0	97	283	11.3	97
	8	35	66	1	102	34.8	2.8	384	42.9	102	286	10.3	102
	9	14	24	0	38	13.0	2.0	413	58.8	38	295	13.5	38
	10	7	9	0	16	5.5	1.3	437	48.5	16	300	11.4	16
	11	3	5	0	8	2.7	1.0	481	45.0	8	308	15.2	8
	12	3	2	0	5	1.7	0.8	439	104.2	5	297	26.0	5
	15	1	0	0	1	0.3	0.3	557	NA	1	320	NA	1
Sample Total		116	176	1	293	100.0		386	55.0	293	287	13.7	293
5/13	5	0	1	0	1	0.6	0.6	323	NA	1	271	NA	1
	6	3	10	0	13	8.2	2.2	379	36.0	13	284	7.8	13
	7	11	31	0	42	26.6	3.5	378	35.7	42	285	10.3	42
	8	23	41	0	64	40.5	3.9	405	47.4	64	290	11.2	64
	9	8	16	0	24	15.2	2.9	432	46.2	24	297	11.7	24
	10	4	5	0	9	5.7	1.8	470	77.3	9	306	15.3	9
	11	2	1	0	3	1.9	1.1	453	47.1	3	301	9.5	3
	12	1	0	0	1	0.6	0.6	509	NA	1	315	NA	1
	14	0	1	0	1	0.6	0.6	538	NA	1	320	NA	1
Sample Total		52	106	0	158	100.0		406	53.4	158	290	12.7	158

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Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/14	5	0	1	1	2	0.7	0.5	381	NA	1	279	NA	1
	6	4	9	4	17	6.0	1.4	371	47.3	13	280	10.3	13
	7	9	24	23	56	19.9	2.4	382	42.1	33	283	10.3	33
	8	17	61	24	102	36.2	2.9	401	49.0	78	290	11.2	78
	9	14	20	18	52	18.4	2.3	442	45.7	34	298	11.6	34
	10	9	16	10	35	12.4	2.0	446	69.3	25	301	14.2	25
	11	5	3	3	11	3.9	1.2	467	66.0	8	303	15.9	8
	12	2	2	0	4	1.4	0.7	503	73.6	4	311	17.3	4
	13	1	0	0	1	0.4	0.4	455	NA	1	316	NA	1
	14	1	0	1	2	0.7	0.5	528	NA	1	319	NA	1
Sample Total		62	136	84	282	100.0		413	59.3	198	292	13.9	198
5/16	6	2	0	0	2	1.3	0.9	402	17.0	2	282	4.9	2
	7	8	7	0	15	9.7	2.4	407	47.1	15	288	13.5	15
	8	13	19	0	32	20.6	3.3	407	39.5	32	287	11.0	32
	9	17	24	0	41	26.5	3.6	441	56.2	41	296	13.2	41
	10	15	18	0	33	21.3	3.3	444	50.7	33	296	13.4	33
	11	6	7	0	13	8.4	2.2	504	54.3	13	314	10.2	13
	12	7	2	0	9	5.8	1.9	506	37.5	9	310	9.4	9
	13	2	4	0	6	3.9	1.6	505	67.2	6	315	16.1	6
	14	0	1	0	1	0.6	0.6	580	NA	1	317	NA	1
	15	1	2	0	3	1.9	1.1	543	50.7	3	312	4.9	3
Sample Total		71	84	0	155	100.0		445	61.5	155	297	15.3	155

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		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
	5	1	0	0	1	0.5	0.5	270	NA	1	264	NA	1
	6	7	4	0	11	5.3	1.5	362	31.2	11	285	7.4	11
	7	11	23	1	35	16.7	2.6	375	49.2	35	287	13.1	35
	8	28	31	0	59	28.2	3.1	401	63.5	59	291	13.3	59
	9	19	28	0	47	22.5	2.9	388	50.1	47	290	12.1	47
5/17	10	16	8	0	24	11.5	2.2	448	53.6	24	303	11.0	24
	11	7	10	0	17	8.1	1.9	477	59.0	17	309	11.9	17
	12	2	5	0	7	3.3	1.2	446	117.6	7	295	27.3	7
	13	3	3	0	6	2.9	1.2	487	73.7	6	308	16.8	6
	14	0	1	0	1	0.5	0.5	532	NA	1	313	NA	1
	16	0	1	0	1	0.5	0.5	567	NA	1	328	NA	1
Sample Total		94	114	1	209	100.0		408	54.2	209	293	16.3	209
Samples Combined		395	616	86	1,097			408	62.5	1,013	291	14.5	1,013

Appendix C3.–Age, sex, and size composition of herring caught by commercial gillnet, all sections.

		Sex (number)						Weight			Length		
Sample Dates	Age	Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/11	4	1	0	0	1	0.3	0.3	380	NA	1	290	NA	1
	5	2	2	0	4	1.4	0.7	301	54.3	4	264	14.1	4
	6	10	11	0	21	7.2	1.5	360	46.2	21	282	12.7	21
	7	40	57	0	97	33.1	2.8	365	40.0	97	283	11.3	97
	8	35	66	1	102	34.8	2.8	384	42.9	102	286	10.3	102
	9	14	24	0	38	13.0	2.0	413	58.8	38	295	13.5	38
	10	7	9	0	16	5.5	1.3	437	48.5	16	300	11.4	16
	11	3	5	0	8	2.7	1.0	481	45.0	8	308	15.2	8
	12	3	2	0	5	1.7	0.8	439	104.2	5	297	26.0	5
	15	1	0	0	1	0.3	0.3	557	NA	1	320	NA	1
Sample Total		116	176	1	293	100.0		386		293	287		293
5/13	5	0	1	0	1	0.6	0.6	323	NA	1	271	NA	1
	6	3	10	0	13	8.2	2.2	379	36.0	13	284	7.8	13
	7	11	31	0	42	26.6	3.5	378	35.7	42	285	10.3	42
	8	23	41	0	64	40.5	3.9	405	47.4	64	290	11.2	64
	9	8	16	0	24	15.2	2.9	432	46.2	24	297	11.7	24
	10	4	5	0	9	5.7	1.8	470	77.3	9	306	15.3	9
	11	2	1	0	3	1.9	1.1	453	47.1	3	301	9.5	3
	12	1	0	0	1	0.6	0.6	509	NA	1	315	NA	1
	14	0	1	0	1	0.6	0.6	538	NA	1	320	NA	1
Sample Total		52	106	0	158	100.0		406	55.7	158	290	13.6	158

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Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/14	5	0	1	1	2	0.7	0.5	381	NA	1	279	NA	1
	6	4	9	4	17	6.0	1.4	371	47.3	13	280	10.3	13
	7	9	24	23	56	19.9	2.4	382	42.1	33	283	10.3	33
	8	17	61	24	102	36.2	2.9	401	49.0	78	290	11.2	78
	9	14	20	18	52	18.4	2.3	442	45.7	34	298	11.6	34
	10	9	16	10	35	12.4	2.0	446	69.3	25	301	14.2	25
	11	5	3	3	11	3.9	1.2	467	66.0	8	303	15.9	8
	12	2	2	0	4	1.4	0.7	503	73.6	4	311	17.3	4
	13	1	0	0	1	0.4	0.4	455	NA	1	316	NA	1
	14	1	0	1	2	0.7	0.5	528	NA	1	319	NA	1
Sample Total		62	136	84	282	100.0		413		198	292		198
5/16	6	2	0	0	2	1.3	0.9	402	17.0	2	282	4.9	2
	7	8	7	0	15	9.7	2.4	407	47.1	15	288	13.5	15
	8	13	19	0	32	20.6	3.3	407	39.5	32	287	11.0	32
	9	17	24	0	41	26.5	3.6	441	56.2	41	296	13.2	41
	10	15	18	0	33	21.3	3.3	444	50.7	33	296	13.4	33
	11	6	7	0	13	8.4	2.2	504	54.3	13	314	10.2	13
	12	7	2	0	9	5.8	1.9	506	37.5	9	310	9.4	9
	13	2	4	0	6	3.9	1.6	505	67.2	6	315	16.1	6
	14	0	1	0	1	0.6	0.6	580	NA	1	317	NA	1
	15	1	2	0	3	1.9	1.1	543	50.7	3	312	4.9	3
Sample Total		71	84	0	155	100.0		445		155	297		155

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Appendix C3.–Page 3 of 3.

Sample Dates	Age	Sex (number)						Weight			Length		
		Male	Female	Unk.	Total	% of Total	SE	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured
5/17	5	1	0	0	1	0.5	0.5	270	NA	1	264	NA	1
	6	7	4	0	11	5.3	1.5	362	31.2	11	285	7.4	11
	7	11	23	1	35	16.7	2.6	375	49.2	35	287	13.1	35
	8	28	31	0	59	28.2	3.1	401	63.5	59	291	13.3	59
	9	19	28	0	47	22.5	2.9	388	50.1	47	290	12.1	47
	10	16	8	0	24	11.5	2.2	448	53.6	24	303	11.0	24
	11	7	10	0	17	8.1	1.9	477	59.0	17	309	11.9	17
	12	2	5	0	7	3.3	1.2	446	117.6	7	295	27.3	7
	13	3	3	0	6	2.9	1.2	487	73.7	6	308	16.8	6
	14	0	1	0	1	0.5	0.5	532	NA	1	313	NA	1
	16	0	1	0	1	0.5	0.5	567	NA	1	328	NA	1
Sample Total		94	114	1	209	100.0		408	54.2	209	293	16.3	209
5/19	5	0	1	0	1	0.5	0.5	389	NA	1	287	NA	1
	6	2	2	0	4	2.0	1.0	330	109.3	4	278	33.5	4
	7	11	19	0	30	15.2	2.6	398	54.0	30	288	11.8	30
	8	14	33	0	47	23.7	3.0	412	54.4	47	293	13.3	47
	9	12	27	0	39	19.7	2.8	436	46.3	39	301	10.0	39
	10	9	24	1	34	17.2	2.7	456	56.9	34	305	12.2	34
	11	10	11	1	22	11.1	2.2	463	58.7	22	309	13.9	22
	12	3	4	0	7	3.5	1.3	513	50.2	7	318	10.9	7
	13	6	3	0	9	4.5	1.5	532	53.5	9	316	9.1	9
	14	0	3	0	3	1.5	0.9	412	29.4	3	294	5.5	3
	15	1	0	0	1	0.5	0.5	439	NA	1	316	NA	1
	16	0	1	0	1	0.5	0.5	511	NA	1	327	NA	1
Sample Total		68	128	2	198	100.0		436	65.1	198	300	15.4	198
Samples Combined		463	744	88	1,295			413	64	1,211	293	15.0	1211

APPENDIX D:
TOGIAK HERRING BIOMASS FORECAST

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

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Date Issued: October 15, 2013
Time: 1:00 p.m.

2013 TOGIAK HERRING FORECAST

The 2013 Togiak herring forecast and harvest allocation are listed below for the Togiak District sac roe and spawn-on-kelp fishery, and the Dutch Harbor food and bait fishery, given a maximum 20% exploitation rate of the projected run biomass (Bristol Bay Herring Management Plan 5 AAC 27.865):

Harvest Allocation of the 2013 Forecasted Pacific Herring Run Biomass, Togiak District, Bristol Bay

	Biomass (Short Tons)	Harvest (Short Tons)
Forecasted Biomass	169,094	
Total Allowable Harvest (20% exploitation rate)		33,819
Togiak Spawn-on-Kelp Fishery (Fixed Allocation)		1,500
Remaining Allowable Harvest		32,319
Dutch Harbor Food/Bait Allocation (7.0% of the remaining allocation)		2,262
Remaining Allowable Harvest for Togiak District Sac Roe Fishery:		30,056
Purse Seine Allocation 70.0%		21,040
Gill Net Allocation 30.0%		9,017

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2013 TOGIAK HERRING FORECAST SUMMARY

The Pacific herring spawning biomass in the Togiak District was estimated at 167,738 tons in 2012 and is forecast to be 169,094 tons in 2013 (Figure 1). Age 7–8 herring returning from the 2006 and 2007 year classes are expected to comprise 46.9% of the biomass in 2013 (Figure 2). The remainder of the run is expected to be comprised of herring ages 4–6 (26.4%), ages 9–11 (22.6%) and ages 12+ (4.1%) by weight. The forecasted individual average weight of herring in the harvest biomass is 317 g.

A run biomass of 169,094 tons would be ~113% of the recent 10-year average. A biomass of this size has the potential to produce an overall harvest of 33,819 tons in all fisheries and 30,056 tons in the Togiak sac roe fisheries (purse seine and gillnet). A harvest of this size in the Togiak sac roe fisheries would be ~146% of the recent 10-year average harvest.

An age-structured analysis (ASA) model is used to forecast the Togiak herring population. This model utilizes catch and age composition data as well as total run biomass estimates. Currently, the ASA model integrates data from purse seine fishery age compositions (1978–2012), total run age compositions (1978–1995, 1997, 1999, 2001, 2005–2010, and 2012), and aerial survey biomass estimates (1981, 1983, 1992–1994, 1997, 1999-2001, 2005–2010, and 2012). Samples from non-selective gear (commercial purse seine) are used to assess age composition of the total run biomass when a total run biomass is estimated. Commercial purse seine catch samples from 2012 ranged from age-3 to age-16. The average weight of age-4 herring for 2013 is estimated as the most recent four-year average while simple linear regression models of historical trends are used to forecast average weights of remaining age classes.

A temporal change in age composition from older to younger herring typically occurs during this fishery. However, the 2012 inshore spawning biomass age composition was fairly stable and consisted largely of age-7 herring. This age class accounted for 36% of the total commercial purse seine harvest and 32% of the total harvest by weight.

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. Estimating the peak inshore biomass is a necessary precondition for estimating total run biomass. Surveys were flown between 27 April and 26 May 2012 with most of the biomass observed in the center of Togiak Bay with smaller concentrations to the east and smaller still to the west (Figure 3).

Herring become visible to our sampling effort when they recruit into the fishery; a process that we believe begins around age-4. Large recruitments in this population generally occur every eight to ten years. The last recruitment event experienced by Togiak herring was observed as relatively large numbers of age-4 herring in 2008 and 2009. It should be noted that measuring contributions of age classes less than three to the spawning biomass is difficult because these fish are not fully recruited (vulnerability to the gear) and they often arrive on the spawning grounds after older fish when sampling has ceased, unlike the post-fishery sampling that occurred in the 1980s.

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There is always uncertainty in forecasting the Togiak District herring biomass. The forecasted mean percent error (MPE) has been relatively stable at ~20% for years with reliable total run biomass estimates (Figure 1). The historical forecast accuracy or mean absolute percent error (MAPE) using the ASA model is 19.6%. Using this historical forecast error, the forecast range for 2013 is between 135,994 tons and 202,194 tons. We consider this population to be healthy and sustainable.

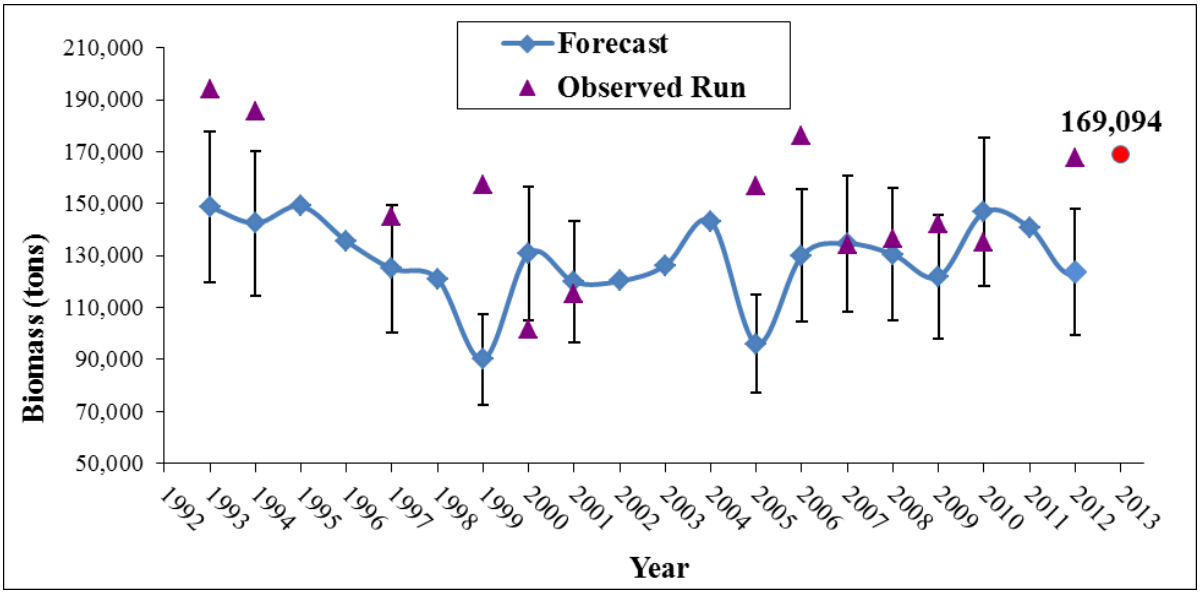

Figure 1.–Annual observed Togiak herring total run biomass estimates and preseason forecasts based on the ASA model. Mean absolute percent error (MAPE) of 20% around the forecast is also shown for years with a reliable total run biomass estimate.

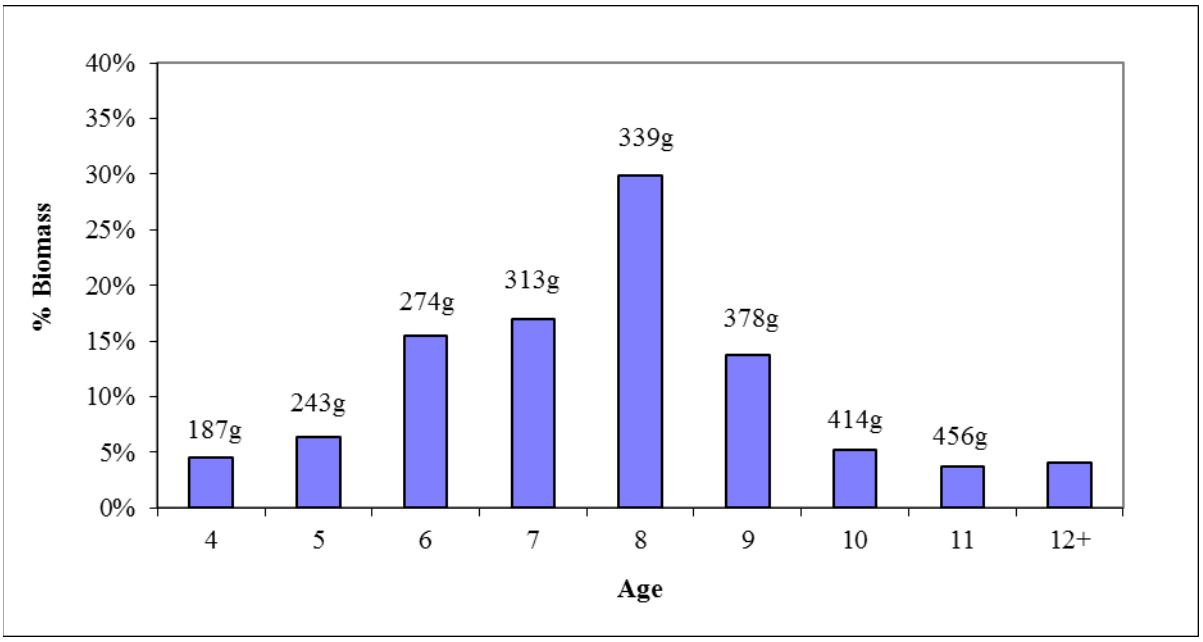

Figure 2.–Forecasted age composition by weight (grams) for the 2013 Togiak herring return. Forecast average weight shown for each age.

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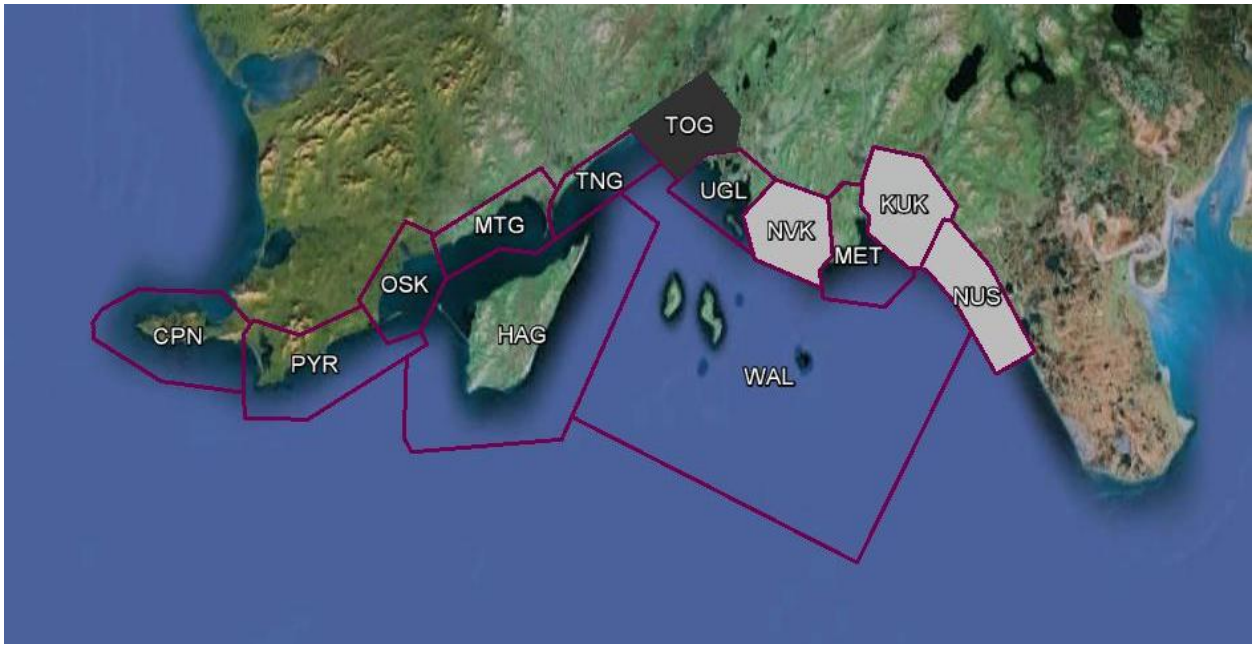

Figure 3.–Herring distribution observed during aerial surveys conducted during 2012. Survey section shaded in black recorded roughly 50% of the cumulative biomass measured across all surveys while sections with 6+% of the cumulative recorded biomass are shaded grey. Herring were observed in all survey sections during 2012 except Cape Newenham.

Note: 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; CPN - Cape Newenham; WAL - Walrus Islands.