

Fishery Data Series No. 08-58

**Analysis of Red King Crab Data from the 2008 Alaska
Department of Fish and Game Trawl Survey of
Norton Sound**

by

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December 2008

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative Code	AAC	fork length	FL
deciliter	dL			mid-eye to fork	MEF
gram	g	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	mid-eye to tail fork	METF
hectare	ha			standard length	SL
kilogram	kg			total length	TL
kilometer	km	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.		
liter	L			Mathematics, statistics	
meter	m			<i>all standard mathematical signs, symbols and abbreviations</i>	
milliliter	mL	at	@		
millimeter	mm	compass directions:			
		east	E	alternate hypothesis	H _A
Weights and measures (English)		north	N	base of natural logarithm	<i>e</i>
cubic feet per second	ft ³ /s	south	S	catch per unit effort	CPUE
foot	ft	west	W	coefficient of variation	CV
gallon	gal	copyright	©	common test statistics	(F, t, χ^2 , etc.)
inch	in	corporate suffixes:		confidence interval	CI
mile	mi	Company	Co.	correlation coefficient	
nautical mile	nmi	Corporation	Corp.	(multiple)	R
ounce	oz	Incorporated	Inc.	correlation coefficient	
pound	lb	Limited	Ltd.	(simple)	r
quart	qt	District of Columbia	D.C.	covariance	cov
yard	yd	et alii (and others)	et al.	degree (angular)	°
		et cetera (and so forth)	etc.	degrees of freedom	df
Time and temperature		exempli gratia		expected value	<i>E</i>
day	d	(for example)	e.g.	greater than	>
degrees Celsius	°C	Federal Information Code	FIC	greater than or equal to	≥
degrees Fahrenheit	°F	id est (that is)	i.e.	harvest per unit effort	HPUE
degrees kelvin	K	latitude or longitude	lat. or long.	less than	<
hour	h	monetary symbols		less than or equal to	≤
minute	min	(U.S.)	\$, ¢	logarithm (natural)	ln
second	s	months (tables and figures): first three letters	Jan,...,Dec	logarithm (base 10)	log
				logarithm (specify base)	log ₂ , etc.
Physics and chemistry				minute (angular)	'
all atomic symbols		registered trademark	®	not significant	NS
alternating current	AC	trademark	™	null hypothesis	H ₀
ampere	A	United States (adjective)	U.S.	percent	%
calorie	cal	United States of America (noun)	USA	probability	P
direct current	DC	U.S.C.	United States Code	probability of a type I error (rejection of the null hypothesis when true)	α
hertz	Hz			probability of a type II error (acceptance of the null hypothesis when false)	β
horsepower	hp	U.S. state	use two-letter abbreviations (e.g., AK, WA)	second (angular)	"
hydrogen ion activity (negative log of)	pH			standard deviation	SD
parts per million	ppm			standard error	SE
parts per thousand	ppt, ‰			variance	
volts	V			population	Var
watts	W			sample	var

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DEPARTMENT OF FISH AND GAME TRAWL SURVEY OF NORTON
SOUND**

by

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ABSTRACT

A trawl survey was conducted in Norton Sound in northwest Alaska to collect and analyze information on the distribution and abundance of demersal fishes and invertebrates from July 24 through August 11, 2008, with primary focus on red king crab *Paralithodes camtschaticus* data. Population estimates were generated using an area-swept method as calculated in previous trawl surveys of Norton Sound. Legal male abundance was estimated at approximately 812,000 crabs, equivalent to a biomass estimate of 2.44 million pounds. The 2008 trawl survey biomass estimate is 112% of the 2006 estimate and is 78% of the long-term trawl survey average. Prerecruit-1 male abundance was estimated at approximately 697,000 crabs, 122% of the 2006 estimate and 114% of the long-term trawl survey average. Prerecruit-2 male abundance was estimated at approximately 796,000 crabs, similar to 2006, and was almost 200% of the long-term trawl survey average.

Key words: red king crab, *Paralithodes camtschaticus*, Norton Sound, trawl survey, abundance, biomass estimate, population estimate, catch sampling, distribution, shell age, species composition.

INTRODUCTION

Norton Sound is located in the Norton Sound Section in the Northern District of the Alaska Department of Fish and Game (ADF&G) Registration Area Q, and includes all waters east of the International Dateline between the latitudes of Cape Romanzof and 66°N (Figure 1). Commercial fisheries for red king crab *Paralithodes camtschaticus* in Norton Sound occur in 2 seasons: (1) from June 15 through September 3 (summer), and (2) through the ice only, from November 15 to May 15 (winter). Although the commercial fishery commenced in 1977, subsistence users who primarily fish through the ice have long harvested red king crabs.

Summer commercial fishery harvests have averaged 500,000 pounds annually, ranging from a high of 3,000,000 pounds in 1979 to a low of 20,000 pounds in 1999. The winter commercial fishery is nominal, averaging about 6,000 pounds annually since 1978.

Population abundance estimates from the trawl survey are evaluated by ADF&G biometricians and incorporated into a model developed by Zheng et al. (1998). This model provides estimates of the legal and sublegal male population sizes. A legal male red king crab is defined as having a carapace width ≥ 121 mm (4.75 inches) or an approximate carapace length (CL) of 105 mm. The model provides population size estimates for 2 male sublegal crab categories: prerecruit-2 crabs, 76 mm to 89 mm CL, requiring 2 or more molts to reach legal size, and prerecruit-1 crabs, 90 mm to 104 mm CL, requiring one molt to reach legal size. Trawl survey and model population estimates are limited to abundances, because reliable paired weight-length information is not available to estimate biomass. The only available paired weight-length data were collected during trawl surveys conducted on board moving ships, which are susceptible to large errors in weight estimation. Therefore, abundance estimates are multiplied by 3.0 pounds, the average weight of legal male crabs from the summer commercial fishery, to calculate estimated biomasses. Since 1976, red king crab trawl survey biomass estimates for legal males have ranged from 1.6 million pounds in 1996 to 4.8 million pounds in 1999, and have averaged 3.0 million pounds.

Triennial Norton Sound trawl surveys were implemented in 1976. Prior to this time, several investigations provided preliminary information on the distribution and abundance of demersal biota (Andriyashev 1937; Ellison et al. 1950) including an Atomic Energy Commission assessment survey of demersal fishes and invertebrates of the southeast Chukchi Sea/Norton Sound region (Wilimovsky 1966). From 1976 through 1991, the National Marine Fisheries

Service (NMFS) conducted comprehensive triennial stock assessment trawl surveys of Norton Sound to gather information on the distribution and abundance of demersal fishes and invertebrates (Wolotira et al. 1977; Sample and Wolotira 1985; NMFS 1982; Stevens and MacIntosh 1986; Stevens 1989; Stevens 1992). Additionally, red king crab summer pot surveys were conducted by ADF&G in Norton Sound in 1980, 1981, 1982, and 1985 to provide annual distribution and abundance as well as preseason information to fishery managers regarding stock size and recruit composition (Powell et al. 1983; ADF&G 1982a, b; Schwarz 1984; and Brannian 1987).

Due to budget constraints, the Norton Sound area was not surveyed during the NMFS 1994 triennial trawl survey. The 1996 ADF&G trawl assessment was the first survey since the 1991 NMFS survey, and the first ever ADF&G trawl survey of Norton Sound (Blau et al. 1996; Fair 1997). Since then, ADF&G has conducted trawl assessment surveys in 1999, 2002, and 2006 (Fair and Brennan 2001; Brennan 2003; Soong and Banducci 2006). A survey was not conducted in 2005 because of difficulties in chartering a vessel. Survey efforts from 1976–2008 are summarized in Table 1. The purpose of the triennial ADF&G trawl surveys are to provide abundance estimates of the Norton Sound red king crab population, crab recruit class composition, and related biological characteristics, as well as to document benthic species composition in Norton Sound. The 2008 survey adds to this historical survey record and employs the same stock assessment methods. Ultimately, information assessed by this project is utilized to determine the size of the legal component of the red king crab population which will then be used to set harvest guidelines for the commercial fisheries in the region. This report includes information on the abundance, recruit class composition, biomass, and distribution of the Norton Sound red king crab population from the 2008 survey data.

OBJECTIVES

Prioritized objectives for the 2008 Norton Sound red king crab trawl survey are as follows:

1. Estimate the Norton Sound red king crab population using an area-swept method, and describe the size composition by sex and recruit class.
2. Describe the spatial distribution of the Norton Sound red king crab population and associated marine life. Compare the estimated abundance, size composition, and distribution of current Norton Sound red king crab population with the historical trawl survey record.
3. Collect lengths, weights, and additional biological data from other commercial or potentially commercial species captured: specifically, blue king crabs *Paralithodes platypus*, Pacific halibut *Hippoglossus stenolepis*, Pacific cod *Gadus macrocephalus*, and walleye pollock *Theragra chalcogramma*.

METHODS

TRAWL SURVEY

The 2008 ADF&G Norton Sound assessment survey was conducted aboard the chartered *R/V Pandalus* from July 24 through August 11. The nonrandom, systematic station location design

used by NMFS in their 6 trawl surveys of Norton Sound and by ADF&G in 1996, 1999, 2002, and 2006, was also used in 2008. This approach provided a comparable survey pattern for the documentation of marine life in this area. The existing 10 by 10 nmi grid pattern previously established for Norton Sound, with each grid identified by a station number, was utilized (Figure 2). The centers of each survey station, denoted by latitude and longitude coordinates, indicate where each trawl began within a station (Table 2). The direction of trawl was determined by the skipper based on wind and sea swell conditions.

As in past ADF&G trawl surveys, a 400 eastern otter trawl net, spread by two 1.5 by 2.1 m Astoria “V” doors, was towed such that the sweep length of the footrope was 40 feet, for approximately one-half hour, at approximately 2 knots/hour covering a distance of 1 nmi. A global positioning system (GPS) calculated location and distance towed, and a computerized submersible probe recorded bottom temperatures at one-minute intervals. Each evening this data was downloaded to a laptop computer after the completion of all stations.

Because of the large area of Norton Sound and time and budget constraints, it was not possible to survey the entire area. Different priorities were therefore assigned to certain areas. The highest priority was to trawl the 37 core stations, not including stations 177, 178, 201, and 205 because past trawls at these rocky-bottomed stations have resulted in torn nets and subsequent small or no trawl catches (Blau et al. 1996; Soong and Banducci 2006). The next priority was to trawl stations in tier 1, not including stations 162, 188, 206, 207, 222, and 223 because again, these stations have rocky bottoms and were deemed to be untrawlable during past surveys (Blau et al. 1996). Core and tier 1 stations make up standard stations (Figure 2). All Norton Sound trawl survey abundance estimates were standardized in 1998 to provide a reliable database for survey comparisons (Fair 1998). Only crab catch numbers from standard stations were used in abundance estimates, because these were the stations most consistently trawled in past surveys. Therefore, core and tier 1 stations were given the highest priority. The 14 stations in tier 2 and 7 stations in tier 3 were trawled as time permitted.

If a tow resulted in 5 or more legal red king crabs, then that station was resurveyed once more, either immediately or as logistics allowed. Resurveys were towed at the same depth, in close proximity to the initial tow track without crossing it, and at similar distances and times at each respective station.

KING CRAB POPULATION ESTIMATION

Population estimates for red king crabs were generated using the area-swept method, for direct comparison to previous analyses (Alverson and Pereyra 1969). Variances were estimated assuming that catch is binomially distributed (Seber 1982, page 22). Using the area-swept method, the total catch in numbers, n , and the total area trawled, a , were computed for each station trawled. Abundance for the j th station was estimated as:

$$\hat{N}_j = n_j * \frac{A_j}{a_j}, \quad (1)$$

where A is the total area of the station (Alverson and Pereyra 1969). Total area trawled a is computed by multiplying the width of the net mouth opening by the distance trawled. The total abundance is estimated as:

$$\hat{N} = \sum_j \hat{N}_j . \quad (2)$$

The variance of \hat{N} is estimated as:

$$\hat{V}(\hat{N}) = \sum_j \hat{N}_j \left(1 - \frac{a_j}{A_j} \right) \frac{A_j}{a_j} \quad (3)$$

(Seber 1982, page 22).

The variation of legal male abundance for comparison between years and between original and resurveys was estimated by incorporating the use of a coefficient of variation (CV), calculated as the standard error divided by the estimate. The CV is determined by using the legal male abundance estimate and its associated standard error.

KING CRAB DISTRIBUTION, SHELL AGE, AND SIZE STRUCTURE

All red and blue king crabs from each trawl were sampled for sex, size, legality, shell age and egg development, if applicable. Total number and weight of each crab species captured was also recorded. Carapace lengths (CL) were measured to the nearest millimeter from the posterior margin of the right eye socket to the midpoint of the rear margin of the carapace (Wallace et al. 1949).

Shell-age classes were defined by shell condition according to the following definitions:

Soft-shell: The crab has molted within recent weeks. Exoskeleton is still soft and pliable from recent molt.

New-shell-pliable: The coxa and ventral surface of the exoskeleton are white. The legs are easily compressed when pinched (legs contain little muscle at this time). The exoskeleton is fragile and subject to breakage or puncture. With carapace removed, the gills appear translucent-cream in color. Crabs with this type of shell have had their present exoskeletons for approximately 1–3 months.

New-shell-hard: The coxa and ventral surface of exoskeleton are white. Exoskeletal spines and dactyls are sharp but may show slight wear. The legs are mostly full of muscle, merus not easily compressed by pinching. If carapace is removed, the gills will be a light cream color. Crabs with this type of shell have had their present exoskeletons for 4–12 months. Note: Some crabs show characteristics of both new-shell-hard and old-shell, i.e., coxa rimmed with brown scratches but exoskeletal spines and dactyls are sharp. Because red king crabs found in Norton Sound typically molt in September and October and therefore should start to show wear at the time of the trawl survey, these crabs were classified as new-shell-hard.

Old-shell: The distal portion of the ventral coxa is partially or totally rimmed with brown scratches or dots. Exoskeletal spines and dactyls are worn and typically dull at the tips. The legs are full of muscle and the merus is difficult to compress when pinched. If carapace is removed, gills are tan in color from fouling microorganisms. Crabs with this type of shell have had their present exoskeletons for 13–24 months.

Very-old-shell: The distal portion of the ventral coxa is continuously rimmed with black scratches or dots. The legs are full of muscle and the merus is difficult to compress when pinched. The tips of the dactyls are worn round and black. If the carapace is removed, gills appear dark gray or dark gray-brown in color from fouling microorganisms. Crabs with this type of shell have had their present exoskeletons more than 24 months.

It should be noted here that there was a difference in determining female crab maturity compared to years prior to 2006. In previous reports, adult females were defined as ≥ 72 mm CL or had matted pleopodal setae or egg clutches, while juveniles were defined as < 72 mm CL with clean pleopodal setae. In 2006 and 2008, the extent of development of the abdominal flap instead of CL was used to determine female maturity. Since 72 mm was based on the statistical probability that 50% of female crabs will be mature at this size, abdominal flap development was deemed a more accurate measure of female maturity.

CATCH SAMPLING

As the net was retrieved, all species, including fishes and crabs, were shaken from the intermediate portion of the net down to the codend. Once the codend was on board, a boom was used to lift and weigh the codend using a crane scale. The contents of the trawl were then emptied on deck, and the tare weight of the net section originally weighed was reweighed and recorded to calculate the net haul weight.

The trawl catch was then sorted for large debris and large fish. Besides king crab, all Pacific halibut *Hippoglossus stenolepis*, large walleye pollock *Theragra chalcogramma* and large Pacific cod *Gadus macrocephalus* were retrieved from each haul before subsampling so that accurate numbers of these commercially valuable species were recorded and their mortality reduced. Number, total weight, and individual lengths (snout tip to end of tail, in mm) were recorded before returning these species to the sea. The combined weight of these species and large debris were subtracted from the net haul weight to get the adjusted haul weight.

While 2 crewmembers recorded measurements from king crab and large fish, other crewmembers filled 2 or 3 baskets from the remaining haul and shoveled the rest overboard. The combined weight of the sampling baskets was recorded, then the contents were separated to the lowest taxon, and any additional debris (sticks, rocks, etc.) removed. Each taxon was counted, weighed, assigned a NMFS species code, and recorded.

The adjusted haul weight was divided by the combined subsampling weight to provide the raising factor for that haul. The weight of each taxon was then multiplied by the raising factor to estimate the total weight of the species from each haul. All data was checked for accuracy and entered each day into Excel spreadsheets on a laptop computer. Completed stations were emailed daily to the ADF&G office in Nome. Digital cameras were used to photograph and video survey activities and copies of these are located in the Nome office. Also located in the Nome office, for educational purposes, are various preserved specimens collected during the trawl survey.

RESULTS

TRAWL SURVEY

In daylight hours between July 24 and August 11, there were 68 successful tows from 69 attempts (Table 1). One station (185) was retowed because in the original tow, the net was hanging improperly as it was pulled in and catch was small, indicating that the net might have towed incorrectly. Another station (184) was retowed because 5 or more legal crabs were caught. Another station (183) also had 5 or more legal crabs, but was not retowed due to time constraints. Crab catch from the one bad tow at station 185 was not included in any calculations. The net was torn at several stations by either thick mud or large rocks, but the distance trawled was still at least 0.7 nmi and the haul size was not noticeably smaller. Twelve stations were not trawled in 2008. Station 201, adjacent to station 177, had the same substrate, and trawling at the latter had resulted in a torn net in the 2006 survey; therefore, station 201 was not trawled. Similarly, substrate for stations 97 and 174 were likely to cause extensive damage to the net, so they were not trawled. Stations 177, 178 and 205 were not trawled because they have never been successfully trawled. Stations 162, 188, 206, 207, 222 and 223 have never been trawled by ADF&G because they have a rocky substrate and are unsuitable for trawl gear. The sole resampled station (due to number of legal crabs) was successfully resurveyed immediately after the original survey.

The average distance towed was 1.0 nmi and the average trawl depth was 9.7 fathoms, ranging from 5.0 fathoms at stations 120 and 147 to 17 fathoms at station 135 (Table 2).

Bottom temperatures for all tows ranged between 0.7°C and 9.4°C. The coldest temperatures occurred at stations 120 and 147, which are the closest stations to shore near Unalakleet, while the warmest temperatures occurred in the central portion (stations 101, 130, and 182) of the trawled area of Norton Sound (Table 2; Figure 3).

KING CRAB POPULATION ESTIMATION

Some trawls were conducted in stations in tiers 2 and 3, which were outside of the standardized zone defined in Fair (1998). Crabs caught in these 19 nonstandard stations were excluded from population estimates. Both male and female crabs were captured in tiers 2 and 3 stations. The legal population estimate from the 7 nonstandard stations, in which 14 crabs were caught, was 212,766 crabs. The prerecruit-1 male catch from the nonstandard stations was 3 crabs, yielding a population estimate of 45,593 crabs. Lastly, 5 prerecruit-2 male crabs were captured at nonstandard stations for a population estimate of 75,988 crabs.

Prerecruit-1 male catch was greater in 2008 than in 2006; however, legal and prerecruit-2 male catches were lower (Table 3). From the standardized area, 68 legal, 65 prerecruit-1, and 69 prerecruit-2 males were caught. The estimated abundance of legal male red king crabs was 811,727 crabs with a corresponding biomass of approximately 2.44 million pounds, up 12% from the 2006 legal male abundance estimate of 726,251 crabs (Table 3). The estimated abundance for prerecruit-1 males was 697,442 crabs, and for prerecruit-2 males, 795,777 crabs. The 2008 prerecruit-1 male abundance estimate is up 22% from the 2006 abundance of 569,833 crabs. The prerecruit-2 male abundance estimate is slightly greater than the 2006 prerecruit-2 abundance, by 3%. A female abundance estimate was not generated, but the female catch of 92 crabs was 133% of the 2006 survey. For legal male abundance estimates, the CV was 12.7% in 2008, the same as in 2006.

Similarly to 2006, the 2008 trawl survey provided resurvey catch information that could be used for replicate abundance estimation with a corresponding variance between surveys for each retowed station (Appendix A1). Each of the 2 resurveyed stations captured legal males in both tows.

KING CRAB DISTRIBUTION, SHELL AGE, AND SIZE STRUCTURE

The 2008 distribution of male and female red king crabs changed only slightly from the 2006 survey. Females were most abundant south of Nome and in the central portion of Norton Sound (stations 185, 128, and 101) in 2006, while in 2008, they were most abundant southeast of Nome and in the central portion of Norton Sound (stations 183, 158, and 129). In 2006 more male crabs were found in stations south-southwest of Nome (stations 185 and 186), while in 2008, they were most abundant in the area south-southeast of Nome (stations 183-185) (Figures 4, 5, 6, and 7).

The size composition of male crabs (n=316) caught during the 2008 Norton Sound trawl survey consisted of 72.8% prerecruits, 13.6% recruits, and 13.6% postrecruits, ranging in size from 23 mm to 140 mm CL (Figure 8). Slightly over half of the legal crabs captured (n=86) were new-shelled (Figure 9), compared to almost 90% of sublegal crabs (n=230) were new-shelled (Figure 10). The size composition of legal males from the 2008 trawl survey differed slightly from the winter pot study (n=1,045) and summer commercial fishery (n=5,766) (Figure 11), while it is shifted just slightly to the right of the 2006 trawl survey (Figure 12).

Adult (n=57) and juvenile female crabs (n=56) made up the catch evenly (Table 4). Of the adults, 24 (or 42%) had relatively full ($\geq 60\%$) egg clutches. The majority of the clutches were purple colored, indicating recent extrusion, and all clutches were uneyed.

CATCH COMPOSITION

There were 113 taxa identified for a combined weight of 18,164 kg. The 5 top-ranking taxa composed 66% of the total weight of all marine life, and consisted of the purple-orange sea star (*Asterias amurensis*), saffron cod (*Eleginus gracilis*), black-spined sea star (*Lethasterias nanimensis*), giant sea star (*Evasterias echinosoma*), and unidentified sculpins (*Myoxocephalus*) (Table 5). Of the 30 top-ranking taxa by weight, invertebrate species accounted for 77% of the catch.

One mature female blue king crab (113 mm CL) was captured during the 2008 survey at station 187. It was old-shelled and had barren, matted pleopods. Of the large fish captured, there were 27 Pacific halibut with an average weight of 4.9 kg and average length of 692 mm, 30 Pacific cod with an average weight of 4.7 kg and average length of 696 mm, and 11 walleye pollock with an average weight of 2.8 kg and average length of 736 mm (Table 6).

DISCUSSION

TRAWL SURVEY

Due to continuous rough weather and logistical constraints, the number of trawl stations completed in 2008 was fewer compared to 2006. However, of the 12 stations not sampled, 9 have never been trawled successfully. As in 2006, the only station in the core and tier 1 areas not sampled was 201 because in 2002, a trawl of that station resulted in a ripped net. In 2008, station 201 was still deemed

untrawlable by the skipper of the *R/V Pandalus*. All 5 ADF&G Norton Sound trawl surveys (1996, 1999, 2002, 2006, and 2008) were similar; however, they differed from previous NMFS surveys in design and trawl gear. The total area surveyed in Norton Sound in 1976, 1979, and 1982 was slightly larger than the area surveyed from 1985 to the present. The trawl net used on all 6 NMFS surveys in Norton Sound from 1976 to 1991 was an 83-112 trawl net, whereas ADF&G used a 400 eastern trawl net. The 83-112 net has a similar footrope configuration to the 400 eastern and tows similarly over rough bottom; therefore, it is unlikely that large catch selectivity differences exist between the 2 nets (Robert Otto, NMFS, personal communication to Lowell Fair, 1996).

KING CRAB POPULATION ESTIMATION

The 2008 trawl survey results show an increase in legal population size relative to 2006 with increased prerecruit populations as well (Table 3). Prerecruit-1 and female crab catches were greater than for the 2006 survey even though there was only one retow (due to legal crabs) in 2008 compared to 3 retows in 2006. Prerecruit-1 and legal population estimates for 2008 were 122% and 112%, respectively, of the 2006 estimates, and are the highest since the 1999 survey, which showed record abundance estimates for these 2 categories. For prerecruit-2 male abundance, the 2008 estimate was slightly higher than the 2006 estimate, and is the highest on record. Prerecruit-1 and prerecruit-2 crabs will molt over the next 2 years and contribute to the legal portion of the population in 2009 and 2010; therefore, there should be an increase in legal abundance in the near future. These findings correlate with results from the 2008 Norton Sound winter pot study (Joyce Soong, Commercial Fisheries Biologist, ADF&G, Nome; unpublished data¹) pointing to an above average prerecruit-1 and prerecruit-2 populations, indicating that the legal crab population is expected to increase over the next 2 years.

KING CRAB DISTRIBUTION, SHELL AGE, AND SIZE STRUCTURE

In 2008, the male crab population appears to have shifted northeast of the area where they were most abundant in 2006. For females, the shift was to the southeast. For both sexes, the shifts were slight, and differences in distribution were to be expected. In general, male crabs have been found in most abundance immediately south of Nome whereas females have been found in greater abundance south of Nome as well as in the central portion of Norton Sound.

The area-swept method for abundance estimation assumes that catch is proportional to the area physically trawled and to crab density (Ricker 1940; Gulland 1964). This assumption is likely satisfied. The method also assumes crab density in the area physically trawled is representative of the grid section in which a trawl is located. The variance estimator assumes that the probability of a crab being located within the trawl area is equal to the relative size of the trawl area, a uniformity assumption. The validity of these assumptions is difficult to assess. However, distribution of crabs within an area is likely dependent on various factors, such as bottom topography, salinity, temperature, tidal influence, and patterns of seasonal migration. Given the relatively large size of the sampling grid and the project design, these factors have not been fully examined in the context of this trawl survey. The degree to which these factors may bias the estimator is unknown.

¹ Alaska Department of Fish and Game, Norton Sound winter crab study; information supplied by project leader Joyce Soong.

FUTURE STUDY

One topic for future study should be an analysis of how temperature and salinity affect king crab migration and distribution. Most ADF&G trawl studies currently use a 78 ft headrope in their Eastern otter trawl nets, whereas our survey used a 70 ft headrope. It would be interesting to do comparison studies and see what, if any, differences result from using a different size of headrope. The next Norton Sound trawl survey is scheduled to take place in 2011.

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TABLES AND FIGURES

Table 1.—Norton Sound trawl survey dates, gear type, total number of successful tows, number of resampled stations, and sampling time schedule, 1976–2008.

Year	Dates	Gear Type	Total Number of Successful Tows	Number of Resampled Stations	Sampling Time
1976	9/2–9/5, 9/16–10/6	83-112 Eastern Otter Trawl	192	17	24-Hour-Basis
1979	7/26–8/5	83-112 Eastern Otter Trawl	115	16	24-Hour-Basis
1982	9/5–9/11	83-112 Eastern Otter Trawl	53	0	24-Hour-Basis
1985	9/16–10/1	83-112 Eastern Otter Trawl	78	0	Daylight Hours
1988	8/16–8/30	83-112 Eastern Otter Trawl	82	4	24-Hour-Basis
1991	8/22–8/30	83-112 Eastern Otter Trawl	53	0	Daylight Hours
1996	8/7–8/18	400 Eastern Otter Trawl	69	21	Daylight Hours
1999	7/28–8/7	400 Eastern Otter Trawl	59	9	Daylight Hours
2002	7/27–8/6	400 Eastern Otter Trawl	60	3	Daylight Hours
2006	7/25–8/8	400 Eastern Otter Trawl	75	4	Daylight Hours
2008	7/24-8/11	400 Eastern Otter Trawl	68	2	Daylight Hours

Table 2.—Station location and number of red king crabs captured, by sex and size, during the Norton Sound trawl survey, July 24–August 11, 2008.

Haul Number	Station Number	Date	Location				Compass Heading (true)	Distance Towed (nmi)	Average Depth (fm)	Bottom Temp. (°C)	Males							
			N. Lat.		W. Long.						Females		Sublegal			Legal ^f		
			Deg.	Min.	Deg.	Min.					Juvenile ^a	Adult ^b	Threes ^c (<76 mm)	Twos ^d (76 mm to 89 mm)	Ones ^e (>89)	Recruit ^e	Postrecruit ^h	
1	155	7/24	64	9.99	164	12.46	106	1.0	9.7	6.1	2	0	0	0	0	1	2	
2	126	7/24	64	0.02	163	27.97	81	1.0	9.9	4.0	0	1	1	0	0	1	2	
3	96	7/25	63	49.42	162	18.63	312	1.0	8.0	5.0	3	2	2	0	0	0	4	
4	123	7/25	63	59.65	162	18.41	323	1.0	9.0	3.2	1	0	1	0	0	1	1	
5	122	7/25	64	0.97	161	56.96	141	1.0	9.0	0.7	1	0	0	0	0	1	0	
6	95	7/25	63	50.75	161	58.93	138	1.0	8.4	2.2	0	1	0	1	0	2	1	
7	94	7/25	63	51.09	161	36.41	146	1.0	7.8	1.2	0	0	1	0	0	0	0	
8	121	7/25	64	0.33	161	35.70	111	1.0	8.7	1.0	2	0	0	0	0	0	0	
9 ⁱ	93	7/26	63	49.82	161	12.66	212	1.0	5.8	5.0	0	0	0	0	0	0	1	
10 ⁱⁱ	70	7/27	63	39.97	161	58.46	120	0.7	6.4	3.2	0	3	0	0	0	0	0	
11 ⁱ	69	7/27	63	40.28	161	35.92	208	1.0	6.5	0.7	0	0	0	0	0	1	1	
12 ^j	68	7/27	63	39.99	161	13.97	253	0.7	5.6	2.2	1	1	0	0	0	0	0	
13	120	7/27	63	59.99	161	11.10	23	1.0	5.1	1.2	0	0	0	1	2	0	0	
14	147	7/27	64	9.17	161	9.42	351	1.0	5.0	1.4	0	0	0	0	0	0	2	
15	150	7/28	64	10.00	162	18.26	265	1.0	8.8	2.6	2	0	3	0	0	0	0	
16	151	7/28	64	10.78	162	42.38	103	1.0	10.7	3.3	0	0	0	0	0	1	0	
17	124	7/28	64	0.03	162	41.86	234	1.0	9.3	4.8	0	0	8	1	3	0	0	
18	152	7/28	64	10.02	163	3.98	57	1.0	12.7	4.1	0	0	2	2	0	2	2	
19	179	7/30	64	19.97	163	26.36	223	1.0	10.3	4.8	1	0	2	0	0	0	0	
20	153	7/30	64	10.08	163	27.06	142	1.0	10.5	4.0	1	0	1	0	0	0	0	
21	125	7/30	63	59.97	163	5.25	82	1.0	9.7	4.8	0	1	1	1	2	0	0	
22	127	7/30	64	0.11	163	50.80	110	1.0	9.2	5.4	1	0	1	0	0	0	0	
23	154	7/30	64	10.07	163	49.92	83	1.0	9.7	4.6	1	0	1	0	1	0	0	
24	180	7/30	64	20.00	163	49.11	60	1.0	8.7	6.1	1	1	1	0	0	0	0	
25	202	7/31	64	29.99	163	49.01	250	1.0	8.2	6.8	0	0	0	0	0	0	0	
26 ^j	203	7/31	64	29.91	164	12.29	278	1.0	10.4	7.9	0	0	0	0	0	0	0	
27	181	7/31	64	20.03	164	12.33	103	1.0	7.3	8.2	0	1	0	0	0	0	0	
28	128	7/31	63	59.89	164	13.06	286	1.0	8.5	8.8	0	0	2	0	0	0	1	
29	129	7/31	64	0.17	164	35.21	47	1.0	9.8	7.3	11	1	13	3	1	0	1	
30	156	7/31	64	9.85	164	34.72	84	1.0	7.6	6.0	0	0	2	1	2	0	0	

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Table 2.—Page 2 of 3.

Haul Number	Station Number	Date	Location				Compass Heading (true)	Distance Towed (nmi)	Average Depth (fm)	Bottom Temp. (°C)	Males							
			N. Lat.		W. Long.						Females		Sublegal			Legal ^f		
			Deg.	Min.	Deg.	Min.					Juvenile ^a	Adult ^b	Threes ^c (<76 mm)	Twos ^d (76 mm to 89 mm)	Ones ^e (>89 mm)	Recruit ^g	Postrecruit ^h	
31	186	8/2	64	20.84	166	6.29	209	1.0	12.7	k	1	0	3	0	1	2	0	
32	187	8/2	64	19.96	166	30.02	136	1.0	13.4	5.1	0	0	0	0	0	0	0	
33	161	8/2	64	9.87	166	30.06	199	1.0	13.7	4.6	0	0	0	0	0	0	0	
34	135	8/3	63	59.98	166	51.67	245	1.0	17.1	4.0	0	0	0	0	0	0	0	
35	134	8/3	64	0.08	166	29.06	278	1.0	15.5	5.4	0	0	0	0	0	0	0	
36	133	8/3	63	59.99	166	6.18	284	1.0	12.2	6.0	0	0	0	0	1	0	0	
37	160	8/3	64	10.10	166	7.59	272	1.0	11.7	5.4	0	0	0	0	0	0	0	
38	159	8/4	64	9.80	165	42.86	133	1.0	10.0	7.6	3	0	4	8	5	0	1	
39	158	8/4	64	10.22	165	20.89	151	1.0	9.0	8.7	0	16	0	0	0	0	1	
40	131	8/4	63	59.98	165	20.91	172	1.0	8.7	8.5	1	1	0	0	0	0	0	
41	130	8/4	63	59.95	164	58.26	127	1.0	8.8	9.4	0	0	0	0	0	0	0	
42	157	8/4	64	9.99	164	58.23	127	1.0	7.9	7.0	0	0	0	0	0	0	0	
43	182	8/4	64	19.95	164	35.15	149	1.0	7.2	9.3	0	0	1	0	0	0	0	
44	132	8/5	63	59.97	165	43.69	217	1.0	10.1	k	0	0	0	1	1	0	1	
45	106	8/5	63	50.21	166	5.69	23	1.0	13.3	k	0	0	0	0	0	0	0	
46	107	8/5	63	49.95	166	28.52	206	1.0	15.9	4.7	0	0	0	0	0	0	0	
47	82	8/5	63	40.01	166	27.92	275	1.0	14.3	5.3	0	0	0	0	0	0	0	
48	81	8/5	63	39.91	166	5.53	199	1.0	13.5	5.8	0	0	0	0	0	0	1	
49	80	8/5	63	40.06	165	42.98	219	1.0	11.5	6.9	1	0	1	1	0	0	3	
50 ^j	79	8/5	63	40.05	165	20.70	227	1.0	9.1	7.6	2	1	4	1	0	1	0	
51	78	8/6	63	40.09	164	58.11	206	1.0	7.7	k	0	1	0	0	0	0	0	
52	103	8/6	63	50.01	164	58.22	35	1.0	8.1	8.2	1	0	0	1	0	0	1	
53 ⁱ	204	8/8	64	30.03	165	44.77	101	1.0	8.6	k	0	0	0	0	0	0	0	
54 ^l	185	8/8	64	19.94	165	44.57	119	1.0	10.4	7.2	1	0	3	5	3	3	1	
55	184	8/8	64	19.82	165	20.84	125	1.0	11.8	7.7	1	1	2	15	19	10	4	
56	184	8/8	64	19.98	165	21.14	148	1.0	11.7	7.6	1	1	5	18	19	10	5	
57 ⁱ	183	8/8	64	19.93	164	57.82	114	1.0	14.8	7.6	8	15	5	9	5	3	5	
58	105	8/9	63	49.99	165	43.39	49	1.0	10.4	7.2	2	0	0	1	1	0	0	
59	104	8/9	63	49.99	165	20.83	63	1.0	8.8	7.5	2	3	2	1	0	0	0	
60	102	8/9	63	50.01	164	35.62	27	1.0	8.0	8.5	0	0	0	0	0	0	0	

-continued-

Table 2.–Page 3 of 3.

Haul Number	Station Number	Date	Location				Compass Heading (true) (degrees)	Distance Towed (nmi)	Average Depth (fm)	Bottom Temp. (°C)	Males							
			N. Lat.		W. Long.						Females		Sublegal			Legal ^f		
			Deg.	Min.	Deg.	Min.					Juvenile ^a	Adult ^b	Threes ^c (<76 mm)	Twos ^d (76 mm to 89 mm)	Ones ^e (>89 mm)	Recruit ^g	Postrecruit ^h	
61	101	8/9	63	50.03	164	13.05	186	1.0	8.1	9.1	0	3	0	0	0	0	0	
62	100	8/9	63	49.90	163	49.58	122	1.0	8.1	7.9	0	1	0	0	1	0	0	
63	99	8/9	63	50.25	163	28.44	311	1.0	8.1	6.9	1	1	0	0	0	0	0	
64	98	8/10	63	49.98	163	5.26	319	1.0	8.6	5.8	0	0	1	1	0	0	0	
65	149	8/10	64	9.97	161	55.52	114	1.0	9.1	1.7	0	0	0	0	0	0	0	
66	148	8/10	64	10.01	161	32.58	169	1.0	8.1	4.5	0	0	0	1	0	0	0	
67	175	8/10	64	19.99	161	54.55	77	1.0	7.9	4.6	0	0	1	1	0	0	1	
68	176	8/10	64	20.07	162	16.91	215	1.0	8.8	2.3	2	1	0	0	0	0	1	
69 ⁱ	185	8/10	64	20.02	165	44.69	315	1.0	10.4	7.9	1	0	6	5	4	4	0	

Note: Stations resurveyed due to ≥ 5 legal red king crabs caught are indicated in bold.

^a Juvenile female red king crabs include all females that were non-ovigerous, had clean pleopodal setae, and had abdominal flaps that did not extend over the coxa.

^b Adult female red king crabs include all ovigerous females and all non-ovigerous females with abdominal flaps that extended over the coxa.

^c Prerecruit threes include all sublegal male crabs < 76 mm carapace length (CL).

^d Prerecruit twos include all sublegal male crabs 76 mm to 89 mm CL.

^e Prerecruit ones include all sublegal male crabs > 89 mm CL.

^f Legal male red king crabs are ≥ 121 mm (4.75 in) carapace width, including lateral spines.

^g Recruits are legal new-shell male crabs ≤ 115 mm CL.

^h Postrecruits are legal new-shell male crabs > 115 mm CL, and all old-shell legal crabs of legal width.

ⁱ Net damaged.

^j Tow contained a large amount of mud.

^k Temperature logger was not deployed.

^l Net towed badly the first time, so the station was retowed.

Table 3.–Standardized results from population assessment surveys for red king crabs in Norton Sound, 1976–2008.

Year	Dates	Research Agency	Gear	Number of Red King Crabs Captured ^{a, b}				Population Abundance Estimates ^c			Standard Error		
				Prerecruit-2	Prerecruit-1	Legal Males ^d	Females	Prerecruit-2	Prerecruit-1	Legal	Prerecruit-2	Prerecruit-1	Legal
				Males	Males	Males ^d		Males	Males	Males	Males	Males	Males
1976	9/02–9/05 9/16–10/7	NMFS	Trawl	58(38)	110(213)	180(614)	101(35)	331,555	808,091	1,742,755	44,653	70,094	104,941
1979 ^e	7/26–8/05	NMFS	Trawl			90(86)	N/A			809,799			61,176
1980 ^f	7/04–7/14	ADF&G	Pots			3,290	158			1,900,000			
1981	6/28–7/14	ADF&G	Pots			3,415	1,933			1,285,195			
1982	7/06–7/20	ADF&G	Pots			2,001	424			353,273			
1982	9/05–9/11	NMFS	Trawl	42	107	97	256	356,724	832,581	877,722	50,116	76,454	79,907
1985	7/01–7/14	ADF&G	Pots			4,645	181			907,579			
1985	9/16–10/1	NMFS	Trawl	63	94	139	139	466,858	707,140	1,051,857	58,598	71,999	87,931
1988	8/16–8/30	NMFS	Trawl	82(0)	69(1)	135(3)	212(2)	565,255	493,030	978,748	62,339	58,224	82,083
1991	8/22–8/30	NMFS	Trawl	39	42	166	105	294,801	303,682	1,287,486	46,648	46,960	98,101
1996	8/07–8/18	ADF&G	Trawl	39(36)	32(17)	53(14)	98(70)	452,580	325,699	536,235	52,324	47,338	69,647
1999	7/28–8/07	ADF&G	Trawl	9(3)	64(38)	103(63)	64(18)	103,832	940,198	1,594,341	40,841	120,449	129,864
2002	7/27–8/06	ADF&G	Trawl	34(18)	42(23)	61(29)	116(35)	427,703	518,638	771,569	73,494	80,741	85,303
2006	7/25–8/08	ADF&G	Trawl	77(3)	37(16)	51(18)	66(1)	775,076	569,833	726,251	91,812	82,883	92,590
2008	7/11–8/11	ADF&G	Trawl	51(18)	46(19)	53(15)	90(2)	795,777	697,442	811,727	100,778	91,542	103,155

Note: Blank cells are because the numbers were not calculated.

^a Number of crabs captured on ADF&G pot surveys represent data standardized for a 24-hour soak.

^b The 1976, 1979, 1988, and all ADF&G trawl catches include resampled stations (in parentheses). The 1979, 1996, and 2006 population estimates incorporated resampled stations by combining catches and tow distances for each station resampled.

^c Population estimates are valid for the date of the survey (i.e., either before or after the summer commercial fishery).

^d Legal male red king crabs were defined as ≥ 121 mm (4.75 in) in carapace width (CW) for the pot surveys and all ADF&G trawl surveys, and ≥ 104 mm CL for all of the NMFS trawl surveys except the 1979 survey which defined legal males as ≥ 100 mm CL.

^e Prerecruit-1 and prerecruit-2 male, and female data is not available for the 1979 NMFS trawl survey and the legal male abundance estimate is fully standardized.

^f The 1980 pot survey estimate has been revised from the original estimate of 13.4 million pounds which was thought inaccurate due to an under-reporting of recovered tagged crabs.

Table 4.-Length, frequency, and percent ovigerity of female red king crabs captured during the 2008 Norton Sound trawl survey.

Carapace Length (mm)	Adult Percent Ovigerity					Total Adults	Juvenile (Immature)	All Females
	0%	1-29%	30-59%	60-89%	90-100%			
23	0	0	0	0	0	0	1	1
26	0	0	0	0	0	0	1	1
27	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	3	3
31	0	0	0	0	0	0	3	3
32	0	0	0	0	0	0	2	2
36	0	0	0	0	0	0	1	1
38	0	0	0	0	0	0	1	1
39	0	0	0	0	0	0	1	1
40	0	0	0	0	0	0	3	3
42	0	0	0	0	0	0	1	1
48	0	0	0	0	0	0	1	1
49	0	0	0	0	0	0	1	1
52	0	0	0	0	0	0	1	1
54	0	0	0	0	0	0	2	2
55	0	0	0	0	0	0	1	1
56	0	0	0	0	0	0	2	2
57	0	0	0	0	0	0	2	2
59	0	0	0	0	0	0	3	3
60	0	0	1	0	0	1	1	2
62	0	0	0	0	0	0	3	3
63	0	0	0	0	0	0	2	2
64	0	1	0	0	0	1	1	2
65	0	0	0	0	0	0	1	1
66	0	0	0	0	0	0	6	6
67	0	1	0	0	0	1	2	3
68	0	0	0	0	0	0	5	5
69	0	1	1	0	0	2	0	2
71	2	1	1	1	0	5	1	6
72	0	2	0	0	0	2	1	3
73	0	1	0	0	0	1	1	2
74	0	0	2	0	0	2	0	2
75	1	0	0	1	0	2	0	2
76	0	0	0	1	0	1	0	1
77	0	0	1	0	0	1	0	1
78	0	0	1	1	0	2	0	2
79	0	0	1	1	0	2	1	3
80	0	0	0	2	0	2	0	2
81	0	0	1	3	0	4	0	4
82	0	1	1	1	1	4	0	4
83	0	0	2	2	1	5	0	5
84	0	0	1	0	0	1	0	1
85	0	0	1	1	0	2	0	2
86	0	1	0	1	1	3	0	3
87	0	0	1	0	1	2	0	2
88	0	0	1	0	0	1	0	1
89	0	0	1	0	0	1	0	1
90	0	0	1	1	1	3	0	3
91	0	0	0	2	0	2	0	2
93	0	0	1	0	0	1	0	1
95	0	0	1	0	0	1	0	1
118	0	0	1	0	0	1	0	1
122	0	0	0	1	0	1	0	1
Totals	3	9	21	19	5	57	56	113

Table 5.–The top 30 taxa, ranked by weight, identified during the 2008 ADF&G Norton Sound red king crab trawl survey.

Rank	NMFS Species Code	Common Name	Scientific Name or Taxon	Weight (kg)
1	81742	Purple-orange sea star	<i>Asterias amurensis</i>	8494
2	21735	Saffron cod	<i>Eleginus gracilis</i>	1426
3	80200	Black-spined sea star	<i>Lethasterias nanimensis</i>	864
4	80020	Giant sea star	<i>Evasterias echinosoma</i>	592
5	21375	Myoxocephalus unidentified	<i>Myoxocephalus sp.</i>	574
6	10220	Starry flounder	<i>Platichthys stellatus</i>	458
7	82510	Green sea urchin	<i>Strongylocentrotus droebachiensis</i>	413
8	10210	Yellowfin sole	<i>Limanda aspera</i>	380
9	43000	Sea anemone unidentified	<i>Actinaria sp.</i>	365
10	71884	Northern neptune	<i>Neptunea heros</i>	296
11	98000	Tunicate unidentified	<i>Ascidian sp.</i>	296
12	69322	Red king crab	<i>Paralithodes camtschaticus</i>	244
13	10285	Alaska plaice	<i>Pleuronectes quadrituberculatus</i>	218
14	69010	Hermit crab unidentified	<i>Paguridae sp.</i>	206
15	21740	Walleye pollock	<i>Theragra chalcogramma</i>	201
16	68781	Helmet crab	<i>Telmessus cheiragonus</i>	191
17	21720	Pacific cod	<i>Gadus macrocephalus</i>	143
18	10120	Pacific halibut	<i>Hippoglossus stenolepis</i>	131
19	40500	Jellyfish unidentified	<i>Scyphozoa sp.</i>	114
20	80595	Leptasterias unidentified	<i>Leptasterias sp.</i>	108
21	69035	Pagurus unidentified	<i>Pagurus sp.</i>	102
22	83020	Basket sea star	<i>Gorgonocephalus eucnemis</i>	88
23	10260	Rock sole unidentified	<i>Lepidopsetta sp.</i>	70
24	23801	Lumpenus unidentified	<i>Lumpenus sp.</i>	67
25	69120	Hairy hermit crab	<i>Pagurus capillatus</i>	65
26	75286	Broad cockle	<i>Serripes laperousii</i>	64
27	65100	Barnacle unidentified	<i>Thoracica</i>	59
28	21110	Pacific herring	<i>Clupea pallasii</i>	59
29	21388	Antlered sculpin	<i>Enophrys diceraus</i>	58
30	80590	Knobby six-rayed sea star	<i>Leptasterias polaris</i>	55

Table 6.—Data on large fish collected during the ADF&G Norton Sound red king crab trawl survey for 2002, 2006, and 2008.

Year	# of Stations Sampled	Species	# of Fish Sampled	Average Length (mm)	Average Weight (kg)
2002	60	Pacific Halibut	10	750	7.4
		Pacific Cod	27	650	3.2
		Walleye Pollock	38	730	2.7
2006	75	Pacific Halibut	28	702	5.1
		Pacific Cod	17	754	4.1
		Walleye Pollock	27	698	3.1
2008	68	Pacific Halibut	27	692	4.9
		Pacific Cod	30	696	4.7
		Walleye Pollock	11	736	2.8

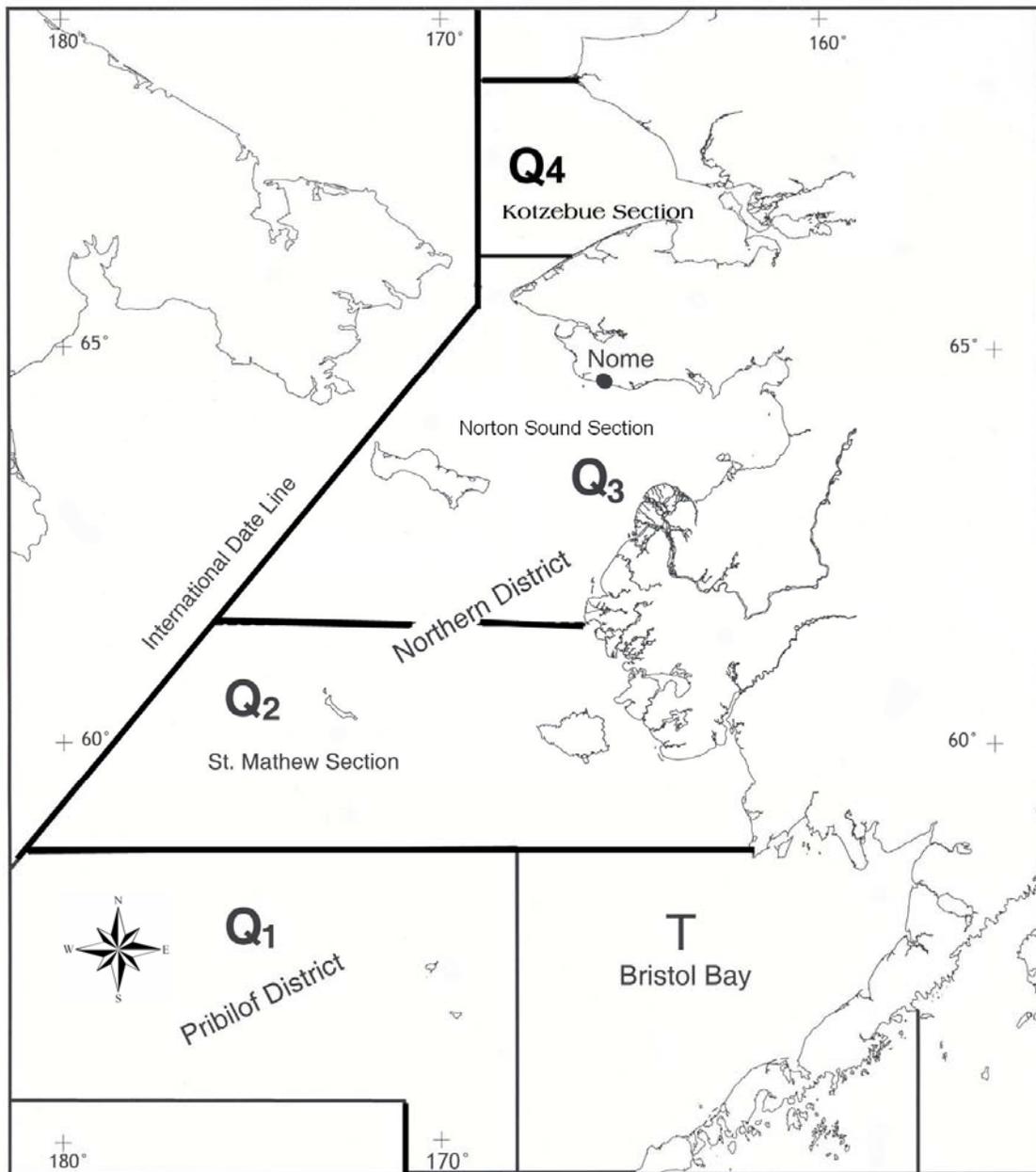


Figure 1.—King crab fishing districts and sections of Registration Area Q.

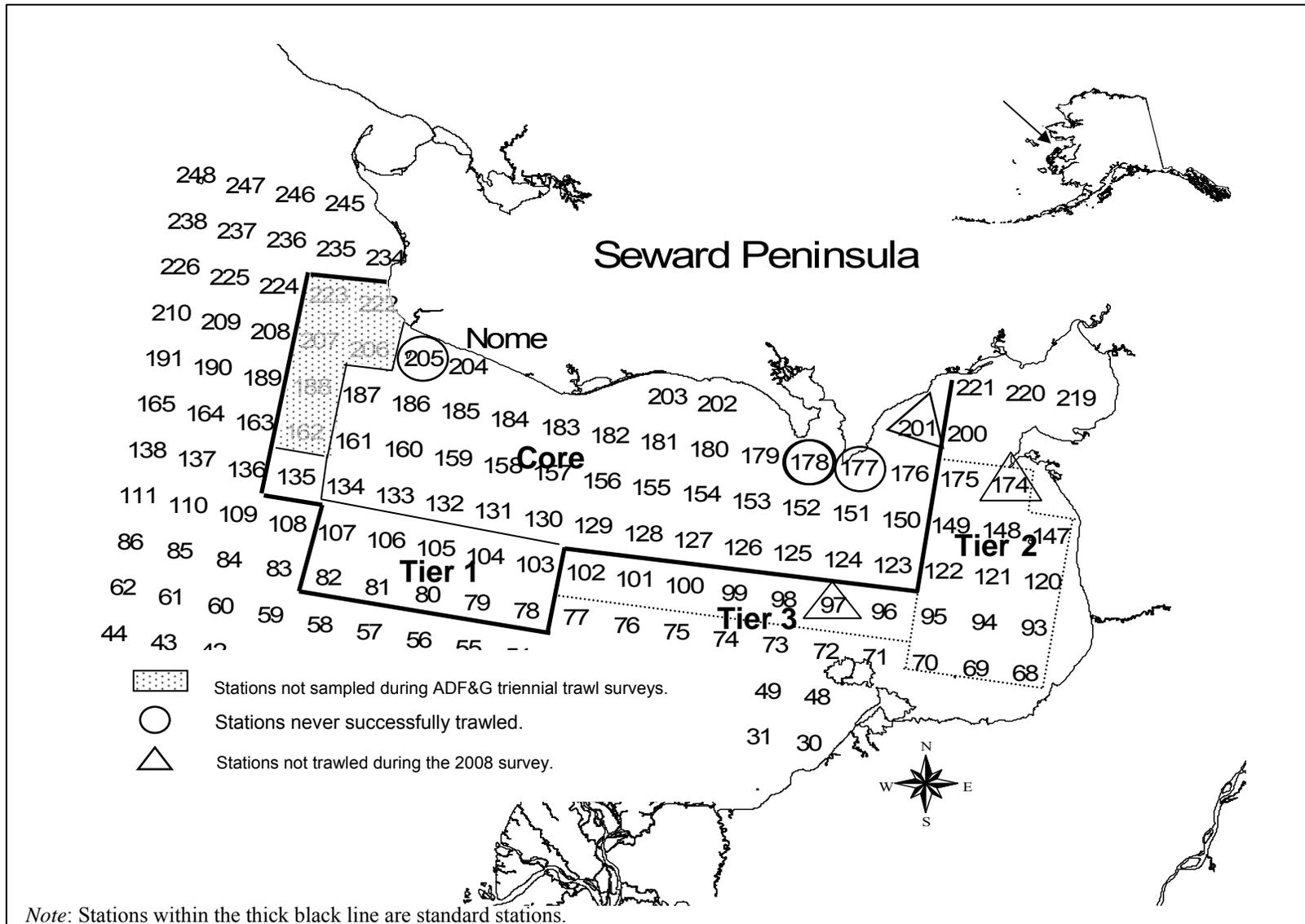
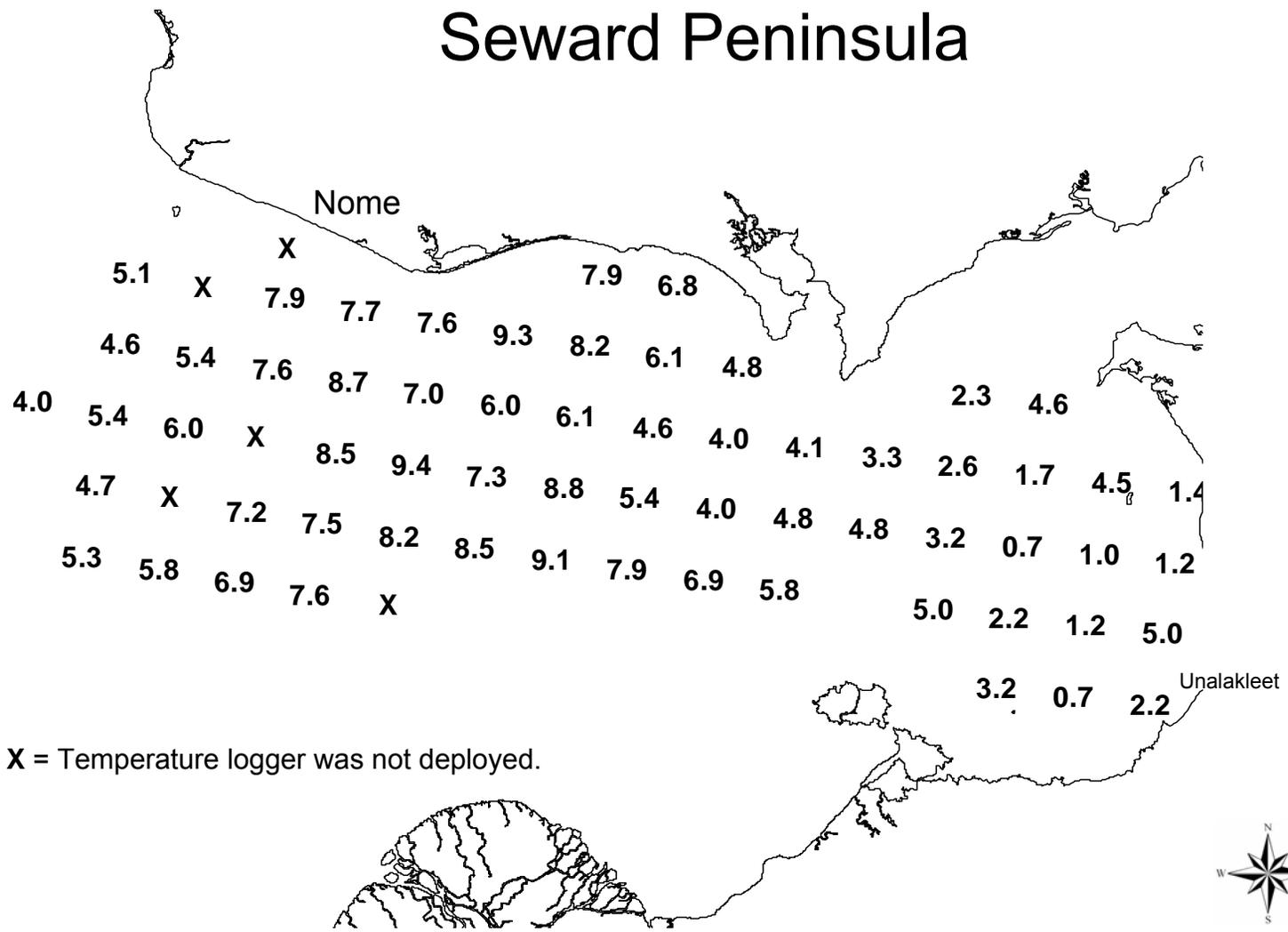


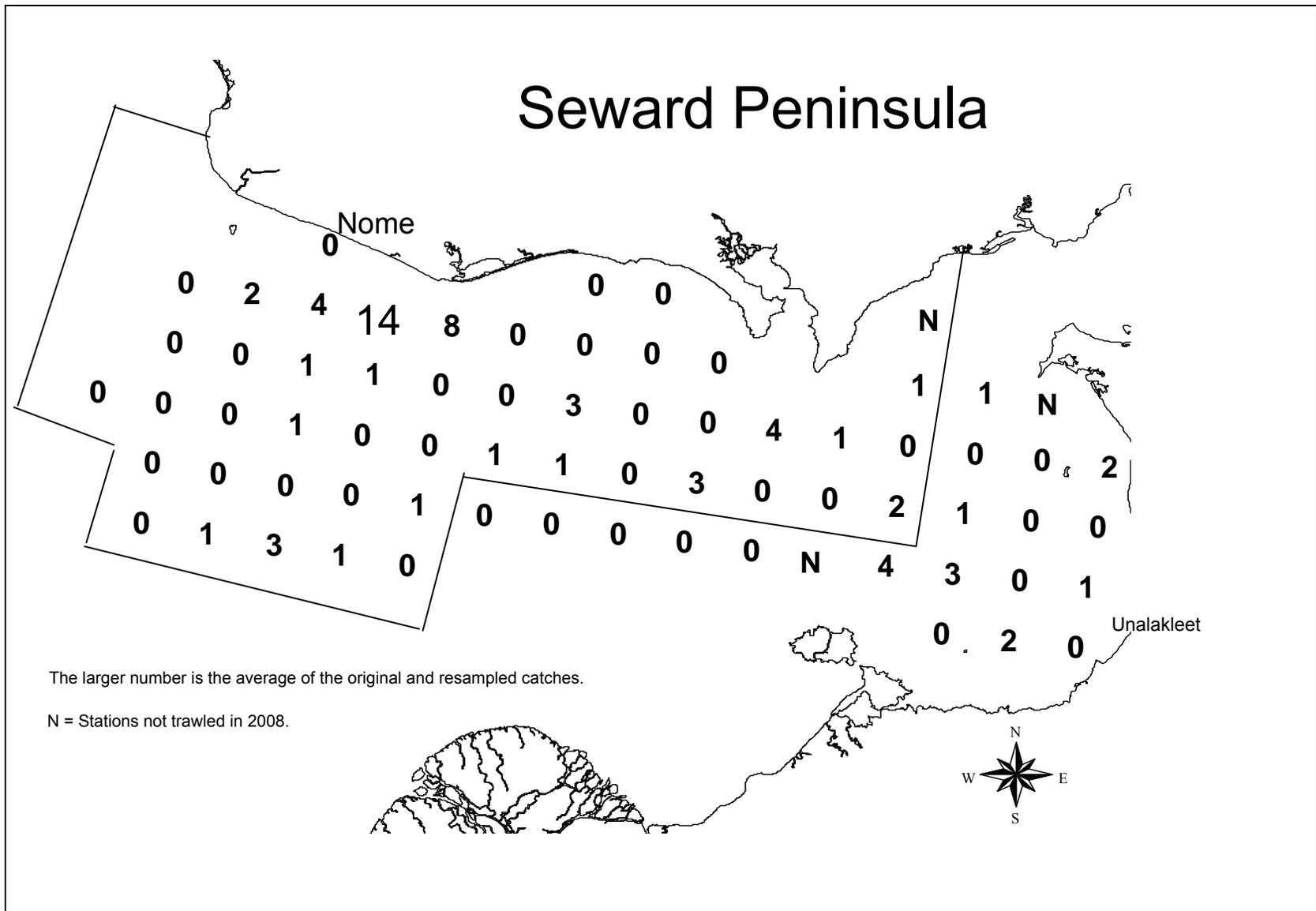
Figure 2.—Station identification numbers for the 2008 ADF&G Norton Sound trawl survey.

Seward Peninsula



X = Temperature logger was not deployed.

Figure 3.—Mean bottom temperatures (°C) from the 2008 ADF&G Norton Sound trawl survey.



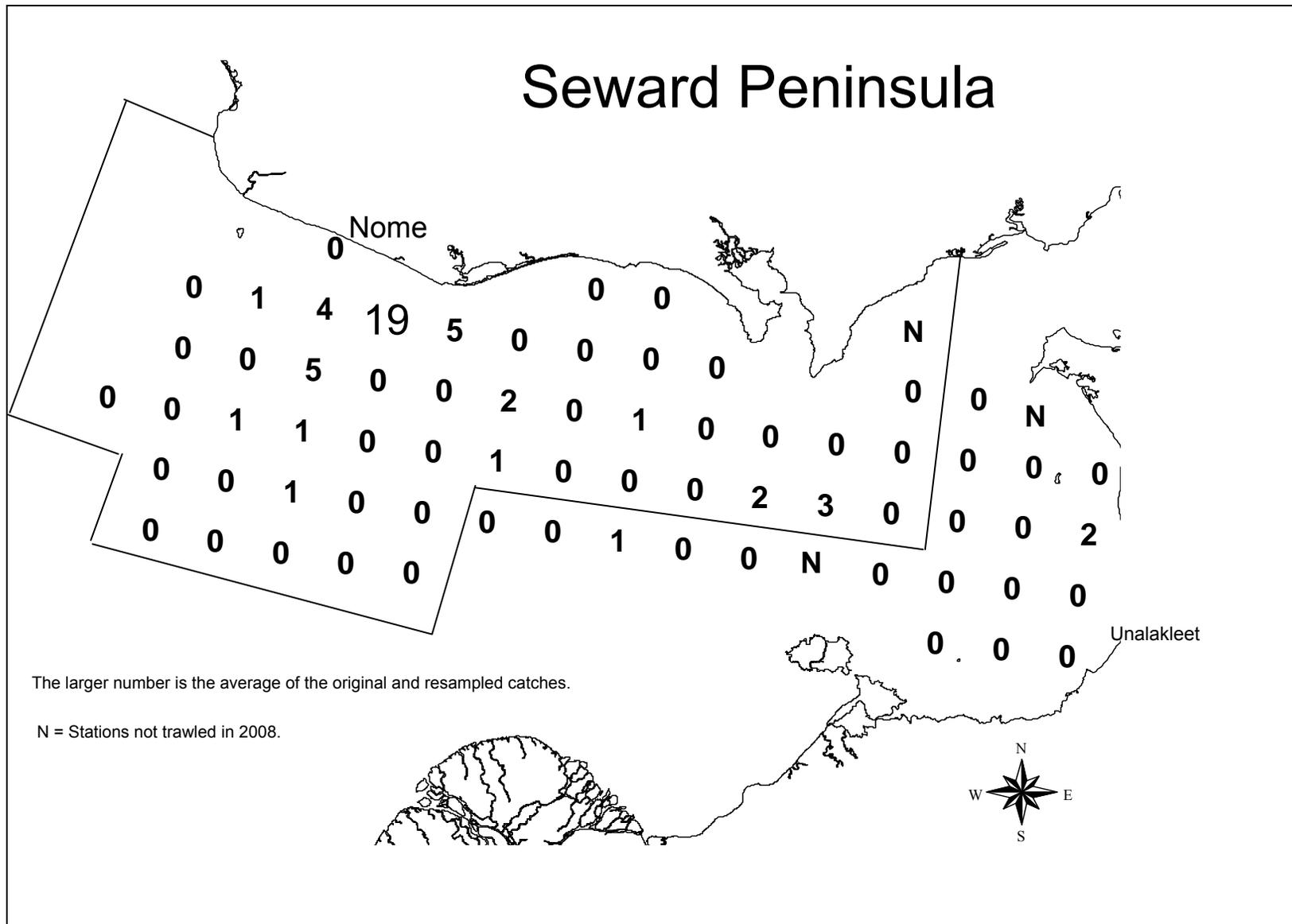


Figure 5.—Prerecruit-1 male red king crab catches from the 2008 ADF&G Norton Sound trawl survey.

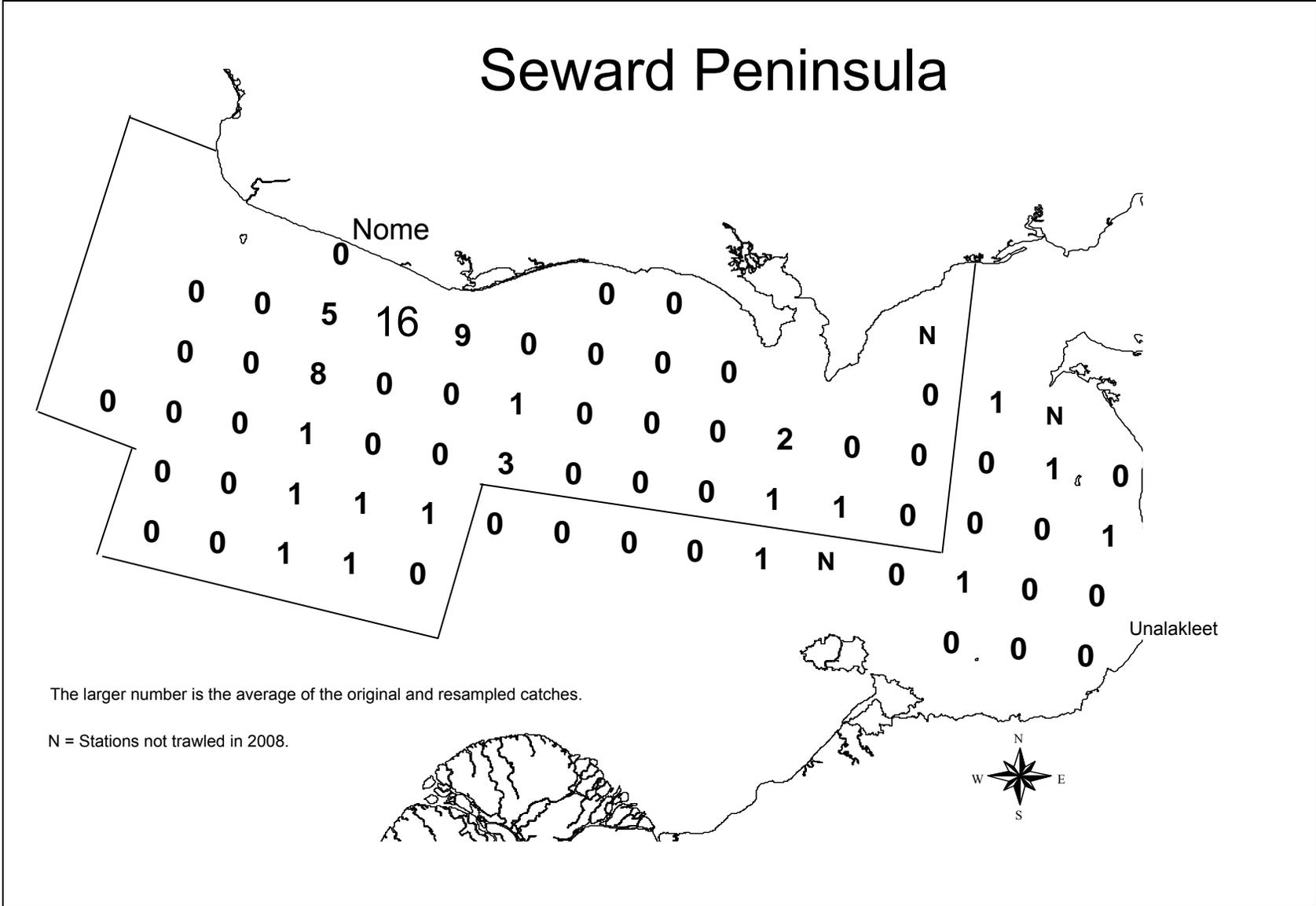
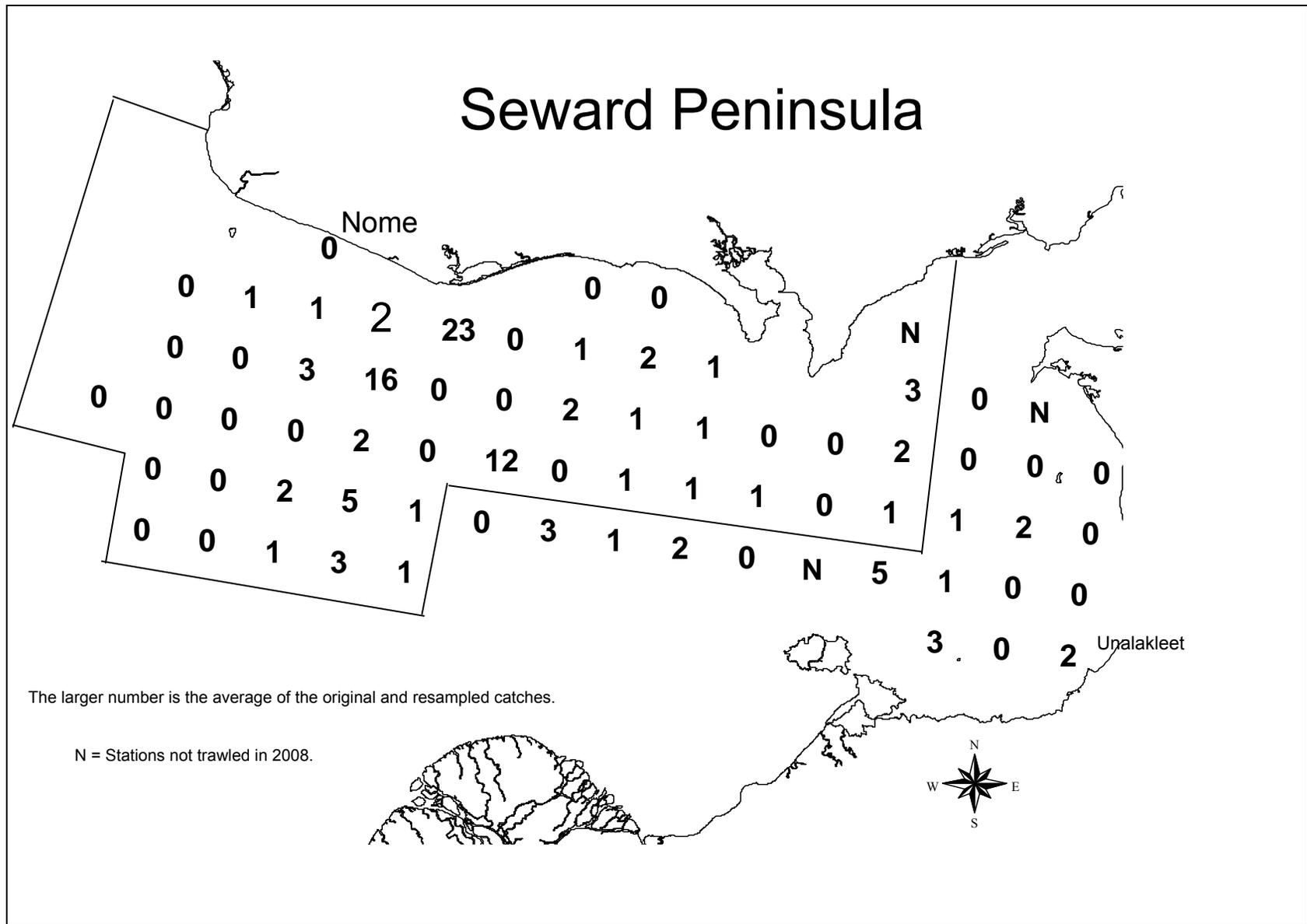


Figure 6.—Prerecruit-2 male red king crab catches from the 2008 ADF&G Norton Sound trawl survey.



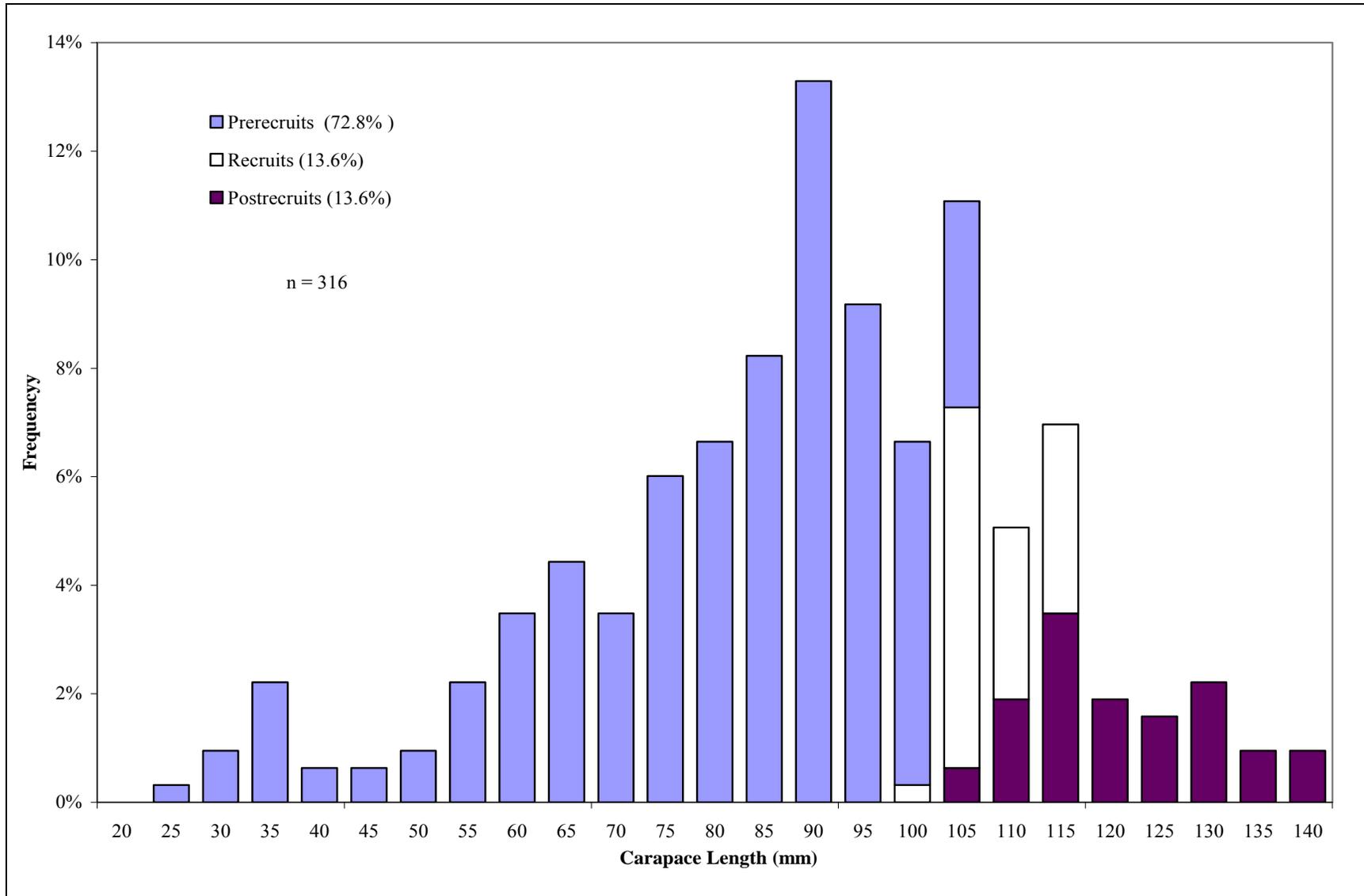


Figure 8.—Size composition of male red king crabs measured at standard and nonstandard stations during the 2008 ADF&G Norton Sound trawl survey.

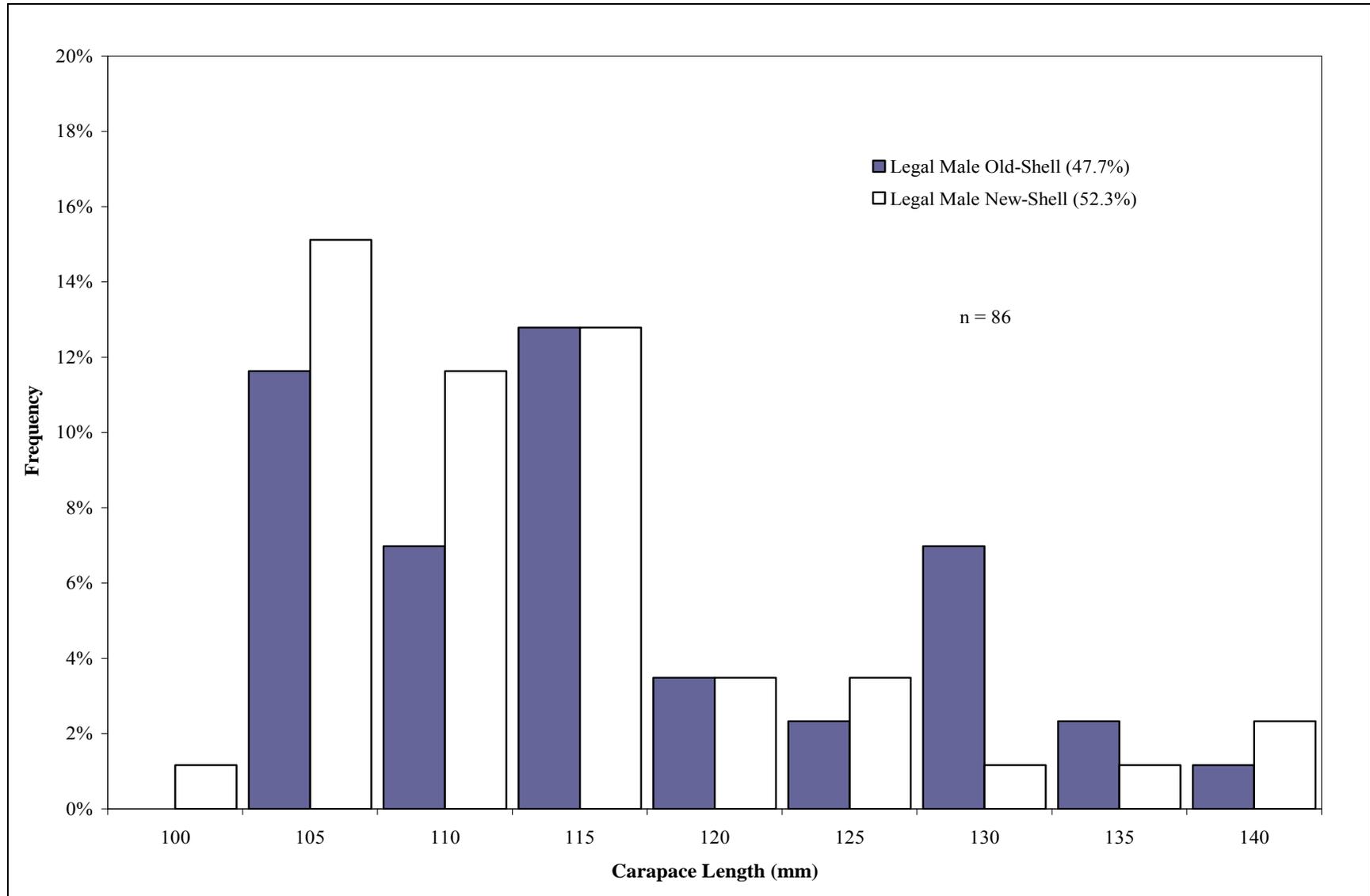


Figure 9.—Size composition by shell age of legal male red king crabs captured at standard and nonstandard stations during the 2008 ADF&G Norton Sound red king crab trawl survey.

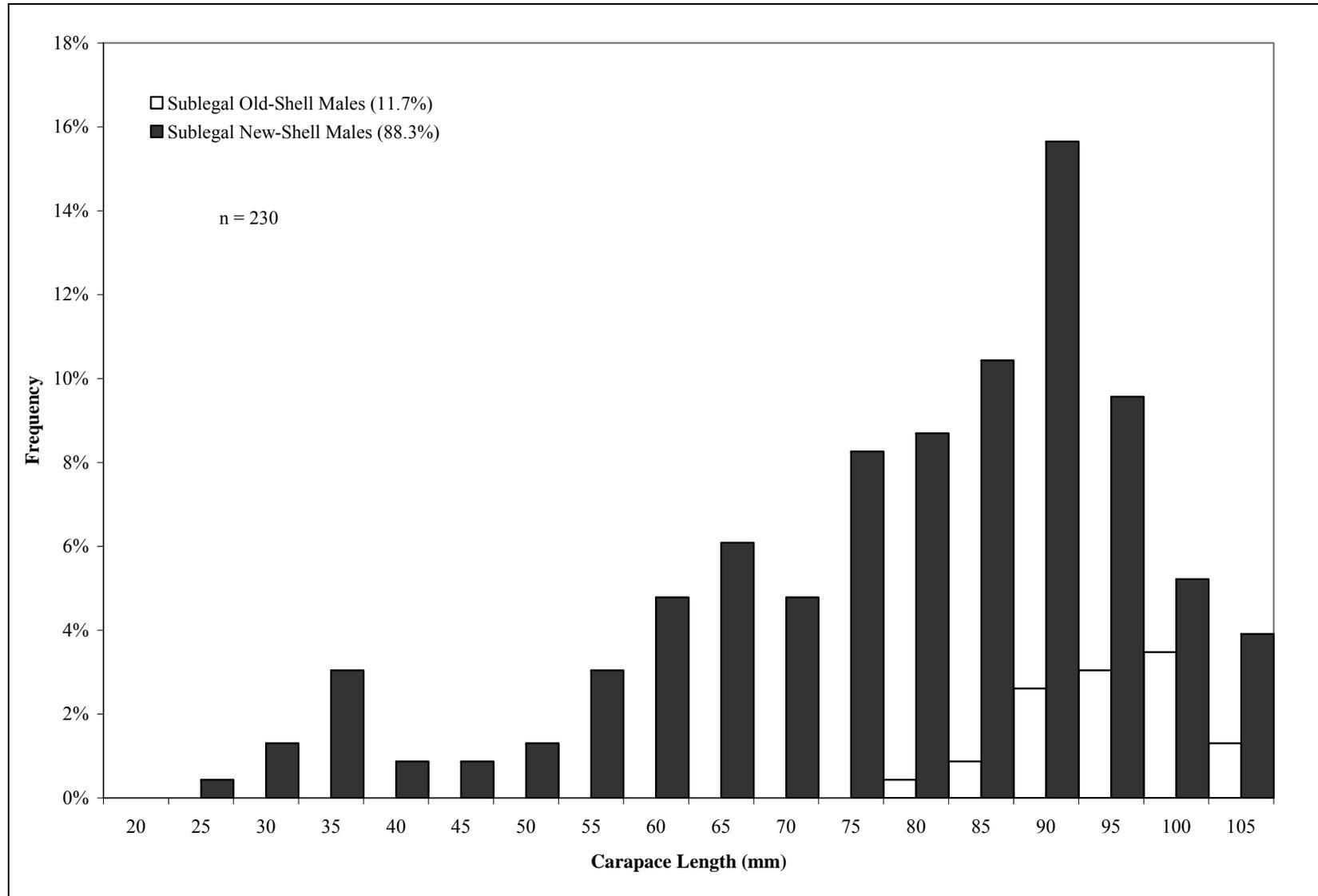


Figure 10.—Size composition by shell age of sublegal male red king crabs captured at standard and nonstandard stations in the 2008 ADF&G Norton Sound red king crab trawl survey.

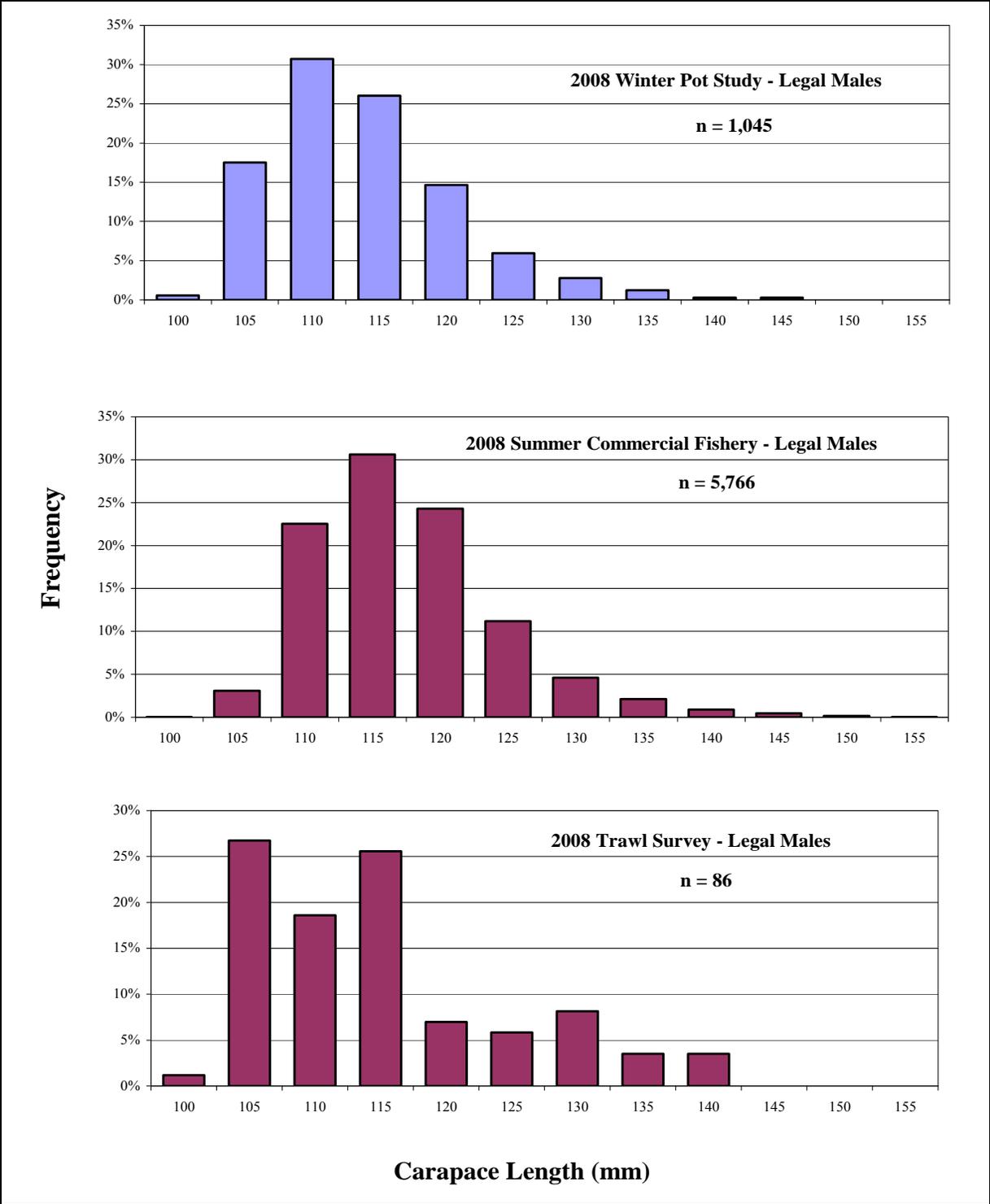


Figure 11.—Norton Sound legal male red king crab size compositions from the 2008 winter pot study (top), 2008 summer commercial fishery (middle), and 2008 ADF&G trawl survey (bottom).

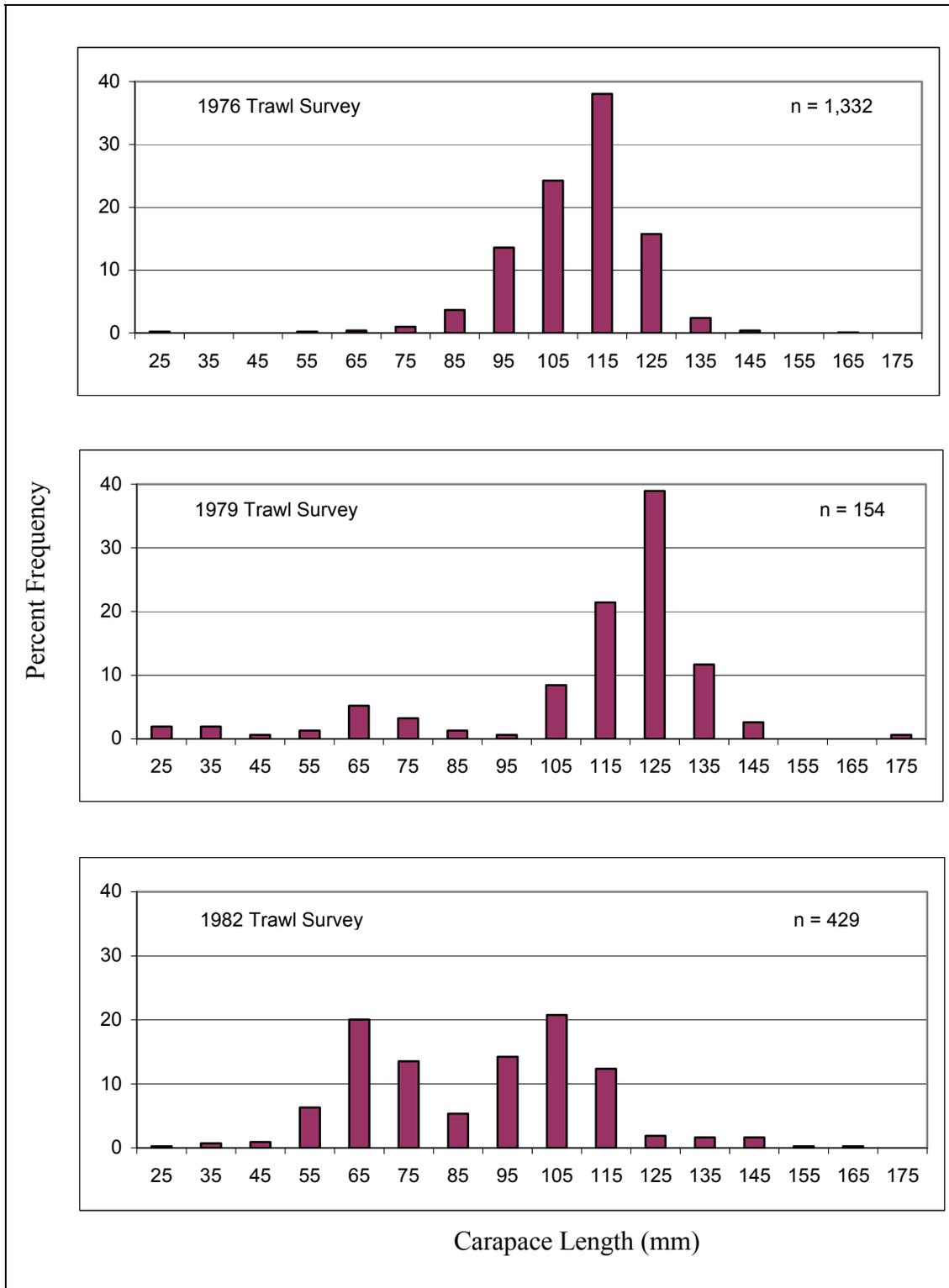


Figure 12.—Norton Sound size compositions for male red king crabs captured at standard and nonstandard stations in the 1976–2008 trawl surveys.

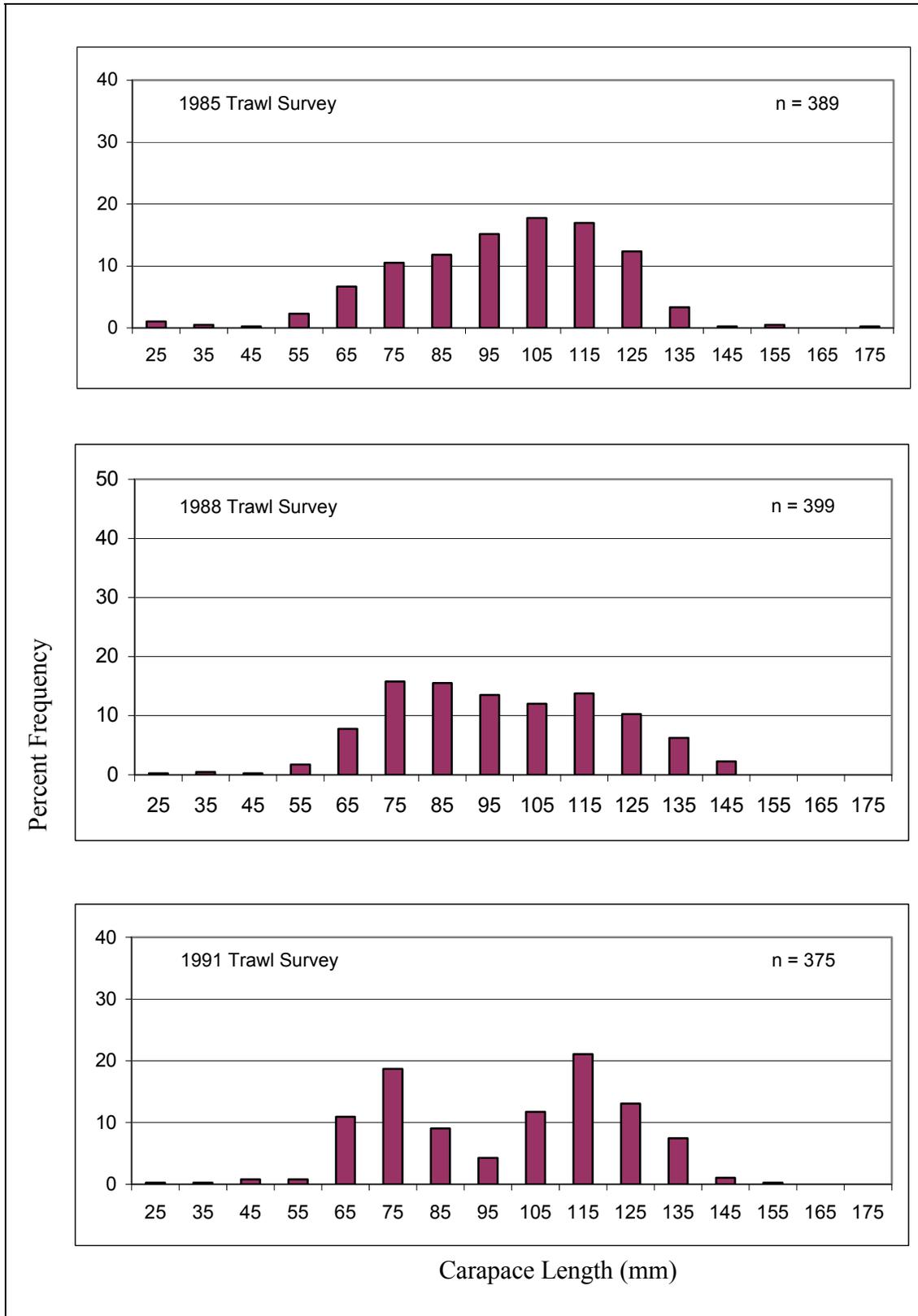


Figure 12.–Page 2 of 4.

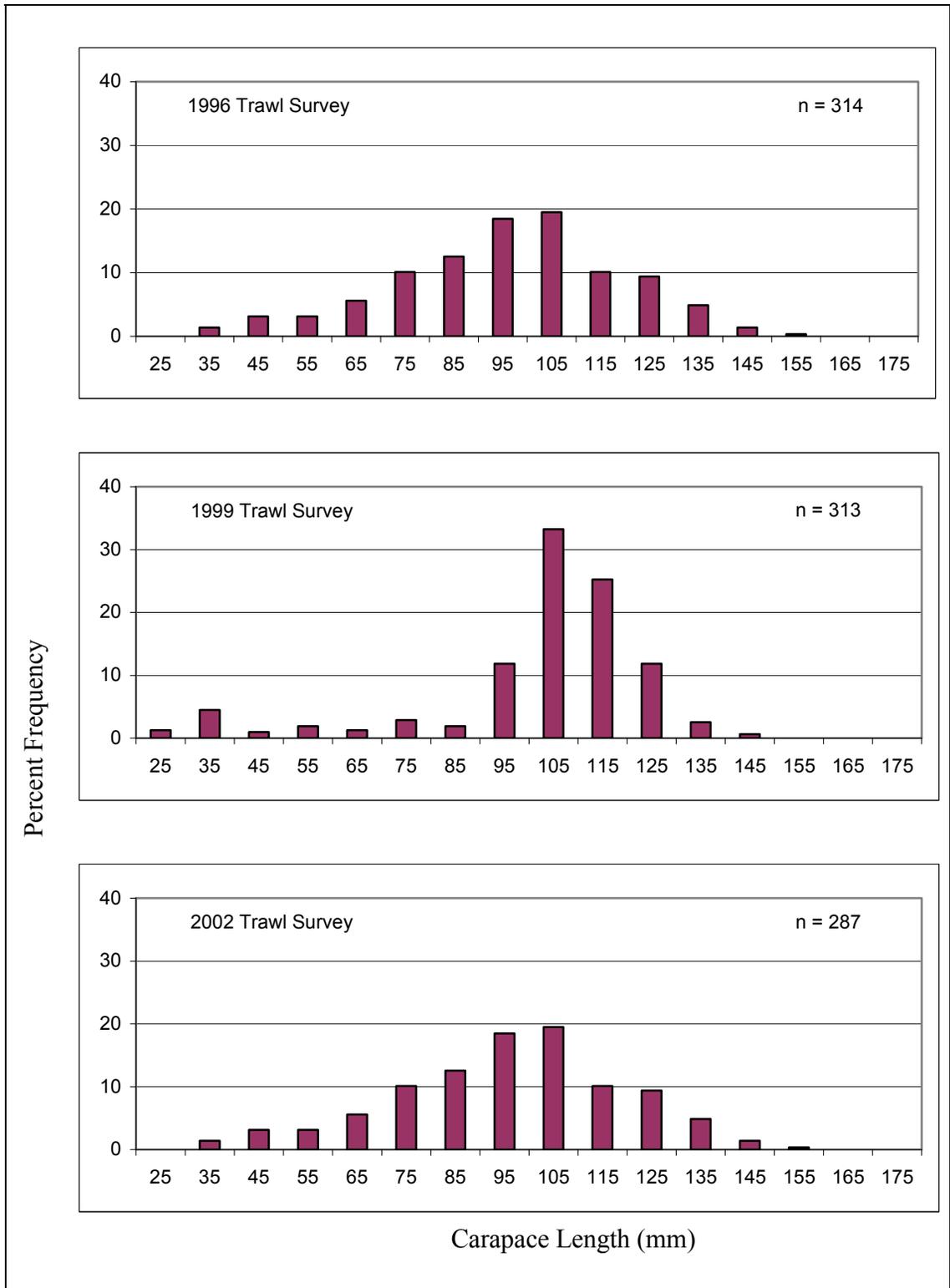


Figure 12.–Page 3 of 4.

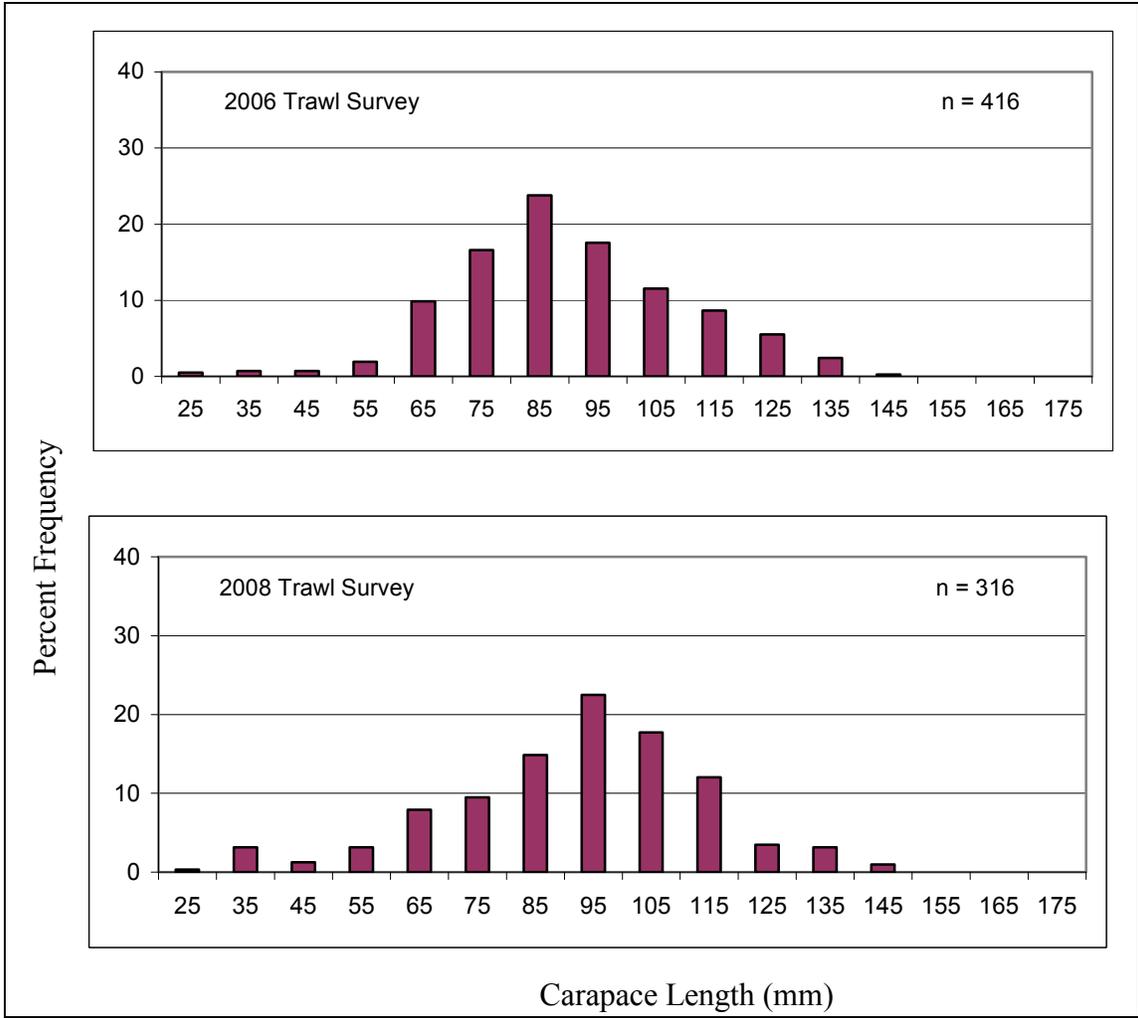


Figure 12.–Page 4 of 4.

APPENDIX A

Appendix A1.–Norton Sound ADF&G trawl survey data for standard and nonstandard stations that produced any legal male crab catch during the original survey and any resurveys, 2008.

Original Survey					Resurvey				
Station Number	No. of Legal Crabs	Area Trawled (sq. miles)	Total Area (sq. miles)	Estimated Abundance	Station Number	No. of Legal Crabs	Area Trawled (sq. miles)	Total Area (sq. miles)	Estimated Abundance
69	2	0.00658	100	30,395					
79	1	0.00671	100	14,900					
80	3	0.00658	100	45,593					
81	1	0.00658	100	15,198					
93	1	0.00658	100	15,198					
95	3	0.00658	100	45,593					
96	4	0.00658	100	60,790					
103	1	0.00658	100	15,198					
122	1	0.00658	100	15,198					
123	2	0.00658	100	30,395					
126	3	0.00658	100	45,593					
128	1	0.00658	100	15,198					
129	1	0.00658	100	15,198					
132	1	0.00658	100	15,198					
147	2	0.00658	100	30,395					
151	1	0.00658	100	15,198					
152	4	0.00658	100	60,790					
155	3	0.00671	100	44,699					
158	1	0.00658	100	15,198					
159	1	0.00665	100	15,047					
175	1	0.00658	100	15,198					
176	1	0.00658	100	15,198					
183	8	0.00658	100	121,581					
184	14	0.00658	100	212,766	184	15	0.00658	100	227,964
185	4	0.00658	100	60,790	185	4	0.00658	100	60,790
186	2	0.00658	100	30,395					