

**ANALYSIS OF RED KING CRAB DATA FROM THE 2002
ADF&G TRAWL SURVEY OF NORTON SOUND**

By

Elisabeth L. Brennan

REGIONAL INFORMATION REPORT¹ NO. 3A02-52

Alaska Department of Fish and Game
Commercial Fisheries Division, AYK Region
333 Raspberry Road
Anchorage, Alaska 99518-1599

December 2002

¹ The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without approval of the author or the Commercial Fisheries Division.

AUTHORS

Elisabeth Brennan is a Fishery Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Division, Nome, AK.

ACKNOWLEDGMENTS

We would like to thank the captain and crew of the F/V *Peggy Jo* who ensured the survey went smoothly and the equipment worked well. The vessel's crew included captain Brian Beaver, Ronald Yaakola, Timothy Yaakola, and Christopher Wait. They were helpful and enthusiastic in all aspects of our study. The ADF&G and vessel survey crew worked well together to ensure sampling was done efficiently and correctly.

Special thanks goes to Larry Neff and Leslie Watson who were diligent in identifying organisms. Larry's experience in the ADF&G Onboard Observer program and previous trawl survey experience proved invaluable during the 2002 survey. Leslie's vast experience and knowledge proved priceless in getting this project completed. Leslie also procured spare trawl nets, doors and other gear, and administered the charter vessel contract. Her assistance was greatly appreciated. Additional thanks goes to ADF&G personnel Wes Jones, and Shawna Karpovich who assisted with onboard sampling. Simon Kinneen a Fishery Biologist with the Norton Sound Economic Development Corporation also assisted with onboard sampling during the survey.

This work was funded in part by Cooperative Agreement NA16FN1275 from the National Oceanic and Atmospheric Administration. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its subagencies.

OEO/ADA STATEMENT

The Alaska Department of Fish and Game administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information please write to ADF&G, P.O. Box 25526, Juneau, AK 99802-5526; U.S. Fish and Wildlife Service, 4040 N. Fairfax Drive, Suite 300 Webb, Arlington, VA 22203; or O.E.O., U.S. Department of the Interior, Washington DC 20240. For information on alternative formats for this and other department publications, please contact the department ADA Coordinator at (voice) 907-465-4120, (TDD) 907-465-3646, or (FAX) 907-465-2440.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES.....	iv
LIST OF FIGURES.....	v
LIST OF APPENDICES.....	vi
ABSTRACT.....	vii
INTRODUCTION.....	1
METHODS.....	2
Trawl Survey.....	2
King Crab Population Estimation.....	3
King Crab Distribution, Shell Age, and Size Structure.....	4
Catch Sampling and Other Species.....	5
RESULTS.....	6
Trawl Survey.....	6
King Crab Population Estimation.....	6
King Crab Distribution, Shell Age, and Size Structure.....	7
Catch Sampling and Other Species.....	7
DISCUSSION.....	8
LITERATURE CITED.....	10
TABLES.....	13
FIGURES.....	21
APPENDIX.....	34

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Station data and number of red king crab, by sex, captured during the Alaska Department of Fish and Game, Norton Sound trawl survey, July 27 – August 6, 2002 (resurveyed stations are indicated in bold).....	13
2. Norton Sound trawl survey dates, gear type, total number of successful tows, number of resampled stations, and the sampling time schedule	15
3. Standardized results from population assessment surveys for red king crabs in Norton Sound since 1976	16
4. Abundance estimates and standard errors for legal male red king crab for those stations sampled twice during the 2002 Norton Sound ADF&G trawl survey.....	17
5. Length frequencies and percent ovigerity of all female red king crab captured during the 2002 Norton Sound trawl survey. Note: one female crab caught was not measurable	18
6. The top 30 ranking by total weight of each taxon identified during the Norton Sound red king crab trawl survey by the ADF&G, 2002.	20

LIST OF FIGURES

<u>Table</u>	<u>Page</u>
1. Station identification numbers for the 2002 ADF&G Norton Sound trawl survey.....	21
2. Bottom temperatures (C) from the 2002 ADF&G Norton Sound trawl survey	22
3. Legal male red king crab catches for the 2002 ADF&G Norton Sound trawl survey.....	23
4. Pre-1 male red king crab catches for the 2002 ADF&G Norton Sound trawl survey.....	24
5. Pre-2 male red king crab catches for the 2002 ADF&G Norton Sound trawl survey.....	25
6. Female red king crab catches for the 2002 ADF&G Norton Sound trawl survey.....	26
7. Length frequency distribution of all male red king crab measured (standard and nonstandard stations) during the 2002 Norton Sound Trawl Survey.....	27
8. Length frequencies by shell age of all legal male red king crab captured (standard and nonstandard stations) in the 2002 Norton Sound red king crab trawl survey.....	28
9. Norton Sound legal red king crab length frequencies from the 2002 winter pot study (top), 2002 summer commercial fishery (middle) and 2002 trawl survey (bottom).....	29
10. Norton Sound length frequencies for all male red king crab captured (standard and non standard stations) in the trawl surveys, 1976 – 2002	30
11. Length frequencies by shell age of all sublegal male red king crab captured (standard and nonstandard stations) in the 2002 Norton Sound red king crab trawl survey.....	33

LIST OF APPENDICES

<u>Appendix</u>	<u>Page</u>
A. 2002 Norton Sound ADF&G trawl survey data for the legal male red king crab at each station sampled during the original survey. Information includes standard and nonstandard stations	34

ABSTRACT

The Alaska Department of Fish and Game conducted a trawl survey of Norton Sound to collect and analyze information on the distribution and abundance of demersal fishes and invertebrates from July 27 through August 6, 2002. This project focuses on red king crab *Paralithodes camtschatica* data; in particular, population size, structure, and distribution; and shell age in relation to prerecruits, recruits, and postrecruit portions of the population. Population estimates were generated using an area-swept method as conducted in previous trawl surveys of Norton Sound. Legal male abundance was estimated at approximately 772,000 crabs, equivalent to a biomass estimate of 2.3 million pounds. The 2002 trawl survey biomass estimate is slightly less than half of the 1999 estimate and is 27% less than the long-term average since 1976. Pre-1 male abundance was estimated at approximately 518,000 crabs, 54% less than the 1999 estimate and only slightly less than the long-term average since 1976. Pre-2 male abundance was estimated at approximately 427,00 crabs, and was more than four times greater than the 1999 pre-2 estimate.

INTRODUCTION

Several investigations provided preliminary information on the distribution and abundance of demersal biota (Andriyashev 1937 and Ellison et al. 1950) before the Atomic Energy Commission assessment survey of demersal fishes and invertebrates of the southeast Chukchi Sea/Norton Sound region in 1959 (Wilimovsky 1966). From 1976 through 1991, the National Marine Fisheries Service (NMFS) carried out a comprehensive program conducting triennial stock assessment trawl surveys of Norton Sound designed 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, and Stevens 1992). Additionally, in 1980, 1981, 1982, and 1985, the Alaska Department of Fish and Game (ADF&G) conducted Norton Sound red king crab *Paralithodes camtschatica* pot surveys designed to provide: (1) annual distribution, abundance, and size class information; and (2) pre-season information to fishery managers regarding stock size and structure (Powell et al. 1983, ADF&G 1982a, ADF&G 1982b, Schwarz 1984, and Brannian 1987).

The NMFS eliminated Norton Sound from the 1994 triennial trawl survey schedule because of budget constraints. The 1996 ADF&G trawl assessment was the first survey since the 1991 NMFS survey, and the first Department trawl survey of Norton Sound (Blau et al. 1996 and Fair 1997). ADF&G conducted the 1999 crab trawl assessment survey and results are summarized in Fair and Brennan (2001). The purpose of the 1996, 1999 and 2002 trawl surveys was to provide abundance estimates of the Norton Sound red king crab population, crab size data and related biological characteristics; and to document benthic species composition in Norton Sound. The 2002 survey adds to the historical survey record and provides continuity in stock assessment methods. Ultimately, the information assessed by this project is used to determine the legal component of the red king crab population to better manage the commercial fisheries in the region. This report includes data on the abundance and size structure, biomass and distribution of the Norton Sound red king crab population from the 2002 survey.

The prioritized objectives for the 2002 Norton Sound red king crab trawl survey are listed below.

- Estimate the abundance and describe the size structure of the Norton Sound red king crab population.
- Describe the spatial distribution of the Norton Sound red king crab population and associated marine life. Compare the abundance, size structure and distribution of the present Norton Sound red king crab population with the historical trawl survey record.
- Collect the lengths, weights and additional biological data from other commercial or potentially commercial species captured; specifically, blue king crabs *Paralithodes platypus* and Pacific halibut *Hippoglossus stenolepis*.

The regulatory description of the Norton Sound section, located in the Northern District of Area Q, includes all waters east of 168° W longitude between the latitudes of Cape Romanzof and Cape Prince of Wales. The commercial fishing seasons for red king crabs in Norton Sound occur in two periods: (1) from June 15 through September 3 (summer season); and (2) through the ice only, from November 15 to May 15 (winter season). Although the commercial fishery commenced in 1977, subsistence users who primarily fish through the ice during the winter have long harvested red king crabs.

Summer commercial fishery harvests have averaged 0.5 million pounds annually, ranging from a high of 2.9 million pounds in 1979 to a low of 0.02 million pounds in 1999. The winter commercial fishery is nominal, averaging about 2,400 crabs annually since 1978.

Population abundance estimates from the trawl survey are evaluated separately and incorporated into a model developed by Zheng et al. (1998). This model provides estimates of the legal and sublegal population size. A legal male red king crab is defined as having a carapace width ≥ 121.8 mm (4.75 inches) or approximately 104 mm carapace length (CL). The model provides population size estimates for the two male sublegal crab categories, pre-2 crab requiring two or more molts to reach legal size and having a CL from 76 to 89 mm, and pre-1 crab requiring one molt to reach legal size and having a CL from 90 to 103 mm. 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 comes from trawl surveys, collected onboard moving ships, which are susceptible to large errors in weight estimation. For management purposes, we simply multiply abundances by 3.0 pounds, the average weight of legal male crabs from the summer commercial fishery. Since 1976, red king crab trawl survey population estimates for legal males have ranged from 0.6 million crabs in 1996 to 1.7 million crabs in 1976, and averaging 1.1 million crabs.

METHODS

Trawl Survey

The 2002 ADF&G assessment survey was conducted aboard the chartered FV *Peggy Jo* from July 27 through August 6. For the 2002 Norton Sound assessment, we adopted the nonrandom, systematic station location design used by NMFS in their six trawl surveys of Norton Sound and by ADF&G in 1996 and 1999. This approach provided us with a comparable survey pattern for the documentation of marine life in this area. We utilized the existing 10 x 10 nmi grid pattern, previously established for Norton Sound, with each grid identified by a station number (Figure 1). The centers of each survey station, denoted by latitude and longitude coordinates, indicate where each trawl began within a station (Table 1).

We towed a 400 eastern otter trawl, spread by two 1.5 x 2.1 m Astoria "V" doors for approximately one-half hour at a speed of approximately two knots/hour to cover a distance of 1.85 km (1-nmi). The global positioning system (GPS) calculated the location and distance towed. We recorded bottom temperatures of each tow with a computerized submersible probe, recorded at one-minute intervals. The probe's data was downloaded to a laptop computer each evening after the completion of all stations.

The highest priority was to trawl the target 38 stations, followed by the 32 stations in tiers 1, 2, and 3 in prioritized fashion, tiers 1-3 (Figure 1).

King Crab Population Estimation

Only catches from standardized stations were included in the population assessment procedures, as described in Fair (1998). Population estimates for red king crab 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 section trawled. Abundance for the j th section was estimated as:

$$\hat{N}_j = n_j * \frac{A_j}{a_j} , \tag{1}$$

where A is the total area of the section (Alverson and Pereyra 1969). The total abundance is estimated as:

$$\hat{N} = \sum_j \hat{N}_j .$$

2)

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

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

(Seber 1982; page 22).

The area-swept method assumes that catch is proportional to the area physically trawled and the density of crab (Ricker 1940, Gulland 1964). This assumption is likely satisfied. The method also assumes that density in the area physically trawled is representative of the grid section in which a trawl is located. The variance estimator assumes the probability that an animal is 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, the distribution of animals within an area is likely dependent on various factors, such as bottom topography and patterns of seasonal migration. Given the

relatively large size of the sampling grid, these assumptions may be violated. The degree to which potential violations of these assumptions may bias the estimator is unknown.

The variation of legal male abundance for comparison between years and between original and resurveys was estimated using two approaches. Both approaches incorporate the use of a coefficient of variation (CV), calculated as the standard error divided by the estimate. The first approach determines CV by using the legal male abundance estimate and its associated standard error. The second approach uses data collected only at those stations surveyed multiple times. Specifically, the standard error of the sum of the original and resurveyed abundance estimates are divided by the sum of the average abundance estimates from the original and resurveys.

King Crab Distribution, Shell Age, and Size Structure

We sampled all red and blue king crabs from each trawl, examining them for sex, size, legality, shell age and egg development, if applicable. We recorded the number and weight of each individual crab by species captured. 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.

We aged all king crab shells based on the shell condition. The shell condition method defines shell-age classes in the following way using the ventral side of the coxa of the walking legs (pereopods).

Soft-shell: 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: Coxa and ventral surface of exoskeleton white. The legs are mostly full of muscle, meri 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.

Old-shell. The distal portion of the ventral coxa is partially or totally rimmed with brown scratches or dots. Note: some crabs classified as old-shell are probably less than one year old but share the coxa characteristic of old-shell crabs. The legs are full of muscle and the meri 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 meri 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.

Catch Sampling and Other Species

As the net was retrieved, fishes and crabs were shaken from the intermediate portion of the net down to the codend. Once onboard, we placed a lifting strap around the codend and weighed it using a crane scale. We recorded all pertinent information on data forms. The contents of the trawl were emptied on deck, and the tare weight of the net section originally weighed was reweighed and recorded.

All Pacific halibut and large Pacific cod *Gadus macrocephalus* were retrieved from each haul before subsampling. The total number of each species captured was recorded. Halibut were measured for total length (snout tip to end of tail) in cm. Halibut were not weighed, but their length was converted to a whole weight using a conversion table.

After the removal of all king crab, Pacific halibut, Pacific cod, large fish, and large debris from the catch, we subsampled the remaining catch. We used a shovel to fill two or three baskets from the remaining haul. The sampling fraction for estimating haul totals is calculated as the weight of the sample, divided by the weight of the total haul, minus the weight of the aforementioned items.

The fishes and invertebrates of each sampling basket were separated to the lowest taxon, and from debris (sticks, algae, garbage, tundra, etc.). We weighed and counted each taxon, assigned a NMFS species code and recorded the data. Total length measurements of non-target fishes were taken when possible.

Each day we checked the data for accuracy and entered it in a database on a notebook PC. Additionally, we maintained a daily radio schedule with the ADF&G office in Nome at 0900 hours to transmit catch information and trawl completion. We used a digital camera to document portions of the survey (e.g. crew, trawling process and captured marine life), files of which are located in the Nome field office.

RESULTS

Trawl Survey

We had 60 successful tows from 76 attempts in daylight hours between July 27 and August 6 (Table 2). Fifteen stations (see footnote b, Table 1) had to be retowed because of problems with gear performance. One tow (stations 101) was unsuccessful and redone because large rocks captured in the net effected fishing efficiency. Stations 177, 178, and 205 were not trawled because these sites have never been successfully trawled previously. Also, stations 162, 188, 206, 207, 222 and 223 were not trawled in 2002 because these stations have a rocky sea bottom and are unsuitable for trawl gear. Of the 60 successfully trawled stations, two were successfully resurveyed on the same day as the original survey, and one was resurveyed two days after the original survey. Resurveys were towed at the same depth, in close proximity to the initial tow track, and for similar lengths at each respective station.

The target tow distance was 1.85 km (1.0 nm); the average tow distance was 2.40 km (1.3 nm) (Table 1). The average trawl depth was 9 fathoms, ranging from 7 fathoms at station 202 to 16 fathoms at station 183.

The average bottom temperature for all tows ranged between 1.33 and 14.37 degrees C. The coldest temperatures occurred at stations 187 and 161 with readings of 1.3 and 1.5 degrees C, respectively (Table 1; Figure 2). The warmest temperatures occurred at stations 201 with a reading of 14.7 degrees C (Table 1).

King Crab Population Estimation

Legal and pre-1 male catches were considerably smaller in 2002 compared to the previous survey in 1999. We captured 94 legal males (Figure 3), of which 90 were located in the standardized area (Table 3). Sixty-six pre-1 males were captured in the survey (Figure 4), including 65 in the standardized area. Fifty-two pre-2 male were captured, all in the standardized area (Figure 5). Most male crabs were found in the stations south-southeast of Nome and in stations south of Golovin Bay. Female crabs were most abundant in the areas just southeast of Nome and south of Golovin Bay (Figure 6).

Similar to the 1999 trawl survey, the 2002 survey provided resurvey catch information that could be used for replicate abundance estimation with a corresponding variance between surveys for each retowed station (Appendix A). All three stations resurveyed captured legal males in both tows.

The estimated abundance of legal male red king crabs was 771,569 with a corresponding biomass of approximately 2.3 million pounds (Table 3), down from the 1999 legal male abundance estimate of 1.6 million crabs. Estimated abundances for pre-1 and pre-2 males were 518,638 and 427,703 crabs, respectively (Table 3). The 2002 pre-1 male abundance estimate is down from the 1999 all time high abundance of 940,198 crabs. Conversely, the pre-2 male abundance estimate of 427,703 crabs is four times greater than the 1999 pre-2 abundance. A female abundance estimate was not generated because of the sporadic female distribution observed, but the female catch of 151 crab almost double that of the 1999 survey.

Stations with original and resurveys had similar abundance estimates for legal male crabs (Table 4). The resulting coefficient of variation for the original and resurveyed abundance estimates was 10%. This is greater than the 1% observed from the 1999 trawl survey, but far less than the 36% observed from the 1996 trawl survey.

King Crab Distribution, Shell Age, and Size Structure

The length frequency for all male crabs (N=287) caught during the 2002 Norton Sound trawl survey is shown in Figure 7. The distribution is made up of 65% prerecruits, 6% recruits, and 29% postrecruit male crabs, ranging in size from 27 to 149 mm CL with a mean of 91 mm CL. In the legal category (N=99), sizes range from 98 to 149 mm CL (Figure 8) with a mean of 115 mm CL. Figure 9 shows the length frequency for legal males from the 2002 winter pot study (N=173), summer commercial fishery (N=5,220), and trawl survey (N=99). From this comparison, we see visually similar distributions for all three. The 2002 trawl survey length frequency distribution for legal males is shifted farther to the left than the 1999 survey, and has distinct similarities to the 1996 distribution (Figure 10). For sublegal males (N=168, Table 5), the average size was 76 mm CL.

Female length frequencies related to adult percent ovigerity shows that most of the adult females had high (60-89%) or full (90-100%) egg clutches (Table 5). Approximately 75% of the female crabs captured were adults. The average length of juvenile female crab was 38.2 mm and the average length of adult female crab was 82.9 mm (Table 5).

Catch Sampling and Other Species

There were 160 taxa identified for a combined weight of 31,209 kg. The top five ranking taxa composed 65% of the total weight of all marine life, consisting of the purple-orange sea star, red king crab, Pacific cod, walleye pollock and the black spined sea star (Table 6). Of the top 30 ranking taxa by weight, invertebrate species accounted for 67% of the catch.

DISCUSSION

The 1996, 1999, and 2002 ADF&G Norton Sound trawl surveys 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 used on all six NMFS surveys in Norton Sound from 1976 to 1991 was an 83-112 trawl, whereas ADF&G used a 400 eastern trawl. The 83-112 trawl has a similar footrope configuration to the 400 eastern and tows similarly over rough bottom. It is unlikely that catch selectivity differences exist between the 83-112 trawl used by NMFS and the 400 eastern used by ADF&G (Robert Otto, NMFS, personal communication to Lowell Fair).

The 2002 legal male abundance estimate was less than half of the 1999 abundance estimate, yet above the all time low in 1996. This decrease was expected, as the 1999 trawl survey indicated an exceptionally weak prerecruit-2 abundance. The prerecruit-2 crabs observed in 1999 now make up the recruit and postrecruit portion of the legal population. The Norton Sound summer commercial crab harvest has shown an almost 10 percent decrease in recruitment since the 1999 season.

The 2002 pre-1 male abundance estimate was lower than the all-time high observed in 1999, but higher than the three prior surveys. These crabs will molt and give a much-needed boost to the recruit portion of the legal crab biomass in 2003. Prerecruit-2 male crab abundance was over four times greater than 1999 and the fourth highest abundance estimate since 1976 indicating increased recruitment for the 2004 and 2005 seasons. These recruitment events should push the legal population to higher levels than we presently observe.

The area-swept method for abundance estimation assumes that catch is proportional to the area physically trawled and crab density (Ricker 1940, Gulland 1964). This assumption is likely satisfied. The method also assumes that crab density in the area physically trawled is representative of the grid section in which a trawl is located. The variance estimator assumes the probability of a crab 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, the distribution of crabs within an area is likely dependent on various factors, such as bottom topography and patterns of seasonal migration. Given the relatively large size of the sampling grid, these assumptions may be violated. The degree to which potential violations of these assumptions may bias the estimator is unknown.

Some of the trawls during the survey were done in areas outside of the standardized zone defined in Fair (1998). Eight nonstandard stations sampled during the 2002 survey were excluded from the population estimates. All crab captured in the nonstandard stations were in tier 2. For legal males, two nonstandard stations accounted for four crabs, which is equivalent to an abundance estimate of 43,422 crab. Pre-1 male catches outside of the

standard area included 1 crab or an abundance estimate of 10,855. No pre-2 male crabs were captured at nonstandard stations.

For legal male abundance estimates, coefficients of variation (CV) were determined using two methods. First, using the standard approach, the CV for 2002 legal male abundance is 11.1%, similar to the 1999 CV of 8.1%. In the second approach the CV is 10% and is based on a comparison of original survey and resurvey abundance estimates. The 1999 CV was only 1.0%. If the resurveys can be considered to provide correct replication, the second estimate of the CV is an essentially nonparametric estimate, and probably the most accurate.

LITERATURE CITED

- Alaska Department of Fish and Game. 1982a. Westward region king crab survey results for 1982. Division of Commercial Fisheries, Kodiak.
- Alaska Department of Fish and Game. 1982b. Annual management report 1982 Norton Sound-Port Clarence-Kotzebue. Division of Commercial Fisheries, Anchorage.
- Alverson, D.L. and W.T. Pereyra. 1969. Demersal fish explorations in the northeastern Pacific Ocean. J. Fish. Res. Board Can. 26:1985-2001.
- Andriyashev, A.P. 1937. A contribution to the knowledge of the fishes from the Bering and Chukchi Seas. In Russian. Explor. Des mers de l' urss. Fasc. 25, Inst. Hydro. Leningrad, p. 292-355.
- Blau, S.F., L. J. Watson, and J. Blackburn. 1996. The 1996 Norton Sound red king crab trawl survey. Alaska Department of Fish and Game, Regional Information Report No. 4K96-54, Kodiak.
- Brannian, L.K. 1987. Population assessment survey for red king crab (*Paralithodes camtschatica*) in Norton Sound, Alaska, 1985. Alaska Department of Fish and Game, Technical Data Report No. 214, Juneau.
- Ellison, J.G., B. Knake, and J. Dassow. 1950. Exploratory fishing expedition to the northern Bering Sea in June and July, 1949. United States Fish & Wildlife Service, Fishery Leaflet 369, Washington, D.C.
- Fair, L.F. and E.L. Brennan. 2001. Analysis of red king crab data from the 1999 ADF&G trawl survey of Norton Sound. Alaska Department of Fish and Game, Commercial Fisheries Division, AYK Region, Regional Information Report 3A00-26, Anchorage.
- Fair, L.F. 1998. Standardization of Norton Sound trawl survey red king crab abundance estimates. Alaska Department of Fish and Game, Commercial Fisheries Division, AYK Region, Regional Information Report 3A98-36, Anchorage.
- Fair, L.F. 1997. Analysis of red king crab data from the 1996 ADF&G trawl survey of Norton Sound. Alaska Department of Fish and Game, Commercial Fisheries Division, AYK Region, Regional Information Report 3A97-10, Anchorage.
- Gulland, J.A. 1964. Catch per unit effort as a measure of abundance. Rappt. Proces.-Verbaux Reunions Conseil Perm. Intern. Exploration Mer. 155:8-14.

LITERATURE CITED (Continued)

- National Marine Fisheries Service. 1982. Cruise results: cruise no. MF-82-3 NOAA R/V *Miller Freeman* (Norton Sound - northeastern Bering Sea crab - groundfish survey). National Marine Fisheries Service, unpublished report. December 1982.
- Powell, G.C., R. Peterson, and L. Schwarz. 1983. The red king crab, *Paralithodes camtschatica* (Tilesius) in Norton Sound, Alaska: history of biological research and resource utilization through 1982. Alaska Department of Fish and Game, Informational Leaflet 222, Juneau.
- Ricker, W.E. 1940. Relation of "catch per unit effort" to abundance and rate of exploitation. J. Fish. Res. Bd. Canada 5:43-70.
- Sample, T.M. and R. J. Wolotira, Jr. 1985. Demersal fish and shellfish resources of Norton Sound and adjacent waters during 1979. National Marine Fisheries Service, Northwest and Alaska Fisheries Center, NOAA Technical Memorandum NMFS F/NWC-89. October 1985. 208 pages.
- Seber, G.A.F. 1982. The Estimation of Animal Abundance and related parameters. Charles Griffin & Company Limited, England.
- Stevens, B.G. 1992. Results of the 1991 NMFS survey of red king crab in Norton Sound. National Marine Fisheries Service, Alaska Fisheries Science Center, unpublished memorandum to the State of Alaska. May 1992.
- Stevens, B.G. 1989. Analysis of crab data from the 1988 NMFS survey of Norton Sound and the northeast Bering Sea. National Marine Fisheries Service, Northwest and Alaska Fisheries Center, unpublished Report. February 1989.
- Stevens, B.G. and R.A. MacIntosh. 1986. Analysis of crab data from the 1985 NMFS survey of the northeast Bering Sea and Norton Sound. National Marine Fisheries Service, Northwest and Alaska Fisheries Center, NWAFC Processed Report 86-16. September 1986.
- Schwarz, L. 1984. Norton Sound section of the Bering Sea 1983 king crab fishery report to the Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region III: Shellfish Report No. 5, Anchorage.
- Wilimovsky, N.J. 1966. Synopsis of previous scientific explorations. In N.J. Wilimovsky and J.N. Wolf (editors), Environment of the Cape Thompson region, Alaska, p. 1-5. U.S. Atomic Energy Comm., Wash., D.C.

LITERATURE CITED (Continued)

- Wolotira, R.J., Jr., T.M. Sample, and M. Morin, Jr. 1977. Demersal fish and shellfish resources of Norton Sound, the southeastern Chukchi Sea, and adjacent waters in the baseline year 1976. National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Processed Report. October 1977. 292 pages.
- Zheng, J., G.H. Kruse, and L. Fair. 1998. Using multiple data sets to assess red king crab in Norton Sound, Alaska: length-based stock synthesis. Fishery Stock Assessment Models, Alaska Sea Grant College Program, AK-SG-98-01.

Table 1. Station data and number of red king crab, by sex, captured during the Alaska Department of Fish and Game, Norton Sound trawl survey, July 27 - August 6, 2002 (resurveyed stations are indicated in bold).

Haul #	Station No.	Month	Day	Station Location				Compass heading (degrees)	Distance towed (nmi)	Ave. Depth (fm)	Bottom temp (°C)	Female Red King Crab		Male Red King Crab			Legal	
				N. Latitude		W. Longitude						Juveniles	Adults	Sublegal			Recruit	Postrecruit
				Deg.	Min.	Deg.	Min.							Threes (<76 mm)	Twos (76 to 89 mm)	Ones (>89 mm)		
1	184	July	27	64	2004	165	2047	140	1.0	12	10.1	3	4	3	2	3	2	2
2	184	July	27	64	1939	165	1713	165	1.0	12	9.8	2	2	5	4	2	3	4
3	183	July	27	64	2009	164	5819	90	1.0	16	10.0	4	14	10	12	11	2	14
4	183	July	27	64	1967	164	5662	270	1.0	14	10.2	0	23	2	7	12	1	15
5	182	July	27	64	2046	164	3675	50	1.0	8	11.9	0	0	0	0	0	0	1
6	181	July	27	64	2018	164	1162	90	1.0	6	12.3	0	0	0	0	0	0	0
7	203	July	27	64	3051	164	0998	240	1.0	9	11.1	0	1	0	0	0	0	0
8	202	July	28	64	3012	163	4747	90	1.0	7	11.0	0	0	0	0	0	0	0
9	180	July	28	64	2024	163	4767	250	1.0	8	11.0	2	0	1	0	0	0	0
10	179	July	28	64	1976	163	2671	270	1.0	9	10.1	0	0	1	0	0	0	0
11	201	a	July	28	64	2915	162	1630	225	0.5	6	14.7						
12	201	July	28	64	2964	162	1583	190	1.0	6	14.4	0	0	0	0	0	0	0
13	176	July	28	64	2010	162	1717	190	1.0	8	9.2	0	0	0	0	0	0	0
14	150	b	July	28	64	1022	162	1921	240	1.0	8	9.2	0	0	0	0	0	0
15	123	b	July	29	64	0011	162	2003	190	1.0	8	6.6	0	0	0	1	0	2
16	124	b	July	29	63	5987	162	4220	260	1.0	9	7.6	0	0	0	1	0	0
17	151	b	July	29	64	0999	162	4049	270	1.0	10	8.4	0	2	1	0	0	0
18	152	b	July	29	64	1003	163	0315	270	1.0	12	7.4	0	0	0	0	0	0
19	125	b	July	29	63	5985	163	0253	270	1.0	8	8.4	0	2	0	0	0	0
20	126	b	July	29	64	0024	163	2558	270	1.0	9	8.1	0	3	1	0	1	1
21	153	b	July	29	64	1026	163	2329	270	1.0	9	8.1	0	3	0	0	0	1
22	154	b	July	29	64	1025	163	4809	280	1.0	9	11.2	1	0	2	0	0	0
23	127	b	July	30	64	0076	163	4962	270	1.0	8	9.3	0	3	1	0	1	0
24	128	b,c	July	30	63	5987	164	1226	270	1.0	8	x	0	0	0	0	0	0
25	155	b,c	July	30	64	1079	164	0992	270	1.0	8	x	3	0	1	0	0	0
26	156	b,c	July	30	64	1062	164	3143	270	1.5	7	x	0	0	0	1	0	0
27	129	b	July	30	64	0018	164	3341	270	1.5	9	11.2	0	0	0	0	0	1
28	129	July	30	64	0004	164	3370	270	1.5	9	9.7	0	6	0	1	0	0	0
29	130	July	30	63	5994	164	5390	285	1.5	8	9.9	0	1	2	2	0	0	1
30	157	July	30	64	0915	164	5651	285	1.5	7	11.1	0	0	0	1	0	0	3
31	158	c	July	31	64	0925	165	1933	320	1.4	8	x	0	1	0	0	0	2
32	131	c	July	31	64	0116	165	1400	270	1.3	8	x	0	5	0	0	1	0
33	132	July	31	64	0045	165	3803	300	1.5	9	5.9	0	1	1	5	3	0	4
34	159	July	31	64	0861	165	4330	330	1.4	9	7.8	0	2	0	1	0	1	1
35	185	July	31	64	1922	165	4546	5	1.4	10	10.4	4	4	7	1	1	0	2
36	204	July	31	64	2948	165	4389	280	1.4	8	10.8	0	0	0	0	0	0	0
37	186	c	Aug	1	64	1988	166	0646	270	1.4	11	x	0	0	1	1	0	1
38	187	Aug	1	64	1962	166	3132	280	1.3	13	1.3	0	0	0	0	0	0	1
39	161	Aug	1	64	0994	166	2898	170	1.4	13	1.5	0	0	0	0	0	0	0
40	160	Aug	1	64	0872	166	0764	0	1.4	11	1.7	0	0	0	0	0	0	1
41	133	Aug	1	64	0039	166	0510	160	1.4	11	1.7	0	0	0	0	0	0	2
42	134	Aug	1	63	5982	166	2682	320	1.4	14	1.6	0	0	0	0	0	0	1
43	135	Aug	1	63	5957	166	5050	320	1.4	16	2.2	0	1	0	0	1	0	0

(Continued)

Continued

Haul #	Station No.	Month	Day	Station Location				Compass heading (degrees)	Distance towed (nmi)	Ave. Depth (fm)	Bottom temp	Female Red King Crab		Male Red King Crab			Recruit	Postrecruit
				N. Latitude	W. Longitude	Deg.	Min.					Deg.	Min.	Juveniles	Adults	Threes (<76 mm)		
44	107	Aug	2	63	5022	166	2807	165	1.4	15	2.9	0	0	0	0	0	0	0
45	82	Aug	2	63	4016	166	2794	90	1.4	13	2.4	0	0	0	0	0	0	0
46	81	Aug	2	63	3990	166	0680	0	1.4	13	2.0	0	0	0	0	0	0	0
47	106	Aug	2	63	4918	166	0549	0	1.4	13	1.6	0	0	0	0	0	0	0
48	105	Aug	2	63	5002	165	4335	120	1.5	10	3.1	0	0	0	0	2	0	2
49	80	Aug	2	63	4088	165	4250	180	1.5	10	2.1	0	0	0	0	0	0	2
50	79	Aug	2	63	3931	165	2211	0	1.4	8	6.6	0	0	0	1	4	0	1
51	104	Aug	2	63	4988	165	2018	0	1.4	8	7.8	0	1	2	2	3	1	2
52	78	Aug	3	63	4064	164	5625	340	1.4	7	9.7	0	0	0	0	0	0	0
53	103	Aug	3	63	4975	164	5926	330	1.4	7	10.7	3	1	0	0	0	0	0
54	156	^d Aug	3	64	1035	164	3580	90	1.4	7	11.0	0	1	0	0	0	0	0
55	155	^d Aug	3	64	1086	164	1208	85	1.4	8	10.3	8	1	16	2	0	0	0
56	128	^d Aug	3	64	0002	164	1434	90	1.4	7	10.8	0	0	0	0	0	0	0
57	127	^d Aug	3	64	0030	163	5188	85	1.4	8	9.0	1	9	0	0	0	0	3
58	154	^d Aug	3	64	1014	163	5009	90	1.4	9	10.7	3	1	0	0	0	0	0
59	153	^d Aug	4	64	1035	163	2513	90	1.4	9	8.3	0	4	0	0	0	0	1
60	126	^d Aug	4	64	0041	163	2792	90	1.4	9	8.7	1	2	0	2	8	3	2
61	125	^d Aug	4	63	5996	163	0481	90	1.4	8	8.3	1	13	2	0	0	0	0
62	152	^d Aug	4	64	0986	163	0523	90	1.4	12	7.4	3	1	3	1	3	0	0
63	151	^d Aug	4	64	1008	162	4287	90	1.5	10	8.2	0	4	0	0	0	0	0
64	124	^d Aug	4	64	0005	162	4420	90	1.4	8	7.5	0	1	0	0	0	0	0
65	123	^d Aug	4	63	5997	162	2090	90	1.5	8	6.8	0	0	1	0	1	2	1
66	150	^d Aug	4	64	0983	162	2012	90	1.4	7	8.7	0	1	0	0	0	0	0
67	149	Aug	5	64	1028	161	5634	20	1.4	9	5.3	0	0	0	0	1	0	1
68	148	Aug	5	64	0986	161	3303	20	1.4	8	6.2	0	2	0	0	0	0	0
69	121	^e Aug	5	63	5972	161	3422	20	1.4	8	5.1	0	0	1	0	0	0	0
70	94	Aug	5	63	4975	161	3527	10	1.3	7	7.3	0	1	0	0	0	0	0
71	95	Aug	5	63	4970	161	5810	10	1.4	7	9.1	0	0	0	0	0	0	0
72	122	Aug	5	63	5972	161	5692	10	1.4	8	6.1	0	0	1	0	0	0	3
73	126	Aug	6	64	0055	163	2439	270	1.4	9	10.1	2	6	1	7	9	2	4
74	101	^f Aug	6	63	5039	164	1258	270	1.4	8	11.3	0	0	0	0	0	0	0
75	101	Aug	6	63	5007	164	1490	0	1.4	8	12.2	0	0	0	0	0	0	0
76	102	Aug	6	63	5014	164	3491	0	1.4	7	12.0	0	0	0	0	0	0	0
												41	127	65	55	68	17	82

^a Net damaged, no sample.^b Poor gear performance. Crab numbers not use in estimate. Tows were redone later in the survey.^c No temperature data because of problem with temperature probe.^d Stations were retowed because of poor gear performance.^e Tow contained a large amount of mud.^f Large rocks in the net effecting the fishing efficiency.

Notes: Juvenile female red king crab include all females with a carapace length < 72 mm that were nonovigerous and had had clean pleopodal setae.

Adult female red king crab include all ovigerous females and all non-ovigerous female crab with a carapace length ≥ 72 mm.

Prerecruit ones include all sublegal male crab with a carapace length > 89 mm.

Legal male red king crab are those crab with a carapace width ≥ 4.75 inches across.

Recruits are all legal newshell male crab with carapace length ≤ 115 mm.

Postrecruits are all legal newshell crab with carapace length > 115 mm, and all old shell legal crab that have obtained legal width.

Table 2. Norton Sound trawl survey dates, gear type, total number of successful tows, number of resampled stations, and the sampling time schedule.

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 Easter Otter Trawl	192	17	24-Hour-Basis
1979	7/26-8/5	83-112 Easter Otter Trawl	115	16	24-Hour-Basis
1982	9/5-9/11	83-112 Easter Otter Trawl	53	0	24-Hour-Basis
1985	9/16-10/1	83-112 Easter Otter Trawl	78	0	Daylight Hours
1988	8/16-8/30	83-112 Easter Otter Trawl	82	4	24-Hour-Basis
1991	8/22-8/30	83-112 Easter 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

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

Year	Date	Research Agency	Gear	Number of Red King Crabs Captured ^{a,c}				Population Abundance Estimates ^c			Standard Errors		
				Pre-2 Males	Pre-1 Males	Legal Males ^b	Females	Pre-2 Males	Pre-1 Males	Legal Males	Pre-2 Males	Pre-1 Males	Legal Males
1976 ^e	9/2 - 9/5, 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 ^f	7/26 - 8/5	NMFS	Trawl	N/A	N/A	90(86)	N/A			809,799			61,176
1980 ^d	7/4 - 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	7/6 - 7/20	ADF&G	Pots			2,001	424			353,273			
1982	9/5 - 9/11	NMFS	Trawl	42	107	97	256	356,724	832,581	877,722	50,116	76,454	79,907
1985	7/1 - 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 ^e	8/7 - 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 ^e	7/28 - 8/7	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 ^e	7/27 - 8/6	ADF&G	Trawl	34(18)	42(23)	61(29)	116(35)	427,703	518,638	771,569	73,494	80,741	85,303

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

^b Legal male red king crabs were defined as ≥ 121.8 mm (4.75 in) in carapace width for the pot surveys and the 1996 ADF&G trawl survey, and ≥ 104 mm for all of the NMFS trawl surveys except the 1979 survey which defined legal males as ≥ 100 mm.

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

^d 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.

^e The 1976, 1979, 1996, and 1999 catches include resampled stations (in parenthesis). The 1979 and 1996 population estimates incorporated resampled stations by combining catches and tow distances for each station resampled.

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

Table 4. Abundance estimates and standard errors for legal male red king crab for those stations sampled twice during the 2002 Norton Sound ADF&G trawl survey.

Station Number	Abundance			Standard Error	Coefficient of Variation
	Original Survey	Resurvey	Average		
126	54,277	65,132	59,705	7,676	13%
183	243,161	243,161	243,161	0	0%
184	60,790	106,383	83,587	32,239	39%
Sum	358,228	414,676	386,452	39,915	10%

Table 5. Length frequencies and percent ovigerity of all female red king crab captured during the 2002 Norton Sound trawl survey. Note: one female crab caught was not measurable.

Carapace Length (mm)	Adult Percent Ovigerity					Juvenile <72 mm	Total
	Full 90 - 100%	High 60 - 89%	Medium 30 - 59%	Low 1 - 29%	None 0%		
11						1	1
12						1	1
13							0
14							0
15							0
16						1	1
17						1	1
18							0
19							0
20							0
21							0
22							0
23							0
24							0
25							0
26						1	1
27							0
28							0
29							0
30							0
31						1	1
32							0
33							0
34							0
35							0
36							0
37							0
38							0
39						1	1
40							0
41							0
42							0
43							0
44						2	2
45							0
46							0
47						1	1
48						2	2
49							0
50						1	1
51							0
52						1	1
53						1	1
54						1	1
55							0
56							0
57						1	1
58						3	3
59						3	3
60						1	1
61							0
62						2	2
63						3	3
64						1	1
65			1			1	2

Table 5. Continued

Carapace Length (mm)	Adult Percent Ovigerity					Juvenile <72 mm	Total
	Full 90 - 100%	High 60 - 89%	Medium 30 - 59%	Low 1 - 29%	None 0%		
66						1	1
67		2				1	3
68		1				2	3
69			1			3	4
70							0
71		2	1			3	6
72	1	1	1		2		5
73	3	1					4
74	4	4					8
75		3	1		1		5
76	3		2		1		6
77	1	2	1				4
78		1					1
79	2	2	1				5
80	3	4		1			8
81	2	2	2				6
82	1	5	1		1		8
83		3	1				4
84	2	3	1				6
85	1	2		1			4
86	3	2					5
87	1	1	1		1		4
88	1		1				2
89	2	2					4
90	1	1					2
91	1	1	1				3
92	1						1
93	2	2					4
94	1						1
95	1	1					2
96	1						1
97							0
98	3						3
99							0
100							0
101		1	1				2
102							0
103	1	2	1				4
104							0
105	1		1				2
106	1	1					2
107							0
108							0
109	2						2
110							0
111							0
112							0
113	1						1
Total:	47	52	20	2	6	41	168
Percent	28%	31%	12%	1%	4%	24%	

Total number of adult females (≥ 72 mm) =
 Total number of juvenile females (<72mm) =
 Average length of juvenile females (<72mm) =
 Average length of adult females (≥ 72 mm) =
 Average length of all females =

127
 41
 38.2 mm
 82.9 mm
 76.3 mm

Table 6. The top 30 ranking by total weight of each taxon identified during the Norton Sound red king crab trawl survey by the ADF&G, 2002.

Rank	Common Name	Weight (kg)	Scientific Name or Taxon
1	Purple-orange sea star	12,239	<i>Asterias amurensis</i>
2	Red king crab	2,040	<i>Paralithodes camtschaticus</i>
3	Pacific cod	2,180	<i>Gadus macrocephalus</i>
4	Walleye pollock	2,165	<i>Theragra chalcogramma</i>
5	Black spined sea star	1,599	<i>Lethasterias nanimensis</i>
6	Saffron cod	964	<i>Eleginus gracilis</i>
7	Arctic Argid	912	<i>Argis dentata</i>
8	Myoxocephalus unidentified	883	<i>Myoxocephalus sp.</i>
9	Basket sea star	595	<i>Gorgonocephalus eucnemis</i>
10	Pacific Halibut	790	<i>Hippoglossus stenolepis</i>
11	Northern neptune	638	<i>Neptunea heros</i>
12	Giant sea star	616	<i>Evasterias echinosoma</i>
13	Harry hermit crab	578	<i>Pagurus capillatus</i>
14	Starry flounder	508	<i>Platichthys stellatus</i>
15	Yellowfin Sole	442	<i>Pleuronectes asper</i>
16	Green sea urchin	400	<i>Strongylocentrotus droebachiensis</i>
17	Helmut crab	268	<i>Telemessus cheiragonus</i>
18	Plain sculpin	243	<i>Myoxocephalus jaok</i>
19	Fuzzy hermit crab	240	<i>Pagurus trigonocheirus</i>
20	Alaska plaice	218	<i>Pleuronectes quadrituberculatus</i>
21	Rose sea star	217	<i>Crossaster papposus</i>
22	Sea anemone unidentified	187	<i>Actinaria sp</i>
23	Knobby six-rayed sea star	146	<i>Leptasterias polaris</i>
24	Aplidium unidentified	98	<i>Aplidium sp.</i>
25	Sea potato	94	<i>Styela rustica</i>
26	Antlered sculpin	81	<i>Enophrys diceraus</i>
27	Sea raspberry unidentified	80	<i>Gersemia sp</i>
28	Humpy shrimp	69	<i>Pandalus goniurus</i>
29	Fat welk	63	<i>Neptunea ventricosa</i>
30	Rock sole	62	<i>Pleuronectes bilineatus</i>

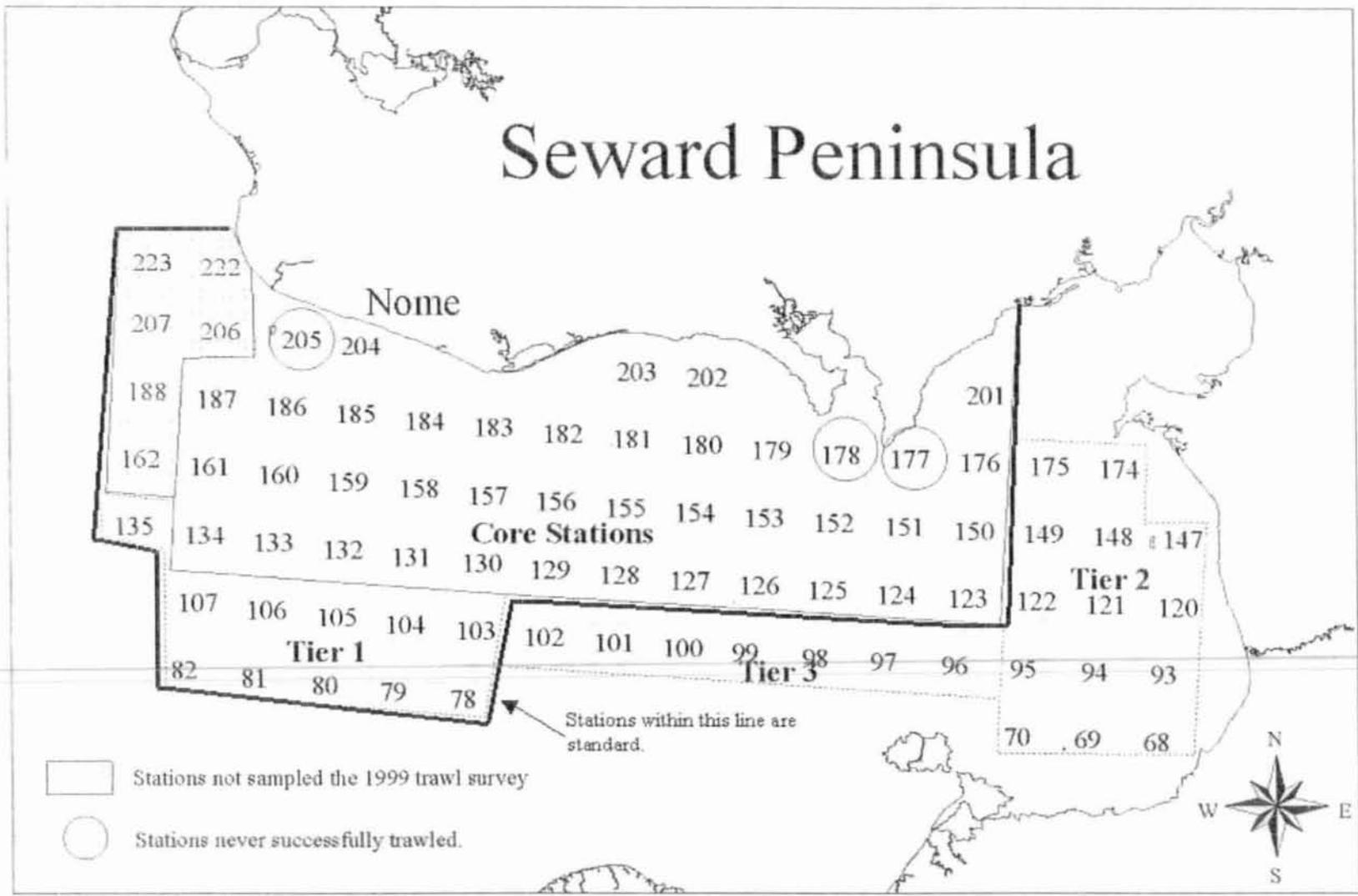


Figure 1. Station identification numbers for the 2002 ADF&G Norton Sound trawl survey.

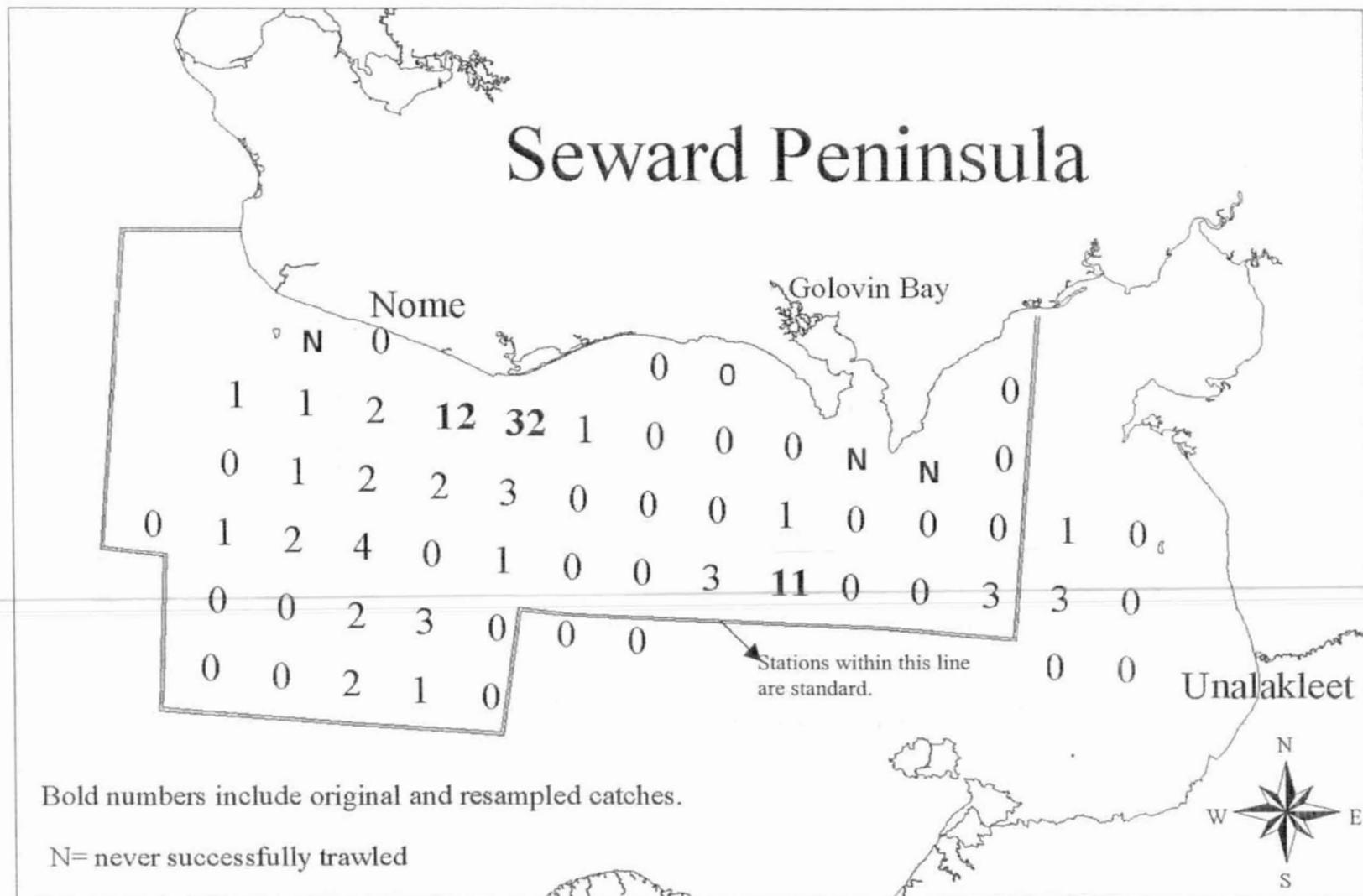


Figure 3. Legal male red king crab catches for the 2022 ADF&G Norton Sound trawl survey.

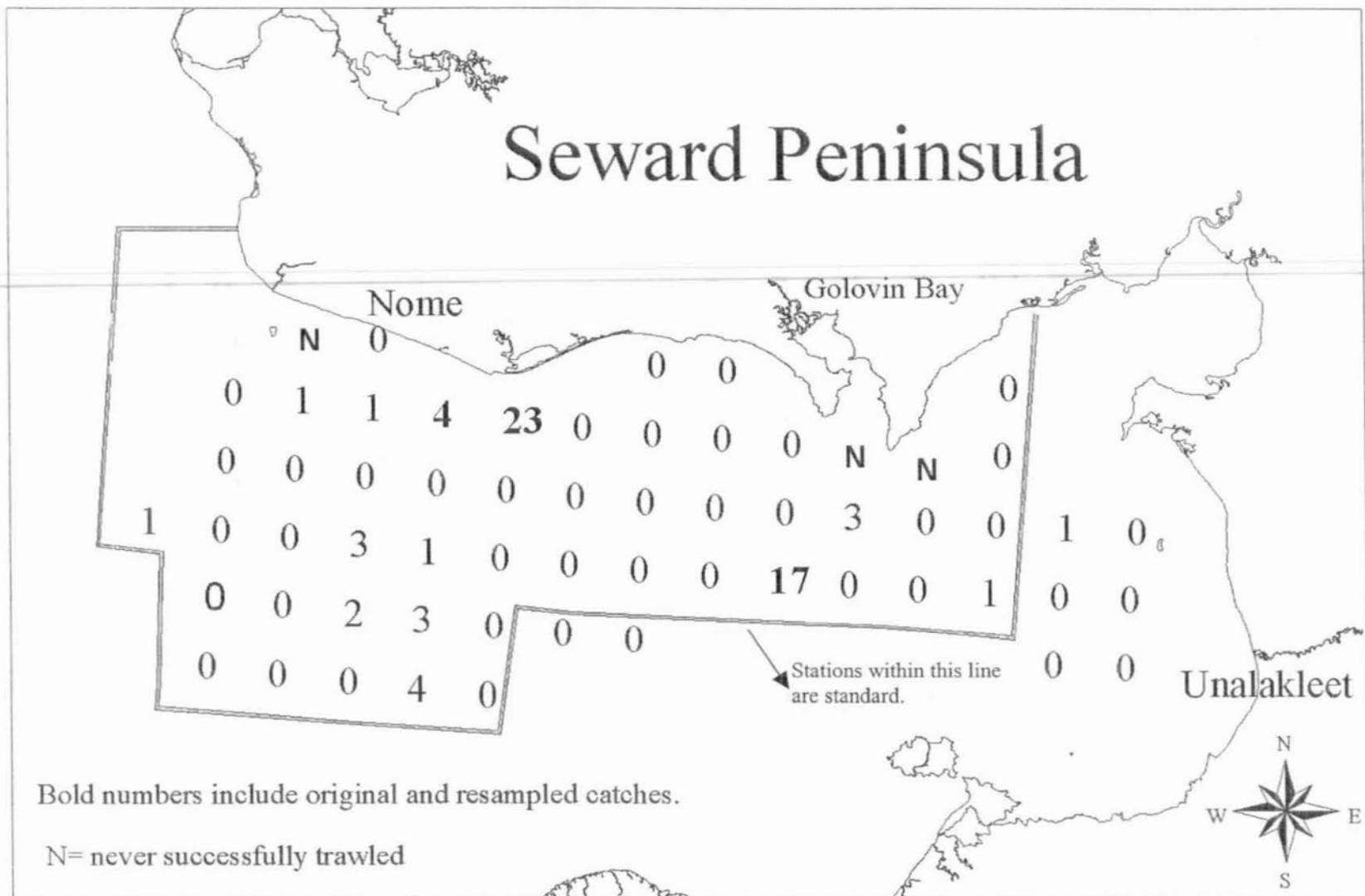


Figure 4. Pre-1 male red king crab catches for the 2002 ADF&G Norton Sound trawl survey.

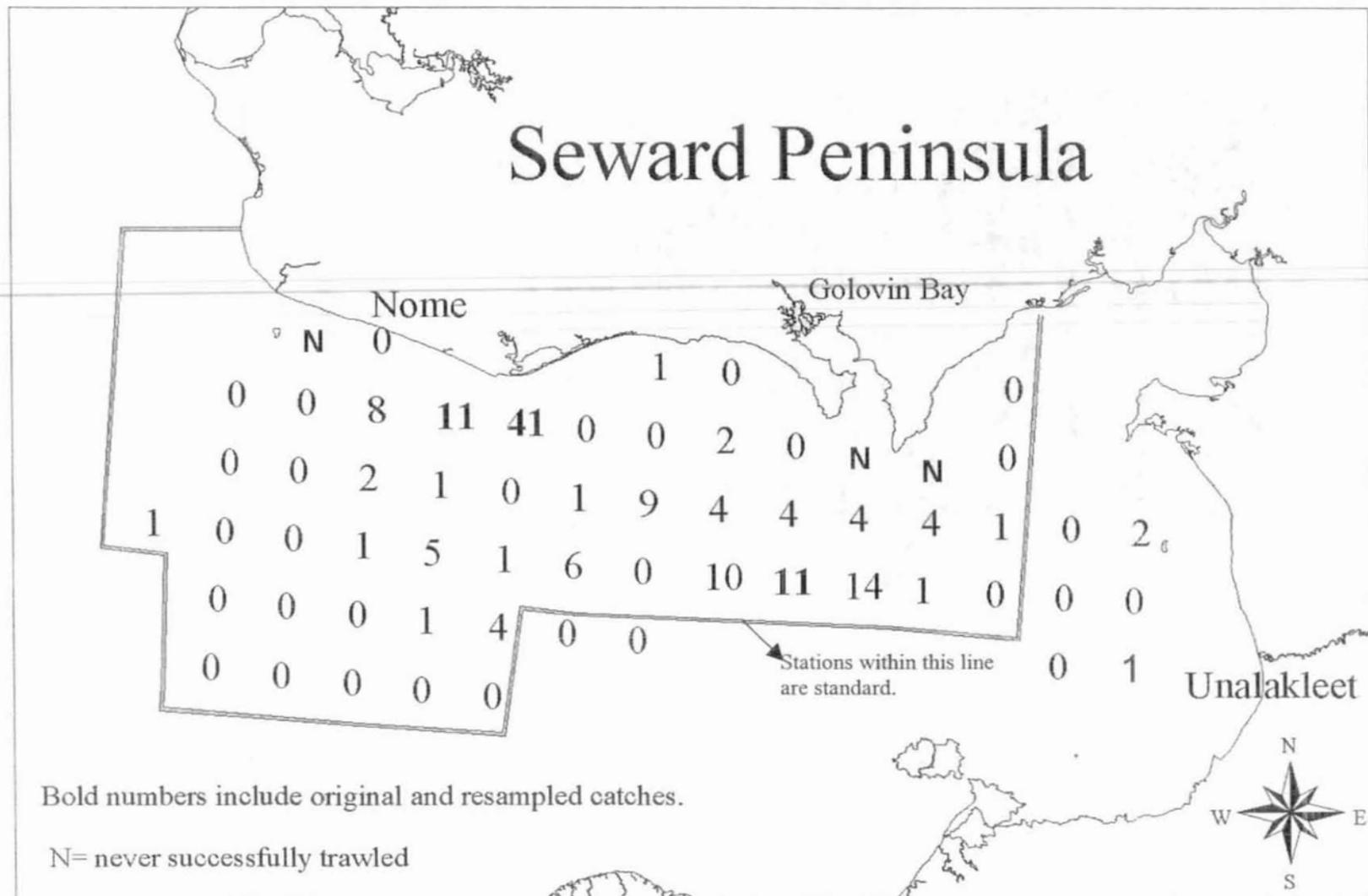


Figure 6. Female red king crab catches for the 2002 ADF&G Norton Sound trawl survey.

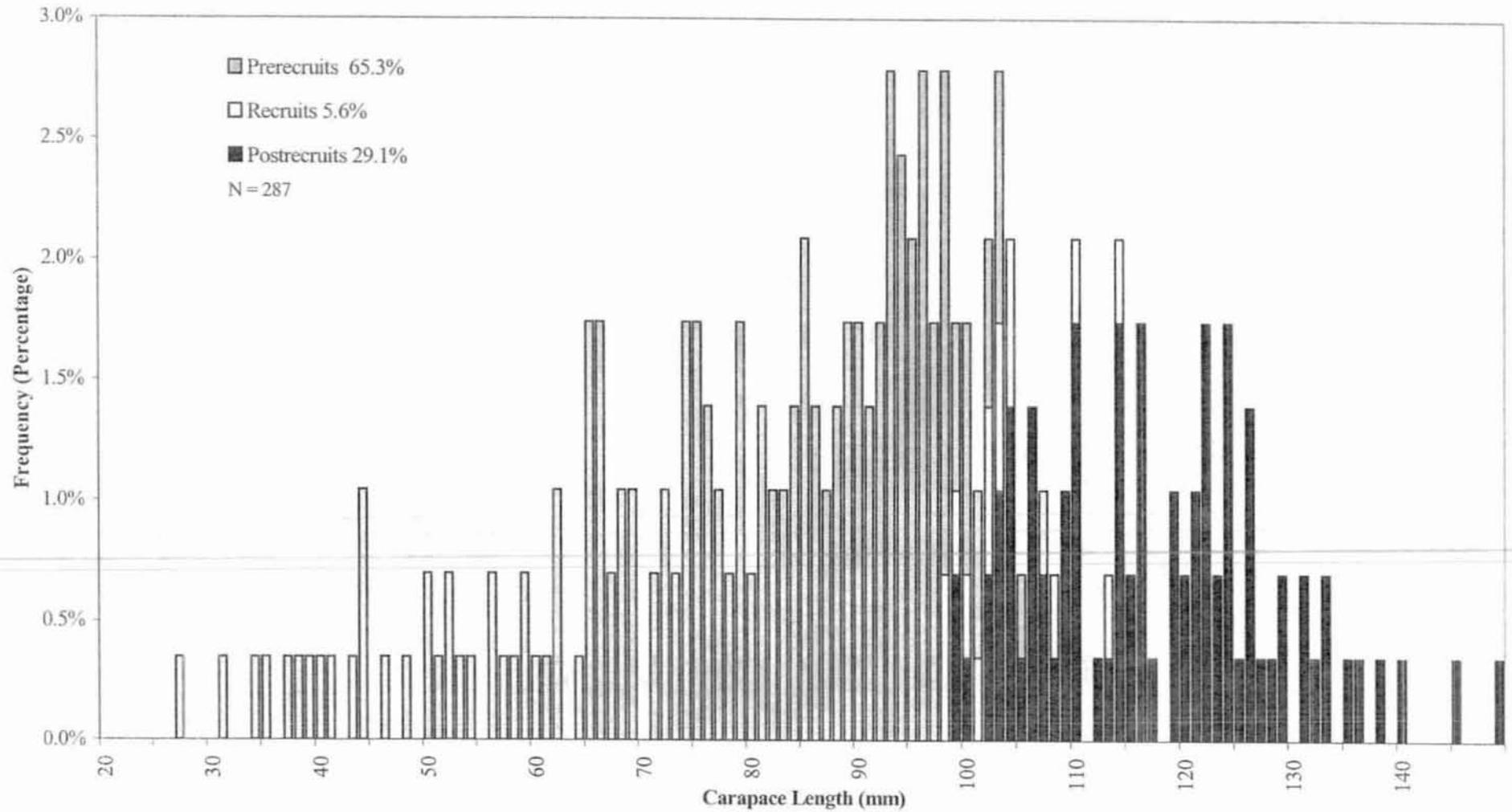


Figure 7. Length frequency distribution of all male red king crab measured (standard and nonstandard stations) during the 2002 Norton Sound Trawl Survey,

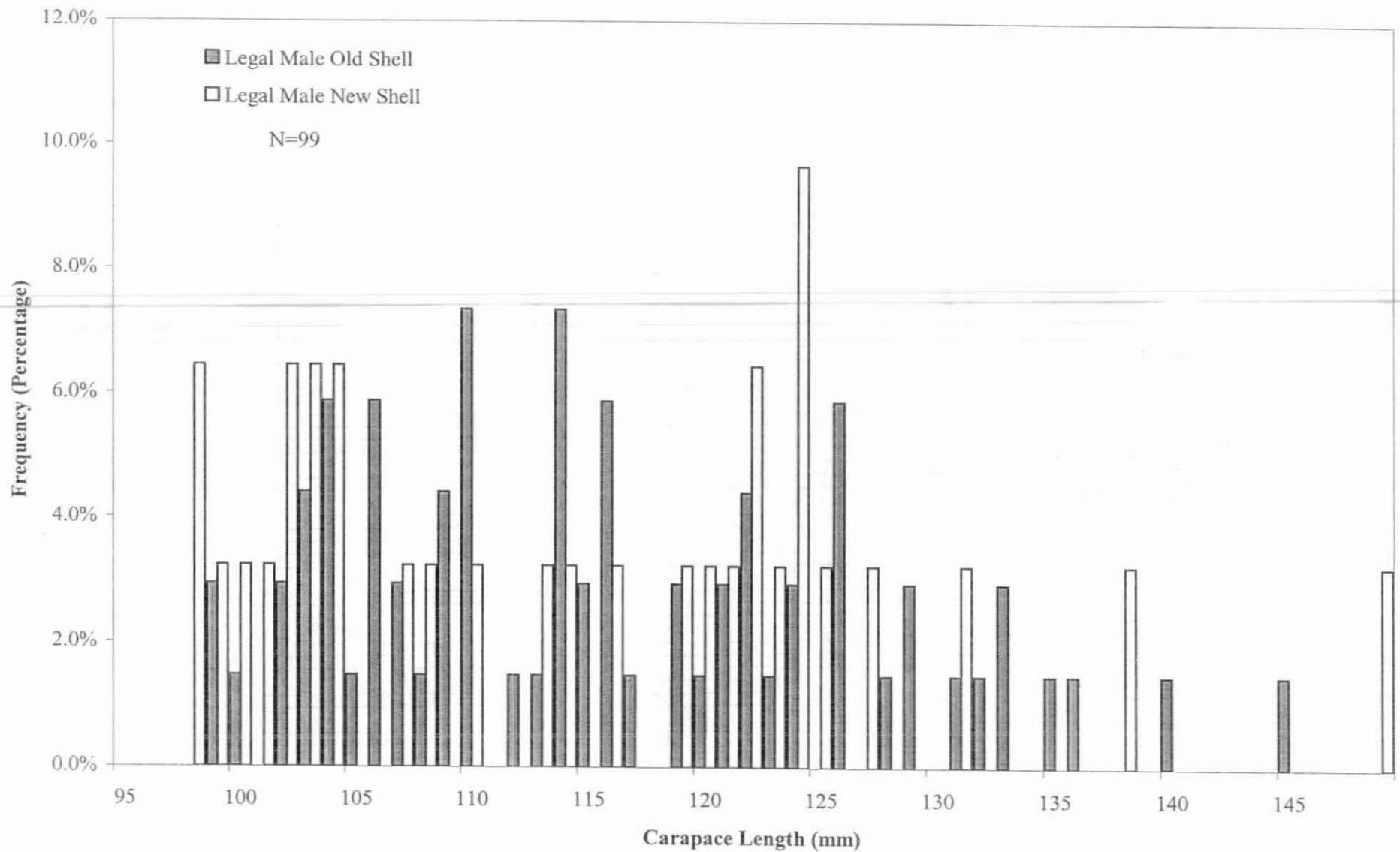


Figure 8. Length frequencies by shell age of all legal male red king crab captured (standard and nonstandard stations) in the 2002 Norton Sound red king crab trawl survey.

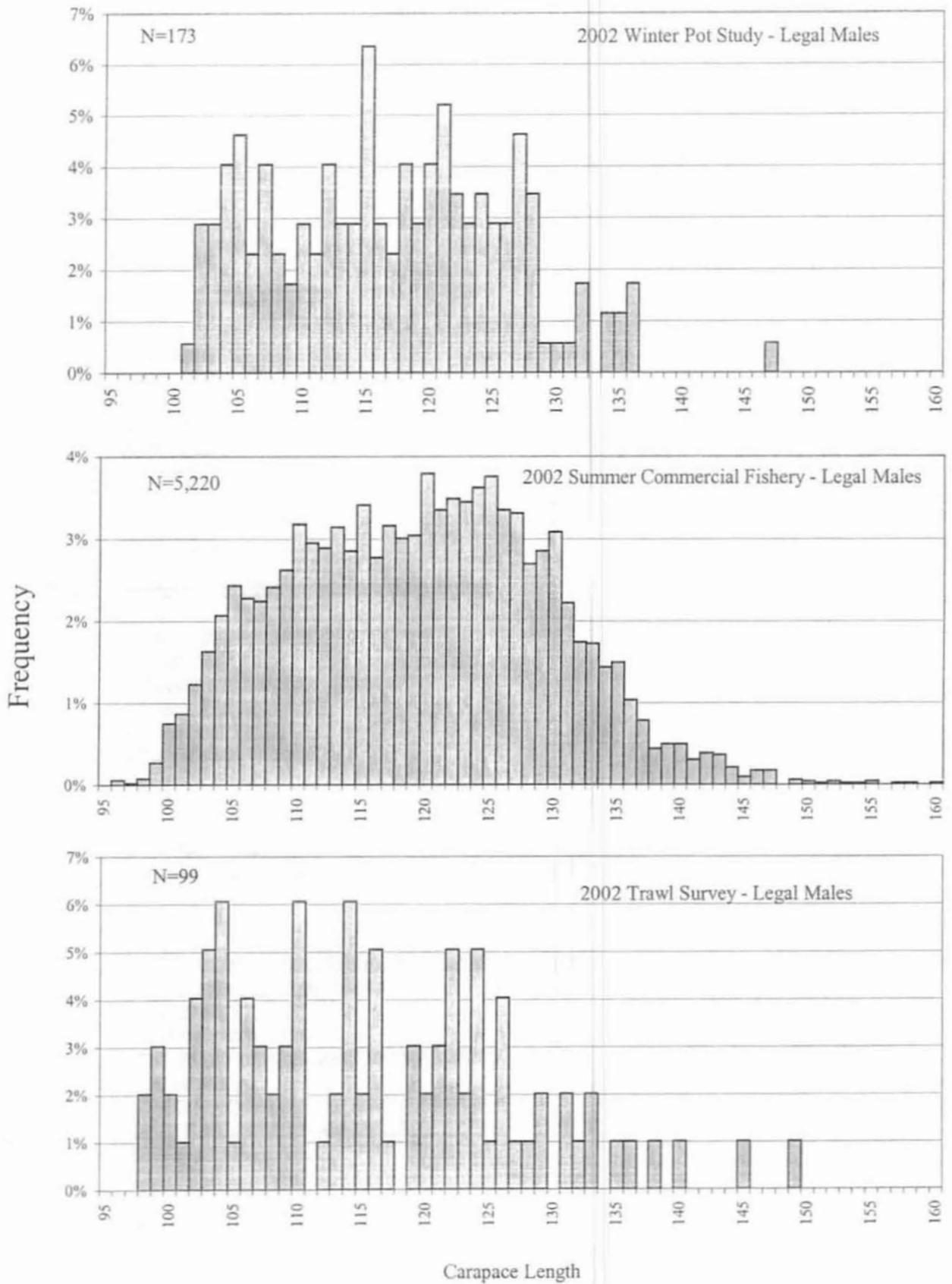


Figure 9. Norton Sound legal male red king crab length frequencies from the 2002 winter pot study (top), 2002 summer commercial fishery (middle) and 2002 trawl survey (bottom).

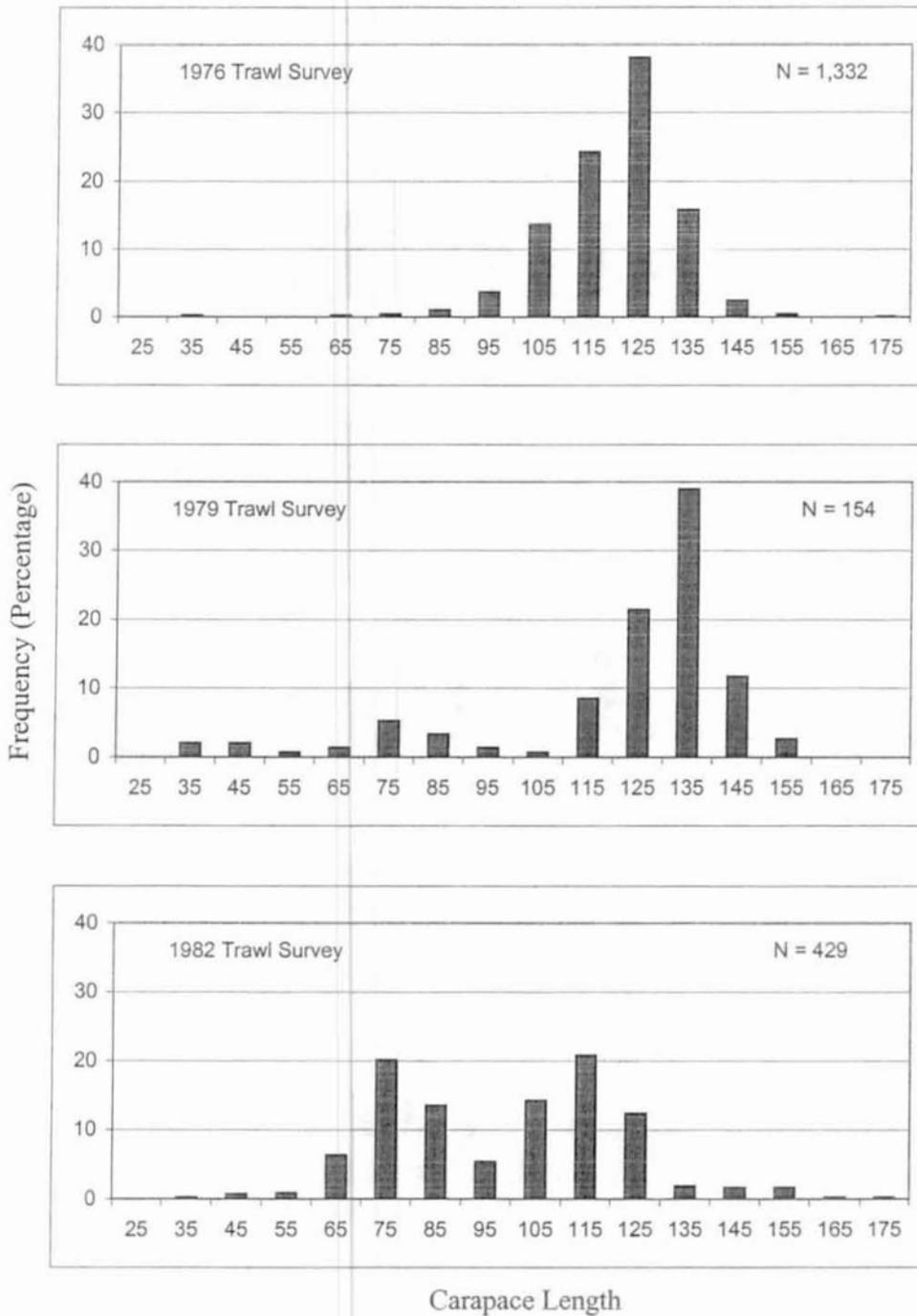


Figure 10. Norton Sound length frequencies for all male red king crab captured (standard and non standard stations) in the trawl surveys, 1976 - 2002.

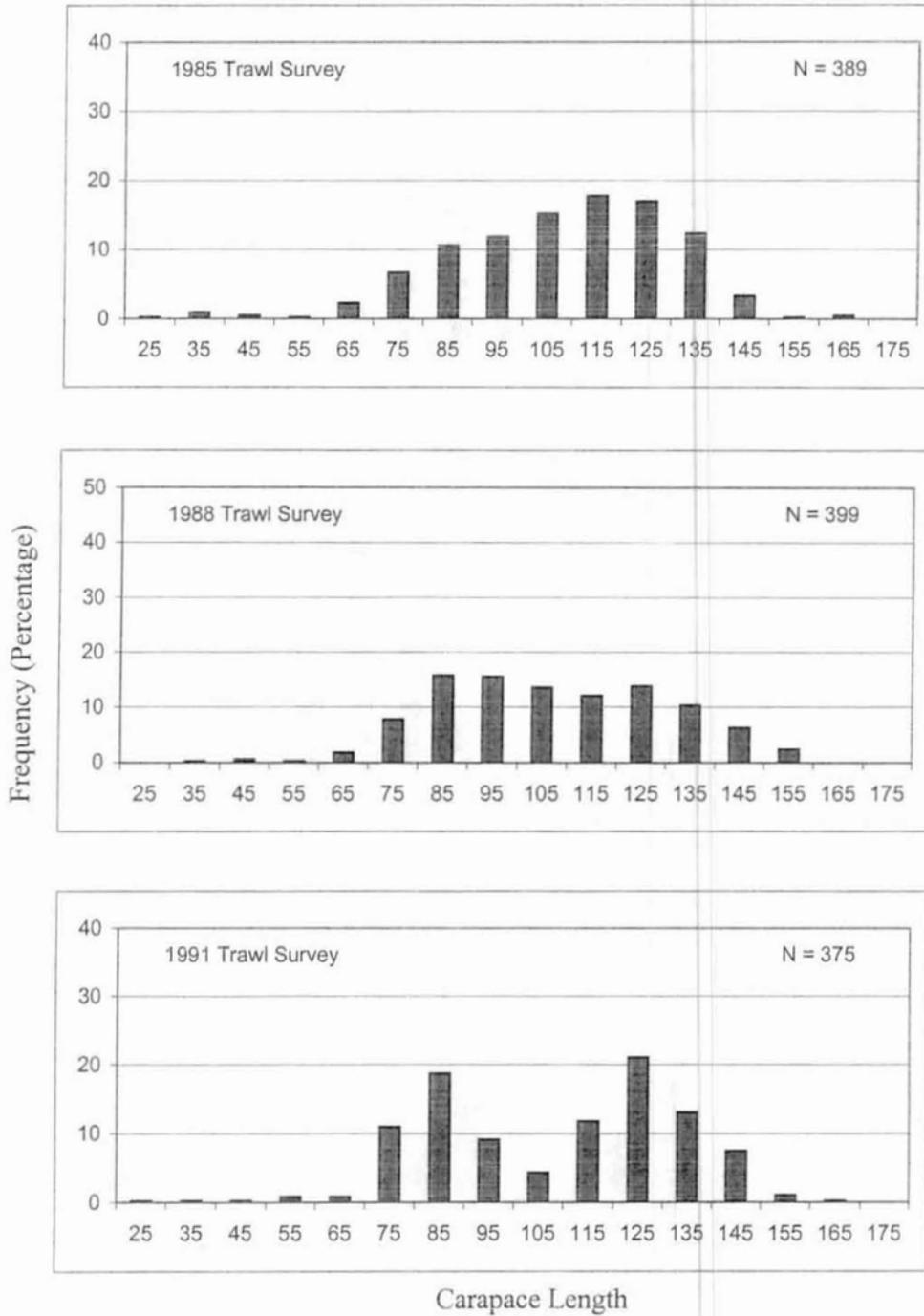


Figure 10. Continued

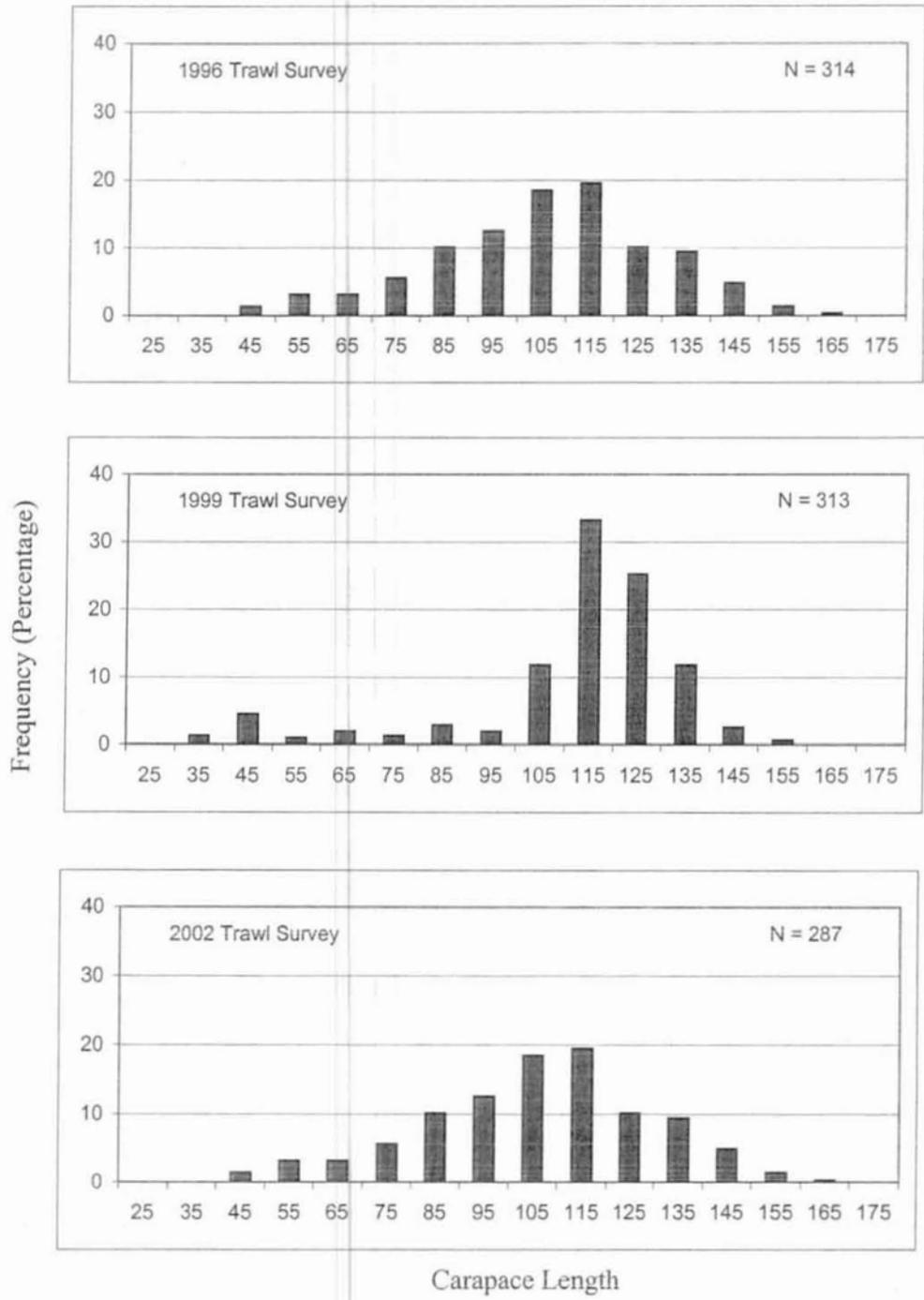


Figure 10. Continued

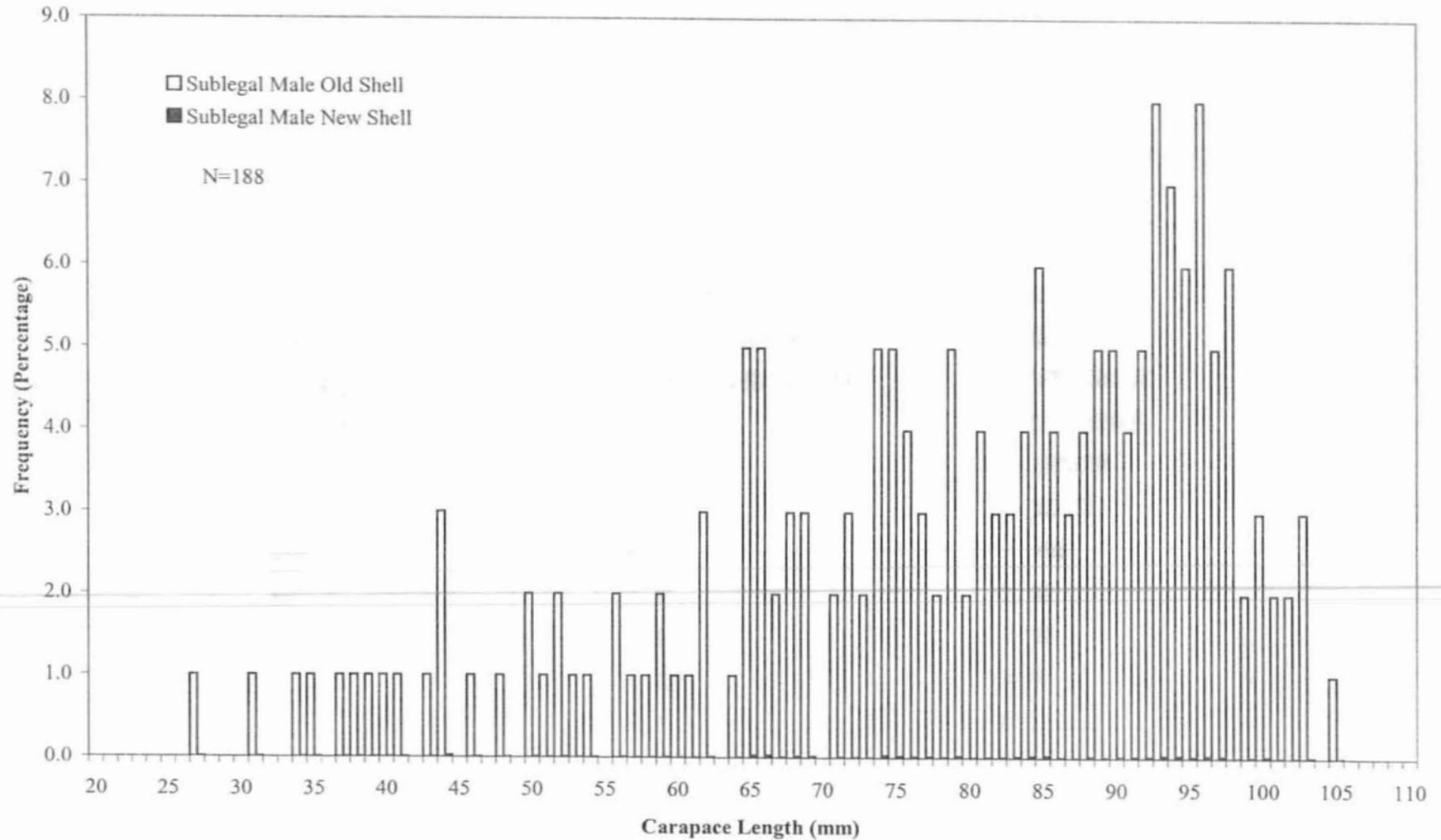


Figure 11. Length frequencies by shell age of all sublegal male red king crab captured (standard and nonstandard stations) in the 2002 Norton Sound red king crab trawl survey.

Appendix A. 2002 Norton Sound ADF&G trawl survey data for legal male red king crab at each station samples during the original survey and the resurvey. Information includes standard and nonstandard stations.

Original Survey					Resurvey				
Station Number	Legal Crab Catch (#)	Area Trawled (sq. miles)	Total Area (sq. miles)	Abundance	Station Number	Legal Crab Catch (#)	Area Trawled (sq. miles)	Total Area (sq. miles)	Abundance
184	4	0.0066	100	60,790	184	7	0.0066	100	106,383
183	16	0.0066	100	243,161	183	16	0.0066	100	243,161
182	1	0.0066	100	15,198					
181	0	0.0066	100	0					
203	0	0.0066	83	0					
202	0	0.0066	86	0					
180	0	0.0066	100	0					
179	0	0.0066	100	0					
201	0	0.0066	91	0					
176	0	0.0066	100	0					
129	0	0.0099	100	0					
130	1	0.0099	100	10,132					
157	3	0.0099	100	30,395					
158	2	0.0092	100	21,711					
131	0	0.0086	100	0					
132	4	0.0099	100	40,527					
159	2	0.0092	100	21,711					
185	2	0.0092	100	21,711					
204	0	0.0092	100	0					
186	1	0.0092	100	10,855					
187	1	0.0086	100	11,690					
161	0	0.0092	100	0					
180	1	0.0092	100	10,855					
133	2	0.0092	100	21,711					
134	1	0.0092	100	10,855					
135	0	0.0092	100	0					
107	0	0.0092	100	0					
82	0	0.0092	100	0					
81	0	0.0092	100	0					
106	0	0.0092	100	0					
105	2	0.0099	100	20,263					
80	2	0.0099	100	20,263					
79	1	0.0092	100	10,855					
104	3	0.0092	100	32,566					
78	0	0.0092	100	0					
103	0	0.0092	100	0					
156	0	0.0092	100	0					
155	0	0.0092	100	0					
128	0	0.0092	100	0					
127	3	0.0092	100	32,566					
154	0	0.0092	100	0					
153	1	0.0092	100	10,855					
126	5	0.0092	100	54,277	126	6	0.0092	100	65,132
125	0	0.0092	100	0					
152	0	0.0092	100	0					
151	0	0.0099	100	0					
124	0	0.0092	100	0					
123	3	0.0099	100	30,395					
150	0	0.0092	100	0					
149	1	0.0092	100	10,855					
148	0	0.0092	100	0					
121	0	0.0092	100	0					
94	0	0.0086	100	0					
95	0	0.0092	100	0					
122	3	0.0092	100	32,566					
101	0	0.0092	100	0					
102	0	0.0092	100	0					
Sum	65	0.5023	5,660.0	786,763		29	0	300	414,676