Fishery Data Series No. 09-05

Norton Sound Winter Red King Crab Studies, 2008

by

Joyce Soong

and

Joshua Mumm

February 2009

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

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

FISHERY DATA SERIES NO. 09-05

NORTON SOUND WINTER RED KING CRAB STUDIES, 2008

by
Joyce Soong and Joshua Mumm
Alaska Department of Fish and Game, Division of Commercial Fisheries, Nome

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518

February 2009

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Joyce Soong and Joshua Mumm
Alaska Department of Fish and Game, Division of Commercial Fisheries,
P.O. Box 1148, Nome, AK 99762, USA

This document should be cited as:
Soong, J., and J. Mumm. 2009. Norton Sound winter red king crab studies, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 09-05, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Biological data were collected for a red king crab *Paralithodes camtschaticus* winter pot survey project by the Alaska Department of Fish and Game in 2008, to monitor the near shore distribution, abundance, and life history parameters of the red king crab population in the Nome area. Red king crabs were caught with pots, measured, and tagged through established survey stations in the sea ice offshore of Nome. Staff also monitored the winter subsistence and commercial fisheries to evaluate crab abundance available to local users. Project data, along with data from various other sources, were incorporated into a length-based population model which was developed to predict population estimates for the red king crab biomass in Norton Sound. A total of 3,557 male and 102 female red king crabs were captured and sampled at 14 survey sites between February 11 and April 14, 2008. A total of 142 pot lifts were made for an overall catch per unit of effort (CPUE) of 25.0 male and 0.7 female red king crabs. Carapace length measurements and shell age were recorded from all male king crabs caught. Of the male king crabs, 71% were prerecruit, 18% were recruit, and 11% postrecruit. Analysis of the 2008 winter data indicated recruitment is greater than last year and will likely continue to increase for the next 2 years.

Key words: Norton Sound, *Paralithodes camtschaticus,* red king crab, distribution, abundance, tagging, sea ice, subsistence, crab pots, population model, biomass.

INTRODUCTION

Red king crabs *Paralithodes camtschaticus* support both commercial and subsistence harvests in the Norton Sound area. For both fisheries, effort is concentrated within 100 miles of Nome. Commercial fisheries occur during the winter and summer months, with most of the catch occurring in the summer. Subsistence fisheries occur primarily in winter months and sporadically in summer months. The king crab population is concentrated near the shore from December through April, during which time shorefast ice allows subsistence fishers easy access. A winter red king crab pot survey project began in February of 1982 and sampling procedures were standardized in 1983. With the exception of 1988 (poor ice conditions), 1992 and 1994 (lack of funding), the survey has occurred every year up to the present.

The purpose of this study is to collect biological data during winter months (February–April) to monitor near-shore distribution, abundance, and size frequencies of the Norton Sound red king crab population. Collection is done by catching, measuring, and tagging red king crabs through established survey stations in the sea ice offshore of Nome. Since shorefast and sea ice conditions around Nome constantly change during winter months and from year to year, placement of survey sites has also changed through time.

Winter project data, along with data from the summer commercial fishery and the triennial trawl survey, are incorporated into a length-based population model that was developed to predict population estimates for the red king crab biomass in Norton Sound (Zheng et al. 1998). This model improves management of the red king crab fisheries by providing an annual estimate used to determine the guideline harvest level (GHL) for the summer commercial red king crab fishery. Before development of the length-based model, the triennial Norton Sound king crab trawl survey was the only means of determining crab biomass.

OBJECTIVES

Objectives for the 2008 winter field season:

1. Measure and record shell age, size, and number of sublegal and legal male red king crabs caught in order to evaluate recruitment into legal population before the summer fishery.
2. Tag all male new-shell red king crabs ≤ 100 mm carapace length (CL), as part of ongoing studies to estimate growth and movement of tagged crabs recaptured in summer and winter fisheries.
3. Monitor abundance of red king crab catch accessible to winter subsistence and commercial users in the Nome area.
4. Monitor intensity and distribution of winter fishing effort in the Nome area.
5. Measure and record size and number of female red king crabs captured and their egg clutch size.
6. Describe relative distribution of crabs within the winter 2008 study area using catch per unit effort (CPUE) information.
7. Record other biological data such as incidence of disease, parasitism, and other species captured.

METHODS

SURVEY STATIONS

Historically, survey stations were generally comprised of paired sites located 7 and 2 miles west of Nome, directly in front of Nome, and 2 and 5 miles east of Nome. Water depth ranged from 30 to 50 feet deep and the sites were located 1 to 2 miles offshore. From 1982 until 1987, survey sites were confined to a single transect of shorefast ice extending 0.5 to 2.0 miles directly offshore from the Nome Post Office (Lean 1987). In 1988, due to unstable ice and stormy weather, pots were lost and no study was conducted (Merkouris and Lean 1989). From 1989 until 1995, to reduce lost fishing time due to unstable ice at the original sites, the study area was expanded a few miles to the west of Nome where dredging activity occurred and a few miles east of Nome where little subsistence activity occurred (Brennan and LaFlamme 1995). In 1996, pots placed within 5 miles of Nome were lost due to moving ice so the study site was expanded further to the vicinity of Bluff, 50 miles east of Nome (Rob 1996). Until 2008, this was the only year that survey sites were located near Bluff. The following year, 1997, the active ice edge was closer to shore, and unstable ice prevented fishing with pots in the vicinity of Bluff (Rob and Fair 1997). From 1997 to 2000, traditional ice stations closer to Nome were fished (Brennan 2000). In 2001 sea ice around Nome was extremely unstable. Pots deployed in traditional areas were lost when shore ice broke off at the beginning of the project. Three pots were deployed from the ice that remained close to shore, but few crabs were captured in these pots. In 2002 and 2004, some stations were deployed outside of the traditional study area up to 8 miles east and 14 miles west of Nome where sea ice was more stable (Brennan and Karpovich 2002; Soong and Kohler 2004). In 2003 and 2005, traditional ice stations were fished once again and ice was

stable throughout most of the winter (Brennan and Karpovich 2003; Soong and Kohler 2005), but in 2006 and 2007, sea ice around Nome was again unstable and several pots were lost at different times of the season (Soong 2007a; Soong 2007b).

In 2008, seven survey stations comprised of 14 sampling sites were established in an area spanning from approximately 13 miles west to 47 miles east of Nome (Table 1; Figure 1) beginning February 11. Each sampling site was located in water ranging from 25 to 60 feet deep and from approximately 1 mile to 2 miles offshore. Travel to and from stations was by snowmachines, with a sled to carry supplies and equipment. The sampling sites were recorded with a handheld Global Positioning System (GPS) receiver (Garmin GPS 76[1]), and a chain saw or auger was used to cut through the ice to determine its thickness. When ice was found between 1 and 3 feet thick, a square hole about 5 feet long on each side was cut in the ice. Water depth was checked using a weighted string. Other tools used included ice chisels or "tusk," shovels, and long poles.

SAMPLE COLLECTION

Conical, 4 foot in diameter "Japanese style" king crab pots were baited with 2 one-quart bait containers filled with semi-frozen herring chopped into inch-long pieces. Each pot was deployed and attached to a line tethered to a stake at the ice surface. Each hole was covered with styrofoam and plywood to reduce refreezing of the hole and the stake marked per regulation (5 AAC 34.925).

Each pot was checked and rebaited after soaking from 2 to 8 days. When pots were checked, they were brought to the surface and suspended to keep all crabs in the pot immersed in water. Crabs were removed one at a time and determined to be legal (males ≥ 121 mm (4.75 in) carapace width including lateral spines) or sublegal. Crabs were also measured for carapace length (CL), from the posterior margin of the right eye orbit of the carapace to the center of the posterior carapace margin, to determine the age class. Based on CL, male crabs were considered to be postrecruit (legal, new-shell crabs > 115 mm CL and all legal old-shells), recruit (legal, new-shell crabs ≤ 115 mm CL), or prerecruit (sublegal crabs ≤ 115 mm). Prerecruits were further broken down into ones (> 89 mm CL), twos (76 mm to 89 mm CL), and threes (< 76 mm CL). Other biological features recorded were sex, shell age, and, for females, egg development and clutch fullness, which was categorized using the ADF&G research classification scheme (Donaldson and Byersdorfer 2005).

Shell-aging was based on the shell condition method, which defines shell-age classes using the ventral side of the coxa (first segment closest to the body) of the walking legs and other determinants (Donaldson and Byersdorfer 2005). *New-shell:* Coxa and ventral surface of exoskeleton are dull. Legs are mostly full of meat and not easily compressed by pinching. If carapace is removed, the gills will be a light cream color. Crabs are estimated to have had exoskeletons for 2–12 months. *Old-shell:* Distal portion of the ventral coxa is partially or totally rimmed with brown scratches or dots. Legs are full of meat and not easily compressed when pinched. If carapace is removed, gills will be tan in color from fouling microorganisms. Crabs are estimated to have had their exoskeletons for 13–24 months. (*Note:* Some crabs classified as old-shell are probably less than a year old but share the coxa characteristic of old-shell crabs.)

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

Very old-shell: Distal portion of ventral coxa are continuously rimmed with black scratches or dots. Legs are full of meat and not easily compressed when pinched. Tips of the dactyls are worn round and black. Epifauna is almost always present. If carapace is removed, gills will be dark gray or dark gray-brown in color from fouling microorganisms. Crabs are estimated to have had their exoskeletons for > 24 months.

Spaghetti tags were attached with hog rings to male king crabs < 100 mm CL so that tagged crabs recovered in future can provide growth and movement information. Tagging smaller, sublegal crabs reduces the chance of the crabs being recovered during the same-year summer commercial fishery, which would provide no useful information. Any prior injuries on crabs caught were noted. Then crabs were released into the same hole in which they were caught.

CPUE was calculated as the number of crabs caught per pot. Thus, comparison of CPUE between different survey sites gave an indication of relative abundance. CPUE for the entire season was calculated as the total number of crabs caught divided by the total number of pot lifts.

Additionally, conversation with commercial and subsistence fishers was solicited to get their impressions of the season, and how abundant the crabs appeared. The winter commercial fishery, which must occur through the ice, runs from November 15 to May 15 and commercial fishers must report and turn in fish tickets to the Nome Alaska Department of Fish and Game (ADF&G) office weekly. Required permits that must be returned were given out to subsistence fishers of Norton Sound for recording their catches. Although there is no closed season for subsistence crab fishing, the winter permit is valid only from December 1 to May 31, after which time the fishers must use a summer subsistence crab permit.

RESULTS

Shorefast ice was stable near Nome during the entire study and extended to approximately 2.6 miles offshore. There were no high pressure ridges; therefore we were able to place all of the stations in 2008 near historical locations: 2 and 7 miles west, directly south, and 5 and 8 miles east of Nome. Two stations were also used outside of the historical sampling area, at 13 miles west (near Penny River mouth) and 46 miles east (near Bluff). Two sampling sites were placed at each station approximately one half mile apart. Traveling conditions were excellent all through the study period because the snowpack was deep.

More crabs were caught in the 2008 study than in any prior year. A total of 3,557 males (of which 2,249 were tagged) and 102 female red king crabs were captured and sampled at 14 sampling sites between February 11 and April 14 (Table 2). The number of pot lifts totaled 142, which made for an overall CPUE of 25.0 male and 0.7 female red king crabs (Table 1). Sampling sites B1 and B2 had the highest CPUEs, whereas sites N2 and N3 had the lowest. Soak time averaged 5 days for all the sites except the ones near Bluff. Male catch rates varied between 1.3 and 62.0 over the season depending on which pots were pulled and how long they soaked (Table 2). Of the 3,557 male crabs caught, recruit crabs made up 17.8 % of the catch, postrecruit crabs 11.6%, and prerecruits made up the remainder, at 70.6% (Table 3; Figure 2).

For the first time since 2005, the legal crab catch proportion has increased while correspondingly the sublegal proportion has decreased (Table 4). The increase in legal catch proportion was comprised of a 58% increase in percentage of recruits and an 8% increase in percentage of

postrecruits. The decrease in catch proportion of sublegal was comprised of a 41% and 61% decline in percentage of pre-1 and pre-3 crabs respectively and a 121% increase in percentage of pre-2 crabs.

Of the 102 female crabs caught, 3 were juveniles (abdominal flap did not cover coxa). Of the adults, 23% had full clutches, 26% had high clutch fullness, 45% had medium clutch fullness and 1% had low clutch fullness, and 2 % were barren. Forty percent of the egg clutches were eyed.

In 2008, other species caught included flatbottom sea stars *Asterias* (1,708), saffron cod *Eliginus gracillis (79),* helmet crabs *Telmessus cheiragonus* (16), arctic lyre crabs *Hyas coarctatus* (11), sculpins (6), jellyfish (3), green urchins *Strongylocentrotus droebachiensis* (2), soft crab *Hapalogaster grebnitzkii* (1), and redscaled sea cucumber *Psolus* sp. (1).

Several crabs showed signs of diseases described by Donaldson and Byersdorfer in their booklet "Biological Field Techniques for Lithodid Crabs" (2005). One sublegal male red king crab had "cottage cheese disease," which is an infection caused by a microsporidian and is characterized by a swollen, firm belly and white, large cottage cheese-like appearance in the abdominal cavity. Eight males had nemertean worms, which are egg predators, attached to the shell externally. Thirteen males showed signs of "torch" disease, caused by an infection of a chitinoclastic bacteria that consumes the chitin of the exoskeleton. The infection appears as dark spots or lesions on the shell such that it looks like the infected host had holes burned through its shell with a blow torch, giving rise to the name.

Subsistence fishing effort for Nome residents was concentrated between 5 miles east to 4 miles west of town, with some fishers going as far east as 8–12 miles. The number of subsistence permits issued for all of Norton Sound was 139, almost 20% above the average number of permits issued per year since 1983 (Table 5). Of the 137 fishers who returned their permit by mid July, 108 actually fished, harvesting 9,485 crabs, or 80% more than the average harvest from 1983–2007. Residents of Brevig Mission, Elim, St. Michael, and White Mountain had a combined harvest of 1,552 crabs, or 16% of the total harvest. Almost all returned permits specified how many pots (and/or handlines) were used (and lost) and when fishing occurred. Out of 208 pots reported fishing, only 6 were lost during the season due to moving ice. Four fishers reported fishing with handlines, for a combined harvest of 17 crabs. Based on the permits returned by mid July, percentages of subsistence crabs harvested each month are as follows: December 0%, January 6%, February 23%, March 45%, April 21%, and May 3%, with 2% unspecified. Pots were placed from ½ mile to more than 2 miles off shore from Nome.

The winter commercial season opened November 15, 2007, and 9 fishers registered to fish. Based on fish tickets submitted, the first landing was made February 20. From then until the last landing on May 5, the 9 fishers made a total of 129 landings and 1,008 potlifts, with an overall CPUE of 5.8 and average weight of 2.5 pounds per crab. Price per pound of crab averaged $3.03. A total of 5,796 crabs were sold (either to the local seafood plant or directly to Nome residents), with percentages of crabs sold (and CPUE) each month as follows: February 9% (7.3), March 64% (7.1), April 26% (3.9), and May 1% (1.7). Total number of crabs harvested was 75% greater than for 2007, and more than twice as much as the average harvest from 1978–2007 (Table 5). No commercial fishers reported losing their pots during the 2008 winter season, and they fished their pots from 12 miles east to 7 miles west of Nome, excluding the area closed to commercial fishing from 3.5 miles east to 2.0 miles west of Nome (Figure 3).

Twenty-four tags were turned in during the 2008 winter season by subsistence or commercial crab fishers. Due to the high number of tags released this season (2,249 tags), the majority of returned tags (20 tags) were from this season. Of the 4 remaining tags, which provided useful information, one was deployed in 2006 five miles west of Nome, whereas the other 3 were deployed in 2007 in 2 different sampling sites: south of town and 7 miles west of Nome. Two tags were recovered in statistical area 656403, the area immediately south and east of Nome, and the other two were recovered in statistical area 656430, the area to the west of Nome. These 4 crabs had all molted, with an average growth of 15 mm in CL. Generally, more tags are recovered during the summer commercial crab fishery.

DISCUSSION

Red king crab winter pot studies have been conducted in the Nome area during 23 of the past 26 years since sampling procedures were standardized in 1983. The winter study has provided opportunities to collect and interpret valuable information on the crab population available to residents of Nome during winter subsistence and commercial fisheries. Since 1987, the study area has continually expanded from the original single transect extending straight south from Nome, to areas farther east and west of Nome. Usually, the area was expanded because unstable ice prevented fishing in the original study area. In 1996, due to unstable ice near Nome, the study was expanded to the area of Bluff, nearly 50 miles east of Nome. This opportunity gave the investigators a chance to see that crab population size frequencies observed near Nome also applied to wider areas of Norton Sound (Rob 1996). Therefore, in 2008, sampling stations were located in historical fishing areas as well as near Bluff, with the intention of possibly expanding the study area farther in the future.

In 2008, based on information gathered from commercial and subsistence fishers, and from study results, crab abundance was high enough in nearshore waters of Nome to allow fishers' harvests to greatly exceed the average comparable harvest from 1978–2007 (Table 5). In addition, excellent ice conditions allowed easy access to fishing grounds for fishers and for the study and only 4 subsistence pots were reported lost.

Winter catch of red king crab for ADF&G studies, and subsistence and commercial fisheries have varied widely over the years 1983–2008, with lowest harvests in years 1988, 1993, 1997, 2001, 2004, and 2006 (Figure 4). Annual management reports for 1988 and 2001, and winter crab studies indicate prevalent bad ice conditions and lost pots during these years (Brennan (1993); Brennan et al. (2003); Merkouris and Lean (1989); Rob and Fair (1997); Soong and Kohler (2004); and Soong (2007a)). These are also the years when fewer people fished for winter subsistence crab compared to other years (Figure 4). Fishers are less likely to put out pots when the pack ice is unstable for fear of losing their pots. Also, when potential fishers hear from early fishers that harvest is poor, as indicated by lower harvest average rates in 1993, 2001, and 2004, they are less likely to put out their pots, resulting in lower harvest numbers. Unstable pack ice sometimes, but not always, results in high pressure ridges, making travel to favored fishing spots difficult. In 1984 and 1998, the pack ice was unstable and pots were lost, yet subsistence harvests were high. In those years, ice conditions were good later in the season (ADF&G 1984), or no large pressure ridges formed (Brennan 1998), which allowed easier access to fishing grounds. In 2008, the pack ice was stable throughout the study period, from mid February to mid April. No large pressure ridges formed and snow was thick which allowed for easy access to traditional fishing stations. With the timely mid

February start, the study was fully in operation during March when both subsistence and commercial fishers harvested the majority of their catch.

Ice condition and harvest timing are not the only factors affecting catch. Variable distribution of crabs in nearshore waters also appear to impact catch performance. Comparing data from 2002 and 2006, legal abundance estimates and ice conditions for these years were very similar, yet subsistence catch and average harvest were greater in 2002 than 2006 (Table 6; Figures 4 and 5). Average CPUE in 2002 for the survey sites directly in front of Nome (sites N2 and N3) was 17.4, the highest CPUE for any survey sites that year, while in 2006, average CPUE for the same sites was 1.9, the lowest CPUE of any survey sites for the year (Brennan and Karpovich 2002; Soong 2007). Since subsistence fishers usually concentrated their effort within 2–3 miles of Nome, lower distribution of crab in this area would have a great impact on winter fishing success. In 2008, the survey sites directly in front of Nome (N2 and N3) had the lowest CPUE of any other sites, but at an average of 17 CPUE, crab abundance even in front of Nome was high; therefore, it contributed to the successful harvests observed in 2008 (Table 1).

In addition to ice conditions, harvest timing, and changes in crab distribution, crab population and recruitment also play a role in success of harvest rates. Results from Norton Sound trawl survey abundance estimates indicate that the legal population was high in the years 1985 and 1991 and highest in 1999 (Table 6; Figure 4). Subsistence harvests in these years were also relatively high. Legal abundance estimate for 1996 was the lowest on record, while the pre-1 estimate for that year was the second lowest, indicating a low legal population for the following year, 1997. Correspondingly, winter catches for both years were among the lowest. Pre-2 estimates were lowest for 1991 and 1999, indicating lower legal populations in 1993 and 2001, which had 2 of the lowest subsistence catch numbers.

The last triennial Norton Sound red king crab trawl survey was conducted in summer of 2006. Survey results that year suggested that 2008 and 2009 legal king crab populations should increase from 2007 (Soong and Banducci 2006). Legal and pre-1 male abundance estimates were similar to 2002 estimates, while pre-2 estimate was more than 80% above 2002 and is the highest on record (Brennan 2003; Table 6). These pre-2 crabs would likely have molted in 2006 (post survey) and 2007 to become part of the legal population this year, and contribute to the legal population for next year. Therefore, factors affecting winter catch performance include ice conditions, harvest timing, and changes in the nearshore distribution of crab during winter, and fluctuations in crab population and recruitment.

The 2008 winter study data indicate recruitment has increased compared to 2007 and will likely continue to increase for the next 2 years. Current size composition data show the portion of the crab population classified as recruits has increased 58% since the 2007 survey and postrecruit male crab population has increased 9%. The high percentage of prerecruit-1 crabs observed in 2007 likely contributed to the increase in recruitment. The winter pot study also points to a slightly above average pre-1 population and a pre-2 population that is nearly double the 24 year average (Table 4). Pre-1 crabs require one molt to become part of legal population next year, while pre-2 crabs require 2 molts. These findings indicate that legal crab population is greater than 2007, and will likely continue to increase in the near future, indications that are also supported by data from the 2006 trawl survey.

Winter project data are incorporated into a length-based population model developed to predict biomass for the red king crab population in Norton Sound. Also incorporated into the model are

data from trawl surveys, summer pot studies, and summer and winter fisheries from 1976 to present. This model improves upon the trawl estimate because it includes several different sources of data and uses historical abundance trends based on length. Additionally, the model can be used to project estimates in years when there is no trawl survey, allowing abundance based management of the Norton Sound red king crab summer fishery. The length frequency data from the 2008 winter crab project were added into the computer model to predict the Norton Sound summer crab biomass. The expected legal male crab abundance was 4.1 million pounds (1.5 million crabs), which is up 22% from the revised 2007 model abundance estimate of 3.4 million pounds (1.2 million crabs). The model revised the 2007 estimate from 3.2 million pounds (1.2 million crabs) to 3.4 million pounds, since every time new data is incorporated into the population model, it estimates current abundance as well as revises prior years' abundances. A 10% exploitation rate on the legal population, in accordance with the harvest strategy set by the Alaska Board of Fisheries, equates to a GHL of 412,000 pounds of crab. Therefore, the 2008 summer commercial open-access king crab fishery allocation will be 381,100 pounds, and the Community Development Quota (CDQ) allocation will be 30,900 pounds.

ACKNOWLEDGEMENTS

Paul Thompson was the project technician and provided invaluable assistance during this study.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1984. Annual management report for Norton Sound, Port Clarence, and Kotzebue, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage.

Brennan, E. L. 1993. Norton Sound winter red king crab studies, 1993. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 3A93-13, Anchorage.

Brennan, E. L. 1998. Norton Sound winter red king crab studies, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A98-25, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.1998.25.pdf

Brennan, E. L. 2000. Norton Sound winter red king crab studies, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-24, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2000.24.pdf

Brennan, E. L. 2003. Analysis of red king crab data from the 2002 ADF&G trawl survey of Norton Sound. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-52, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.2002.52.pdf

Brennan, E. L., and S. Karpovich. 2002. Norton Sound winter red king crab studies, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.2002.40.pdf

Brennan, E. L., and S. Karpovich. 2003. Norton Sound winter red king crab studies, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-22, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2003.22.pdf

REFERENCES CITED (Continued)

Brennan, E. L., W. Jones, and J. Menard. 2003. Annual management report for Norton Sound, Port Clarence, and Kotzebue, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-04, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2003.04.pdf

Brennan, E. L., and T. R. LaFlamme. 1995. Norton Sound winter red king crab studies, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 3A95-20, Anchorage.

Donaldson, W. E., and S. C. Byersdorfer. 2005. Biological field techniques for lithodid crabs. University of Alaska, Alaska Sea Grant College Program, Fairbanks.

Lean, C. F. 1987. Catch rates, size composition and growth of red king crab taken in Norton Sound near Nome during the winter of 1987. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Shellfish Report No. 12, Nome.

Merkouris, S. E., and C. F. Lean. 1989. Annual management report for Norton Sound, Port Clarence, and Kotzebue, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3N89-10, Anchorage.

Rob, P. J. 1996. Norton Sound winter red king crab studies, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 3A96-22, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.1996.22.pdf

Rob, P. J., and L. F. Fair. 1997. Norton Sound winter red king crab studies, 1997. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A97-25, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.1997.25.pdf

Soong, J. 2007a. Norton Sound winter red king crab studies, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 07-16, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-16.pdf

Soong, J. 2007b. Norton Sound winter red king crab studies, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 07-53, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-16.pdf

Soong, J., and A. Banducci. 2006. Analysis of red king crab data from the 2006 ADF&G trawl survey of Norton Sound. Alaska Department of Fish and Game, Fishery Data Series No. 06-55, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-55.pdf

Soong, J., and T. Kohler. 2004. Norton Sound winter red king crab studies, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-12, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-12.pdf

Soong, J., and T. Kohler. 2005. Norton Sound winter red king crab studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 05-48, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-48.pdf

Zheng, J., G. H. Kruse, and L. Fair 1998. Using multiple data sets to assess red king crab *Paralithodes camtschaticus* in Norton Sound, Alaska: A length-based stock synthesis approach. Pages 591-612 *in* Fishery Stock Assessment Models, edited by F. Funk, T. J. Quinn II, J. Heifetz, J. N. Ianelli, J. E. Powers, J. F. Schweigert, P. J. Sullivan, and C. I. Zhang, Alaska Sea Grant College Program Report. AK-SG-98-01, University of Alaska Fairbanks.

TABLES AND FIGURES

Table 1.–Location, number of pot lifts, catch rate per sampling site, and CPUE per station during the winter red king crab pot survey, Norton Sound, 2008.

Station	Sampling Site	Location (decimal degrees) Latitude	Longitude	Depth (ft)	Distance Nome (mi)	Historical Location	Number Pot Lifts	Male Red King Crab Number Caught	CPUE	Female Red King Crab Number Caught	CPUE
1	W8	64.52938	165.81503	25	12.6 W	no	5	121	24.2	3	0.6
	W9	64.52177	165.81651	38	12.6 W	no	5	144	28.8	2	0.4
2	W1	64.51309	165.62997	37	6.8 W	yes	14	261	18.6	2	0.1
	W2	64.50658	165.63136	48	6.8 W	yes	14	353	25.2	5	0.4
3	W3	64.49453	165.47211	33	2.1 W	yes	14	322	23.0	5	0.4
	W4	64.48655	165.48424	47	2.1 W	yes	14	369	26.4	5	0.4
4	N2	64.48221	165.41135	48	1.0 S	yes	14	240	17.1	9	0.6
	N3	64.47388	165.41298	58	1.6 S	yes	14	234	16.7	4	0.3
5	E1	64.46481	165.24498	30	5.1 E	yes	13	442	34.0	35	2.7
	E2	64.45670	165.24719	49	5.1 E	yes	13	242	18.6	5	0.4
6	E3	64.43566	165.16528	60	7.9 E	yes	8	232	29.0	9	1.1
	E4	64.43053	165.13829	61	8.9 E	yes	8	311	38.9	8	1.0
7	B1	64.55316	163.89915	37	45.2 E	no	3	147	49.0	1	0.3
	B2	64.55064	163.83670	48	47.1 E	no	3	139	46.3	9	3.0
Total							142	3,557	25.0	102	0.7

Table 2.–Daily catch of red king crabs for all sampling sites in the winter pot survey, Norton Sound, 2008.

Date Checked	Sampling Sites[a] (soak time in days)	Pot Lifts	Males	Females	Male CPUE	Female CPUE
11-Feb	N2+N3 (5)	2	99	2	49.5	1.0
13-Feb	W1+W2 (6), W4 (5)	3	136	2	45.3	0.7
14-Feb	N2+N3 (3), W3 (6)	3	73	0	24.3	0.0
19-Feb	E1+E2 (7)	2	124	5	62.0	2.5
20-Feb	W1+W2+W4 (7)	3	114	2	38.0	0.7
21-Feb	N2+N3+W3 (7)	3	55	0	18.3	0.0
22-Feb	E2 (3), E3+E4 (8)	3	120	4	40.0	1.3
25-Feb	E1 (6), W1+W2 (5)	3	99	6	33.0	2.0
26-Feb	N2+N3+W3 (5), W4 (6)	4	77	1	19.3	0.3
27-Feb	E1 (2), E2+E3+E4 (5)	4	105	2	26.3	0.5
28-Feb	W1+W2 (3)	2	51	0	25.5	0.0
3-Mar	N2+N3+W3+W4 (6)	4	137	5	34.3	1.3
4-Mar	E1+E2+E3+E4 (6)	4	187	12	46.8	3.0
5-Mar	W1+W2 (6)	2	91	1	45.5	0.5
6-Mar	W8+W9 (6)	2	44	3	22.0	1.5
9-Mar	N2+N3+W3+W4 (6)	4	168	3	42.0	0.8
10-Mar	E1+E2+E3+E4 (6)	4	196	13	49.0	3.3
11-Mar	W1+W2 (6), W8+W9 (5)	4	142	1	35.5	0.3
14-Mar	N2+N3+W3+W4 (5)	4	58	2	14.5	0.5
15-Mar	E1+E2+E3+E4 (5)	4	166	9	41.5	2.3
16-Mar	W1+W2+W8+W9 (5)	4	121	0	30.3	0.0
17-Mar	N2+N3+W3+W4 (3)	4	50	2	12.5	0.5
18-Mar	E1+E2+E3+E4 (3)	4	133	3	33.3	0.8
19-Mar	W1+W2+W8+W9 (3)	4	65	0	16.3	0.0
20-Mar	N2+N2+W3+W4 (3)	4	54	2	13.5	0.5
21-Mar	E1+E2+E3+E4 (3)	4	63	3	15.8	0.8
24-Mar	W1+W2+W8+W9 (5)	4	51	2	12.8	0.5
25-Mar	N2+N3+W3+W4 (5)	4	74	2	18.5	0.5
26-Mar	E1+E2+E3+E4 (5)	4	59	1	14.8	0.3
28-Mar	W1+W2(4), W3+W4 (3)	4	56	0	14.0	0.0
29-Mar	N2+N3 (4), E1+E2 (3)	4	84	2	21.0	0.5
1-Apr	W1+W2+W3+W4 (4)	4	44	0	11.0	0.0
2-Apr	N2+N3+E1+E2 (4)	4	11	0	2.8	0.0
4-Apr	B1+B2 (8)	2	108	2	54.0	1.0
6-Apr	W1+W2+W3+W4 (5)	4	79	1	19.8	0.3
7-Apr	E1+E2+N2 (5)	3	4	0	1.3	0.0
8-Apr	W1+W2+W3+W4 (2), N3 (6)	5	34	0	6.8	0.0
9-Apr	B1+B2 (5)	2	101	4	50.5	2.0
10-Apr	N3 (2), N2+E1+E2 (3)	4	17	1	4.3	0.3
11-Apr	W1+W2+W3+W4 (3)	4	30	0	7.5	0.0
14-Apr	B1+B2 (5)	2	77	4	38.5	2.0
	Total / Average	142	3,557	102	25.0	0.7

[a] Sampling sites grouped by "+" means the pots soaked for the same number of days.

Table 3.–Summary of male red king crab data from the winter pot survey, Norton Sound, 2008.

	Number	Percent	Average CL (mm)
Sublegal Male Crabs			88
New Shell	2001	56.3%	
Old Shell	509	14.3%	
Legal Male Crabs			112
New Shell	821	23.1%	
Old Shell	226	6.4%	
Total	3557	100%	
Prerecruit One Males[a]	1101	31.0%	
Prerecruit Twos[b]	1288	36.2%	
Prerecruit Threes[c]	121	3.4%	
Total	2510	70.6%	
Prerecruit Males[d]	2,510	70.6%	
Recruit Males[e]	633	17.8%	
Postrecruit Males[f]	414	11.6%	
Total	3,557	100.0%	

Note: CL = carapace length.

[a] Prerecruit one crabs are sublegal crabs > 89mm CL.

[b] Prerecruit twos are 76 mm to 89 mm CL.

[c] Prerecruit threes are < 76 mm CL.

[d] Prerecruits are sublegal crabs ≤ 115 mm CL.

[e] Recruits are new-shell, legal crabs with ≤ 115 mm CL.

[f] Postrecruits are new-shell, legal crabs with > 115 mm CL and all old-shell legal crabs.

Table 4.–Summary of red king crab data from the winter pot surveys, Norton Sound, 1983–2008.

		Females	Males							
					Prerecruits[a] / Sublegal			Legal		
Year (dates)[b,c]	Pot Lifts	Number Caught	Number Caught	CPUE	Threes[d,e]	Twos[d,f]	Ones[g]	Recruits[h]	Postrecruits[i]	CL (mm)
1983	107	236	2,586	24.2		26.2%	38.0%	26.1%	9.6%	[j]
1984	70	78	1,677	24.0		34.7%	31.0%	18.6%	15.8%	[j]
1985	31	14	760	24.5		24.7%	45.1%	20.4%	9.8%	[j]
1986	31	74	594	19.2		25.7%	35.0%	21.7%	17.7%	[j]
1987	26	6	151	5.8		12.5%	31.3%	10.4%	45.8%	[j]
1989	42	9	548	13.0		26.8%	15.4%	27.3%	30.5%	[j]
1990	99	18	2,076	21.0		15.9%	33.5%	24.7%	26.0%	115
1991 (1/01-4/23)	56	8	1,283	22.9	0.2%	4.8%	30.6%	33.5%	30.9%	114
1993 (3/03-4/16)	33	1	181	5.5	0.0%	3.3%	8.8%	17.1%	70.7%	118
1995[k] (3/03-4/07)	126	10	776	6.2	2.1%	9.8%	11.4%	32.3%	44.4%	117
1996 (2/06-4/17)	159	26	1,582	9.9	9.2%	22.1%	33.1%	10.1%	25.5%	117
1997 (2/18-4/14)	140	60	399	2.9	11.0%	32.3%	20.8%	14.3%	21.6%	118
1998 (2/18-4/22)	84	38	882	10.9	0.8%	36.6%	44.3%	8.7%	9.5%	113
1999 (2/08-4/20)	122	15	1,308	10.7	0.7%	6.5%	42.4%	39.0%	11.3%	110
2000 (2/14-4/10)	93	22	575	6.2	3.1%	13.2%	20.3%	38.6%	24.9%	113
2001 (2/16-4/02)	14	1	44	3.1	4.5%	18.2%	15.9%	13.6%	47.7%	106
2002 (2/13-4/18)	64	46	832	13.0	10.7%	43.1%	25.5%	9.0%	11.8%	117
2003 (2/12-4/14)	86	22	826	9.6	4.2%	19.7%	41.6%	20.2%	14.2%	113
2004 (2/23-4/09)	77	9	286	3.7	0.0%	9.4%	40.2%	37.1%	13.3%	112
2005 (2/18-4/21)	93	20	406	4.4	1.5%	15.8%	23.9%	25.4%	33.5%	116
2006 (1/26-4/19)	85	25	512	6.0	1.0%	28.5%	33.0%	15.6%	21.9%	115
2007 (2/27-4/10)	22	15	160	7.3	8.8%	16.4%	52.8%	11.3%	10.6%	112
2008 (2/11-4/14)	142	102	3,557	25.0	3.4%	36.2%	31.0%	17.8%	11.6%	112
Avg. 1983-2007	78	35	838	11.5	3.9% [l]	18.6% [l]	30.6%	21.6%	24.9%	114

[a] Prerecruits are sublegal crabs ≤ 115 mm CL.

[b] Unstable ice conditions in 1988 and 2001.

[c] The project was not funded in 1992 and 1994.

[d] Prior to 1991, carapace lengths (CL) were consolidated in pairs so that prerecruit threes and twos cannot be accurately separated.

[e] Prerecruit three crabs are < 76 mm CL.

[f] Prerecruit two crabs are 76 mm to 89 mm CL.

[g] Prerecruit ones are sublegal crabs > 89 mm CL.

[h] Recruits are new-shell, legal crabs ≤ 115 mm CL.

[i] Postrecruits are new-shell, legal crabs > 115 mm CL and all old-shell legal crabs.

[j] Prior to 1990, CL averages were not calculated.

[k] Includes catch from 12 sampling sites and from one commercial fisher's catch on April 5.

[l] Average comes from 1991–2007.

Table 5.–Winter commercial and subsistence red king crab harvests, Norton Sound, 1978–2008.

Commercial			Subsistence						
				Permits			Total Crabs		Average Harvested/
Year[a]	# Fishers	# Crabs Harvested	Winter[b]	Issued	Returned	Fished	Caught[c]	Harvested[d]	Permit Fished
1978	37	9,625	1977-78	290	206	149	[e]	12,506	84
1979	[f]	[f]	1978-79	48	43	38	[e]	224	6
1980	[f]	[f]	1979-80	22	14	9	[e]	213	24
1981	0	0	1980-81	51	39	23	[e]	360	16
1982	[f]	[f]	1981-82	101	76	54	[e]	1,288	24
1983	5	549	1982-83	172	106	85	[e]	10,432	123
1984	8	856	1983-84	222	183	143	15,923	11,220	78
1985	9	1,168	1984-85	203	166	132	10,757	8,377	63
1985-86	5	2,168	1985-86	136	133	107	10,751	7,052	66
1986-87	7	1,040	1986-87	138	134	98	7,406	5,772	59
1987-88	10	425	1987-88	71	58	40	3,573	2,724	68
1988-89	5	403	1988-89	139	115	94	7,945	6,126	65
1989-90	13	3,626	1989-90	136	118	107	16,635	12,152	114
1990-91	11	3,800	1990-91	119	104	79	9,295	7,366	93
1991-92	13	7,478	1991-92	158	105	105	15,051	11,736	112
1992-93	8	1,788	1992-93	88	79	37	1,193	1,097	30
1993-94	25	5,753	1993-94	118	95	71	4,894	4,113	58
1994-95	42	7,538	1994-95	166	131	97	7,777	5,426	56
1995-96	9	1,778	1995-96	84	44	35	2,936	1,679	48
1996-97	[f]	[f]	1996-97	38	22	13	1,617	745	57
1997-98	5	984	1997-98	94	73	64	20,327	8,622	135
1998-99	5	2,714	1998-99	95	80	71	10,651	7,533	106
1999-2000	10	3,045	1999-2000	98	64	52	9,816	5,723	107
2000-01	3	1,098	2000-01	50	27	12	366	256	21
2001-02	11	2,591	2001-02	114	101	67	8,805	3,669	55
2002-03	13	6,853	2002-03	107	73	64	9,052	4,140	65
2003-04[g]	2	522	2003-04	96	77	41	1,775	1,181	29
Average 1978-2007	9	2,288	Average 1983-2007	118	93	71	8,607	5,254	65

-continued-

Table 5.–Page 2 of 2.

	Commercial		Subsistence						
				Permits			Total Crabs		Average Harvested/
Year[a]	# Fishers	# Crabs Harvested	Winter[b]	Issued	Returned	Fished	Caught[c]	Harvested[d]	Permit Fished
2004-05	4	2,091	2004-05[h]	170	102	60	6,496	3,973	66
2005-06	[f]	[f]	2005-06	98	97	67	2,083	1,239	18
2006-07	8	3,313	2006-07	129	127	116	21,444	10,690	92
2007-08	9	5,796	2007-08	139	106	86	16,233	8,260	96
Average 1978-2007	9	2,288	Average 1983-2007	118	93	71	8,607	5,254	65

[a] Prior to 1985 the winter commercial fishery occurred from January 1–April 30. As of March 1985, fishing may occur from November 15–May 15.

[b] The winter subsistence fishery can occur as early as December and continues through May.

[c] The number of crabs actually caught; some may have been released.

[d] The number of crabs harvested is the number of crabs caught and kept.

[e] Information not available.

[f] Data confidential under AS 16.05.815.

[g] Confidentiality was waived by the fishers.

[h] During the 2004-5 season, permits were given out in Elim, Golovin, Shaktoolik, and White Mountain. In other years, permits were only given out of the Nome ADF&G office.

Table 6.–Standardized results from population assessment surveys for red king crab in Norton Sound, 1976–2006.

				Number of Red King Crabs Captured [a, b]				Population Abundance Estimates[c]			Standard Error		
Year	Dates	Research Agency	Gear	Pre-2 Males	Pre-1 Males	Legal Males [d]	Females	Pre-2 Males	Pre-1 Males	Legal Males	Pre-2 Males	Pre-1 Males	Legal 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	N/A	N/A	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 - 10/01	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

[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 parenthesis). 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) carapace width 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] 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.

[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.

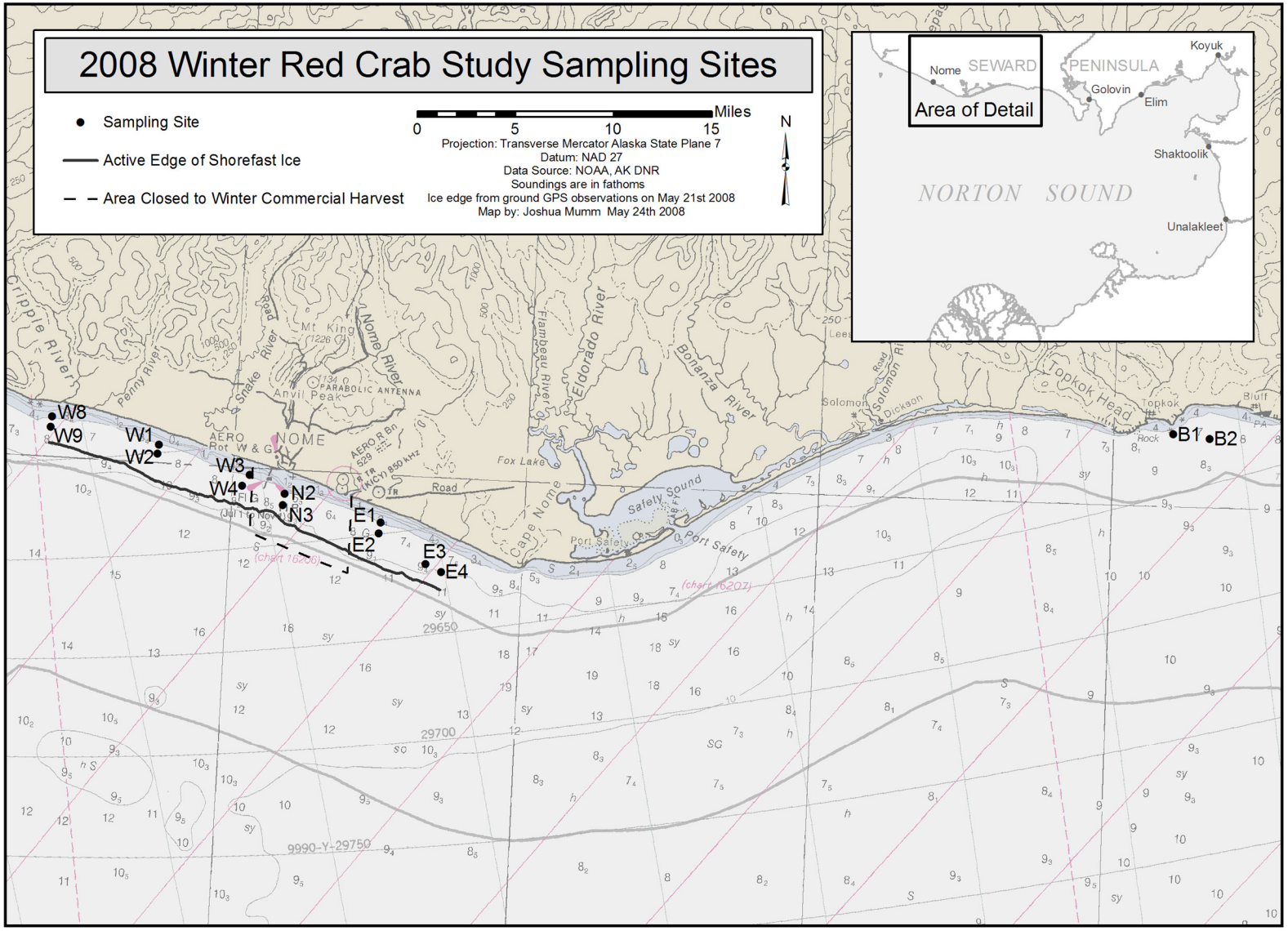


Figure 1.–Location of sampling sites for the winter red king crab pot survey, Norton Sound, 2008.

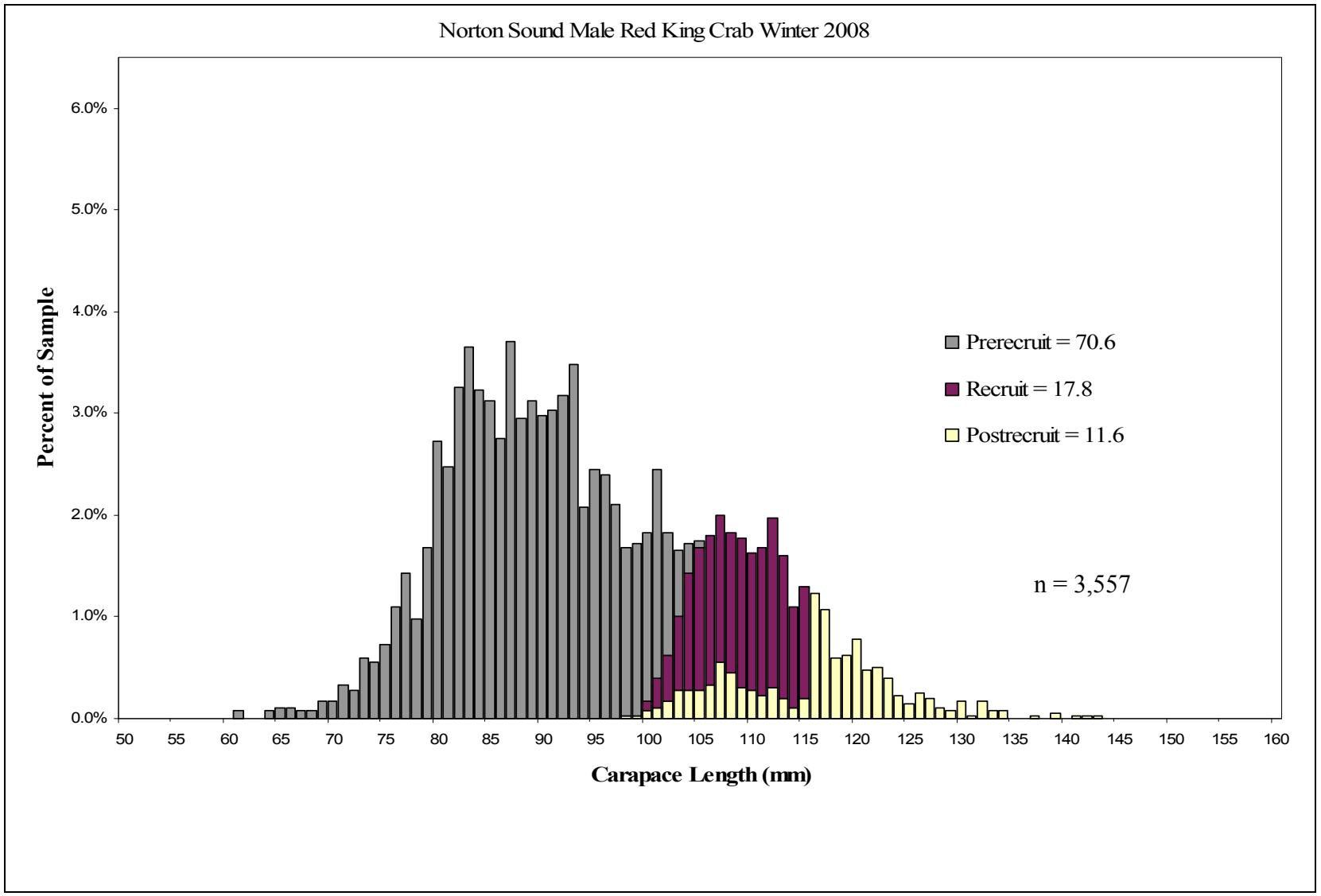


Figure 2.–Length frequency distribution of male red king crabs captured during the winter pot survey, Norton Sound, 2008.

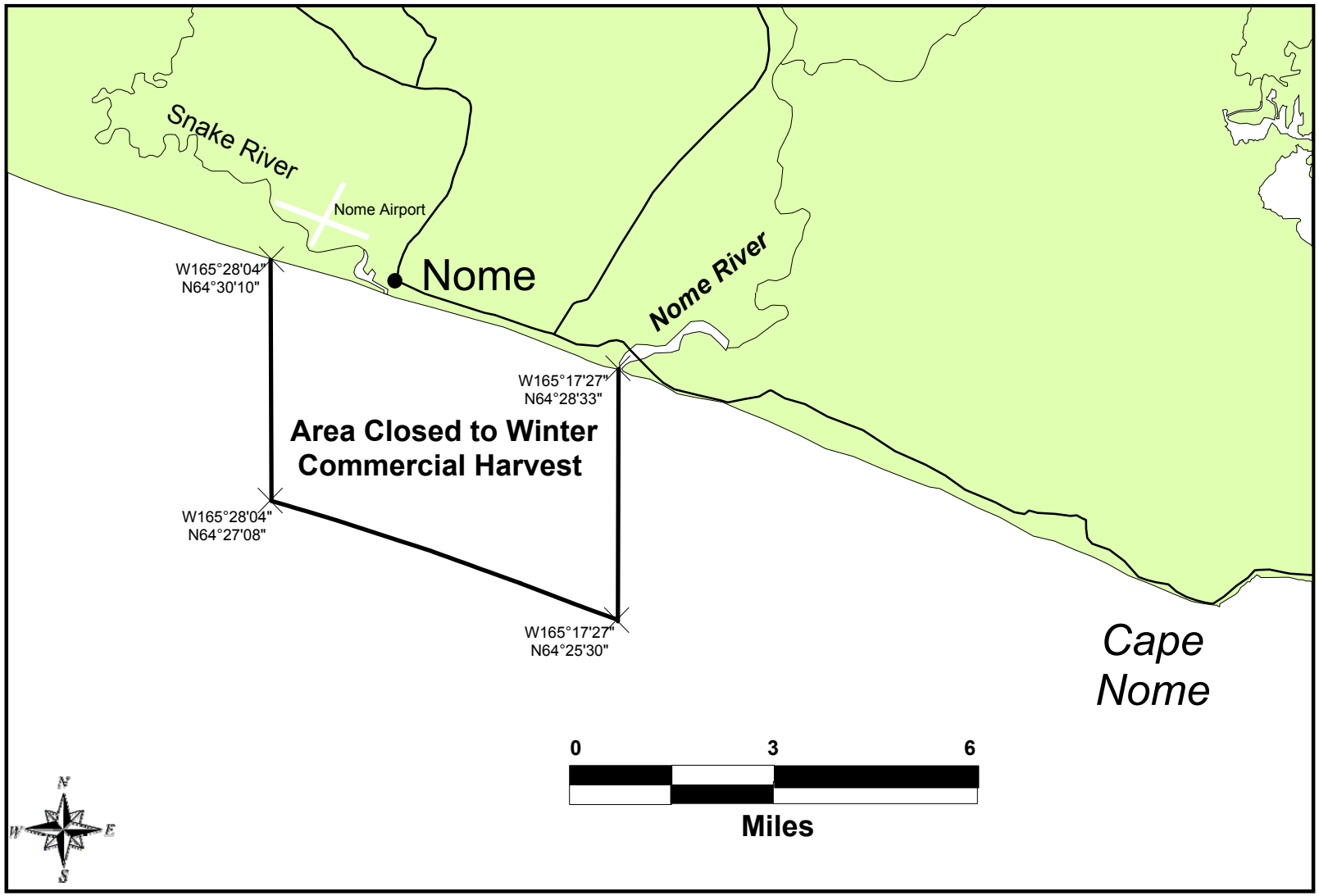
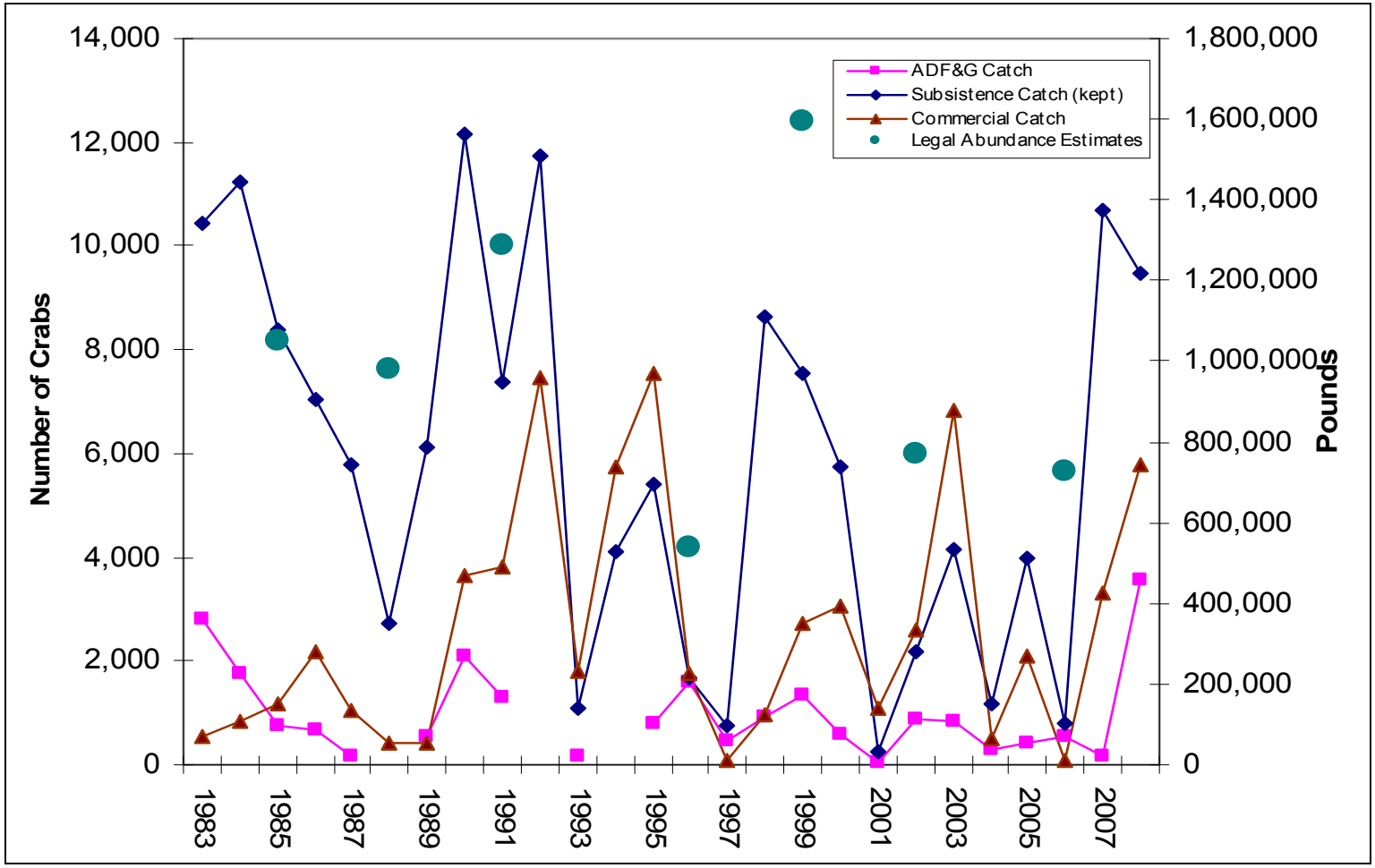


Figure 3.–Area closed to winter commercial harvest, Norton Sound.



Note: Only data from 1983 to 2008 is compared because information from commercial fishers is limited prior to these years. Catches are plotted on the primary axis, and biomass estimates are plotted on the secondary axis. Blanks for ADF&G catch are because no studies were conducted in these years.

Figure 4.–Comparison of winter red king crab catches between ADF&G surveys and commercial and subsistence fisheries, and legal abundance estimates from trawl surveys, Norton Sound, 1983–2008.

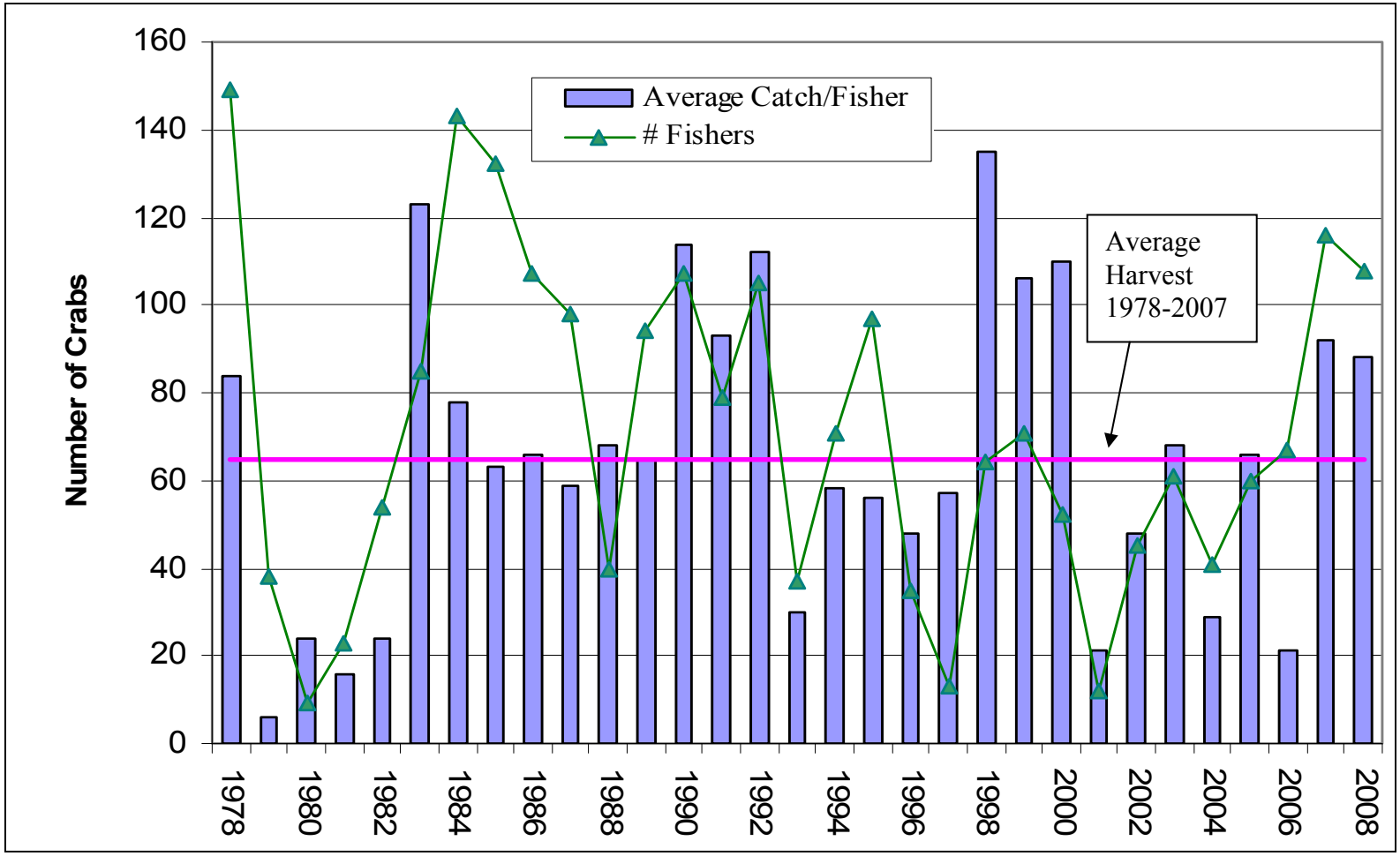


Figure 5.–Number of winter subsistence red king crab fishers and average catch per fisher, Norton Sound, 1978–2008.

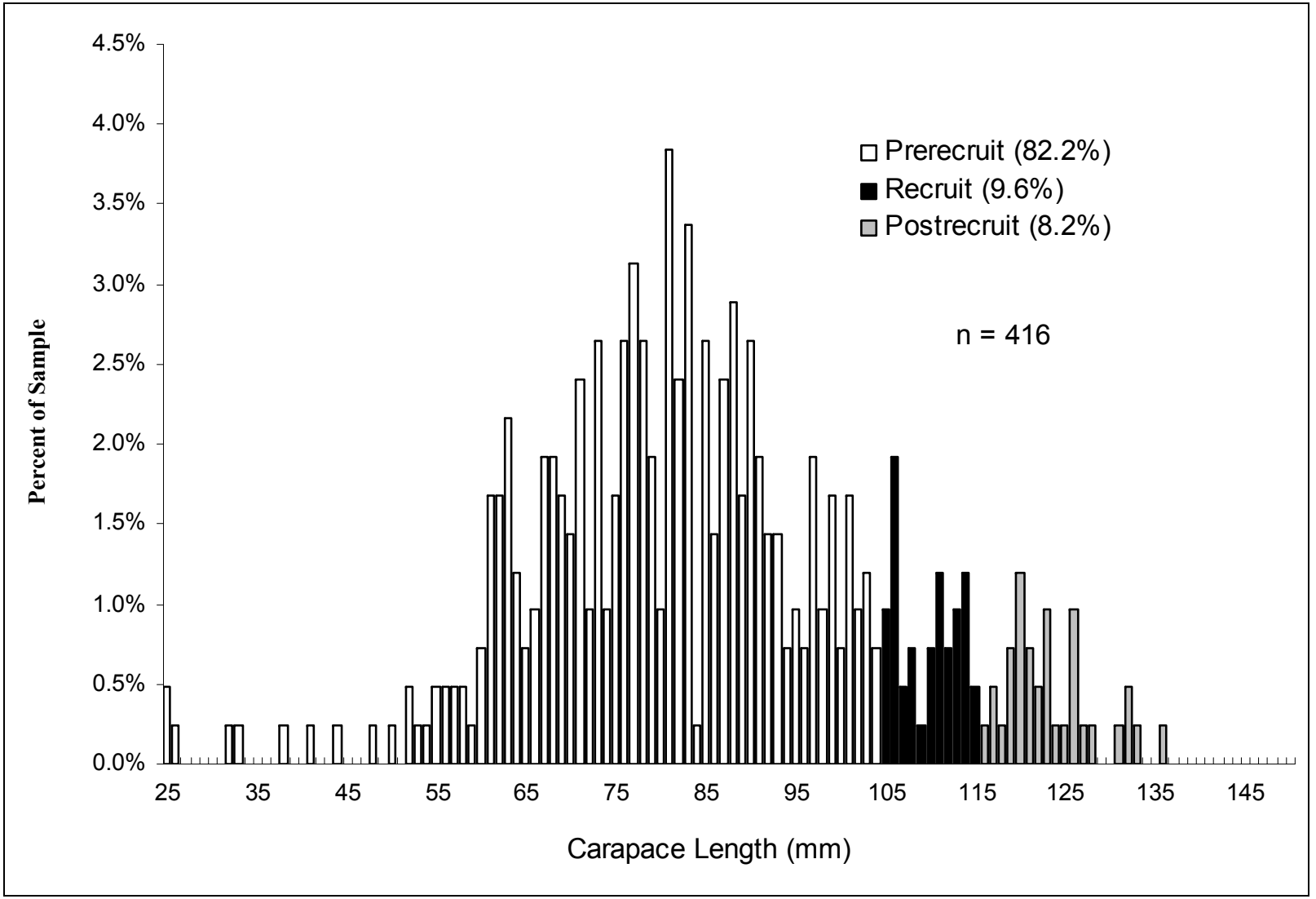


Figure 6.–Length frequency distribution of all male red king crabs captured during the summer trawl survey, Norton Sound, 2006.