

Fishery Data Series No. 07-53

Norton Sound Winter Red King Crab Studies, 2007

by

Joyce Soong

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Divisions of Sport Fish and Commercial Fisheries



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by
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Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
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ABSTRACT

Biological data were collected for a winter red king crab *Paralithodes camtschaticus* pot survey project, begun in February of 1982 by the Alaska Department of Fish and Game, 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 area 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 160 male and 15 female red king crabs were captured and sampled at 8 survey sites between March 1 and April 10, 2007. A total of 22 pot lifts were made for an overall CPUE of 7.3 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, 78% were prerecruit, 11% were recruit, and 11% postrecruit. Analysis of the 2007 winter data indicated recruitment is less than last year but is expected to increase for next year.

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 area 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. 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). 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). In 2006, pots were lost when shore ice broke off at the beginning of the project, but new pots were deployed in traditional areas when the ice later stabilized (Soong 2006).

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 2007 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 \leq 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 2007 study area using CPUE information.
7. Record other biological data such as incidence of disease, parasitism, and other species captured.

METHODS

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. Landmarks used were oil rig (7 miles west), dredge #6 (2 miles west), Nome post office, roadhouse (2 miles east), and Farley's Camp (5 miles east). Water depth ranged from 30 to 50 feet deep and the sites were located 1 to 2 miles offshore. In 2007, four survey stations comprised of 10 sampling sites were established in an area spanning from approximately 6 miles west to 5 miles east of Nome

(Table 1; Figure 1) beginning February 27. Each sampling site was located in water ranging from 18 to 52 feet deep and from approximately 0.5 mile to 1.2 mile 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 76¹), 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. 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).

Once pots were deployed, each pot was checked and rebaited once or twice per week, depending on weather. 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 \geq 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 \leq 115-mm CL), or prerecruit (sublegal crabs \leq 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 shell age (determined as new or old shell by observing features such as scarring on the ventral surface, dullness on the dactyl tips, and attached barnacle sizes), sex, and egg development and clutch size of female crabs. 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. This length determination, roughly the break between legal and sublegal crabs, was chosen to prevent tagged crabs from being harvested in the same-year summer commercial fishery. 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

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

crab fishing, the winter permit is valid only from November 15 to May 15, after which time the fishers must use a summer subsistence crab permit.

RESULTS

Ice conditions in front of and near Nome were stable in January and February. There were few high pressure ridges, therefore we were able to place all of the stations in 2007 near historical locations: 2 and 6 miles west, directly south, and 5 miles east of Nome. Two sampling sites were placed at each station approximately a quarter mile apart. The first pots (N2 and N3) were deployed February 27, 2007. These pots and 4 additional pots (W1, W2, W3, and W4) set out in late February and early March, were all lost when the ice went out on March 9. The active ice edge then stabilized at approximately ½ to 1 mile offshore and 4 more pots (E1, N2a, W1a, and W3a) were set out near this ice edge in mid March (Figure 1). A week later, between March 23 and 25, pot E1 was lost due to moving ice, but the remaining 3 pots (set in shallower water and closer to shore) stayed in place until they were pulled on April 10 due to low catch rates and uncertain ice conditions. All through the season, trail conditions along the beach line were good and the lack of high pressure ridges made for easy travel out on the pack ice.

A total of 160 males (of which 63 were tagged) and 15 female red king crabs were captured and sampled at 10 sampling sites between March 1 and April 10 (Table 2). The number of pot lifts totaled 22, which made for an overall CPUE of 7.3 male and 0.7 female red king crabs (Table 1). Sampling sites W3, N2, and E1 had the highest CPUEs, whereas sites N2a and W3a had the lowest. Comparisons of CPUE between stations were not made due to the loss of pots and the small number of lifts made at each station. Catch rates varied between 0.7 and 42.0 over the season depending on which pots were pulled and how long they soaked (Table 2). Of the 160 male crabs caught, recruit crabs made up less than 12% of the catch, postrecruit crabs less than 11%, and prerecruits made up the remainder, at 78% (Table 3; Figure 2).

Number of pot lifts, and male and female red king crabs caught were less than the 2006 study and all were less than half of the averages from historical winter surveys 1983–2006 (Table 4). Only male CPUE was greater than the 2006 study, and was 63% of the 1983–2006 average. Percentage of recruits was 72% of 2006, and postrecruits were 48% of 2006. Of the sublegal catch, percentage of pre-3 crabs was 780% higher compared to 2006, pre-2 crabs decreased by 42%, and pre-1 crabs increased by 60% (Table 4). For the past 2 years, the prerecruit catch proportion has increased compared to prior year, while correspondingly, the legal crab catch proportion has decreased.

Of the 15 female crabs caught, one was a juvenile (< 72-mm CL, no eggs). Of the adults, 10 had an egg clutch above 60% full, one had a clutch of 5%, and the remaining three were barren. All egg clutches were either purple or dark brown. Half of the female crabs had eyed eggs.

In 2007, other species caught included helmet crabs *Telmessus cheiragonus* (1), Arctic Lyre crabs *Hyas coarctatus* (3), flatbottom sea stars *Asterias* (277), sea urchins of the genus *Strongylocentrotus* (5), shrimp *Pandalus spp.* (1), and jellyfish (1). Species caught in prior years but not in 2007 were fiddler crabs *Hapalogaster grebnitzkii*, saffron cod *Eleginus gracilis*, and sculpins. In contrast to the last 3 years, sand fleas were again abundantly observed in the bait jars, similar to years prior to 2004 (P. Thompson, Fish & Wildlife Technician II, ADF&G,

Nome; personal communication). No visible signs of disease were detected on the crabs caught in 2007; however, meat fill was noticeably thinner as determined by the amount of give when the crab legs were pinched.

Subsistence fishing effort for Nome residents was concentrated between 3 miles east to 2 miles west of town. The number of subsistence permits issued, for all of Norton Sound, was 129, slightly above the average number of permits issued per year since 1983 (Table 5). Of the 127 fishers who returned their permit, 116 actually fished, harvesting 10,690 crabs, or twice as much as the average harvest from 1983–2006. Residents of Elim, Unalakleet, and White Mountain had a combined harvest of 2,177 crabs, or 20% 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 256 pots reported fishing, 132 (or 52%) were lost during the season due to the moving pack ice. Sixteen fishers reported fishing with handlines, for a combined harvest of at least 95 crabs. Percentages of subsistence crabs harvested each month are as follows: November 0%, December 0%, January 9%, February 54%, March 25%, April 11%, and May 1%. Most crabs were harvested during February before the ice shifted.

The winter commercial season opened November 15, 2006, and 8 fishers registered to fish. Based on fish tickets submitted, the first landing was made January 17. From then until the last landing on May 5, 8 fishers made a total of 106 landings and 926 potlifts, with an overall CPUE of 3.6 and average weight of 2.4 pounds per crab. Price per pound of crab averaged \$3.06. A total of 3,313 crabs were sold, with percentages of crabs sold (and CPUE) each month as follows: January 2% (1.5), February 37% (3.4), March 36% (3.7), April 24% (4.2), and May 2% (5.0). Some commercial fishers also reported losing their pots during the 2007 winter season, fishing their pots from 12 miles east to 12 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).

Ten tags were turned in during the 2007 winter season by subsistence or commercial crab fishers. Two tags were brought in without either the tag number or the crab shell. Three of the returned tags were deployed this season. Of the 5 remaining tags, which provided useful information, all had been deployed during the previous season in three different sampling sites from 3.5 miles to 5.5 miles west of Nome. All these tags were recovered in statistical area 656403, the area immediately south and east of Nome. These 5 crabs had all molted, with an average growth of 15.2-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 22 of the past 25 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. In 2007, 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 equal or exceed the average comparable harvest from 1978–2006 (Table 5). However, easy access to crab for subsistence fishers and for the study, was limited starting in March due to unstable ice in front of Nome and pots lost.

Winter catch of red king crab for ADF&G studies, and subsistence and commercial fisheries have varied widely over the years 1983–2007, 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 (2007)]. 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 2007, the ice pack was stable in January and February, with subsistence fishers harvesting most of their catch in February. In March, the ice in front of Nome broke off and subsistence and ADF&G harvest numbers declined. However, commercial fishers, who set out their pots further east and west of Nome where the ice was more stable, had similar harvest numbers in February and March, and their CPUE increased from January to May. These results along with relatively high average harvest per subsistence fisher (Figure 5) indicate that crab numbers were abundant, but shifting ice in the subsistence area affected both subsistence harvest and department catch numbers.

In 2007, the late start of the winter study project also had an impact on catch results. Both subsistence and commercial fishers harvested the majority of their catch in February, but the first study pot was not deployed until late February due to budget concerns. Catch rates for the department study was high in the first 3 weeks of March until the ice shifted and pots were lost. With pots redeployed in shallower waters, department catch rates declined (Table 2).

Ice condition and harvest timing are not the only factors affecting catch. 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 two of the lowest subsistence catch numbers.

In addition to ice conditions and changes in crab population and recruitment, variable distribution of crabs in nearshore waters also appear to impact catch performance. It was not possible to monitor the distribution of crabs in nearshore waters in 2007, because few pot lifts were made at each station and because pots were later placed in shallower waters where few crabs were found. However, 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. Therefore, factors affecting winter catch performance include ice conditions, fluctuations in crab population and recruitment, and changes in the nearshore distribution of crab during winter.

The 2007 winter study data indicate recruitment has peaked and is less than 2006. Current size composition data show the portion of the crab population classified as recruits has decreased 28% since the 2006 survey and postrecruit male crab population has decreased 52%. The high percentage of recruit and postrecruit crabs observed in 2004 and 2005 has passed out of the system, yet it was not replaced by the high percentage of prerecruit crabs seen the previous year. It is possible that prerecruit population suffered higher than normal mortality or that data from 2006 winter study did not present an accurate picture of the crab population. Exact reasons for the disparity are unclear. The winter pot study also points to the highest percentage of pre-1 population in the last 20 years and a slightly below average pre-2 population (Table 4). Pre-1 crabs require one molt to become part of legal population next year, while pre-2 crabs require two molts. These findings indicate that legal crab population is less compared to 2006, but is expected to increase next year followed by a possible decline in 2009. The smaller than average sample size creates less confidence in 2007 study results; however, data from the last trawl survey support the finding that legal crab population will increase next year.

The triennial Norton Sound red king crab trawl survey was conducted in summer of 2006. Results from the survey suggest that 2008 and 2009 legal king crab populations should increase from the current population (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 have molted last year (post survey) to become part of the pre-1 population this year. A comparison of Figures 2 and 6 illustrates the progression of this class size from the time of the trawl survey (pre-molt) to this winter's study (post-molt). This pre-1 population will contribute to the legal population for the next couple of years.

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 2007 winter crab project were added into the computer model to predict the Norton Sound summer crab biomass. The expected legal male crab abundance was 3.1 million pounds, which is a decline of approximately 3% from the revised population estimate of 3.2 million pounds for 2006. A 10% exploitation rate on the legal population, in accordance with the harvest strategy set by the Alaska Board of Fisheries, equates to a GHF of 315,000 pounds of crab. Therefore, the 2007 summer commercial open-access king crab fishery allocation will be 291,375 pounds, and the Community Development Quota (CDQ) allocation will be 23,625 pounds.

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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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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 3A99-32, 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.
- 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.
- Soong, J. 2007. 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., 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>

REFERENCES CITED (Continued)

- 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, 2007.

Station	Sampling Site ^a	<u>Location (decimal degrees)</u>		Depth (ft)	Distance from Nome (mi)	Historical Location	Number of Pot Lifts	<u>Male Red King Crab</u>		<u>Female Red King Crab</u>	
		Latitude	Longitude					Number Caught	CPUE	Number Caught	CPUE
1	W1	64.30269	165.37032	50	6.0 W	yes	0	0	0.0	0	0.0
	W2	64.30101	165.36992	52	6.0 W	yes	0	0	0.0	0	0.0
	W1a	64.50758	165.61449	45	6.0 W	yes	5	25	5.0	1	0.2
2	W3	64.29390	165.28056	41	2.0 W	yes	1	22	22.0	1	1.0
	W4	64.29239	165.28165	51	2.0 W	yes	1	9	9.0	1	1.0
	W3a	64.49786	165.46581	18	2.0 W	yes	5	6	1.2	0	0.0
3	N2	64.29129	165.24283	39	0.8 S	yes	2	41	20.5	4	2.0
	N3	64.28752	165.24469	50	1.2 S	yes	2	12	6.0	0	0.0
	N2a	64.48975	165.40558	25	0.5 S	yes	5	3	0.6	0	0.0
4	E1	64.46605	165.25168	40	5.0 E	yes	1	42	42.0	8	8.0
Total							22	160	7.3	15	0.7

^a Pots W1, W2, W3, W4, N2, and N3 were lost March 9. Pot E1 was lost between March 23 and 25.

Table 2.—Daily catch of red king crabs for all sampling sites in the winter pot survey, Norton Sound, 2007.

Date Checked	Sampling Sites^a (soak time in days)	Pot Lifts	Males	Females	Male CPUE	Female CPUE
1-Mar	N2+N3 (2)	2	17	1	8.5	0.5
5-Mar	W3+W4 (5)	2	31	2	15.5	1.0
6-Mar	N2+N3 (5)	2	36	3	18.0	1.5
22-Mar	E1 (3)	1	42	8	42.0	8.0
26-Mar	N2a (4), W1a (5), W3a (6)	3	4	0	1.3	0.0
29-Mar	N2a (3), W1a (3), W3a (3)	3	3	0	1.0	0.0
3-Apr	N2a (5), W1a (5), W3a (5)	3	9	0	3.0	0.0
6-Apr	N2a (3), W1a (3), W3a (3)	3	16	1	5.3	0.3
10-Apr	N2a (4), W1a (4), W3a (4)	3	2	0	0.7	0.0
Total / Average		22	160	15	7.3	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, 2007.

	Number	Percent	Average CL (mm)
Sublegal Male Crabs			90
New Shell	124	77.5%	
Old Shell	1	0.6%	
Legal Male Crabs			112
New Shell	25	15.6%	
Old Shell	10	6.3%	
Total	160	100.0%	
Prerecruit One Males ^a	84	52.8%	
Prerecruit Twos ^b	26	16.4%	
Prerecruit Threes ^c	15	8.8%	
Total	125	78.0%	
Prerecruit Males ^d	125	78.0%	
Recruit Males ^e	18	11.3%	
Postrecruit Males ^f	17	10.7%	
Total	160	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, 1983–2007.

Year (dates) ^{b,c}	Pot Lifts	Females		Males						
		Number Caught	Number Caught	CPUE	Prerecruits ^a / Sublegal			Legal		CL (mm)
					Threes ^{d,e}	Twos ^{d,f}	Ones ^g	Recruits ^h	Postrecruits ⁱ	
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	56	8	1,283	22.9	0.2%	4.8%	30.6%	33.5%	30.9%	114
1993	33	1	181	5.5	0.0%	3.3%	8.8%	17.1%	70.7%	118
1995 ^k	126	10	776	6.2	2.1%	9.8%	11.4%	32.3%	44.4%	117
1996	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 (2/8-4/20)	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 (2/16-4/2)	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 (2/23-4/9)	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
Avg. 1983-2006	78	35	838	11.5	3.5% ^l	18.8% ^l	29.6%	22.1%	25.5%	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 1991–2006.

Table 5.—Winter commercial and subsistence red king crab harvests, Norton Sound, 1978–2007.

Year ^a	Commercial		Subsistence						
	# Fishers	# Crabs Harvested	Winter ^b	Permits			Total Crabs		Average Harvested/ Permit Fished
				Issued	Returned	Fished	Caught ^c	Harvested ^d	
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	61	45	5,119	2,177	48
2002-03	13	6,853	2002-03	107	70	61	9,052	4,140	68
2003-04 ^g	2	522	2003-04	96	77	41	1,775	1,181	29
Average			Average						
1978-2006	9	2,357	1983-2006	119	95	72	8,049	5,301	68

-continued-

Table 5.–Page 2 of 2.

Year ^a	Commercial		Subsistence						Average Harvested/ Permit Fished
	# Fishers	# Crabs Harvested	Winter ^b	Permits		Fished	Total Crabs		
				Issued	Returned		Caught ^c	Harvested ^d	
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
Average 1978-2006	9	2,357	Average 1983-2006	119	95	72	8,049	5,301	68

^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.

Year	Dates	Research Agency	Gear	Number of Red King Crabs Captured ^{a, b}				Population Abundance Estimates ^c			Standard Error		
				Pre-2	Pre-1	Legal	Females	Pre-2	Pre-1	Legal	Pre-2	Pre-1	Legal
				Males	Males	Males ^d		Males	Males	Males	Males	Males	Males
1976	9/02 - 9/05, 9/16 - 10/7	NMFS	Trawl	58(38)	110(213)	180(614)	101(35)	331,555	808,091	1,742,755	44,653	70,094	104,941
1979 ^e	7/26 - 8/05	NMFS	Trawl	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.

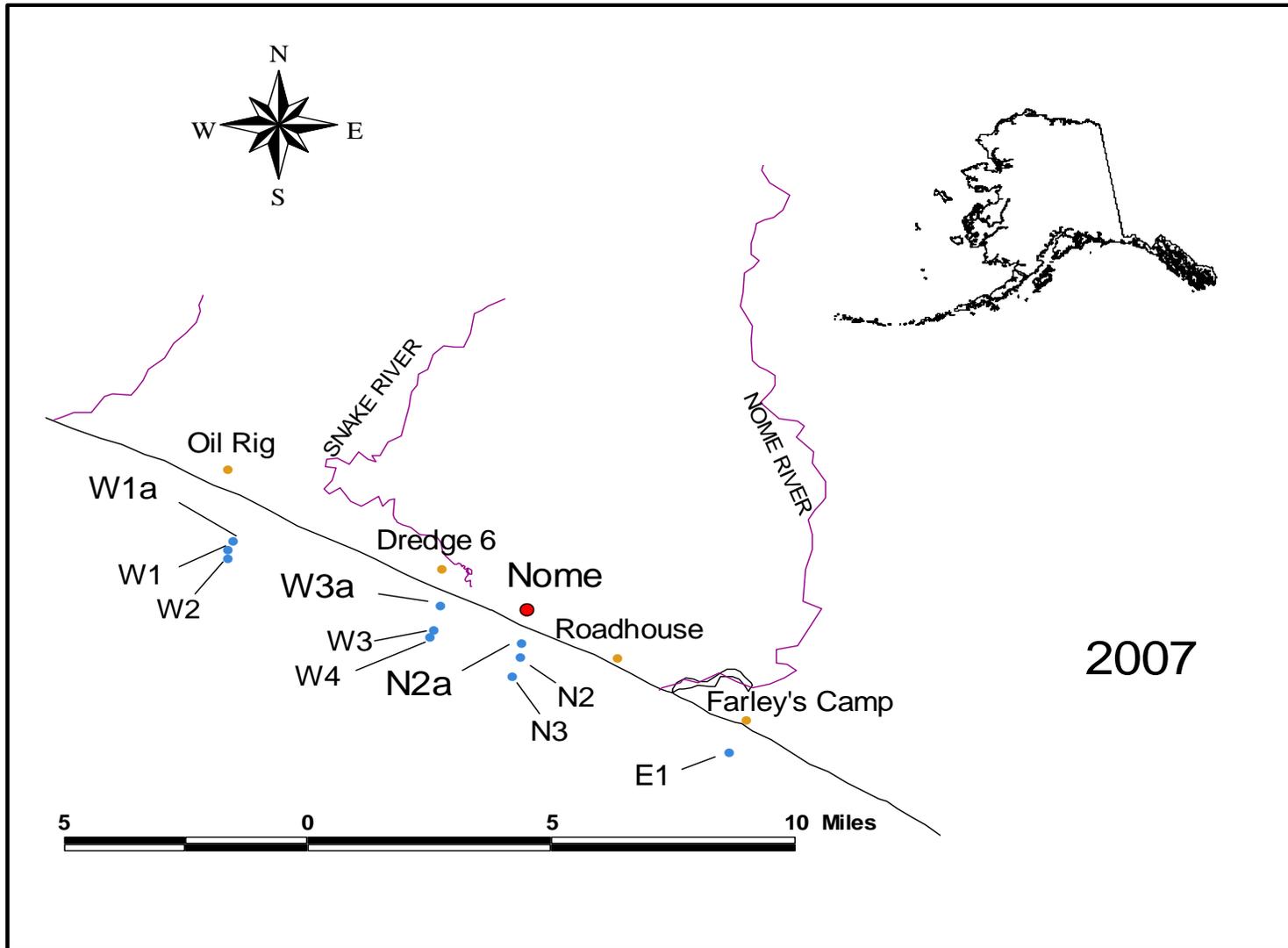
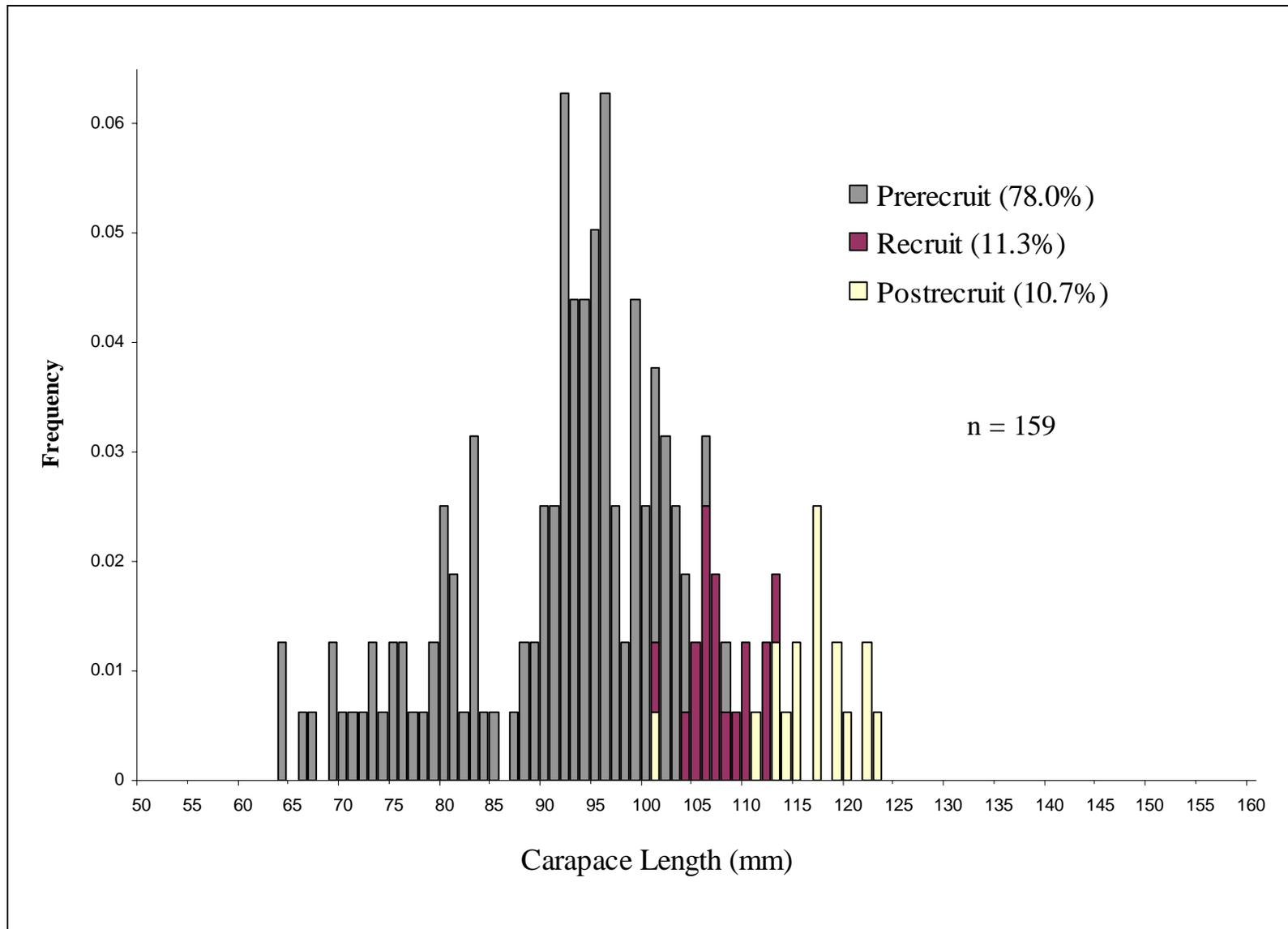


Figure 1.—Location of sampling sites for the winter red king crab pot survey, Norton Sound, 2007.



Note: Histogram does not include 1 crab with 25-mm CL.

Figure 2.—Length frequency distribution of male red king crabs captured during the winter pot survey, Norton Sound, 2007.

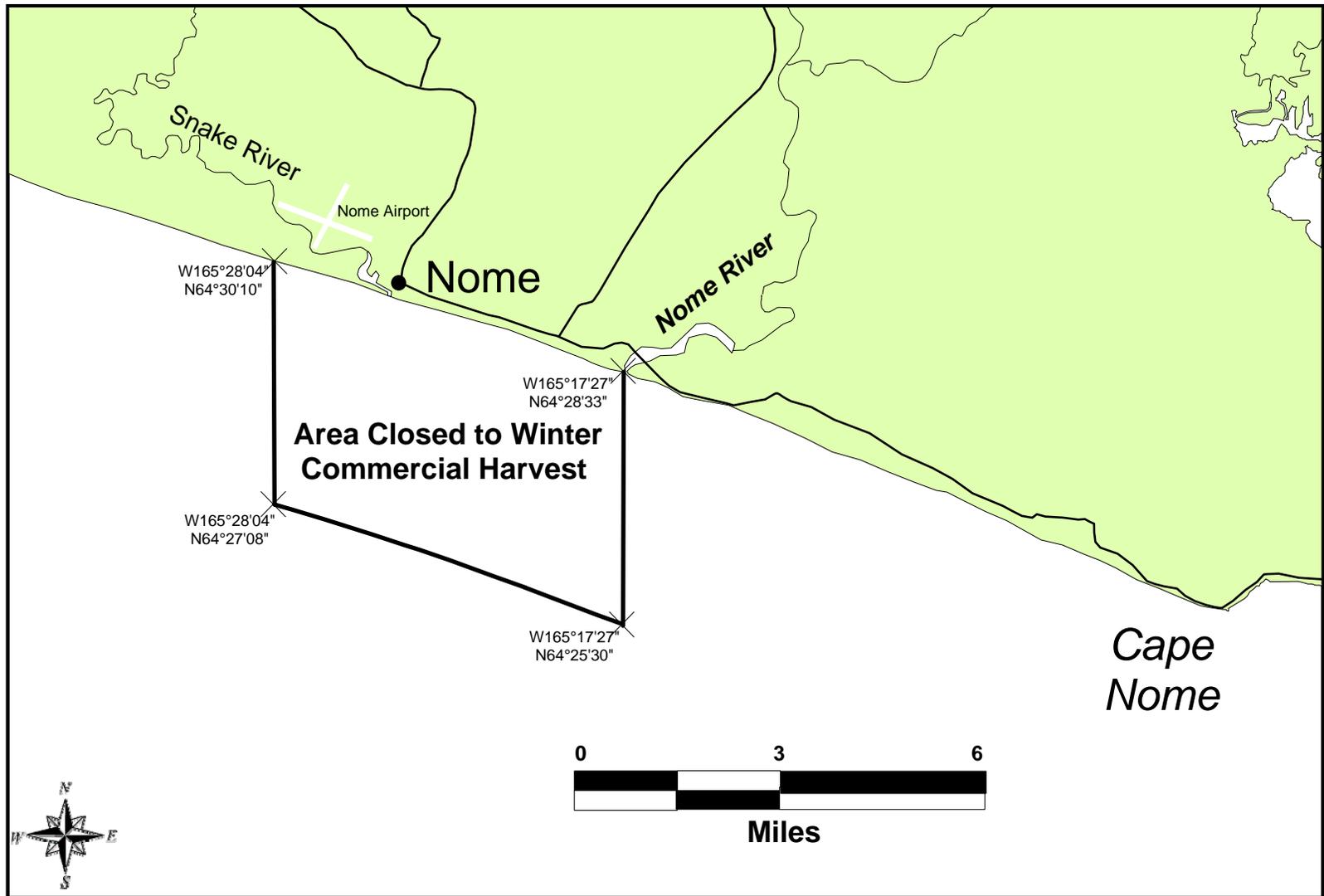
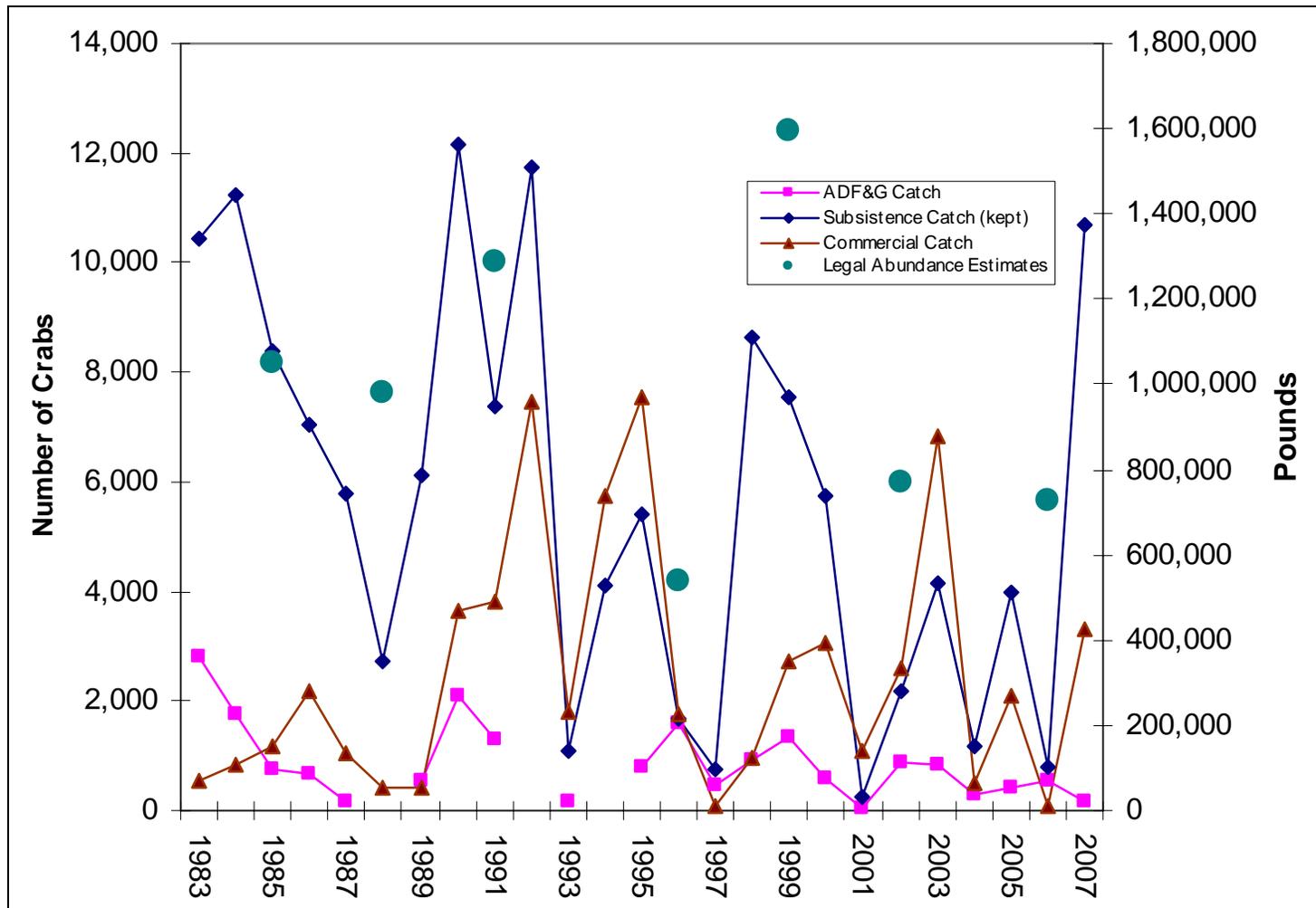


Figure 3.—Area closed to winter commercial harvest, Norton Sound.



Note: Only data from 1983 to 2007 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, 1983–2007.

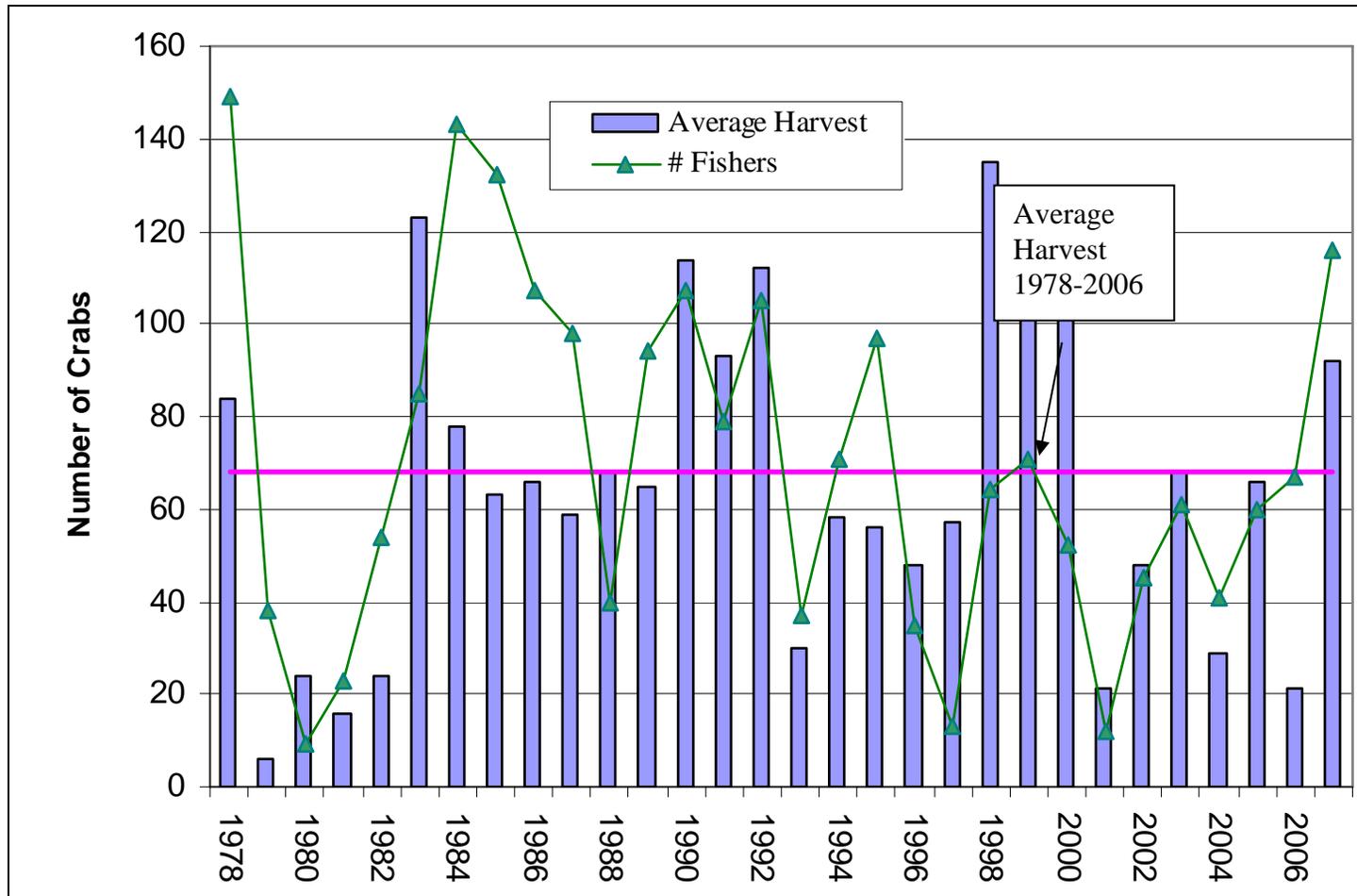


Figure 5.—Number of winter subsistence red king crab fishers and average harvest per fisher, Norton Sound, 1978–2007.

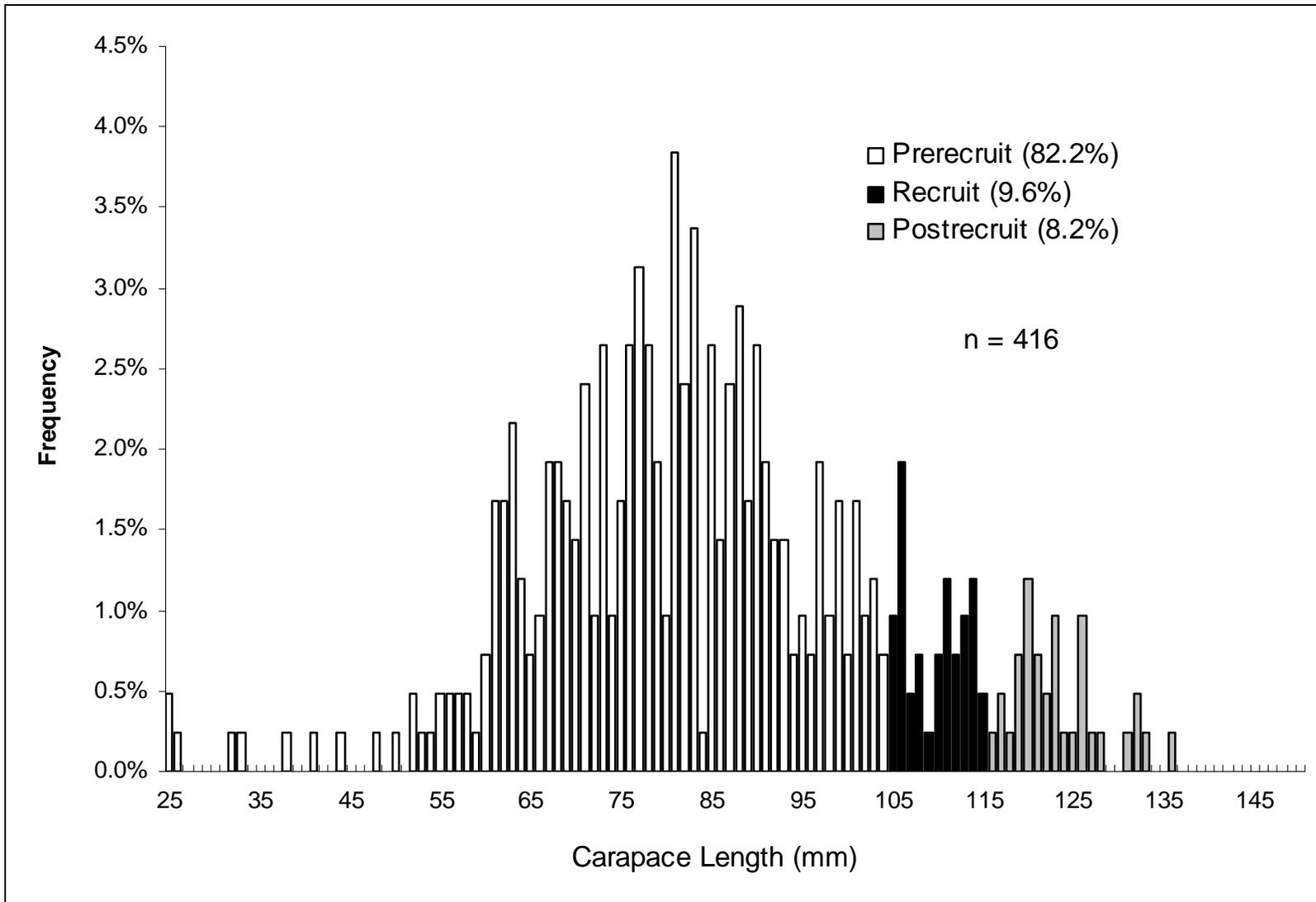


Figure 6.—Length frequency distribution of all male red king crabs captured during the summer trawl survey, Norton Sound, 2006.