TECHNICAL FISHERY REPORT 92-14

Alaska Department of Fish and Game
Division of Commercial Fisheries
P.O. Box 25526
Juneau, Alaska 99802-5526

October 1992

A Summary of Biological Data Collected During the 1991 Bristol Bay Red King Crab Tagging Study

by

Susan Byersdorfer

and

Leslie J. Watson

The Technical Fishery Report Series was established in 1987, replacing the Technical Data Report Series. The scope of this new series has been broadened to include reports that may contain data analysis, although data oriented reports lacking substantial analysis will continue to be included. The new series maintains an emphasis on timely reporting of recently gathered information, and this may sometimes require use of data subject to minor future adjustments. Reports published in this series are generally interim, annual, or iterative rather than final reports summarizing a completed study or project. They are technically oriented and intended for use primarily by fishery professionals and technically oriented fishing industry representatives. Publications in this series have received several editorial reviews and at least one *blind* peer review refereed by the division's editor and have been determined to be consistent with the division's publication policies and standards.

A SUMMARY OF BIOLOGICAL DATA COLLECTED DURING THE 1991 BRISTOL BAY RED KING CRAB TAGGING STUDY

By

Susan Byersdorfer

and

Leslie J. Watson

Technical Fishery Report No. 92-14

Alaska Department of Fish and Game
Division of Commercial Fisheries
Juneau, Alaska

October 1992

AUTHORS

Susan Byersdorfer is a shellfish research fishery biologist for the Westward region. Leslie J. Watson is a marine fishery biologist and project leader for the Westward Region Bering Sea shellfish research section. Both authors work for the Division of Commercial Fisheries, 211 Mission Road, Kodiak AK, 99615.

ACKNOWLEDGMENTS

We thank co-cruise leader Dean Beers and Alaska Department of Fish and Game technicians David Skordelis, Tom Pearson, and Tamela Anderson for their efforts in collecting the survey data. Captain Brian Walker and the crew of the FV *Kristen Gail* deserve special recognition for completing the 1991 survey in a timely manner. Database management and data analysis by Jim Blackburn and Douglas Pengilly is gratefully acknowledged. Critical review of this manuscript by Forrest Blau and Douglas Pengilly is greatly appreciated.

SPONSORSHIP

Funding for the 1990 and 1991 tagging studies was under the State of Alaska Test Fishery Program, where fishery resources may be caught and sold to support research and management objectives.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Catch composition and biological data were gathered during a tagging study of Bristol Bay red king crab *Paralithodes camtschaticus* conducted in 1991. A total of 330 crab pots were sampled from 141 stations over the 35-d study. New-shell, male red king crab dominated survey catches, followed by Tanner crab *Chionoecetes bairdi.* Legal male red king crabs were widely distributed over the study area and averaged 16.7 crabs per pot. Size of maturity (SM50) of female red king crabs was 93.4 mm carapace length. The overall rate of handling-induced injury or mortality was low (<3.0%). A total of 7,554 male red king crabs were tagged during the survey.

KEY WORDS: Red king crab, *Paralithodes camtschaticus*, Tanner crab, *Chionoecetes bairdi*, Bristol Bay, carapace length, carapace width, shell age, SM50, catch per pot

INTRODUCTION

In 1990 the Alaska Department of Fish and Game (ADF&G) initiated tagging studies of red king crabs *Paralithodes camtschaticus* in Bristol Bay (Watson et al. 1991). A second ADF&G tagging study was conducted in the summer of 1991 for the primary purpose of externally tagging mature male red king crabs using polyvinyl isthmus tags described by Gray (1965). All healthy, non-injured male red king crabs $\geq$ 120 mm CL were tagged for a total of 7,554. The overall purpose of ADF&G tagging studies conducted on Bristol Bay red king crab has been extensively reviewed (Watson et al. 1991; Pengilly and Watson 1992).

In the course of these tagging surveys ADF&G collected biological data on all commercially important crab species caught. Data collected on the tagging target, mature male red king crabs, was used to characterize these animals for analysis of differential tag return rates due to shell condition or size, as well as expand the biological database (e.g., Stevens and MacIntosh 1990; Stevens et al. 1991). During the tagging study length frequency distributions were obtained for the entire range of red king crab caught, as well as for Tanner crab *C.bairdi* and snow crab *C. opilio*. For Bristol Bay red king crabs the ADF&G length frequency distribution is particularly important as a supplement to annual assessment surveys of eastern Bering Sea crab stocks conducted by National Marine Fisheries Service (NMFS; e.g., Stevens et al. 1991). The NMFS survey covers a large area from which few crabs are actually caught: < 1,000 crabs in the past 2 years. In contrast, ADF&G tagging surveys cover a smaller area from which many crabs are caught; e.g., > 24,000 red king crabs were caught during the 1991 tagging survey (Watson et al. 1991). Because it now appears that the Bristol Bay red king crab stock may be in decline, the importance of data collected independently from the trawl survey cannot be overstated. The purpose of this report is to document the biological data collected during the 1991 tagging study, with particular emphasis on red king crabs.

METHODS AND PROCEDURES

For purposes of this report, terms related to the classification of sampled red king crabs are as follows:

Carapace Length (CL) — the straight line distance across the carapace from the posterior margin of the right eye orbit to the medial-posterior margin of the carapace.
Legal Size — male crabs $\geq$ 165 mm (6.5 in) in width including the lateral spines.
Mature Males — all male crabs $\geq$ 120 mm CL.
Immature Males — all male crabs < 120 mm CL.
Mature Females — all female crabs $\geq$ 90 mm CL.
Immature Females — all female crabs < 90 mm CL.
New-Shell Males — individuals that molted during the last molting season.
Old-Shell Males — individuals that failed to molt during the last molting season.

Tanner crabs were classified as follows:

Carapace Width (CW) — the straight line distance across the carapace at a right angle to a line midway between the eyes to the medial-posterior margin of the carapace.
Legal Size — male crab $\geq$ 140 mm (5.5 in) in width, including the lateral spines.
New-Shell Males — individuals that molted during the last molting season.
Old-Shell Males — individuals that failed to molt during the last molting season.

Survey Itinerary

The study took place in two segments over a 35 d period from September 2 to October 6, 1991 aboard the 39-m (128-ft) chartered crabber, FV *Kristen Gail.* Catch sampling and tagging were conducted between September 5 and 14 and between September 26 and October 4. Fishing for cost recovery to offset costs of the tagging study was conducted opportunistically throughout the charter: the greatest production occurred near the end of each survey segment.

Study Area

The Bristol Bay red king crab management area (Area T) was too large to cover in a 35-d survey. The survey was therefore concentrated in a 7,776-km^2 (2,400-nm^2) area encompassing a portion of the harvestable red king crab population located in Bristol Bay. The study area and the orientation of stations within it were based on crab distribution results from the 1990 ADF&G study and the 1991 NMFS eastern Bering Sea crab survey (Stevens et al. 1991; Figure 1) showing the highest concentration of legal male red king crabs.

Sampling Design

To maximize coverage of crab concentrations within the study area, 564 pots were set, or 4 pots at each of 141 sampling stations. Pots were identified for sampling in a systematic pattern (Figure 2). Each station was sampled using four 2.1-m x 2.1-m (7-ft x 7-ft) commercial side-loading king crab pots with 12.7-cm (5-in) stretch mesh set in a 1.85-km (1.0-nm) northeast-to-southwest line with a spacing of 0.63 km (0.34 nm) between pots. The location identified for a station was the northernmost point of the string of four pots. The north-south distance between strings was 4.33 km (2.75 nm); the east-west distance between strings was 13.88 km (7.5 nm). An itinerary for setting and picking pots was established prior to the study but was adjusted during the survey depending on the number of crabs tagged each day. A target soak time for each pot was 48 h. Pots were baited with 1.9 L (2 qt) of frozen, chopped herring and when available Pacific cod was used as additional hanging bait.

Catch Sampling

The contents of each sampled pot were unloaded to a sorting table where all crabs were separated by species and sex and then transferred to another table for measuring. Each sampled crab was measured to the nearest millimeter (carapace length or CL for red king crab; carapace width or CW for Tanner and snow crab). Shell age was also examined and noted. An additional, commercial measure of carapace width was made for males to classify them as either legal or sublegal crab. All male red king crabs $\geq$120 mm CL were sampled. To allow sufficient time for tagging, only twenty measurements of all female and male red king crabs <120 mm CL were taken. A maximum of five measurements of each sex of Tanner and snow crabs were taken.

All sampled crabs were examined for handling-induced injury or mortality. Red king crabs were grossly examined for the microsporidian infestation commonly known as cottage cheese disease (Sparks and Morado 1985) and the parasitic barnacle *Briarosaccus callosum*. Tanner crabs were grossly examined for black mat and bitter crab syndromes.

All sampled females were examined for the presence of eggs, empty egg cases, and egg stalks for determination of maturity. Clutches were also grossly examined for the presence of nemertean and turbellarian worms.

For female red king crabs, data on percentage mature at carapace length were fit to a logistic curve (e.g., Cox and Snell 1989), using

$$p_m(l) = \frac{e^{\beta_0 + \beta_1 l}}{1 + e^{\beta_0 + \beta_1 l}} ,$$

where $P_{m(l)}$ is the predicted percentage of females with carapace length l that are mature. The maximum likelihood estimates (MLE's) for β_0 and β_1 were obtained using the nonlinear estimation routine (NONLIN) of SYSTAT (Wilkinson 1990). Size at 50% maturity (SM50) was estimated by computing the ratio of the MLE of β_0 to the MLE of β_1 and multiplying that ratio by -1. The variance for the estimate of SM50 was estimated by applying the variance and covariance estimates for the MLEs of β_0 and β_1 to the Taylor series approximation for the variance of the ratio of two random variables (e.g., Mood et al. 1974).

RESULTS AND DISCUSSION

A total of 141 stations were fished with four pots per station. In stations 1-24, all four pots were sampled. In stations 25-141, two out of the four pots were sampled. A total of 564 pots were set and pulled for the survey; 330 pots were sampled. Following the first set day, 12-64 pots were set and picked each day. The number of pots pulled each day was dependent on the number of crabs to be tagged and weather. Soak time for each pot averaged 59.1 h and ranged from 23.9 to 205.6 h. Due to weather and travel time between stations, 260 pots had a soak time greater than 48 h and pots from eight stations (stations 69-72 and 77-80) had a soak time over 144 h or 6 d.

Catch Composition

A total of 15,842 crabs were captured during the survey. Red king crabs dominated catches (80.4%), followed by Tanner crabs (16.7%), snow crabs (2.6%), Tanner x snow crab hybrids (0.36%), and Korean hair crabs *Erimacrus isenbeckii* (<0.001%). For the remainder of this report only results related to red king crab and Tanner crab will be reported.

Red King Crab

Red king crab length, width, and shell age data have been expanded to account for subsampling of crabs. Female size at maturity and handling-induced injury or mortality, and disease data represent the real numbers of crabs caught or examined; i.e., these data have not been expanded.

Sex Composition and Catch Per Unit Effort

A total of 12,732 red king crab were caught in the 330 sampled pots; 70% were males and 30% were females. Average catch per pot (C/P) of legal male red king crabs within stations ranged from 0.0 to 78.5 crabs, with an overall average C/P of 16.7 crabs for the survey (Figure 3, Appendix A). In contrast, during the 1990 survey twice as many, 24,194 red king crabs were caught from 579 sampled pots and sex composition was roughly equal: 47% males, 53% females. Additionally, the range of average C/P of legal males was narrower, 0.6 to 40.7, in 1990 and the overall average C/P was nearly half as much (9.2) as the 1991 level (Watson et al. 1991). In comparing the 1990 and 1991 data, it is important to note that the 1990 survey covered a broader portion of Bristol Bay, 4,000 nm^2 versus 2,400 nm^2 in 1991. Examination of sex ratio and C/P data for the two surveys indicates that the 1991 survey more effectively targeted concentrations of legal male red king crabs; the representativeness of the study area in relation to the entire legal male red king crab population is unknown.

Distribution and Shell Age

Length frequency distributions for male and female red king crab are shown in Figure 4. Male red king crab size modes were noted around 85, 105, and 140 mm CL. Size modes for females were noted around 85 and 120 mm CL. In our study area, 71.1% of the 7,774 mature males $\geq$ 120 mm CL were of legal size. This compares to an estimated 77.8% for all of Bristol Bay as determined from the 1991 NMFS trawl survey (Bradley Stevens, National Marine Fisheries Service, Kodiak, personal communication).

Among all males, 78% were new-shell and 22% were old-shell (Figure 5). However, of the 5,531 legal-size males caught, 25% were old-shell crabs which is slightly higher than the 16.1% old-shell crabs determined by the NMFS eastern Bering Sea crab survey (Stevens et al. 1991). Overall, this represents a marked reduction in old-shell crabs from 1990 when Stevens and MacIntosh (1990) reported 44.4% old shells and Watson et al. (1991) reported 41.1% old shells.

The overall incidence of old-shell crabs retained during the last two commercial fishing seasons has also diminished, from 14.7% in 1990 to 12.1% in 1991 (ADF&G 1992). Comparisons of shell-age data collected from the past two commercial fisheries and NMFS and ADF&G surveys indicates that old-shell crabs are likely harvested at a disproportionately lower rate than their overall occurrence in the surveyed population.

Spatial Distribution

Although legal male old-shell and new-shell crabs were captured together over most of the survey area, old-shell crabs were nearly absent from the western portion. They were most heavily concentrated in the northeast (Figure 6). Mature legal and sublegal male crabs were widely distributed over the study area, but immature males appeared to be concentrated in a narrow section of the east-southeastern area (Figure 7).

The distribution of mature and immature female red king crabs was similar, although most females were located in the southeastern area. However, a concentration of mature females distinctly separate from all immature female and all male concentrations existed in the far southwestern portion of the study area (Figure 8).

The survey was not designed to study the effects of depth on the distribution of red king crab. Nonetheless, we plotted the distribution of mature and immature male and female red king crabs against station depth to ascertain whether depth was a factor in their distribution. No significant clumping of sex or maturity state by depth was noted in the study area.

Female Size of Maturity

Maximum likelihood estimates for the parameters, β_0 and β_1, of the logistic curve fit (Figure 9) to the percent mature by CL data (Appendix B) were -30.1 and 0.322, respectively, producing an estimated size of maturity (SM50) of 93.4 mm CL (SE = 0.6). The SM50 of 93.4 mm is somewhat larger than the 15-year (1975-1989) mean of 88.8 mm reported by Otto et al. (1989) for Bristol Bay females. The size range of females in our analysis, 67-149 mm CL, was much narrower than the 17-162 mm CL range reported by Otto et al. (1989). Comparisons of estimated SM50 values for Bristol Bay red king crab, however, has been compromised by differences in sampling gear and survey area.

Incidence of Handling-Induced Injury or Mortality, and Diseases

The overall rate of handling-induced injury or mortality was quite low: 2.0% were injured (mostly torn leg segments or broken carapaces), <0.1% of the examined crabs were dead and 0.1% had cottage cheese disease (Table 1).

Cost Recovery

Approximately 30,300 male red king crabs $\geq$ 152mm (6 in) CW were sold to offset the cost of 1991 Bering Sea tagging studies. An additional 300 male red king crabs were landed as dead loss. The average weight per crab as calculated from fish ticket receipts was 2.9 kg (6.4 lb), a notable increase from 1990 (Watson et al. 1991) when crabs averaged 2.6 kg (5.7 lb).

Tanner Crab

Sex Composition and Catch Per Unit Effort

Of the total 2,643 Tanner crabs caught in the 330 sampled pots, 92% were males. Average C/P of legal male Tanner crabs within stations ranged from 0.0 to 35.8 crabs; the overall average was 5.5 crabs per pot for the survey. Male and female Tanner crab catch by station is summarized in Appendix C.

Width Distribution and Shell Age

Width frequency distributions for male and female Tanner crabs are shown in Figure 10. Size modes for males were noted around 125, 135, and 160 mm CW. Size modes for females were noted around 85, 95, and 105 mm CW. Among all males, 72.8% were new-shell and 28.2% were old-shell. Of the 1,833 legal males caught, 82% were new-shell crabs (Figure 11).

Because the survey targeted on a portion of the known legal male red king crab population, sex and size composition data presented here for Tanner crab should not be considered representative of the population.

Incidence of Handling-Induced Injury or Mortality, and Diseases

As with red king crab, the overall rate of injury or mortality was low: 3.0% were injured (torn leg segments or broken carapaces), 0.5% of the Tanner crabs examined were dead (Table 1). Black mat and bitter crab syndromes were not reported for any of the crabs examined.

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 1992. Annual management report for the shellfish fisheries of the Westward region, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K92-9. Kodiak.

Cox, D.R., and E.J. Snell. 1989. Analysis of binary data. Chapman and Hall, New York.

Gray, G.W., Jr. 1965. Tags for marking king crabs. Progressive Fish-Culturist 27:221-227.

Mood, A.M., F.A. Graybill, and D.C. Boes. 1974. Introduction to the theory of statistics, 3rd edition. McGraw-Hill, Inc, New York.

Otto, R.S., R.A. MacIntosh, and P.A. Cummiskey. 1989. Fecundity and other reproductive parameters of female red king crab (*Paralithodes camtschatica*) in Bristol Bay and Norton Sound, Alaska. Pages 65 to 90 *in* Proceedings of the international symposium on king and Tanner crabs. Alaska Sea Grant College Program Report 90-04, University of Alaska Fairbanks.

Pengilly, D., and L.J. Watson. 1992. Visible (Floy) and non-visible (PIT) tag retention experiments and automated PIT tag detection trials conducted on Bristol Bay red king crab in 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K92-28. Kodiak.

Sparks, A.K., and J.F. Morado. 1985. A preliminary report on the diseases of Alaska king crabs. Pages 333 to 339 *in* Proceedings of the international king crab symposium. Alaska Sea Grant Report 85-12, University of Alaska Fairbanks.

Stevens, B.G., and R.A. MacIntosh. 1990. Report to industry on the 1990 eastern Bering Sea crab survey. National Marine Fisheries Service, Alaska Fisheries Science Center Processed Report 90-09, Kodiak.

LITERATURE CITED

Stevens, B.G., R.A. MacIntosh, and J.A. Haaga. 1991. Report to industry on the 1991 eastern Bering Sea crab survey. National Marine Fisheries Service, Alaska Fisheries Science Center Processed Report 91-17, Kodiak.

Watson, L.J., D. Pengilly, W.E. Donaldson, and D. Schmidt. 1991. A pilot mark-recapture study using external tags and implantable passive integrated transponder (PIT) tags on red king crab in Bristol Bay, Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K91-21, Kodiak.

Wilkinson, L. 1990. SYSTAT: The system for statistics. SYSTAT, Inc., Evanston, Illinois.

Table 1. Incidence of handling-induced injury and mortality, and disease for red king and Tanner crabs caught during the 1991 Bristol Bay tagging study.

Injury or Disease Category	Species/Sex							
	Red King Crab				Tanner Crab			
			Total				Total	
	Males	Females	No.	%	Males	Females	No.	%
Dead	5	1	6	0.1	6	0	6	0.5
Injured	179	10	189	2.0	35	1	36	3.0
Cottage Cheese disease[a]	10	0	10	0.10	NA	NA	NA	-
No apparent injury or disease	8,537	798	9,335	97.8	1,079	74	1,153	96.5
Total	8,731	809	9,540	100.0	1,120	75	1,195	100.0

[a]Microsporidian disease.

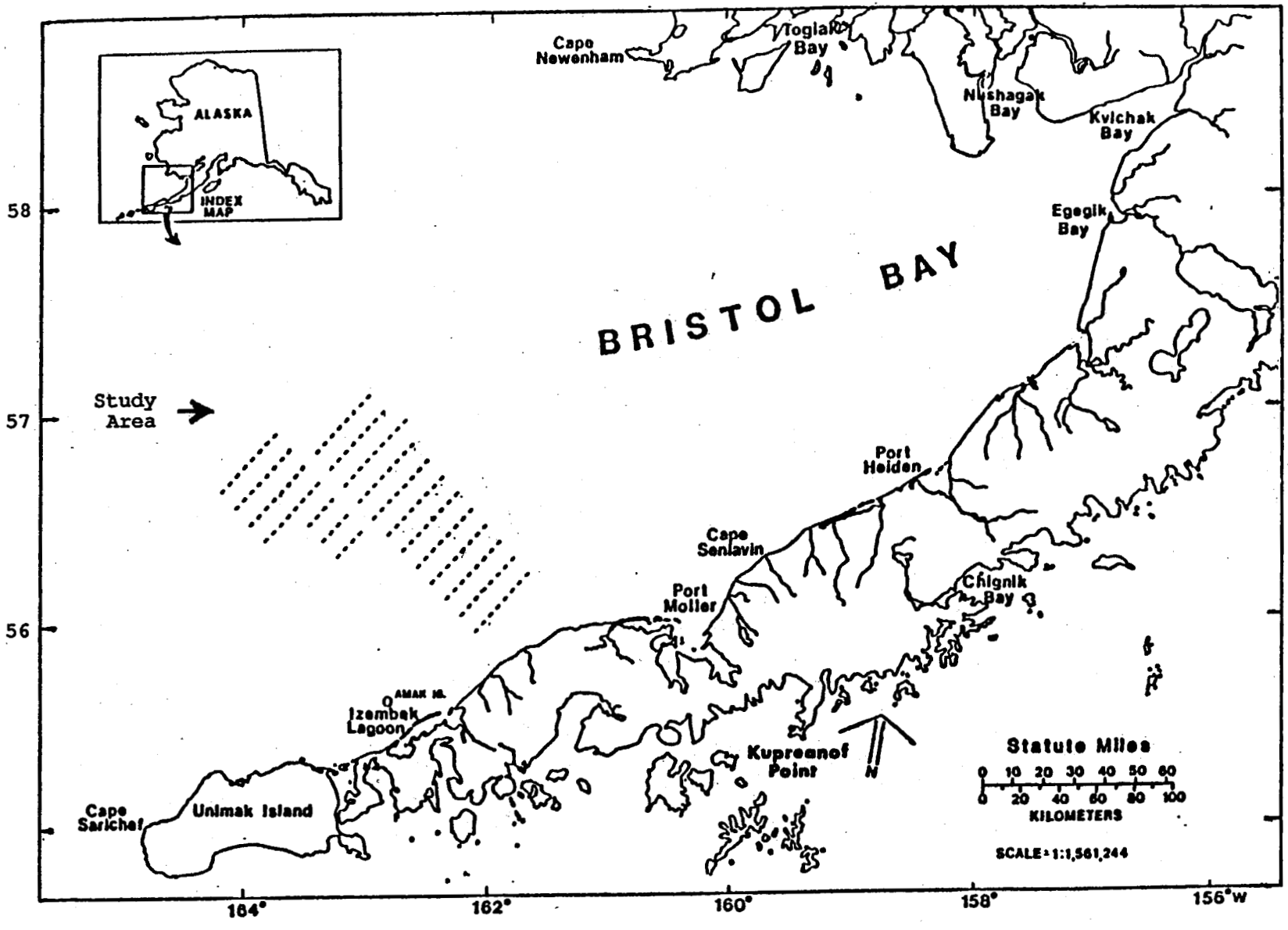

Figure 1. Location of 1991 Bristol Bay red king crab tagging study.

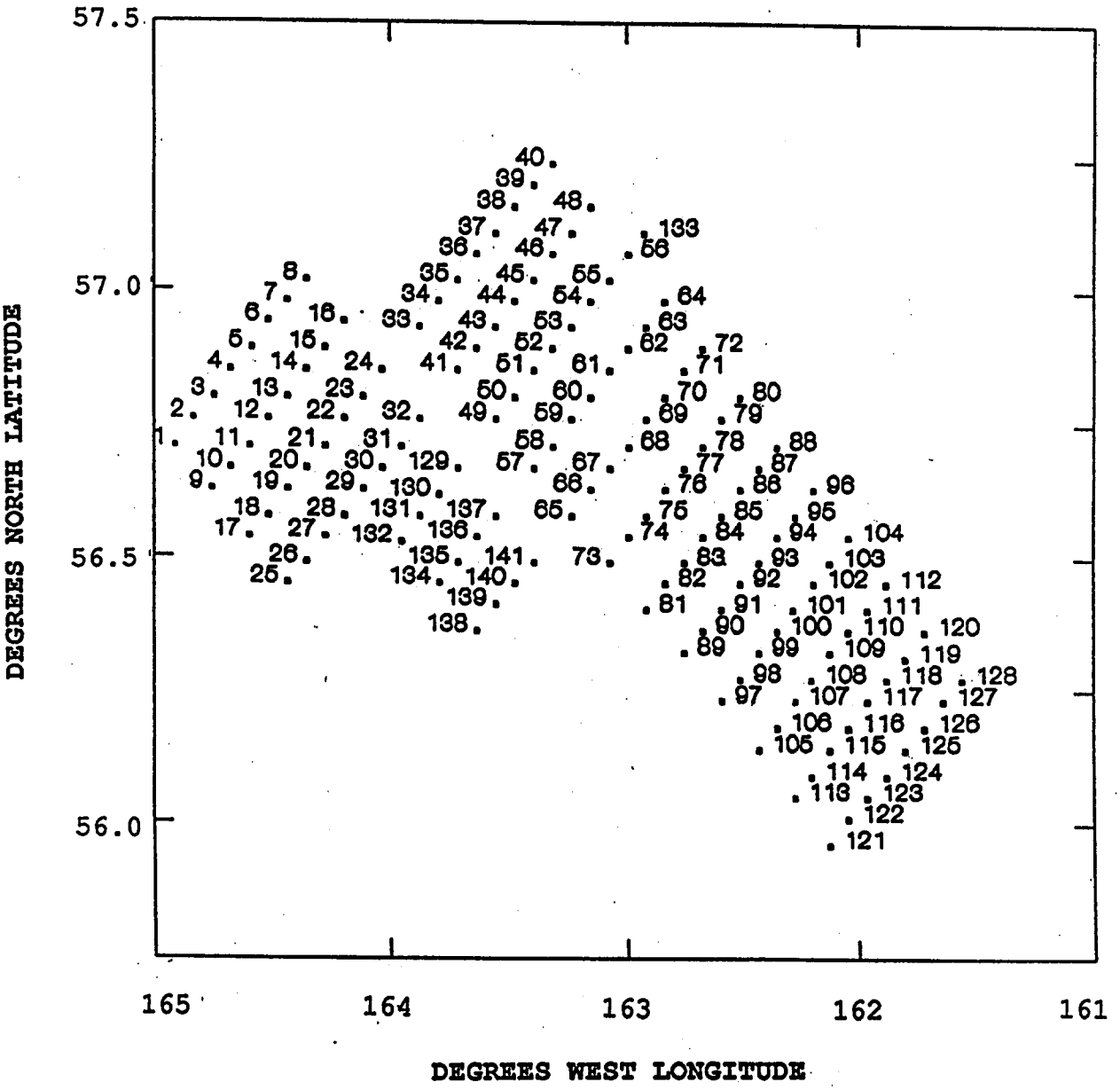

Figure 2. Layout of the 141 tagging stations in the 1991 Bristol Bay red king crab tagging study.

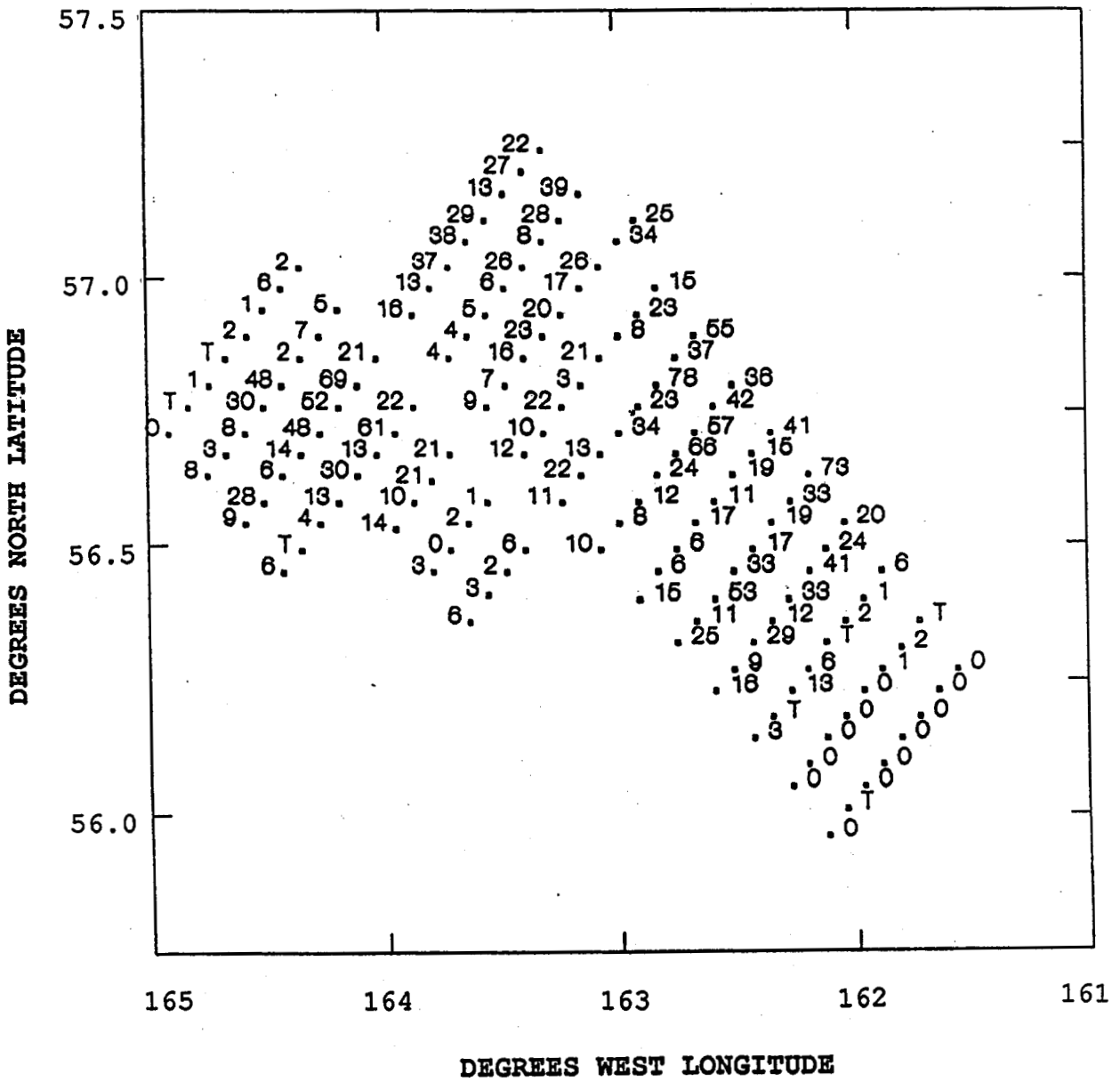

Figure 3. Average catch per pot of legal male red king crabs at 141 stations sampled during the 1991 Bristol Bay red king crab tagging study. Values are rounded down to the nearest whole integer, except for trace (T), which is between 0 and 1.

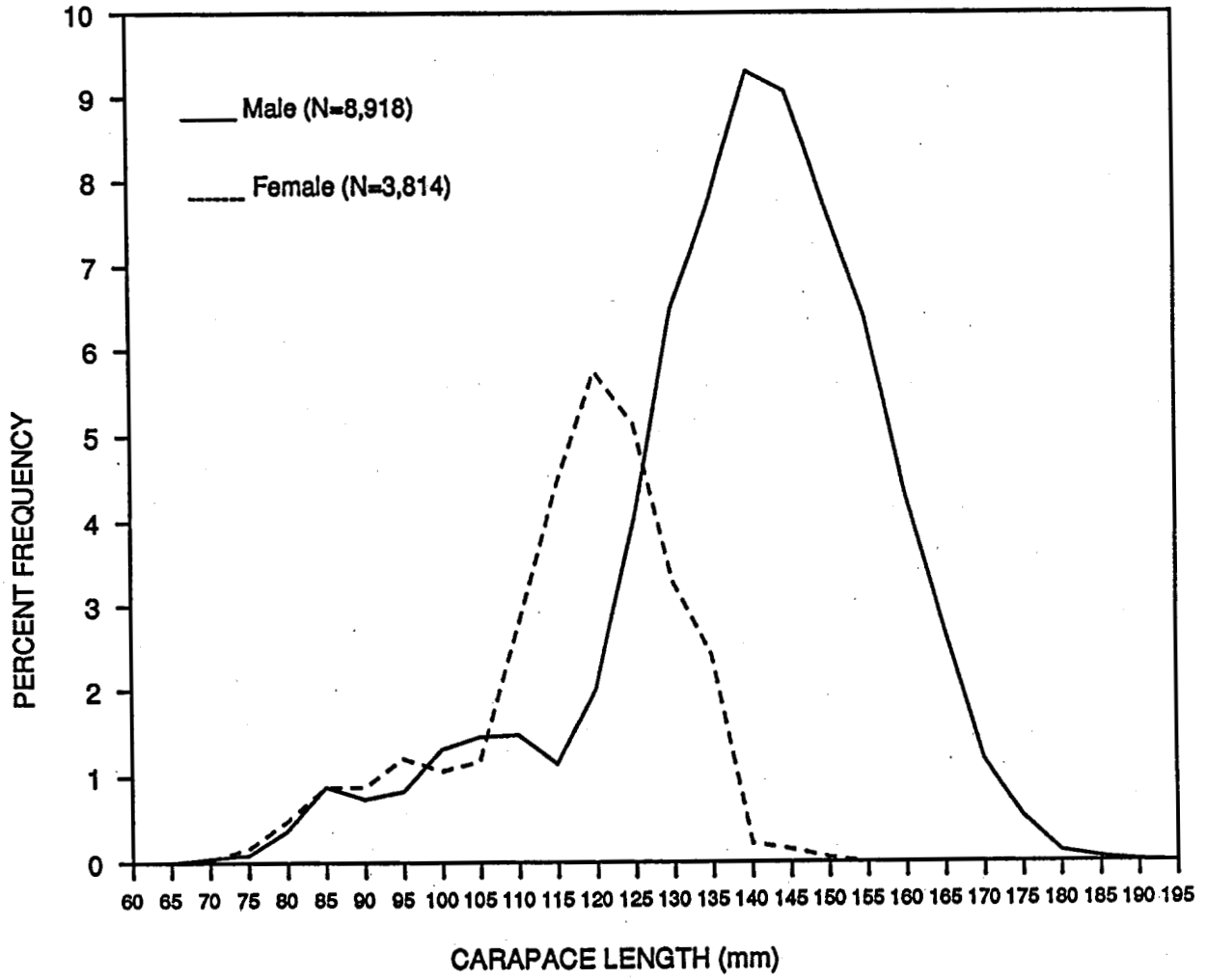

Figure 4. Length frequency of male and female red king crabs caught during the 1991 Bristol Bay tagging study, by 5-mm length classes.

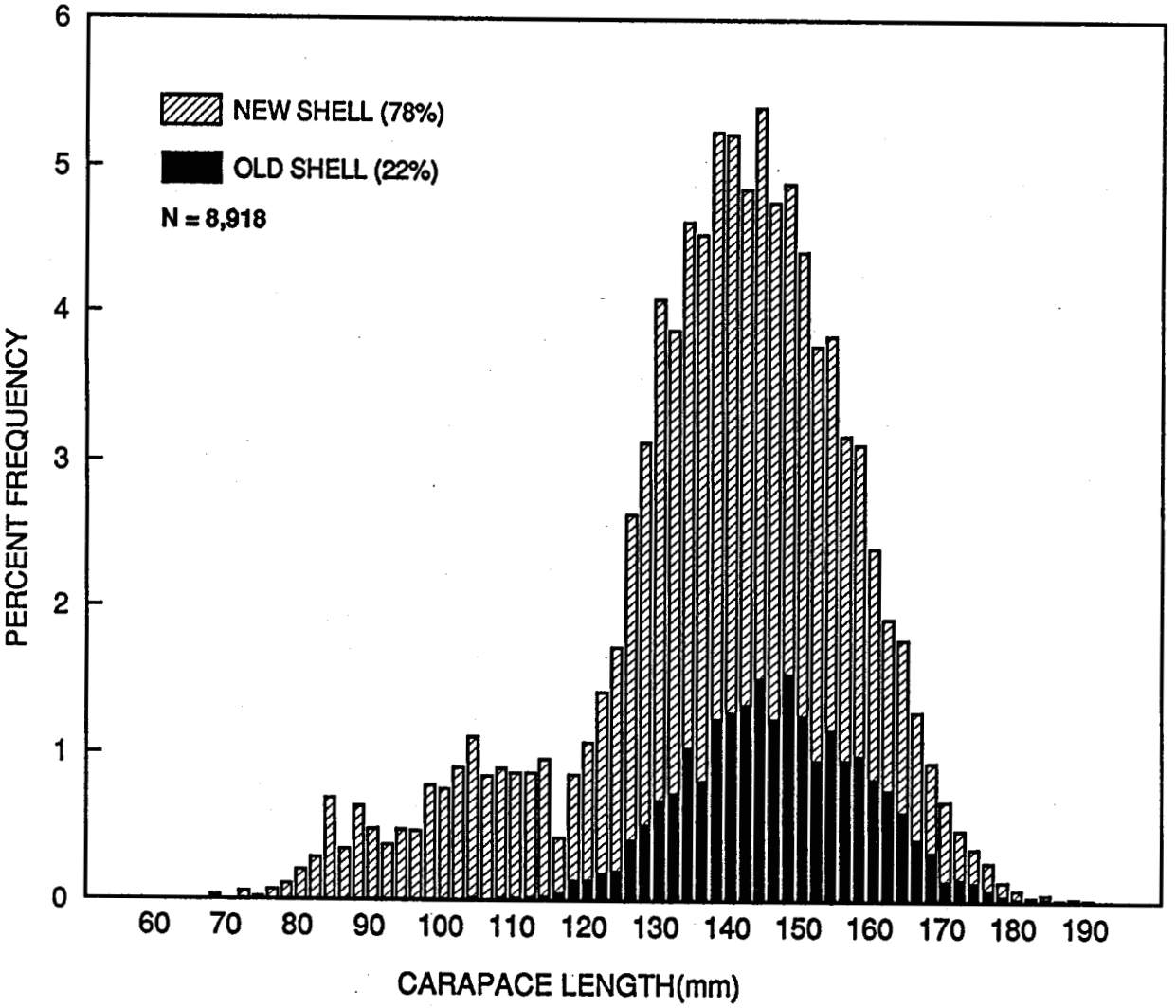

Figure 5. Shell age of male red king crabs caught during the 1991 Bristol Bay tagging study, by 2-mm length classes.

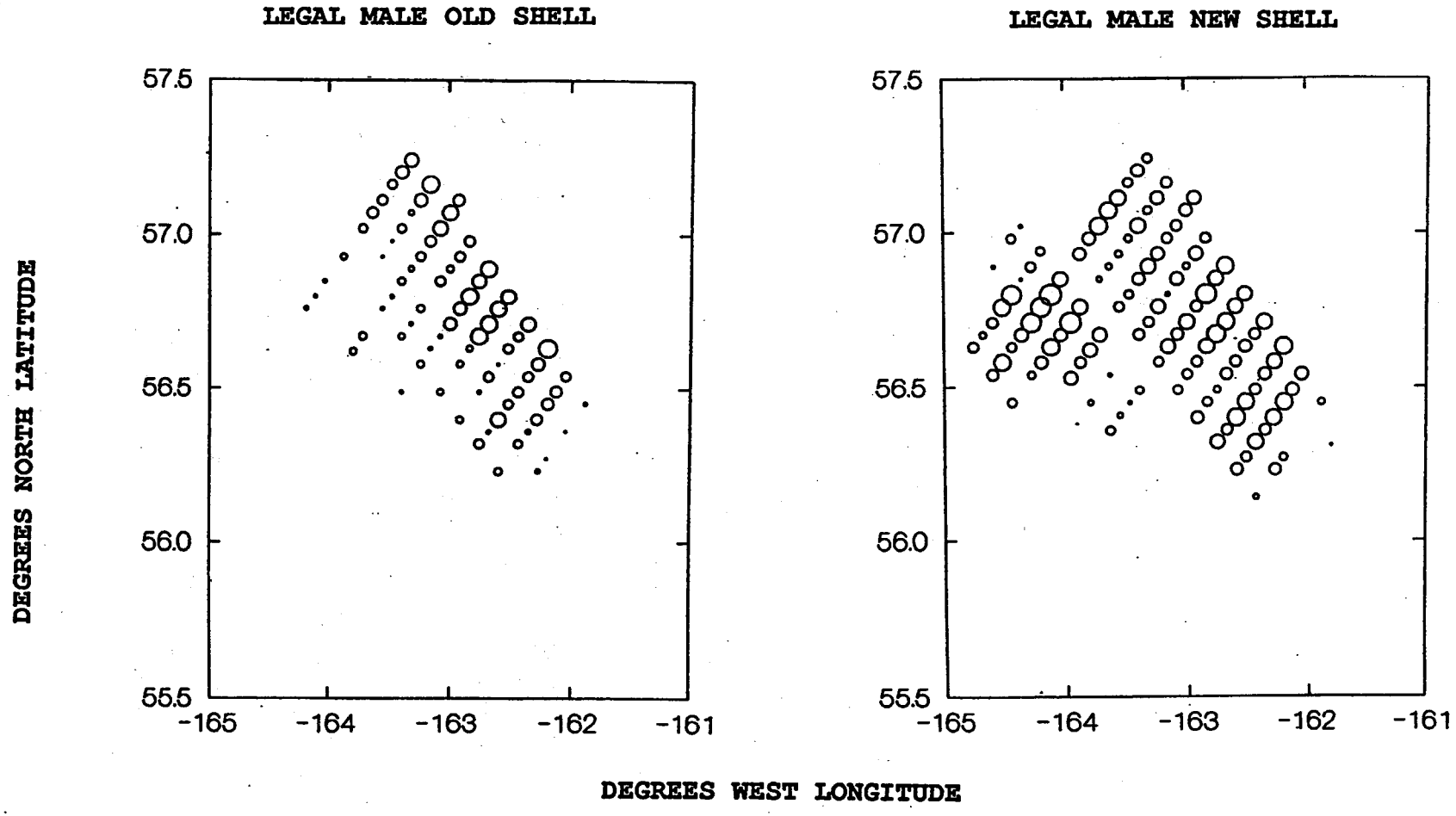

Figure 6. Distribution by station of legal male old-shell and new-shell red king crabs, caught during the 1991 Bristol Bay tagging study. Circle size in the above graphs is proportional to the log of the catch per pot.

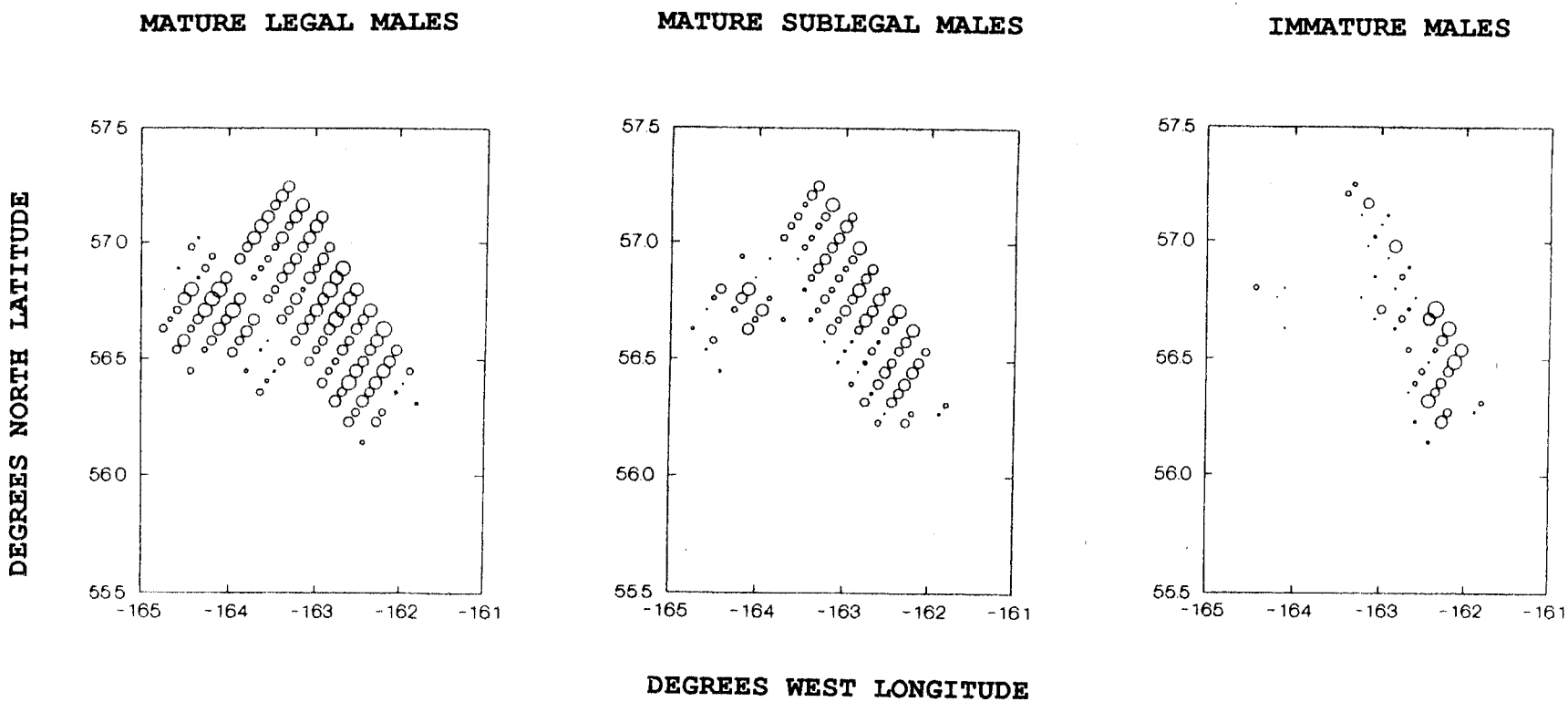

Figure 7. Distribution by station of mature legal and sublegal, and immature male red king crabs caught during the 1991 Bristol Bay tagging study. Circle size in the above graphs is proportional to the log of the catch per pot.

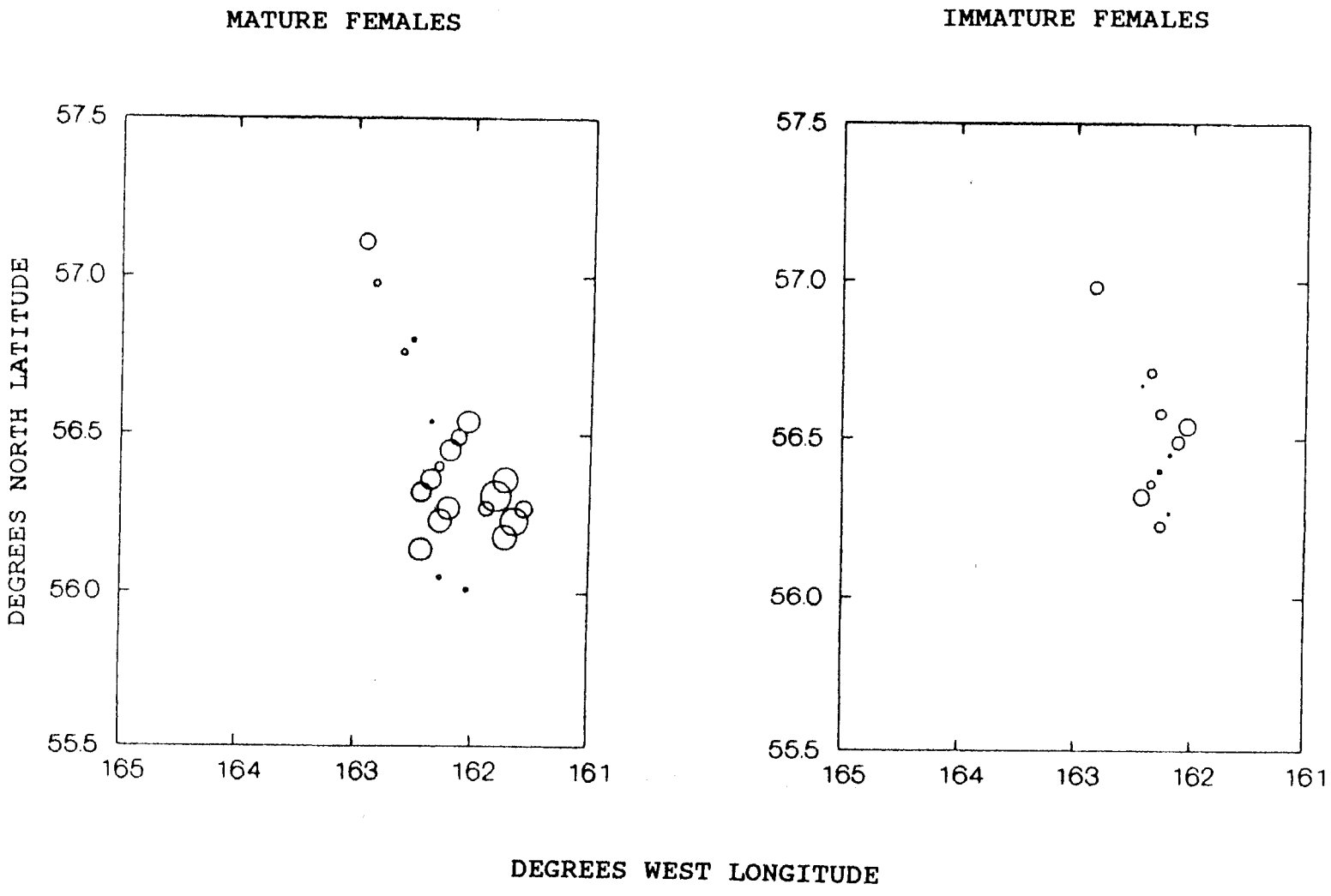

Figure 8. Distribution by station of mature and immature female red king crabs caught during the 1991 Bristol Bay tagging study. Circle size in the above graphs is proportional to the log of the catch per pot.

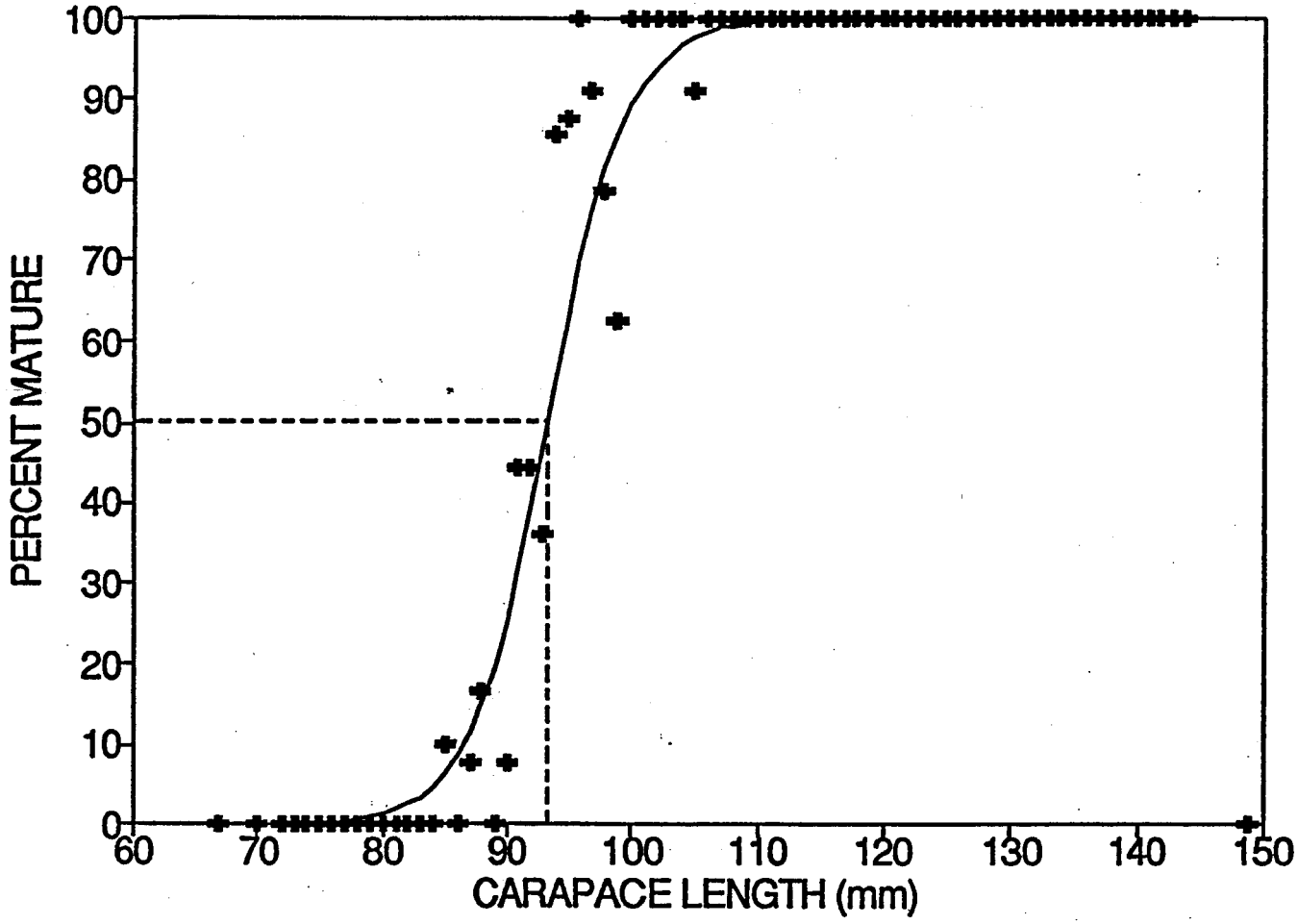

Figure 9. Logistic curve for female red king crabs caught during the 1991 Bristol Bay tagging study; SM50 is 93.4 mm CL.

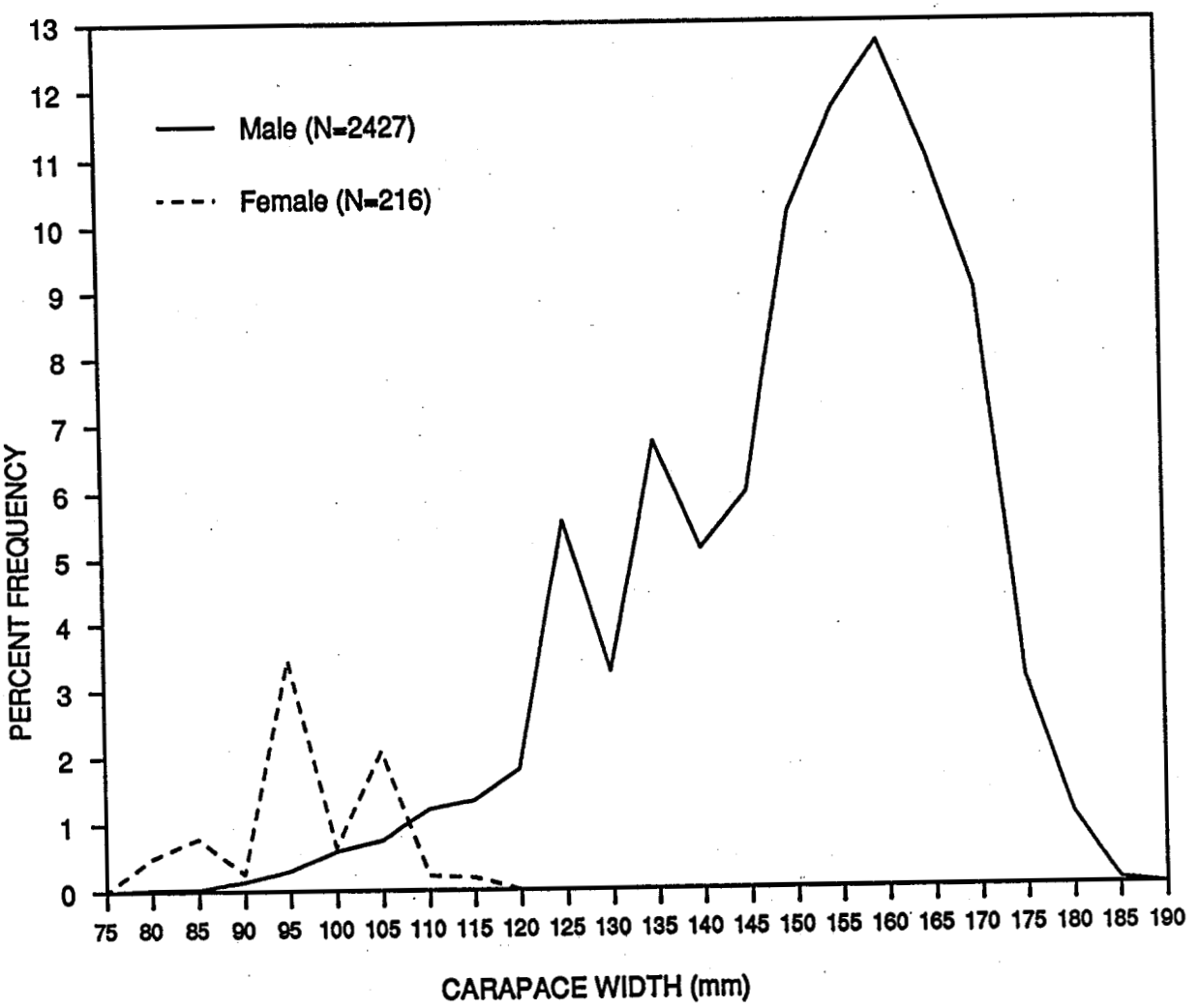

Figure 10. Width frequency of male and female Tanner crabs caught during the 1991 Bristol Bay tagging study, by 5-mm width classes.

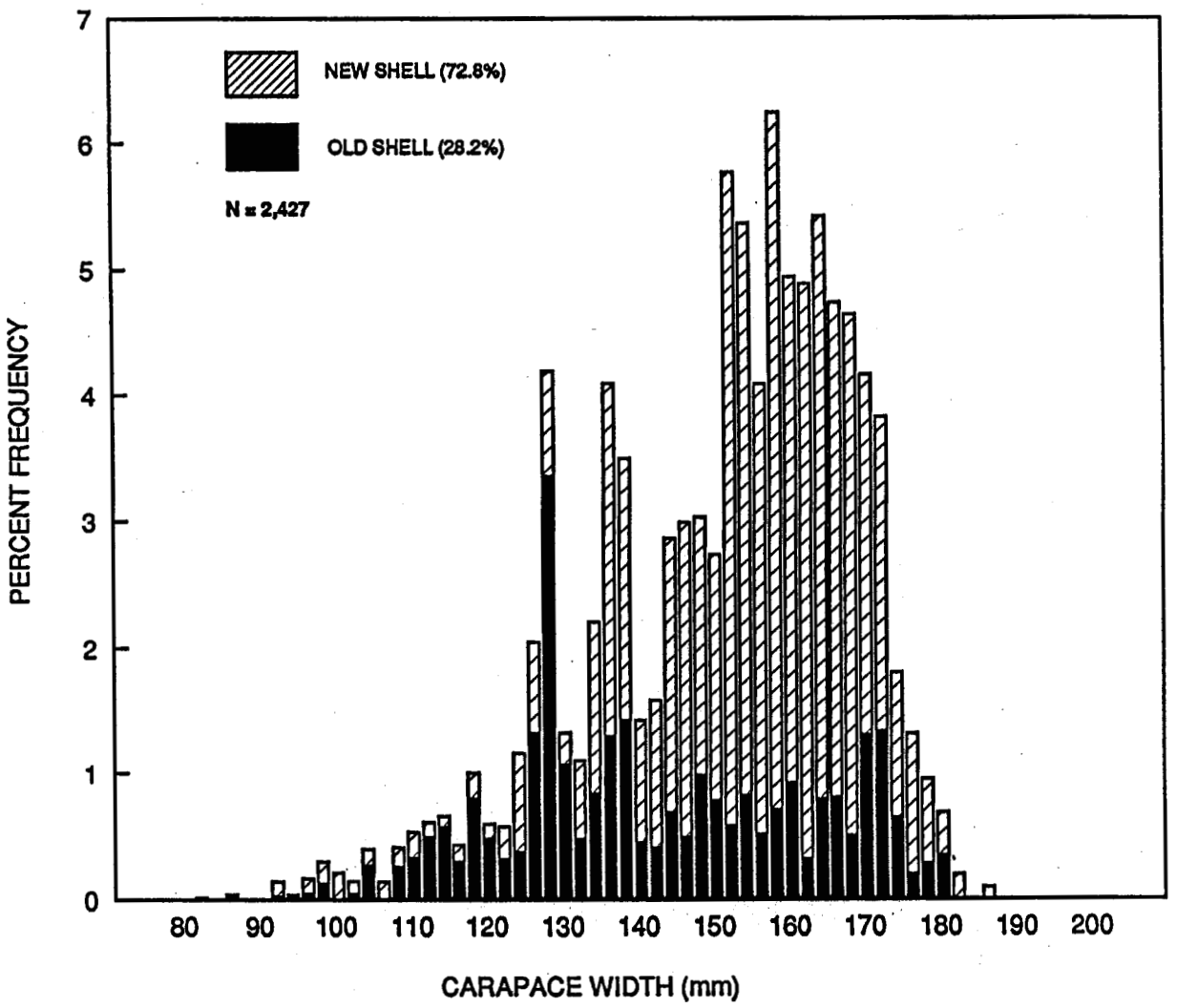

Figure 11. Shell age of male Tanner crabs caught during the 1991 Bristol Bay tagging study, by 2-mm width classes.

APPENDIX

Appendix A. Summary of red king crab fishing and catch data at 141 stations in the 1991 Bristol Bay tagging study.

Station	Date	North Latitude	West Longitude	Depth (m)	No. of Pots Sampled	Females	Males: Sublegal <120mm CL	Males: Sublegal ≥120mm CL	Males: Legal No.	Males: Legal Avg C/P
1	09/05	56 43.	164 54.39	75	4	0	0	0	0	0.0
2	09/05	56 46.	164 49.53	75	4	0	0	0	1	0.3
3	09/05	56 48.	164 44.61	73	4	0	0	0	5	1.3
4	09/06	56 51.	164 40.00	73	4	0	0	0	1	0.3
5	09/06	56 53.	164 35.10	71	4	0	0	0	8	2.0
6	09/06	56 56.	164 30.34	70	4	0	0	2	4	1.0
7	09/06	56 59.	164 25.72	70	4	0	0	3	25	6.3
8	09/06	57 1.3	164 20.84	68	4	0	0	2	8	2.0
9	09/08	56 38.	164 44.88	75	4	0	0	9	32	8.0
10	09/08	56 40.	164 40.03	73	4	0	0	1	15	3.8
11	09/08	56 43.	164 35.25	71	4	0	0	6	34	8.5
12	09/08	56 46.	164 30.44	73	4	0	0	14	122	30.5
13	09/06	56 48.	164 25.61	73	4	0	16	56	193	48.3
14	09/06	56 51.	164 20.87	71	4	0	0	1	9	2.3
15	09/06	56 53.	164 16.12	71	4	0	0	3	29	7.3
16	09/06	56 57.	164 11.42	70	4	0	4	13	22	5.5
17	09/08	56 32.	164 35.24	79	4	0	0	7	37	9.3
18	09/08	56 35.	164 30.40	75	4	0	0	24	112	28.0
19	09/08	56 38.	164 25.66	75	4	0	0	2	27	6.8
20	09/08	56 40.	164 20.89	73	4	0	0	0	58	14.5
21	09/08	56 43.	164 16.10	73	4	0	1	18	192	48.0
22	09/09	56 45.	164 11.40	73	4	0	5	81	209	52.3
23	09/09	56 48.	164 6.59	71	4	0	6	138	276	69.0
24	09/09	56 51.	164 1.69	71	4	0	1	5	86	21.5
25	09/10	56 27.	164 25.72	82	2	0	0	4	12	6.0
26	09/10	56 30.	164 20.92	82	2	0	0	0	1	0.5
27	09/10	56 32.	164 16.07	79	2	0	0	0	9	4.5
28	09/10	56 35.	164 11.34	77	2	0	0	1	26	13.0
29	09/10	56 38.	164 6.47	77	2	0	3	43	60	30.0
30	09/10	56 40.	164 1.76	75	2	0	1	9	27	13.5
31	09/10	56 43.	163 57.03	73	2	0	1	54	122	61.0
32	09/10	56 46.	163 52.08	71	2	0	0	7	44	22.0
33	09/11	56 56.	163 52.21	70	2	0	0	3	32	16.0
34	09/11	56 59.	163 47.45	70	2	0	0	2	27	13.5
35	09/11	57 1.4	163 42.56	68	2	0	0	12	74	37.0
36	09/11	57 4.	163 37.85	66	2	0	0	12	76	38.0
37	09/12	57 6.7	163 32.99	66	2	0	1	14	58	29.0
38	09/12	57 9.3	163 28.33	64	2	0	0	7	26	13.0
39	09/12	57 12.	163 23.42	62	2	0	9	28	54	27.0
40	09/12	57 15.	163 18.55	59	2	2	7	33	45	22.5
41	09/12	56 51.	163 42.64	70	2	0	0	0	8	4.0
42	09/12	56 53.	163 37.78	70	2	0	0	0	8	4.0
43	09/12	56 56.	163 33.09	68	2	0	0	3	11	5.5
44	09/12	56 59.	163 28.28	66	2	0	1	9	12	6.0
45	09/12	57 1.4	163 23.41	66	2	0	2	8	53	26.5
46	09/12	57 4.1	163 18.76	64	2	0	1	10	17	8.5
47	09/12	57 6.7	163 13.89	62	2	0	3	18	56	28.0
48	09/12	57 9.4	163 9.13	62	2	1	34	81	78	39.0
49	09/13	56 45.	163 33.03	73	2	0	0	2	18	9.0
50	09/13	56 48.	163 28.27	71	2	0	0	5	15	7.5
51	09/13	56 51.	163 23.45	71	2	0	0	12	32	16.0

-Continued-

Appendix A. (page 2 of 3)

Station	Date	North Latitude	West Longitude	Depth (m)	No. of Pots Sampled	Females	Males: Sublegal <120mm CL	Males: Sublegal ≥120mm CL	Males: Legal No.	Males: Legal Avg C/P
52	09/13	56 53.	163 18.68	70	2	0	0	25	46	23.0
53	09/13	56 56.	163 13.92	68	2	0	2	38	41	20.5
54	09/13	56 59.	163 9.12	68	2	1	3	29	34	17.0
55	09/13	57 1.3	163 4.48	68	2	1	5	34	53	26.5
56	09/14	57 4.1	162 59.52	68	2	0	3	56	69	34.5
57	09/14	56 40.	163 23.48	77	2	0	0	6	25	12.5
58	09/14	56 43.	163 18.67	73	2	0	0	8	20	10.0
59	09/14	56 45.	163 13.9	71	2	0	3	21	44	22.0
60	09/14	56 48.	163 9.09	70	2	0	1	9	7	3.5
61	09/14	56 51.	163 4.33	66	2	1	4	14	43	21.5
62	09/14	56 53.	162 59.55	64	2	0	2	9	16	8.0
63	09/14	56 56.	162 54.72	62	2	0	3	18	47	23.5
64	09/14	56 59.	162 49.95	60	2	36	63	78	31	15.5
65	09/14	56 35.	163 13.93	79	2	0	2	3	22	11.0
66	09/14	56 38.	163 9.09	77	2	0	1	28	44	22.0
67	09/14	56 40.	163 4.20	77	2	0	3	10	27	13.5
68	09/14	56 43.	162 59.53	73	2	0	20	37	68	34.0
69	09/26	56 45.	162 54.61	68	2	0	2	26	46	23.0
70	09/26	56 48.	162 49.72	66	2	0	3	79	157	78.5
71	09/26	56 51.	162 44.89	64	2	2	9	29	75	37.5
72	09/26	56 53.	162 40.14	66	2	0	4	31	111	55.5
73	09/26	56 30.	163 4.33	80	2	0	0	4	20	10.0
74	09/26	56 32.	162 59.48	79	2	0	1	4	16	8.0
75	09/26	56 35.	162 54.69	79	2	0	0	4	24	12.0
76	09/26	56 38.	162 49.83	79	2	0	4	17	48	24.0
77	09/25	56 40.	162 45.03	71	2	1	11	59	133	66.5
78	09/25	56 43.	162 40.23	71	2	0	5	38	115	57.5
79	09/25	56 45.	162 35.43	70	2	7	3	59	85	42.5
80	09/25	56 48.	162 30.57	68	2	5	2	16	72	36.0
81	09/26	56 24.	162 54.61	80	2	0	2	7	31	15.5
82	09/27	56 27.	162 50.01	80	2	0	0	3	13	6.5
83	09/27	56 30.	162 45.17	79	2	0	0	6	12	6.0
84	09/27	56 32.	162 40.33	79	2	0	8	15	35	17.5
85	09/27	56 35.	162 35.53	75	2	0	2	5	22	11.0
86	09/27	56 38.	162 30.75	73	2	0	2	13	38	19.0
87	09/27	56 40.	162 25.87	70	2	4	55	22	31	15.5
88	09/27	56 43.	162 21.02	70	2	14	192	81	82	41.0
89	09/29	56 19.	162 45.23	80	2	1	2	24	51	25.5
90	09/29	56 22.	162 40.40	80	2	0	3	5	23	11.5
91	09/29	56 24.	162 35.63	75	2	0	7	30	106	53.0
92	09/29	56 27.	162 30.79	75	2	2	10	39	66	33.0
93	09/29	56 30.	162 25.97	75	2	1	3	22	34	17.0
94	09/29	56 32.	162 21.17	73	2	5	7	21	38	19.0
95	09/29	56 35.	162 16.39	73	2	16	40	32	67	33.5
96	09/29	56 38.	162 11.47	73	2	4	98	63	147	73.5
97	09/30	56 14.	162 35.59	75	2	2	4	11	32	16.0
98	09/30	56 16.	162 30.83	75	2	1	1	3	18	9.0
99	09/30	56 19.	162 26.05	75	2	140	99	32	58	29.0
100	09/30	56 22.	162 21.28	70	2	125	26	30	25	12.5
101	09/30	56 24.	162 16.52	68	2	18	33	51	67	33.5
102	09/30	56 27.	162 11.70	68	2	138	31	46	83	41.5
103	09/30	56 30.	162 6.92	75	2	76	105	30	48	24.0
104	09/30	56 32.	162 2.11	71	2	245	68	17	40	20.0

-Continued-

Appendix A. (page 3 of 3)

Station	Date	North Latitude	West Longitude	Depth (m)	No. of Pots Sampled	Females	Males: Sublegal <120mm CL	Males: Sublegal ≥120mm CL	Males: Legal No.	Males: Legal Avg C/P
105	10/01	56 8.3	162 26.02	75	2	197	5	1	7	3.5
106	10/01	56 11.	162 21.27	77	2	0	0	0	1	0.5
107	10/01	56 14.	162 16.48	75	2	235	56	20	27	13.5
108	10/01	56 16.	162 11.75	79	2	201	18	8	13	6.5
109	10/01	56 19.	162 6.99	79	2	0	0	0	1	0.5
110	10/01	56 22.	162 2.23	82	2	0	0	1	5	2.5
111	10/01	56 24.	161 57.38	80	2	0	0	0	3	1.5
112	10/01	56 27.	161 52.60	84	2	0	0	1	12	6.0
113	10/02	56 3.	162 16.45	71	2	5	0	0	0	0.0
114	10/02	56 5.7	162 11.74	71	2	0	0	0	0	0.0
115	10/02	56 8.3	162 7.01	73	2	0	0	0	0	0.0
116	10/02	56 11.	162 2.21	71	2	0	0	0	0	0.0
117	10/02	56 14.	161 57.45	73	2	0	0	0	0	0.0
118	10/02	56 16.	161 52.66	75	2	41	3	4	2	1.0
119	10/02	56 19.	161 47.99	75	2	1026	8	8	5	2.5
120	10/02	56 22.	161 43.16	70	2	317	0	0	1	0.5
121	10/02	55 58.	162 7.03	46	2	0	0	0	0	0.0
122	10/02	56 0.3	162 2.21	51	2	5	0	0	1	0.5
123	10/02	56 3.	161 57.43	51	2	0	0	0	0	0.0
124	10/02	56 5.6	161 52.73	51	2	0	0	0	0	0.0
125	10/02	56 8.3	161 47.95	55	2	0	0	0	0	0.0
126	10/02	56 11.	161 43.12	59	2	260	1	0	0	0.0
127	10/02	56 14.	161 38.42	59	2	559	0	0	0	0.0
128	10/02	56 16.	161 33.36	59	2	64	0	0	0	0.0
129	09/11	56 40.	163 42.78	73	2	0	1	6	43	21.5
130	09/11	56 37.	163 47.62	75	2	0	0	1	43	21.5
131	09/11	56 35.	163 52.43	77	2	0	0	2	20	10.0
132	09/11	56 32.	163 57.22	79	2	0	0	1	29	14.5
133	09/14	57 6.4	162 55.13	59	2	55	4	21	51	25.5
134	10/03	56 45	163 78.80	79	2	0	0	2	6	3.0
135	10/05	56 30.	163 42.48	80	2	0	0	0	0	0.0
136	10/05	56 32.	163 37.73	79	2	0	0	1	4	2.0
137	10/05	56 35.	163 32.88	77	2	0	2	1	3	1.5
138	10/05	56 22.	163 37.65	82	2	0	0	1	13	6.5
139	10/05	56 24.	163 32.95	82	2	0	0	2	6	3.0
140	10/05	56 27.	163 28.00	80	2	0	0	0	4	2.0
141	10/05	56 30.	163 23.25	79	2	0	0	1	13	6.5
TOTAL					330	3,814	1,151	2,243	5,531	16.7

Appendix B. Percent maturity by length class of new-shell, female red king crabs caught during the 1991 Bristol Bay tagging study.

Carapace Length (mm)	Without Embryos	With Embryos[a]	Total	Percent Mature
67	1	0	1	0.0
70	1	0	1	0.0
72	1	0	1	0.0
73	1	0	1	0.0
74	4	0	4	0.0
75	1	0	1	0.0
76	3	0	3	0.0
77	3	0	3	0.0
78	10	0	10	0.0
79	13	0	13	0.0
80	3	0	3	0.0
81	5	0	5	0.0
82	8	0	8	0.0
83	15	0	15	0.0
84	13	0	13	0.0
85	9	1	10	10.0
86	18	0	18	0.0
87	12	1	13	7.7
88	15	3	18	16.7
89	6	0	6	0.0
90	12	1	13	7.7
91	5	4	9	44.4
92	5	4	9	44.4
93	7	4	11	36.4
94	1	6	7	85.7
95	1	7	8	87.5
96	0	5	5	100.0
97	1	10	11	90.9
98	3	11	14	78.6
99	3	5	8	62.5
100	0	5	5	100.0
101	0	9	9	100.0
102	0	6	6	100.0
103	0	5	5	100.0
104	0	7	7	100.0
105	1	10	11	90.9
106	0	6	6	100.0
107	0	5	5	100.0
108	0	7	7	100.0
109	0	4	4	100.0
110	0	11	11	100.0
111	0	5	5	100.0
112	0	21	21	100.0
113	0	9	9	100.0

-Continued-

Appendix B. (page 2 of 2)

Carapace Length (mm)	Without Embryos	With Embryos[a]	Total	Percent Mature
114	0	18	18	100.0
116	0	15	15	100.0
117	0	20	20	100.0
118	0	34	34	100.0
119	0	22	22	100.0
120	0	14	14	100.0
121	0	20	20	100.0
122	0	25	25	100.0
123	0	22	22	100.0
124	0	30	30	100.0
125	0	25	25	100.0
126	0	13	13	100.0
127	0	22	22	100.0
128	0	27	27	100.0
129	0	19	19	100.0
130	0	20	20	100.0
131	0	16	16	100.0
132	0	12	12	100.0
133	0	15	15	100.0
134	0	15	15	100.0
135	0	9	9	100.0
136	0	10	10	100.0
137	0	6	6	100.0
138	0	3	3	100.0
139	0	2	2	100.0
140	0	2	2	100.0
141	0	1	1	100.0
142	0	1	1	100.0
143	0	1	1	100.0
144	0	5	5	100.0
149	1	0	1	0.0
Totals	182	627	809	77.5

[a]Includes females with embryo membrane remnants (empty egg cases) or funicili.

Appendix C. Summary of Tanner crab fishing and catch data at 141 stations, in the 1991 Bristol Bay tagging study.

Station	Date	North Latitude	West Longitude	Depth (fms)	No. of Pots Sampled	Females	Males		
							Sub-legal	Legal	
								No.	Ave C/P
1	09/05	56 43.	164 54.39	41	4	0	23	13	3.2
2	09/05	56 46.	164 49.53	41	4	4	7	12	3.0
3	09/05	56 48.	164 44.61	40	4	0	1	7	1.8
4	09/06	56 51.	164 40.00	40	4	0	0	2	0.5
5	09/06	56 53.	164 35.10	39	4	1	4	1	0.3
6	09/06	56 56.	164 30.34	38	4	0	4	9	2.2
7	09/06	56 59.	164 25.72	38	4	0	3	5	1.3
8	09/06	57 1.3	164 20.84	37	4	0	1	11	2.7
9	09/08	56 38.	164 44.88	41	4	0	5	8	1.9
10	09/08	56 40.	164 40.03	40	4	0	1	6	1.5
11	09/08	56 43.	164 35.20	39	4	0	5	14	3.4
12	09/08	56 46.	164 30.40	40	4	0	7	8	2.0
13	09/06	56 48.	164 25.61	40	4	0	4	34	8.4
14	09/06	56 51.	164 20.87	39	4	0	7	34	8.4
15	09/06	56 53.	164 16.12	39	4	1	0	38	9.5
16	09/06	56 57.	164 11.42	38	4	0	11	39	9.7
17	09/08	56 32.	164 35.24	43	4	0	10	8	2.1
18	09/08	56 35.	164 30.40	41	4	0	4	6	1.5
19	09/08	56 38.	164 25.66	41	4	0	3	18	4.5
20	09/08	56 40.	164 20.89	40	4	0	1	2	0.5
21	09/08	56 43.	164 16.10	40	4	0	0	13	3.3
22	09/09	56 45.	164 11.40	40	4	0	6	21	5.2
23	09/09	56 48.	164 6.59	39	4	0	0	15	3.8
24	09/09	56 51.	164 1.69	39	4	0	2	15	3.7
25	09/10	56 27.	164 25.72	45	2	1	14	8	4.2
26	09/10	56 30.	164 20.92	45	2	2	1	17	8.4
27	09/10	56 32.	164 16.07	43	2	0	6	23	11.6
28	09/10	56 35.	164 11.34	42	2	0	7	19	9.4
29	09/10	56 38.	164 6.47	42	2	1	2	6	3.0
30	09/10	56 40.	164 1.76	41	2	0	1	9	4.3
31	09/10	56 43.	163 57.03	40	2	0	12	5	2.5
32	09/10	56 46.	163 52.08	39	2	1	4	25	12.3
33	09/11	56 56.	163 52.21	38	2	0	4	39	19.3
34	09/11	56 59.	163 47.45	38	2	0	9	24	12.2
35	09/11	57 1.4	163 42.56	37	2	0	18	26	13.2
36	09/11	57 4.	163 37.85	36	2	0	2	5	2.5
37	09/12	57 6.7	163 32.99	36	2	0	3	10	4.8
38	09/12	57 9.3	163 28.33	35	2	0	8	13	6.6
39	09/12	57 12	163 23.42	34	2	0	6	0	0.0
40	09/12	57 15.	163 18.55	32	2	0	2	1	0.5
41	09/12	56 51.	163 42.64	38	2	0	2	16	7.8
42	09/12	56 53.	163 37.78	38	2	0	2	17	8.7
43	09/12	56 56.	163 33.09	37	2	0	7	19	9.5
44	09/12	56 59.	163 28.28	36	2	0	11	12	6.2
45	09/12	57 1.4	163 23.41	36	2	0	0	7	3.5
46	09/12	57 4.1	163 18.76	35	2	0	6	5	2.4
47	09/12	57 6.7	163 13.89	34	2	1	9	10	5.0
48	09/12	57 9.4	163 9.13	34	2	0	2	2	1.0
49	09/13	56 45.	163 33.03	40	2	0	2	17	8.4
50	09/13	56 48.	163 28.27	39	2	0	7	27	13.6
51	09/13	56 51.	163 23.45	39	2	0	6	20	9.8
52	09/13	56 53.	163 18.60	38	2	0	10	14	7.2

-Continued-

Appendix C. (page 2 of 3)

Station	Date	North Latitude	West Longitude	Depth (fms)	No. of Pots Sampled	Females	Males		
							Sub-legal	Legal No.	Legal Ave C/P
53	09/13	56 56.	163 13.92	37	2	0	1	5	2.5
54	09/13	56 59.	163 9.12	37	2	0	2	3	1.5
55	09/13	57 1.3	163 4.48	37	2	0	2	3	1.5
56	09/14	57 4.1	162 59.52	37	2	0	1	0	0.0
57	09/14	56 40.	163 23.48	42	2	0	0	37	18.5
58	09/14	56 43.	163 18.67	40	2	0	6	8	4.1
59	09/14	56 45.	163 13.90	39	2	0	16	62	31.2
60	09/14	56 48.	163 9.09	38	2	0	2	9	4.5
61	09/14	56 51.	163 4.33	36	2	2	2	9	4.5
62	09/14	56 53.	162 59.55	35	2	0	2	1	0.5
63	09/14	56 56.	162 54.72	34	2	1	1	4	2.0
64	09/14	56 59.	162 49.95	33	2	0	3	1	0.5
65	09/14	56 35.	163 13.93	43	2	94	25	38	19.0
66	09/14	56 38.	163 9.09	42	2	0	4	19	9.7
67	09/14	56 40.	163 4.2	42	2	0	1	8	4.0
68	09/14	56 43.	162 59.53	40	2	0	2	20	9.8
69	09/26	56 45.	162 54.61	37	2	0	0	9	4.5
70	09/26	56 48.	162 49.72	36	2	0	4	13	6.3
71	09/26	56 51.	162 44.89	35	2	0	5	3	1.5
72	09/26	56 53.	162 40.14	36	2	0	0	1	0.5
73	09/26	56 30.	163 4.33	44	2	5	3	26	12.8
74	09/26	56 32.	162 59.48	43	2	0	0	14	7.0
75	09/26	56 35.	162 54.69	43	2	1	10	37	18.7
76	09/26	56 38.	162 49.83	43	2	0	8	28	14.2
77	09/25	56 40.	162 45.03	39	2	0	2	12	5.9
78	09/25	56 43.	162 40.23	39	2	0	0	11	5.5
79	09/25	56 45.	162 35.43	38	2	0	1	6	3.0
80	09/25	56 48.	162 30.57	37	2	0	0	7	3.5
81	09/26	56 24.	162 54.61	44	2	9	1	13	6.4
82	09/27	56 27.	162 50.01	44	2	0	0	10	5.0
83	09/27	56 30.	162 45.17	43	2	0	2	16	8.2
84	09/27	56 32.	162 40.33	43	2	0	3	12	5.9
85	09/27	56 35.	162 35.53	41	2	0	0	3	1.5
86	09/27	56 38.	162 30.75	40	2	0	2	13	6.7
87	09/27	56 40.	162 25.87	38	2	0	3	14	7.2
88	09/27	56 43.	162 21.02	38	2	0	1	12	5.8
89	09/29	56 19.	162 45.23	44	2	0	0	4	2.0
90	09/29	56 22.	162 40.40	44	2	0	3	15	7.6
91	09/29	56 24.	162 35.63	41	2	0	1	5	2.5
92	09/29	56 27.	162 30.79	41	2	0	5	12	6.2
93	09/29	56 30.	162 25.97	41	2	0	2	1	0.5
94	09/29	56 32.	162 21.17	40	2	0	0	5	2.5
95	09/29	56 35.	162 16.39	40	2	0	3	14	6.8
96	09/29	56 38.	162 11.47	40	2	1	5	36	18.2
97	09/30	56 14.	162 35.59	41	2	0	0	2	1.0
98	09/30	56 16.	162 30.83	41	2	1	7	8	4.2
99	09/30	56 19.	162 26.05	41	2	0	0	0	0.0
100	09/30	56 22.	162 21.28	38	2	0	0	4	2.0
101	09/30	56 24.	162 16.52	37	2	0	1	8	3.8
102	09/30	56 27.	162 11.7	37	2	0	0	2	1.0
103	09/30	56 30.	162 6.92	41	2	0	2	4	2.0
104	09/30	56 32.	162 2.11	39	2	0	6	10	4.9

-Continued-

Appendix C. (page 3 of 3)

Station	Date	North Latitude	West Longitude	Depth (fms)	No. of Pots Sampled	Females	Males		
							Sub-legal	Legal	
								No.	Ave C/P
105	10/01	56 8.3	162 26.02	41	2	0	9	32	15.8
106	10/01	56 11.	162 21.27	42	2	0	0	1	0.5
107	10/01	56 14.	162 16.48	41	2	0	6	1	0.5
108	10/01	56 16.	162 11.75	43	2	0	4	36	18.0
109	10/01	56 19.	162 6.99	43	2	0	0	14	7.0
110	10/01	56 22.	162 2.23	45	2	3	14	54	27.2
111	10/01	56 24.	161 57.38	44	2	0	0	3	1.5
112	10/01	56 27.	161 52.6	46	2	0	0	1	0.5
113	10/02	56 3.	162 16.45	39	2	0	16	0	0.0
114	10/02	56 5.7	162 11.74	39	2	0	0	0	0.0
115	10/02	56 8.3	162 7.01	40	2	0	1	0	0.0
116	10/02	56 11.	162 2.21	39	2	0	1	0	0.0
117	10/02	56 14.	161 57.45	40	2	0	2	0	0.0
118	10/02	56 16.	161 52.66	41	2	0	3	5	2.3
119	10/02	56 19.	161 47.99	41	2	1	5	2	1.0
120	10/02	56 22.	161 43.16	38	2	0	0	0	0.0
121	10/02	55 58.	162 7.03	25	2	0	0	0	0.0
122	10/02	56 0.3	162 2.21	28	2	0	0	0	0.0
123	10/02	56 3.	161 57.43	28	2	0	0	0	0.0
124	10/02	56 5.6	161 52.73	28	2	0	0	0	0.0
125	10/02	56 8.3	161 47.95	30	2	0	2	0	0.0
126	10/02	56 11.	161 43.12	32	2	0	0	0	0.0
127	10/02	56 14.	161 38.42	32	2	0	0	0	0.0
128	10/02	56 16.	161 33.36	32	2	1	2	0	0.0
129	09/11	56 40.	163 42.78	40	2	0	0	42	21.0
130	09/11	56 37.	163 47.62	41	2	0	0	32	16.0
131	09/11	56 35.	163 52.43	42	2	0	8	26	12.8
132	09/11	56 32.	163 57.22	43	2	0	0	30	15.0
133	09/14	57 6.4	162 55.13	32	2	0	3	1	0.5
134	10/03	56 45	163 78.80	43	2	6	5	5	2.5
135	10/05	56 30.	163 42.48	44	2	10	0	49	24.5
136	10/05	56 32.	163 37.73	43	2	7	0	32	16.0
137	10/05	56 35.	163 32.88	42	2	58	74	72	35.8
138	10/05	56 22.	163 37.65	45	2	0	2	7	3.5
139	10/05	56 24.	163 32.95	45	2	0	1	9	4.5
140	10/05	56 27.	163 28.00	44	2	4	7	7	3.6
141	10/05	56 30.	163 23.25	43	2	0	6	11	5.4
TOTALS					332	222	604	1,833	5.5