Fishery Data Series No. 11-04

Summary of the 2009/2010 Mandatory Crab Observer Program Database for the Bering Sea/Aleutian Islands Commercial Crab Fisheries

by

William B. Gaeuman

March 2011

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. 11-04

SUMMARY OF THE 2009/2010 MANDATORY CRAB OBSERVER PROGRAM DATABASE FOR THE BERING SEA/ALEUTIAN ISLANDS COMMERICAL CRAB FISHERIES

by
William B. Gaeuman
Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

March 2011

This investigation was financed in part by the National Oceanic and Atmospheric Administration (NOAA) Award NA07NMF4370268. The views expressed here are those of the author and do not necessarily reflect the view of NOAA or any of its sub-agencies.

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.

William B. Gaeuman
Alaska Department of Fish and Game, Division of Commercial Fisheries
211 Mission Road, Kodiak, AK 99615-6399

This document should be cited as:
Gaeuman, W. B. 2011. Summary of the 2009/2010 mandatory crab observer program database for the Bering Sea/Aleutian Islands commercial crab fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 11-04, Anchorage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF APPENDICES (Continued)

ABSTRACT

Since 1988 Alaska Department of Fish and Game has required varying levels of observer coverage aboard vessels participating in Bering Sea and Aleutian Islands (BSAI) crab fisheries. In the 2009/2010 BSAI crab fisheries, commercially harvested crab species included golden king crab *Lithodes aequispinus* from the Aleutian Islands and Bering Sea and red king crab *Paralithodes camtschaticus,* blue king crab *P. platypus*, snow crab *Chionoecetes opilio,* and Tanner crab *C. bairdi* from the Bering Sea. This report summarizes data collected in the 2009/2010 BSAI commercial crab fisheries by crab observers deployed on floating-processor vessels, catcher-processor vessels, and catcher vessels and provides historical data for comparison. Primary data summaries include estimates of catch and per unit effort (CPUE) and information about size and shell condition of both captured and retained crabs. Further information about catch rates by soak time and depth, female reproductive condition, sampled pot-lift locations, species composition of sampled pot lifts, and total legal tally results is provided in a series of appendices. Notable are the low reported harvest (0.461 million pounds) in the St. Matthew Island blue king crab fishery, reopened for the first time after a 10-year hiatus, and the high estimated CPUE (83.6 crabs per pot lift) of legal retained crabs in the Bering Sea Tanner crab fishery east of 166° W long, almost double that of the previous year.

Key words: Alaska Department of Fish and Game, Bering Sea, Aleutian Islands, crab observer, golden king crab, red king crab, blue king crab, snow crab, Tanner crab.

INTRODUCTION

Regulations adopted by the Alaska Board of Fisheries (BOF) in 1999 have provided the Alaska Department of Fish and Game (ADF&G) with the full authority and responsibility for deploying onboard observers on any vessel participating in the commercial Bering Sea and Aleutian Islands (BSAI) crab fisheries or in any fishery conducted under a commissioner's permit as necessary for fishery management and data-gathering needs. Those regulations required deployment of observers on all vessels that process Tanner crab *Chionoecetes* spp., red king crab *Paralithodes camtschaticus,* blue king crab *P. platypus*, or golden king crab *Lithodes aequispinus*. Additionally, those regulations charged ADF&G with deploying observers as needed on catcher vessels participating in commercial BSAI king and Tanner crab fisheries (excluding those of Norton Sound and St. Lawrence Island Sections). Bowers et al (2010) provide details on the regulations pertaining to the State of Alaska Shellfish Onboard Observer Program and a history of that program from its inception in 1988.

Along with gear type, location, depth, and soak time of each sampled pot lift, onboard observers collect data describing pot contents, including species composition and the sex and legal status of all commercially important captured crabs. For a subset of sampled pot lifts, a range of biological measurements and assessments of all commercially important crabs and selected other species of interest is also recorded. They also document overall vessel catch, bycatch, and effort, monitor vessel activities for regulatory compliance, take size-frequency samples, conduct legal tallies, and estimate average weight of delivered catch. ADF&G Westward Region staff maintain observer-collected information in a database that is used in management and research applications to develop stock-assessment models, to estimate the magnitude and composition of bycatch, to chronicle female reproductive cycles, and as an aid in preseason and inseason projections of fishery performance. The database provides a source of information crucial to the comprehensive management of Alaska's BSAI crab stocks.

This report summarizes data collected by onboard observers and dockside samplers during the 2009/2010 Bristol Bay red king crab fishery, Bering Sea Tanner crab fishery east of 166° W long, Bering Sea snow crab fishery, St. Matthew Island blue king crab fishery, and Aleutian Islands golden king crab fisheries east and west of 174° W long (Table 1). For each of these six fisheries, this report gives estimates of catch per unit effort (CPUE), catch, and size and shell-

condition frequency distributions for both captured and retained crabs. Further information about catch rates by soak time and depth, female reproductive condition, location and species composition of sampled pot lifts, and total legal tally sample results is provided in the appendices. In 2010 ADF&G also placed observers on board a single catcher vessel harvesting Bering Sea golden king crabs by commissioner's permit in the Pribilof District of the Bering Sea. However, because the terms of the permit allow fishing throughout the 2010 calendar year, observer data for this fishery will be presented in next year's report following season closure.

METHODS

Methods described in this report correspond only to the data presented and are not inclusive of all observer sampling duties. Comprehensive shellfish observer sampling methods are detailed in the 2010 ADF&G Crab Observer Training and Deployment Manual[1]. In accordance with the provisions of **5 AAC 39.645**, observers were deployed on all floating-processor and catcher-processor vessels participating in each fishery, on randomly selected catcher vessels participating in the Bristol Bay red king crab fishery and Bering Sea Tanner and snow crab fisheries, and on all catcher vessels prosecuting the St. Matthew Island blue king crab fishery. In the Aleutian Islands golden king crab fisheries all catcher vessels were required to carry an observer during harvest of at least 50% of their total harvested weight in each three-month trimester of the nine month season. The number of pot lifts observers were required to sample on each day of fishing activity on board catcher-processor and catcher vessels varied by fishery and vessel type. In general, sample pot-lift goals, as well as observer ability to attain them, depend on a number of variables unique to each fishery and season, including weather, catch rates, assigned research data collection projects, and the order of sampling priorities established by ADF&G. Fishery specific observer deployments and pot-lift sampling goals are given in Table 1.

TERMS

For the purposes of this report, terms related to the discussion of sampled crabs and observer sampling duties are defined as follows:

Pot-lift sample	A randomly selected pot lift from which captured crabs of all species are identified and enumerated. For a subset of these pot lifts, measurements and assessments of ancillary characteristics are also recorded for crabs of selected species.
Legal tally	Examination of up to 600 crabs randomly selected from the retained catch to assure regulatory compliance regarding the retention of crabs by species, size, and sex.
Carapace length (CL)	The biological size measurement of all species of king crab *Lithodes, Paralithodes* and hair crab *Erimacrus isenbeckii* taken as the straight-line distance from the posterior margin of the right eye orbit to the medial-posterior carapace margin.

[1] Crab Observer Training and Deployment Manual. September 2010 edition. ADF&G Shellfish Observer Program, Dutch Harbor, unpublished.

Carapace width (CW)	The biological size measurement of all species of *Chionoecetes* crab taken as the greatest straight-line distance perpendicular to a line midway between the eyes to the medial-posterior margin, not including the spines.
Legal measurement	The greatest straight-line distance across the carapace of male crabs, including the spines, perpendicular to a line midway between the eyes to the medial-posterior margin.
Size frequency sample	Biological measurements of up to 100 randomly selected retained crabs for the purpose of determining carapace size and shell condition distribution.
Catch per unit effort (CPUE)	The mean catch (number) of crabs for a standard unit of fishing effort. In this report CPUE represents the mean catch per pot lift.
Uneyed eggs	Early developmental stages of an egg with no distinguishing markings.
Eyed eggs	Later developmental stages of an egg distinguished by dark eye spots.
Ovigerous	Bearing eggs, either eyed or uneyed (pertaining to female crabs).
Mated/barren	Not carrying eggs but displaying evidence of previous mating activity (pertaining to female crabs).
Non-mated/barren	Not carrying eggs and not displaying evidence of previous mating activity (pertaining to female crabs).
Recruit	New-shell male crabs of legal size in the first year of availability to the commercial fishery.
Post-recruit	All old-shell male crabs of legal size and all new-shell male crab one or more molts subsequent to initial recruitment.

Shell condition is recorded to provide an estimate of the time since a crab's last molt (Jadamec et al. 1999; Donaldson and Byersdorfer 2005). Observers scored the shell condition of sampled crabs as either "soft", "new pliable", "new", "old", or "very old" on the basis of shell hardness and color, the nature and extent of abrasions and wear of the shell surfaces, spines and dactyls, and the number and type of epibionts on the shell surfaces.

SAMPLING DUTIES

During the 2009/2010 BSAI commercial crab fisheries, observers were deployed on floating-processor vessels, catcher-processor vessels, and catcher vessels. Observers deployed on floating-processors had access only to previously sorted retained catch from delivering catcher vessels, whereas observers placed on catcher-processor and catcher vessels were able to examine the contents of pot lifts prior to sorting.

Floating-Processor Vessels

Observers deployed on floating-processor vessels primarily monitor deliveries from catcher vessels. Sampling duties during each delivery included obtaining a size-frequency sample, conducting a legal tally, and determining average weight of retained crabs.

Catcher-Processor Vessels

Sampling duties for observers deployed on catcher-processor vessels included pot-lift sampling, size-frequency sampling, legal-tally sampling, and determination of average weight of retained crabs for each day the vessel retained catch. Occasionally, catcher vessels delivered to a catcher-processor vessel. In those situations, the observer sampled the catcher vessel catch as if deployed on a floating processor.

Catcher Vessels

Sampling duties for observers deployed on catcher vessels included pot-lift sampling, which was usually the main sampling activity for each day the vessel fished. When the vessel delivered to a processing facility, whether at sea or on shore, the observer obtained a size-frequency sample, conducted a legal tally, and determined average weight of retained crab. If deliveries were made at sea, all sampling was completed by the observer deployed on the catcher vessel.

ESTIMATION OF CPUE AND TOTAL FISHERY CATCH

Estimates of CPUE presented here were generated from observer-collected data using a ratio estimator introduced by Gaeuman (2009). For the purpose of estimation it is assumed that within a fishery observers are assigned to all participating catcher-processor vessels and by simple random sampling to a subset of all participating catcher vessels. It is also assumed that sampled pot lifts are selected by simple random sampling from all pot lifts on each vessel fishing day, independently across days. Under these assumptions it is straightforward to estimate both total catch and the total number of pot lifts for all vessels based on observed vessel days, treating vessel types as strata, vessels as primary sampling units within them, vessel days as strata within vessels, and pot lifts as secondary sampling units within those. The ratio of these estimates of total catch and total number of pot lifts then estimates fishery mean CPUE defined as fishery total catch divided by fishery total effort, i.e. total number of pot lifts. An estimated variance for this estimator can be developed using standard variance estimators for the component estimators of total catch and total number of pot lifts. Appendix A1 describes both the ratio estimator of CPUE and the derivation of its variance estimator.

Prior to Gaeuman (2009), different estimates of CPUE were calculated depending on the information available and on varying assumptions about the sampling design. The “sample CPUE” reported before 1996 (Tracy 1994, 1995a, b) was calculated as the simple average catch over all sampled pot lifts. Burt and Barnard (2003) introduced stratification by vessel type into the report series with their “weighted mean” estimator of CPUE. Their later “stratified CPUE” estimator, most recently described in Barnard and Burt (2008), additionally assumed stratification by vessel day.

By contrast with these design-based estimates of CPUE, actual total fishery (ATF) CPUE as reported in annual management reports for commercial crab fisheries in BSAI management areas is based on effort and catch information extracted from a combination of fish tickets, daily fishing logs (DFL), and confidential interviews with vessel captains, and represents an

independent estimate of fishery CPUE[2]. ATF CPUE estimates, however, are available only for retained legal crabs. Estimated total catches reported in this document, as opposed to ATF values, were calculated by multiplying CPUE estimates from observer-collected data by corresponding ATF estimates of fishery pot-lift totals.

Cod Pots

In some crab fisheries regulations allow deployment of a specified number of groundfish-configured pots targeting Pacific cod *Gadus macrocephalus* for use as bait (**5 AAC 34.825(k)** and **5 AAC 35.525(d)**). Although some crabs are typically captured in these pots, they generally have a much lower CPUE than pots targeting crabs and arguably misrepresent or at least mask a more telling characterization of fishing efficiency in the directed crab pot fishery. For this reason, as well as others, ADF&G crab observers are currently instructed not to sample cod pots in these fisheries (2010 Crab Observer Training and Deployment Manual. *Unpublished*). In 2009/2010 the relevant fisheries were Bristol Bay red king crab, Bering Sea Tanner crab, and Bering Sea snow crab, in which groundfish-configured pots respectively accounted for 5%, 9% and 7% of all pots lifted during observer pot-lift sampling days. Consequently, for these fisheries estimators of CPUE can be expected to be biased slightly high with respect to ATF CPUE, which does not distinguish between conventional and groundfish-configured pots with respect to fishery effort and CPUE.

RESULTS

BRISTOL BAY RED KING CRAB

The 2009/2010 Bristol Bay red king crab season commenced October 15 and continued until January 15. Total allowable catch (TAC) in this fishery was set at 16.01 million pounds. Two catcher-processors and 68 catcher vessels took part. Onboard observers sampled 1,950 pot lifts accounting for 1.6% of the ATF reported 118,521 pot lifts (Table 1). Appendix B1 (*confidential*) shows locations of pot lifts sampled by onboard observers during the 2009/2010 Bristol Bay red king crab fishery.

During the season, onboard observers collected CL measurements of 92,005 male red king crabs from sampled pot-lifts (Figure 1). Average CL was 136.1 mm, and 92.9% of the crabs were classified as new shell. CL measurements of 6,032 female red king crabs from sampled pot lifts averaged 118.2 mm (Figure 2). Approximately 96.1% of the females were new shell. CL measurements were also recorded for 19,033 retained male red king crabs by onboard observers and dockside samplers in size-frequency sampling. Average CL was 150.2 mm, and 87.8% of the sampled crabs were new shell (Table 2).

Estimated CPUE for legal retained red king crabs was 21.8 crabs per pot lift (Table 3). A 95% confidence interval for this estimate is (19.54, 23.99), from a t-distribution as detailed in Appendix A. Based on the ATF reported 118,521 total pot lifts, this yields an estimated total retained catch of 2,584,000 crabs. The ATF reported CPUE, 21.4 legal retained crabs per pot lift, is statistically indistinguishable from that based on observer data. Estimated bycatch of sublegal males exceeded legal retained catch at 24.5 crabs per pot lift; estimated female bycatch was 2.6 crabs per pot lift. All 2009/2010 CPUE estimates were low by comparison with estimates from the previous two seasons (Figure 3). In addition to a small concurrent legal harvest of Tanner

[2] Forrest Bowers, BSAI Area Management Biologist, ADF&G, Dutch Harbor, personal communication.

crabs, some incidental Tanner crab bycatch, mostly of discarded legal-sized male crabs, was observed in the directed Bristol Bay red king crab fishery, as shown in Table 3.

Total catches of all animals identified in sampled pot lifts during the 2009/20010 Bristol Bay red king crab season are provided in Appendix C1. Additional appendices contain CPUE by soak time (Appendix C2) and depth (Appendix C3) and the reproductive condition of female red king crabs from sampled pot lifts (Appendix C4).

Legal tallies conducted on catcher-processor vessels and catcher vessels totaled 31,399 crabs by the end of the 2009/2010 season and comprised 1.4% of the fishery reported harvest (Appendix D1). Approximately 0.54% of sampled crabs were illegal due to size, sex, or species.

BERING SEA TANNER CRAB

The Bering Sea Tanner crab fishery is currently managed as separate fisheries east and west of 166° W long. Due to concern about high Tanner crab bycatch mortality resulting from the directed Bering Sea Tanner and snow crab fisheries, the 2009/2010 western Bering Sea Tanner crab fishery was closed; however, the eastern fishery proceeded. In addition, properly licensed vessels prosecuting the directed Bristol Bay red king crab fishery were permitted to retain legal-sized Tanner crabs as incidental catch up to 5% of total landed weight of red king crab. The following summary reflects only fishing activity attributable to the 2009/2010 **directed** Bering Sea Tanner crab fishery east of 166° W long, as do ATF estimates of effort, catch, and CPUE presented here, which may differ from those otherwise reported for the fishery. This is because all estimates reported here are based only on pot lifts targeting Tanner crabs, as opposed to pot lifts contributing to legal Tanner crab landings but targeting red king crabs.

The fishery opened October 15 with a TAC of 1.35 million pounds and closed by regulation on March 31. A single catcher-processor vessel and 16 catcher vessels took part. Onboard observers sampled 354 pot lifts accounting for 5.3% of the ATF reported 6,635 pot lifts in the directed fishery (Table 1). Locations of observer sampled pot lifts are displayed in Appendix B2 (*confidential*).

While at sea, onboard observers obtained CW measurements of 17,289 male and 147 female Tanner crabs from sampled pot lifts (Figures 4 and 5). Average male CW was 151.1 mm, and 93.3% of the males were new shell. Average female CW was 98.5 mm, and observers classified 19.7% of the females as new shell. Size-frequency sampling of 2,417 retained Tanner crabs yielded an average CW of 157.0 mm (Table 4). Of the sampled retained crabs 98.0% were recorded as new shell.

Estimated CPUE for legal retained Tanner crabs in the directed Tanner crab fishery east of 166° W long was 83.6 crabs per pot lift (Table 5), with 95% confidence interval (65.89, 101.40). Given the estimated fishery reported 6,635 total number of pot lifts in the **directed** Tanner crab fishery, the associated estimate of total retained catch is 555,000 crabs. Estimated ATF CPUE in the **directed** Tanner crab fishery, by contrast, was 71.8 legal retained crabs per pot lift, which, however, falls within the confidence interval reported above. It is estimated that legal retained Tanner crabs accounted for about 80% of all Tanner crabs captured in the fishery, with most of the Tanner crab bycatch consisting of sublegal males. The estimated 2009/2010 CPUE of 83.6 for legal retained Tanner crabs was 79% higher than the previous season estimate of 46.7 (Figure 6), which in turn was 81% higher than the 2007/2008 estimate of 25.8. Bycatch of sublegal males, on the other hand, is estimated to have decreased markedly in recent years; female

bycatch appears to have remained about the same at no more than 1.0 crabs per pot lift. Observers additionally registered some limited bycatch of discarded red king crabs and male snow crabs, as documented in Table 5.

Total catches of all animals identified in sampled pot lifts during the 2009/2010 eastern Bering Sea Tanner crab fishery are provided in Appendix C5. Summaries of CPUE by soak time and depth can be found in Appendices C6 and C7, respectively. Reproductive condition of female Tanner crabs from sampled pot lifts is documented in Appendix C8.

Legal tallies conducted during the season totaled 9,600 crabs and comprised 2.0% of the reported Tanner crab harvest in the directed fishery (Appendix D1). Approximately 0.40% were illegal due to size, sex, or species restrictions.

BERING SEA SNOW CRAB

The 2009/2010 Bering Sea snow crab fishery opened October 15 with a TAC of 48.02 million pounds and closed May 15. Two catcher-processor vessels and 67 catcher vessels participated. Onboard observers sampled 1.2% (1,646) of the ATF reported 137,018 pot lifts (Table 1). Sampled pot-lift locations are shown in Appendix B3 (*confidential*).

Onboard observers collected CW measurements of 155,592 male snow crabs during pot-lift sampling. Average CW was 108.8 mm, and 93.2% of the crab were categorized as new shell, as indicated in Figure 7, which tracks male snow crab CW distribution by shell condition over the last 6 seasons based on intervals of 5 mm. Observers also measured CW of 246 female snow crabs. The average was 70.5 mm, with 13.0% of the females judged new shell. CW measurements were additionally recorded for 30,745 retained snow crabs in size-frequency sampling of retained catch. Average CW was 112.9 mm, and 95.3% were new shell (Table 6).

Estimated CPUE for legal retained snow crabs was 269.0 crabs per pot lift (Table 7), essentially indistinguishable from the ATF reported CPUE of 257.6 given the assessed statistical imprecision of the estimate from observer data, with estimated 95% confidence interval (238.9, 299.1). The corresponding estimate of total harvest based on the ATF reported pot-lift total was 36,858,000 crabs. It was estimated that legal retained males accounted for 77% of all captured snow crabs, while discarded legal-sized male crabs less than 4 inches (~102 mm) CW made up the bulk of the remaining 23%. (Although the minimum legal size for snow crabs is 3.1 inches (~79 mm) CW, processing plants generally do not accept crabs less than 4 inches CW.) The 2009/2010 point estimate of CPUE for legal retained snow crabs was the lowest in this fishery since the 2005/2006 season (Figure 8); the associated uncertainty, however, precludes inference of any real trend. By contrast, bycatch of discarded legal males, estimated in 2009/2010 to be 76.4 crabs per pot lift, has arguably genuinely declined over the last four years. As shown in Table 7, some bycatch of both Tanner crabs and bairdi-type hybrid crabs, i.e. those identified as Tanner x snow crab hybrids but meeting the state regulatory definition for Tanner crabs, was also observed in this fishery, by far the largest component of which consisted of sublegal Tanner crabs, estimated at 22.1 crabs per pot lift for an estimated total discarded catch of 3,028,000 crabs.

Total catches of all animals identified in sampled pot lifts during the 2009/2010 season are provided in Appendix C9. Additional appendices contain sampled pot lift CPUE by soak time (Appendix C10) and depth (Appendix C11) and the reproductive condition of female snow crabs in pot-lift samples (Appendix C12).

Legal tallies conducted on catcher-processor vessels and catcher-only vessels delivering snow crabs to processors totaled 90,861 crabs, which accounted for 0.3% of the total reported catch (Appendix D1). Of these, 0.25% were illegal due to size, sex, or species restrictions.

SAINT MATTHEW ISLAND BLUE KING CRAB

The St. Matthew Island blue king crab fishery opened for the first time since 1998 on October 15, 2009 with a TAC of 1.17 million pounds and closed by regulation February 1, 2010, though most fishing had concluded by the end of November. All 7 participating catcher vessels were required to carry an observer. Of the ATF reported 10,697 pot lifts in this fishery, observers sampled 989, about 9.2% (Table 1). Locations of sampled pot lifts are mapped in Appendix B4 (*confidential*).

Observers measured CL of 21,368 male and 1,637 female crabs in pot-lift sampling. Respective average values were 116.8 mm and 84.8 mm. Of the males, 85.8% were new shell, whereas 59.3% of the females were new shell (Figure 9). Size-frequency sampling of 1,433 fishery retained blue king crabs yielded an average CL of 129.8 mm, with 86.7% judged new shell (Table 8).

Estimated CPUE for legal retained crabs was 10.2 crabs per pot (Table 9), with approximate 95% confidence interval (9.84, 10.55), compared to the ATF reported value of 9.7 legal retained crabs per pot. Corresponding estimated total harvest, including deadloss, was 109,000 crabs. Estimated bycatch of sublegal males slightly exceeded the catch of legal crabs, whereas the estimated female bycatch of 1.4 crabs per pot was modest by comparison with both. Though the historical fishery had been considerably more efficient in some years, the 2009/2010 CPUE for legal retained crabs is in line with fishery performance prior to the 10-year closure following the 1998/1999 season (Figure 10). As is evident in Table 9, some incidental bycatch of snow crabs occurred in the 2009/2010 St. Matthew Island blue king crab fishery, most of it consisting of discarded legal-size males.

Total catches of all animals identified in sampled pot lifts during the 2009/2010 season are provided in Appendix C13. Additional appendices contain sampled pot lift CPUE by soak time (Appendix C14) and depth (Appendix C15) and the reproductive condition of female blue king crab in pot-lift samples (Appendix C16).

Legal tallies conducted on catcher vessels delivering blue king crab to processors totaled 6,666 crabs, which accounted for 6.4% of the reported harvest (Appendix D1). Approximately 0.44% of the sampled crabs were illegal due to size, sex, or species restrictions.

ALEUTIAN ISLANDS GOLDEN KING CRAB

In March 1996, the BOF re-designated the Aleutian Islands king crab registration area by combining two existing areas, Dutch Harbor and Adak, and directed ADF&G to manage golden king crab stocks of the Aleutian Islands east and west of 174° W long separately as two distinct stocks (Bowers et al. 2010). In 2009/2010 both fisheries were open from August 15 to May 15.

East of 174° W Longitude

Three catcher vessels participated in the eastern Aleutian Islands golden king crab fishery, where the TAC was set at 3.15 million pounds. Onboard observers sampled 411 pot lifts accounting for 1.6% of the ATF reported 26,298 pot lifts in the fishery (Table 1). Appendix B5 (*confidential*) shows sampled pot-lift locations.

Average CL of 14,083 male golden king crabs measured in pot-lift sampling was 145.7 mm, and 96.9% were new shell (Figure 11). Average CL of 2,593 females measured in pot-lift sampling was 130.6 mm, and 98.8% were new shell (Figure 12). In size-frequency sampling of 2,355 retained crabs, average CL was 152.2 mm, and 96.1% were new shell (Table 10).

Estimated legal retained, sublegal, and female CPUEs in the 2009/2010 eastern Aleutian Islands golden king crab fishery were consistent with estimates from previous years since rationalization (Figure 13). The catch of legal retained males was estimated to be 25.7 crabs per pot (Table 11), with 95% confidence interval (23.92, 27.45), making it statistically indistinguishable from the ATF reported CPUE 25.9 legal retained crabs per pot lift. Associated estimated catch was 675,000 animals. There was no significant bycatch of any incidental crab species in this fishery.

Total catches of all animals identified in sampled pot lifts during the 2009/2010 eastern Aleutian Islands golden king crab fishery are provided in Appendix C17. Additional appendices contain sampled pot-lift CPUE by soak time (Appendix C18) and depth (Appendix C19) and reproductive condition of female golden king crabs (Appendix C20) from sampled pot lifts.

Legal tallies conducted throughout the season onboard catcher-processor vessels and catcher vessels delivering golden king crab from the eastern Aleutian Islands fishery totaled 7,210 crabs. Sampled crabs made up approximately 1.1% of the fishery estimated harvest of 679,886 crabs (Appendix D1). Approximately 0.42% were illegal due to size, sex, or species restrictions

West of 174° W Longitude

The TAC was set at 2.83 million pounds in the western fishery, with a single catcher-processor and 2 catcher vessels participating. ATF reported effort was 26,489 pot lifts, of which observers sampled 893, or 2.4% (Table 1). Locations of sampled pot lifts are shown in Appendix B6 (*confidential*).

Onboard observers recorded CL of 30,133 male and 7,147 female golden king crabs captured in sampled pot lifts. Male and female CL averages were respectively 146.0 mm and 137.8 mm. New-shell crabs made up 98.1% of the males and 98.8% of the females (Figures 14 and 15). Average CL of 9,790 retained crabs measured in size-frequency sampling was 152.5 mm, and 98.3% of the crabs were new shell (Table 12).

Estimated legal retained CPUE in this fishery was markedly higher at 30.2 crabs per pot (Table 13) than the ATF reported value of 23.7, which is well outside the 95% confidence interval of (28.07, 32,24), and also higher than previous historical estimates (Figure 16). Bycatch of both female and sublegal crabs, on the other hand, showed a slight reduction by comparison with estimates from recent years. Observers recorded no noteworthy bycatch of incidental species in this fishery.

Appendix C21 lists total catches of all animals observed in sampled pot lifts during the 2009/2010 western Aleutian Islands golden king crab fishery. Appendices C22 and C23 give sampled pot-lift CPUE by soak time and depth. Appendix C24 characterizes reproductive condition of captured female golden king crabs.

Legal tallies conducted onboard catcher vessels delivering golden king crabs from the Aleutian Islands fishery west of 174° W long totaled 35,232 crabs by the end of the 2009/2010 season. Sampled crabs made up approximately 5.6% of the fishery reported harvest of 628,332 (Appendix D1). Approximately 0.52% were illegal due to size, sex, or species restrictions.

ACCURACY AND PRECISION OF CPUE ESTIMATES

In assessing CPUE estimates for directed catch and bycatch, their precision should be considered. In general, the precision of an estimator is a function of its repeatability or, more formally, its variance. A convenient measure of precision is the coefficient of variation (CV), which is the ratio of the standard deviation to the mean. An estimate of this quantity is provided by the ratio of the standard error (square root of the estimated variance) to the estimate itself. For the observer-based CPUE estimates of legal retained crab for the six fisheries described in this document, these values indicate generally good levels of precision, ranging from 1.8% (most precise) for the St. Matthew Island blue king crab fishery to 9.2% (least precise) for the Bering Sea Tanner crab fishery east of 166° W long. The reduced precision of the latter is consistent both with the small number of observer sampled pot lifts and the high variability in catch per sampled pot lift in this fishery.

A related measure of estimator precision is the confidence interval associated with a suitably chosen level of confidence, frequently 90 or 95%. Along with standard errors for all CPUE estimates in each directed fishery (Tables 3, 5, 7, 9, 11, 13), this document additionally reports 95% confidence intervals associated with each estimated CPUE. These confidence intervals are based on a *t*-distribution, as described in more detail in Appendix A1.

Because an estimator may be precise yet still be inaccurate in the sense of assuming a value very far from the target parameter, it is of interest to assess an estimator's accuracy, as well as its precision. Some indication of the accuracy of an estimated CPUE for legal retained crab within a particular fishery may be extracted by directly comparing it to the corresponding ATF reported value. As these two numbers represent essentially independent estimates of fishery CPUE, substantial agreement between the two presumably reflects the fact that neither is wildly inaccurate. On the other hand, a very great disparity between them guarantees at least one estimate is well wide of the target. For the six fisheries here described, such a comparison shows mixed results (Table 14), ranging from a relative difference of less than 1% for the eastern Aleutian Islands golden king crab fishery to a relative difference of 21.5% for the western Aleutian Islands golden king crab fishery. Moreover, in this last case the difference between the two is larger than is readily attributable to statistical imprecision in the estimate from observer data, with estimated CV of just 3.5%. Alternatively, the fact that observer coverage in the Aleutian Islands golden king crab fisheries is limited to just 50% of each 3-month trimester of the season is a potential source of estimator bias, which makes the very close agreement between the two estimates in the eastern fishery all the more noteworthy.

In assessing estimates based on observer-sampled pot lifts, the reader should take note of 1) whether the data were gathered by observers deployed on all participating fishing vessels or on catcher-processor vessels and only a sample of registered catcher-only vessels and 2) the extent of coverage with respect to the number of days fished by vessels selected for observation, which is of particular concern in the Aleutian Islands golden king crab fisheries. Estimator performance depends generally both on the proportion of pot lifts sampled and on the extent to which catch rates of sampled pot lifts on observed days aboard observed vessels are "representative" of those of the remaining component of fishery effort. It can at least be hoped that the conscientious application of probability sampling mechanisms in observer deployment and data collection protocols will allow for defensible assessments of estimator precision and greatly reduce the potential for non-ignorable and unquantifiable sampling bias.

ACKNOWLEDGMENTS

Shellfish observers deployed during the 2009/2010 Bering Sea fisheries collected the data summarized in this report. Their diligence in collecting biological and fisheries management information while living and working at sea, often for extended periods and sometimes under extremely challenging conditions, is essential to management of these fisheries.

I thank ADF&G Dutch Harbor staff for answering questions and fulfilling data requests, ADF&G colleagues Jeanette Alas, Ryan Burt, and Vicki Vanek for reviewing this report, and Lindsay Gann for assistance in finding my way through the ADF&G publication process.

This project was funded in part by the National Oceanic and Atmospheric Administration (NOAA) Award NA07NMF4370268. The views expressed here are those of the author and do not necessarily reflect the view of NOAA or any of its sub-agencies.

REFERENCES CITED

Barnard, D. R. and R. Burt. 2008. Alaska Department of Fish and Game summary of the 2006/2007 mandatory shellfish observer program database for the rationalized crab fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 08-17, Anchorage.

Burt, R. and D. R., Barnard. 2003. Alaska Department of Fish and Game summary of the 2003 mandatory shellfish observer program database for the general and CDQ fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 05-05, Anchorage.

Bowers, F. R., M. Schwenzfeier, K. Herring, M. Salmon, K. Milani, J. Shaishnikoff, H. Barnhart, J. Alas, R. Burt, B. Baechler and A. Buettner. 2010. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea and the Westward Region's Shellfish Observer Program, 2008/09. Alaska Department of Fish and Game, Fishery Management Report No. 10-24, Anchorage.

Cochran, W. G. 1977. Sampling techniques. John Wiley and Sons. New York.

Donaldson, W. E. and S. C. Byersdorfer. 2005. Biological field techniques for *Lithodid* crabs. Alaska Sea Grant College Program, University of Alaska Fairbanks, AK-SG-05-03.

Gaeuman, W. B. 2009. Summary of the 2007/2008 mandatory shellfish observer program database for the rationalized crab fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 09-76, Anchorage.

Jadamec, L. S., W. E. Donaldson, and P. Cullenberg. 1999. Biological field techniques for *Chionoecetes* crabs. Alaska Sea Grant College Program. University of Alaska Fairbanks, AK-SG-99-02.

Lohr, S. L. 1999. Sampling: design and analysis. Brooks and Cole, Pacific Grove.

Tracy, D. A. 1994. Alaska Department of Fish and Game biological summary of the 1992 mandatory shellfish observer program database. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 4K94-10, Kodiak.

Tracy, D. A. 1995a. Alaska Department of Fish and Game biological summary of the 1993 mandatory shellfish observer program database. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 4K95-14, Kodiak.

Tracy, D. A. 1995b. Alaska Department of Fish and Game summary of the 1994 mandatory shellfish observer program database. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 4K95-32, Kodiak.

TABLES AND FIGURES

Table 1.–Observer fisheries, observer deployment, and observer pot-lift sampling effort during 2009/10.

			Catcher-processor vessels		Catcher vessels				
Fishery	Dates	TAC[a]	Number[b]	Daily pot-lift sampling goal	Number	With onboard observers	Daily pot-lift sampling goal	ATF pot-lift total[c]	Observed pot lifts
Bristol Bay red king crab	15Oct-15Jan	16.01	2	4	68	19	7	118,521	1,950
Bering Sea Tanner crab (east of 166° W)	15Oct-31Mar	1.35	1	4	16	9	6	6,635	354
Bering Sea Snow crab	15Oct-15May	48.02	2	3	67	26	4	137,018	1,646
St Matthew Island blue king crab	15Oct-1Feb	1.17	0	10	7	7	14	10,697	989
Aleutian Islands golden king crab (east of 174° W)	15Aug-15May	3.15	0	4	3	3	7	26,298	411
Aleutian Islands golden king crab (west of 174° W)	15Aug-15May	2.83	1	4	2	2	7	26,489	893

[a] Total Allowable Catch in millions of pounds.

[b] All catcher-processor vessels are required to carry observers.

[c] Actual Total Fishery reported number of pot lifts, except in the Tanner crab fishery, provided by Jeanette Alas, ADF&G, Dutch Harbor.

Table 2.–Carapace length (CL) frequency distribution by shell condition from biological measurements of retained red king crabs sampled during the 2009/2010 Bristol Bay red king crab fishery.

	Percent			
CL[a] (mm)	New	Old	Very old	All
≤ 130	0.1	0.2	0	0.1
131-135	2.1	< 0.1	0	2.2
136-140	14.1	0.6	< 0.1	14.7
141-145	21.4	1.3	<0 .1	22.7
146-150	17.0	1.5	< 0.1	18.5
151-155	12.6	2.0	< 0.1	14.6
156-160	8.0	2.0	< 0.1	10.1
161-165	5.6	1.9	< 0.1	7.5
166-170	3.7	1.4	< 0.1	5.2
171-175	2.0	0.7	< 0.1	2.7
176-180	0.9	0.2	< 0.1	1.1
181-185	0.4	< 0.1	< 0.1	0.4
> 185	< 0.1	< 0.1	0	< 0.1
Total crabs	16,708	2,256	69	19,033
Total percent	87.8	11.9	0.4	100

[a] Average CL = 150.2 mm.

Table 3.–Estimated CPUE and total catch of selected crab species from 1,950 pot lifts sampled by observers deployed during the 2009/2010 directed Bristol Bay red king crab fishery.

Species	CPUE	SE	95% CI	Crabs[a]
Red King Crab				
legal retained	21.8	1.065	(19.54, 23.99)	2,584,000
female	2.6	0.723	((1.07, 4.09)	308,000
sublegal	24.5	2.162	(20.03, 29.05)	2,904,000
legal not retained	0.6	0.250	(0, 1.32)	71,000
Tanner Crab				
legal retained	0.2	0.099	(0.02,0.44)	24,000
female	< 0.1	–	–	< 12,000
sublegal	0.4	0.104	(0.22, 0.65)	47,000
legal not retained	0.9	0.247	(0.20, 1.65)	107,000

[a] Product of estimated CPUE and ATF reported 118,521 total number of pot lifts.

Table 4.–Carapace width (CW) frequency distribution by shell condition from biological measurements of retained Tanner crabs sampled during the 2009/2010 directed Bering Sea Tanner crab fishery east of 166° W long.

	Percent			
CW[a] (mm)	New	Old	Very old	All
≤ 135	< 0.1	0	0	< 0.1
136-140	3.0	< 0.1	0	3.1
141-145	7.3	0.5	0	7.8
146-150	13.8	0.3	0	14.1
151-155	17.0	0.4	0	17.4
156-160	19.2	0.4	0	19.6
161-165	19.3	0.2	0	19.5
166-170	13.0	0.1	0	13.1
171-175	4.4	< 0.1	0	4.5
176-180	0.7	0	0	0.7
181-185	0.2	0	0	0.2
186-190	< 0.1	0	0	< 0.1
Total crabs	2,369	48	0	2,417
Total percent	98.0	2.0	0	100

[a] Average CW = 157.0 mm.

Table 5.–Estimated CPUE and total catch of selected crab species from 354 pot lifts sampled by observers deployed during the 2009/2010 directed Bering Sea Tanner crab fishery east of 166° W long.

Species	CPUE	SE	95% CI	Crabs[a]
Tanner Crab				
legal retained	83.6	7.700	(65.89, 101.40)	555,000
female	0.8	0.450	(0, 1.86)	6,000
sublegal	15.7	3.659	(7.29, 24.17)	104, 000
legal not retained	< 0.1	--	--	< 7,000
Red King Crab				
legal retained	0	--	--	
female	1.0	1.033	(0, 3.37)	7,000
sublegal	0.3	0.285	(0, 0.97)	2,000
legal not retained	0.1	0.153	(0, 0.50)	1,000
Snow Crab				
female	0	--	--	
sublegal	< 0.1	--	--	< 7,000
legal not retained	0.4	0.251	(0, 1.00)	3,000

[a] Product of estimated CPUE and ATF reported 6,635 total number of pot lifts in the **directed** Bering Sea Tanner crab fishery.

Table 6.–Carapace width (CW) frequency distribution by shell condition from biological measurements of retained snow crabs sampled during the 2009/2010 Bering Sea snow crab fishery.

	Percent			
CW[a] (mm)	New	Old	Very old	All
≤ 90	< 0.1	0.4	0	< 0.1
91-95	0.3	< 0.1	0	0.4
96-100	2.6	0.2	< 0.1	2.8
101-105	13.7	1.0	< 0.1	14.7
106-110	20.6	1.3	< 0.1	21.9
111-115	22.8	1.0	< 0.1	23.9
116-120	18.9	0.6	< 0.1	19.5
121-125	11.7	0.4	< 0.1	12.1
126-130	3.7	0.1	< 0.1	3.8
131-135	0.8	< 0.1	0	0.8
136-140	< 0.1	0	0	< 0.1
Total crabs	29,303	1,421	21	30,745
Total percent	95.3	4.6	0.1	100

[a] Average CW = 112.9 mm.

Table 7.–Estimated CPUE and total catch of selected crab species from 1,646 pot lifts sampled by observers deployed during the 2009/2010 Bering Sea snow crab fishery.

Species	CPUE	SE	95% CI	Crabs[a]
Snow Crab				
legal retained	269.0	14.628	(238.87, 299.13)	36,858,000
female	0.7	0.517	(0, 0.77)	96,000
sublegal	1.5	0.402	(0.71, 2.37)	206,000
legal not retained	76.4	9.930	(55.96, 96.87)	10,468,000
Tanner Crab				
legal retained[b]	< 0.1	–	–	< 14,000
female	0.5	0.153	(0.23, 0.86)	69,000
sublegal	22.1	4.199	(13.40, 30.70)	3,028,000
legal not retained	0.8	0.254	(0.31, 1.36)	110,000
bairdi-Type Hybrid Crab				
legal retained[c]	0.9	1.080	(0, 3.07)	123,000
female	0	–	–	
sublegal	0.4	0.193	(0, 0.76)	55,000
legal not retained	1.1	0.131	(0, 0.38)	151,000

[a] Product of estimated CPUE and ATF reported 137,018 total number of pot lifts.

[b] Observers recorded legal-size retained Tanner crabs in just 2 sampled pots: 1 pot contained 1 crab and the other contained 14.

[c] Observers recorded legal-size retained bairdi-type hybrid crabs in just 2 sampled pots: 1 pot contained 2 crabs and the other contained 362. These were not the same pots as those containing legal-size Tanner crabs.

Table 8.–Carapace length (CL) distribution by shell condition from biological measurements of retained blue king crabs sampled during the 2009/2010 St. Matthew Island blue king crab fishery.

	Percent			
CL[a] (mm)	New	Old	Very old	All
≤ 110	0.3	0	0	0.3
111-115	0.1	0.1	0	0.3
116-120	4.6	0.8	0.1	5.5
121-125	19.1	4.0	0.8	23.9
126-130	22.1	3.2	0.6	25.8
131-135	22.4	2.0	0.3	24.6
136-140	11.7	0.9	0.2	12.8
141-145	4.9	0.2	0	5.1
146-150	1.3	0.1	0	1.5
151-155	0.3	0	0	0.3
Total crabs	1,242	162	29	1,433
Total percent	86.7	11.3	2.0	100

[a] Average CL = 129.8 mm.

Table 9.–Estimated CPUE and total catch of selected crab species from 989 pot lifts sampled by observers deployed during the 2009/2010 St. Matthew Island blue king crab fishery.

Species	CPUE	SE	95% CI	Crabs[a]
Blue King Crab				
legal retained	10.2	0.181	(9.84, 10.55)	109,000
female	1.4	0.125	(1.20, 1.68)	15,000
sublegal	10.7	0.236	(10.23, 11.16)	114,000
legal not retained	0.3	0.021	(0.25, 0.33)	3,000
Snow Crab				
female	0.1	0.028	(0.03, 0.17)	1,000
sublegal	0.4	0.043	(0.27, 0.44)	4,000
legal not retained	1.1	0.064	(0.96, 1.21)	12,000

[a] Product of estimated CPUE and ATF reported 10,697 total number of pot lifts.

Table 10.–Carapace length (CL) distribution by shell condition from biological measurements of retained golden king crabs sampled during the 2009/2010 Aleutian Islands golden king crab fishery east of 174° W long.

	Percent			
CL[a] (mm)	New	Old	Very old	All
131-135	1.5	0	0	1.5
136-140	8.4	0.2	0	8.6
141-145	17.7	0.2	0	17.9
146-150	20.0	0.4	0	20.4
151-155	17.2	0.7	0	17.9
156-160	12.5	0.7	0	13.2
161-165	8.9	0.6	0	9.5
166-170	6.0	0.5	0	6.5
171-175	2.2	0.4	0	2.6
176-180	1.1	0.2	0	1.3
181-185	0.3	< 0.1	0	0.4
186-190	0.1	0	0	0.1
191-195	0	< 0.1	0	< 0.1
Total crabs	2,263	92	0	2,355
Total percent	96.1	3.9	0	100

[a] Average CL = 152.2 mm.

Table 11.–Estimated CPUE and total catch of golden king crabs from 411 pot lifts sampled by observers deployed during the 2009/2010 Aleutian Islands golden king crab fishery east of 174° W long.

Species	CPUE	SE	95% CI	Crabs[a]
Golden King Crab				
legal retained	25.7	0.900	(23.92, 27.45)	675,000
female	7.9	0.913	(6.12, 9.70)	208,000
sublegal	10.9	0.943	(9.05, 12.75)	287,000
legal not retained	0.9	0.088	(0.70, 1.04)	23,000

[a] Product of estimated CPUE and ATF reported 26,298 total number of pot lifts.

Table 12.–Carapace length (CL) distribution by shell condition from biological measurements of retained golden king crabs sampled during the 2009/2010 Aleutian Islands golden king crab fishery west of 174° W long.

	Percent			
CL[a] (mm)	New	Old	Very old	All
≤ 130	< 0.1	0	0	< 0.1
131-135	1.9	< 0.1	0	1.9
136-140	11.0	< 0.1	0	11.1
141-145	18.3	0.1	0	18.4
146-150	17.6	0.2	< 0.1	17.8
151-155	15.2	0.3	0	15.4
156-160	11.6	0.2	< 0.1	11.8
161-165	8.9	0.3	0	9.2
166-170	6.5	0.3	0	6.7
171-175	4.1	0.2	< 0.1	4.3
176-180	2.1	< 0.1	0	2.2
181-185	0.8	< 0.1	0	0.8
186-190	0.3	0	0	0.3
> 190	< 0.1	0	0	< 0.1
Total crabs	9,623	164	3	9,790
Total percent	98.3	1.7	0	100

[a] Average CL = 152.5 mm.

Table 13.–Estimated CPUE and total catch of golden king crabs from 893 pot lifts sampled by observers deployed during the 2009/2010 Aleutian Islands golden king crab fishery west of 174° W long.

Species	CPUE	SE	95% CI	Crabs[a]
Golden King Crab				
legal retained	30.2	1.064	(28.07, 32.24)	799,000
female	9.9	0.900	(8.14, 11.67)	262,000
sublegal	7.6	0.492	(6.62, 8.55)	201,000
legal not retained	0.4	0.041	(0.29, 0.45)	10,000

[a] Product of estimated CPUE and ATF reported 26,489 total number of pot lifts.

Table 14.–Comparison of actual total fishery (ATF) and observer data estimates of retained catch CPUE and number (including deadloss) for 2009/2010 Bering Sea/Aleutian Islands crab fisheries. ATF numbers, except for the Tanner crab fishery, provided by Jeanette Alas, ADF&G, Dutch Harbor.

	ATF estimates		Observer data estimates		
Fishery	CPUE	Crabs	CPUE	Crabs	% Difference[b]
Bristol Bay red king crab	21.4	2,537,221	21.8	2,584,000	1.9
Bering Sea Tanner Crab[a] (east of 166° W)	71.8	476,668	83.6	555,000	14.1
Bering Sea snow crab	257.6	35,289,023	269	36,858,000	4.4
St. Matthew Island blue king crab	9.7	103,376	10.2	107,000	2.9
Eastern Aleutian Islands golden king crab	25.9	679,886	25.7	675,000	-0.8
Western Aleutian Islands golden king crab	23.7	628,332	30.2	799,000	21.5

[a] Excludes pot lifts targeting red king crabs.

[b] Computed as $(CPUE_{Obs} - CPUE_{ATF}) / CPUE_{ATF} \times 100$.

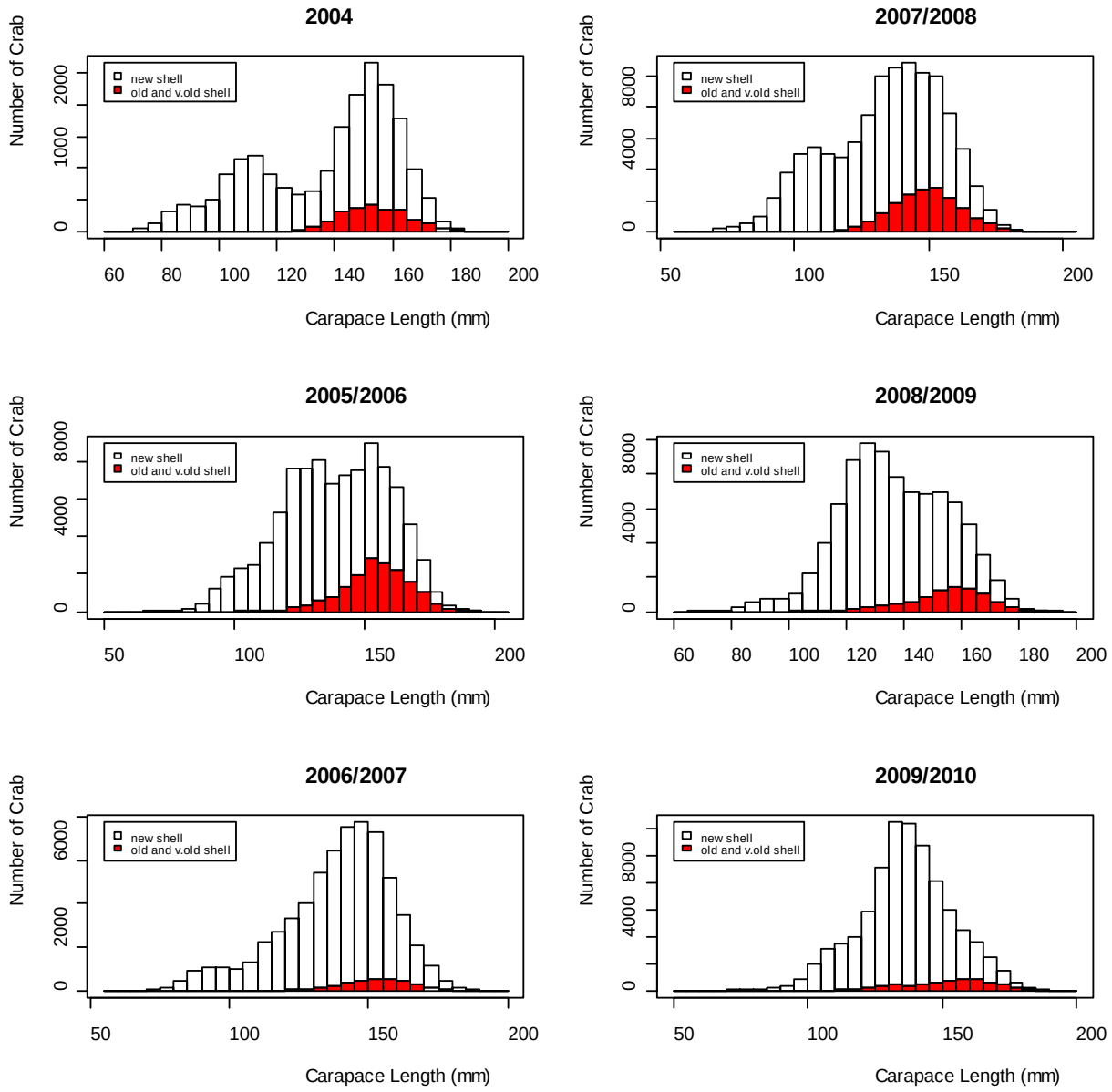

Figure 1.–Carapace length distribution with shell condition for male red king crabs from pot lifts sampled during the 2004–2009/2010 Bristol Bay red king crab fisheries.

Female Red King Crabs

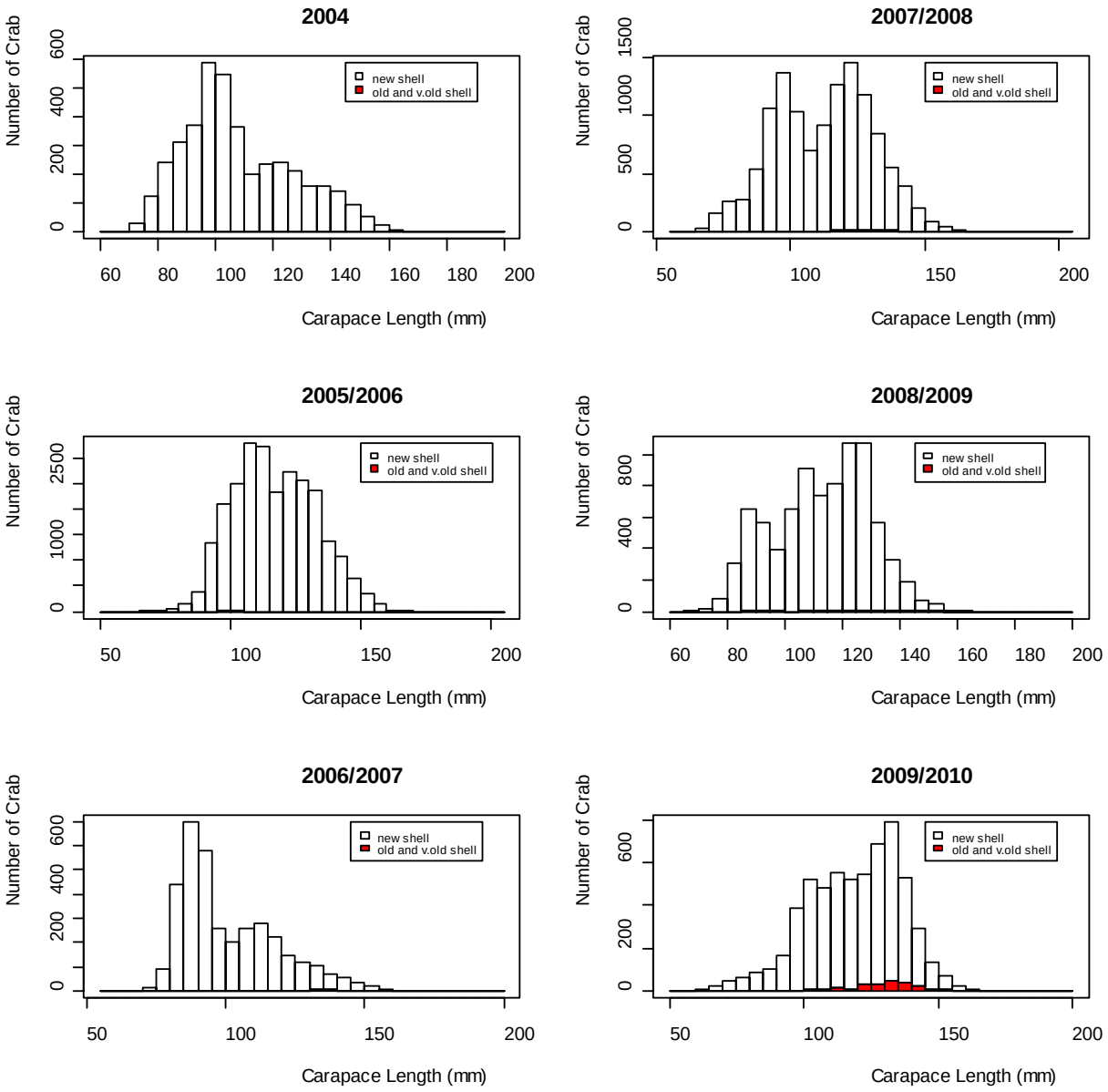

Figure 2.–Carapace length distribution with shell condition for female red king crabs from pot lifts sampled during the 2004–2009/2010 Bristol Bay red king crab fisheries.

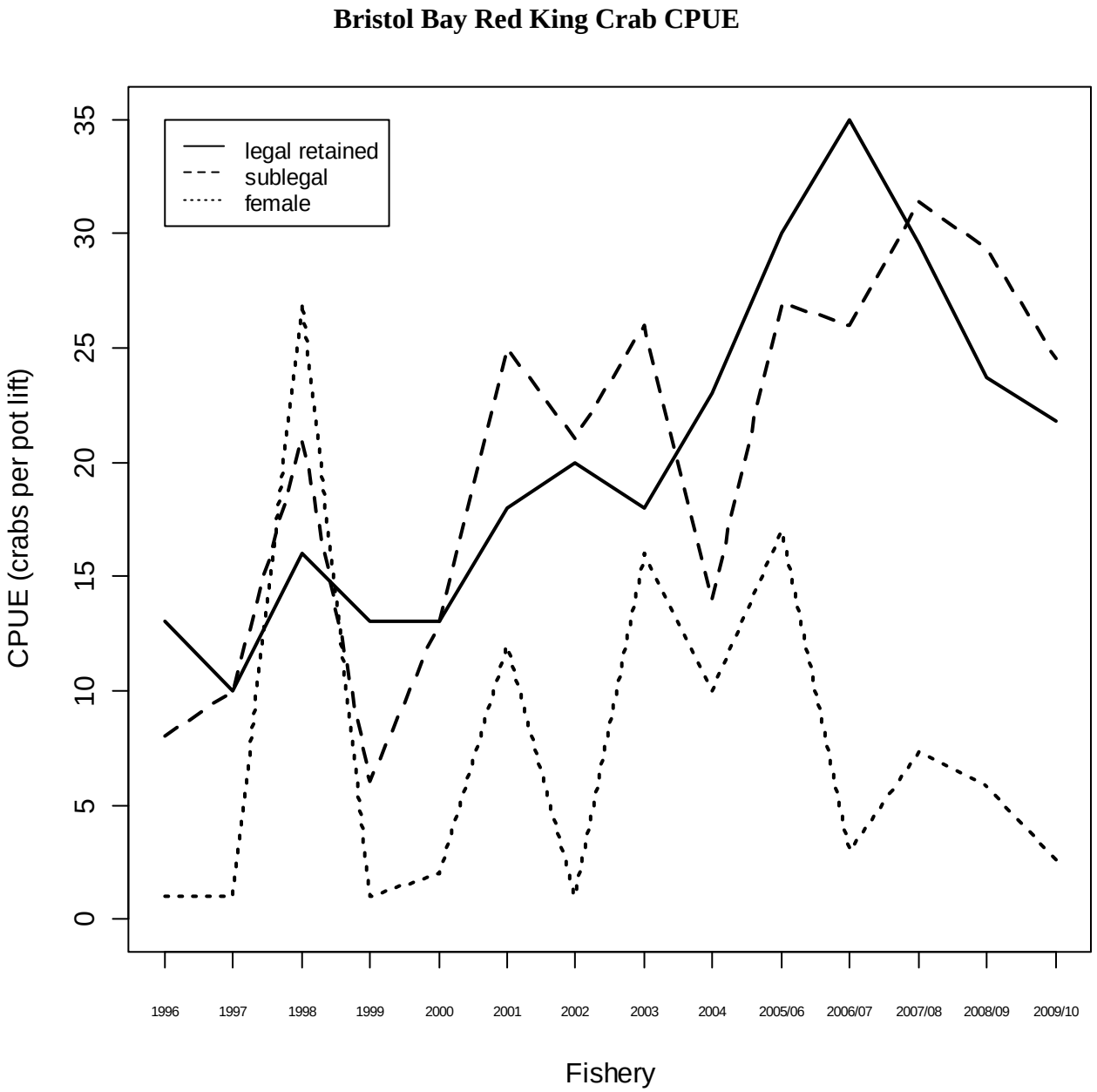

Figure 3.–Estimated CPUE of red king crabs from pot lifts sampled during the 1996–2009/2010 Bristol Bay red king crab fisheries.

Male Tanner Crabs

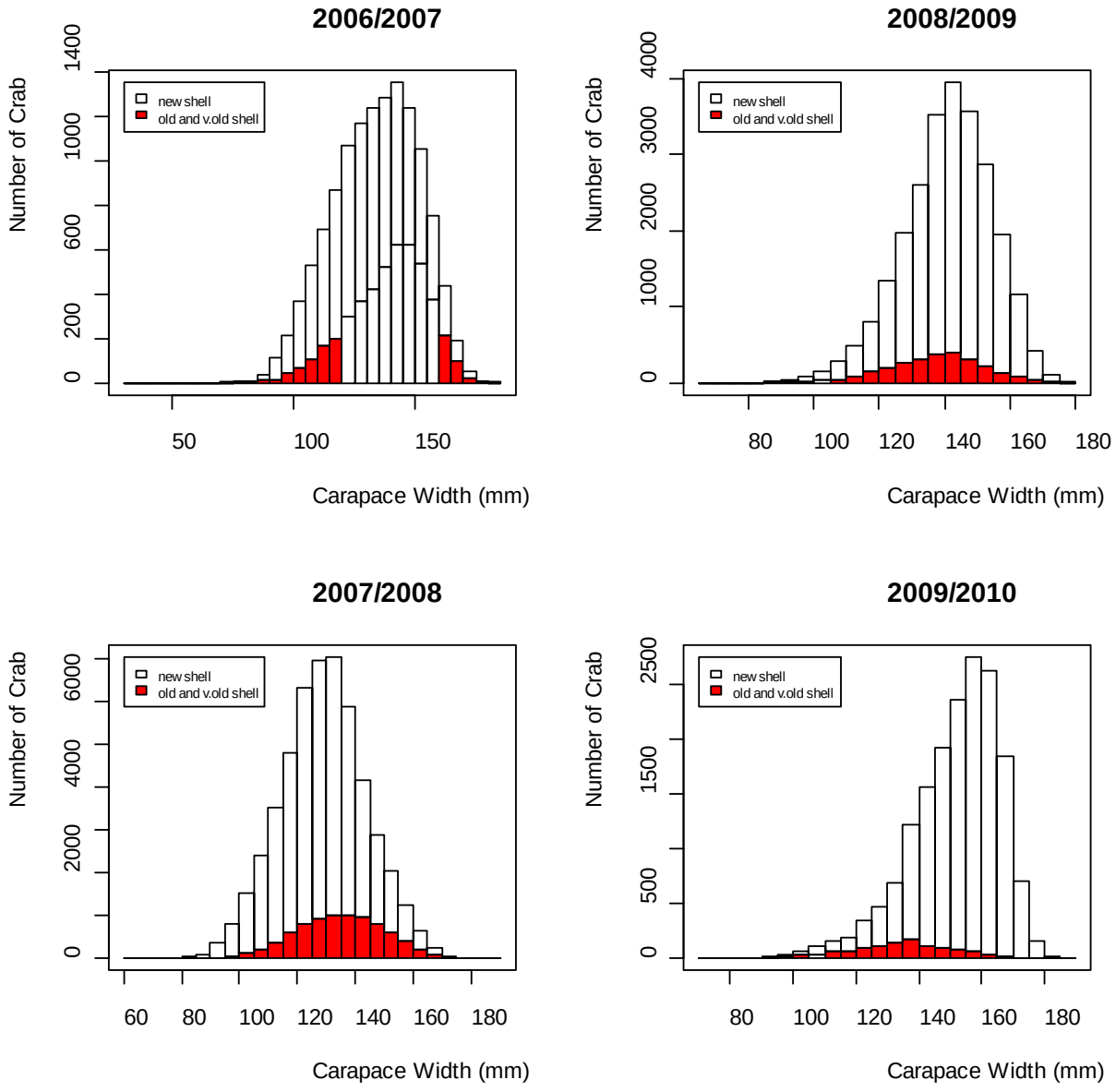

Figure 4.–Carapace width distribution with shell condition for male Tanner crab from pot lifts sampled during the 2006/2007–2009/2010 directed Bering Sea Tanner crab fisheries east of 166° W long.

Female Tanner Crabs

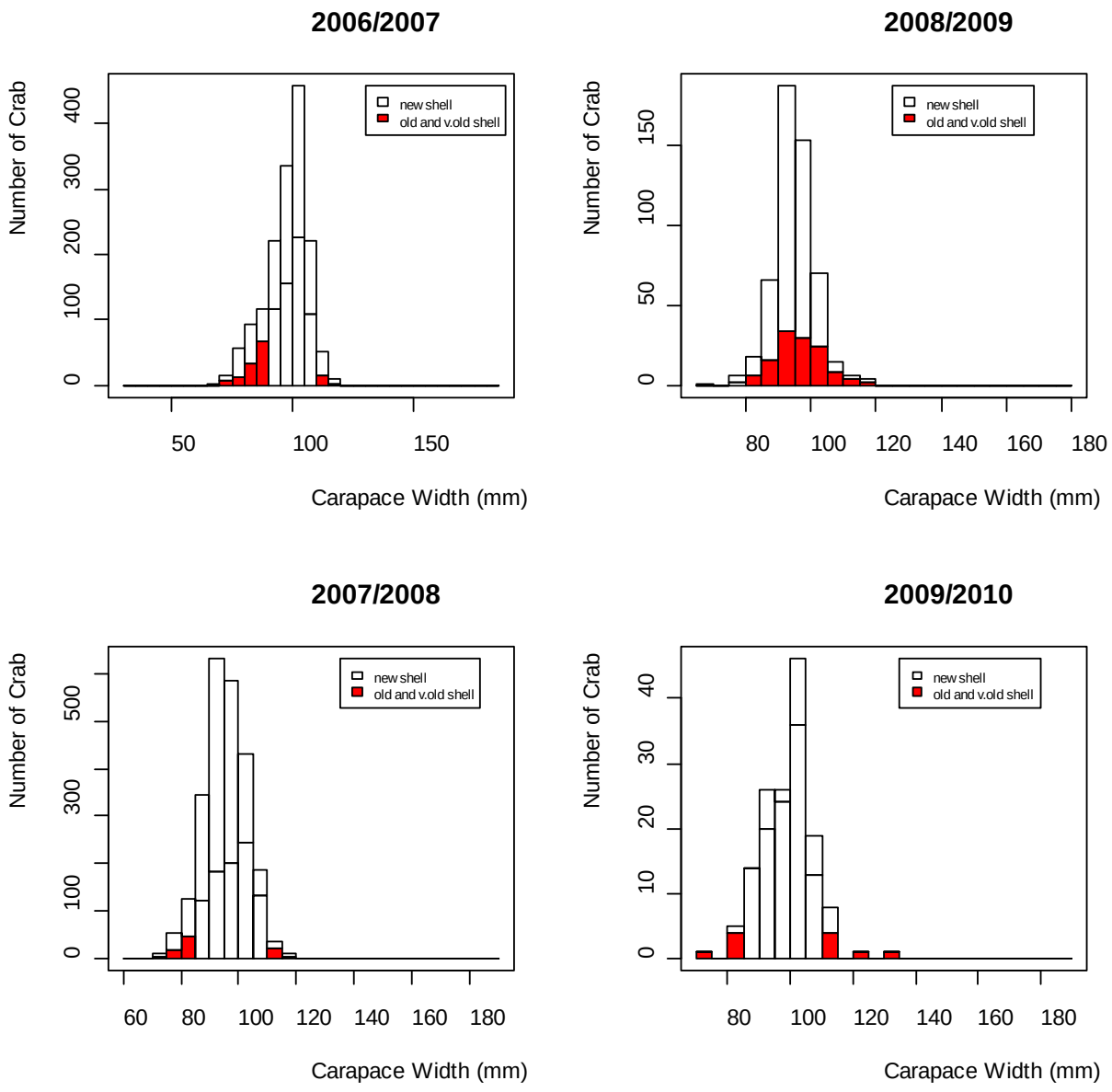

Figure 5.–Carapace width distribution with shell condition for female Tanner crabs from pot lifts sampled during the 2006/2007–2009/2010 directed Bering Sea Tanner crab fisheries east of 166° W long.

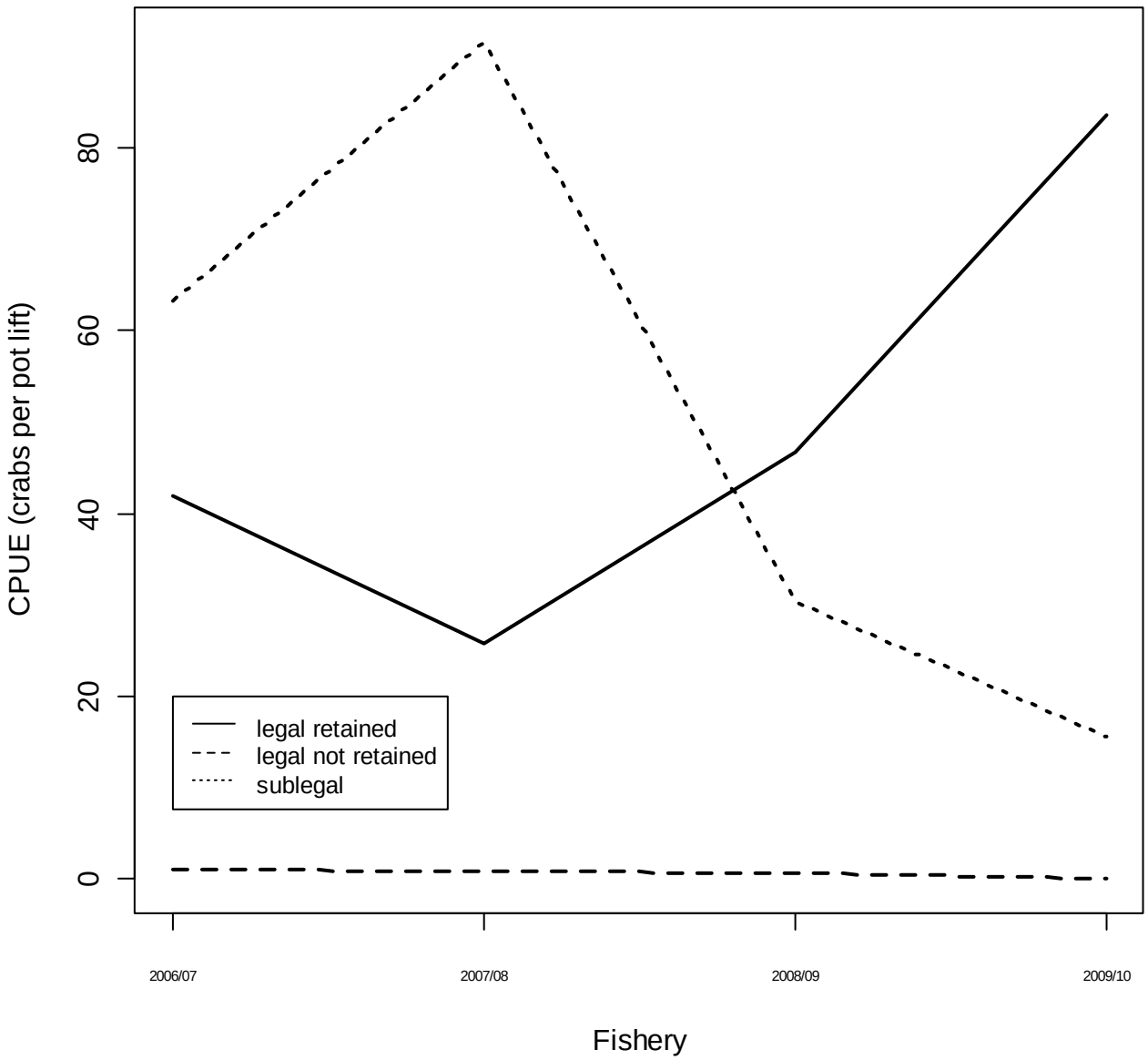

Figure 6.–Estimated CPUE of male Tanner crabs from pot lifts sampled during the 2006/2007–2009/2010 directed Bering Sea Tanner crab fisheries east of 166° W long.

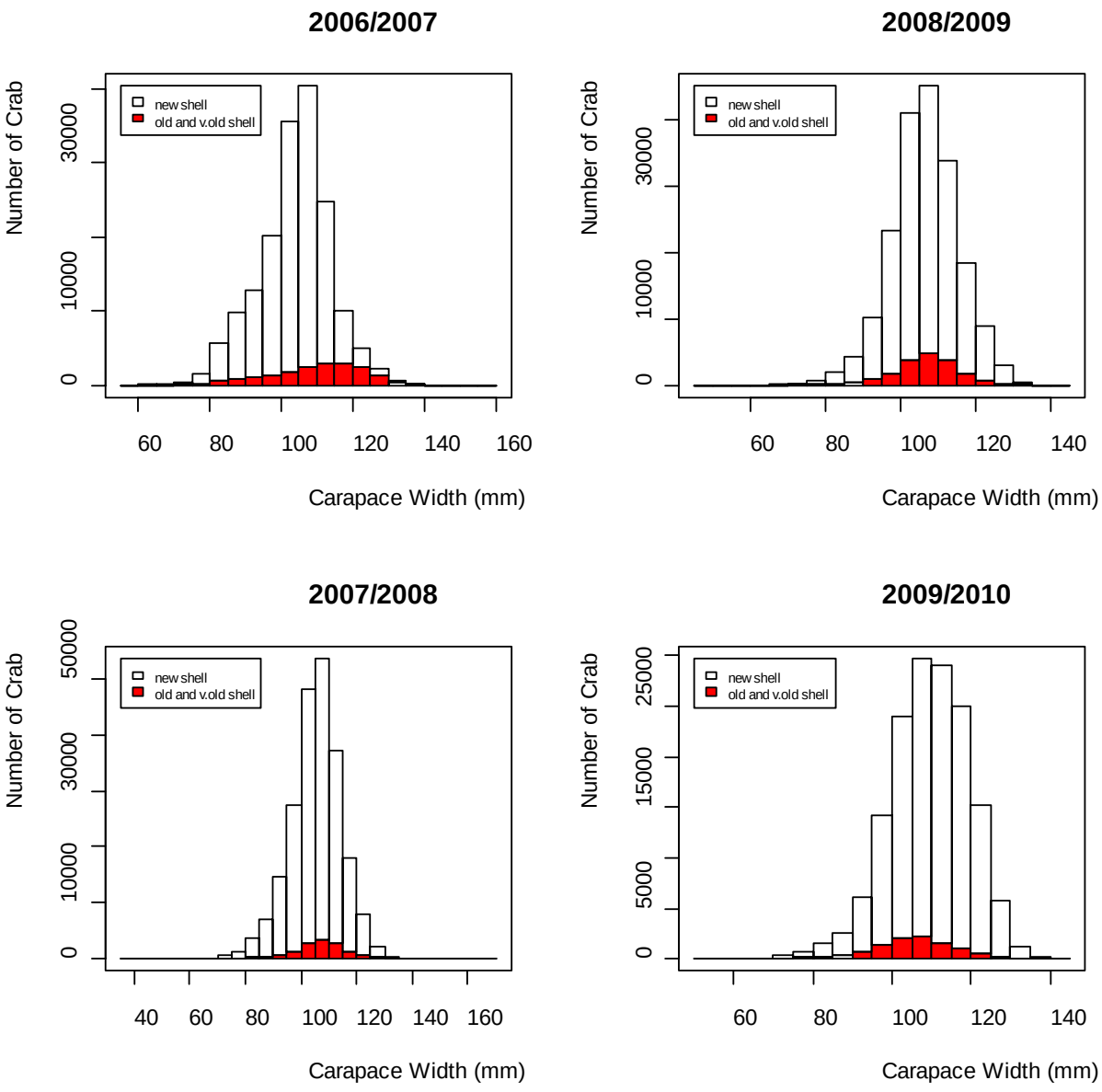

Figure 7.–Carapace width distribution with shell condition for male snow crabs from pot lifts sampled during the 2006/2007–2009/2010 Bering Sea snow crab fisheries.

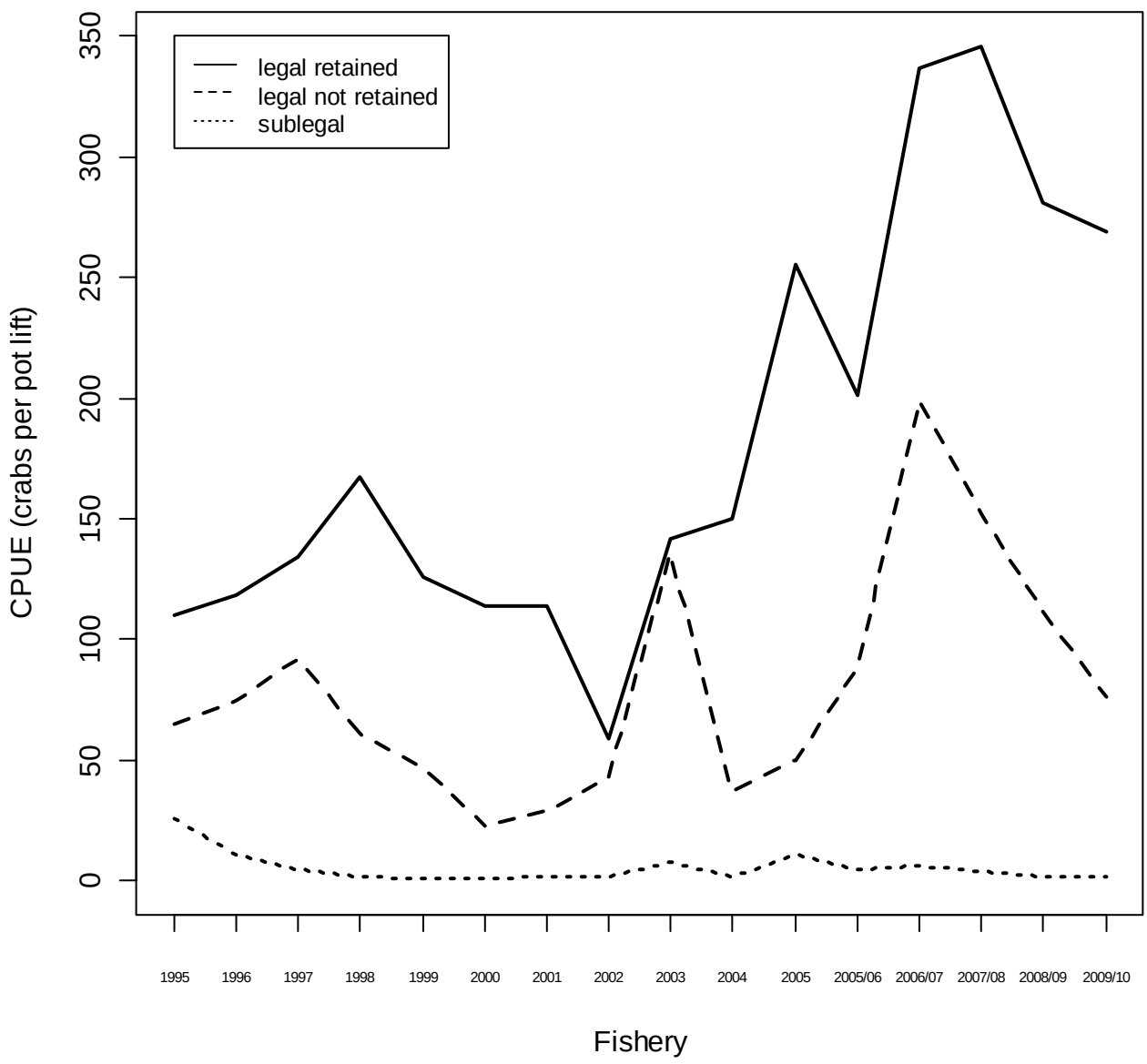

Figure 8.–Estimated CPUE of male snow crabs from pot lifts sampled during the 1995–2009/2010 Bering Sea snow crab fisheries.

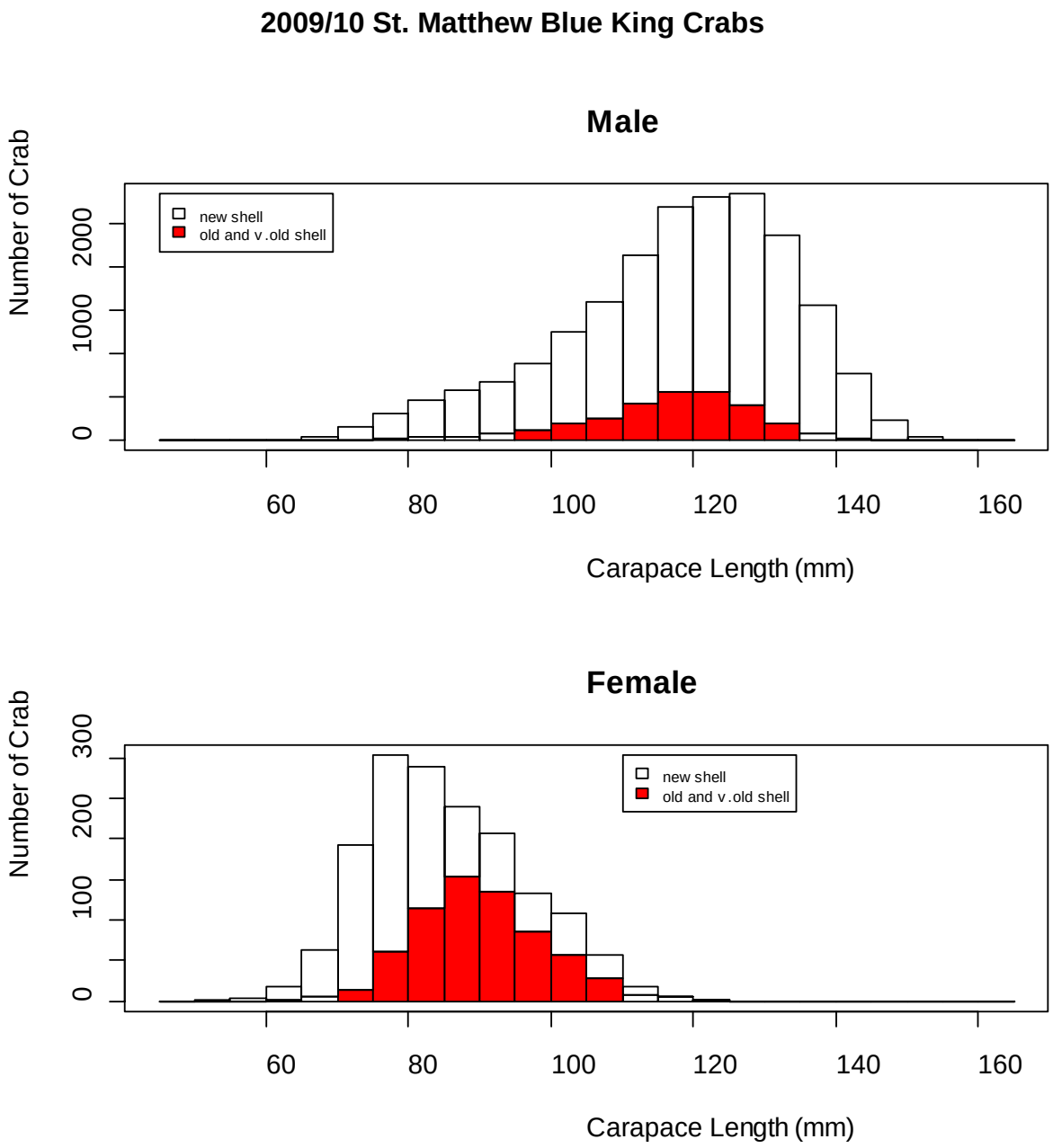

Figure 9.–Carapace width distribution with shell condition for male and female blue king crabs from pot lifts sampled during the 2009/2010 St. Mathew Island blue king crab fishery.

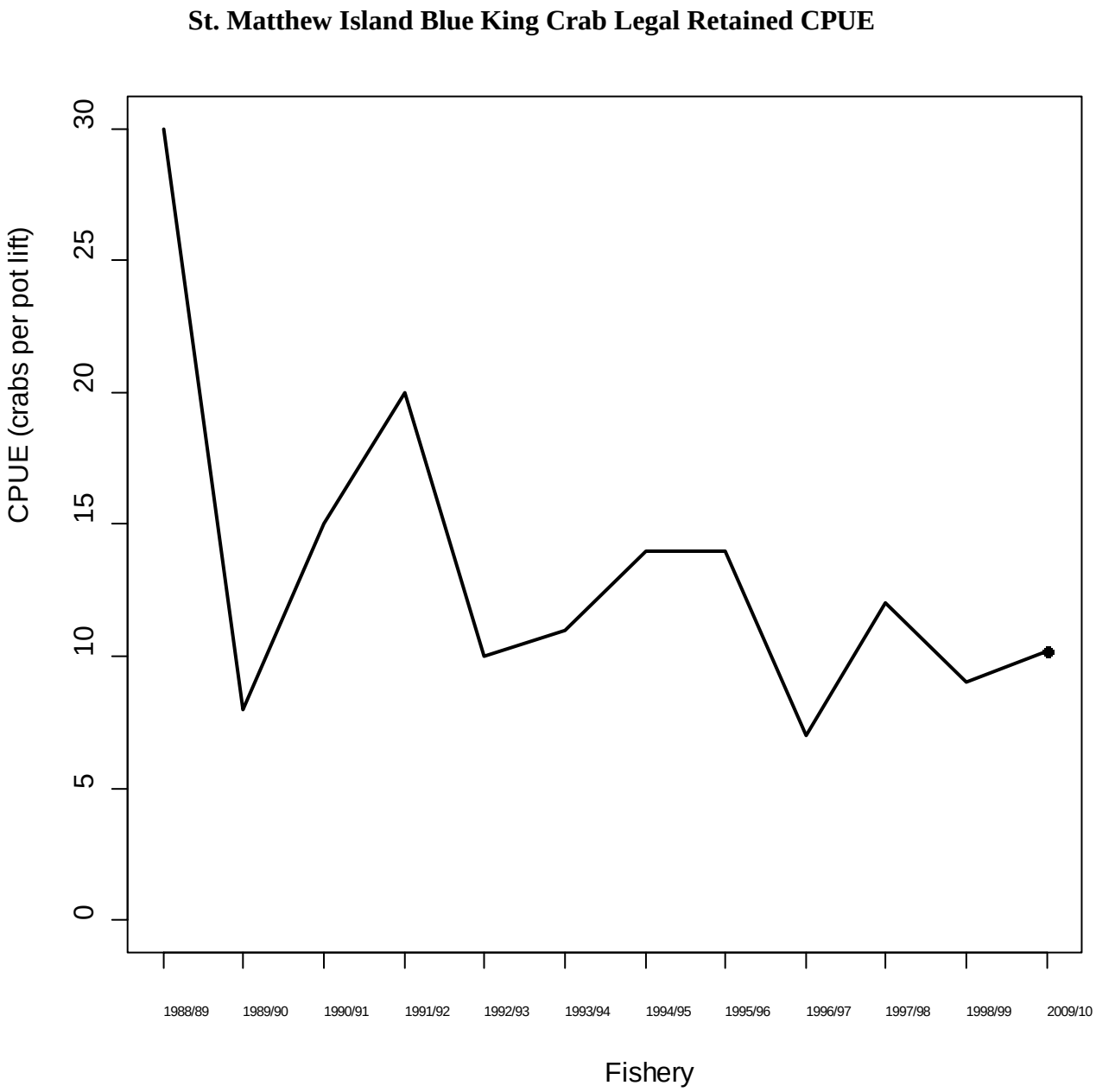

Figure 10.–Comparison of estimated 2009/2010 St. Matthew Island blue king crab fishery legal retained CPUE (right end point of trajectory) with historical ATF reported values. The fishery was closed for 10 years prior to the 2009/2010 season.

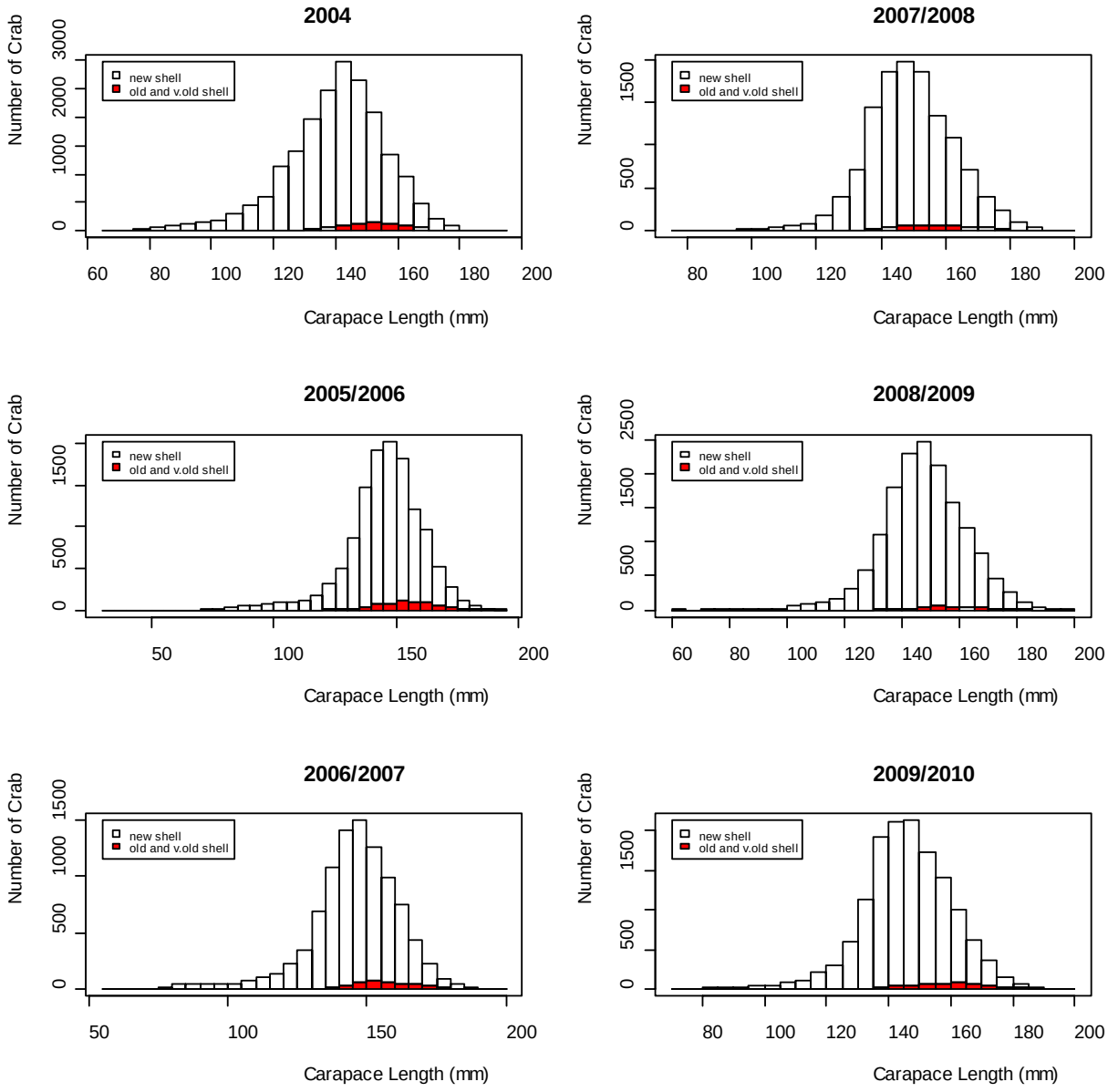

Figure 11.–Carapace length distribution with shell condition for male golden king crabs from pot lifts sampled during the 2004–2009/2010 Aleutian Islands golden king crab fisheries east of 174° W long.

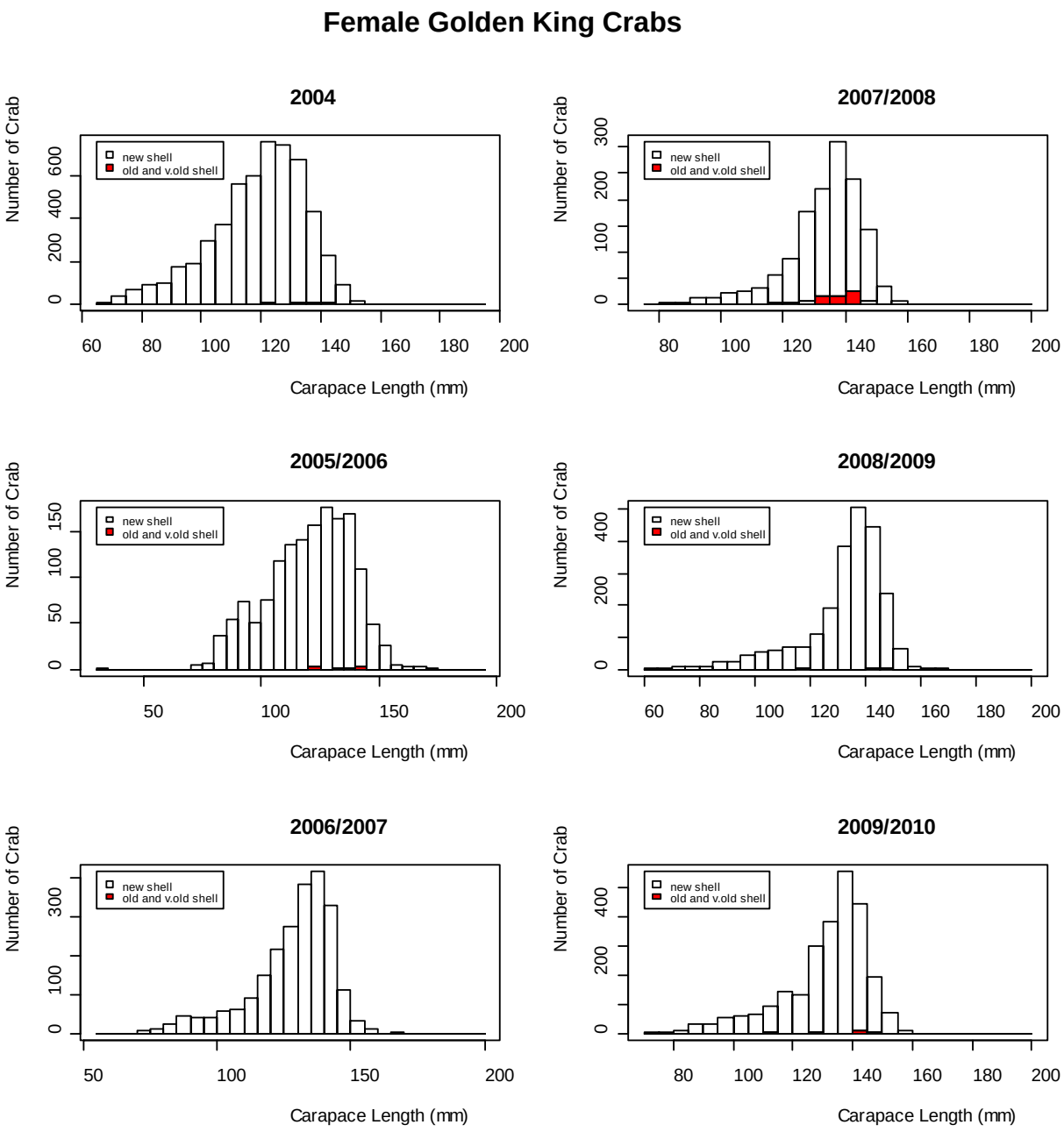

Figure 12.–Carapace length distribution with shell condition for female golden king crabs from pot lifts sampled during the 2004–2009/2010 Aleutian Islands golden king crab fisheries east of 174° W long.

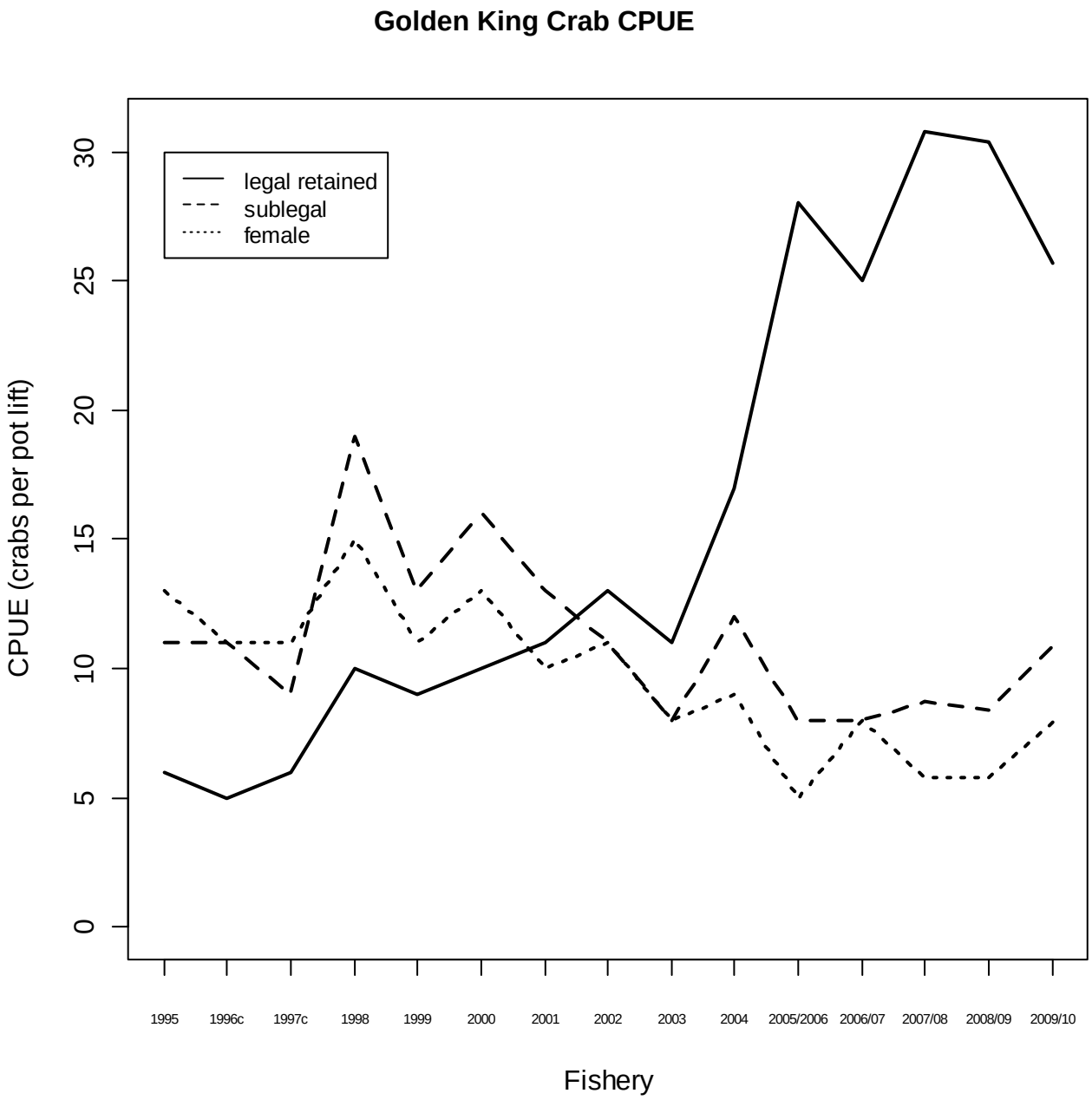

Figure 13.–Estimated CPUE of golden king crabs from pot lifts sampled during the 1995–2009/2010 Aleutian Islands golden king crab fisheries east of 174° W long. Note: 1996 and 1997 values are for the combined eastern and western fisheries.

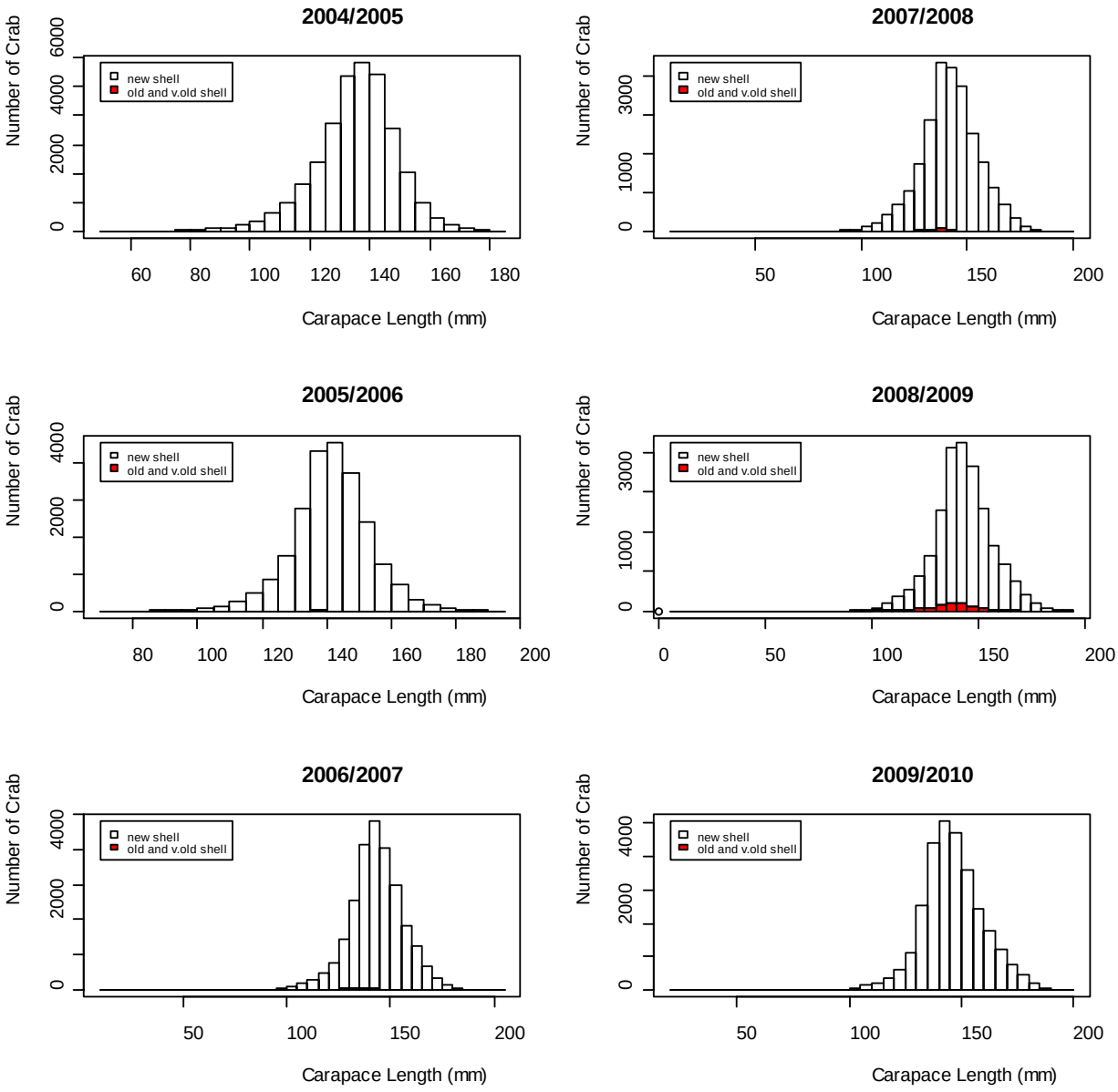

Figure 14.–Carapace length distribution with shell condition for male golden king crabs from pot lifts sampled during the 2004/2005–2009/2010 Aleutian Islands golden king crab fisheries west of 174° W long.

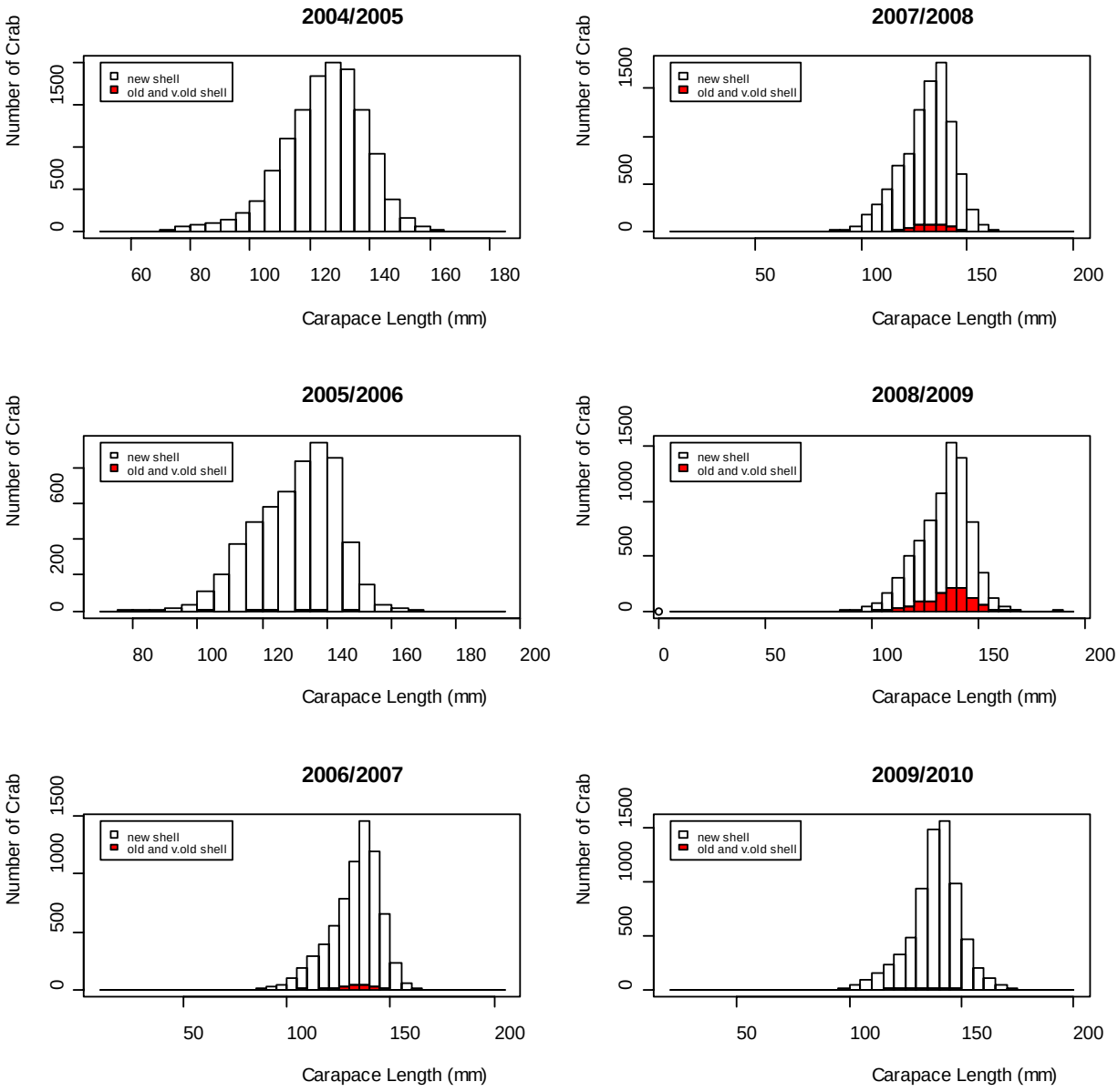

Figure 15.–Carapace length distribution with shell condition for female golden king crabs from pot lifts sampled during the 2004/2005–2009/2010 Aleutian Islands golden king crab fisheries west of 174° W long.

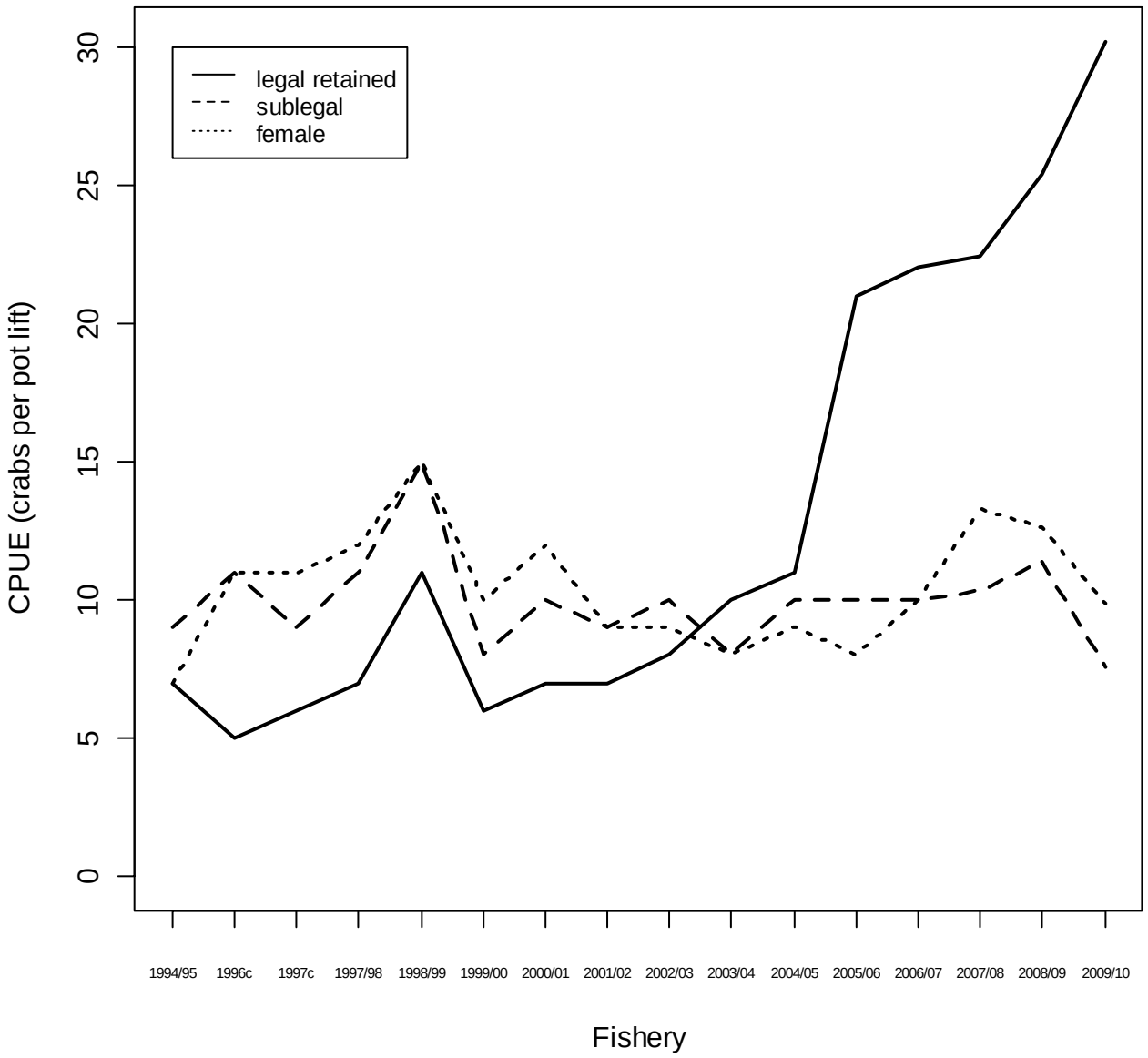

Figure 16.–Estimated CPUE of golden king crabs from pot lifts sampled during the 1994/1995–2009/2010 golden king crab fisheries west of 174° W long. Note: 1996 and 1997 values are for the combined eastern and western fisheries.

APPENDIX A. ESTIMATION OF CPUE FROM OBSERVER DATA

Appendix A1.–Estimation of CPUE from observer data and estimator precision.

Under the current sampling design, observed vessels are selected independently within each vessel type, as are randomly sampled pot lifts within each day fished by each observed vessel. We first consider vessels of a single type, e.g. catcher vessels. Let

M = number of vessels of given type (catcher-only or catcher-processor) in fishery

m = number of vessels within given type sampled for observation

D_j = number of days fished by vessel j

N_{jk} = number of pots lifted by vessel j on day k

N_j = total number of pots lifted by vessel j over all D_j days fished

N = total number of pots lifted by all vessels of the given type during fishery

c_{jkl} = number of crabs observed on vessel j on day k in sampled pot l

n_{jk} = number of pots sampled on vessel j on day k

$\bar{c}_{jk} = \frac{1}{n_{jk}} \sum_{l}^{n_{jk}} c_{jkl}$

= vessel j sample average number of crabs per pot on day k

Further, let τ_j = vessel j total catch over all pots and days fished. We want to estimate overall vessel type CPUE $\mu = \frac{\sum_{j}^{M} \tau_j}{\sum_{j}^{M} N_j}$ (vessel type total catch divided by total number of pot lifts) from the observer data $\{c_{jkl}\}$. Under independent simple random sampling of pots on each day on each vessel and stratifying by day, the usual stratified estimator of τ_j is

$$\hat{\tau}_j = \sum_{k}^{D_j} N_{jk} \bar{c}_{jk} \tag{1}$$

with variance estimator

$$\hat{V}[\hat{\tau}_j] = \sum_{k}^{D_j} N_{jk}^2 \hat{V}ar[\bar{c}_{jk}]$$

$$= \sum_{k}^{D_j} N_{jk}^2 \left(1 - \frac{n_{jk}}{N_{jk}}\right) \frac{1}{n_{jk}} \frac{\sum_{l}^{n_{jk}} (c_{jkl} - \bar{c}_{jk})^2}{n_{jk} - 1} \tag{2}$$

-continued-

by virtue of standard results. See, for example, Cochran (1977). Assuming a simple random sample *S* of *m* out of *M* vessels of the given type, an unbiased estimator of vessel type total catch τ is then simply

$$\hat{\tau} = \frac{M}{m}\sum_{j}^{m}\hat{\tau}_j\,, \tag{3}$$

since conditioning on *S* we have

$$\begin{aligned}
E[\hat{\tau}] &= E[\frac{M}{m}\sum_{j}^{m}\hat{\tau}_j] \\
&= E[E[\frac{M}{m}\sum_{j}^{m}\hat{\tau}_j \mid S]] \\
&= E[\frac{M}{m}\sum_{j}^{m}E[\hat{\tau}_j \mid S]] \\
&= E[\frac{M}{m}\sum_{j}^{m}\tau_j] \\
&= ME[\frac{1}{m}\sum_{j}^{m}\tau_j] \\
&= M\frac{1}{M}\sum_{j}^{M}\tau_j \\
&= \sum_{j}^{M}\tau_j \\
&= \tau\,.
\end{aligned}$$

Its variance, which may also be obtained by conditioning on the initial sample of vessels, is given by $Var[\hat{\tau}] = M^2(1-\frac{m}{M})\frac{1}{m}\frac{\sum_{j}^{M}(\tau_j-\bar{\tau})^2}{M-1} + \frac{M}{m}\sum_{j}^{M}Var[\hat{\tau}_j]$, where $\bar{\tau}$ denotes the mean of the τ_j. An unbiased estimate of this variance is

$$\hat{Var}[\hat{\tau}] = M^2(1-\frac{m}{M})\frac{1}{m}\frac{\sum_{j}^{m}(\hat{\tau}_j-\bar{\hat{\tau}})^2}{m-1} + \frac{M}{m}\sum_{j}^{m}Var[\hat{\tau}_j] \tag{4}$$

with $\bar{\hat{\tau}} = \frac{1}{m}\sum_{j}^{m}\hat{\tau}_j$, the average of the observed vessel estimated total catches (Cochran 1977,

-continued-

Theorem 11.2). Note that if all vessels of the given type are sampled, as is typically true of the catcher/processor fleet, this reduces to $\hat{Var}[\hat{\tau}] = \sum_{j}^{m=M} Var[\hat{\tau}_j]$. On the other hand, since fishery pot lift totals N_j for each observed vessel are in principle known, an unbiased estimate of the vessel type total number of pot lifts is the simple expansion estimator

$$\hat{\lambda} = \frac{M}{m}\sum_{j}^{m} N_j \tag{5}$$

with unbiased variance estimator

$$\hat{Var}[\hat{\lambda}] = M^2(1-\frac{m}{M})\frac{1}{m}\frac{\sum_{j}^{m}(N_j - \overline{N})}{m-1}, \tag{6}$$

where $\overline{N}$ is the N_j sample mean, again in accordance with basic results.

For the combined fishery, given estimates $\hat{\tau}_C$ and $\hat{\tau}_{CP}$ of catcher vessel and catcher-processor vessel total catch, an estimate of overall fishery total catch τ_F is simply their sum

$$\hat{\tau}_F = \hat{\tau}_C + \hat{\tau}_{CP}, \tag{7}$$

and under the assumption that sampling of vessels within each type occurs independently, an estimate of its variance is

$$\hat{Var}[\hat{\tau}_F] = \hat{Var}[\hat{\tau}_C] + \hat{Var}[\hat{\tau}_{CP}]. \tag{8}$$

Both of these estimators inherit unbiasedness from their components. In the same way, an estimate of the overall fishery total number of pot lifts and an estimate of its variance are given by

$$\hat{\lambda}_F = \hat{\lambda}_C + \hat{\lambda}_{CP} \tag{9}$$

and

$$\hat{Var}[\hat{\lambda}_F] = \hat{Var}[\hat{\lambda}_C] + \hat{Var}[\hat{\lambda}_{CP}], \tag{10}$$

likewise unbiased under unbiasedness of the individual vessel type estimators. Overall fishery CPUE can then be estimated using the ratio estimator

$$\hat{\mu} = \frac{\hat{\tau}_F}{\hat{\lambda}_F}. \tag{11}$$

To obtain an approximate variance for (11) we first expand it in a first order Taylor series around

-continued-

$\mu = \frac{\tau_F}{\lambda_F}$ as $\hat{\mu} \cong \mu + \frac{1}{\lambda_F}(\hat{\tau}_F - \tau_F) - \frac{\tau_F}{\lambda_F^2}(\hat{\lambda}_F - \lambda_F)$. Since vessels are selected independently within the two vessel types, taking variances and rearranging things results in

$$\hat{Var}[\hat{\mu}] \cong \frac{M_C^2}{m_C^2} Var[\sum_j^{m_C}(\frac{1}{\lambda_F}\hat{\tau}_j^C - \frac{\tau_F}{\lambda_F^2}N_j^C)] + \frac{M_{CP}^2}{m_{CP}^2} Var[\sum_j^{m_{CP}}(\frac{1}{\lambda_F}\hat{\tau}_j^{CP} - \frac{\tau_F}{\lambda_F^2}N_j^{CP})]. \quad (12)$$

The variances on the right side of (12) can be evaluated by conditioning on the initial simple random sample *S* of vessels within each type. Ignoring for the moment the particular vessel type, this procedure leads to

$$\begin{aligned} Var[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j)] &= Var[E[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j) \mid S]] + E[Var[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j) \mid S]] \\ &= Var[\sum_j^m(\frac{1}{\lambda_F}E[\hat{\tau}_j \mid S] - \frac{\tau_F}{\lambda_F^2}N_j)] + E[\sum_j^m \frac{1}{\lambda_F^2}Var[\hat{\tau}_j \mid S]] \\ &= Var[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j)] + E[\sum_j^m \frac{1}{\lambda_F^2}Var[\hat{\tau}_j] \\ &= m(1-\frac{m}{M})\frac{\sum_j^M (q_j - \bar{q})^2}{M-1} + \frac{m}{M\lambda_F^2}\sum_j^M Var[\hat{\tau}_j], \end{aligned} \quad (13)$$

where $q_j = \frac{1}{\lambda_F}\tau_j - \frac{\tau_F}{\lambda_F^2}N_j$ and $\bar{q} = \frac{1}{M}\sum_j^M q_j$. Appropriate double substitution of (13) into the right side of (12) then gives

$$\begin{aligned} Var[\hat{\mu}] \cong{}& \frac{M_C^2}{m_C}(1-\frac{m_C}{M_C})S_{qC}^2 + \frac{M_C}{m_c\lambda_F^2}\sum_j^{M_C} Var[\hat{\tau}_j^C] \\ &+ \frac{M_{CP}^2}{m_{CP}}(1-\frac{m_{CP}}{M_{CP}})S_{qCP}^2 + \frac{M_{CP}}{m_{CP}\lambda_F^2}\sum_j^{M_{CP}} Var[\hat{\tau}_j^{CP}], \end{aligned} \quad (14)$$

where S_{qC}^2 and S_{qCP}^2 denote the population variances of the quantities q_j^C and q_j^{CP}. Upon replacing these with their sample analogues s_{qC}^2 and s_{qCP}^2 and substituting the estimators determined by (2) for $Var[\hat{\tau}_j^C]$ and $Var[\hat{\tau}_j^{CP}]$ and those in (3) and (5) for τ_F and λ_F, we obtain the variance estimator

$$\hat{Var}[\hat{\mu}] = \frac{M_C^2}{m_C}(1-\frac{m_C}{M_C})s_{qC}^2 + \frac{M_C}{m_c\hat{\lambda}_F^2}\sum_j^{m_C}\hat{Var}[\hat{\tau}_j^C] + \frac{M_{CP}^2}{m_{CP}}(1-\frac{m_{CP}}{M_{CP}})s_{qCP}^2 + \frac{M_{CP}}{m_{CP}\hat{\lambda}_F^2}\sum_j^{m_{CP}} Var[\hat{\tau}_j^{CP}]. \quad (15)$$

-continued-

It should be noted that the overall totals τ_F and λ_F are used in defining the quantities q_j^C and q_j^{CP} and so (3) and (5) are to be used in estimating the latter. With (11) and (15) in hand an approximate $100(1-2\alpha)$ percent confidence interval for overall fishery CPUE μ is

$$\hat{\mu} \pm t_{df,\alpha} \sqrt{\hat{V}ar[\hat{\mu}]}\,, \tag{16}$$

where $t_{df,\alpha}$ denotes the $100(1-\alpha)^{\text{th}}$ percentile of the *t*-distribution on *df* degrees of freedom. In general, we take $df = m_C - 1$, unless all catcher-only vessels are observed, in which case we use the standard normal distribution to determine an appropriate multiplier, i.e. we put $df = \infty$. (Recall that m_C is the number of observed catcher-only vessels in the directed fishery.) Small sample sizes at some levels of the design, underlying skewed pot count distributions, theoretical bias of the ratio estimator and the use of an approximate variance admittedly give reason for concern about the applicability of standard asymptotic confidence intervals, and future investigation is warranted. Nevertheless, we believe this approach is reasonable and likely conservative rather than otherwise.

As a final note we remark that if the total number of pot lifts λ_F is in fact known, the unbiased estimator

$$\hat{\mu}_u = \frac{\hat{\tau}_F}{\lambda_F} \tag{17}$$

is a natural candidate for estimating fishery CPUE, and an estimate of its variance is easily obtained from (8). However, though ratio estimators such as (11) are in general not design unbiased, in some applications they can perform well in the sense of having smaller mean square error (MSE) than their unbiased counterparts (Lohr 1999, p. 151). For the application at hand we expect vessel catch and vessel pot lift totals to be highly positively correlated and hence that (11) should provide reasonable estimates of the target parameter. Moreover, (11) is robust to undercoverage resulting from failure to sample pots on all days fished by a vessel selected for observation, so long as sampled pots and observed daily pot-lift totals are mostly representative of those on unobserved days. The unbiased estimator (17) decidedly lacks this sort of robustness, and we note that significant undercoverage of the type described can occur, especially in the Aleutian Islands golden king crab fishery. It should also be observed that although fishery pot lift totals λ_F, as well as λ_C and λ_{CP}, are routinely extracted from fish ticket data, some uncertainty is associated with these values. More importantly, neither that uncertainty nor its relationship to the observer-collected data is readily quantified, rendering problematic the inferential usefulness of those values in this context.

APPENDIX B. LOCATIONS OF SAMPLED POT LIFTS

Appendix B1.–Locations of pot lifts sampled by observers during the 2009/2010 Bristol Bay red king crab fishery.

CONFIDENTIAL

Appendix B2.–Locations of pot lifts sampled by observers during the 2009/2010 directed Bering Sea Tanner crab fishery east of 166° W long.

CONFIDENTIAL

Appendix B3.–Locations of pot lifts sampled by observers during the 2009/2010 Bering Sea snow crab fishery.

CONFIDENTIAL

Appendix B4.–Locations of pot lifts sampled by observers during the 2009/2010 St. Matthew blue king crab fishery.

CONFIDENTIAL

Appendix B5.–Locations of pot lifts sampled by observers during the 2009/2010 Aleutian Islands golden king crab fishery east of 174° W long.

CONFIDENTIAL

Appendix B6.–Locations of pot lifts sampled by observers during the 2009/2010 Aleutian Islands golden king crab fishery west of 174° W long.

CONFIDENTIAL

APPENDIX C. ADDITIONAL CATCH AND BIOLOGICAL SUMMARIES

Appendix C1.–Total contents of 1,950 pot lifts sampled during the 2009/2010 Bristol Bay red king crab fishery.

Commercial crab species	Total catch	Other species	Total catch
red king crab		yellowfin sole	1,143
legal	43,593	starfish unident.	725
sublegal	49,023	jellyfish unident.	406
female	6,050	Pacific cod	241
Tanner crab		snail unident.	186
legal	2,162	sculpin unident.	158
sublegal	724	tunicate unident.	92
female	70	great sculpin	66
snow crab		Pacific halibut	50
legal	307	starry flounder	40
sublegal	3	hermit crab unident.	23
female	0	hairy triton (or Oregon triton)	20
hybrid *C. bairdi*		sponge unident.	18
legal	0	Pacific lyre crab	17
sublegal	4	sea cucumber unident.	16
female	0	basket star	14
blue king crab		flatfish unident.	6
legal	1	arrowtooth flounder	5
sublegal	0	sea anemone unident.	5
female	1	yellow Irish lord	5
hair crab		crab unident.	4
legal	16	snailfish unident.	4
sublegal	3	giant octopus	3
female	4	Alaska plaice	2
		mussel unident.	2
		rock sole unident.	2
		sand dollar unident.	2
		scallop unident.	2
		walleye pollock	2
		Coral unident.	1
		graceful decorator crab	1
		rockfish unident.	1
		sea urchin unident.	1
		sea whip unident.	1
		shrimp unident.	1
		skate unident.	1

Appendix C2.–Red king crab CPUE by soak time for 1,950 pot lifts sampled during the 2009/2010 Bristol Bay red crab fishery.

Soak time[a] (hours)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
0-11	0.3	2.4	0.0	4.4	0.0	6.8
12-23	3.0	18.3	1.8	25.4	3.1	48.6
24-35	14.6	16.5	0.3	23.1	2.0	42.0
36-47	33.9	20.2	0.6	25.1	3.0	49.1
48-59	18.8	22.2	0.5	27.6	1.8	52.1
60-71	7.0	23.3	1.2	25.2	4.2	54.0
72-83	1.9	21.6	1.8	21.7	12.2	57.4
84-95	2.8	25.8	0.1	25.5	7.2	58.6
96-107	3.8	23.5	0.0	30.3	7.5	61.3
108-119	2.7	27.7	0.1	28.0	2.0	57.8
120-131	2.8	30.9	0.1	25.4	1.8	58.1
132-143	1.7	29.0	3.0	28.4	2.0	62.3
144-155	1.8	29.6	3.7	23.5	0.8	57.7
156-167	1.1	35.0	0.6	19.7	1.3	56.6
168-179	1.0	22.7	0.8	12.9	1.3	37.8
180-191	0.7	23.7	1.3	18.8	10.1	53.8
192-203	0.5	19.2	0.3	10.9	5.4	35.9
204-215	0.3	42.0	7.5	34.2	0.2	83.8
216-227	0.9	24.3	0.2	16.9	1.2	42.6
228-239	0.1	36.0	0.0	16.0	0.0	52.0
240-251	0.1	5.0	0.0	2.5	36.5	44.0
360-371	0.2	36.7	0.0	14.0	0.0	50.7

[a] Average soak time was 62 hours.

Appendix C3.–Red king crab CPUE by depth for 1,950 pot lifts sampled during the 2009/2010 Bristol Bay red king crab fishery.

Depth[a] (fathoms)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
20-24	0.1	40.0	0.0	83.0	0.0	123.0
25-29	1.4	19.1	0.2	32.7	1.4	53.4
30-34	12.8	20.9	0.8	24.0	6.2	51.9
35-39	18.6	22.3	1.8	25.0	5.8	54.9
40-44	25.8	21.5	0.8	24.0	2.5	48.9
45-49	29.9	22.1	0.2	28.3	1.7	52.3
50-54	11.3	20.1	0.1	19.8	0.5	40.4
55-59	0.1	76.0	0.0	22.0	0.0	98.0

[a] Average depth was 42 fathoms.

Appendix C4.–Reproductive condition of female red king crabs from pot lifts sampled during the 1996–2009/2010 Bristol Bay red king crab fisheries.

Year	Crab sampled	Percent			
		Eyed eggs	Uneyed eggs	Barren, mated	Barren, non-mated
1996	11	0.0	0.0	0.0	100.0
1997	70	65.7	18.6	0.0	15.7
1998	4,091	45.6	51.8	<0.1	2.6
1999	36	0.0	86.1	2.8	11.1
2000	1,486	4.0	22.3	0.5	73.2
2001	4,574	66.0	18.7	0.3	15.0
2002	311	32.1	2.6	0.6	64.6
2003	10,391	9.1	51.5	3.4	35.9
2004	4,111	21.4	48.4	0.6	29.6
2005/2006	26,753	41.3	45.0	0.2	13.4
2006/2007	3,586	16.5	32.5	1.4	49.5
2007/2008	12,451	41.0	41.0	1.7	22.9
2008/2009	8,486	50.5	27.8	1.1	20.6
2009/2010	6,049	17.2	71.4	1.0	10.2

Appendix C5.–Total contents of 354 pot lifts sampled during the 2009/2010 directed Bering Sea Tanner crab fishery east of 166° W long.

Commercial crab species	Total catch	Other species	Total catch
Tanner crab		starfish unident.	2,051
legal	27,615	snail unident.	523
sublegal	5,604	yellowfin sole	406
female	452	Pacific cod	56
snow crab		jellyfish unident.	43
legal	371	hermit crab unident.	17
sublegal	15	octopus unident.	14
female	0	giant octopus	12
hybrid *C. opilio*		Pacific halibut	7
legal	1	sea anemone unident.	4
sublegal	0	flathead sole	3
female	0	hairy triton (or Oregon triton)	3
red king crab		Pacific lyre crab	3
legal	32	sand dollar unident.	3
sublegal	54	starry flounder	3
female	141	yellow Irish lord	3
Dungeness crab		sculpin unident.	2
legal	7	sea urchin unident.	2
sublegal	0	arrowtooth flounder	1
female	1	bivalve unident.	1
hair crab		butter sole	1
legal	4	flatfish unident.	1
sublegal	0	great sculpin	1
female	0	Pribilof neptune (or Pribilof whelk)	1
		tunicate unident.	1

Appendix C6.–Tanner crab CPUE by soak time for 354 pot lifts sampled during the 2009/2010 directed Bering Sea Tanner crab fishery east of 166° W long.

Soak time[a] (hours)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
12-23	9.1	52.1	0.2	12.0	1.8	66.1
24-35	28.3	63.7	0.0	16.6	2.0	82.3
36-47	30.3	92.0	0.5	17.2	0.6	110.2
48-59	9.1	52.4	0.3	8.1	0.1	60.9
60-71	3.1	90.4	0.0	18.4	1.0	109.7
72-83	4.3	90.4	0.3	17.7	1.5	109.9
84-95	2.6	68.8	15.3	8.2	3.7	96.0
96-107	2.0	96.4	0.6	4.6	0.0	101.6
108-119	2.9	113.0	0.2	5.8	0.0	119.0
120-131	3.1	106.1	0.2	46.3	4.4	156.9
132-143	2.6	99.9	0.3	8.9	0.0	109.1
144-155	0.9	92.3	0.3	36.0	1.7	130.3
156-167	0.3	134.0	1.0	46.0	7.0	188.0
192-203	0.3	48.0	2.0	6.0	0.0	56.0
204-215	0.6	58.0	1.0	4.5	0.0	63.5
240-251	0.6	64.0	2.5	3.5	0.0	70.0

[a] Average soak time was 52 hours.

Appendix C7.–Tanner crab CPUE by depth for 354 pot lifts sampled during the 2009/2010 directed Bering Sea Tanner crab fishery east of 166° W long.

Depth[a] (fathoms)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
20-24	2.8	67.7	0.0	8.0	0.0	75.7
25-29	24.3	92.3	0.3	12.7	0.2	105.6
30-34	28.8	95.6	2.1	18.8	0.7	117.2
35-39	4.0	28.1	0.0	2.9	2.4	33.3
40-44	7.9	64.9	0.1	2.9	0.0	68.0
45-49	15.0	56.9	0.3	5.8	0.3	63.2
50-54	17.2	61.6	0.0	34.1	5.1	100.9

[a] Average depth was 37 fathoms.

Appendix C8.–Reproductive condition of female Tanner crabs from pot lifts sampled during the 2006/2007–2009/2010 directed Bering Sea Tanner crab fisheries east of 166° W long.

Year	Crab sampled	Percent			
		Eyed eggs	Uneyed eggs	Barren, mated	Barren, non-mated
2006/2007	1,573	95.6	2.9	0.8	0.6
2007/2008	2,416	27.9	68.5	1.9	1.2
2008/2009	536	20.1	78.4	0	1.5
2009/2010	147	8.2	87.8	0.7	2.7

Appendix C9.–Total contents of 1,646 pot lifts sampled during the 2009/2010 Bering Sea snow crab fishery.

Commercial crab species	Total catch	Other species	Total catch
snow crab		snail unident.	7,251
legal	555,668	Pacific cod	545
sublegal	3,184	Neptune snail unident.	140
female	1,288	hairy triton (or Oregon triton)	117
Tanner crab		basket star	79
legal	1,346	sea anemone unident.	73
sublegal	35,296	yellow Irish lord	45
female	1,170	hermit crab unident.	44
hybrid *C. bairdi*		Pacific halibut	37
legal	420	starfish unident.	34
sublegal	1,044	sculpin unident.	24
female	0	Pacific lyre crab	17
hybrid *C. opilio*		walleye pollock	11
legal	180	octopus unident.	9
sublegal	0	yellowfin sole	9
female	3	jellyfish unident.	7
Tanner crab unident.		skate unident.	7
legal	0	giant octopus	6
sublegal	2,857	arrowtooth flounder	3
female	0	brittle star unident.	3
		flathead sole	3
		sea urchin unident.	3
		Pacific ocean perch	2
		prowfish	2
		rockfish unident.	2
		Atka mackerel	1
		bigmouth sculpin	1
		Greenland halibut (or Greenland turbot)	1
		northern rockfish	1
		rock sole unident.	1
		sea cucumber unident.	1
		sea pen or sea whip unident.	1
		sea pen unident.	1
		searcher	1
		sea whip unident.	1

Appendix C10.–Snow crab CPUE by soak time for 1,646 pot lifts sampled during the 2009/2010 Bering Sea snow crab fishery.

Soak time[a] (hours)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
0-11	0.3	35.4	8.2	0.0	1.0	44.6
12-23	6.1	183.0	61.3	2.1	0.2	246.5
24-35	30.4	242.4	80.9	2.2	1.2	326.7
36-47	29.2	263.1	72.4	2.1	0.6	338.2
48-59	8.7	274.9	78.3	1.6	0.3	355.2
60-71	3.5	305.2	76.8	1.1	0.2	383.2
72-83	3.9	302.7	91.8	2.6	1.5	398.7
84-95	2.7	310.2	71.0	1.5	0.0	382.7
96-107	2.2	308.4	80.3	1.6	0.2	390.5
108-119	3.5	245.1	68.8	1.7	2.3	317.9
120-131	1.9	293.9	64.7	1.1	0.3	360.0
132-143	3.0	311.5	86.6	1.4	0.4	400.0
144-155	1.5	349.6	68.0	1.2	0.0	418.8
156-167	0.8	327.0	82.1	3.4	0.1	412.5
168-179	0.7	305.9	69.1	1.1	0.1	376.2
180-191	0.4	310.0	160.3	3.4	0.0	473.7
192-203	0.2	325.8	128.0	1.8	0.0	455.5
204-215	0.1	289.5	30.0	0.0	0.0	319.5
216-227	0.2	332.0	205.7	1.0	0.0	538.7
228-239	0.2	177.5	95.8	1.3	7.3	281.8
252-263	0.2	313.7	128.3	0.0	0.0	442.0
264-275	0.1	136.5	16.0	0.5	0.0	153.0
336-347	0.1	151.0	17.5	0.0	0.0	168.5

[a] Average soak time was 55 hours.

Appendix C11.–Snow crab CPUE by depth for 1,646 pot lifts sampled during the 2009/2010 Bering Sea snow crab fishery.

Depth[a] (fathoms)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
55-59	2.2	426.6	186.4	1.5	0.0	614.4
60-64	23.1	258.4	89.9	2.2	1.3	351.9
65-69	38.6	255.8	86.0	3.0	1.1	346.0
70-74	26.5	253.6	45.7	0.6	0.2	300.0
75-79	7.4	255.1	62.6	0.9	0.0	318.6
80-84	1.6	318.0	76.8	0.0	0.1	394.9
85-89	0.5	301.6	77.5	0.0	0.0	379.1
90-94	0.1	487.0	92.0	0.0	0.0	579.0

[a] Average depth was 68 fathoms.

Appendix C12.–Reproductive condition of female snow crabs from pot lifts sampled during the 1995–2009/2010 Bering Sea snow crab fisheries.

Year	Crab sampled	Percent			
		Eyed eggs	Uneyed eggs	Barren, mated	Barren, non-mated
1995	423	80.4	12.5	6.1	0.9
1996	136	59.6	3.7	16.2	20.6
1997	789	40.9	0.6	30.4	28.0
1998	90	21.1	8.9	37.8	32.2
1999	99	68.7	5.1	22.2	4.0
2000	6	0.0	16.7	16.7	66.6
2001	11	18.2	36.4	0	45.4
2002	19	26.3	57.9	10.5	5.3
2003	62	41.9	45.2	9.7	3.2
2004	10	10.0	30.0	0	60.0
2005	9	88.9	11.1	0	0.0
2005/2006	129	6.2	89.2	2.3	2.3
2006/2007	57	84.2	14.0	0	1.8
2007/2008	365	21.9	71.0	1.6	3.8
2008/2009	461	28.4	71.4	0	0.2
2009/2010	246	3.3	64.2	8.9	22.8

Appendix C13.–Total contents of 989 pot lifts sampled during the 2009/2010 St. Matthew Island blue king crab fishery.

Commercial crab species	Total catch	Other species	Total catch
blue king crab		Pacific cod	530
legal	10,521	hermit crab unident.	241
sublegal	10,863	brittle star unident.	213
female	1,638	sculpin unident.	197
snow crab		great sculpin	145
legal	1,158	Pacific lyre crab	120
sublegal	311	circumboreal toad crab	101
female	138	Pacific halibut	82
Tanner crab		basket star	49
legal	0	starfish unident.	41
sublegal	6	yellowfin sole	28
female	1	snail unident.	24
hybrid *C. bairdi*		jellyfish unident.	11
legal	0	Greenland halibut (or Greenland turbot)	8
sublegal	2	skate unident.	5
female	1	octopus unident.	3
hybrid *C. opilio*		sponge unident.	3
legal	1	walleye pollock	3
sublegal	1	arrowtooth flounder	2
female	0	flatfish unident.	2
red king crab		sand dollar unident.	2
legal	1	yellow Irish lord	2
sublegal	1	Alaska plaice	1
female	0	bigmouth sculpin	1
		flathead sole	1
		giant octopus	1
		graceful decorator crab	1

Appendix C14.–Blue king crab CPUE by soak time for 989 pot lifts sampled during the 2009/2010 St. Matthew Island blue king crab fishery.

Soak time[a] (hours)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
0-11	1.7	1.6	0.0	1.1	0.1	2.8
12-23	35.2	10.0	0.2	11.6	2.0	23.8
24-35	41.9	10.3	0.4	12.1	1.6	24.3
36-47	7.2	10.4	0.4	11.1	2.5	24.4
48-59	4.0	10.5	0.6	10.5	0.4	22.1
60-71	3.0	12.4	1.3	6.2	0.5	20.4
72-83	4.9	14.3	0.6	7.7	1.2	23.8
84-95	0.4	23.0	0.0	7.0	0.5	30.5
96-107	0.2	20.0	0.0	8.0	0.5	28.5
324-335	0.5	1.8	0.2	0.6	1.4	4.0
384-395	0.7	1.4	0.3	0.6	0.4	2.7
396-407	0.3	7.7	0.0	0.3	0.0	8.0

[a] Average soak time was 36 hours.

Appendix C15.–Blue king crab CPUE by depth for 989 pot lifts sampled during the 2009/2010 St. Matthew Island blue king crab fishery.

Depth[a] (fathoms)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
20-24	0.7	0.6	0.3	0.6	0.0	1.4
25-29	1.1	0.9	0.2	4.0	5.9	11.0
30-34	8.4	5.3	0.4	10.5	5.0	21.1
35-39	6.0	4.4	0.6	4.6	6.8	16.4
40-44	30.9	11.1	0.5	10.1	1.6	23.3
45-49	42.0	12.6	0.3	12.9	0.6	26.3
50-54	10.4	8.0	0.3	11.6	0.1	20.0
55-59	0.5	3.8	0.2	4.6	0.0	8.6

[a] Average depth was 44 fathoms.

Appendix C16.–Reproductive condition of female blue king crabs from pot lifts sampled during the 2009/2010 directed St. Matthew Island blue king crab fishery. The fishery had been closed the previous 10 years.

Year	Crab sampled	Percent			
		Eyed eggs	Uneyed eggs	Barren, mated	Barren, non-mated
2009/2010	1,638	1.2	13.2	40.8	44.6

Appendix C17.–Total pot lift contents for 411 pot lifts sampled during the 2009/2010 Aleutian Islands golden king crab fishery east of 174° W long.

Commercial crab species	Total catch	Other species	Total catch
golden king crab		basket star	198
legal	10,896	sponge unident.	94
sublegal	3,950	starfish unident.	63
female	2,711	*Stylaster*	31
scarlet king crab		sea urchin unident.	28
legal	22	Primnoidae Group I	25
sublegal	30	skate unident.	12
female	0	*Cyclohelia*	9
		snail unident.	9
		brittle star unident.	8
		Pacific halibut	7
		Fanellia	6
		Kamchatka coral (or bubblegum coral)	6
		arrowtooth flounder	3
		Kamchatka flounder	3
		Anthomastus	2
		Arthrogorgia	2
		Cup coral unident.	2
		Distichopora	2
		Errinopora	2
		Plexauridae unident.	2
		articulated bamboo coral	1
		bivalve unident.	1
		Calcigorgia	1
		Crypthelia	1
		Primnoidae unident.	1
		rougheye rockfish	1
		Stylantheca	1
		yellowfin sole	1

Appendix C18.–Golden king crab CPUE by soak time for 411 pot lifts sampled during the 2009/2010 Aleutian Islands golden king crab fishery east of 174° W long.

Soak time[a] (hours)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
132-143	2.7	19.9	3.9	34.9	0.3	59.0
180-191	4.9	19.6	2.8	11.3	1.3	34.9
228-239	6.4	15.8	2.9	5.2	0.8	24.7
276-287	11.3	21.7	2.7	8.5	8.0	40.9
324-335	9.8	26.8	0.8	9.9	6.7	44.2
372-383	21.3	28.3	0.3	12.2	8.4	49.1
420-431	10.8	31.8	0.4	10.9	14.5	57.5
468-479	5.9	29.2	0.0	10.6	7.3	47.1
516-527	2.5	26.3	0.0	4.1	3.3	33.7
564-575	12.7	22.2	0.1	4.6	3.5	30.4
612-623	8.3	30.3	1.3	7.9	7.5	46.9
708-719	1.5	24.0	0.0	4.7	0.3	29.0
756-767	2.0	27.0	0.3	5.5	1.8	34.5

[a] Average soak time was 391 hours.

Appendix C19.–Golden king crab CPUE by depth for 411 pot lifts sampled during the 2009/2010 Aleutian Islands golden king crab fishery east of 174° W long.

Depth[a] (fathoms)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
60-79	0.5	27.5	5.0	40.5	1.5	74.5
80-99	5.9	20.3	1.8	12.6	0.8	35.6
100-119	8.8	23.0	1.9	10.8	6.1	41.8
120-139	12.5	27.1	1.4	7.8	4.1	40.5
140-159	17.9	23.5	1.3	8.1	7.0	39.9
160-179	9.3	27.8	1.2	8.1	1.8	38.8
180-199	8.1	24.1	1.8	10.9	7.6	44.4
200-219	4.2	25.5	0.5	12.5	7.4	45.8
220-239	10.0	28.1	0.1	12.0	11.1	51.2
240-259	6.4	29.3	0.2	11.3	16.2	57.0
260-279	8.3	25.8	0.1	6.4	5.2	37.6
280-299	3.9	29.4	0.4	7.5	7.9	45.2
300-319	3.4	26.3	0.0	9.5	7.1	42.9
320-339	0.7	26.7	0.0	17.0	7.0	50.7

[a] Average depth was 183 fathoms.

.

Appendix C20.–Reproductive condition of female golden king crabs from pot lifts sampled during the 1996/1997–2009/2010 Aleutian Islands golden king crab fisheries east of 174° W long.

		Percent			
Year	Crab sampled	Eyed eggs	Uneyed eggs	Barren, mated	Barren, non-mated
1996/1997	59,210	20.8	22.5	18.6	38.1
1997/1998	5,383	25.2	19.3	22.1	33.4
1998/1999	44,352	18.1	21.0	23.9	37.0
1999/2000	36,695	22.1	21.0	23.1	33.8
2000/2001	13,615	26.9	18.7	20.1	34.3
2001/2002	14,912	20.4	12.5	15.4	51.1
2002/2003	9,651	29.6	19.2	18.9	32.3
2003/2004	7,990	20.9	33.2	13.6	31.5
2004/2005	5,430	24.9	24.7	24.9	25.5
2005/2006	1,489	25.8	25.2	18.3	30.7
2006/2007	2,328	29.6	35.7	9.1	25.6
2007/2008	1,397	18.3	52.5	10.1	19.1
2008/2009	2,308	31.3	35.3	17.9	15.5
2009/2010	2,604	45.0	26.8	9.4	18.3

Appendix C21.–Total pot lift contents for 893 pot lifts sampled during the 2009/2010 Aleutian Islands golden king crab fishery west of 174° W long.

Commerical crab species	Total catch	Other species	Total catch
golden king crab		sponge unident.	474
legal	23,583	hydroid unident.	439
sublegal	6,561	brittle star unident.	425
female	7,155	basket star	345
scarlet king crab		Primnoidae Group I	172
legal	19	*Stylaster*	168
sublegal	0	tunicate unident.	131
female	1	bryozoan unident.	101
red king crab		snail unident.	80
legal	1	worm unident.	78
sublegal	4	starfish unident.	75
female	0	sea urchin unident.	63
grooved Tanner crab		Plexauridae unident.	42
legal	1	*Distichopora*	37
sublegal	0	*Fanellia*	37
female	0	*Calcigorgia*	32
hair crab		sea lily (or feather star) unident.	24
legal	0	*Arthrogorgia*	22
sublegal	1	*Crypthelia*	18
female	0	Kamchatka coral (or bubblegum coral)	18
		Cyclohelia	16
		sea spider unident.	14
		octopus unident.	12
		Anthomastus	10
		Clavularia	10
		coral unident.	7
		red-tree coral	7
		rockfish unident.	6
		sea cucumber unident.	6
		hairy triton (or Oregon triton)	5
		invertebrate unident.	5
		barnacle unident.	4
		chiton unident.	4
		jellyfish unident.	4
		Pacific ocean perch	4
		sea anemone unident.	4
		Caryophyllia	3
		sculpin unident.	3
		Atka mackerel	2
		leech unident.	2
		Pacific halibut	2
		Primnoidae unident.	2
		rougheye rockfish	2
		sea whip unident.	2
		shrimp unident.	2
		arrowtooth flounder	1
		cup coral unident.	1
		Errinopora	1
		giant octopus	1
		Hind's scallop (or reddish scallop)	1
		Neptune snail unident.	1
		poacher unident.	1
		sea pen unident.	1

Appendix C22.–Golden king crab CPUE by soak time for 893 pot lifts sampled during the 2009/2010 Aleutian Islands golden king crab fishery west of 174° W long.

Soak time[a] (hours)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
180-191	0.1	19.0	0.0	7.0	23.0	49.0
276-287	0.6	15.0	0.0	16.0	43.8	74.8
372-383	0.4	23.5	0.0	12.8	50.0	86.3
420-431	13.8	20.7	0.5	10.0	6.4	37.7
468-479	12.7	24.1	0.4	6.7	8.4	39.7
516-527	11.2	28.2	0.7	11.1	10.7	50.6
564-575	13.5	30.2	0.3	8.9	5.2	44.5
612-623	3.6	19.4	0.4	6.6	16.9	43.3
660-671	5.7	22.9	0.2	6.2	10.9	40.1
708-719	5.0	25.6	0.2	5.6	4.7	36.0
756-767	6.4	25.4	0.2	3.6	4.4	33.5
804-815	5.9	26.4	0.3	3.5	10.2	40.5
852-863	4.6	38.2	0.8	7.7	5.7	52.3
900-911	3.9	33.1	0.7	7.6	7.0	48.3
948-959	2.4	26.9	0.0	5.5	7.0	39.4
996-1007	3.6	29.1	0.1	5.8	9.9	44.8
1044-1055	2.7	29.5	0.0	4.2	7.4	41.2
1092-1103	1.6	29.4	0.3	4.5	1.8	36.0
1140-1151	0.2	37.5	0.0	3.5	4.0	45.0
1236-1247	0.2	14.0	0.0	0.5	0.0	14.5
1284-1295	0.8	3.6	0.0	0.1	4.7	8.4
1380-1391	0.7	1.7	0.0	0.0	0.0	1.7
1524-1535	0.2	0.5	0.0	0.0	0.5	1.0

[a] Average soak time was 643 hours.

Appendix C23.–Golden king crab CPUE by depth for 893 pot lifts sampled during the 2009/2010 Aleutian Islands golden king crab fishery west of 174° W long.

Depth[a] (fathoms)	Percent of sampled pots	CPUE				
		LRT	LNR	SUB	FEM	Total
60-79	0.1	30.0	0.0	2.0	1.0	33.0
80-99	2.0	50.8	0.3	6.1	12.4	69.5
100-119	4.9	27.1	0.3	4.8	10.9	43.1
120-139	12.0	33.1	0.4	8.3	10.9	52.8
140-159	16.2	28.3	0.3	7.3	6.4	42.2
160-179	21.1	27.4	0.5	8.7	6.1	42.6
180-199	21.1	21.2	0.4	6.9	7.3	35.7
200-219	12.1	22.2	0.3	8.6	6.8	37.9
220-239	4.5	18.5	0.8	3.7	9.4	32.4
240-259	4.1	24.4	0.3	5.7	18.7	49.0
260-279	0.9	13.0	0.3	6.9	1.3	21.4
280-299	0.1	3.0	0.0	1.0	2.0	6.0
300-319	0.7	21.8	0.3	4.0	3.2	29.3
320-339	0.2	29.5	0.5	2.0	1.0	33.0

[a] Average depth was 174 fathoms.

Appendix C24.–Reproductive condition of female golden king crabs from pot lifts sampled during the 1996/1997–2009/2010 Aleutian Islands golden king crab fisheries west of 174° W long.

Year	Crab sampled	Percent			
		Eyed eggs	Uneyed eggs	Barren, mated	Barren, non-mated
1996/1997	67,314	23.6	25.5	21.2	29.6
1997/1998	39,343	24.0	26.8	19.8	29.4
1998/1999	22,208	23.4	25.9	16.3	34.4
1999/2000	45,645	21.3	29.6	19.1	29.9
2000/2001	53,716	26.2	28.7	17.1	27.9
2001/2002	38,829	26.6	27.8	22.4	23.2
2002/2003	22,479	32.8	20.9	11.9	33.9
2003/2004	5,946	32.8	26.8	19.2	21.2
2004/2005	12,970	26.1	31.7	21.6	20.6
2005/2006	5,798	35.2	33.5	21.7	9.6
2006/2007	7,136	31.6	36.0	19.3	13.0
2007/2008	9,281	43.2	23.9	19.1	13.8
2008/2009	7,922	27.5	34.5	15.3	22.7
2009/2010	7,155	31.3	30.3	29.1	5.9

APPENDIX D. RESULTS OF LEGAL TALLY SAMPLES

Appendix D1.–Results of ADF&G legal tally samples from the 2009/2010 Bering Sea and Aleutian Islands directed crab fisheries.

Fishery	Sample size	Percent of landed catch	Number of illegal crabs				Percent illegal
			Male	Female	Non-target species	Total	
Bristol Bay red king crab	31,399	1.4	164	2	2	168	0.54
E. Bering Sea Tanner crab[a]	9,600	2.0	38	0	0	38	0.40
Bering Sea snow crab	90,861	0.3	12	2	211	225	0.25
St. Matthew Island blue king crab	6,666	6.4	28	1	0	29	0.44
E. Aleutian Islands golden king crab[b]	7,210	1.1	29	1	0	30	0.42
W. Aleutian Islands golden king crab[c]	35,232	5.6	177	5	0	182	0.52

[a] East of 166° W long.

[b] East of 174° W long.

[c] West of 174° W long.