Fishery Data Series No. 13-21

Summary of the 2011/2012 Mandatory Crab Observer Program Database for the Bering Sea/Aleutian Islands Commercial Crab Fisheries

by

William B. Gaeuman

May 2013

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

Symbols and Abbreviations

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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)

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. 13-21

SUMMARY OF THE 2011/2012 MANDATORY CRAB OBSERVER PROGRAM DATABASE FOR THE BERING SEA/ALEUTIAN ISLANDS COMMERCIAL CRAB FISHERIES

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ABSTRACT

Since 1988 Alaska Department of Fish and Game (ADF&G) has required varying levels of observer coverage aboard vessels participating in Bering Sea and Aleutian Islands (BSAI) crab fisheries. This report summarizes data collected in the 2011/12 BSAI commercial crab fisheries and the 2011 Pribilof Islands commercial golden king crab fishery by ADF&G crab observers deployed on floating-processor vessels, catcher-processor vessels, and catcher vessels and by ADF&G dockside samplers. Primary data summaries include estimates of catch and catch per unit effort (CPUE) and information about size and shell condition of both discarded and retained crab. Further information about catch rates by soak time and depth, female reproductive condition, sampled pot lift locations, species composition of sampled pot lifts, and legal tally results is provided in a series of appendices.

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 (5 AAC 39.645) adopted by the Alaska Board of Fisheries (BOF) grant the Alaska Department of Fish and Game (ADF&G) 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 require deployment of observers on all vessels that process snow crab *Chionoecetes opilio*, Tanner crab *C. bairdi*, grooved Tanner crab *C. tanneri*, triangle Tanner crab *C. angulatus*, red king crab *Paralithodes camtschaticus*, blue king crab *P. platypus*, or golden king crab *Lithodes aequispinus*. Those regulations additionally charge 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. Schwenzfeier et al. (2012) provide details on regulations pertaining to the State of Alaska Shellfish Onboard Observer Program and a history of that program from its inception in 1988.

ADF&G observers deployed on fishing vessels in the BSAI crab fisheries record the gear type, location, depth, and soak time of a daily random sample of pot lifts and describe the species composition of their contents, including 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 obtained. In addition, ADF&G onboard observers and dockside samplers document overall vessel catch and effort, take size-frequency samples, conduct legal tallies, and estimate the average weight of delivered catch. ADF&G Westward Region staff maintain the information collected by observers and dockside samplers in a database that is used in research and management of Alaska's BSAI crab stocks.

This report summarizes data collected by onboard observers and dockside samplers during the 2011/12 Bristol Bay red king crab fishery, 2011/12 Bering Sea snow crab fishery, 2011/12 St. Matthew Island blue king crab fishery, 2011 Pribilof Islands golden king crab fishery, and 2011/12 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 distributions for both discarded 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 a series of appendices.

METHODS

Methods described in this report relate to ADF&G observer and dockside sampler data-collection activities and do not reflect all observer and dockside sampler duties. 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 all catcher vessels prosecuting the St. Matthew Island blue king crab fishery, on randomly selected catcher vessels participating in the Bristol Bay red king crab and Bering Sea snow crab fisheries, and on the two catcher vessels permitted to harvest Pribilof Island golden king crab during 2011. In the Aleutian Islands golden king crab (AIGKC) 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. Dockside samplers were responsible for sampling retained catch delivered by vessels with no onboard observer.

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 crab of all species are identified and enumerated. For a subset of these pot lifts, measurements and assessments of ancillary characteristics are also recorded for crab of selected species.
Legal tally	Examination of up to 600 crab randomly selected from the retained catch to assure regulatory compliance regarding the retention of crab by species, size, and sex.
Size frequency sample	Biological measurements of up to 100 randomly selected retained crab for the purpose of determining carapace size and shell condition distribution.
Carapace length (CL)	The biological size measurement of all species of king crabs *Lithodes* and *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.
Carapace width (CW)	The biological size measurement of all species of *Chionoecetes* crabs taken as the greatest straight-line distance perpendicular to a line midway between the eyes to the medial-posterior margin, not including the spines (cf. *Legal measurement*, below).
Legal measurement (LM)	The measurement used to determine if male crabs are at or greater than the minimum legal size for retention: 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 (cf. *Carapace width*, above.
Ovigerous	Bearing a clutch of extruded eggs (pertains only to mature female crabs).

Uneyed eggs	Eggs that are unfertilized or in early developmental stages with no visible eyespots.
Eyed eggs	Eggs in later developmental stages with visible eyespots or prezoeae.
Barren/matted setae	An egg clutch is not present but previous egg brooding is evidenced by dirty pleopodal setae or the presence of attached dead eggs or empty egg cases.
Barren/clean setae	An egg clutch is not present and there is no evidence of previous egg brooding; pleopodal setae are clean, shiny, light in color, and very fine or, rarely, there are no visible setae on the pleopods. Females assigned this code are usually immature.
Shell condition	A description of the appearance of the crab exoskeleton that is determined by examining characteristics that change or show wear with time since the last molt (Donaldson and Byersdorfer 2005; Jadamec et al. 1999). Observers scored the shell condition of sampled crabs as either "soft," "new pliable," "new," "old," or "very old" based on 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.
Catch per unit effort (CPUE)	The mean catch for a standard unit of fishing effort. In this report CPUE represents the mean catch in number of crab per pot lift.

CRAB OBSERVER SAMPLING DUTIES

During the 2011/12 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 by the crew. The number of pot lifts observers were required to sample on each day of fishing activity varied by fishery and vessel type. In general, pot lift sampling 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 outlined in Table 1. In all cases observers were expected to communicate with the vessel skipper and to examine the Daily Fishing Log (DFL) or other records in documenting daily and total catch and effort (number of pot lifts). Comprehensive ADF&G crab observer sampling methods are detailed in the 2011 ADF&G Crab Observer Training and Deployment Manual[1].

[1] Crab Observer Training and Deployment Manual. September 2011. ADF&G Shellfish Observer Program, Dutch Harbor, unpublished.

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 crab 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. (On rare occasions a catcher-processor vessel will deliver to a shore side processor, in which case the observer assumes the responsibilities of an observer deployed on a catcher vessel.)

Catcher Vessels

The main duty for observers deployed on catcher vessels was pot lift sampling on 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 to a floating-processor vessel, all sampling was completed by the observer deployed on the catcher vessel.

DOCKSIDE SAMPLER SAMPLING DUTIES

Dockside samplers were responsible for sampling retained catch delivered to shore-side processors by vessels with no onboard observer. Sampling duties during each delivery included obtaining a size-frequency sample, conducting a legal tally, and determining average weight of retained crabs. Dockside samplers were also required to document trip catch and effort (number of pot lifts) through a confidential interview with the vessel captain and examination of the DFL or other records. A full account of dockside sampler duties is available in the ADF&G Shellfish Dockside Sampling Manual[2].

ESTIMATION OF CPUE AND TOTAL FISHERY CATCH

With exception of the Aleutian Islands golden king crab fisheries, estimates of CPUE presented here were generated from observer-collected data using a ratio estimator introduced by Gaeuman (2009). In earlier reports different estimates of CPUE were calculated depending on the information available and on varying assumptions about the sampling design. The "sample CPUE" reported before 1997 (e.g., Tracy 1995) was calculated as the simple average catch over all sampled pot lifts. Boyle et al. (1997) introduced stratification by day within vessel, and Burt and Barnard (2003) introduced additional stratification by vessel type (catcher-processor or catcher-only) into the report series.

Inference using the current ratio estimator depends on the fact 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. In addition, it is assumed that sampled pot lifts are selected by simple random sampling from all pot lifts on each vessel fishing day, independently across days.

[2] Shellfish Dockside Sampling Manual. September 2011. ADF&G Dockside Sampling Program, Dutch Harbor, unpublished.

Under that setup 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, with vessels as primary sampling units within them, and vessel days as strata within vessels, with 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. A variance 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.

For estimation of CPUE in the Aleutian Islands golden king crab fisheries, partial observer coverage on individual participating catcher vessels makes the ratio estimator used for the other BSAI crab fisheries unsuitable. Instead, for these two fisheries overall fishery CPUE is estimated assuming independent simple random sampling of pots on individual vessels, with stratification by vessel and reported vessel proportions of total fishery effort (number of pot lifts) applied as known weights. It should be noted, however, that the lack of any randomization in the specific assignment of observer coverage in these fisheries fundamentally precludes properly valid design-based inference of CPUE or other fishery characteristics.

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 the BSAI management areas (e.g., Fitch et al. 2012) 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[3]. ATF CPUE estimates, however, are available only for retained legal crab. 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)). Though some crab are typically captured in these pots, they generally have a much lower CPUE than pots targeting crab and so misrepresent fishing efficiency in the directed crab pot fishery. For this reason, ADF&G crab observers are currently instructed not to sample them, and they are omitted in the estimates of CPUE reported in this document. Cod pots were deployed during the 2011/12 Bristol Bay red king crab and Bering Sea snow crab fisheries and accounted for approximately 5% and 8%, respectively, 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 relative to ATF values, which depend on effort totals that do not distinguish between conventional and groundfish-configured pots.

RESULTS

BRISTOL BAY RED KING CRAB

The 2011/12 Bristol Bay red king crab season commenced October 15 and closed January 15. Most fishing occurred early in the season. Total allowable catch (TAC) in this fishery was set at

[3] Forrest Bowers, BSAI Area Management Biologist, ADF&G, Dutch Harbor, 2010, personal communication.

7.834 million pounds, with legal male crab at least 6.5 in LM. Two catcher-processors and 60 catcher vessels participated. Onboard observers sampled 698 (1.5%) of the ATF reported total of 45,166 pot lifts (Table 1). Appendix B1 shows locations of sampled pot lifts.

Onboard observers collected CL measurements of 40,212 male red king crab from sampled pot lifts (Figure 1). Average CL was 135.8 mm, and 92.3% of the crab were classified as new shell. CL measurements of 1,752 female red king crab from sampled pot lifts averaged 107.3 mm. Approximately 99.3% of the females were new shell. CL measurements were also recorded for 10,707 male red king crab by onboard observers and dockside samplers in size-frequency sampling of retained catch. Average CL was 148.5 mm, and 88.7% of the sampled crab were new shell.

Estimated fishery CPUE of legal-retained red king crab was 31.0 crab per pot lift (Table 2), with 95% confidence interval (26.67, 35.40), from a t-distribution as detailed in Appendix A. This value, which compares to an ATF reported value of 28.3, is roughly double the 2010/11 estimate of 17.2 and the highest since 2006/07 (Figure 2). Estimated bycatch of discarded sublegal males was nearly as high at 28.8 crab per pot lift; estimated female bycatch was 2.2 crab per pot lift, down slightly from last year's value. Some incidental bycatch of discarded Tanner and snow crab, mostly legal-size males, was also observed in this fishery.

Total catches of all animals identified in sampled pot lifts during the 2011/12 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 crab from sampled pot lifts (Appendix C4).

Legal tallies conducted during the 2011/12 season by onboard observers and dockside samplers totaled 16,079 crabs, accounting for 1.3% of the fishery reported harvest (Appendix D1). Approximately 0.27% of all sampled crabs were illegal, all of them sublegal male red king crab.

BERING SEA SNOW CRAB

The 2011/12 Bering Sea snow crab fishery opened October 15 with a TAC of 88.894 million pounds. Legal harvest was restricted to male crab at least 3.1 in LM. (Note that although the minimum legal size for snow crab in this fishery is 3.1 in LM, processing plants generally do not accept crab smaller than 4 in LM.) Whereas the regulatory fishery closure is May 31 in the Western subdistrict (west of 173° W long.) and May 15 in the Eastern subdistrict (east of 173° W long.), the season was extended by emergency order to June 15 west of 171° W long. as a result of unusual sea ice conditions that disrupted fishing activity during much of the season. Two catcher-processor vessels and 70 catcher vessels participated. Onboard observers sampled 2,235 (0.8%) of the ATF reported 270,602 pot lifts (Table 1). Sampled pot lift locations are shown in Appendix B2.

Onboard observers collected CW measurements of 165,344 male snow crab during pot lift sampling (Figure 3). Average CW was 112.1 mm and 90.3% of the crab were categorized as new shell. Average female snow crab CW was 58.7 mm, based on 5,607 measured females, with 70.0% of them judged new shell. CW measurements were additionally recorded on 58,499 male snow crab in size-frequency sampling of retained catch. Average CW was 115.4 mm and 94.0% of the crab were new shell.

Estimated CPUE of legal-retained snow crab was 231.3 crab per pot lift in 2011/12 (Table 3), with 95% confidence interval (211.19, 251.46). Like the 2011/2 ATF reported value of 223.8, it

suggests a continuing decline over the last few years (Figure 4). Average catch per pot for discarded legal-size males, mostly animals smaller than 4 in (~102 mm) CW, also decreased further in 2011/12. On the other hand, estimated 2011/12 female CPUE at 11.1 crab per pot lift was notably high and about 10 times the previous year's rate. As shown in Table 3, observers also documented some bycatch of discarded Tanner crab, mostly legal-size males, along with smaller numbers of crabs considered to be hybrid *Chionoecetes*, including an estimated 50-thousand retained males judged legally retainable by the criteria of 5 AAC 35.521.

Total catches of all animals identified in sampled pot lifts during the 2011/12 season are provided in Appendix C5. Additional appendices contain sampled pot lift CPUE by soak time (Appendix C6) and depth (Appendix C7) and the reproductive condition of female snow crab in sampled pot lifts (Appendix C8).

Legal tallies conducted on catcher-processor vessels and on catcher vessels delivering snow crab to processors totaled 128,155 crabs, which accounted for 0.2% of the reported total catch (Appendix D1). Of those, 0.21% were illegal, most of them non-target Tanner *C.bairdi*. By contrast, most of the illegal crabs encountered in in other 2011/12 BSAI crab fisheries were undersized males of the target species.

SAINT MATTHEW ISLAND BLUE KING CRAB

The St. Matthew Island blue king crab fishery opened for the third consecutive time since 1998 on October 15, 2011 with a TAC of 2.539 million pounds and closed by regulation February 1, 2012, though fishing was completed by the end of 2011. Legal harvest was limited to male crab at least 5.5 in LM. All 18 participating catcher vessels were required to carry an observer (Table 1). Of the ATF reported 48,554 pot lifts in this fishery, observers sampled 3,359 (6.9%). Locations of sampled pot lifts are mapped in Appendix B3.

Observers took CL measurements from 62,868 male and 4,135 female blue king crab in pot lift sampling (Figure 5). Respective average CL values were 117.9 mm and 90.0 mm. Observers recorded 91.3% of the males and 60.7% of the females as new shell. Size-frequency sampling of 4,954 fishery-retained male blue king crab yielded an average CL of 130.0 mm, with 94.3% of the sampled animals judged new shell.

Estimated 2011/12 CPUE of legal-retained crab was 9.4 crab per pot lift (Table 4), with approximate 95% confidence interval (9.22, 9.58). The ATF reported value was slightly lower at 9.0 crab per pot lift. Catch rates in this fishery since its resumption in 2009/10 have been low by comparison to values prior to the 1999 closure (Figure 6). Estimated 2011/12 bycatch of discarded sublegal males slightly exceeded the legal catch, as was true in each of the two previous seasons, whereas estimated female discard CPUE was down from 5.1 in 2010/11 at 1.3 crab per pot lift. Some incidental bycatch of subsequently discarded snow crab occurred in the 2011/12 St. Matthew Island blue king crab fishery, most of it consisting of legal-size males.

Total catches of all animals identified in sampled pot lifts during the 2011/12 season are provided in Appendix C9. Additional appendices contain CPUE by soak time (Appendix C10) and depth (Appendix C11) and the reproductive condition of female blue king crab in sampled pot lifts (Appendix C12).

Legal tallies conducted on catcher vessels delivering blue king crab to processors totaled 22,398 crabs, or 5.1% of the reported harvest (Appendix D1). Approximately 0.41% of the sampled animals were illegal due to size, sex, or species restrictions.

PRIBILOF ISLANDS GOLDEN KING CRAB

This non-rationalized fishery is currently managed using a guideline harvest level (GHL) of 0.150 million pounds under authority of an ADF&G commissioner's permit valid for a calendar year, with legal harvest limited to male crab a minimum of 5.5 in LM. Observer coverage is mandatory during all fishing activity. Because only two catcher vessels made landings in 2011, all information relating to the specifics of fishing activity and observer sampling effort is confidential.

ALEUTIAN ISLANDS GOLDEN KING CRAB

The BOF re-designated the Aleutian Islands king crab registration area in March 1996 by combining two existing areas, Dutch Harbor and Adak, and directed ADF&G to manage golden king crab of the Aleutian Islands east and west of 174° W long. separately as two distinct stocks (Baechler et al. 2012). In 2011/12 both fisheries were open from August 15 to May 15. Legal harvest was restricted to male crab measuring at least 6.5 in LM.

East of 174° W Longitude

Three catcher vessels participated in the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long., where the TAC was set at 3.15 million pounds. Onboard observers sampled 361 pot lifts accounting for 2.0% of the ATF reported 17,915 pot lifts in the fishery (Table 1). Appendix B5 shows sampled pot lift locations.

Average CL of 18,607 male golden king crab measured in pot lift sampling was 146.2 mm, and 97.5% were new shell; average CL of 3,172 measured females was 129.2 mm, and 99.9% were new shell (Figure 8). In size-frequency sampling of 2,507 retained crab, average CL was 153.2 mm, and 98.3% were recorded as new shell.

Estimated legal-retained CPUE was 38.6 crab per pot lift (Table 6), with 95% confidence interval (36.52, 40.74). This value is statistically indistinguishable from the ATF estimate of 37.3, which is higher than the previous record-high CPUE for this fishery (28 in 2007/08; Baechler 2012). By contrast, estimated bycatch rates of sublegal and female golden king crab were in line with historical fisheries (Figure 9). No notable bycatch of any other commercially important crab species was observed in this fishery.

Total catches of all animals identified in sampled pot lifts during the 2011/12 eastern AIGKC crab fishery are provided in Appendix C17. Additional appendices contain CPUE by soak time (Appendix C18) and depth (Appendix C19) and reproductive condition of female golden king crab (Appendix C20) from sampled pot lifts.

Legal tallies conducted throughout the season onboard catcher vessels delivering golden king crab from the eastern Aleutian Islands fishery totaled 8,305 crabs, representing approximately 1.2% of the fishery reported harvest (Appendix D1). Of these, 0.31% were illegal due to size, sex, or species restrictions.

West of 174° W Longitude

A single catcher-processor and 2 catcher vessels participated in the 2011/12 AIGKC crab fishery west of 174° W long., where the TAC was set at 2.835 million pounds. ATF reported effort was 26,326 pot lifts, of which observers sampled 837, or 3.2% (Table 1). Locations of sampled pot lifts are shown in Appendix B6.

Onboard observers recorded CL measurements of 26,081 male and 7,362 female golden king crab captured in sampled pot lifts (Figure 10). Male and female CL averages were respectively 145.9 mm and 137.9 mm. New-shell crab made up 97.0% of the males and 96.9% of the females. Average CL of 10,639 male crab measured in size-frequency sampling of retained catch was 153.4 mm, and 96.3% of them were new shell.

Estimated legal-retained CPUE in this fishery was 22.9 crab per pot lift (Table 7), with 95% confidence interval (21.54, 24.29). As in the eastern AIGKC fishery, this value is consistent with the higher estimated catch rates following crab rationalization (Figure 11) and also close to the ATF reported 23.4 crab per pot lift. Estimates of discarded male and female golden king crab CPUE in the 2011/12 western fishery are likewise consistent with those from other years since rationalization. Observers in this fishery recorded no noteworthy bycatch of other commercially important crab species.

Appendix C21 lists total catches of all animals observed in sampled pot lifts during the 2011/12 western AIGKC 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 crab.

Legal tallies conducted onboard catcher and catcher-processor vessels prosecuting the 2011/12 AIGKC fishery west of 174° W long. totaled 18,875 crabs. Sampled crabs made up 3.1% of the ATF reported harvest (Appendix D1). Approximately 0.60% of sampled animals were illegal due to size, sex, or species restrictions.

Table 8 summarizes all 2011/12 BSAI crab fishery observer-based estimates of legal retained CPUE and harvest number in comparison to their ATF reported analogs.

ACKNOWLEDGMENTS

Shellfish observers deployed during the 2011/12 BSAI crab 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.

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TABLES AND FIGURES

Table 1.–BSAI observer fisheries, observer deployment, and observer pot lift sampling effort during 2011/12.

			Catcher-processor vessels		Catcher vessels				
Fishery	Regulatory season	TAC[a]	Number[b]	Daily pot lift sampling goal	Number	With onboard observers	Daily pot lift sampling goal	ATF pot lift total[c]	Sampled pot lifts
Bristol Bay red king crab	15Oct–15Jan	7.834	2	4	60	16	7	45,166	698
Bering Sea snow crab	15Oct–31May	88.894	2	3	70	22	4	270,602	2,235
Pribilof Islands golden king crab	01Jan–31Dec	0.150[d]	0	NA[e]	2	2	10	-[f]	-[f]
St Matthew Island blue king crab	15Oct–01Feb	2.539	0	7	18	18	10	48,554	3,359
Aleutian Islands golden king crab (east of 174° W)	15Aug–15May	3.15	0	4	3	3	7	17,915	361
Aleutian Islands golden king crab (west of 174° W)	15Aug–15May	2.835	1	4	2	2	7	26,326	837

[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.

[d] Guideline Harvest Level (GHL) in millions of pounds.

[e] No catcher-processor vessels participate in this fishery.

[f] Confidential.

Table 2.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 698 pot lifts sampled by observers deployed during the 2011/12 Bristol Bay red king crab fishery.

Species	CPUE	SE	95% CI	Crab[a]
Red King Crab				
legal retained	31.0	2.05	(26.67, 35.40)	1,400
female	2.2	0.41	(1.27, 3.03)	99
sublegal	28.8	2.68	(23.08, 34.52)	1,300
legal not retained	0.3	0.06	(0.12, 0.38)	10
Tanner Crab				
female	< 0.1	–	–	< 5
sublegal	0.1	0.02	(0.04, 0.13)	5
legal not retained	0.4	0.12	(0.07, 0.77)	20
Snow Crab				
Female	< 0.1	–	–	< 5
sublegal	< 0.1	–	–	< 5
legal not retained	0.1	0.02	(0.09, 0.19)	5

[a] Product of estimated CPUE and ATF reported 45,166 total number of pot lifts.

Table 3.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 2,235 pot lifts sampled by observers deployed during the 2011/12 Bering Sea snow crab fishery.

Species	CPUE	SE	95% CI	Crab[a]
Snow Crab				
legal retained	231.3	9.68	(211.19, 251.46)	62,590
female	11.1	2.79	(5.25, 16.85)	3,000
sublegal	4.0	1.13	(1.64, 6.35)	1,100
legal not retained	51.0	5.28	(40.03, 61.98)	13,800
Tanner Crab				
female	0.3	0.06	(0.14, 0.37)	80
sublegal	2.0	0.21	(1.56, 2.45)	540
legal not retained	11.3	2.10	(6.92, 15.61)	3,060
Hybrid Tanner crab (legally *bairdi*[b])				
female	< 0.1	–	–	< 30
sublegal	< 0.1	–	–	< 30
legal not retained	0.1	0.03	(0, 0.10)	30
Hybrid Tanner crab (legally *opilio*[c])				
legal retained	0.2	0.18	(0, 0.60)	50
female	< 0.1	–	–	< 30
sublegal	< 0.1	–	–	< 30
legal not retained	0.7	0.28	(0.08, 1.22)	200

[a] Product of estimated CPUE and ATF reported 270,602 total number of pot lifts in the Bering Sea snow crab fishery.

[b] Hybrid Tanner crab considered to be *C. bairdi* by the criteria of 5 AAC 35.521; observers recorded no females in pot lift sampling.

[c] Hybrid Tanner crab considered to be *C. opilio* by the criteria of 5 AAC 35.521; observers recorded just 6 females and no sublegal males in pot lift sampling.

Table 4.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 3,359 pot lifts sampled by observers deployed during the 2011/12 St. Matthew Island blue king crab fishery.

Species	CPUE	SE	95% CI	Crab[a]
Blue King Crab				
legal retained	9.4	0.09	(9.22, 9.58)	460
female	1.3	0.09	(1.12, 1.48)	63
sublegal	10.0	0.12	(9.77, 10.24)	486
legal not retained	0.2	0.01	(0.15, 0.19)	10
Snow Crab				
female	< 0.1	–	–	< 5
sublegal	0.2	0.01	(0.12, 0.17)	10
legal not retained	0.6	0.03	(0.54, 0.67)	29

[a] Product of estimated CPUE and ATF reported 48,554 total number of pot lifts.

Table 5.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 463 pot lifts sampled by observers deployed during the 2011 Pribilof Islands golden king crab fishery.

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Table 6.–Estimated CPUE and total catch (thousands of crab) of golden king crab from 361 pot lifts sampled by observers deployed during the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long.

Species	CPUE	SE	95% CI	Crab[a]
Golden King Crab				
legal retained	38.6	1.08	(36.52, 40.74)	692
female	9.8	0.76	(7.67, 11.64)	180
sublegal	13.2	0.77	(11.67, 14.70)	236
legal not retained	2.1	0.13	(1.83, 2.33)	38

[a] Product of estimated CPUE and ATF reported 17,915 total number of pot lifts.

Table 7.–Estimated CPUE and total catch (thousands of crab) of golden king crab from 837 pot lifts sampled by observers deployed during the 2011/12 Aleutian Islands golden king crab fishery west of 174° W long.

Species	CPUE	SE	95% CI	Crab[a]
Golden King Crab				
legal retained	22.9	0.70	(21.54, 24.29)	602
female	8.7	0.65	(7.38, 9.94)	230
sublegal	7.3	0.49	(6.31, 8.21)	190
legal not retained	0.9	0.06	(0.76, 0.99)	20

[a] Product of estimated CPUE and ATF reported 26,326 total number of pot lifts.

Table 8.–Comparison of actual total fishery (ATF) and observer data estimates of retained catch CPUE and number (thousands of crab; including deadloss) for 2011/12 BSAI crab fisheries.

	ATF estimates		Observer data estimates		
Fishery	CPUE	Crab	CPUE	Crab	% difference CPUE[a]
Bristol Bay red king crab	28.3	1,279	31.0	1,400	9.5
Bering Sea snow crab	223.8	60,555	231.3	62,590	3.3
St. Matthew Island blue king crab	9.0	438	9.4	460	4.4
Pribilof Islands golden king crab	-[b]	-[b]	-[b]	-[b]	-[b]
Eastern Aleutian Islands golden king crab	37.3	669	38.6	692	3.5
Western Aleutian Islands golden king crab	23.4	616	22.9	602	-2.1

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

[b] Confidential.

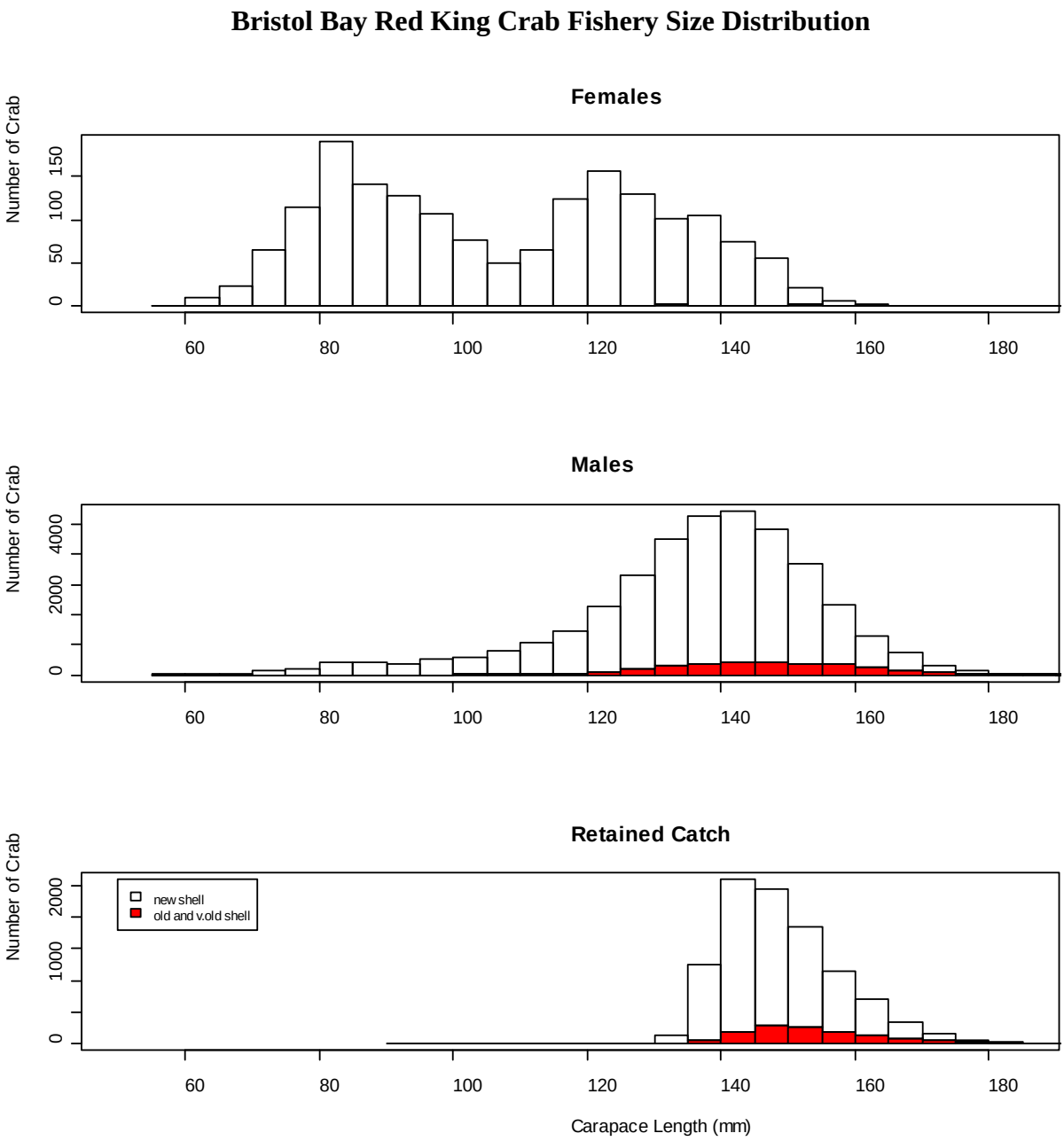


Figure 1.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) red king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2011/12 Bristol Bay red king crab fishery.

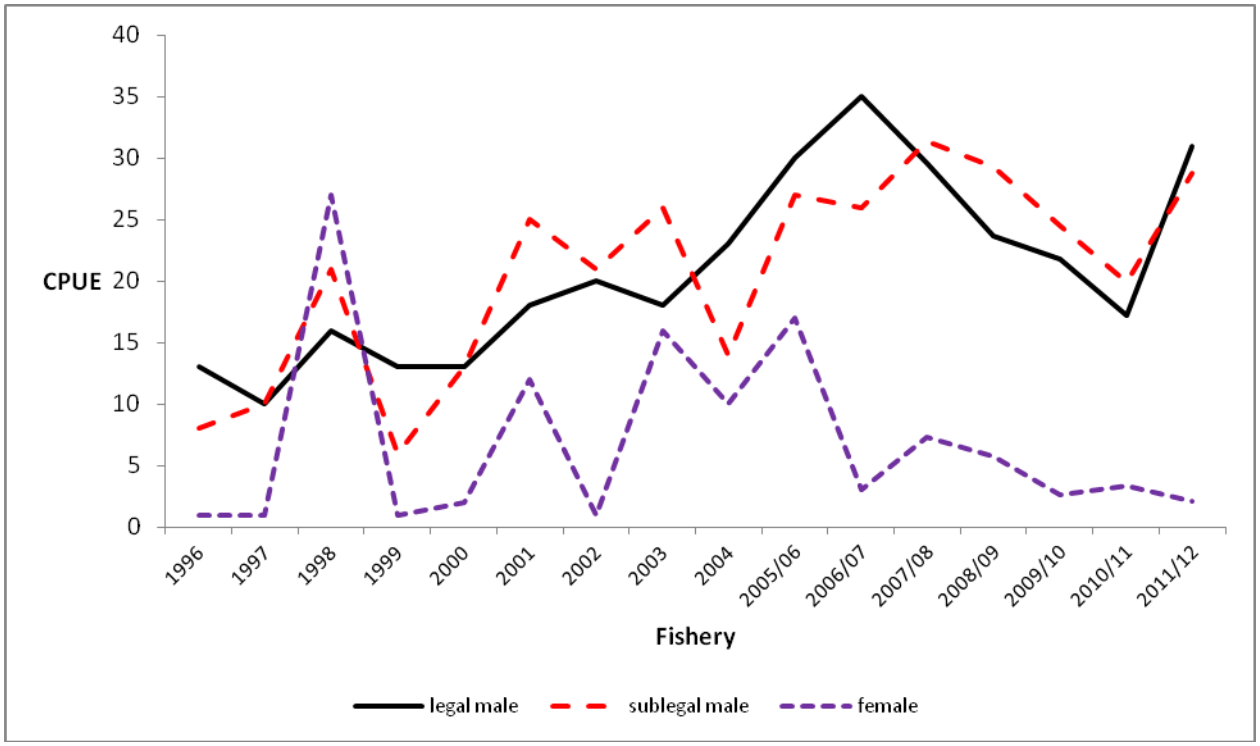


Figure 2.–Estimated red king crab CPUE from pot lifts sampled during the 1996–2011/12 Bristol Bay red king crab fisheries.

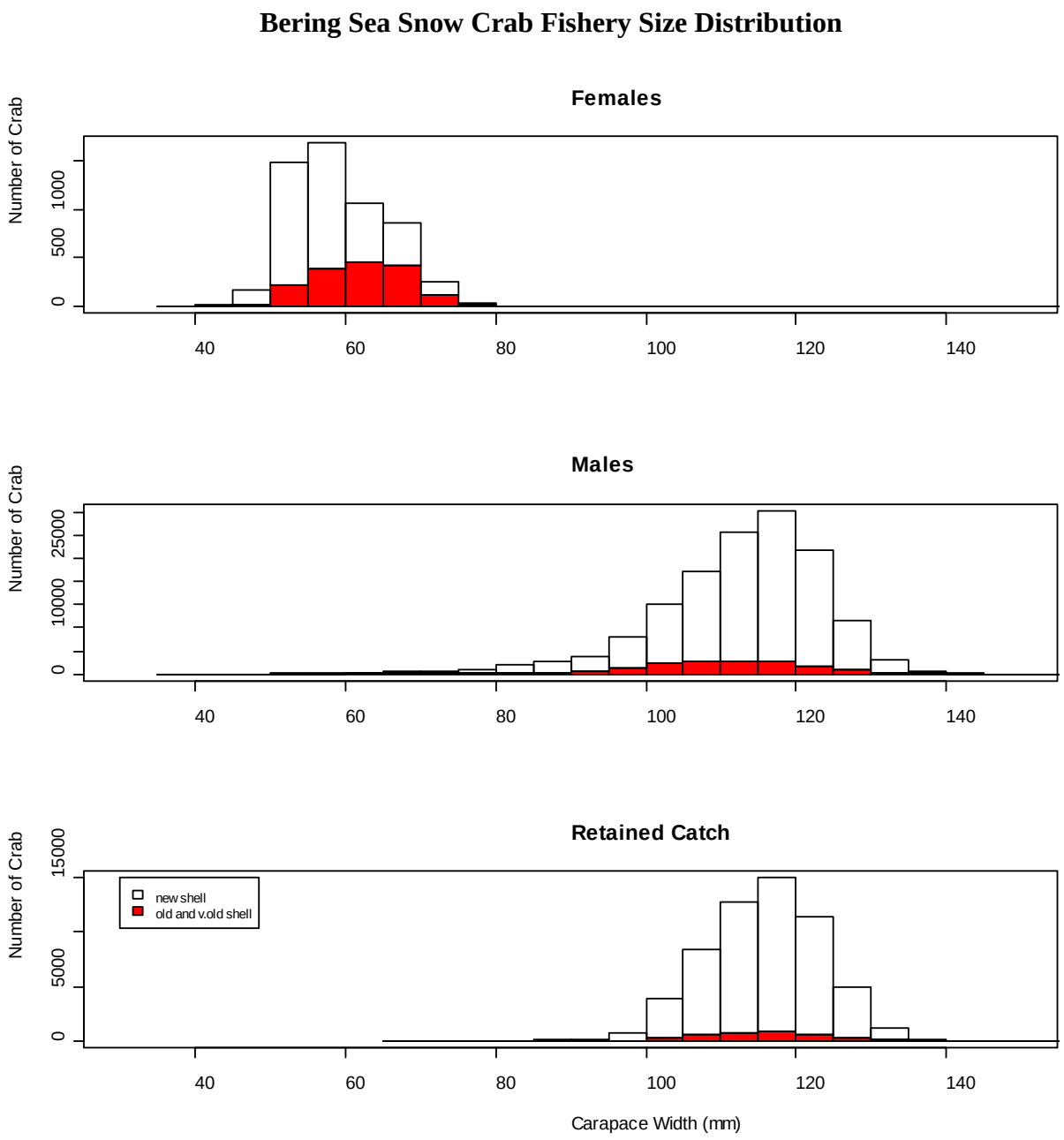


Figure 3.–Carapace width distribution with shell condition for female (top panel) and male (middle panel) red king crab from sampled pot lifts and for males from size-frequency sampling (bottom panel) of retained catch during the 2011/12 directed Bering Sea snow crab fishery.

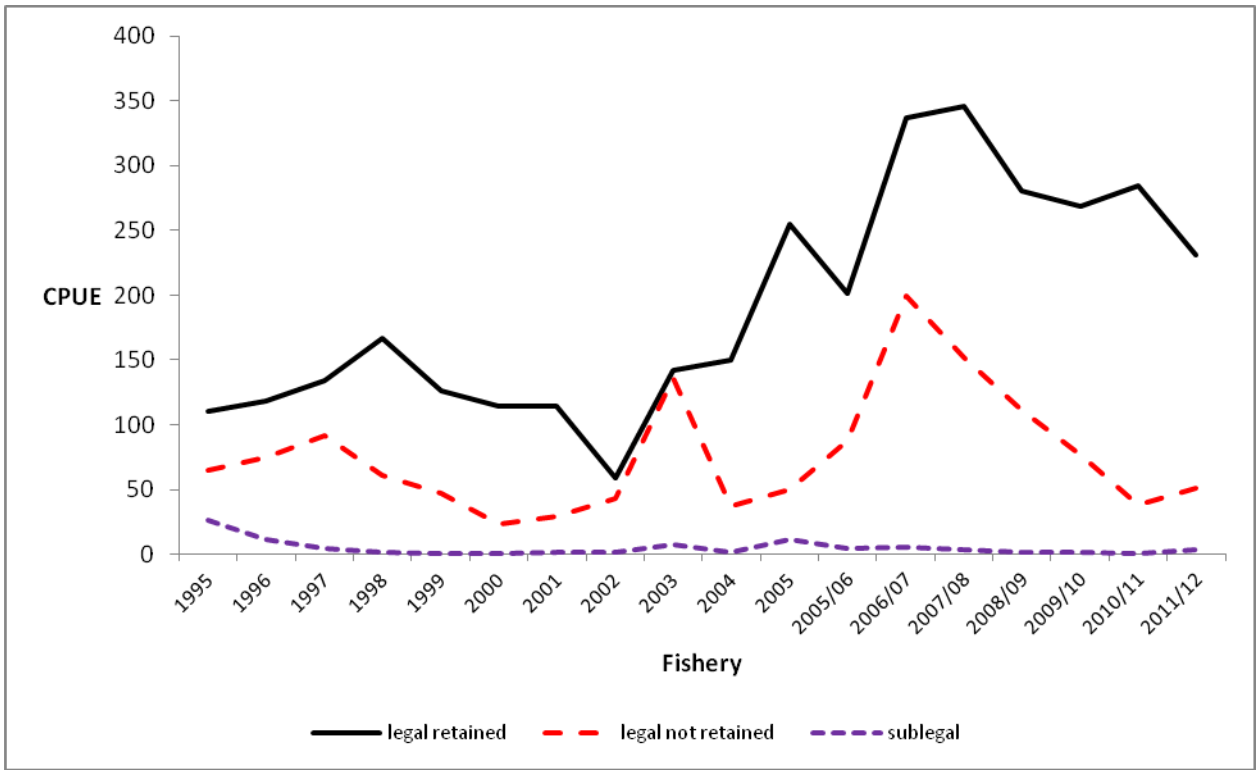


Figure 4.–Estimated snow crab CPUE from pot lifts sampled during the 1995–2011/12 Bering Sea snow crab fisheries.

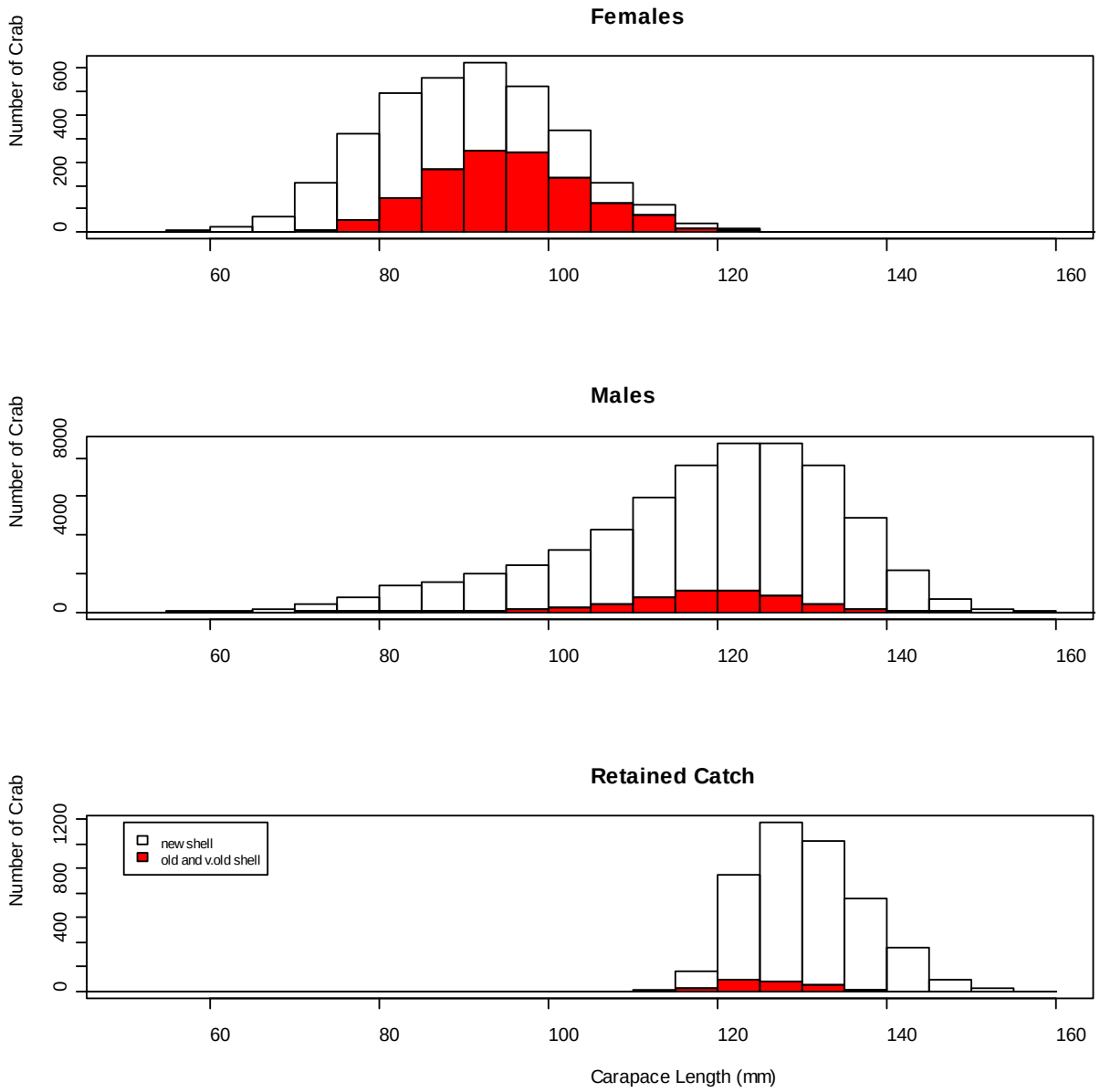
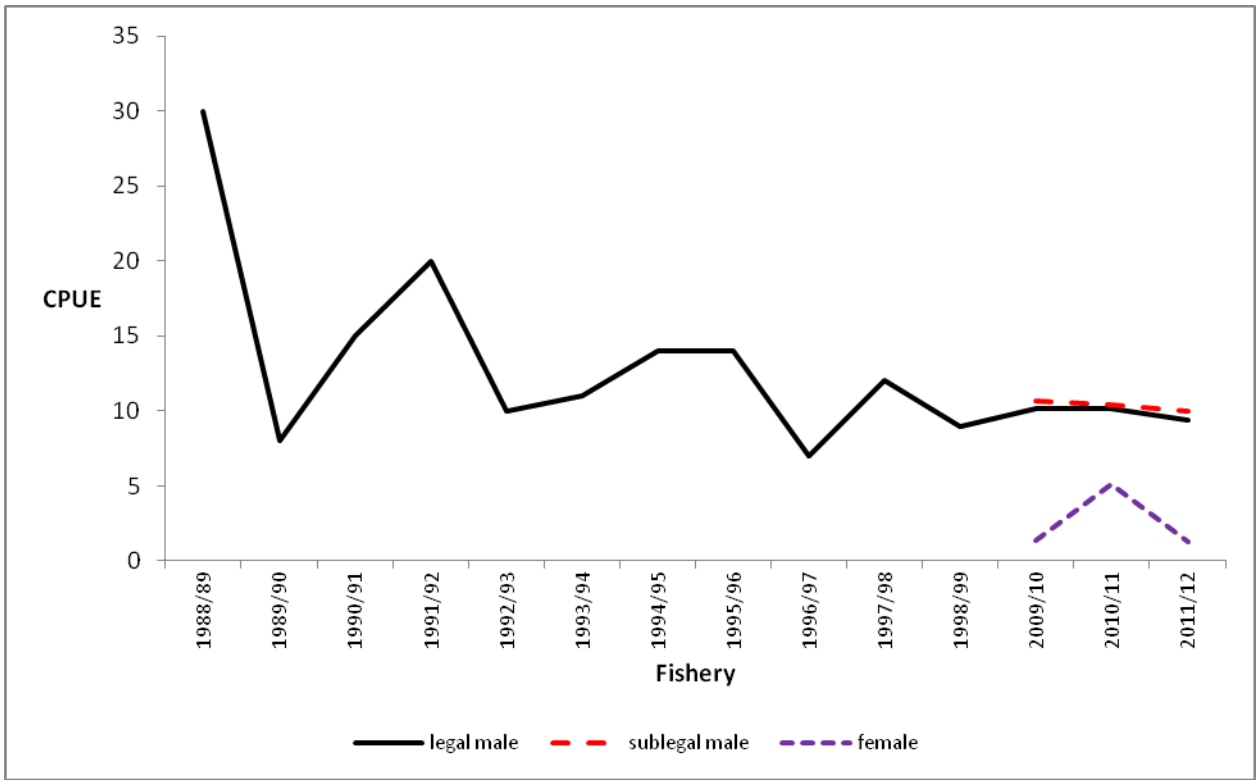


Figure 5.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) blue king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2011/12 St. Matthew Island blue king crab fishery.

St. Matthew Island Blue King Crab Fishery CPUE



Note: The 2009/10, 2010/11, and 2011/12 numbers are estimates from observer data; earlier numbers are ATF-reported values. The fishery was closed for 10 years after the 1998/99 season.

Figure 6.–Estimated blue king crab CPUE from the 1988/89–2011/12 St. Matthew Island blue king crab fisheries.

Pribilof Islands Golden King Crab Fishery Size Distribution

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Figure 7.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) golden king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2011 Pribilof Islands golden king crab fishery.

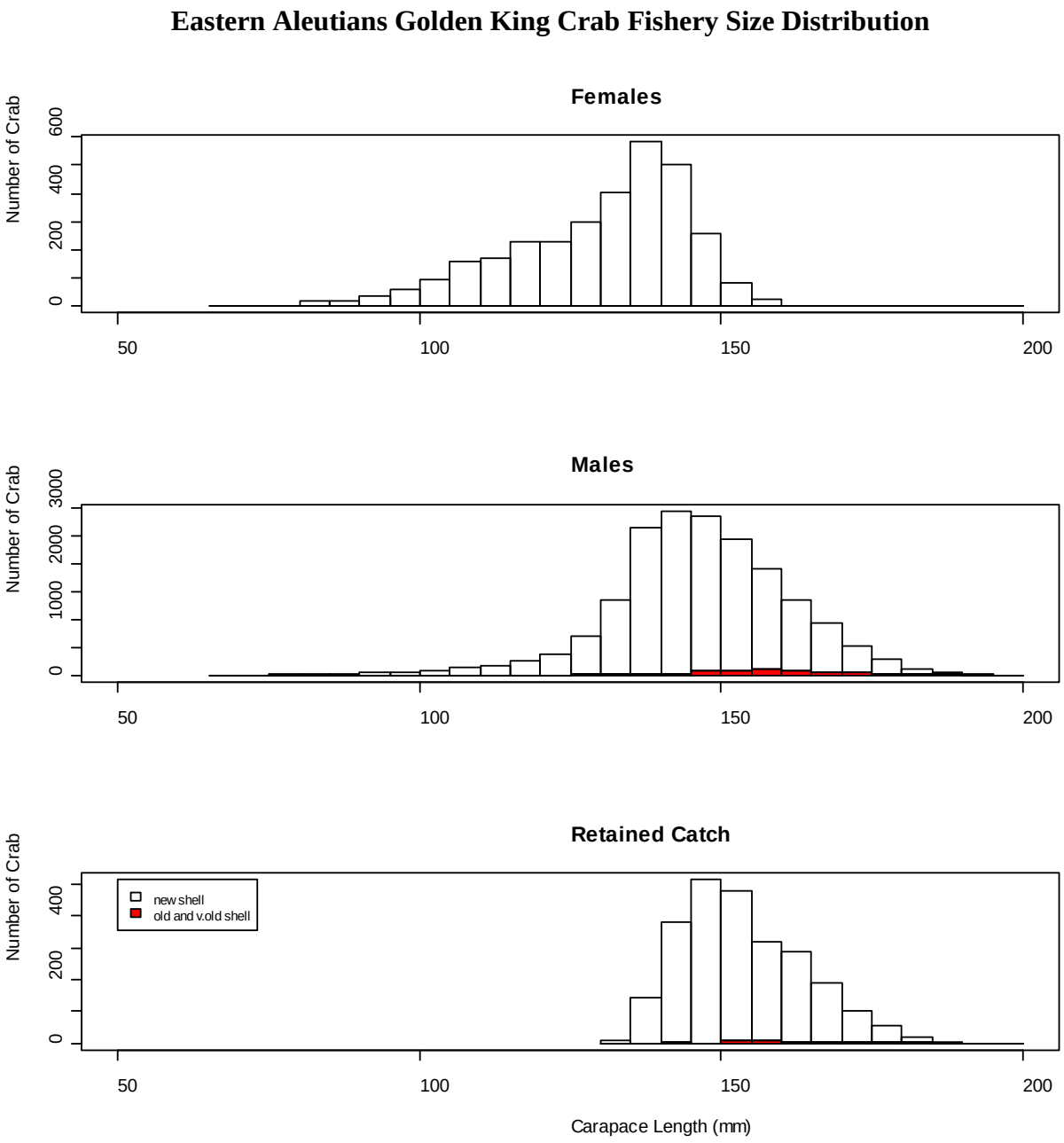

Figure 8.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) golden king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long.

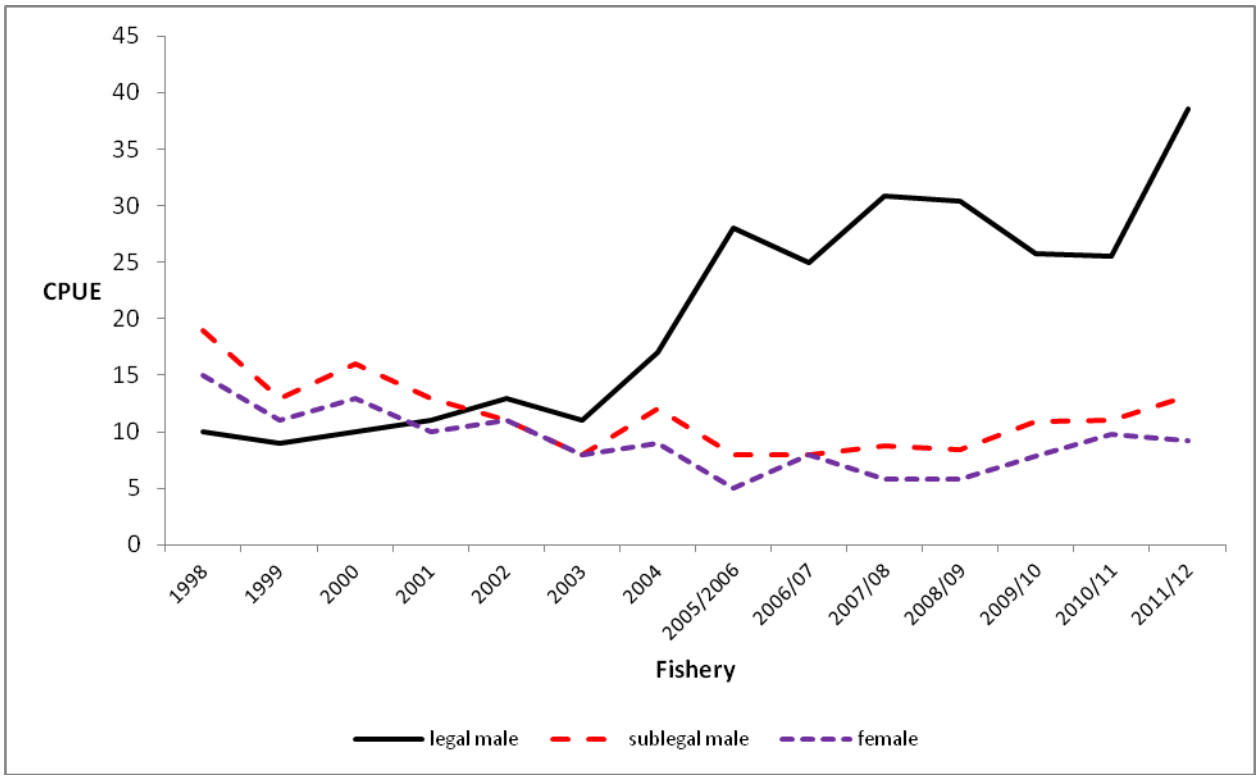

Figure 9.–Estimated golden king crab CPUE from pot lifts sampled during the 1998–2011/12 Aleutian Islands golden king crab fisheries east of 174° W long.

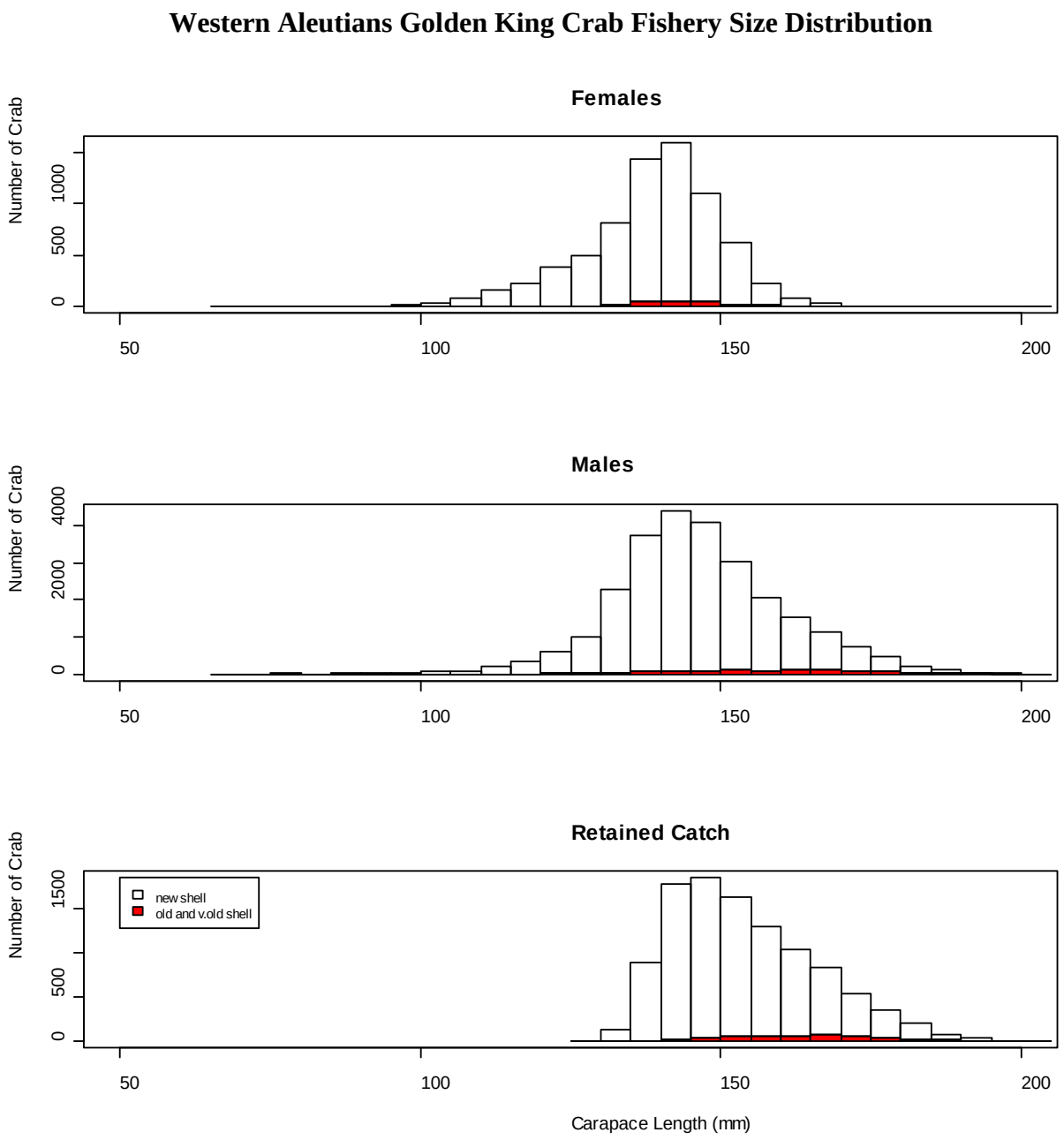

Figure 10.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) golden king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2011/12 Aleutian Islands golden king crab fishery west of 174° W long.

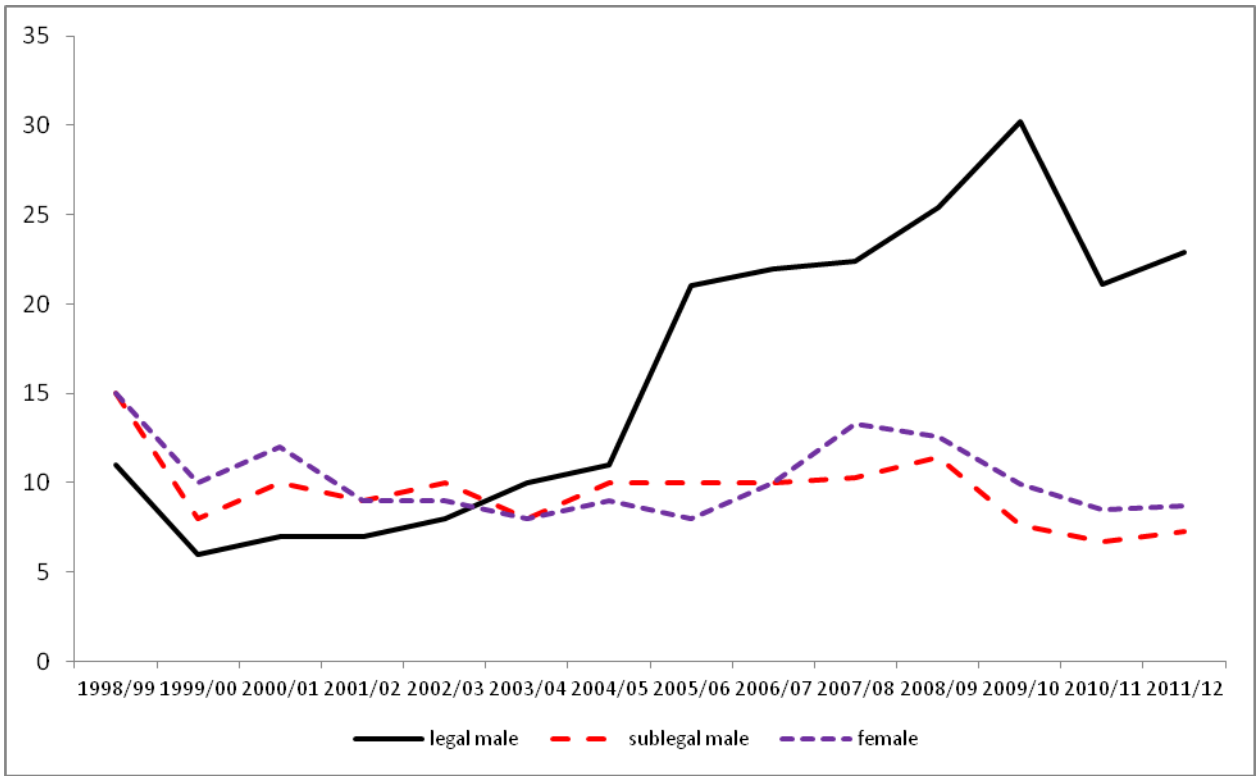

Figure 11.–Estimated golden king crab CPUE from pot lifts sampled during the 1998/99–2011/12 golden king crab fisheries west of 174° W long.

APPENDIX A. ESTIMATION OF CPUE FROM OBSERVER DATA

It is here assumed that under the current sampling design, observed vessels are randomly selected independently within each vessel type, as are 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 given type during fishery

c_{jkl} = number of crab 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 crab per pot on day k

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

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

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

-continued-

by virtue of standard results (e.g. 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 (e.g. from confidential interviews with vessel captians), 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

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$\mu = \frac{\tau_F}{\lambda_F}$ 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. 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 2011/12 Bristol Bay red king crab fishery.

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Appendix B2.–Locations of pot lifts sampled by observers during the 2011/12 Bering Sea snow crab fishery.

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Appendix B3.–Locations of pot lifts sampled by observers during the 2011/12 St Matthew Island blue king crab fishery.

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Appendix B4.–Locations of pot lifts sampled by observers during the 2011 Pribilof Islands golden king crab fishery.

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Appendix B5.–Locations of pot lifts sampled by observers during the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long.

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Appendix B6.–Locations of pot lifts sampled by observers during the 2011/12 Aleutian Islands golden king crab fishery west of 174° W long.

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APPENDIX C. ADDITIONAL CATCH AND BIOLOGICAL SUMMARIES

Appendix C1.–Total contents of 698 pot lifts sampled during the 2011/12 Bristol Bay red king crab fishery.

Commercial crab species	Total catch (number)	Other species	Total catch (number)
Red King Crab		circumboreal toad crab	1
legal	20,949	graceful decorator crab	1
sublegal	19,278	great sculpin	30
female	1,752	hermit crab unident.	1
Tanner Crab		*Hyas* sp.	1
legal	266	jellyfish unident.	110
sublegal	58	Neptune snail unident.	2
female	4	Pacific cod	140
Snow Crab		Pacific halibut	25
legal	92	sculpin unident.	44
sublegal	1	sea anemone unident.	1
female	0	sea cucumber unident.	2
Hybrid Tanner Crab		snail unident.	51
(legally *opilio*[a])		sponge unident.	14
legal	1	starfish unident.	81
sublegal	0	starry flounder	1
female	0	tunicate unident.	15
Hair Crab		yellowfin sole	199
legal	34	yellow Irish lord	3
sublegal	6		
female	23		

[a] Hybrid Tanner crab that are considered to be *C. opilio* by the criteria of 5 AAC 35.521.

Appendix C2.–Red king crab per pot by soak time for 698 pot lifts sampled during the 2011/12 Bristol Bay red crab fishery.

Soak time[a] (hours)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
12-23	4.7	11.1	0.2	23.3	6.3	40.9
24-35	21.3	18.1	0.2	21.3	1.9	41.5
36-47	26.4	28.3	0.4	31.4	2.2	62.3
48-59	12.6	28.9	0.2	31.5	1.4	61.9
60-71	9.2	34.1	0.3	26.2	2.5	63.0
72-83	3.6	41.3	0.2	27.2	0.7	69.4
84-95	2.0	42.8	0.2	51.4	15.2	109.6
96-107	1.3	42.1	0.2	40.4	0.8	83.6
108-119	1.7	25.7	0.1	12.8	0.7	39.2
120-131	0.7	37.0	0.4	19.6	0.6	57.6
132-143	1.3	31.2	0.0	22.4	4.8	58.4
144-155	3.2	35.9	0.0	29.1	2.3	67.4
156-167	1.7	49.8	0.0	23.6	1.2	74.6
168-179	2.0	49.6	0.3	22.9	0.9	73.6
180-191	1.9	39.5	0.0	30.5	8.6	78.7
192-203	2.0	55.4	0.4	30.1	2.1	87.9
204-215	< 0.05	34.0	4.0	7.0	0.0	45.0
216-227	1.3	60.8	4.3	45.2	5.7	116.0
228-239	0.6	42.8	3.3	16.0	0.0	62.0
240-251	1.0	45.4	0.0	15.4	0.1	61.0
252-263	0.3	51.0	13.0	64.0	4.0	132.0
264-275	0.9	56.5	0.0	15.8	0.8	73.2
312-323	0.1	59.0	0.0	48.0	3.0	110.0

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average soak time was 70 hours.

Appendix C3.–Red king crab per pot by depth for 698 pot lifts sampled during the 2011/12 Bristol Bay red king crab fishery.

Depth[a] (fathoms)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
20-24	0.1	18.0	0.0	15.0	15.0	48.0
25-29	4.9	22.3	0.3	18.2	2.0	42.8
30-34	6.6	31.4	0.7	27.0	1.2	60.2
35-39	21.4	29.1	0.3	33.9	3.3	66.6
40-44	32.5	29.4	0.4	28.8	2.3	60.9
45-49	32.8	31.3	0.3	24.9	2.7	59.2
50-54	1.7	29.7	0.3	13.0	0.4	43.3

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average depth was 41 fathoms.

Appendix C4.–Reproductive condition (by percent) of female red king crab from pot lifts sampled during the 1996–2011/12 Bristol Bay red king crab fisheries.

		Ovigerous		Barren	
Year	Number of crab	Eyed eggs	Uneyed eggs	Matted setae	Clean setae
1996	11	0	0	0	100
1997	70	65.7	18.6	0	15.7
1998	4,091	45.6	51.8	<0.1	2.6
1999	36	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
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
2005/06	26,753	41.3	45.0	0.2	13.4
2006/07	3,586	16.5	32.5	1.4	49.5
2007/08	12,451	41.0	41.0	1.7	22.9
2008/09	8,486	50.5	27.8	1.1	20.6
2009/10	6,049	17.2	71.4	1.0	10.2
2010/11	6,840	15.4	76	0.3	8.3
2011/12	1,752	32.8	24.8	0.7	41.4

Appendix C5.–Total contents of 2,235 pot lifts sampled during the 2011/12 Bering Sea snow crab fishery.

Commercial crab species	Total catch (number)	Other species	Total catch (number)
Snow Crab		arrowtooth flounder	3
legal	584,924	basket star	473
sublegal	8,435	bivalve unident.	2
female	21,551	flatfish unident.	3
Tanner Crab		flathead sole	6
legal	25,583	giant octopus	13
sublegal	4434	hairy triton	113
female	601	hermit crab unident.	54
Hybrid Tanner Crab		*Hyas* spp.	53
(legally *opilio*[a])		invertebrate unident.	1
legal	1,514	jellyfish unident.	19
sublegal	4	kelp crab unident.	3
female	37	octopus unident.	17
Hybrid Tanner Crab		Pacific cod	1,275
(legally *bairdi*[b])		Pacific halibut	33
legal	146	Pacific ocean perch	1
sublegal	36	Pribilof neptune	126
female	4	prowfish	3
Blue King Crab		rockfish unident.	3
legal	0	rock sole unident.	1
sublegal	1	sculpin unident.	44
female	0	sea anemone unident.	95
Golden King Crab		sea pen or sea whip unident.	1
legal	1	sea pen unident.	2
sublegal	0	sea urchin unident.	12
female	0	silky buccinum (or ladder whelk)	8
		skate unident.	18
		snail unident.	5,146
		sponge unident.	5
		starfish unident.	28
		tunicate unident.	8
		walleye pollock	35
		weathervane scallop	1
		yellowfin sole	92
		yellow Irish lord	203

[a] Hybrid Tanner crab that are considered to be *C. opilio* by the criteria of 5 AAC 35.521.

[b] Hybrid Tanner crab that are considered to be *C. bairdi* by the criteria of 5 AAC 35.521.

Appendix C6.–Snow crab per pot by soak time for 2,235 pot lifts sampled during the 2011/12 Bering Sea snow crab fishery.

Soak[a] (hours)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
0-11	1.7	61.1	15.8	3.7	39.1	119.7
12-13	23.1	170.5	35.5	2.8	9.2	218.1
24-35	37.6	209.3	45.5	3.5	12.1	270.3
36-47	14.5	217.0	48.6	4.7	6.9	277.3
48-59	6.1	203.8	38.2	2.2	4.4	248.6
60-71	3.0	245.1	52.2	4.1	8.0	309.3
72-83	1.8	275.6	36.7	2.9	3.4	318.6
84-95	1.3	286.0	55.1	3.0	4.8	348.9
96-107	1.7	300.5	32.1	3.7	5.3	341.6
108-119	1.2	255.7	51.9	1.1	2.3	311.1
120-131	1.5	394.7	102.1	5.6	4.5	506.9
132-143	2.0	428.0	83.4	4.2	8.8	524.5
144-155	1.3	356.1	86.0	4.9	12.3	459.3
156-167	1.3	308.9	101.1	7.4	4.9	422.2
168-179	0.3	404.1	160.4	14.3	23.4	602.3
180-191	0.2	286.4	54.0	7.2	4.0	351.6
192-203	0.3	236.9	55.6	0.4	0.0	292.9
204-215	0.4	257.0	31.1	0.1	0.0	288.2
216-227	0.4	341.0	23.3	2.1	0.0	366.4
228-239	0.1	169.3	17.3	0.0	0.3	187.0
240+	0.1	43.0	7.0	0.0	0.0	50.0

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average soak time was 44 hours.

Appendix C7.–Snow crab per pot by depth for 2,235 pot lifts sampled during the 2011/12 Bering Sea snow crab fishery.

Depth[a] (fathoms)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
< 50	0.2	328.0	249.8	35.8	102.3	715.9
50-54	0.2	4.0	1.3	1.0	2.8	9.0
55-59	3.5	255.9	148.8	14.4	61.8	480.9
60-64	27.8	226.4	51.2	4.2	20.3	302.1
65-69	33.3	230.2	49.9	4.4	4.4	288.9
70-74	21.2	196.0	28.1	1.2	0.5	225.8
75-79	10.4	179.0	23.3	0.6	0.6	203.5
80-84	2.3	231.0	35.9	0.1	0.0	267.0
85-89	0.6	85.8	6.9	0.0	0.0	92.6
90-94	0.1	0.0	0.0	0.0	0.0	0.0
95-99	0.2	145.8	27.3	0.0	0.0	173.0
100+	0.2	116.5	30.0	3.5	5.5	155.5

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average depth was 68 fathoms.

Appendix C8.–Reproductive condition (by percent) of female snow crab from pot lifts sampled during the 1995–2011/12 Bering Sea snow crab fisheries.

		Ovigerous		Barren	
Year	Number of crab	Eyed eggs	Uneyed eggs	Matted setae	Clean setae
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	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
2005/06	129	6.2	89.2	2.3	2.3
2006/07	57	84.2	14.0	0	1.8
2007/08	365	21.9	71.0	1.6	3.8
2008/09	461	28.4	71.4	0	0.2
2009/10	246	3.3	64.2	8.9	22.8
2010/11	459	3.7	56.0	11.1	29.2
2011/12	5,607	88.7	4.6	3.5	2.5

Appendix C9.–Total contents of 3,359 pot lifts sampled during the 2011/12 St. Matthew Island blue king crab fishery.

Commerical crab species	Total catch (number)	Other species	Total catch (number)
Blue King Crab		arrowtooth flounder	12
legal	31,269	basket star	105
sublegal	31,632	bigmouth sculpin	23
female	4,138	brittle star unident.	69
Snow Crab		bryozoan unident.	1
legal	2,129	circumboreal toad crab	615
sublegal	541	eelpout unident.	1
female	103	flatfish unident.	7
Tanner Crab		flathead sole	3
legal	4	giant octopus	5
sublegal	24	great sculpin	122
female	5	Greenland turbot	2
Red King Crab		helmet crab	1
legal	2	hermit crab unident.	595
sublegal	1	invertebrate unident.	6
female	0	jellyfish unident.	289
		Kamchatka flounder	3
		nudibranch unident.	1
		octopus unident.	4
		Pacific cod	873
		Pacific halibut	136
		Pacific lyre crab	25
		sand dollar unident.	8
		sculpin unident.	174
		sea anemone unident.	3
		sea cucumber unident.	2
		sea spider unident.	1
		sea urchin unident.	5
		skate unident.	25
		snailfish unident.	26
		snail unident.	1,731
		sponge unident.	5
		starfish unident.	152
		tunicate unident.	1
		walleye pollock	18
		worm unident.	1
		yellowfin sole	22
		yellow Irish lord	54

Appendix C10.–Blue king crab per pot by soak time for 3,359 pot lifts sampled during the 2011/12 St. Matthew Island blue king crab fishery.

Soak time[a] (hours)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
0-11	0.2	1.1	0.0	3.4	14.4	18.9
12-23	17.5	8.6	0.3	12.2	1.6	22.7
24-35	34.1	9.2	0.1	10.9	1.5	21.7
36-47	15.0	10.7	0.1	10.4	1.7	22.9
48-59	8.7	10.2	0.2	8.1	0.7	19.1
60-71	4.5	9.5	0.1	6.6	0.4	16.6
72-83	3.3	9.6	0.2	9.0	0.7	19.5
84-95	3.1	6.5	0.1	5.4	0.7	12.7
96-107	4.4	10.0	0.2	5.0	0.1	15.4
108-119	3.3	7.3	0.2	4.5	0.3	12.2
120-131	2.5	7.9	0.2	4.4	0.2	12.7
132-143	0.7	6.7	0.3	3.2	0.2	10.4
144-155	1.1	8.3	0.1	2.7	0.4	11.4
156-167	0.3	5.1	0.0	1.9	0.0	7.0
168-179	0.1	2.0	0.0	0.3	0.0	2.3
180-191	0.2	0.7	0.0	0.9	0.0	1.6
192-203	0.4	4.5	0.1	0.7	0.1	5.3
204-215	0.0	18.0	1.0	16.0	0.0	35.0
216-227	0.1	3.3	0.0	1.7	0.0	5.0
240-251	0.1	2.7	0.0	0.7	0.0	3.3
264-275	0.1	2.2	0.0	1.2	0.2	3.6
276-287	0.1	0.8	0.0	0.5	0.0	1.3

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average soak time was 50 hours.

Appendix C11.–Blue king crab per pot by depth for 3,359 pot lifts sampled during the 2011/12 St. Matthew Island blue king crab fishery.

Depth[a] (fathoms)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
20-24	0.4	1.5	0.1	1.5	1.0	4.0
25-29	1.0	3.5	0.0	3.7	7.8	15.0
30-34	3.0	6.2	0.3	12.9	5.2	24.6
35-39	4.3	8.3	0.7	16.3	15.1	40.4
40-44	27.9	8.9	0.2	8.8	1.0	18.9
45-49	45.6	10.0	0.1	9.8	0.2	20.1
50-54	14.4	9.0	0.1	7.6	0.0	16.7
55-59	3.4	7.3	0.0	7.6	0.0	14.9

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average depth was 45 fathoms.

Appendix C12.–Reproductive condition (by percent) of female blue king crab from pot lifts sampled during the 2009/10–2011/12 St. Matthew Island blue king crab fisheries.

		Ovigerous		Barren	
Year	Number of crab	Eyed eggs	Uneyed eggs	Matted setae	Clean setae
2009/10	1,638	1.2	13.2	40.8	44.6
2010/11	10,948	0.6	58.9	15.0	25.6
2011/12	4,138	0.9	13.3	62.0	23.5

Appendix C13.–Total contents of 463 pot lifts sampled during the 2011 Pribilof Islands golden king crab fishery.

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Appendix C14.–Golden king crab per pot by soak time for 463 pot lifts sampled during the 2011 Pribilof Islands golden king crab fishery.

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Appendix C15.–Golden king crab per pot by depth for 463 pot lifts sampled during the 2011 Pribilof Islands golden king crab fishery.

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Appendix C16.–Reproductive condition (by percent) of female golden king crab from pot lifts sampled during the 2010 and 2011 Pribilof Islands golden king crab fisheries.

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Appendix C17.–Total pot lift contents for 361 pot lifts sampled during the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long.

Commerical crab species	Total catch (number)	Other species	Total catch (number)
Golden King Crab		*Alaskagorgia aleutiana*	1
legal	14,486	*Anthomastus* spp.	2
sublegal	4,620	*Arthrogorgia* spp.	4
female	3,173	basket star	188
Scarlet King Crab		brittle star unident.	41
legal	0	bryozoan unident.	9
sublegal	0	*Calcigorgia* spp.	6
female	1	*Caryophyllia* sp.	1
		chiton unident.	2
		Clavularia spp.	6
		Crypthelia sp.	1
		Cyclohelia spp.	12
		Distichopora spp.	5
		Errinopora spp.	3
		Fanellia spp.	9
		hydroid unident.	113
		Kamchatka coral (or bubblegum coral)	3
		Pacific halibut	3
		Plexauridae unident.	8
		Primnoidae Group I	31
		red-tree coral	3
		sea lily (or feather star) unident.	1
		sea spider unident.	2
		sea urchin unident.	5
		skate unident.	3
		snail unident.	14
		sponge unident.	98
		starfish unident.	13
		Stylaster spp.	38
		tunicate unident.	3
		worm unident.	6

Appendix C18.–Golden king crab per pot by soak time for 361 pot lifts sampled during the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long.

Soak time[a] (days)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
4-5	1.4	28.8	0.0	0.2	0.0	29.0
6-7	3.0	22.9	0.1	2.5	1.5	27.0
8-9	6.6	35.2	0.1	11.0	5.0	51.3
10-11	10.0	31.9	0.4	15.2	5.4	52.9
12-13	8.3	28.1	0.9	14.8	10.7	54.6
14-15	11.1	33.6	1.8	15.4	6.2	56.9
16-17	11.4	45.4	1.3	16.1	12.5	75.4
18-19	9.4	47.7	1.3	13.6	12.1	74.7
20-21	5.0	48.2	0.1	6.1	4.1	58.4
22-23	3.3	40.9	5.4	11.4	14.5	72.3
24-25	9.7	41.4	3.9	14.5	11.6	71.3
26-27	15.5	35.0	3.2	10.5	9.3	58.0
28-29	3.0	56.9	4.3	12.2	13.8	87.2
30-31	1.4	51.4	1.4	13.8	2.8	69.4
36-37	0.8	36.7	5.3	17.3	2.3	61.7

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average soak time was 18.5 days.

Appendix C19.–Golden king crab per pot by depth for 361 pot lifts sampled during the 2011/12 Aleutian Islands golden king crab fishery east of 174° W long.

Depth[a] (fathoms)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
80-99	3.9	30.4	2.8	18.0	4.1	55.4
100-119	15.8	33.0	1.9	8.2	6.3	49.3
120-139	11.9	38.1	0.7	8.7	3.4	50.9
140-159	14.1	38.8	1.6	9.6	6.8	56.8
160-179	8.0	43.1	1.2	11.9	10.3	66.5
180-199	5.0	41.4	1.4	11.0	12.4	66.2
200-219	6.1	41.6	1.7	14.6	14.2	72.0
220-239	6.9	40.7	1.8	13.4	11.2	67.1
240-259	6.6	42.0	1.7	14.7	9.8	68.2
260-279	7.2	35.8	2.1	16.4	10.3	64.6
280-299	5.0	37.5	2.7	18.6	9.8	68.6
300-319	6.4	39.3	3.5	22.9	18.0	83.7
320-339	2.8	39.4	4.2	18.7	4.0	66.3
340-359	0.3	52.0	6.0	13.0	11.0	82.0

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average depth was 189 fathoms.

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Appendix C20.–Reproductive condition (by percent) of female golden king crab from pot lifts sampled during the 1996/97–2011/12 Aleutian Islands golden king crab fisheries east of 174° W long.

		Ovigerous		Barren	
Year	Number of crab	Eyed eggs	Uneyed eggs	Matted setae	Clean setae
1996/97	59,210	20.8	22.5	18.6	38.1
1997/98	5,383	25.2	19.3	22.1	33.4
1998/99	44,352	18.1	21.0	23.9	37.0
1999/00	36,695	22.1	21.0	23.1	33.8
2000/01	13,615	26.9	18.7	20.1	34.3
2001/02	14,912	20.4	12.5	15.4	51.1
2002/03	9,651	29.6	19.2	18.9	32.3
2003/04	7,990	20.9	33.2	13.6	31.5
2004/05	5,430	24.9	24.7	24.9	25.5
2005/06	1,489	25.8	25.2	18.3	30.7
2006/07	2,328	29.6	35.7	9.1	25.6
2007/08	1,397	18.3	52.5	10.1	19.1
2008/09	2,308	31.3	35.3	17.9	15.5
2009/10	2,604	45.0	26.8	9.4	18.3
2010/11	3,769	40.8	32.3	8.1	18.8
2011/12	3,173	37.4	21.6	26.3	12.7

Appendix C21.–Total pot lift contents for 837 pot lifts sampled during the 2011/12 Aleutian Islands golden king crab fishery west of 174° W long.

Commercial crab species	Total catch (number)	Other species	Total catch (number)	Other species	Total catch (number)
Golden King Crab		*Anthomastus* spp.	10	*Lillipathes* spp.	2
legal	20,131	*Arthrogorgia* spp.	10	octopus unident.	3
sublegal	5,987	Atka mackerel	3	Pacific halibut	3
female	7,370	barnacle unident.	1	Pacific ocean perch	7
Red King Crab		basket star	260	Plexauridae unident.	14
legal	0	*Bathypathes* sp.	1	Primnoidae Group I	84
sublegal	0	bigmouth sculpin	1	Primnoidae unident.	6
female	1	black rockfish	1	red-tree coral	10
Scarlet King Crab		brittle star unident.	134	rockfish unident.	2
legal	12	bryozoan unident.	3	rougheye rockfish	1
sublegal	0	*Calcigorgia* spp.	10	scale worm unident.	1
female	0	*Clavularia* sp.	1	scallop unident.	1
		Crypthelia spp.	4	sculpin unident.	1
		Cup coral unident.	3	sea cucumber unident.	1
		Cyclohelia spp.	12	sea lily unident.	8
		Distichopora spp.	5	sea urchin unident.	25
		Dover sole	2	sea whip unident.	3
		eelpout unident.	1	shortspine thornyhead	2
		Errinopora spp.	3	skate unident.	2
		Fanellia spp.	37	snail unident.	11
		giant octopus	1	soft coral unident.	22
		Greenland turbot	1	sponge unident.	194
		hairy triton	18	starfish unident.	73
		hermit crab unident.	2	*Stylaster* spp.	73
		hydroid unident.	1	worm unident.	1
		bubblegum coral	6		

Appendix C22.–Golden king crab per pot by soak time for 837 pot lifts sampled during the 2011/12 Aleutian Islands golden king crab fishery west of 174° W long.

Soak time[a] (days)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
6-7	0.2	34.0	0.5	13.0	7.0	54.5
8-9	0.2	19.5	4.5	7.5	4.5	36.0
10-11	0.1	21.0	1.0	7.0	0.0	29.0
14-15	0.4	46.0	1.7	11.0	0.0	58.7
16-17	9.6	23.0	0.9	10.7	7.3	42.0
18-19	11.6	21.8	1.0	9.3	4.4	36.5
20-21	13.3	17.0	0.6	7.9	5.8	31.3
22-23	9.7	24.9	1.7	6.5	19.7	52.9
24-25	3.7	35.3	0.9	12.5	7.5	56.2
26-27	4.9	16.0	0.8	5.4	8.9	31.1
28-29	9.7	21.0	1.0	7.3	10.8	40.1
30-31	9.5	24.2	0.9	4.9	11.1	41.1
32-33	5.2	31.1	0.2	5.7	10.6	47.7
34-35	3.0	18.8	0.3	3.1	10.0	32.2
36-37	2.3	23.3	0.4	3.1	7.9	34.8
38-39	2.2	17.3	0.9	4.2	10.6	33.1
40-41	2.4	30.8	0.3	3.7	6.3	41.0
42-43	1.3	29.0	0.5	5.4	2.9	37.7
44-45	3.8	27.8	0.2	5.1	5.1	38.2
46-47	3.0	35.3	1.1	11.5	7.4	55.3
48-49	1.4	21.5	0.7	1.2	9.8	33.1
50-51	0.7	19.3	0.5	0.8	4.8	25.5
52-53	1.0	21.0	0.6	1.4	4.3	27.3
54-55	0.2	29.5	0.0	20.0	4.5	54.0
56-57	0.2	6.5	0.0	1.0	0.0	7.5
64-65	0.1	21.0	0.0	0.0	0.0	21.0

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average soak time was 27.7 days.

Appendix C23.–Golden king crab per pot by depth for 837 pot lifts sampled during the 2011/12 Aleutian Islands golden king crab fishery west of 174° W long.

Depth[a] (fathoms)	Percent of sampled pots	Number of crab per pot				
		LRT	LNR	SUB	FEM	Total
50-74	0.7	1.3	0.2	0.0	1.0	2.5
75-99	4.4	26.6	1.3	5.0	8.5	41.3
100-124	9.8	26.2	0.8	6.6	10.3	43.8
125-149	17.8	29.0	0.8	6.0	10.0	45.8
150-174	20.8	23.5	0.7	8.3	7.9	40.4
175-199	21.4	21.2	0.6	5.8	4.1	31.8
200-224	14.4	19.8	1.2	10.6	9.8	41.4
225-249	7.4	17.2	1.1	5.5	14.4	38.3
250-274	1.9	24.7	0.8	4.2	29.4	59.0
275-299	0.7	27.8	1.5	19.5	8.0	56.8
300-324	0.4	17.7	0.7	5.7	18.0	42.0
375-399	0.1	32.0	1.0	15.0	0.0	48.0
475-499	0.1	36.0	0.0	11.0	14.0	61.0

Note: Observers categorize all sampled crabs as either legal-size retained male (LRT), legal-size non-retained male (LNR), sublegal male (SUB), or female (FEM).

[a] Average depth was 170 fathoms.

Appendix C24.–Reproductive condition (by percent) of female golden king crab from pot lifts sampled during the 1996/97–2011/12 Aleutian Islands golden king crab fisheries west of 174° W long.

		Ovigerous		Barren	
Year	Number of crab	Eyed eggs	Uneyed eggs	Matted setae	Clean setae
1996/97	67,314	23.6	25.5	21.2	29.6
1997/98	39,343	24.0	26.8	19.8	29.4
1998/99	22,208	23.4	25.9	16.3	34.4
1999/00	45,645	21.3	29.6	19.1	29.9
2000/01	53,716	26.2	28.7	17.1	27.9
2001/02	38,829	26.6	27.8	22.4	23.2
2002/03	22,479	32.8	20.9	11.9	33.9
2003/04	5,946	32.8	26.8	19.2	21.2
2004/05	12,970	26.1	31.7	21.6	20.6
2005/06	5,798	35.2	33.5	21.7	9.6
2006/07	7,136	31.6	36.0	19.3	13.0
2007/08	9,281	43.2	23.9	19.1	13.8
2008/09	7,922	27.5	34.5	15.3	22.7
2009/10	7,155	31.3	30.3	29.1	5.9
2010/11	7,382	31.3	33.4	20.0	15.3
2011/12	7,370	31.6	29.1	19.6	18.5

APPENDIX D. RESULTS OF LEGAL TALLY SAMPLES

Appendix D1.–Results of ADF&G legal tally samples from the 2010/11 Bering Sea and Aleutian Islands directed crab fisheries.

Fishery	Sample size	Percent of landed catch[a]	Number of illegal crabs: Male	Female	Non-target species	Total	Percent illegal
Bristol Bay red king crab	16,079	1.3	43	0	0	43	0.27
Bering Sea snow crab	128,155	0.2	26	18	227	271	0.21
St. Matthew Island blue king crab	22,398	5.1	91	1	0	92	0.41
Pribilof Islands golden king crab	-[d]	-[d]	-[d]	-[d]	-[d]	-[d]	-[d]
E. Aleutian Islands golden king crab[b]	8,305	1.2	22	4	0	26	0.31
W. Aleutian Islands golden king crab[c]	18,875	3.1	111	2	0	113	0.60

[a] Based on ATF reported catch number.

[b] East of 174° W long.

[c] West of 174° W long.

[d] Confidential.