Fishery Data Series No. 13-54

Summary of the 2012/2013 Mandatory Crab Observer Program Database for the Bering Sea/Aleutian Islands Commercial Crab Fisheries

by

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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. 13-54

SUMMARY OF THE 2012/2013 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 2012/13 BSAI commercial crab fisheries and the 2012 Pribilof Islands golden king crab commercial 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 species, sex, 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 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 2012/13 Bristol Bay red king crab fishery, 2012/13 Bering Sea snow crab fishery, 2012/13 St. Matthew Island blue king crab fishery, 2012 Pribilof Islands golden king crab fishery, and 2012/13 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 single catcher vessel permitted to harvest Pribilof Island golden king crab during 2012. 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 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 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 2012/13 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 2012 ADF&G Crab Observer Training and Deployment Manual.[1]

[1] Crab Observer Training and Deployment Manual. September 2012. 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.

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[2] Shellfish Dockside Sampling Manual. September 2012. 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, DFLs, 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 2012/13 Bristol Bay red king crab and Bering Sea snow crab fisheries and accounted for approximately 3% and 7%, respectively, of all pot lifts (ADF&G data from confidential interviews with vessel captains). 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 2012/13 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.

7.853 million pounds, with legal male crab at least 6.5 in LM. Two catcher-processors and 63 catcher vessels participated. Onboard observers sampled 437 (1.1%) of the ATF reported total of 38,144 pot lifts (Table 1). Appendix B1 shows locations of sampled pot lifts.

Onboard observers collected CL measurements of 20,017 male red king crab from sampled pot lifts (Figure 1). Average CL was 142.9 mm, and 91.1% of the crab were classified as new shell. CL measurements of 562 female red king crab from sampled pot lifts averaged 115.3 mm, and 98.8% of the females were classified as new shell. CL measurements were also recorded for 8,957 male red king crab by onboard observers and dockside samplers in size-frequency sampling of retained catch. Average CL was 154.3 mm, and 86.8% of the sampled crab were new shell.

Estimated fishery CPUE of legal-retained red king crab was 31.0 crab per pot lift, close to the ATF reported value of 30.3, with 95% confidence interval (25.85, 36.05), from a t-distribution as detailed in Appendix A (Table 2). The 2012/13 estimate was identical to the previous year's value, which in turn was roughly twice as high as the 2010/11 value (Figure 2). Estimated bycatch of discarded sublegal males was 16.9 crab per pot lift, about half last year's value of 28.8; estimated female bycatch was 1.6 crab per pot lift, also down from last year's value. Some incidental bycatch of discarded Tanner and snow crab, mostly males, was also observed in this fishery.

Total catches of all animals identified in sampled pot lifts during the 2012/13 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 2012/13 season by onboard observers and dockside samplers totaled 11,320 crabs, accounting for 1.0% of the fishery reported harvest (Appendix D1). Approximately 0.27% of all sampled crabs were illegal, all but one of them sublegal male red king crab.

BERING SEA SNOW CRAB

The 2012/13 Bering Sea snow crab fishery opened October 15 with a TAC of 66.350 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.) 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.). Two catcher-processor vessels and 68 catcher vessels participated. Onboard observers sampled 2,532 (1.1%) of the ATF reported 225,489 pot lifts (Table 1). Sampled pot lift locations are shown in Appendix B2.

Onboard observers collected CW measurements of 234,120 male snow crab during pot lift sampling (Figure 3). Average CW was 108.2 mm and 87.6% of the crab were categorized as new shell. Average female snow crab CW was 70.7 mm, based on 1,607 measured females, with 83.2% of them judged new shell. CW measurements were additionally recorded on 46,330 male snow crab in size-frequency sampling of retained catch; average CW was 113.1 mm and 90.8% of the crab were new shell.

Estimated CPUE of legal-retained snow crab was 213.1 crab per pot lift in 2012/13 (Table 3), with 95% confidence interval (187.50, 238.67). Like the similar 2012/13 ATF reported value of

210.5, it continues a general decline over the last few years (Figure 4). By contrast, average catch per pot for discarded legal-size males, mostly animals smaller than 4 in (~102 mm) CW, increased in 2012/13. 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 55-thousand retained males judged legally retainable by the criteria of 5 AAC 35.521. In addition, observers recorded 59 male blue king crab, but these occurred mostly in just a few pots south of St. Matthew Island, with a single pot accounting for 15 of the 59, suggesting that extrapolation to the overall fishery would be inappropriate.

Total catches of all animals identified in sampled pot lifts during the 2012/13 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 102,434 crabs, which accounted for 0.2% of the reported total catch (Appendix D1). Of those, 0.15% were illegal, most of them non-target Tanner *C. bairdi*. By contrast, most of the illegal crabs encountered in in other 2012/13 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 fourth consecutive time since 1998 on October 15, 2012 with a TAC of 1.630 million pounds and closed by regulation February 1, 2013, though fishing was completed in early Dec 2012. Legal harvest was limited to male crab at least 5.5 in LM. All 17 participating catcher vessels were required to carry an observer (Table 1). Of the ATF reported 37,065 pot lifts in this fishery, observers sampled 2,841 (7.7%). Locations of sampled pot lifts are mapped in Appendix B3.

Observers measured the CL of 61,975 male and 12,770 female blue king crab in pot lift sampling (Figure 5). Respective average CL values were 116.8 mm and 89.1 mm. Observers recorded 92.0% of the males and 65.5% of the females as new shell. Size-frequency sampling of 4,278 fishery-retained male blue king crab yielded an average CL of 129.8 mm, with 92.7% of the sampled animals judged new shell.

Estimated 2012/13 CPUE of legal-retained crab was 10.1 crab per pot lift (Table 4), with approximate 95% confidence interval (9.94, 10.36). The 2012/13 ATF reported value was 10.2. Catch rates in this fishery since its resumption in 2009/10 have been stable but low by comparison to historical fishery performance (Figure 6). Estimated bycatch of discarded sublegal males exceeded the legal catch in 2012/13, as has been generally true since resumption of the fishery, and estimated female discard CPUE was up significantly from 2011/12 at 5.5 crab per pot lift. Some incidental bycatch of subsequently discarded snow crab occurred in the 2012/13 St. Matthew Island blue king crab fishery, most of it consisting of a mix of sublegal and legal-size males.

Total catches of all animals identified in sampled pot lifts during the 2012/13 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 19,597 crabs, or 5.2% of the reported harvest (Appendix D1). Approximately 0.37% of the sampled animals were illegal, all but one of them sublegal make blue king crab.

PRIBILOF ISLANDS GOLDEN KING CRAB

This non-rationalized fishery is currently managed using a Guideline Harvest Level 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 a single catcher vessel made landings in 2012 (Table 1), all information relating to the specifics of fishing activity and observer sampling effort is confidential.

ALEUTIAN ISLANDS GOLDEN KING CRAB

The Board of Fisheries 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 2012). In 2012/13 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 2012/13 Aleutian Islands golden king crab fishery east of 174° W long., where the TAC was set at 3.31 million pounds. Onboard observers sampled 438 pot lifts accounting for 2.1% of the ATF reported 20,827 pot lifts in the fishery (Table 1). Appendix B5 shows sampled pot lift locations.

Average CL of 20,739 male golden king crab measured in pot lift sampling was 148.0 mm, and 98.2% were new shell; average CL of 4,510 measured females was 132.4 mm, and 99.7% were new shell (Figure 8). In size-frequency sampling of 2,962 retained crab, average CL was 153.5 mm, and 98.3% were recorded as new shell.

Estimated legal-retained CPUE was 36.0 crab per pot lift (Table 6), with 95% confidence interval (34.23, 37.75). Although this value is somewhat higher than the 2012/13 ATF reported value of 33.0, it is statistically indistinguishable from the previous year's record high observer data-based estimate of 37.3. 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 2012/13 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 8,299 crabs, representing approximately 1.2% of the fishery reported harvest (Appendix D1). Of these, 0.60% were illegal, all but one of them sublegal male golden king crab.

West of 174° W Longitude

A single catcher-processor and three catcher vessels participated in the 2012/13 AIGKC crab fishery west of 174° W long., where the TAC was set at 2.980 million pounds. ATF reported effort was 32,716 pot lifts, of which observers sampled 1,109, or 3.4% (Table 1). Locations of sampled pot lifts are shown in Appendix B6.

Onboard observers recorded CL measurements of 33,110 male and 9,462 female golden king crab captured in sampled pot lifts (Figure 10). Male and female CL averages were respectively 144.3 mm and 136.0 mm. New-shell crab made up 98.3% of the males and 99.2% of the females. Average CL of 6,542 male crab measured in size-frequency sampling of retained catch was 151.5 mm, and 97.9% of them were new shell.

Estimated legal-retained CPUE in this fishery was 21.4 crab per pot lift (Table 7), with 95% confidence interval (20.28, 22.54). 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 20.6 crab per pot lift. Estimates of discarded male and female golden king crab CPUE in the 2012/13 western AIGKC 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 2012/13 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 2012/13 AIGKC fishery west of 174° W long. totaled 29,685 crabs. Sampled crabs made up 4.4% of the ATF reported harvest (Appendix D1). Approximately 0.48% of sampled animals were illegal. The majority of the illegal animals were sublegal golden king crab males.

COMPARISON OF OBSERVER AND ATF ESTIMATES OF CPUE

Table 8 summarizes all 2012/13 BSAI crab fishery observer-based estimates of legal retained CPUE and harvest number along with their ATF reported analogs. Agreement between the two sets of estimates is generally good, except, notably, in the eastern AIGKC fishery. Observer-based estimates tend to be higher than the ATF values, but as that is perhaps to be expected in the Bering Sea snow crab and Bristol Bay red king crab fisheries due to differences in how cod pots enter into the estimation procedures, no significance can be attached to that fact.

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Shellfish observers deployed during the 2012/13 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 2012/13.

			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	7.853	2	4	63	16	7	38,144	437
Bering Sea snow crab	15Oct–31May	66.350	2	3	68	22	4	225,489	2,532
Pribilof Islands golden king crab	01Jan–31Dec	0.150[d]	0	NA[e]	1	1	10	–[f]	–[f]
St Matthew Island blue king crab	15Oct–01Feb	1.630	0	7	17	17	10	37,065	2,841
Aleutian Islands golden king crab (east of 174° W)	15Aug–15May	3.310	0	4	3	3	7	20,827	438
Aleutian Islands golden king crab (west of 174° W)	15Aug–15May	2.980	1	4	3	3	7	32,716	1,109

[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 in millions of pounds.
[e] No catcher-processor vessels participated in this fishery.
[f] Confidential.

Table 2.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 437 pot lifts sampled by observers deployed during the 2012/13 Bristol Bay red king crab fishery.

Species	CPUE	SE	95% CI	Crab[a]
Red King Crab				
legal retained	31.0	2.32	(25.85, 36.05)	1,181
female	1.6	0.92	(0, 3.62)	61
sublegal	16.9	2.92	(10.43, 23.27)	643
legal not retained	1.6	0.92	(0, 3.60)	57
Tanner Crab				
female	0.1	0.02	(0.06, 0.17)	5
sublegal	0.4	0.10	(0.22, 0.65)	16
legal not retained	1.1	0.39	(0.26, 1.97)	43
Snow Crab				
female	0[b]	–	–	< 4
sublegal	0[b]	–	–	< 4
legal not retained	0.3	0.06	(0.21, 0.47)	11

[a] Product of estimated CPUE and ATF reported 38,144 total number of pot lifts.

[b] Observers encountered no female or sublegal male snow crab in pot lift sampling.

Table 3.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 2,532 pot lifts sampled by observers deployed during the 2012/13 Bering Sea snow crab fishery.

Species	CPUE	SE	95% CI	Crab[a]
Snow Crab				
legal retained	213.1	12.30	(187.50, 238.67)	48,049
female	1.7	0.62	(0.42, 3.02)	387
sublegal	3.1	0.80	(1.44, 4.76)	699
legal not retained	88.0	6.61	(74.24, 101.75)	19,842
Tanner Crab				
female	0.2	0.03	(0.13, 0.26)	45
sublegal	1.8	0.25	(1.28, 2.31)	405
legal not retained	7.5	1.37	(4.61, 10.32)	1,684
Hybrid Tanner crab (legally *bairdi*[b])				
female	< 0.1	–	–	< 23
sublegal	< 0.1	–	–	< 23
legal not retained	0.4	0.24	(0, 0.88)	87
Hybrid Tanner crab (legally *opilio*[c])				
legal retained	0.2	0.17	(0, 0.60)	55
female	0[d]	–	–	< 23
sublegal	< 0.1	–	–	< 23
legal not retained	0.5	0.29	(0, 1.12)	118

[a] Product of estimated CPUE and ATF reported 225,489 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.

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

[d] Observers recorded no *opilio*-type hybrid Tanner females in pot lift sampling.

Table 4.–Estimated CPUE and total catch (thousands of crab) of selected crab species from 2,841 pot lifts sampled by observers deployed during the 2012/13 St. Matthew Island blue king crab fishery.

Species	CPUE	SE	95% CI	Crab[a]
Blue King Crab				
legal retained	10.1	0.11	(9.94, 10.36)	376
female	5.5	0.22	(5.07, 5.91)	204
sublegal	12.0	0.18	(11.68, 12.37)	446
legal not retained	< 0.1	–	–	< 4
Snow Crab				
female	< 0.1	–	–	< 4
sublegal	0.3	0.03	(0.27, 0.39)	12
legal not retained	0.2	0.02	(0.19, 0.26)	8

[a] Product of estimated CPUE and ATF reported 37,065 total number of pot lifts.

Table 5.–Estimated CPUE and total catch (thousands of crab) of selected crab species from pot lifts sampled by observers deployed during the 2012 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 438 pot lifts sampled by observers deployed during the 2012/13 Aleutian Islands golden king crab fishery east of 174° W long.

Species	CPUE	SE	95% CI	Crab[a]
Golden King Crab				
legal retained	36.0	0.88	(34.23, 37.75)	749
female	10.3	0.80	(8.72, 11.93)	215
sublegal	9.7	0.56	(8.53, 10.76)	201
legal not retained	1.8	0.14	(1.49, 2.03)	37

[a] Product of estimated CPUE and ATF reported 20,827 total number of pot lifts.

Table 7.–Estimated CPUE and total catch (thousands of crab) of golden king crab from 1,019 pot lifts sampled by observers deployed during the 2012/13 Aleutian Islands golden king crab fishery west of 174° W long.

Species	CPUE	SE	95% CI	Crab[a]
Golden King Crab				
legal retained	21.4	0.56	(20.28, 22.54)	699
female	8.6	0.67	(7.31, 9.98)	282
sublegal	7.6	0.42	(6.78, 8.45)	249
legal not retained	1.0	0.07	(0.90, 1.16)	34

[a] Product of estimated CPUE and ATF reported 32,716 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 2012/13 BSAI crab fisheries.

	ATF estimates		Observer data estimates		
Fishery	CPUE	Crab	CPUE	Crab	CPUE % difference[a]
Bristol Bay red king crab	30.3	1,157	31.0	1,181	2.3
Bering Sea snow crab	210.5	47,456	213.1	48,049	1.2
St. Matthew Island blue king crab	10.2	379	10.1	376	-1.0
Pribilof Islands golden king crab	–[b]	–[b]	–[b]	–[b]	–[b]
Eastern Aleutian Islands golden king crab	33.0	688	36.0	749	7.9
Western Aleutian Islands golden king crab	20.6	673	21.4	699	3.9

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

[b] Confidential.

Bristol Bay Red King Crab Fishery Size Distribution

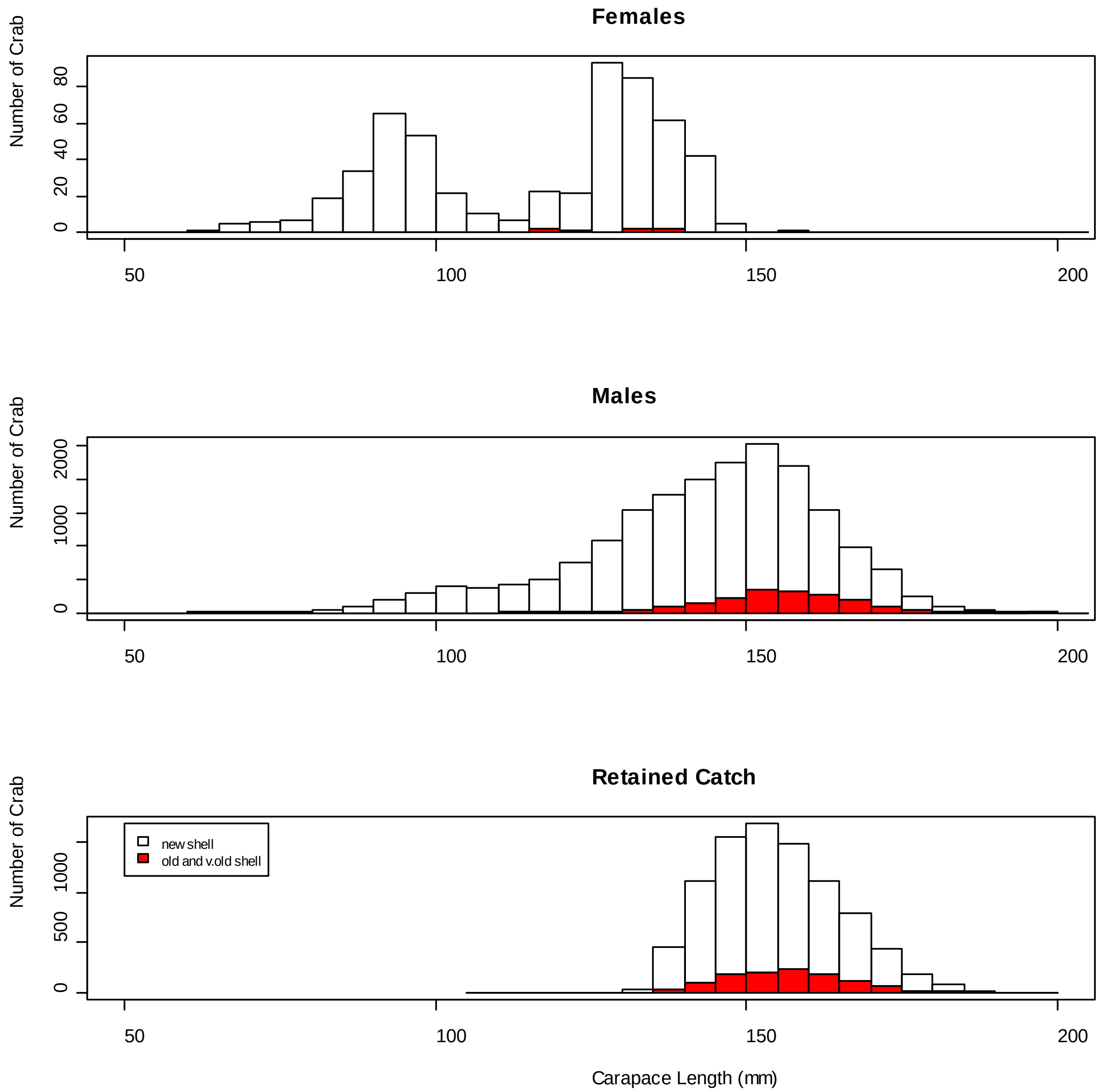


Figure 1.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) red king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2012/13 Bristol Bay red king crab fishery.

Bristol Bay Red King Crab Fishery CPUE

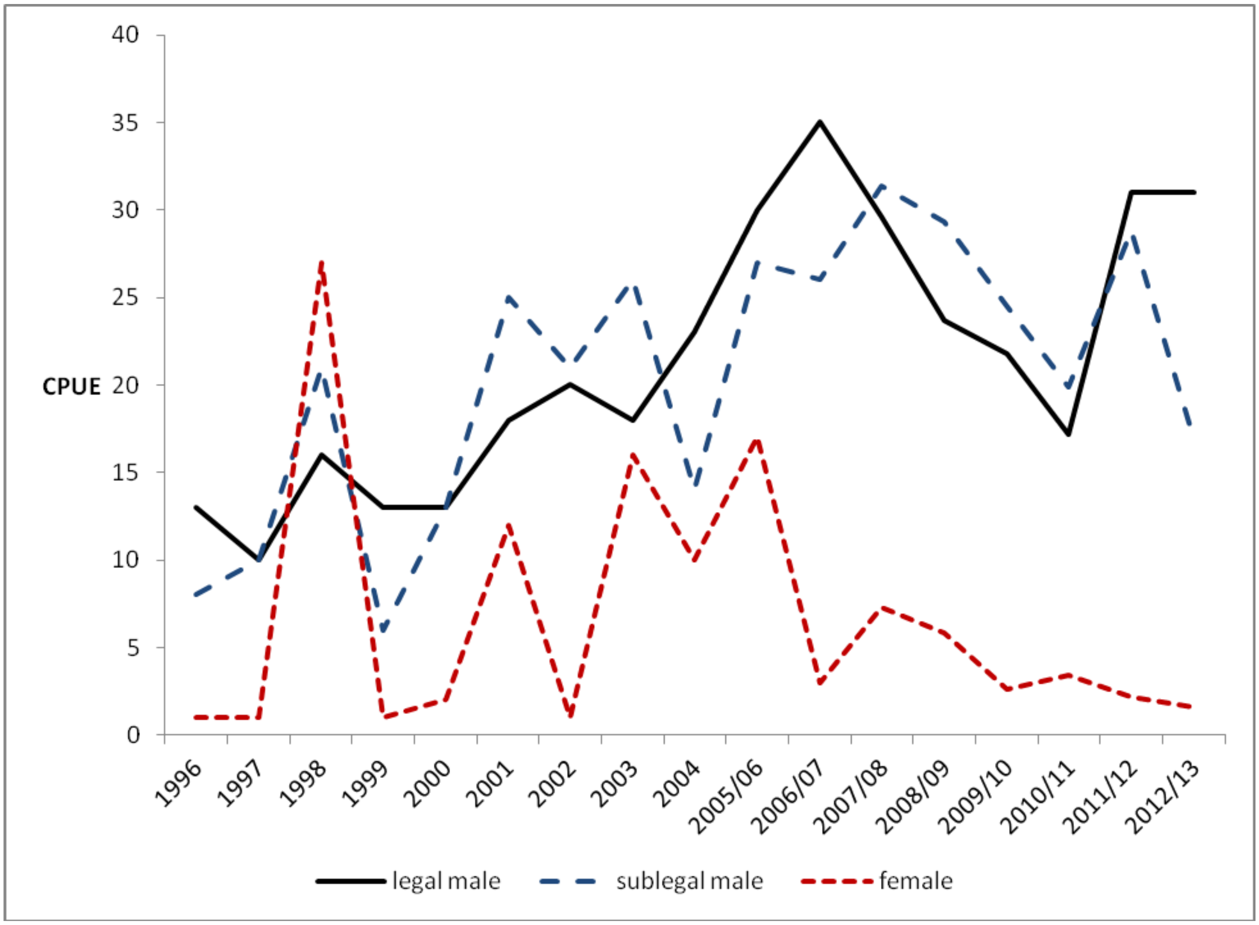


Figure 2.–Estimated red king crab CPUE from pot lifts sampled during the 1996–2012/13 Bristol Bay red king crab fisheries.

Bering Sea Snow Crab Fishery Size Distribution

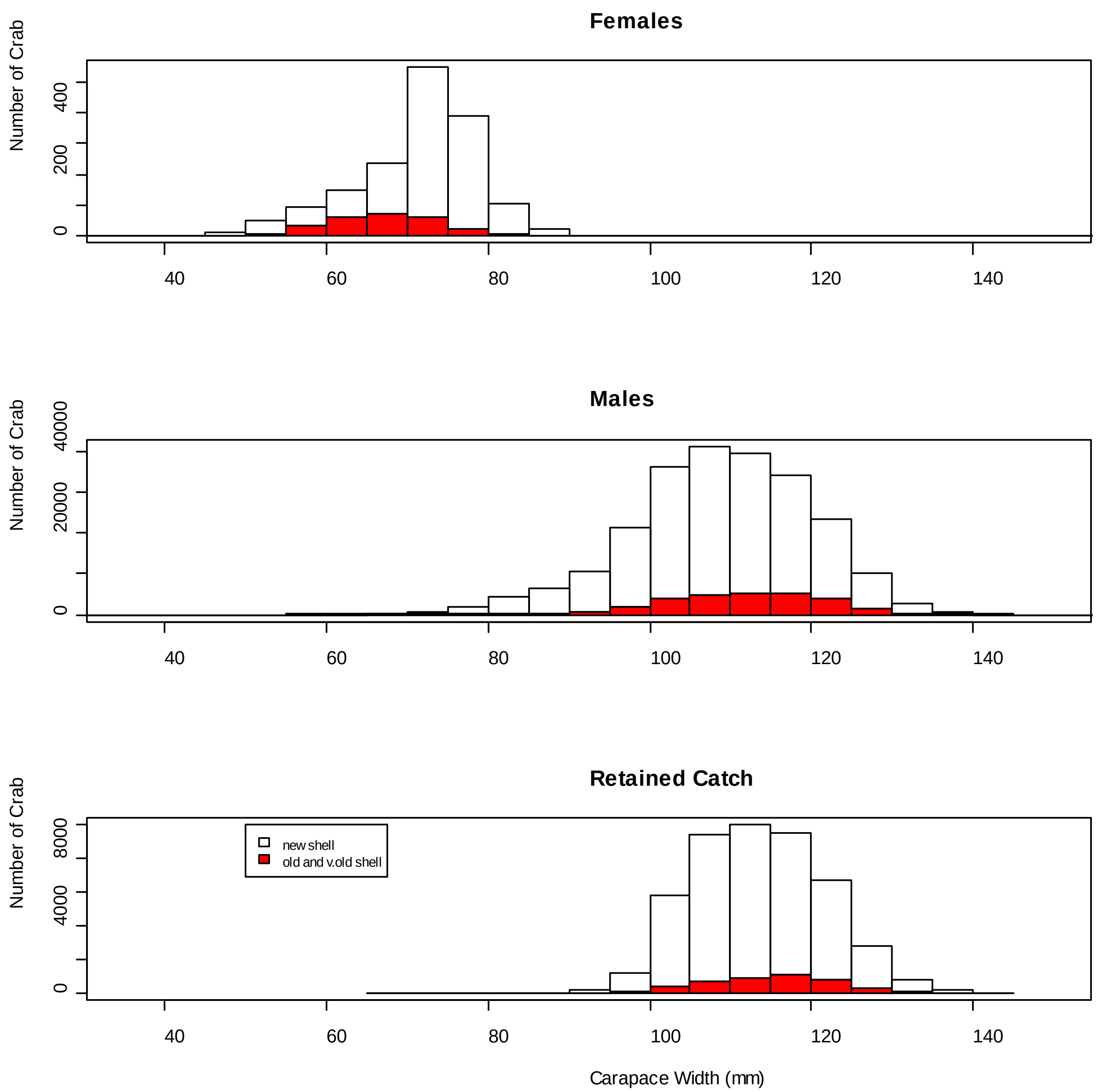


Figure 3.–Carapace width distribution with shell condition for female (top panel) and male (middle panel) snow crab from sampled pot lifts and for males from size-frequency sampling (bottom panel) of retained catch during the 2012/13 directed Bering Sea snow crab fishery.

Bering Sea Sow Crab Fishery CPUE

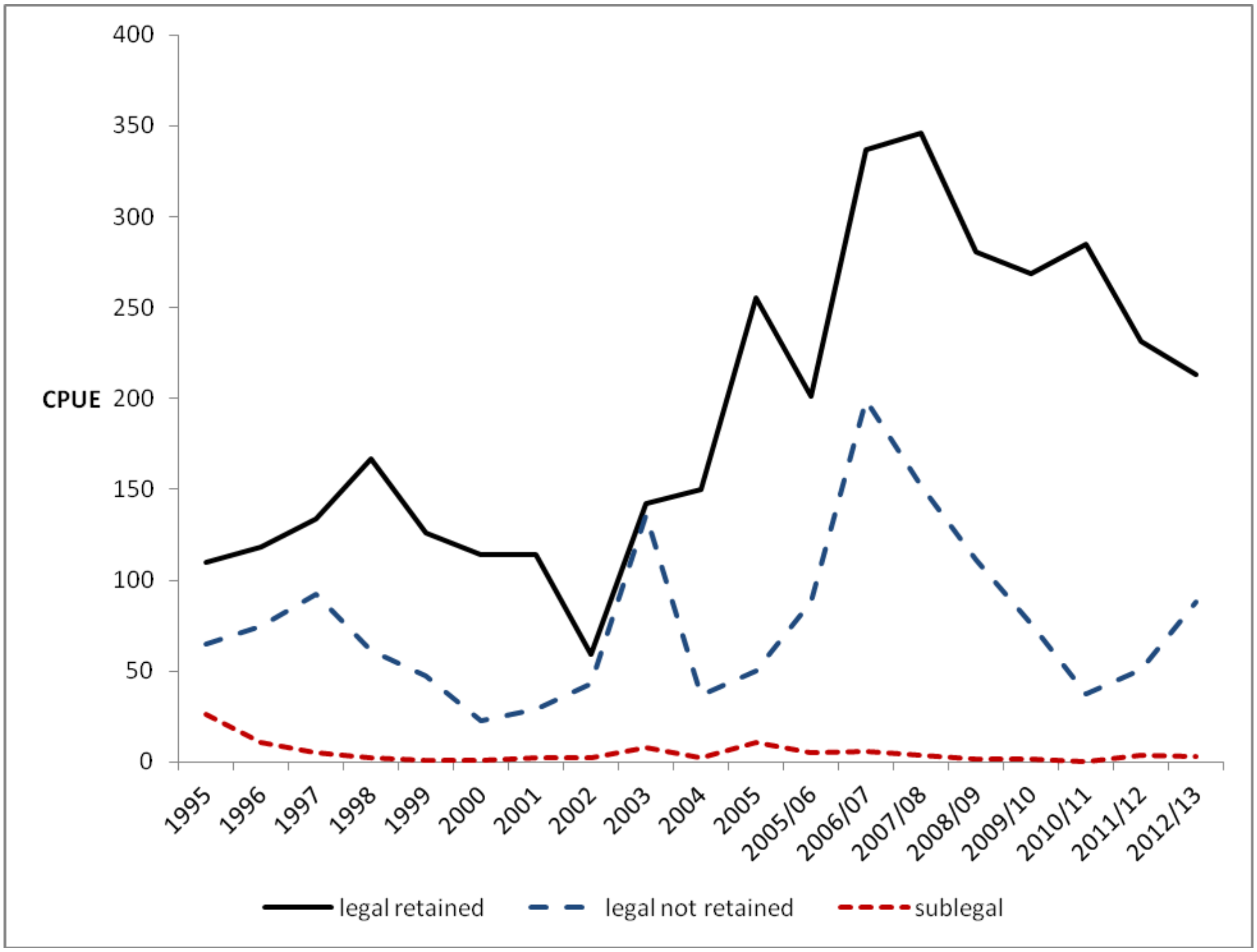


Figure 4.–Estimated snow crab CPUE from pot lifts sampled during the 1995–2012/13 Bering Sea snow crab fisheries.

St. Matthew Island Blue King Crab Fishery Size Distribution

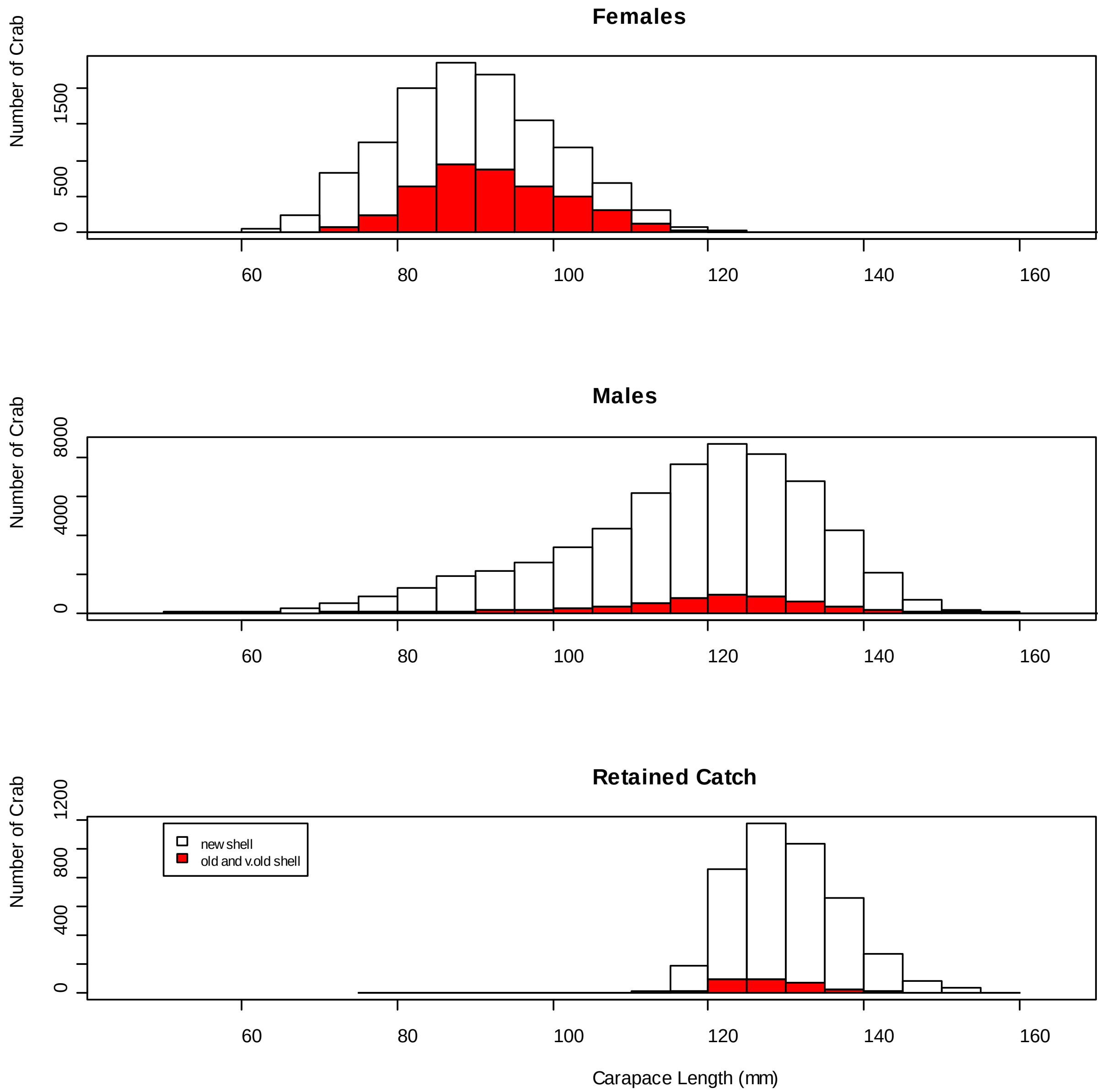
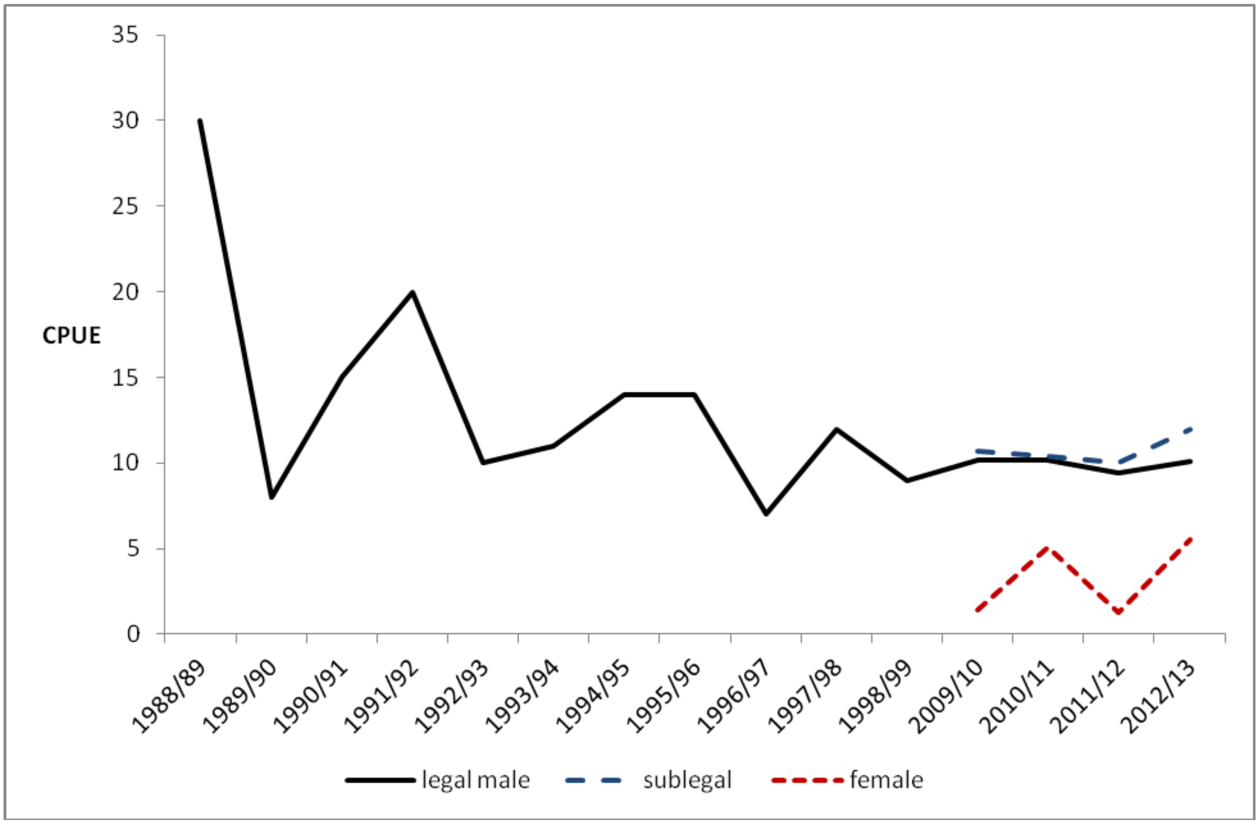


Figure 5.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) blue king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2012/13 St. Matthew Island blue king crab fishery.

St. Matthew Island Blue King Crab Fishery CPUE



Note: The 2009/10 - 2012/13 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 1988/89–2012/13 St. Matthew Island blue king crab fisheries.

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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 2012 Pribilof Islands golden king crab fishery.

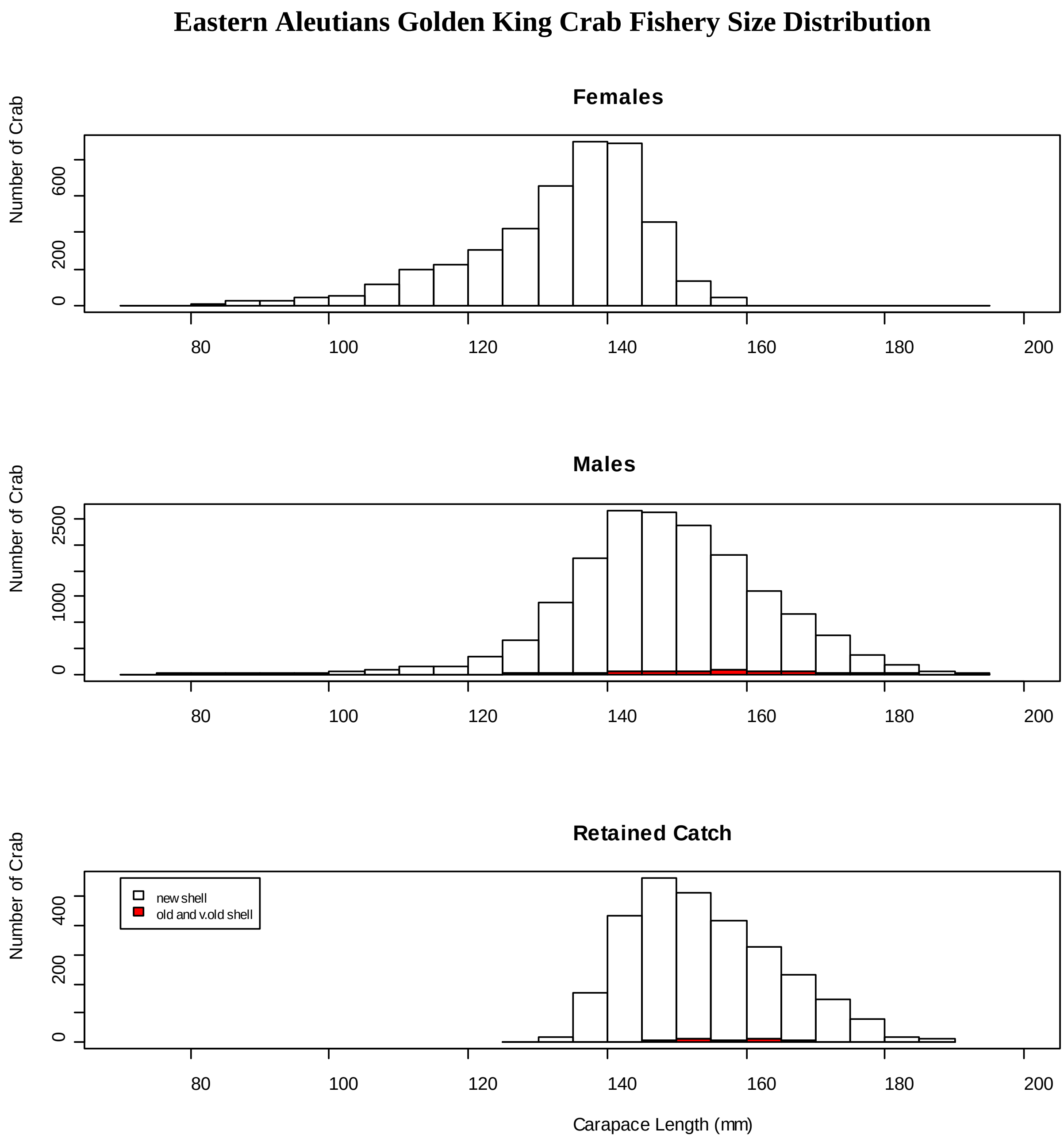

Figure 8.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) golden king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2012/13 Aleutian Islands golden king crab fishery east of 174° W long.

Eastern Aleutians Golden King Crab Fishery CPUE

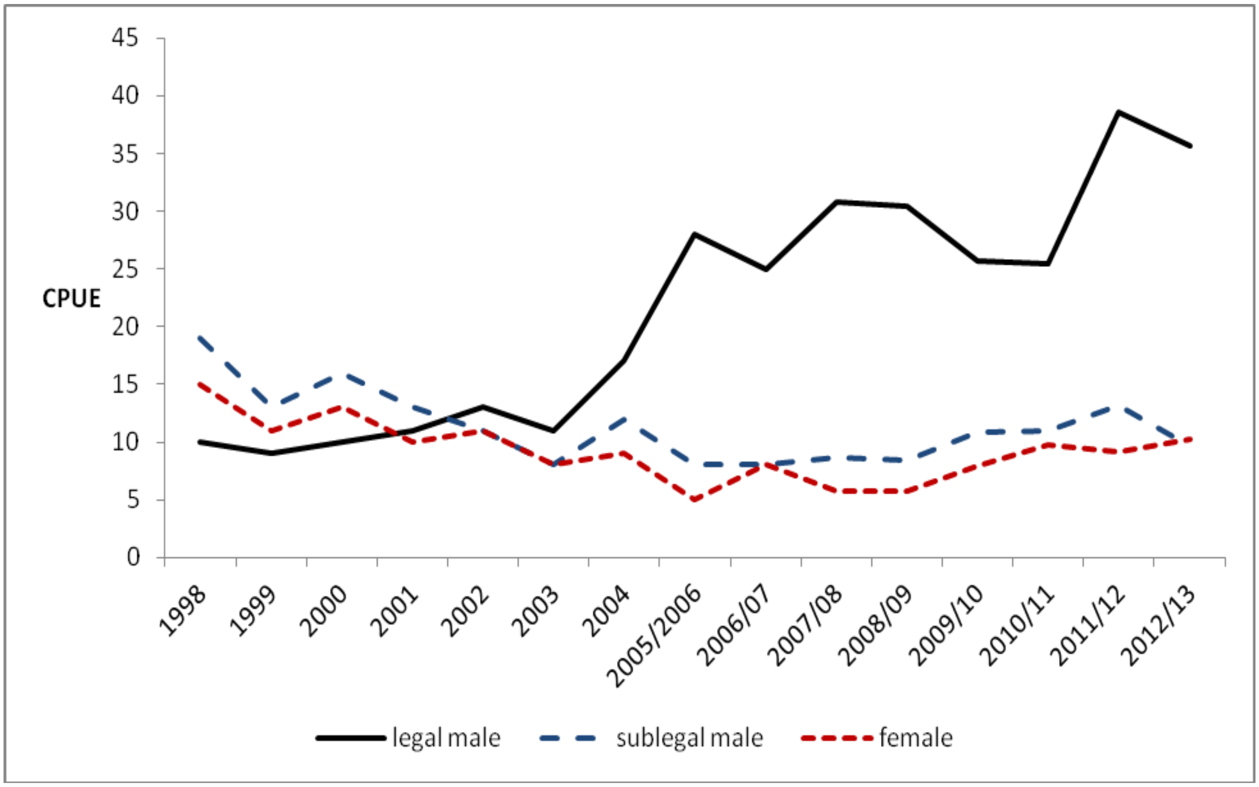

Figure 9.–Estimated golden king crab CPUE from pot lifts sampled during the 1998–2012/13 Aleutian Islands golden king crab fisheries east of 174° W long.

Western Aleutians Golden King Crab Fishery Size Distribution

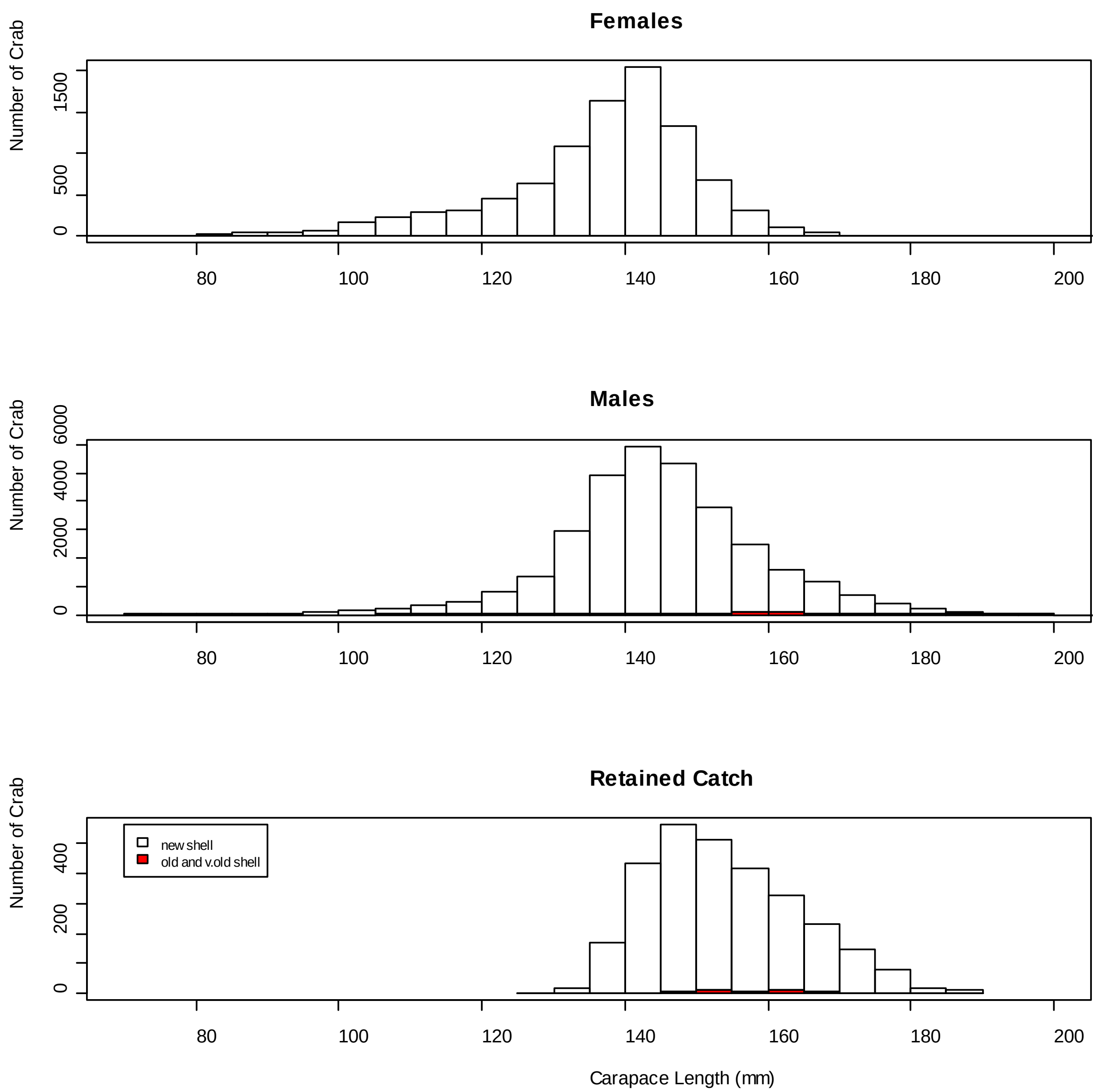

Figure 10.–Carapace length distribution with shell condition for female (top panel) and male (middle panel) golden king crab from sampled pot lifts and for males from size-frequency sampling of retained catch (bottom panel) during the 2012/13 Aleutian Islands golden king crab fishery west of 174° W long.

Western Aleutians Golden King Crab Fishery CPUE

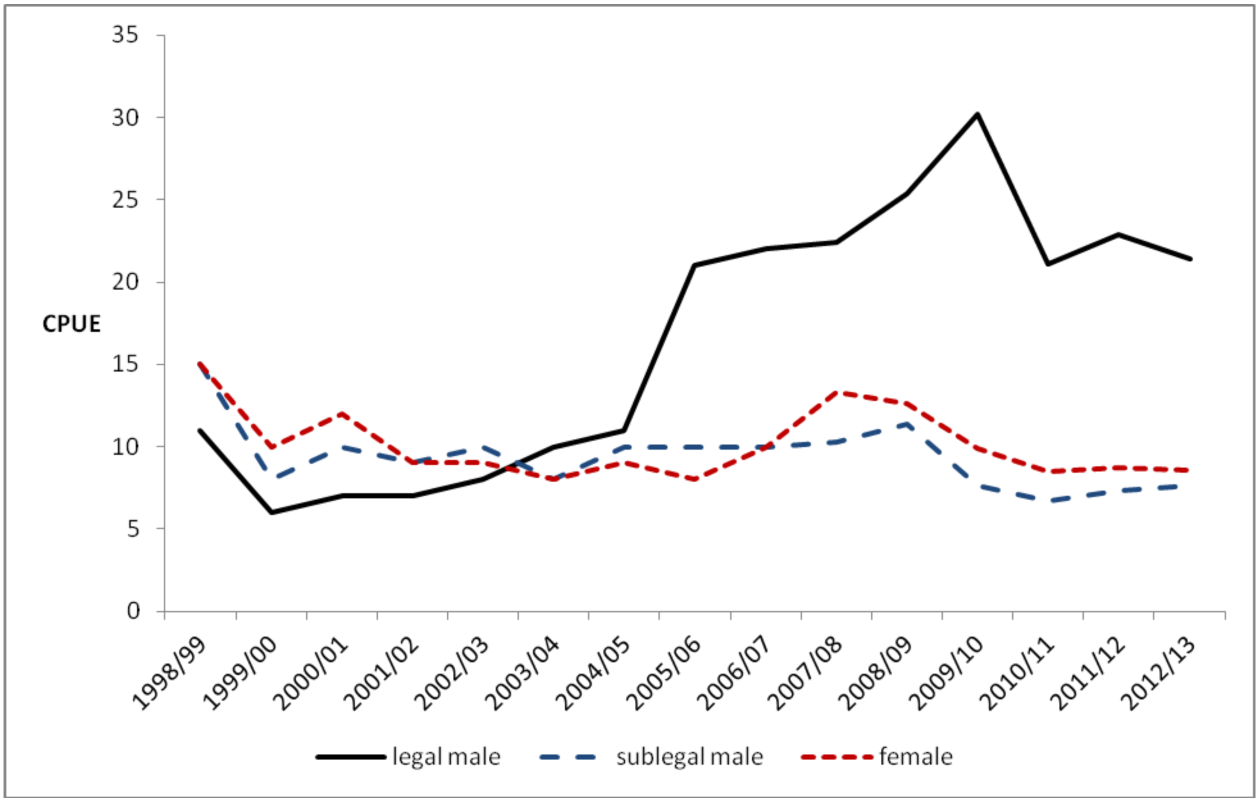

Figure 11.–Estimated golden king crab CPUE from pot lifts sampled during the 1998/99–2012/13 golden king crab fisheries west of 174° W long.

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

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

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 $\hat{V}ar[\hat{\tau}] = \sum_{j}^{m=M} Var[\hat{\tau}_j]$. 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

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

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

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

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

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

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

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

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

$$Var[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j)] = Var[E[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j) \mid S]] + E[Var[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j) \mid S]]$$

$$= Var[\sum_j^m(\frac{1}{\lambda_F}E[\hat{\tau}_j \mid S] - \frac{\tau_F}{\lambda_F^2}N_j)] + E[\sum_j^m \frac{1}{\lambda_F^2}Var[\hat{\tau}_j \mid S]]$$

$$= Var[\sum_j^m(\frac{1}{\lambda_F}\hat{\tau}_j - \frac{\tau_F}{\lambda_F^2}N_j)] + E[\sum_j^m \frac{1}{\lambda_F^2}Var[\hat{\tau}_j]$$

$$= m(1-\frac{m}{M})\frac{\sum_j^M (q_j - \bar{q})^2}{M-1} + \frac{m}{M\lambda_F^2}\sum_j^M Var[\hat{\tau}_j], \qquad (13)$$

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

$$Var[\hat{\mu}] \cong \frac{M_C^2}{m_C}(1-\frac{m_C}{M_C})S_{qC}^2 + \frac{M_C}{m_c\lambda_F^2}\sum_j^{M_C} Var[\hat{\tau}_j^C]$$

$$+ \frac{M_{CP}^2}{m_{CP}}(1-\frac{m_{CP}}{M_{CP}})S_{qCP}^2 + \frac{M_{CP}}{m_{CP}\lambda_F^2}\sum_j^{M_{CP}} Var[\hat{\tau}_j^{CP}], \qquad (14)$$

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

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

-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 – α)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 2012/13 Bristol Bay red king crab fishery.

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Appendix B2.–Locations of pot lifts sampled by observers during the 2012/13 Bering Sea snow crab fishery.

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Appendix B3.–Locations of pot lifts sampled by observers during the 2012/13 St Matthew Island blue king crab fishery.

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Appendix B4.–Locations of pot lifts sampled by observers during the 2012 Pribilof Islands golden king crab fishery.

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Appendix B5.–Locations of pot lifts sampled by observers during the 2012/13 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 2012/13 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 437 pot lifts sampled during the 2012/13 Bristol Bay red king crab fishery.

Commercial crab species	Number	Other speices	Number
Red King Crab		arrowtooth flounder	1
legal	13,267	giant octopus	1
sublegal	6,895	great sculpin	5
female	562	hermit crab unident.	2
Tanner Crab		jellyfish unident.	161
legal	457	Pacific cod	202
sublegal	162	Pacific halibut	26
female	48	scale worm unident.	2
Snow Crab		sculpin unident.	68
legal	137	sea anemone unident.	4
sublegal	0	sea cucumber unident.	1
female	0	snail unident.	16
Hybrid Tanner Crab		sponge unident.	5
(legally *opilio*[a])		starfish unident.	322
legal	2	tunicate unident.	6
sublegal	0	yellowfin sole	266
female	0	yellow Irish lord	1
Hair Crab			
legal	17		
sublegal	0		
female	6		

[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 437 pot lifts sampled during the 2012/13 Bristol Bay red crab fishery.

Soak[a] (hours)	Percent of sampled pots	Average number of crab per pot LRT	LNR	SUB	FEM	Total
12-24	2.1	41.6	0.0	37.6	1.0	80.1
24-36	28.4	22.6	0.5	20.1	1.0	44.2
36-48	36.7	30.4	0.5	15.6	2.3	48.8
48-60	12.4	31.3	0.4	13.4	1.0	46.1
60-72	5.7	27.8	0.4	6.0	0.1	34.4
72-84	5.3	25.2	3.9	8.8	0.1	38.0
84-96	2.8	34.9	0.1	8.2	0.0	43.2
96-108	1.6	46.7	3.1	7.4	0.0	57.3
108-120	2.1	48.0	2.4	6.7	0.0	57.1
132-144	0.7	42.7	1.7	18.7	0.0	63.0
156-168	0.2	49.0	0.0	6.0	0.0	55.0
168-180	0.2	45.0	0.0	6.0	0.0	51.0
228-240	0.2	34.0	3.0	74.0	6.0	117.0
348-360	0.9	72.8	0.2	21.8	0.5	95.2
360-372	0.2	94.0	1.0	25.0	1.0	121.0
372-384	0.2	50.0	2.0	12.0	0.0	64.0
384-396	0.2	60.0	0.0	11.0	1.0	72.0

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 53 hours.

Appendix C3.–Red king crab per pot by depth for 437 pot lifts sampled during the 2012/13 Bristol Bay red king crab fishery.

Depth[a] (fathoms)	Percent of sample pots	Average number of crab per pot				
		LRT	LNR	SUB	FEM	Total
30-35	1.8	17.8	0.4	8.4	0.4	26.9
35-40	17.9	27.9	1.1	12.4	3.9	45.3
40-45	46.3	28.8	0.5	12	0.4	41.7
45-50	31	32.2	0.5	23.7	1.3	57.6
50-55	3	34.7	4.4	18.8	0.8	58.7

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 depth was 43 fathoms.

Appendix C4.–Reproductive condition (by percent) of female red king crab from pot lifts sampled during the 1996–2012/13 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	15.0
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
2005/06	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
2012/13	562	61.4	6.8	0.5	31.3

Appendix C5.–Total contents of 2,532 pot lifts sampled during the 2012/13 Bering Sea snow crab fishery.

Commercial crab species	Number	Other species	Number	Other species	Number
Snow Crab		Alaska plaice	3	silky buccinum	64
legal	813,422	Anthomastus sp.	1	skate unident.	28
sublegal	7,856	arrowtooth flounder	3	snail unident.	6,089
female	6,072	basket star	256	sponge unident.	3
sex unknown	6	bigmouth sculpin	1	starfish unident.	51
Tanner Crab		brittle star unident.	2	tunicate unident.	18
legal	29,471	circumboreal toad crab	1	walleye pollock	17
sublegal	6,150	cockle unident.	1	worm unident.	2
female	806	Cyclohelia sp.	1	yellowfin sole	6
sex unknown	707	dark rockfish	1	yellow Irish lord	214
Tanner Crab unident.		flatfish unident.	1		
male	883	flathead sole	16		
female	6	giant octopus	91		
sex unknown	1	great sculpin	1		
Hybrid Tanner Crab		Oregon triton	879		
(legally *opilio*[a])		hermit crab unident.	92		
legal	1,994	Hyas sp.	1		
sublegal	4	jellyfish unident.	93		
female	5	northern rockfish	1		
Hybrid Tanner Crab		octopus unident.	12		
(legally *bairdi*[b])		Pacific cod	836		
legal	794	Pacific halibut	65		
sublegal	112	Pacific lyre crab	27		
female	1	Pribilof neptune	413		
Blue King Crab		prowfish	4		
legal	7	rockfish unident.	1		
sublegal	52	scale worm unident.	2		
female	0	sculpin unident.	10		
Golden King Crab		sea anemone unident.	178		
legal	1	sea cucumber unident.	1		
sublegal	4	sea urchin unident.	23		
female	0	sea whip unident.	4		

[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 2,532 pot lifts sampled during the 2012/13 Bering Sea snow crab fishery.

		Average number of crab per pot				
Soak[a] (hours)	Percent of sample pots	LRT	LNR	SUB	FEM	Total
0-12	0.5	87.7	43.8	0.7	0.0	132.2
12-24	15.6	157.7	70.1	3.9	2.8	234.4
24-36	36.8	200.6	85.1	3.3	1.6	290.5
36-48	19.5	217.5	84.0	2.6	2.4	306.4
48-60	8.0	215.5	82.2	1.8	0.9	300.3
60-72	3.6	193.7	76.5	1.2	0.7	272.2
72-84	3.2	210.2	99.2	2.1	0.2	311.7
84-96	1.7	196.9	88.5	1.0	7.4	293.8
96-108	2.1	195.1	64.7	0.6	0.0	260.4
108-120	1.7	302.9	87.2	0.7	0.0	390.8
120-132	1.8	184.3	60.2	2.2	0.2	247.0
132-144	0.8	261.1	111.6	8.6	5.5	386.8
144-156	1.5	295.8	149.8	11.8	4.0	461.4
156-168	0.4	334.4	87.1	0.2	0.2	421.9
168-180	0.9	205.2	71.8	1.3	0.5	278.9
180-192	0.2	230.2	120.2	5.8	0.6	356.8
192-204	0.5	181.4	35.8	0.2	0.0	217.4
204-216	0.2	226.8	34.3	0.2	0.0	261.3
216-228	0.2	166.8	59.5	0.0	0.0	226.2
228-240	0.2	162.6	30.2	0.0	0.0	192.8
240-252	0.3	151.6	59.9	1.0	0.0	212.4
264-276	0.1	77.7	26.0	0.0	0.0	103.7
312-324	0.2	55.2	4.5	0.8	0.0	60.5
324-336	0.1	191.0	30.5	0.0	0.0	221.5
360-372	0.2	125.0	29.2	0.2	0.0	154.5

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 soak time was 49 hours.

Appendix C7.–Snow crab per pot by depth for 2,532 pot lifts sampled during the 2012/13 Bering Sea snow crab fishery.

Depth[a] (fathoms)	Percent of sample pots	Average number of crab per pot				
		LRT	LNR	SUB	FEM	Total
50-55	0.0	256.0	90.0	0.0	0.0	346.0
55-60	1.2	156.3	76.9	2.7	0.8	236.7
60-65	28.7	180.7	83.8	1.8	4.1	270.4
65-70	37.9	205.9	84.4	4.0	0.8	295.1
70-75	23.1	221.4	78.9	3.5	1.3	305.0
75-80	4.0	218.5	85.1	0.9	0.0	304.5
80-85	2.6	197.2	78.9	1.0	0.0	277.1
85-90	0.7	246.7	56.5	0.5	0.0	303.7
90-95	1.1	160.1	41.5	0.3	0.0	202.0
95-100	0.2	56.0	10.2	0.5	0.0	66.8
100+	0.5	82.5	27.7	0.5	0.0	110.7

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 depth was 68 fathoms.

Appendix C8.–Reproductive condition (by percent) of female snow crab from pot lifts sampled during the 1995–2012/13 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
2012/13	1,096	24.6	55.1	10.0	6.7

Appendix C9.–Total contents of 2,841 pot lifts sampled during the 2012/13 St. Matthew Island blue king crab fishery.

Commercial crab species	Number	Other species	Number	Other species	Number
Blue King Crab		Alaska plaice	1	Pacific lyre crab	7
legal	29,091	basket star	70	Pribilof neptune	135
sublegal	32,904	Bering flounder	1	sculpin unident.	315
female	12,827	bigmouth sculpin	34	sea anemone unident.	2
sex unknown	15	brittle star unident.	2	searcher	2
Snow Crab		circumboreal toad crab	1,381	sea urchin unident.	2
legal	749	flathead sole	6	skate unident.	10
sublegal	1,035	giant octopus	1	smooth lumpsucker	1
female	201	great sculpin	154	snailfish unident.	14
Tanner Crab		Greenland turbot	1	snail unident.	3,766
legal	11	hermit crab unident.	950	sponge unident.	2
sublegal	22	Hyas sp.	1	starfish unident.	180
female	5	hybrid C. opilio	0	tunicate unident.	2
Red King Crab		jellyfish unident.	64	walleye pollock	32
legal	2	Kamchatka flounder	1	yellowfin sole	51
sublegal	0	Pacific cod	1,115	yellow Irish lord	28
female	1	Pacific halibut	112		

Appendix C10.–Blue king crab per pot by soak time for 2,841 pot lifts sampled during the 2012/13 St. Matthew Island blue king crab fishery.

Soak[a] (hours)	Percent of sample pots	Average number of crab per pot				
		LRT	LNR	SUB	FEM	Total
0-12	0.1	15.2	0.0	24.5	2.2	42.0
12-24	14.8	7.2	0.0	7.9	2.3	17.4
24-36	35.3	9.6	0.1	15.3	9.2	34.2
36-48	26.6	11.1	0.0	11.2	1.7	24.1
48-60	8.3	10.9	0.0	9.6	1.8	22.3
60-72	3.1	10.1	0.1	8.8	0.5	19.4
72-84	2.7	15.9	0.0	12.0	3.1	31.1
84-96	2.0	13.7	0.1	7.8	4.8	26.3
96-108	2.3	10.1	0.0	7.3	1.6	19.1
108-120	1.7	12.0	0.0	6.8	0.9	19.7
120-132	1.4	17.6	0.0	5.5	1.5	24.6
132-144	0.1	4.2	0.0	3.0	6.8	14.0
144-156	0.8	9.3	0.0	5.1	3.5	17.8
156-168	0.1	5.3	0.0	1.3	0.0	6.7
168-180	0.1	5.3	0.0	4.7	0.0	10.0
180-192	0.1	8.0	0.5	0.5	0.0	9.0
192-204	0.1	17.5	0.0	7.0	0.5	25.0
216-228	0.1	15.2	0.0	9.5	1.8	26.5
252-264	0.2	11.0	0.0	1.2	0.0	12.2
288-300	0.0	17.0	0.0	15.0	0.0	32.0

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 50 hours.

Appendix C11.–Blue king crab per pot by depth for 2,841 pot lifts sampled during the 2012/13 St. Matthew Island blue king crab fishery.

Depth[a] (fathoms)	Percent of sample pots	Average number of crab per pot: LRT	LNR	SUB	FEM	Total
20-25	0.3	12.0	0.1	21.6	3.9	37.6
25-30	0.6	8.5	0.0	16.2	4.0	28.7
30-35	9.7	13.8	0.1	21.6	13.6	49.1
35-40	16.3	12.0	0.1	20.2	16.4	48.7
40-45	19.7	8.5	0.1	10.8	2.4	21.7
45-50	11.2	9.1	0.0	7.3	0.2	16.6
50-55	23.1	9.0	0.0	5.5	0.0	14.6
55-60	18.7	10.8	0.0	9.5	0.0	20.2
60-65	0.6	8.6	0.0	12.1	0.0	20.6

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 46 fathoms.

Appendix C12.–Reproductive condition (by percent) of female blue king crab from pot lifts sampled during the 2009/10–2012/13 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
2012/13	12,828	1.1	7.2	72.9	18.4

Appendix C13.–Total contents of pot lifts sampled during the 2012 Pribilof Islands golden king crab fishery.

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Appendix C14.–Golden king crab per pot by soak time for pot lifts sampled during the 2012 Pribilof Islands golden king crab fishery.

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Appendix C15.–Golden king crab per pot by depth for pot lifts sampled during the 2012 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, 2011 and 2012 Pribilof Islands golden king crab fisheries.

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Appendix C17.–Total pot lift contents for 438 pot lifts sampled during the 2012/13 Aleutian Islands golden king crab fishery east of 174° W long.

Commercial crab species	Number	Other species	Number	Other species	Number
Golden King Crab		Anthomastus sp.	2	Plexauridae unident.	1
legal	16,528	Arthrogorgia sp.	6	Primnoidae Group I	21
sublegal	4,217	basket star	264	Primnoidae unident.	5
female	4,510	bigmouth sculpin	1	red-tree coral	3
sex unknown	2	brittle star unident.	38	rockfish unident.	1
Scarlet King Crab		Calcigorgia sp.	3	sculpin unident.	1
legal	4	Caryophyllia sp.	1	sea anemone unident.	1
sublegal	0	Crypthelia sp.	4	sea lily unident.	2
female	0	Cup coral unident.	1	sea raspberry	1
		Cyclohelia sp.	18	sea spider unident.	3
		Distichopora sp.	3	sea urchin unident.	18
		Errinopora sp.	3	shrimp unident.	2
		Fanellia sp.	6	skate unident.	12
		Hyas sp.	1	snail unident.	12
		Javania sp.	1	soft coral unident.	1
		jellyfish unident.	4	sponge unident.	138
		bubblegum coral	9	starfish unident.	16
		Pacific cod	1	Stylaster sp.	52
		Pacific halibut	8		

Appendix C18.–Golden king crab per pot by soak time for 438 pot lifts sampled during the 2012/13 Aleutian Islands golden king crab fishery east of 174° W long.

		Average number of crab per pot				
Soak[a] (days)	Percent of sample pots	LRT	LNR	SUB	FEM	Total
6-8	2.7	27.8	0.1	2.3	0.4	30.6
8-10	5.0	30.0	0.5	7.9	7.9	46.3
10-12	9.4	27.8	1.0	5.2	2.9	37.0
12-14	8.2	41.8	0.8	13.1	9.9	65.6
14-16	13.5	32.7	1.7	8.4	16.3	59.1
16-18	12.3	42.8	2.5	13.7	10.1	69.1
18-20	7.8	37.2	1.7	11.9	8.2	59.0
20-22	11.4	37.8	1.5	8.6	12.1	60.0
22-24	11.6	39.0	2.3	11.3	9.6	62.2
24-26	5.0	37.8	1.6	7.3	11.2	58.0
26-28	5.7	35.4	3.3	11.1	19.2	69.0
28-30	4.8	32.7	1.4	8.5	9.9	52.4
30-32	1.1	29.4	1.6	7.6	2.4	41.0
32-34	0.9	31.8	10.8	6.2	5.0	53.8
34-36	0.5	32.0	0.5	2.5	1.0	36.0

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 18.4 days.

Appendix C19.–Golden king crab per pot by depth for 438 pot lifts sampled during the 2012/13 Aleutian Islands golden king crab fishery east of 174° W long.

Depth[a] (fathoms)	Percent of sample pots	Average number of crab per pot				
		LRT	LNR	SUB	FEM	Total
50-75	0.2	25.0	0.0	0.0	0.0	25.0
75-100	3.0	47.1	1.2	10.8	12.7	71.8
100-125	15.8	37.9	0.3	6.5	4.5	49.2
125-150	21.2	35.5	1.1	5.1	6.5	48.2
150-175	14.2	34.8	2.0	10.3	12.5	59.6
175-200	6.8	37.5	2.4	9.3	15.9	65.0
200-225	7.1	41.8	2.6	15.2	19.2	78.8
225-250	9.4	35.4	2.0	15.1	12.4	65.0
250-275	8.0	36.5	2.6	8.0	13.7	60.7
275-300	5.9	32.6	3.5	14.6	12.5	63.2
300-325	7.3	27.7	2.5	13.0	7.7	50.9
325-350	0.9	31.2	1.2	12.2	4.5	49.2
350-375	0.2	37.0	5.0	22.0	9.0	73.0

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 186 fathoms.

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Appendix C20.–Reproductive condition (by percent) of female golden king crab from pot lifts sampled during the 1996/97–2012/13 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
2012/13	4,510	24.9	29.6	20.7	24.2

Appendix C21.–Total pot lift contents for 1,109 pot lifts sampled during the 2012/13 Aleutian Islands golden king crab fishery west of 174° W long.

Commercial crab species	Number	Other species	Number	Other species	Number
Golden King Crab		Anthomastus sp.	19	Pacific ocean perch	2
legal	24,744	Arthrogorgia sp.	35	Paralomis multispina	1
sublegal	8,388	barnacle unident.	6	Plexauridae unident.	52
female	9,505	basket star	244	Primnoidae Group I	156
sex unknown	122	Bathypathes sp.	1	Primnoidae unident.	2
Scarlet King Crab		bigmouth sculpin	1	red-tree coral	6
legal	19	brittle star unident.	165	rockfish unident.	3
sublegal	3	bryozoan unident.	6	rougheye rockfish	3
female	1	Calcigorgia sp.	20	scale worm unident.	2
Red King Crab		Caryophyllia sp.	1	scallop unident.	1
legal	1	Chrysopathes sp.	2	sculpin unident.	1
sublegal	0	Clavularia sp.	10	sea anemone unident.	1
female	1	Crypthelia sp.	17	sea cucumber unident.	1
		Cup coral unident.	4	sea lily unident.	8
		Cyclohelia sp.	11	sea pen unident.	2
		Debris - man-made	1	sea spider unident.	13
		Distichopora sp.	29	sea urchin unident.	25
		Dover sole	1	sea whip unident.	1
		Errinopora sp.	11	shortspine thornyhead	1
		Fanellia sp.	59	shrimp unident.	5
		giant octopus	2	sidestripe shrimp	1
		Oregon triton	5	skate unident.	4
		hydroid unident.	248	snail unident.	32
		jellyfish unident.	2	sponge unident.	372
		bubblegum coral	13	starfish unident.	194
		Lillipathes spp.	1	Stylaster sp.	136
		octopus unident.	5	tunicate unident.	1
		Pacific cod	1	worm unident.	26
		Pacific halibut	6	yellow Irish lord	6

Appendix C22.–Golden king crab per pot by soak time for 1,109 pot lifts sampled during the 2012/13 Aleutian Islands golden king crab fishery west of 174° W long.

		Average number of crab per pot				
Soak[a] (days)	Percent of sample pots	LRT	LNR	SUB	FEM	Total
3-6	0.1	0.0	3.0	15.0	111.0	129.0
6-9	0.6	14.1	1.4	8.6	3.9	28.0
9-12	2.4	15.8	2.0	20.9	8.7	47.4
12-15	7.9	20.4	1.3	11.0	8.6	41.3
15-18	19.9	21.8	1.4	8.7	11.4	43.3
18-21	6.7	17.6	0.6	7.3	2.4	27.9
21-24	11.9	21.7	1.3	7.3	8.8	39.2
24-27	12.0	19.5	0.8	6.2	7.8	34.3
27-30	15.4	23.1	0.9	6.8	10.0	40.9
30-33	9.1	28.5	0.6	8.2	8.6	45.9
33-36	6.6	22.7	0.6	4.4	4.6	32.3
36-39	1.2	18.7	1.8	5.3	9.3	35.1
39-42	0.5	12.0	0.6	1.0	0.0	13.6
42-45	0.4	9.5	0.8	2.0	19.0	31.2
45-48	1.4	20.5	0.4	3.8	11.8	36.5
48-51	2.9	12.7	0.5	1.4	5.8	20.3
51-54	0.2	25.5	0.0	0.5	0.0	26.0
54-57	0.1	63.0	0.0	9.0	3.0	75.0
66-69	0.3	25.3	0.7	2.3	0.0	28.3
72-75	0.3	0.7	0.0	0.0	0.3	1.0
78-81	0.1	3.0	0.0	1.0	0.0	4.0
81-84	0.2	0.0	0.0	0.5	0.0	0.5

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 soak time was 24.8 days.

Appendix C23.–Golden king crab per pot by depth for 1,109 pot lifts sampled during the 2012/13 Aleutian Islands golden king crab fishery west of 174° W long.

		Average number of crab per pot				
Depth[a] (fathoms)	Percent of sample pots	LRT	LNR	SUB	FEM	Total
25-50	0.1	41.0	0.0	7.0	0.0	48.0
50-75	1.3	15.3	0.9	1.0	4.7	21.9
75-100	6.1	21.9	0.7	4.2	9.6	36.5
100-125	10.1	22.3	0.7	4.8	6.0	33.7
125-150	17.4	22.1	0.8	6.8	9.9	39.6
150-175	18.9	23.6	1.3	10.1	8.5	43.5
175-200	21.5	19.9	1.1	7.4	6.0	34.4
200-225	13.3	20.4	1.3	10.3	9.9	41.9
225-250	5.2	20.1	0.8	5.0	10.4	36.3
250-275	3.2	19.4	1.3	9.4	22.9	52.9
275-300	1.8	16.4	0.9	7.2	3.8	28.4
300-325	0.7	20.4	0.2	7.5	3.2	31.4
325-350	0.4	21.8	0.0	7.5	3.0	32.2

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 1996/97–2012/13 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
2012/13	9,505	28.3	28.6	30.0	11.2

APPENDIX D. RESULTS OF LEGAL TALLY SAMPLES

Appendix D1.–Results of ADF&G legal tally samples from the 2012/13 Bering Sea and Aleutian Islands directed crab fisheries.

			Number of illegal crabs				
Fishery	Sample size	Percent of landed catch[a]	Male	Female	Non-target species	Total	Percent illegal
Bristol Bay red king crab	11,320	1.0	30	0	1	31	0.27
Bering Sea snow crab	102,434	0.2	9	4	144	157	0.15
St. Matthew Island blue king crab	19,597	5.2	72	1	0	73	0.37
Pribilof Islands golden king crab	–[d]	–[d]	–[d]	–[d]	–[d]	–[d]	–[d]
E. Aleutian Islands golden king crab[b]	8,299	1.2	49	1	0	50	0.60
W. Aleutian Islands golden king crab[c]	29,685	4.4	136	4	1	141	0.48

[a] Based on ATF reported catch number.
[b] East of 174° W long.
[c] West of 174° W long.
[d] Confidential.