Regional Information Report No. 1J10-17

Southeast Alaska Golden King Crab Onboard Observer Program Methods

by

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November 2010

Alaska Department of Fish and Game **Division of 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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

Management of golden king crabs in Southeast Alaska is based on a triennial review of fishery-dependent data. Golden king crabs are fished using large pots at the extreme depths (up to 350 fathoms) of Southeast Alaska. The fishery begins between February 10 and 17 each year. Areas with the largest guideline harvest levels, GHLs, have generally closed by emergency order by mid April and areas with smaller GHLs can remain open until December. The fishery is sampled both dockside and onboard commercial fishing vessels. Dockside sampling provides information on recruit and postrecruit crabs only, while the observer program supplies data on female and sublegal crabs, the fine scale distribution of golden king crabs, bycatch, and details on fishing methods such as soak time and gear configuration. In order to obtain information on females and sublegal crabs, observers close escape rings on up to 50 pots per trip; however, they sample pots with both open and closed escape rings. Carapace length is measured and shell age, leg condition, and presence of parasites are visually assessed for all commercially important crab species; for female crabs, clutch fullness, and development and condition of eggs are determined as well. Chela height is measured for a subsample of male crabs sampled. For each pot sampled, location, depth, soak time, debris, substrate, bycatch count by species, pot condition, pot type, pot dimensions and weight, escape device, and bait are recorded.

Key words: golden king crabs, Lithodes aequispinus, stock assessment, observer program, management, Southeast Alaska

INTRODUCTION

Golden king crabs, *Lithodes aequispinus*, (GKC) are found in deep waters, between 100 and 350 fathoms (182–640 m) of northern Southeast Alaska. Important fishing grounds are located at the confluences of Icy Strait, Lynn Canal, and Chatham Strait; of Chatham Strait and western portions of Frederick Sound, and of Stephens Passage and Frederick Sound (Figures 1 and 2). Fishing conditions in the golden king crab fishery are very demanding, because the grounds are exposed to adverse weather conditions, located in great depths, and subject to strong tidal exchanges and heavy currents (Hebert et al. 2005, 2008, 2008).

Harvest of GKC in Southeast Alaska averaged 0.58 million lb for 1999/2000–2008/09 seasons. Management measures in effect for the fishery include seven separate management areas, each with their own guideline harvest range (GHR) and a season start between February 10 and 17 with closure by emergency order when guideline harvest levels (GHLs) are achieved in each management area. In addition there is a gear limit of 100 pots per vessel, and harvest is restricted to male crabs only, with the minimum legal carapace width (CW) of 7 inches (178 mm) (Hebert et al. 2005).

The biology of golden king crabs is poorly understood, but they are thought to have a 24-month reproductive cycle (Otto and Cummiskey 1985), asynchronous timing of mating and molting (McBride et al. 1982; Otto 1984a; Sloan 1985), and large yolk-rich eggs with low fecundity—about 30,000 per female crab (Jewett et al. 1985). Male golden king crabs in Southeast Alaska are thought to become sexually mature at a size of about118 mm carapace length (CL) (Koeneman and Buchanan 1985; Otto 1984a). Extrapolating the juvenile growth data of Paul and Paul (2001) forward, this size is approximately 8 years of age. Golden king crabs in Southeast Alaska enter the fishery at 178 mm CW, which corresponds to about 151 mm CL. This is based on the length-width relationship of $Y = 44.336 + 0.8875X$ where X is carapace length in mm, and Y is carapace width in mm, provided by Koeneman and Buchanan (1985). Adult male molt increment is probably the only parameter that has been well-described for this species in Southeast

Alaska, where it is estimated as 16.4 mm CL (Koeneman and Buchanan 1985). Using this molt increment, the legal size is between two and three molts from the mature size. Since molt frequency is only slightly more than 12 months at this size this means that male golden king crabs in Southeast Alaska have in excess of two years to contribute to the reproductive potential of the population before they begin to be exploited at about 10.5 years of age. To reach the maximum observed size of 215 mm CL from the legal size of 151 mm CL would require 4 molts. Since the molt frequency begins to decline at sexual maturity, it is likely to take well in excess of four years to reach this maximum size. Using a molt frequency of 48 months, the maximum age would be approximately 18.5 years of age.

The lack of a fishery-independent stock assessment program for this species has been the driving force for the implementation of an onboard observer program. The observer program provides information on prerecruits and females, as well as life history information specific to golden king crabs in Southeast Alaska. Stock assessment for GKC consists of a triennial evaluation of fishery (fish ticket and logbook) and sampling (onboard and dockside) information and stock status is determined as a result of this evaluation. Based on stock status, guideline harvest levels, within the regulatory guideline harvest range, are recommended and targeted inseason by fishery managers.

OBJECTIVES

Objectives of the Southeast Alaska golden king crab onboard observer program are to:

1. Describe the size and sex composition of golden king crab captured in a legal crab pot.
2. Describe the size and sex composition of golden king crab captured in a crab pot with the escape rings closed.
3. Describe the bycatch species composition in the golden king crab fishery.
4. Describe fishing methods common in the golden king crab fishery, including bait, gear, and soak times.
5. Describe the commercial fishing grounds within each management area.
6. Describe ontogenetic depth distribution of golden king crab.
7. Describe any periodicity in golden king crab life history.
8. Obtain data on chela height allometry for golden king crab to define Southeast Alaska, and management area-specific size at maturity.

The purpose of this report is to describe the need for, objectives of, and methods used in the golden king crab onboard observer program in Southeast Alaska.

METHODS

SAMPLE SIZE ANALYSIS

A standardized power of analysis test was used on accumulated observer data to determine the appropriate sample size needed to detect changes in GKC catch per unit effort (CPUE). This reduces the likelihood of a type II error, which could falsely conclude that there is no difference in CPUE as a function of year, when in fact there was a significant difference. It also allows for the determination of whether the study is feasible given the logistical and financial constraints that limit sample size (Mills 2007). This test was calculated using 80% power (probability of obtaining a significant result), α

0.05 (significance level),Δ (effect size), and the standard deviation, σ, from the mean CPUE of the number of crab/pot of recruit classes by year and by location (Appendix A) (Kraemer and Theimann 1987). The effect size is standardized at δ=0.2 using the following equation, $d = \frac{\Delta}{\sigma}$.

This equation shows that each management area sampled has the same sample size required to detect a difference in CPUE, therefore allowing each management area to be statistically compared. Results indicate that 100 pots should be sampled during each management area and year in order to detect a change of X mm CL in the XX recruit class (Table 1).

OBSERVER PROGRAM

Data Collection

Alaska Department of Fish and Game employees are placed onboard volunteer vessels during the commercial fishery to sample crabs caught in pots with open and closed escape rings. These volunteer vessels are authorized by the department to close escape rings or stretch mesh in up to 50 of their legal limit of 100 pots. Vessels delay discard of female and sublegal male crabs while observers are onboard to allow for sampling. Live, non-legal crabs are returned to the water unharmed after sampling, and legal-sized crabs are returned to the vessel's crew for storage in live tanks prior to being off loaded to a tender or fish processor.

The annual sampling goal is six trips, preferably from different management areas. Each trip is a minimum of five sampling days in length. Within a sampling day, golden king crabs from at least ten pots with escape rings closed (closed pots) and ten with escape rings open (open pots) are sampled and a minimum of 35 male chelae heights are measured. For each sampled pot, at least 50 golden king crabs are sampled, if available, and pot configuration, substrate and bycatch are documented. During each trip 100 pots are be sampled.

Every 2nd pot set has its escape rings, or 7-inch stretch mesh escape panels, sewn closed, either at the time of first setting—if the observer is aboard from the beginning of the season—or immediately prior to the observer boarding the vessel. In the latter case, the skipper is asked to systematically set every 2nd pot with escape rings closed, to ignore escape ring status in selecting pot locations, and to record buoy tag number and time and date of setting for each pot on a "Skipper Set Log" data sheet (Appendix B1).

Four tidbits are deployed at the beginning of each trip, evenly spaced throughout the gear. Tidbits are placed on closed pots and are retrieved 2 to 3 days before the end of the trip to ensure recovery of all devices. Tidbits are placed in an area of the pot in which it will not get broken when stacking pots on board the vessel. Tidbits are launched using Boxcar (yellow tidbits) and Hoboware (orange tidbits) software and temperature is record in Centigrade at 1-hour intervals.

Sampled pots are selected in a systematic fashion with a random start point. Open pots are selected for sampling prior to their reaching the deck and without the skipper's knowledge that a given pot will be sampled. Sampling closed pots has priority over open

pots and all closed pots are sampled when possible. The biodegradable twine on the closed pots is checked with each lift.

When a pre-selected pot comes up empty of any commercially important crab species it is nonetheless recorded as a sample although there will be no crab survey specimen data. To avoid confusion, a data entry of "EMPTY NO CRAB" is recorded on the “Crab Survey Specimen Form” data sheet and also in the comments section of the “Crab Pot Set Form” data sheet (Appendices B2 and B3).

As each pot is pulled, pot tag number (recorded in place of buoy number), pull time and date, location in latitude and longitude accurate to 0.001 decimal minutes, and depth in fathoms and a gear description which includes pot type, approximate dimensions, weight and escape device, and bait type, are recorded on the “Crab Pot Set Form.” Set time is obtained later from the skipper set log. Header information includes year, trip number, location and sublocation, and recorder name (Table 2).

Sampling Design

For each sampled pot, all bycatch species are identified, counted and recorded on the “Incidental Species Form” (Appendix B4). Bycatch is defined as any animal besides commercially important crab species (i.e. red and golden king crabs, Tanner crab, and Dungeness crab). In addition to bycatch, any non-living or plant debris or substrate observed clinging to a pot and the pot’s condition are also recorded on this form (Table 3).

Ideally, crabs are subsampled at a rate adjusted to allow 50–100 crabs to be measured in each pot and crabs to be processed quickly enough for an open pot to be sampled between closed pots. Crabs are sorted by species and sex before subsampling, so that subsample rates that are reflective of the relative abundance of each species and sex. A higher rate of subsampling may be necessary when environmental conditions are harsh (i.e. freezing spray and rough seas) to avoid long handling times that could significantly increase crab mortality.

All commercially important crab species are sampled during onboard observing; however, golden king crabs are sampled at the highest rate and catch of other crab species is minimal for most areas. The standard measurement for king crab is biological carapace length (Donaldson and Byersdorfer 2005) and male golden king crabs between 144 and 170 mm CL are also measured, using a 7-in diameter measuring stick to determine whether or not they are of legal carapace width (Table 4). Tanner crab are measured for carapace width (Jadamec et al. 1999) and Dungeness crab for shoulder width (the smallest measure immediately anterior to the 10th anterolateral spine). The first 10 male golden king crab sampled from each pot, or 50 crab per day, are measured for chela height—the greatest height of the right chela excluding spines accurate to 1.0 mm (Figure 3). Shell age (Table 5) and leg loss (Table 6) are also determined. The abdominal flaps of king crabs are checked for presence of externa or scars resulting from parasitism by the rhizocephalan barnacle *Briarosacchus* (Table 7). With the skipper’s approval, crabs with a parasite present are to be removed and placed in a ziploc bag labeled with the trip number, location, pot number, and crab number (from the data sheet). These samples are to be placed in the freezer hold of the observer boat and brought back where a muscle tissue sample will be preserved in ethanol for further analysis. Female crabs are examined

for clutch fullness in 10% increments and, egg condition, and development determined according to the criteria in (Table 8). This individual crab specimen data is recorded on the "Crab Survey Specimen Form" (Appendix B2).

SAFETY PROCEDURES

Call-ins to the observer coordinator or the shellfish research project leader are conducted three times weekly on Monday, Wednesday and Friday, to maintain good communication with the observer and to provide information for inseason management of the fishery. State of Alaska Standard Operating Procedure (SOP) #III-740 "Boating Safety" is followed at all times while onboard fishing vessels and strict criteria are applied in the choice of which vessels are chosen to support observers. These criteria are listed in Table 9. In addition, observers are supplied with safety equipment which includes an immersion suit, float coat, and a first aid kit. All observers participating in the program have completed an Alaska Marine Safety Education Association training course.

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TABLES AND FIGURES

Table 1.–Sample size of pots per trip needed to detect a significant change in the prerecruit size class of GKC CPUE for 2008/09 using a standardized effect size of $\delta = 0.2$.

Location	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central*	1.08073432	1.839428	100
Mid-Chatham	1.41571649	0.8594104	100
Northern	0.1784897	0.2103986	100
Lower Chatham	2.54990604	0.754881	100
Icy Strait	0.10104964	0.0655758	100
North Stephens Pass	0.38335704	0.2827608	100

*Note that East Central data is from 2007/08, since no sampling occurred in 2008/09.

Table 2.–Location and sublocation codes for the Southeast Alaska golden king crab onboard observer program.

Location/ Management Area	Location code	Sublocation	Sublocation code	Sublocation areas
East Central	1			
Mid-Chatham Strait	2			
Northern	3			
Southern	4	Deer Is/N Ernest	1	107-10
		Emerald Bay/S	2	107-20
		Rocky	3	106-20
		Steamer Bay	4	106-30
Lower Chatham	5			
Icy Strait	6			
North Stephens Passage	7			
Misc. Golden King	8			

Table 3.–Description of debris, substrate, pot condition, type, dimensions, escape device, and bait codes for the Southeast Alaska golden king crab onboard observer program. Pot weight is also recorded, but is of continuous data type.

	Debris	Substrate	Pot condition	Pot type	Pot dimensions	Escape device	Bait
0		Unknown					
1	Lg. Brn. kelp	Mud	Normal	Pyramid	4’ dia.	None/closed rings	No bait
2	Mussels	Mud/gravel	Not baited	Cone	5–5’11” dia.	King (4, 6 ¼-inch rings)	Jar & hanging
3	Shells	Mud/clay	Lost	Square	6–6’11” dia.	King (9-inch stretch mesh)	Jar only
4	Woody debris	Mud/shell	Door open	Dungeness	7–7’11” dia.	Tanner (4, 4 ¾-inch rings)	Hanging only
5	Hair kelp	Mud/soft	Broken webbing		7x7	Tanner (7-inch stretch mesh)	
6	Barnacles	Mud/hard	Upside down		8x8	Dungeness (2, 4 ⅜-inch rings)	
7	Sponges	Clay	Collapsed tunnel		9x9		
8		Sand	Not on bottom				
9		Gravel	Pot open/broken				
10		Boulder	Lost pot contents				
11		Cobble					
12		Rock					
13		Hard					
14		Soft					
15		Shell					
16		Coral					
17		Mixed					
18		Silt					
19		Barnacle					
20		Mussels					

Table 4.–Probability of a male golden king crab in Southeast Alaska being of legal carapace width or larger, by carapace length. Sample size = 17,870. A 95% confidence interval was used for analysis. Bold text indicates that 50% of crab of this size are legal.

Probability of legal	Predicted carapace length	Lower limit	Upper limit
0.01	143.5	142.9	144.0
0.05	148.2	147.8	148.5
0.10	150.3	150.0	150.6
0.20	152.7	152.4	152.9
0.30	154.2	154.0	154.4
0.40	155.5	155.3	155.7
0.50	**156.6**	**156.5**	**156.8**
0.60	157.8	157.6	158.0
0.70	159.1	158.9	159.3
0.80	160.6	160.4	160.8
0.90	162.9	162.7	163.2
0.95	165.1	164.8	165.4
0.99	169.8	169.4	170.3

Table 5.–Shell age criteria for the Southeast Alaska golden king crab onboard observer program (Donaldson and Byersdorfer 2005).

Code, category	Shell age	Description
1, soft	0–2 weeks	Shells very soft and flaccid, lose shape when out of water. Similar in texture to wet leather. Lack of careful handling will cause shell to lose shape.
2, light	2–8 weeks	Shiny ventral surface of coax and exoskeleton. Few or no scratches, pits or epibionts presents. Dactyls and spines sharp with no wear present. Legs easily compressed when pinched because legs contain little muscle tissue. Merus flexible and does not crack when bent. Chela depressible.
3, new	2–20 months	Coxa and ventral surface of exoskeleton dull. Legs mostly full of muscle tissue, eri not easily compressed by pinching and will crack if bent. Spines and dactyls may show slight wear.
4, old	21–36 months	Skip molts. Distal portion of ventral coax partially or totally covered with grown scratching. Legs full of muscle tissue, meri not easily compressed. Epifauna almost always present.
5, very old	>36 months	Double skip molts. Distal portion of ventral coax densely covered with dark scratching. Legs full of muscle tissue, meri not easily compressed when pinched. Tips of dactyls worn, rounded and dark. Carapace frequently covered with fouling organism to greater extent than with old-shell crabs.

Table 6.–Leg loss codes in use for the Southeast Alaska golden king crab onboard observer program.

Code	Criteria
1	No legs missing or regenerated
2	1 leg missing or regenerated
3	2 or more legs missing or regenerated
4	Carapace damage
5	Combination of conditions

Table 7.–Parasite condition codes used for the Southeast Alaska golden king crab onboard observer program.

Code	Parasite
1	None
2	Briarosacchus, single scar
3	Briarosacchus, double scar
4	Briarosacchus, single externa
5	Briarosacchus, double externa
6	Bitter crab, *Hematodinium*
7	Microsporidian
8	Nemertean worms

Table 8.–Reproductive condition codes used in the Southeast Alaska golden king crab onboard observer program (Donaldson and Byersdorfer 2005).

Code	Clutch condition	Egg Development
1	Normal	Eyed eggs
2	<20% dead eggs in the clutch	Uneyed eggs
3	>20% dead eggs in the clutch	No eggs
4	Barren with silky setae	
5	Barren with matted setae and empty egg cases	

Table 9.–Safety requirements for vessels.

(1) USCG approved first-aid kit. (2) USCG approved vessel EPIRB. (3) USCG approved fire-fighting equipment of the size, type and quantity required for the size and type of the vessel chartered. (4) USCG approved life raft(s). The rated capacity of each raft must be adequate to accommodate all personnel aboard the vessel; this includes the vessel captain and crew, and one (1) ADF&G crew. (5) USCG approved survival suits of appropriate sizes are required for all personnel aboard the vessel, including the vessel captain and crew and the ADF&G crew. The State will supply survival suits for the ADF&G crew. The vessel captain will obey all USCG, State and other applicable regulations, rules, and statutes pertaining to the safe and legal operation of the vessel. The captain must provide a safety orientation briefing to all vessel and ADF&G crew prior to departure from port. Both the vessel crew and ADF&G crew must have general instructions regarding the following: (1) The location and operation of lifesaving and emergency equipment. (2) Operation of assigned equipment. (3) Instructions for making a distress call. (4) What to do in the event of a person overboard. (5) What to do in the event of a fire. (6) What to do in the event of flooding. (7) What to do if an 'abandon ship' order is issued.
Sleeping space to accommodate one (1) ADF&G personnel, in addition to sleeping space for the vessel captain and crew. Each sleeping space used by ADF&G personnel must be at least twenty-six (26) inches in width at the shoulders and seventy-seven (77) inches long.
Vessel length of not less than forty eight (48) feet. Length will be determined by measuring the length overall from the foremost part of the hull to the aftermost part of the hull, excluding bowsprits, rudders, accessory brackets and similar fittings and attachments.

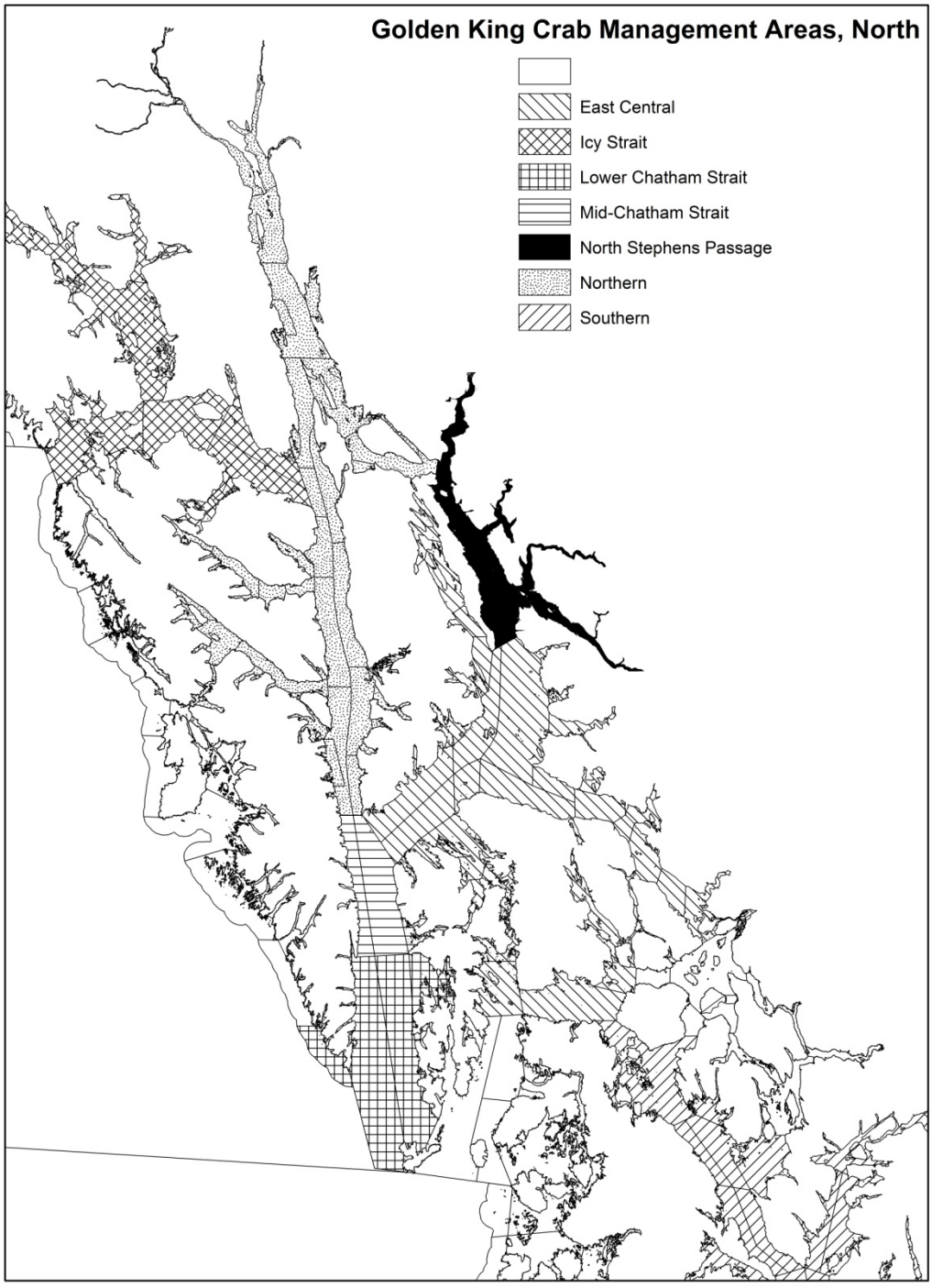

Figure 1.–Management area boundaries for the golden king crab fishery in Northern Southeast Alaska**.**

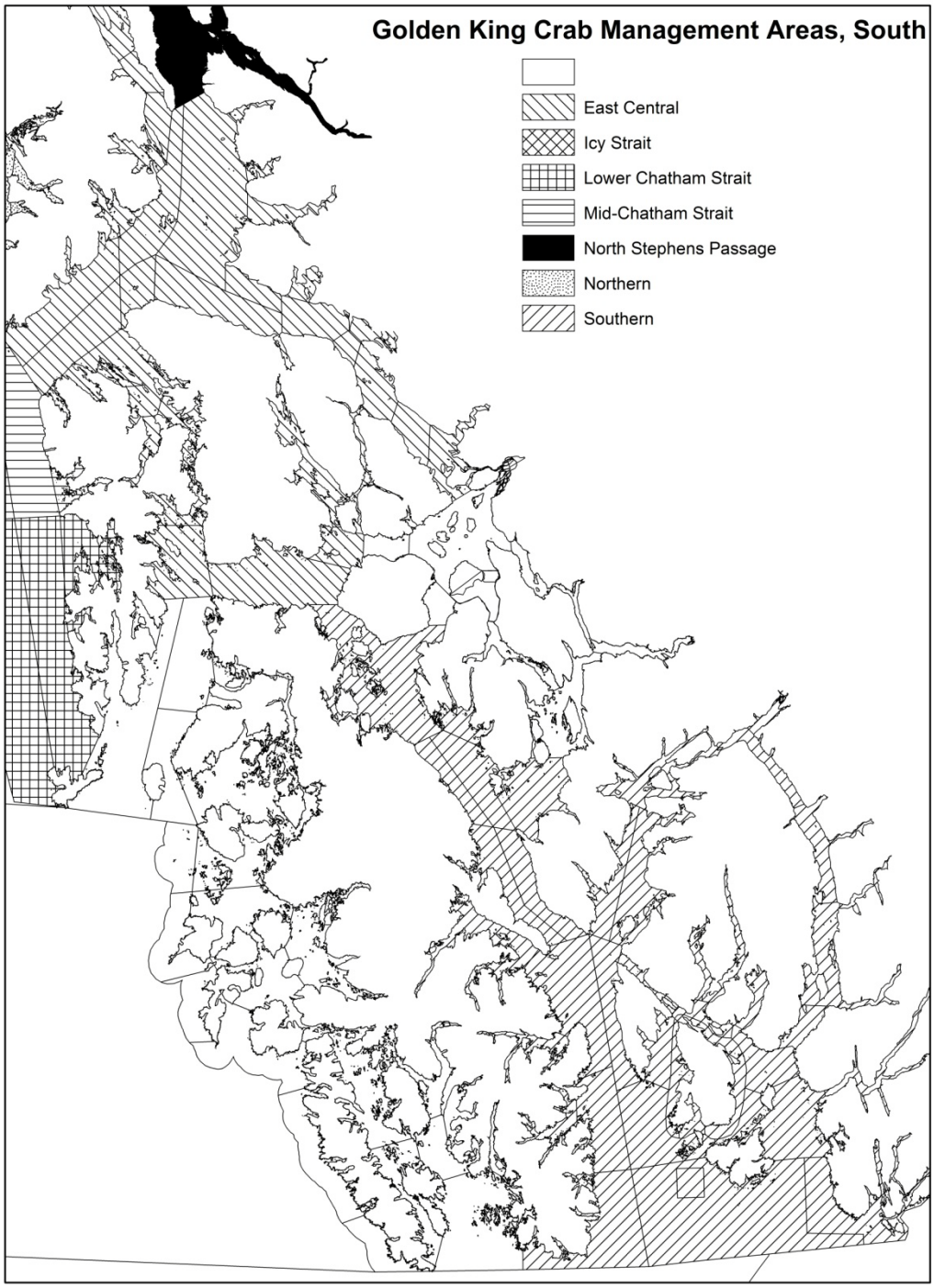

Figure 2.–Management area boundaries for the golden king crab fishery in Southern Southeast Alaska**.**

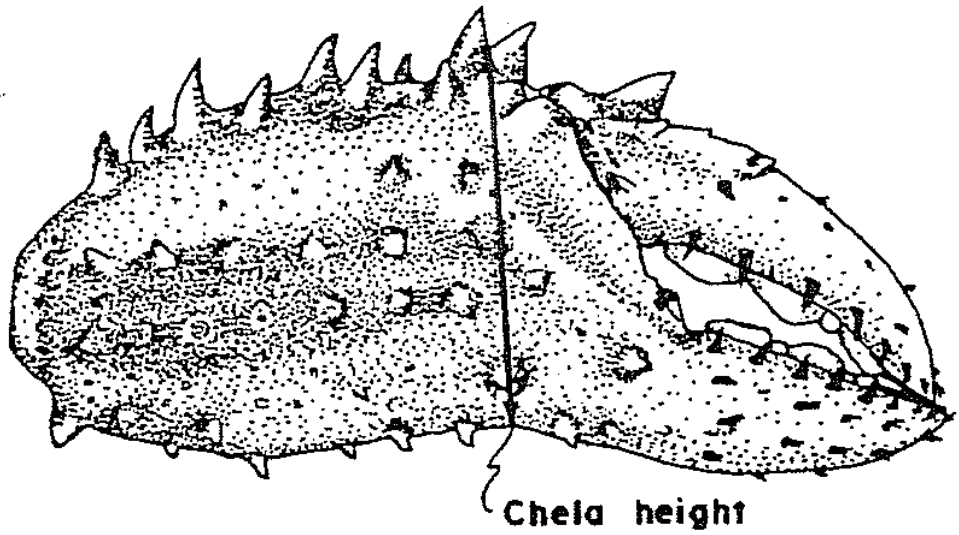

Figure 3.–Standard procedure to measure chela height on golden king crabs. The measurement is always taken in the notch between the two large spines on the dorsal edge of the chela. (Jewett et al. 1985).

APPENDIX A. ADDITIONAL POWER ANALYSIS RESULTS

Appendix A.1–Sample size of pots per trip needed to detect a significant change in the immature female size class of GKC CPUE for 2008/09 using standardize effect size of $\delta = 0.2$.

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	Immature Female	0.08089934	0.0414618	100
Mid-Chatham	Immature Female	0.16307139	0.147373	100
Northern	Immature Female	0		
Lower Chatham	Immature Female	0.08907383	0.0927412	100
Icy Strait	Immature Female	0		
North Stephens Pass	Immature Female	0.02631579	0.0188166	100

Appendix A.2–Sample size of pots per trip needed to detect a significant change in the mature female size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	Mature Female	0.4660066	3.188594	100
Mid-Chatham	Mature Female	5.16111967	2.36509	100
Northern	Mature Female	1.03146453	0.4531298	100
Lower Chatham	Mature Female	1.0394094	0.889162	100
Icy Strait	Mature Female	0.26365416	0.2195542	100
North Stephens Pass	Mature Female	0.42816501	1.051345	100

Appendix A.3–Sample size of pots per trip needed to detect a significant change in the juvenile size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	Juvenile	0.04476273	1.9667032	100
Mid-Chatham	Juvenile	0.62085259	0.7377152	100
Northern	Juvenile	0.04405034	0.063345	100
Lower Chatham	Juvenile	0.49777181	0.2486396	100
Icy Strait	Juvenile	0.0122754	0.0281614	100
North Stephens Pass	Juvenile	0.00995733	0.1048766	100

Appendix A.4–Sample size of pots per trip needed to detect a significant change in the recruit size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	Recruit	4.27727	0.8956134	100
Mid-Chatham	Recruit	2.98669748	0.7995582	100
Northern	Recruit	1.13415332	1.8273162	100
Lower Chatham	Recruit	2.43973154	0.5738506	100
Icy Strait	Recruit	0.51325387	0.2046498	100
North Stephens Pass	Recruit	1.0455192	0.456391	100

Appendix A.5–Sample size of pots per trip needed to detect a significant change in the post recruit 1 size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	PR1	0.63642739	0.4925164	100
Mid-Chatham	PR1	1.01566513	0.4228236	100
Northern	PR1	0.49284897	0.431738	100
Lower Chatham	PR1	0.19414765	0.1060584	100
Icy Strait	PR1	0.56662716	0.3372392	100
North Stephens Pass	PR1	0.7517781	0.5376286	100

Appendix A.6–Sample size of pots per trip needed to detect a significant change in the post recruit 2 size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	PR2	0.3654703	0.2205112	100
Mid-Chatham	PR2	0.01869543	0.1742648	100
Northern	PR2	1.80091533	2.99994	100
Lower Chatham	PR2	0.00128859	0.0170866	100
Icy Strait	PR2	0.37697919	0.3157778	100
North Stephens Pass	PR2	0.58677098	0.4023906	100

Appendix A.7–Sample size of pots per trip needed to detect a significant change in the post recruit 3 size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	PR3	0.0865099	0.0869532	100
Mid-Chatham	PR3	0.05521315	0.0761716	100
Northern	PR3	1.20022883	1.8686614	100
Lower Chatham	PR3	0		
Icy Strait	PR3	0.40277531	0.153424	100
North Stephens Pass	PR3	1.21692745	0.3565468	100

Appendix A.8–Sample size of pots per trip needed to detect a significant change in the post recruit 4 size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	PR4	0.000540005	0.0144426	100
Mid-Chatham	PR4	0.00606061	0.014334	100
Northern	PR4	0.13043478	0.1145778	100
Lower Chatham	PR4	0		
Icy Strait	PR4	0.03896104	0.0279146	100
North Stephens Pass	PR4	0.56899004	0.2065298	100

Appendix A.9–Sample size of pots per trip needed to detect a significant change in the post recruit 5 size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	PR5	0		
Mid-Chatham	PR5	0		
Northern	PR5	0.326087	0.0263654	100
Lower Chatham	PR5	0		
Icy Strait	PR5	0		
North Stephens Pass	PR5	0.13513514	0.0778078	100

Appendix A.10–Sample size of pots per trip needed to detect a significant change in the post recruit 6 size class of GKC CPUE for 2008/2009 using standardize effect size of $\delta = 0.2$

Location	Recruit Class	Diff. Mean	Standard Effect Size d=0.2	80% Power
East Central	PR6	0		
Mid-Chatham	PR6	0.0030303	0.0101512	100
Northern	PR6	0		
Lower Chatham	PR6	0		
Icy Strait	PR6	0		
North Stephens Pass	PR6	0		

APPENDIX B. FORMS

Appendix B.1–Skipper set log.

Year_____ Vessel name_____

Management area_____

Buoy tag number	Time/date set Month/day	Time

Appendix B. 2–Crab survey specimen form.

CRAB SURVEY SPECIMEN

Date ____ / ____ / ____ Page _____ of _____

Year _____ Project _____ Trip # _____ Recorder _____

Location Code _____ Location Name _____ Pot # (Order) _____ Buoy # _____

Specimen #	Subsample Rate	910 Dung. 921 RKC 922 BKC 923 GKC 931 Bairdi	Sex	Size (mm)	Weight (gms)	Legal Size	Shell Condition	Blackmat 1= Present	Female Data Eggs Percent	Development	Condition	Parasite	Leg Condition	Tag Number	Tag Code	Comments
1																
2																
3																
4																
5																
6																
7																
8																
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Appendix B. 3–Crab pot set form**.**

CRAB POT SET FORM

Year________ Project________________________________ Trip #______ Vessel name_____________________________________

* Bait: **J** = Jar **H** = Hanging **B** = Both

* Pot type: **S** = Square (7x7) **C** = Cone **P** = Pyramid **D** = Dungeness

Location name____ Location code______ Recorders name____________________________________

Stratum	Pot # (order)	Escape Rings O/C	Pot type *	Pot Weight Lbs.	Bait type *	Buoy #	Depth (fathoms)	Set Gear			Lift Gear			Latitude/Longitude												Tidbit # (if used)	Comments
								Month	Day	Time (military)	Month	Day	Time (military)	Deg. N	Minutes to 1000th (Examples below)					Deg. W	Minutes to 1000th (Examples below)						
														55	2	0.	6	0	5	131	5	1.	2	7	0		

Appendix B. 4–Incidental species form.

INCIDENTAL SPECIES

Year_____ Project _____ Trip # _____ Location Name _____ Code:_____ Recorder:_____

Pot #	Buoy #	Substrate	Debris	Box crab	Buccinum	Fusitriton	Great Sculpin	Hairy crab	Halibut	Helmet crab	Hermit crab	Lyre crab	Neptunea	Pacific cod	Pycnopodia	Quillback	Sculpin (general)	Spot shrimp	Yellowfin sole									Comments
				900	360	361	342	312	200	316	313	314	362	110	381	147	160	965	127									

Codes for:

Pot Condition

1-Normal
2-Not baited
3-Lost
4-Door open
5-Broken webbing
6-Upside down
7-Collapsed tunnel
8-Not on bottom
9-Pot open/broken
10-Lost pot contents
11-Close escape ring
12-Open escape ring

Substrate

0-Unknown
1-Mud
2-Mud/gravel
3-Mud/clay
4-Mud/shell
5-Mud/soft
6-Mud/hard
7-Clay
8-Sand
9-Gravel
10-Boulder
11-Cobble
12-Rock
13-Hard
14-Soft
15-Shell
16-Coral
17-Mixed
18-Silt
19-Barnacle
20-Mussels
21-Woody debris

Debris

1-Large brown kelp
2-Mussels
3-Shells
4-Woody debris
5-Hair kelp
6-Barnacles
7-Sponges

341	Big mouth sculpin	964	Coonstripe shrimp	134	Greenland turbot	999	Misc. note in comments	270	Pollock	123	Rock sole	896	Sea urchin, general	691	Spiny dogfish shark
121	Arrowtooth flounder	899	Coral	190	Greenling, general	870	Octopus	373	Prowfish	139	Rockfish, other	960	Shrimp, general	355	Sponge
301	Brachiopods	311	Decorator crab	963	Humpy shrimp	212	Pacific hagfish	371	Ratfish	710	Sablefish	962	Sidestripe shrimp	380	Starfish, general
330	Brown rockfish	210	Eels or eel-like fish	345	Irish lord, general	141	Pacific ocean perch	346	Red Irish lord	315	Scale crab	157	Silvergray rockfish	129	Starry flounder
343	Buffalo sculpin	128	English sole	194	Kelp greenling	340	Pacific staghorn	892	Red sea urchin	850	Scallop	700	Skate, general	156	Widow rockfish
146	Canary rockfish	122	Flathead sole	940	Korean horsehair crab	390	Peanut worm	153	Redbanded rockfish	350	Sea anemone	890	Snail, general	211	Wrymouths
310	*Cancer gracilis*	120	Flounder, general	130	Lingcod	131	Petrale sole	125	Rex sole	895	Sea cucumber	370	Snailfish	145	Yelloweye rockfish
305	Chiton, general	893	Green sea urchin	372	Lumpsucker	961	Pink shrimp								

Appendix B.5–Chela height tally form.

Golden King Crab Chela Height Size Category Tally Sheet

Instructions: This tally sheet can be used to track the number of male GKC of each size category to be sampled. Throughout the day, collect chela height for carapace length categories listed below.

Golden King Crab male Chela Heights

Carapace size	**<100**	**100-110**	**111-120**	**121-130**	**131-140**	**141-150**	**>151**
Sample date	**5**	**5**	**5**	**5**	**5**	**5**	**5**