Regional Operational Plan CF.1J.2019.12

Operational Plan: Southeast Alaska Tanner Crab Survey

by

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and

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

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

REGIONAL OPERATIONAL PLAN CF.1J.2019.12

SOUTHEAST ALASKA TANNER CRAB SURVEY

by

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Division of Commercial Fisheries

November 2019

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SIGNATURE PAGE

Project Title:	Southeast Alaska Tanner Crab Survey
Project leader(s):	*Joe Stratman*
Division, Region, and Area	*Commercial Fisheries, Region I, Southeast Alaska*
Project Nomenclature:	
Period Covered	2019–2023
Field Dates:	October
Plan Type:	Category II

Approval

Title	Name	Signature	Date
Project leader	Joe Stratman		10/11/2019
Biometrician	Katie Palof		10/11/2019
Research Coordinator	Andrew Olson		10/11/2019

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PURPOSE

The Southeast Alaska Tanner crab survey provides stock health indices and catch per unit of effort (CPUE) data, which is used in the assessment of Tanner crab in Southeast Alaska and providing management recommendations for the commercial fishery.

OBJECTIVES

PRIMARY

1. Capture and collect biological information on Tanner crab from four survey areas in the central and northern portion of Southeast Alaska for model-based biomass estimation.
2. Obtain a pre-season index of legal and pre-recruit male abundance as well as female abundance and reproductive status for Tanner crab.
3. Use results from survey analysis to determine whether the minimum biomass threshold of mature males for a commercial fishery opening has been exceeded and number of fishing days.
4. Capture and collect biological information on other commercial crab bycatch species, such as king crab and Dungeness crab.

SECONDARY

5. Maintain long-term data set on bottom temperature (from HOBO temperature tidbits) for future climate analysis and comparisons.
6. Collect chela height ratios of male Tanner crab to estimate size at maturity.
7. Visual identification of bitter crab prevalence.

BACKGROUND

The survey is currently conducted in the central and northern part of Southeast Alaska in four survey areas: Icy Strait, Thomas, Holkham, and Glacier Bay (Figure 1). Previously surveyed areas included Port Camden and Stephens Passage; these areas were excluded from the assessment since 2015.

A range of 52 to 78 pots are set in each survey area, dependent on the size of the area and time needed to work the gear. Table 1 includes location codes for each survey location. CPUE of mature male crab are incorporated in a model to produce estimates of mature male population size for each surveyed area. Population size is estimated using a three-stage catch survey analysis model (CSA) that tracks three recruit categories (classified using size and shell condition; Table 2) of male crabs over the range of survey years, which in most areas is from 1997 to present, to estimate the current abundance of mature and legal male crab in each area.

In addition to estimating abundance, other factors that contribute to the overall health of the population are examined, including CPUE of juvenile male and female crab, egg condition, clutch fullness, and size distributions. Estimates of harvestable surplus are generated for each survey area and expanded using the mean proportion of harvest occurring in the surveyed areas to produce a regional biomass estimate for mature male crab. The regional mature male biomass estimate is

compared to a regulatory threshold of 2,300,000 pounds (5 AAC 35.113), which is the minimum level for the commercial fishery to open in February. Survey results are also used to set the season length; additional fishing days are added when the estimated biomass of mature males exceeds 5,500,000 pounds.

METHODS

Survey methods were first detailed in *Tanner crab pot survey methods for Southeast Alaska* (Bednarski et al. 2008). This Regional Operational Plan updates those methods for the 2019 to 2023 field seasons.

Southeast Alaska Tanner crab stocks are assessed using a stratified random sampling design. Four important fishing locations in Southeast Alaska are surveyed annually at the smallest tidal range in October of each year. Commercially important bycatch species are counted, recorded, and returned to the sea (Table 3). All king, Tanner, and Dungeness crabs are retained for collection of biological information and then returned to the sea.

SURVEY DESIGN

Updates to the survey design were performed prior to the 2013 survey. The survey areas were stratified based on total crab abundance from previous surveys and depth data obtained from NOAA (Tanner restratification memo *in progress*). These methods were similar to the density stratification currently in place for red king crab stock assessment survey (Clark 2008). The stratification provides five density strata in a design that minimizes within strata variability, therefore efficiently providing a statistically robust estimate of CPUE for use in the CSA model. More statistically robust estimates of CPUE will provide additional confidence in the biomass forecasts coming out of the CSA model.

POT LOCATIONS

Pot locations are selected within five density strata through a stratified random sampling design. The number of pots within each stratum is determined using a Neyman allocation based on the variance of total crab CPUE estimates by strata from 2013–2015 survey data, which is updated using new data every three years (Cochran 1977). The allocation was updated for the 2019 survey season, using the 2016–2018 data, and the next update is scheduled for 2021. The total number of pots within each survey area is determined based on logistics and time that the crew can efficiently sample and set pots. Exact pot locations are determined using randomly generated locations within each stratum, with a minimum distance of 0.1 nautical miles between pots using ArcGIS. Details of pot locations for each survey year are presented starting with the 2019 information in Appendix D. Extra pot locations are provided in the tables and figures, for each area, in the event there may be conflicts with gear from concurrent fisheries in the vicinity or if set locations are otherwise unattainable.

SETTING AND PULLING

Approximately 26 pots are deployed each day to increase sampling efficiency and spatial coverage of each survey area. Setting and pulling times will be recorded for each pot on the "Crab Pot Set Form" (Appendix B1). Pots will be set between 12:00 and 18:00 hours and pulled between 07:00 and 13:00 hours; pots are generally pulled in the same order as they are set. Soak times will range from 16– 20 hours. Tanner crab pot soak time experiments conducted in 2004 and 2005 in Icy

Strait and Excursion Inlet found no gear saturation occurring with the gear and standard soak period used in this survey (Rumble et al. 2008).

POT GEAR AND BAIT

Conical, top-loading commercial crab pots with an eighty-eight-inch diameter and no escape rings will be used for the survey. Bio-twine (30-thread untreated cotton twine) will be laced through an 18 inch opening on a side wall of each pot. Pots will be baited with one ½ round of pink salmon and approximately four pounds of frozen, winter-caught Pacificbait herring (caught the same year as the current survey) and chopped within 24-hours of use. Two bait containers, on opposite sides of the pot and each filled with approximately two pounds of chopped herring, will be used for each pot along with the one ½ round of pink salmon. The bait jars will be suspended so that the top of the bait jar is approximately the same height as the bottom of the pot cone and about halfway between the cone and the exterior webbing. The bio-twine will be replaced on all pots prior to setting gear on the first day of leg 1 of the survey in each year.

HOBO Stowaway Tidbit® temperature loggers will be attached to all pots with zip ties prior to the first set on each leg of the survey. Tidbits should be attached to pots so that the tag number is facing out and visible to crew on deck. Temperature is recorded at hourly intervals to the nearest thousandth °C. All tidbits should be removed from the pots and the information downloaded at the end of each survey leg. Temperature logger protocols are found in Appendix A.

Setting and pulling the gear is the responsibility of the vessel crew. Biologists are available to help work gear at the request of the deck supervisor.

DATA COLLECTION

Pot Condition and Substrate

When a pot is pulled, its condition and proper fishing status will be recorded using the "Crab Specimen Form" (Appendix B2). Any evidence that the pot was on its side, mesh had holes, errors in closing the pot, and the sediment type, if any, found on the pot will be noted (Table 4). Holes or other features that would allow small crabs to escape will be repaired before the pot is used again. Contents of pots will be emptied onto a sampling table. Commercially important bycatch species (Table 3) will be counted and numbers recorded on the "Crab Survey Specimen" form (Appendix B2), then returned to the sea. All king, Tanner, and Dungeness crabs will be assessed for collection of biological information before being returned to the sea.

Biological Information

The carapace **widths** (CW) of **Tanner** and **Dungeness** crabs and carapace **length** (CL) of all **king** crab will be measured with Vernier calipers to the nearest millimeter, using the standard biological measurement for that species (Figure 2). Shell condition of crabs will also be assessed (Table 2).

All legal and pre-recruit sized Tanner crab will be measured and should be made priority above all other size/sex class and species.

If there are pots with high numbers of crab, a maximum of approximately 100 crab (50 minimum for male crab) should be sampled. If there is high variability in clutch size, as many females as

possible will be sampled. The scientific lead on each leg will determine if and at what rate to sub-sample using the following criteria:

- subsampling can occur by species and sex at a rate not to exceed 1:15, preferably from 1:2–1:5;
- male Tanner crab should be sampled 1:1;
- female Tanner crab will be sub-sampled first, **please note that every effort must be made to separate juvenile females and mature females prior to subsampling, and to subsample individuals of similar sizes as this could affect analyses;**
- small male Tanner crab will be sub-sampled second.

For each crab, missing legs or abnormalities in the carapace will be noted (Table 5) Presence of any parasites or diseases such as black mat or bitter crab syndrome will be noted (Table 6).

For all female crabs, the percent clutch fullness will be estimated in 10% increments and the development and condition of the eggs will be noted (Table 7).

Chela heights of adult Tanner crab will be measured to monitor any changes in the size at functional maturity (point when mature males are "large clawed"). For each survey area, a total of 150 male Tanner crab are randomly sampled until target numbers are achieved within each of six size groups and measured for biological carapace width (to the nearest 1 mm) and right_chela height, (also to the nearest 1 mm) using Vernier calipers (Jadamec et al, 1999) (Table 8, Figure 3, and Appendix B3).

Individual crab weights, for use in the length weight relationship for each area, were last measured in 2010 and will continue to not be measured in order to increase sampling efficiency.

DATA ENTRY

Data will be recorded on standard data sheets (Appendix B2) and entered into the Zander database onboard the vessel by the survey biological staff. Once the data is entered, datasheets are marked with initials of person entering the data (entered by: initials). The database is then re-checked against the datasheets for errors and datasheets are marked with initials of person verifying the data (verified by: initials). This should be completed **prior to disembarking from the vessel** to ensure a time efficient analysis of the data.

LOST POT PROTOCOL

If a pot is lost (buoy is not visible); a retrieval pot (with biotwine cut, escape rings opened, and tidbit removed) will be set next to the lost pot with a pot saver (an upside down grappling hook that is attached to and slides onto the floating line) attached just above the bridle. Extra line should be placed on the retrieval pot, depending on depth, to allow the vessel to adequately circle the lost pot a **minimum of four** times. The line from the retrieval pot should be left in the block and tied off to a cleat until four rotations are complete before the retrieval pot may be hauled. The skipper should make every attempt to keep the line at ninety degrees to the boat. **This process should be repeated a second time** if the pot is not retrieved on the first attempt, if time allows.

VOLUNTEERS

Occasionally, volunteers such as graduate students or National Parks Service employees, join the crew for a portion of a Tanner crab survey leg. They typically help with gear work and/or sorting

crab species once they have been briefed by both the boat and scientific crew. Prior to boarding the R/V Medeia, all volunteers must be approved by the Crab Group staff and complete the "Volunteer Agreement" form (Appendix B4).

VESSEL

The Tanner crab stock assessment survey is conducted on a 110-foot Department owned vessel, R/V Medeia, whose home port is Juneau, Alaska. The vessel crew consists of four positions: Boat Officer IV, Boat Officer III, Boat Officer II, and a Boat Officer I.

DATA ANALYSIS

All data are entered and stored in OceanAK, the ADF&G Southeast Region's database. Data analyses are done using the most updated version of R (version 3.4.0, R Core Team 2017) and Microsoft Excel.

SURVEY CATCH PER UNIT OF EFFORT

Data, including sex and size, is collected for all Tanner crab in each pot. Based on the sex and size designations, crab are classified into recruit classes. Males are classified based on size and shell conditions according to Table 2. Females are classified as either large and mature or small and immature based on both size and presence of physical maturity (Donaldson & Byersdorfer 2005). CPUE is summarized for each recruit class in each pot, with the goal of calculating a stratified weighted average CPUE for each survey area. Only pots that are classified as "normal" are included in this analysis. Abnormal pots are removed to prevent bias (refer to Table 4 for abnormal pots designations).

Due to the stratified design of the survey the average CPUE for each area must be calculated as a weighted average, including both the number of pots sampled in each strata and the area of each strata. Catch in each pot is weighted by a multiplier of the area of each strata divided by the number of pots sampled in that strata in the current year. Once each pot's catch is weighted, an average CPUE for each recruit class in computed for each survey area. Weighting the CPUE is essential due to the stratified design of the survey and differential sample size in each stratum.

STOCK HEALTH DETERMINATION

Historically the weighted CPUEs and survey data calculated for each recruit class have been used to help determine the overall stock health for each survey area. This is accomplished by comparing the current year's data to long-term and short-term indicators (Siddon et al. 2009). This method for evaluating stock health is repeatable and objective; additionally, it has been used for other crab and invertebrate species in Southeast Alaska. The following metrics are examined to evaluate stock health: mature female clutch fullness and catch rate (CPUE), pre-recruit CPUE, recruit CPUE, and post-recruit CPUE.

All the metrics, except mature female clutch fullness, are calculated using weighted CPUE from the survey. For the long-term trends the current year's metric is compared, using a t-test, to the long-term mean calculated from baseline years (1997– 2006). This specific time-period, from 1997– 2006, was established in 2007 as the first ten years of survey data. In the future this year range should be evaluated to ensure that it encompasses a range of population levels. If the current year is significantly above the long-term mean it is scored +1, if not different from the mean it is scored 0, and if significantly lower than the mean it is scored -1. The short-term trends are

examined by performing a linear regression on the last four years of data for each metric. The significance of these regressions is then scored similarly to the long-term trends, with a positive trend having a score of 0.25, no trend having a score of 0, and a negative trend having a score of -0.25. The area scores sums all the long-term and short-term scores for each metric into one score for each area. Scores less -3.25 are considered poor, between -3.25 and -1.26 below average, between -1.25 and 1.25 moderate, between 1.26 and 3.25 above average, and above 3.25 healthy.

Mature female clutch fullness is evaluated differently by calculating the mean proportion of mature females in each pot with a clutch fullness of < 25% (i.e. very small clutches). The level allows for biologist error in assessing clutch fullness to the nearest 10 % on the survey, low clutches (<25%) are usually noticeably low.

STOCK ASSESSMENT

Tanner crab biomass, both mature and legal, is estimated using a CSA model which relies on inputs from both the survey and the fishery (in years when the fishery was open).

Model Inputs

Inputs from the survey data include: weighted CPUE of pre-recruit, recruit, and post-recruits by survey area, mid-date for the survey, and average weight (using the established length-weight relationships) of pre-recruit, recruit, and post-recruits. The mid-date for the survey is the middle date for the pots set in each survey area. If the area is surveyed an even number of days the date used would be the first day of the second half of the survey for that area. For example, if an area were surveyed for four days, the date used would be the third day of the survey.

The average weight of male crab in each survey year is calculated from the length composition collected on the survey using a survey area specific length-weight relationship. These relationships were established from survey data (1997– 2007). A summary of the relationships for each area is provided in Table 9.

Inputs from the fishery include catch in numbers and the mid-date of the fishery, both of which are obtained from the commercial fish ticket database. The mid-date for the fishery is computed as the sum of the days in the season, the ratio of the catch for that day, divided by the total catch for the area and season (Clark et al. 2003).

The Model

A CSA model is used to estimate mature and legal abundance of Tanner crab for each of the surveyed areas. This analysis type was initially developed by Collie and Sissenwine (1983) and adapted to crab abundance estimation in the 1990s (Kruse and Collie 1991, Collie and Kruse 1998, Zheng et al. 1997). Starting in 2007 a three-stage model was used to estimate abundance of Tanner crab in Southeast Alaska, using pre-recruits, recruits, and post-recruits (Zheng et al. 2007).

This type of model estimates the abundance of a population by comparing the changes in survey catches to the number of crab removed by the commercial and personal use effort. In a three-stage model pre-recruits are estimated every year and recruits are related to the number of pre-recruits that survive and molt to become recruits (Eq. 1). Post-recruits are estimated from the recruits and post-recruits in the previous year and the fishery removals that occur between the survey years (Eq. 2). Errors are associated with both survey and fishery catch and are assumed to be log-

normally distributed (Eq. 3). A constant instantaneous natural mortality of 0.30 is used; this translates to an annual natural mortality of 26% (Zheng at al. 2007).

Equations depicted below are modified from those already published in documents pertaining to CSA models in Southeast Alaska (Woodby 1994, Clark et al. 2003, Zheng et al. 2007).

These are the two processes described in the three-stage CSA model:

$$R_{yr+1} = \mu A_{yr} \quad (1)$$

$$P_{yr+1} = \left(R_{yr} + P_{yr}\right)e^{Mt_{yr}} - qC_{yr}e^{Ml_{yr}} \quad (2)$$

Where:

R_{yr+1} = relative abundance of recruit crab in year +1

A_{yr} = relative abundance of pre-recruit crab in year yr

μ = proportional constant, a function of the relative catchability of pre-recruit and recruit crab, along with the survival and probability of molting from pre-recruit to recruit crab

P_{yr+1} = relative abundance of post-recruit crab in year +1

C_{yr} = total harvest (in number of crab) in year *yr*

t_{yr} = time interval between surveys (in years)

l_{yr} = time lag between the midpoint of the fishery in year *yr* and the survey in year *yr +1*

q = catchability coefficient relating relative abundance measured as catch per pot in the survey to absolute abundance of crab in the area

M = instantaneous natural mortality coefficient

The observed catches in the survey are the relative abundances with lognormally distributed measurement error:

$$\tilde{A}_{yr} = A_{yr}e^{\tau_{yr}} \quad (3)$$

$$\tilde{R}_{yr} = R_{yr}e^{\upsilon_{yr}}$$

$$\tilde{P}_{yr} = P_{yr}e^{\omega_{yr}}$$

Where:

$\tau_{yr}, \upsilon_{yr,}$and ω_{yr} = normal deviates

The values of A_{yr}, R_{yr}, and P_{yr} are estimated by minimizing the squared deviation of the log of the estimated values and observed values. The squared deviations are not weighted to take into account differences in survey methods throughout the years because survey methods have remained consistent over the time series. Minimizing the sum of the squared deviations was performed using the "optim" function in the most recent version of R (3.4.0, R Core Team 2017).

Model Output

The CSA model computes an estimated relative index value for each of the three recruit classes (pre-recruit, recruit, and post-recruit), which is then scaled (using q which is estimated in the model) to a number of male crab for each recruit class. The number of crab in each recruit class is

converted to a biomass (lb) using the average weight of all three recruit classes from the survey (using the length-weight relationship established for each area). For each survey area the biomass of both legal (recruits and post-recruits) and mature (all three male recruit classes) is reported. These are summarized annually in the Southeast Alaska Tanner crab stock assessment memorandum prepared by the biometrics group.

REGIONAL ESTIMATION

Tanner crab are managed regionally in Southeast Alaska, therefore the estimate of biomass from all surveyed areas combined is used to produce a regional estimate of Tanner crab by expanding the estimate to the non-surveyed areas based on historic catch data. The period of 1980-2000 is used to establish the proportion of catch in survey (66%) vs. non-surveyed areas (34%). Total estimated biomass is reported annually in the Southeast Alaska Tanner crab stock assessment memorandum, as well as being used to establish season length in the commercial fishery.

STAFF RESPONSIBILITIES

- Joe Stratman, Fishery Biologist III (Lead Crab Biologist/Scientific Crew Lead)
- Adam Messmer, Fishery Biologist II (Scientific Crew Lead)
- April Rebert, Fishery Biologist II (Scientific Crew Lead)
- Tessa Bergmann, Fishery Biologist I (Scientific Crew Lead)
- Katie Palof, Biometrician III (Biometric Review)

LOGISTICS AND FIELD STUDIES

Joe Stratman has primary responsibilities associated with logistics and field studies. One of the four fishery biologists listed will be the principle investigator of each leg of the survey, the specific person responsible will be listed annually in Appendix D1.

DATABASE INTEGRITY

April Rebert has primary responsibilities associated with data entry and database integrity queries. April will be assisted by field crews.

DATA ANALYSIS

Katie Palof will have the primary responsibility for catch-survey modeling and matrix analyses.

STOCK ASSESSMENT

Katie Palof will provide catch-survey analysis tables and draft the overview section providing matrix tables, stock trend figures, and draft the “Bay by Bay” section.

SCHEDULE AND DELIVERABLES

CALENDAR OF ACTIVITIES

Dates	Activity	Personnel
May/June	Define pot survey locations in ArcGIS	FB II's
September	Regional Operation Planning	FB II's
September	Purchase, prepare, and stage survey gear	FB II's
October	Conduct two legs of at-sea surveys	All
November	Compile and edit Tanner crab survey data and submit to biometrics for stock assessment report	Biometrician and FB II's
November	Stock assessment analysis of catch survey data.	Biometrician
December	Finalize stock assessment and management memo.	All
December	Management announces potential season and start date	Management staff

REFERENCES CITED

Bednarski, J., G. Bishop, and C. Siddon. 2008. Tanner Crab Pot Survey Methods for Southeast Alaska Regional Information Report 1J08-02, Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau.

Clark, J. E., T. Koeneman, C. A. Botelho, S. Merkouris, and D. Woodby. 2003. Estimateion of red king crab (Paralithodes Camtschaticus) abundance and available harvest in southeast Alaska for the 2001/2002 season using a pot survey. Alaska Regional Information Report 1J03-25, Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau.

Cochran, W. G. 1977. Sampling Techniques, 3rd edition. John Wiley & Sons, Inc., New York.

Donaldson, W.E. and S. C. Byersdorfer. 2005. Biological Field Techniques for lithodid crabs. Alaska Sea Grant College Program, University of Alaska Fairbanks.

Jadamec, L.S., W. E. Donaldson, and P. Cullenberg. 1999. Biological Field Techniques for Chionoecetes Crabs. Alaska Sea Grant College Program, University of Alaska Fairbanks.

Rumble, J., C. Siddon, and G. Bishop. 2008. Southeast Alaska Tanner Crab Soak Time Experiment. Alaska Department of Fish and Game, Fishery Data Series No. 08-55, Anchorage.

Woodby, D. 1994. Population sizes and harvest rates of red king crabs in southeast Alaska, 1993.

Alaska Department of Fish and Game., Commercial Fisheries Management and Development Division. Regional Information Report 1J94-20.

Zheng, J., Rumble, J.M., and G.H. Bishop. 2007. Estimating Southeast Alaska Tanner Crab Abundance Using Pot Survey and Commercial Catch Data. Alaska Fisheries Research Bulletin. 12(2): 227–242.

TABLES AND FIGURES

Table 1.–Tanner crab survey location codes.

Survey area	Location code
Icy Strait	2
Holkham Bay	8
Glacier Bay	3
Thomas Bay	5

Table 2.–Shell age criteria for the Southeast Tanner crab survey (Jadamec et al. 1999).

Shell condition	Shell age	Description
1, soft	0–2 weeks	The exoskeleton is soft, flaccid, similar in texture to skin, and loses shape out of water. No scratches, abrasions, or epibionts are present.
2, light	2–8 weeks	Carapace and chela are firm, but thin and flexible and can be easily indented with slight thumb pressure. Legs are easily compressed when pinched. Colors are bright. Iridescence is common. Abdominal flap may appear translucent. Spines, chela tips, chela teeth, and dactyls are sharp. No scratches, abrasions, or epibionts are present.
3, new	2–12 months	Carapace and chela are hard and will crack when pressure is applied. Legs are not easily compressed when pinched and will break if bent. Colors are bright and iridescence (especially on the chelas) is often visible. Ventral surfaces can be any variation of white or pink and are not translucent. Spines, chela teeth, and dactyls are sharp. Abdomen and legs have little or no scratches and abrasions. Slight fouling may be present, including; leech egg cases, small barnacles, and encrusting bryozoans. Adult females rarely have grasping marks on the meri.
4, old	13 - 24 months	Skip molts. Colors are dull, but there may be some visible iridescence on the chelas. Ventral surfaces typically appear yellow to brown. Spines, chela tips, chela teeth, and dactyls show some wear and appear dull. Abdomen and legs have few to numerous scratches and abrasions, which are slightly darker than the shell. The meat content is full. Some fouling may be present, including but not limited to; leech egg cases, barnacles, bryozoans, and tubeworm casings. Females mated a second time will can show grasping marks on the meri.
5, very old	>24 months	Color is dull and dark on dorsal surface. Ventral surface typically appears yellow to brown with darker areas. Spines, chela tips, chela teeth, and dactyls are heavily worn. Legs are commonly damaged or missing. Abdomen and legs have numerous scratches and abrasions, which are typically darker than the shell. Moderate to heavy fouling is common, including but not limited to; leech egg cases, large barnacles, bryozoans, hydroids, anemones, and tubeworm casings. Adult females will have abdomens that appear very worn and scuffed. Females that have been mated more than two times can have multiple grasping marks on the merus.

Table 3.–Commercially important bycatch species code list for use during the Tanner crab survey

Species code	Species	Species code	Species
110	Pacific cod	850	Scallop
127	Yellowfin Sole	870	Octopus
129	Starry Flounder	892	Red sea urchin
130	Lingcod	895	Sea cucumber
145	Yelloweye rockfish	910	Dungeness crab
147	Quillback rockfish	921	Red king crab
200	Halibut	922	Blue king crab
270	Pollock	923	Golden king crab
363	Neptunea sp.	964	Coonstripe shrimp
710	Sablefish	965	Spot shrimp

Table 4.–Description of debris, substrate, pot condition, type, dimensions, escape device, and bait codes, for the Southeast Alaska crab surveys. Pot weight is also recorded but is of continuous data type.

Code	Debris	Substrate	Pot condition	Pot type	Pot dimensions	Escape device	Bait
0		Unknown					
1	Lg. Brn.	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	Jar &
3	Shells	Mud/clay	Lost	Square	6–6’11” dia.	King (9-inch	Jar only
4	Woody	Mud/shell	Door open	Dungeness	7–7’11” dia.	Tanner (4, 4 ¾-	Hanging
5	Hair kelp	Mud/soft	Broken		7x7	Tanner (7-inch	
6	Barnacles	Mud/hard	Upside down		8x8	Dungeness (2, 4	
7	Sponges	Clay	Collapsed		9x9		
8		Sand	Not on				
9		Gravel	Pot				
10		Boulder	Lost pot				
11		Cobble					
12		Rock					
13		Hard					
14		Soft					
15		Shell					
16		Coral					
17		Mixed					
18		Silt					
19		Barnacle					
20		Mussels					

Table 5.–Leg loss codes used for the Tanner crab survey.

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 6.–Parasite condition codes used for the Tanner crab survey.

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

Table 7.–Female reproductive condition codes used for the Tanner crab survey (Jadamec et al. 1999, 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 8.–Sample goals by carapace width range category for male Tanner crab chela height measurements.

Carapace width	Sample goal
<106	25
106–114	25
115–122	25
123–131	25
132–152	25
>153	25

Table 9.–Coefficients for length-weight conversion formulas.

Area	Intercept	Slope
Glacier Bay	-9.48	3.30
Icy Strait	-9.48	3.29
Thomas Bay	-9.67	3.32
Holkham Bay	-9.73	3.34

Note: Formula = $Weight\ (lbs) = \ e^{(Intercept + slope * \ln\ (carapace\ width)} * (\frac{2.2}{100})$

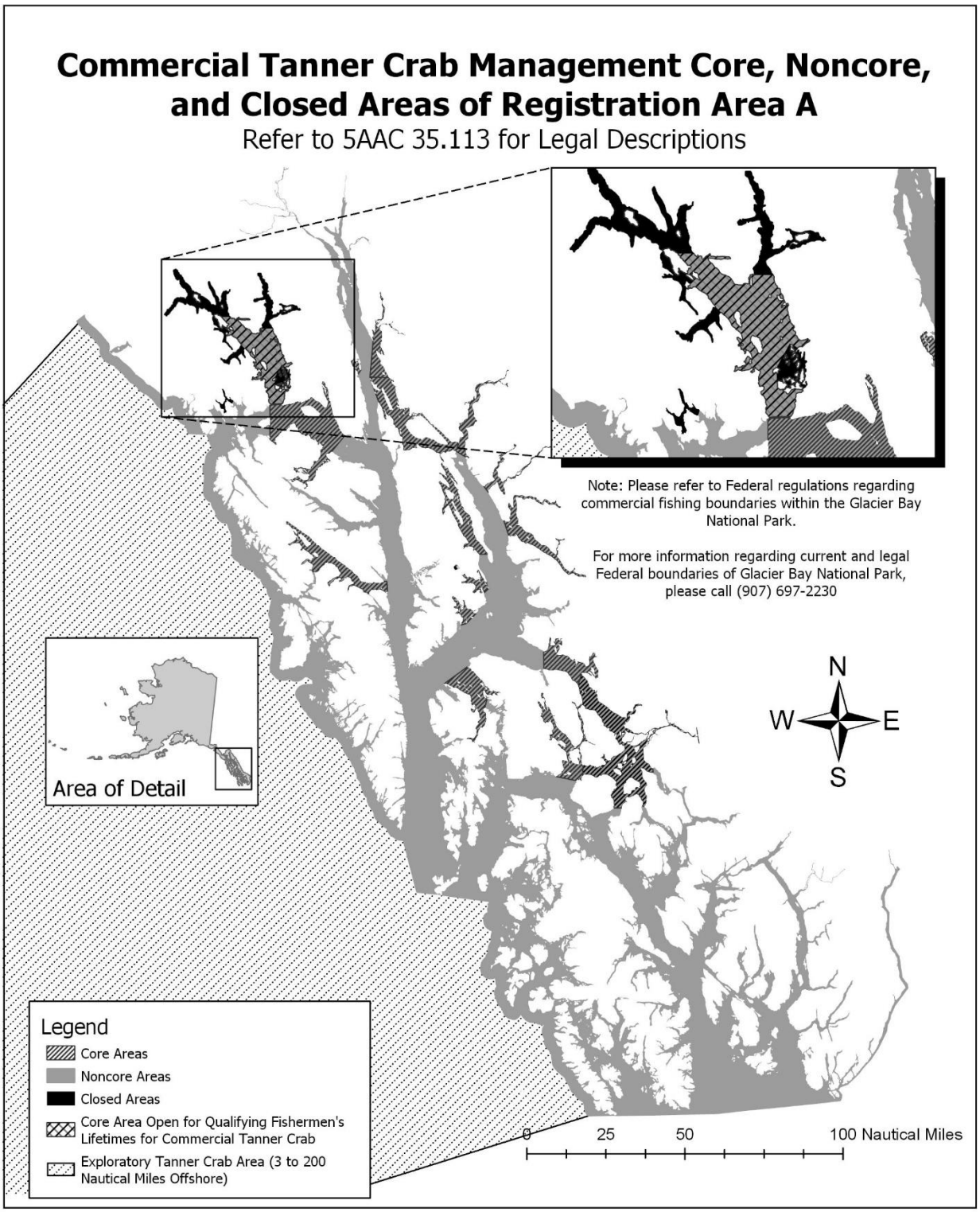


Figure 1.–Tanner crab survey areas in Southeast Alaska.

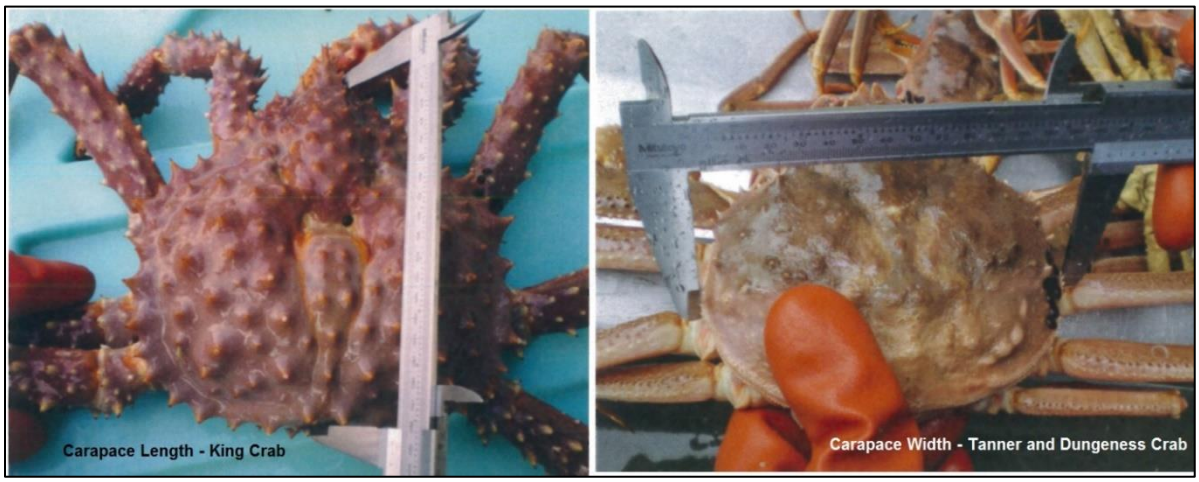


Figure 2.– Pictures showing both types of carapace measurements. Left: Measuring carapace length for all king crab. Right: Measuring carapace width for both Tanner and Dungeness crab.

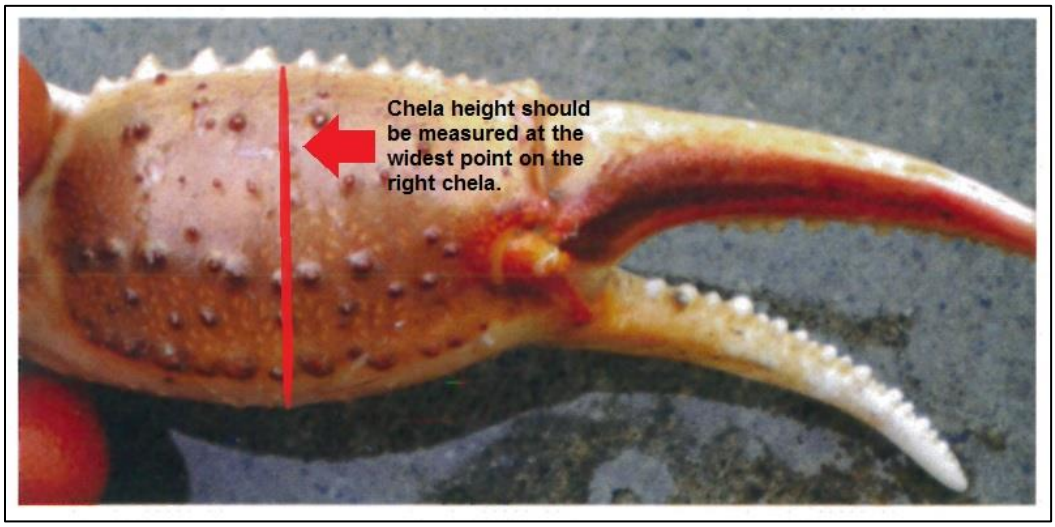


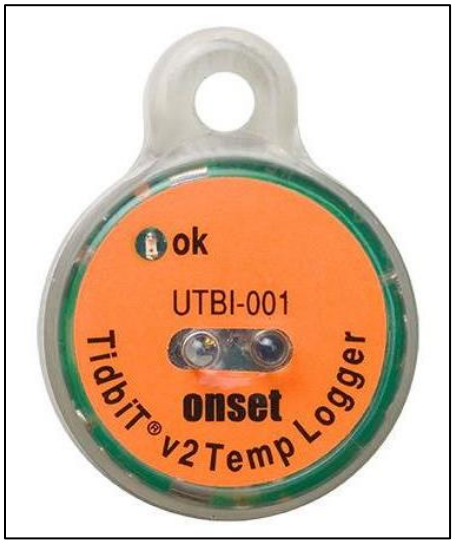
Figure 3.–Picture showing the approximate location in which chela height should be measured on the right chela of male Tanner crab.

APPENDIX A: HOBO WATER TEMPERATURE DATA LOGGER INSTRUCTIONS

HOBO WATER TEMPERATURE DATA LOGGER INSTRUCTIONS.

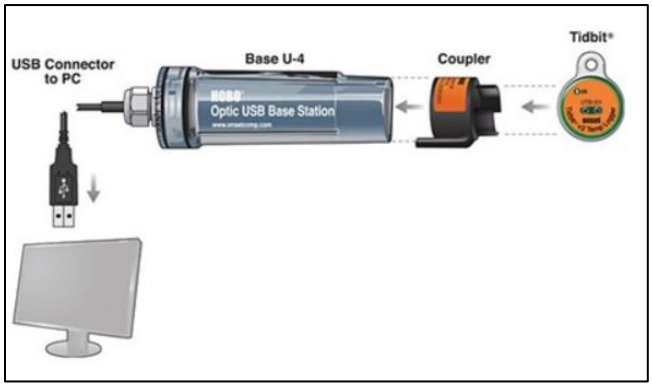
1) One logger for each pot (~20–28) will be deployed on the first day of setting per trip (Appendix A1).

Appendix A1.–Picture of HOBO water temperature data logger device that will be attached to each deployed crab pot.



2) Activate logger using optical USB base station attached to computer (Figure A2).
    a. Name will be a unique number that matches the buoy number of the pot in which logger will be attached.
    b. Time interval: 1-hour.
    c. Check that red ‘OK’ light is flashing before activating the next tidbit.

Appendix A2.–Picture of optic USB base station attached to computer. This device is used to activate loggers.



3) One temperature logger will be placed on each deployed pot with a cable tie near the tunnel of the pot, and with the buoy number facing out.

4) Write in comments column of skipper form, 'Tidbit # X' (where X is the number of the tidbit). This should be done by the crewmember in the wheelhouse documenting coordinates and associated data during the setting of pots each day.

5) Temperature loggers will be downloaded at the end of each leg, saved in Excel, and transferred to a file on the desktop of the R/V Medeia computer.

6) Files will be saved on a memory stick (or other media) aboard vessel; leave backup copy aboard R/V Medeia computer.

7) Files will be saved to: CF…Shellfish\Temperature\current year.

8) Detailed Data Download Instructions:

    a. Files will be saved using the .dtf format and subsequently exported to a .txt format.

    b. Export file:
        i. Plug tidbit into the docking device
        ii. Device → Readout → Stop.
        iii. Create a custom folder for the survey
        iv. File → Export Table Data → Export.
        v. Date format: Month/Day/Year
        vi. Date/Time Separator: Tab
        vii. Time Format: Hr:Min:Sec
        viii. Data Separator: Tab
        ix. Highlight "Temperature (*C)" only.

    c. Save file as the tidbit number to the custom survey folder created in b:

i. For example, Tidbit #8 should be saved as **8.txt**

d. Open .txt file in Excel:
   i. File → Open (Do not double click the text file to open).
   ii. Select "Finish" on the import menu.

e. To be done post survey:
   i. Delete all temperature data that does not correspond to time the pot was in the water.
   ii. Do not include data that is within 15 minutes of pot set time (e.g., if pot is set at 1200hrs and there is a temperature reading at 1210hrs delete data point).
   iii. Query Alex for skipper data, cut and paste into "Temperature Database" file on desktop.
   iv. Cut and paste temperature data in columns next to skipper data.
   v. Copy down skipper data to match temperature data.
   vi. Copy next line of skipper data (i.e., next pot) into "Temperature Database"
   vii. Repeat steps i-vi until all temp data is entered.

f. Return to step a and repeat for each tidbit.

APPENDIX B: SURVEY DATA FORMS

Appendix B1.–Crab Pot Set Form

CRAB SURVEY SKIPPER FORM

Vessel _____

Recorder _____

Year _____ Project _____ Trip No. _____ Location Code _____

Location Name _____

Stratum	Pot # (order)	Pot type*	Buoy #	Depth (fathoms)	Set Gear			Lift Gear			Latitude/Longitude				Comments
					Month	Day	Time	Month	Day	Time	Deg. N	Minutes to 1000th (ie. 15.360)	Deg. W	Minutes to 1000th (ie. 15.360)	

* Pot types: S = square (7x7) C = cone P = pyramid D = Dungeness

Appendix B2.–-Crab Survey Specimen and Incidental Species Form

CRAB SURVEY SPECIMEN **Date**_____ **Page**_____ **of**_____

Year_____ **Project**_____ **Trip #**_____ **Recorder**_____

Location_____ **Pot # (Order)**_____ **Buoy#**_____

Pot Condition	Substrate	Debris

Incidental Species

#				
Species				

Specimen #	Subsample Rate	910 Dung, 921 RKC 922 BKC 923 GKC 931 Bairdi Species Code			Sex	Size (mm)			Weight (gms)			Legal Size	Shell Condition	Leg Condition	Female Egg Data			Parasite	Blackmat 1= Present	Tag #					Comments
															% Clutch Fullness		Development Condition								
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Appendix B3.–Tanner Crab Chela Height Size Category Tally Sheet

Male Tanner crab chela heights: This tally sheet can be printed and used to track the number of male Tanner crab of each size category to be sampled in the field. Throughout the day, collect chela height for carapace length categories listed below:

Carapace size	**<106**	**106–114**	**115–122**	**123–131**	**132–152**	**>153**
Sample number	**25**	**25**	**25**	**25**	**25**	**25**
Thomas Bay						
Holkham Bay						

Carapace size	**<106**	**106–114**	**115–122**	**123–131**	**132–152**	**>153**
Sample number	**25**	**25**	**25**	**25**	**25**	**25**
Glacier Bay						
Icy Strait						

Appendix B4.–Volunteer Agreement Form.

VOLUNTEER AGREEMENT – Alaska Department of Fish & Game

This agreement is entered into between the State of Alaska Department of Fish and Game (State) whose address is

_____ and

Volunteer Name	Address	Phone
_____	_____	_____

WHEREAS, the volunteer desires to participate as an unpaid worker alongside, but not displacing, state employees, as follows:

Division: _____ Region:_____

Location: _____ Dates: _____ to _____

Description of Project and Duties:

Questions marked with * are considered high risk and must be approved by the Division Director or Designee if 'Yes' is checked.**

*** ***Is the Volunteer a minor under the age of 18?*** ☐ Yes ☐ No

If 'Yes' is checked above, please state the age of the minor volunteer _____

Parent(s) of the minor volunteer have read/will comply with the department's SOP No. III-524 ☐ Yes ☐ No

*** ***Will activities require use or carrying of firearms and/or ammunition?*** ☐ Yes ☐ No

If 'Yes' is checked above, the volunteer MUST complete the State of Alaska Volunteer Qualification Inquiry - Firearm Possession form and attach it to this form. In accordance with the Federal Omnibus Consolidated Appropriations Act of 1997 (PL 104-208), anyone convicted of a misdemeanor crime of domestic violence may not perform duties that require the use of or access to firearms and/or ammunition.
Further, if 'Yes' is checked above, the volunteer MUST provide proof of training in firearm safety in the form of a certificate or other documentation reflecting completion of a formal class.

Will activities require travel in or operation of a state vehicle? ☐ Yes ☐ No
If 'Yes', indicate below:

***Travel in*:** ☐ highway vehicle ☐ off-road vehicle ☐ small boat ☐ large boat ☐ aircraft*

*** ***Operate:*** ☐ highway vehicle* ☐ off-road vehicle* ☐ small boat*

Describe below the justification for and the limited circumstances under which the volunteer is authorized to operate a state vehicle or travel in a state aircraft:

*As a general rule, volunteers are *not* authorized to drive state vehicles, operate small boats, or travel in state aircraft. Under certain circumstances and with pre-approval, limited operation of state equipment or travel in state aircraft when necessary to further the volunteer's project/assignment may be allowable. Such use should be kept to a minimum and is allowable only if specified on this agreement form, approved by the regional supervisor (or equivalent), and only if the volunteer is properly licensed and trained to operate such vehicle/equipment. For additional details, see the following ADF&G Standard Operating Procedures: III-524, Volunteer Workers; III-004 Aircraft-Authorized Passengers; II-091 State-Owned Vehicles, Vessels, and Equipment.

WHEREAS, the State desires to allow the volunteer to participate in said program.

NOW, THEREFORE, the parties agree as follows:

The Volunteer agrees to participate without compensation for his/her activities in the Program under the direct supervision of state employee _____ (ADF&G Supervisor).

- For the duration of the Volunteer's participation in the program, the State agrees to provide to the volunteer medical coverage and disability compensation, in amounts comparable to that afforded employees under the Alaska Workers' Compensation Act (AWCA), if the volunteer suffers injury, illness or death that arises out of, and occurs while acting within the course and scope of performance of his/her volunteer duties. It is agreed that weekly compensation for disability or death will be based on the minimum rate of compensation under AS 23.30.175. It is agreed that compensation or medical coverage will not be provided when the volunteer may be eligible for coverage by any other health or disability policy, insurance, payment or benefit, (inc. Medicaid, Medicare, Social Security, or pension) or workers' compensation coverage by another employer. Disputes regarding payment of compensation and medical benefits under this agreement are agreed to be decided by the Alaska Workers' Compensation Board without stipulating to the Board's jurisdiction. The State is not subject to AWCA penalty, interest, Second Injury Fund (SIF), or other payment in regard to the volunteer.
- The State agrees to defend, indemnify, and hold harmless the Volunteer in the same manner and to the same extent the State protects its employees from any claim, demand, suit for property damages or personal injury including death allegedly caused by the Volunteer's activities if the Volunteer: a) at the time of the occurrence was acting in good faith within the course and scope of his/her volunteer duties in accordance with the directions of the supervisor; b) the volunteer provides immediate notice to the State of any claim; and c) the volunteer cooperates in the defense and does not stipulate to any judgment or settlement without the State's approval.
- The volunteer understands the State does not insure loss or physical damage to its employee's personal vehicle, equipment, or other personal property used while performing state work; nor will the State provide property insurance coverage for loss or physical damage to any volunteer's personal vehicle, equipment, or other personal property used while performing his/her volunteer duties.
- In consideration of the benefits received from participation in the program and the protection offered by this agreement, the volunteer: 1) accepts the remedy provided by the State, and dispute resolution by the Alaska Workers' Compensation Board, as his/her sole legal remedy from the State if the volunteer suffers injury, illness or death arising out of, and occurring while acting within the course and scope of, his/her volunteer duties; 2) transfers his/her right to recover from others who may be responsible for the injury, illness, or death to the State and/or its assigns upon payment of compensation or medical expenses by the State; and 3) agrees to cooperate and to do everything necessary to enable the State and/or its assigns to enforce the right to recover from others.

The Agreement is effective on the day when signed by the person designated below as the Regional Supervisor and filed with the Division of Risk Management. The Alaska Department of Fish and Game agrees to provide transportation to/from _____ and _____. The following provisions (lodging, food, camp and sampling supplies, etc.) will be supplied:
_____.

The volunteer acknowledges he/she has read this agreement, understands it, and agrees to be bound by its terms.

Person to be notified in event of serious illness or accident:

Name	Address	Phone	Relationship
_____	_____	_____	_____

SIGNATURES:

Volunteer: _____ **Date** _____
(or parent of minor volunteer)

ADF&G Supervisor: _____ **Date** _____

Regional Supervisor: _____ **Date** _____

Questions marked with * on page 1 are considered high risk and must be approved by the Division Director or Designee if 'Yes' is checked.**

Division Director or Designee: _____ **Date** _____
(Designee must be equivalent to Assistant Director or Division Operations Manager)

When complete, send the form to divisional headquarters office for distribution as described below.

Original or email: State of Alaska (SOA) Division of Risk Management by e-mail; Copies: ADF&G divisional headquarters, Volunteer, DAS Director when Division Director approval is needed.

SOP III-524 Form, Rev 5/15/2015 Page 2 of 2

APPENDIX C: INSTRUCTIONS FOR TRANSFERRING POT COORDINATE DATA TO R/V MEDEIA NAVIGATIONAL COMPUTERS

Appendix C1.–Instructions for transferring pot coordinate data to R/V Medeia navigational computers**.**

MEDEIA COMPUTER

- Open "Site 200X.txt file.
- Open "Medeia template" file.
- Cut and paste lat/long into appropriate columns from text file to template file.
    - **The lat/long column order is reversed in the template file. Make sure "latitude" is before "longitude" in the template file or Maptech will not recognize it.**
- Cut and paste "strata" into "Notes/Strata" column.
- Enter name. This entry must start with 48sgw for Maptech to recognize it.
- Individually name each pot location an (e.g., 48sgwHolkham 1, 48sgwHolkham 2, 48sgwHolkham 3,….).
- Save as "marks32.txt" (This is the only file name Maptech recognizes).

MAPTECH

- Open Maptech (on Medeia wheelhouse computer).
- File> Import from File and browse for the folder where the "marks32" file is located.
- Select all marks for the site and import. It will give the number of marks imported successfully.
- Check the chart to make sure pot locations have in fact shown up in the appropriate spot.
- Repeat procedure for each site text file.
- Overwrite the "marks32" file each time.
- A detailed explanation of the Maptech import/export format in R:/>…… /Tanner pot location maps /Transfer to Medeia> Maptech export format explanation.

MAXSEA

- Open Maxsea
- File> Import from File and browse for the folder where the "marks32" file is located
- Select import files
- Once locations are imported click the tab on the top of the screen to view marks.
- Go through each new mark and click the box at the left to lock the mark.

APPENDIX D: 2019 SURVEY SCHEDULE AND POT LOCATIONS

Appendix D1.–2019 Tanner crab Survey Schedule.

SCHEDULE

Leg 1: Icy Strait and Glacier Bay (7 days)
Dates: October 5–11, 2019

Vessel: R/V *Medeia*

Biologists: PI Joseph Stratman, April Rebert, & Jason Jones

Date	Day	Location	Morning task	Afternoon task	# of Pots
10/05	Sat	Icy Strait	Run to Icy Strait		
10/06	Sun	Icy Strait	Run to Icy Strait	Set pots	26
10/07	Mon	Icy Strait	Pull pots	Set pots	26
10/08	Tues	Icy Strait	Pull pots	Set pots Glacier Bay	26
10/09	Weds	Glacier Bay	Pull pots	Set pots	26
10/10	Thurs	Glacier Bay	Pull pots	Run to Juneau	
10/11	Fri		Run to Juneau		

Leg 2: Thomas Bay and Holkham Bay (8 days)

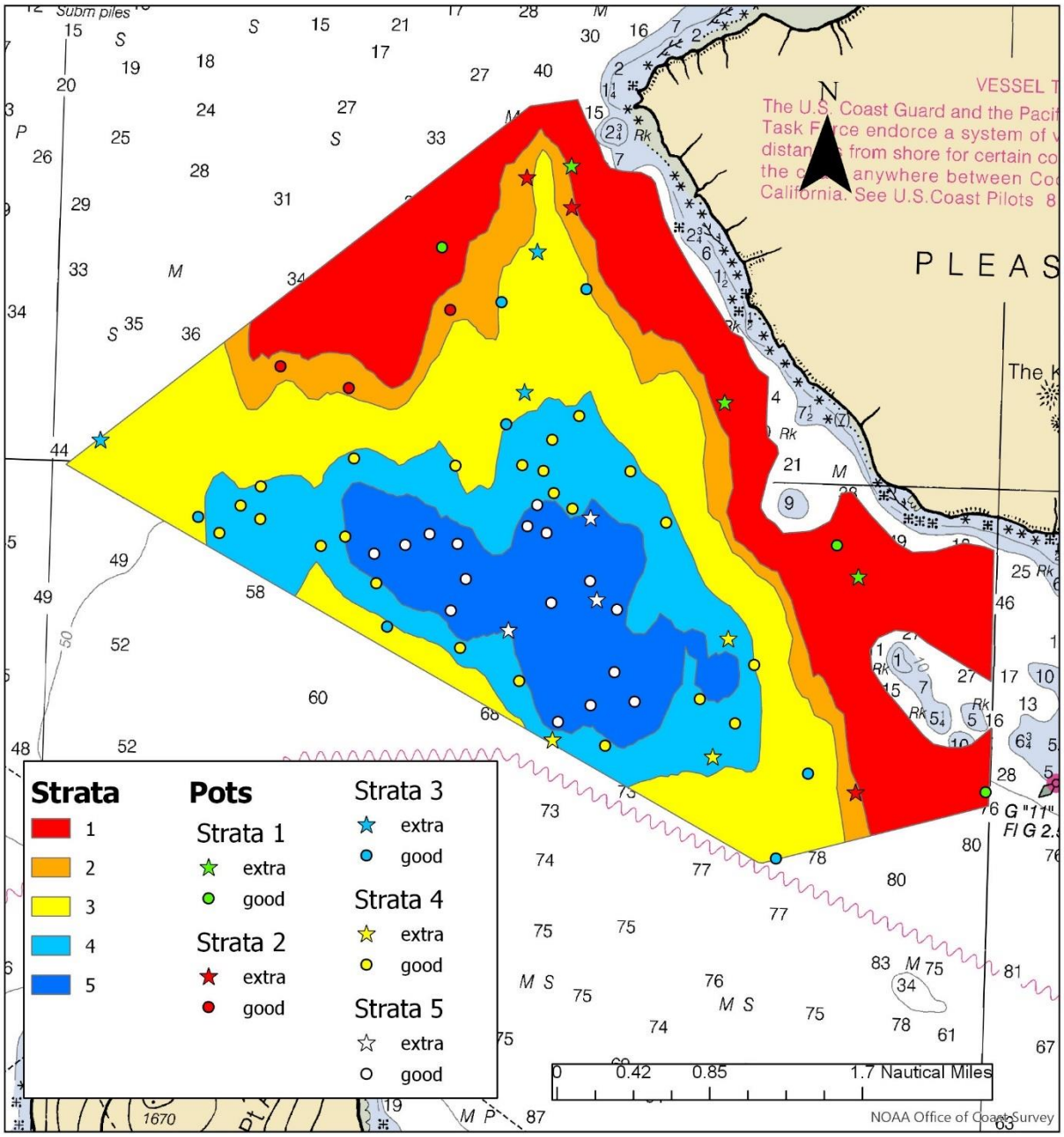
Dates: October 15–22, 2019

Vessel: R/V *Medeia*

Biologists: PI Adam Messmer, Tessa Bergmann, & Katie Palof

Date	Day	Location	Morning task	Afternoon task	# of Pots
10/15	Tues	Thomas Bay	Run to Thomas Bay		
10/16	Weds	Thomas Bay	Run to Thomas Bay	Set pots Thomas Bay	26
10/17	Thurs	Thomas Bay	Pull Pots	Set Pots	26
10/18	Fri	Thomas Bay	Pull Pots	Run to Holkham Bay	
10/19	Sat	Holkham Bay		Set Pots	26
10/20	Sun	Holkham Bay	Pull Pots	Set Pots	26
10/21	Mon	Holkham Bay	Pull Pots	Set Pots	26
10/22	Tues	Holkham Bay	Pull Pots	Run to Juneau	

Appendix D2.–Tanner crab pot locations (circles) in the Icy Strait survey area with extra pot locations (stars) for each stratum.



Appendix D3.–Coordinates for 2019 pot locations in Icy Strait (52 pot locations, 15 extra pot locations).

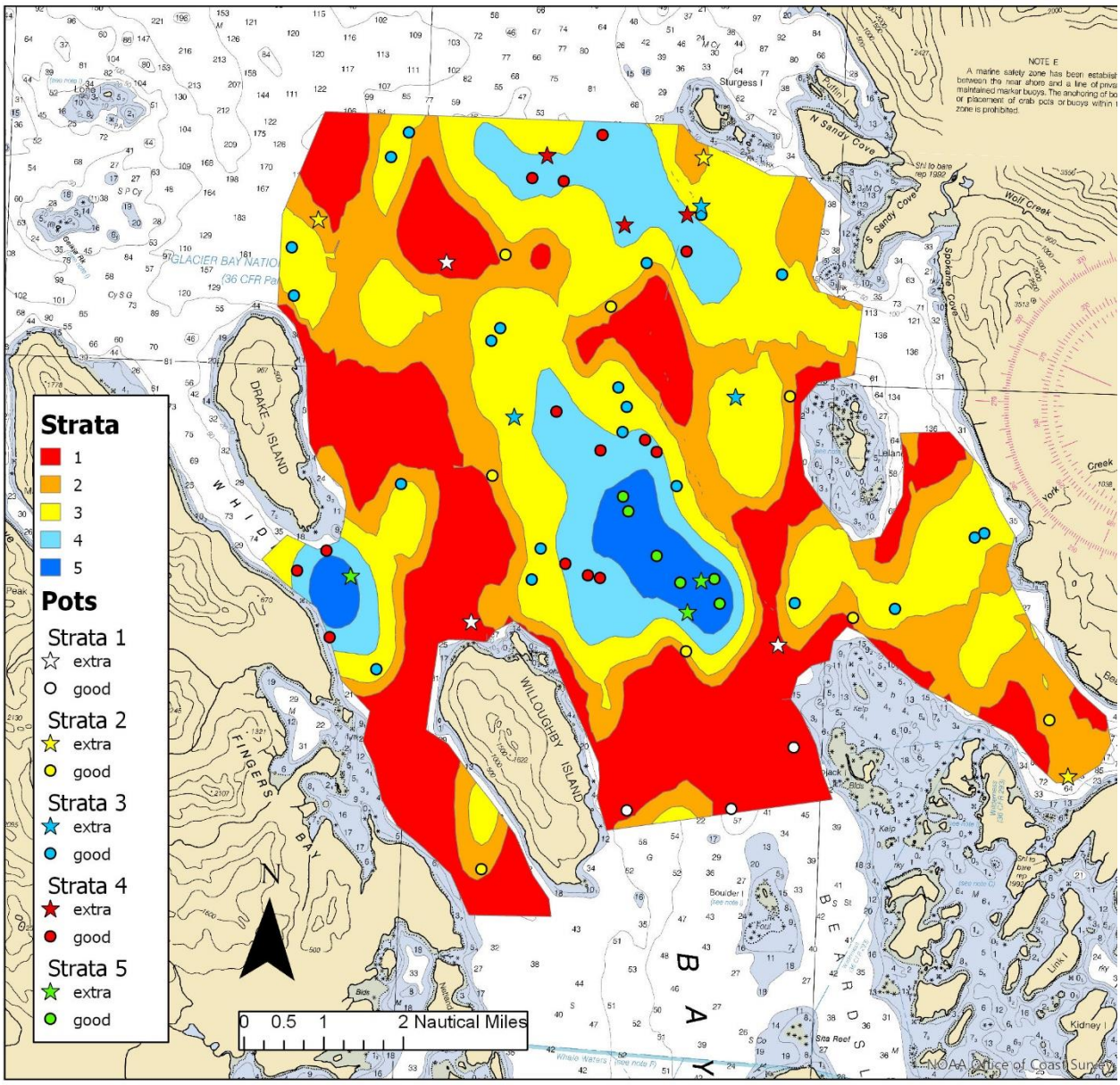
Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
Icy Strait	1	58.3542252	-135.7660065	Primary
	1	58.3053398	-135.6674194	Primary
	1	58.3277435	-135.6948547	Primary
	1	58.3621559	-135.7436066	Extra
	1	58.324913	-135.6909485	Extra
	1	58.3406906	-135.7153778	Extra
	2	58.3484764	-135.7641754	Primary
	2	58.34095	-135.7816315	Primary
	2	58.3427544	-135.793808	Primary
	2	58.3609619	-135.7513885	Extra
	2	58.3049507	-135.6903076	Extra
	2	58.358326	-135.7433472	Extra
	3	58.3285637	-135.8074493	Primary
	3	58.2985992	-135.70401	Primary
	3	58.3189888	-135.7736206	Primary
	3	58.3065414	-135.6987457	Primary
	3	58.3507996	-135.7403259	Primary
	3	58.3380318	-135.7537537	Primary
	3	58.34935	-135.7551727	Primary
	3	58.354126	-135.7491455	Extra
	3	58.3354454	-135.8250122	Extra
	3	58.3410873	-135.7506561	Extra
	4	58.3171997	-135.7606049	Primary
	4	58.308567	-135.7346039	Primary
	4	58.329422	-135.7250214	Primary
	4	58.3316078	-135.7966003	Primary
	4	58.3262711	-135.7856903	Primary
	4	58.3271599	-135.8036346	Primary
	4	58.3389969	-135.7409515	Primary
	4	58.3338242	-135.746933	Primary
	4	58.3271942	-135.7814789	Primary
	4	58.3340569	-135.7316437	Primary
	4	58.3143158	-135.7500916	Primary
	4	58.3318291	-135.7449646	Primary
	4	58.3367195	-135.7455292	Primary
	4	58.3164711	-135.7088165	Primary
	4	58.3340874	-135.7624359	Primary
	4	58.3304214	-135.7416534	Primary
	4	58.3344498	-135.7803192	Primary

-continued-

Appendix D3.-Page 2 of 2.

Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
	4	58.3342857	-135.7507172	Primary
	4	58.3297348	-135.8000488	Primary
	4	58.3229675	-135.7757111	Primary
	4	58.310997	-135.7118835	Primary
	4	58.3285675	-135.7964935	Primary
	4	58.3131485	-135.7181854	Primary
	4	58.3089828	-135.743866	Extra
	4	58.3078613	-135.7156067	Extra
	4	58.3188324	-135.713501	Extra
	5	58.3212051	-135.7332458	Primary
	5	58.3206215	-135.7625122	Primary
	5	58.3286819	-135.7494354	Primary
	5	58.3153954	-135.7333221	Primary
	5	58.3276787	-135.7666321	Primary
	5	58.3122711	-135.7374115	Primary
	5	58.3268356	-135.7616577	Primary
	5	58.3106728	-135.7430115	Primary
	5	58.3236198	-135.7600403	Primary
	5	58.3265839	-135.770874	Primary
	5	58.3237762	-135.7381287	Primary
	5	58.3257065	-135.7762756	Primary
	5	58.3216667	-135.744873	Primary
	5	58.3127327	-135.7296448	Primary
	5	58.3306389	-135.747818	Primary
	5	58.3280792	-135.7460175	Primary
	5	58.3220711	-135.7368317	Extra
	5	58.3190193	-135.7522125	Extra
	5	58.3296318	-135.7383575	Extra

Appendix D4.–2019 Tanner crab survey pot locations (circles) in the Glacier Bay survey area with extra pot locations (stars) for each stratum.



Appendix D5.–Coordinates for 2019 pot locations in Glacier Bay (52 pot locations, 15 extra pot locations).

Location	TC Strata Density	DD Latitude	DD Longitude	Location Status
Glacier Bay	1	58.5764809	-136.0769958	Primary
	1	58.590847	-136.0112	Primary
	1	58.5776176	-136.0352478	Primary
	1	58.6121826	-136.0188446	Extra
	1	58.6895828	-136.1569519	Extra
	1	58.6147423	-136.1418152	Extra
	2	58.5631447	-136.1342316	Primary
	2	58.6915932	-136.1334991	Primary
	2	58.6641197	-136.0176544	Primary
	2	58.6183434	-135.9891968	Primary
	2	58.6453133	-136.135437	Primary
	2	58.6101227	-136.0554657	Primary
	2	58.6815147	-136.0905762	Primary
	2	58.5983505	-135.9093475	Primary
	2	58.7133217	-136.0554657	Extra
	2	58.6974716	-136.2089233	Extra
	2	58.5867577	-135.9011993	Extra
	3	58.6209412	-136.0127258	Primary
	3	58.6428604	-136.171875	Primary
	3	58.7013664	-136.0556641	Primary
	3	58.689476	-136.0223083	Primary
	3	58.6040878	-136.1790619	Primary
	3	58.6553726	-136.084137	Primary
	3	58.6761856	-136.134491	Primary
	3	58.63694	-135.9379883	Primary
	3	58.6646881	-136.0864563	Primary
	3	58.6734695	-136.1378479	Primary
	3	58.7110672	-136.1807709	Primary
	3	58.6239433	-136.1183777	Primary
	3	58.6444931	-136.0617676	Primary
	3	58.6304512	-136.1151733	Primary
	3	58.6606674	-136.0826569	Primary
	3	58.6359863	-135.9415894	Primary
	3	58.6205101	-135.9725952	Primary
	3	58.7162704	-136.1739807	Primary
	3	58.6814041	-136.2175903	Primary
	3	58.6908188	-136.0767212	Primary

-continued-

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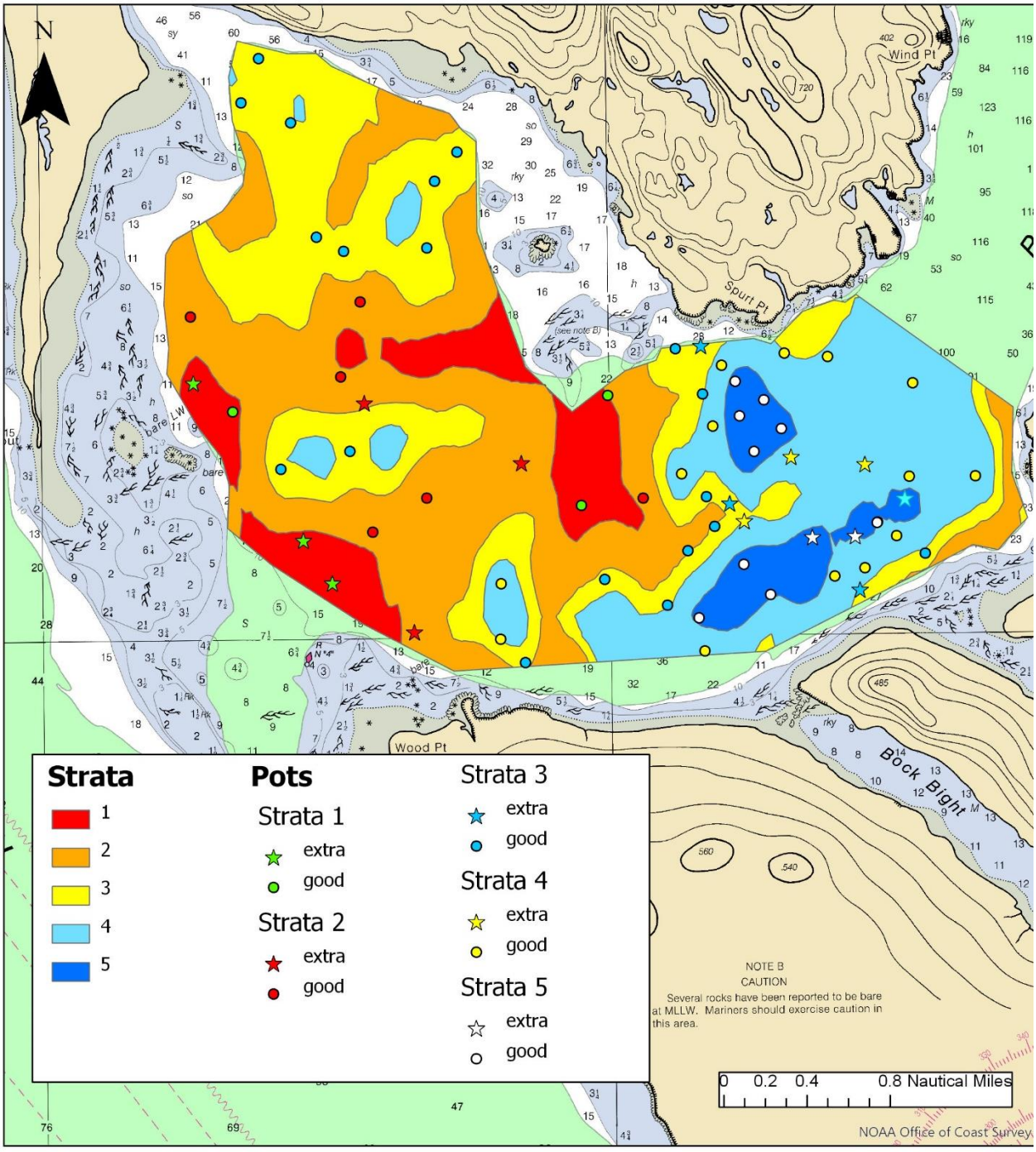
Location	TC Strata Density	DD Latitude	DD Longitude	Location Status
	3	58.691391	-136.2191315	Primary
	3	58.6635971	-136.0392761	Extra
	3	58.7032318	-136.0557556	Extra
	3	58.6578217	-136.127594	Extra
	4	58.6275215	-136.1050873	Primary
	4	58.6515121	-136.0701141	Primary
	4	58.7076874	-136.1238556	Primary
	4	58.6240578	-136.212204	Primary
	4	58.7172623	-136.0963898	Primary
	4	58.6252785	-136.0959778	Primary
	4	58.6514549	-136.0926361	Primary
	4	58.7073402	-136.1113281	Primary
	4	58.6283684	-136.2007294	Primary
	4	58.624855	-136.0909271	Primary
	4	58.6591606	-136.1108856	Primary
	4	58.610405	-136.198288	Primary
	4	58.6539001	-136.0749359	Primary
	4	58.693531	-136.0610962	Primary
	4	58.6987114	-136.0861816	Extra
	4	58.7013283	-136.0612335	Extra
	4	58.7126083	-136.1182098	Extra
	5	58.6389046	-136.080719	Primary
	5	58.6419296	-136.0829926	Primary
	5	58.6203117	-136.0428009	Primary
	5	58.6254654	-136.0452271	Primary
	5	58.629837	-136.068573	Primary
	5	58.6244583	-136.0589294	Primary
	5	58.6233253	-136.1906891	Extra
	5	58.6249962	-136.0504761	Extra
	5	58.6183395	-136.055481	Extra

Appendix D6.–2019 Tanner crab survey pot locations (circles) in the Thomas Bay survey area with extra pot locations (stars) for each stratum.



Appendix D7.–Coordinates for 2019 pot locations in Thomas Bay (52 pot locations, 15 extra pot locations).

Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
Thomas Bay	1	57.0105057	-132.9208832	Primary
	1	57.0192642	-132.9168701	Primary
	1	57.0182571	-132.9718781	Primary
	1	57.0079155	-132.9617004	Extra
	1	57.0205765	-132.9776154	Extra
	1	57.0044785	-132.9575195	Extra
	2	57.0112076	-132.943573	Primary
	2	57.0110435	-132.9117737	Primary
	2	57.0259056	-132.9779816	Primary
	2	57.0209923	-132.9560242	Primary
	2	57.0085411	-132.9515076	Primary
	2	57.0269661	-132.9530029	Primary
	2	57.0188637	-132.9525604	Extra
	2	57.0139389	-132.9296112	Extra
	2	57.0005035	-132.9455566	Extra
	3	57.03125	-132.9431305	Primary
	3	57.0045547	-132.9175415	Primary
	3	57.0150185	-132.9547272	Primary
	3	57.0087204	-132.9013824	Primary
	3	57.0310326	-132.9553833	Primary
	3	57.0192986	-132.9029236	Primary
	3	57.0365677	-132.9418945	Primary
	3	57.0321732	-132.9593201	Primary
	3	57.0413589	-132.9629517	Primary
	3	57.0136375	-132.9648743	Primary
	3	57.0024414	-132.9084167	Primary
	3	57.0465202	-132.9675598	Primary
	3	57.0229721	-132.9068756	Primary
	3	56.9979973	-132.9293213	Primary
	3	57.0064011	-132.8704987	Primary
	3	57.0067749	-132.9053345	Primary
	3	57.0110893	-132.9025421	Primary
	3	57.0388718	-132.9385529	Primary
	3	57.042984	-132.9702148	Primary
	3	57.0035286	-132.8801422	Extra
	3	57.023159	-132.9031219	Extra
	3	57.01054	-132.8991241	Extra

-continued-

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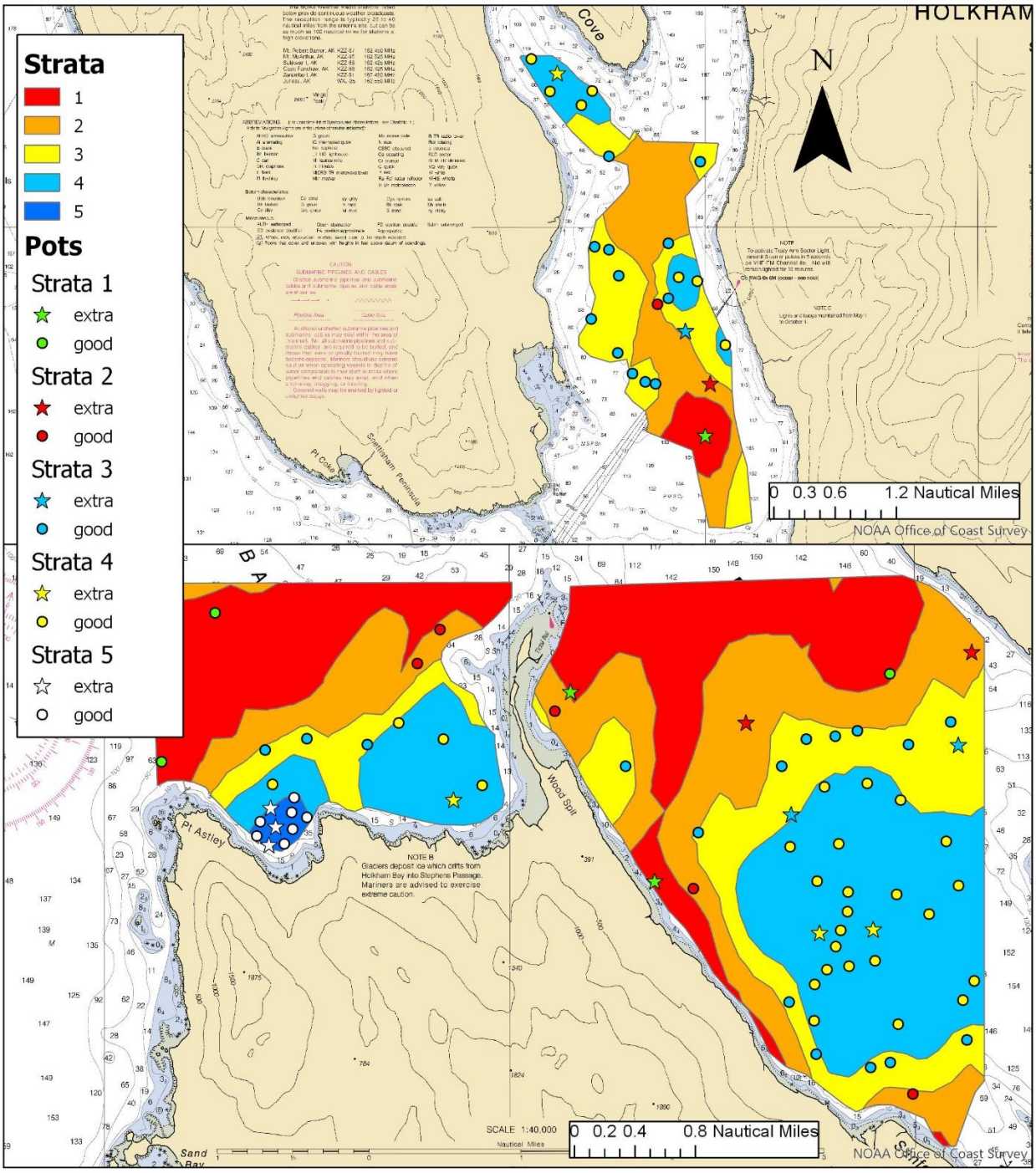
Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
	4	57.0215988	-132.9001007	Primary
	4	56.9987679	-132.9029846	Primary
	4	57.0046501	-132.8838196	Primary
	4	57.0077992	-132.874675	Primary
	4	57.005291	-132.8794098	Primary
	4	57.022213	-132.8845673	Primary
	4	57.0125313	-132.8727722	Primary
	4	57.0125198	-132.8630219	Primary
	4	57.0224953	-132.8908844	Primary
	4	57.0129662	-132.9061432	Primary
	4	57.0200157	-132.8721161	Primary
	4	56.9998741	-132.9329071	Primary
	4	57.0043068	-132.9327698	Primary
	4	57.0167427	-132.9014893	Primary
	4	57.0142059	-132.8900604	Extra
	4	57.0091133	-132.8970032	Extra
	4	57.0135651	-132.8792267	Extra
	5	57.0164871	-132.8914032	Primary
	5	57.0146751	-132.895462	Primary
	5	57.008934	-132.8774567	Primary
	5	57.003212	-132.89328	Primary
	5	57.0056572	-132.8971558	Primary
	5	57.0014114	-132.9037933	Primary
	5	57.0088615	-132.877533	Primary
	5	57.0187988	-132.8939819	Primary
	5	57.0175438	-132.8975372	Primary
	5	57.0202789	-132.8981323	Primary
	5	57.0107765	-132.8734131	Extra
	5	57.0078163	-132.8807678	Extra
	5	57.0077667	-132.8870239	Extra

Appendix D8.–2019 Tanner crab survey pot locations (circles) in the Holkham Bay survey area with extra pot locations (stars) for each stratum.



Appendix D9.–Coordinates for 2019 pot locations in Holkham Bay (78 pot locations, 15 extra pot locations).

Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
Holkham Bay	1	57.7220993	-133.6549988	Primary
	1	57.7317009	-133.5050049	Primary
	1	57.7384987	-133.6439972	Primary
	1	57.7296982	-133.5709991	Extra
	1	57.7089005	-133.5529938	Extra
	1	57.7994003	-133.5829926	Extra
	2	57.736599	-133.5980072	Primary
	2	57.7276001	-133.5740051	Primary
	2	57.7328987	-133.602005	Primary
	2	57.7080994	-133.5460052	Primary
	2	57.6855011	-133.5	Primary
	2	57.8208008	-133.5980072	Primary
	2	57.8078995	-133.5820007	Extra
	2	57.7262993	-133.5350037	Extra
	2	57.7340012	-133.4880066	Extra
	3	57.7215004	-133.5269928	Primary
	3	57.7248001	-133.5160065	Primary
	3	57.8129005	-133.6100006	Primary
	3	57.8218002	-133.5950012	Primary
	3	57.8184013	-133.6179962	Primary
	3	57.8255005	-133.6100006	Primary
	3	57.7246017	-133.625	Primary
	3	57.8450012	-133.6130066	Primary
	3	57.6913986	-133.4889984	Primary
	3	57.7244987	-133.5220032	Primary
	3	57.8440018	-133.5850067	Primary
	3	57.7234001	-133.6340027	Primary
	3	57.8297005	-133.6130066	Primary
	3	57.6889	-133.5050049	Primary
	3	57.8307991	-133.5950012	Primary
	3	57.7215004	-133.5590057	Primary
	3	57.6883011	-133.5090027	Primary
	3	57.8078003	-133.598999	Primary
	3	57.8081017	-133.602005	Primary
	3	57.6898003	-133.5200043	Primary
	3	57.6955986	-133.526001	Primary
	3	57.7142982	-133.5440063	Primary
	3	57.7262993	-133.4929962	Primary

-continued-

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Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
	3	57.725399	-133.5119934	Primary
	3	57.8302002	-133.6170044	Primary
	3	57.723999	-133.6130066	Primary
	3	57.8095016	-133.6060028	Primary
	3	57.7238998	-133.5010071	Primary
	3	57.8165016	-133.5890045	Extra
	3	57.7238007	-133.4909973	Extra
	3	57.7162018	-133.5249939	Extra
	4	57.8609009	-133.6360016	Primary
	4	57.7128983	-133.5160065	Primary
	4	57.7036018	-133.5090027	Primary
	4	57.6935005	-133.5209961	Primary
	4	57.7052002	-133.496994	Primary
	4	57.7055016	-133.5140076	Primary
	4	57.7016983	-133.5160065	Primary
	4	57.7033997	-133.5149994	Primary
	4	57.7089005	-133.5200043	Primary
	4	57.699501	-133.5140076	Primary
	4	57.7178001	-133.503006	Primary
	4	57.8246002	-133.5859985	Primary
	4	57.7076988	-133.5140076	Primary
	4	57.7074013	-133.5039978	Primary
	4	57.6991997	-133.5180054	Primary
	4	57.6957016	-133.4900055	Primary
	4	57.7083015	-133.4909973	Primary
	4	57.7244987	-133.5970001	Primary
	4	57.6974983	-133.5209961	Primary
	4	57.7131996	-133.4940033	Primary
	4	57.8140984	-133.5769958	Primary
	4	57.7196007	-133.5099945	Primary
	4	57.7126007	-133.526001	Primary
	4	57.8555984	-133.6179962	Primary
	4	57.7000999	-133.5079956	Primary
	4	57.6977997	-133.4880066	Primary
	4	57.8532982	-133.6210022	Primary
	4	57.7195015	-133.5890045	Primary
	4	57.7186012	-133.6329956	Primary
	4	57.8252983	-133.5910034	Primary
	4	57.7192001	-133.5189972	Primary

-continued-

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Location	TC Density Strata	DD Latitude	DD Longitude	Location Status
	4	57.7262993	-133.6060028	Primary
	4	57.6931	-133.5039978	Primary
	4	57.8554993	-133.6309967	Primary
	4	57.7178993	-133.5950012	Extra
	4	57.7032013	-133.5200043	Extra
	4	57.8585014	-133.628006	Extra
	5	57.7181015	-133.628006	Primary
	5	57.7146988	-133.628006	Primary
	5	57.7165985	-133.6260071	Primary
	5	57.7134018	-133.6300049	Primary
	5	57.7159996	-133.625	Primary
	5	57.7151985	-133.6340027	Primary
	5	57.7140007	-133.6340027	Primary
	5	57.7140007	-133.6320038	Extra
	5	57.7169991	-133.6320038	Extra
	5	57.714901	-133.6309967	Extra