Regional Operational Plan CF.4K.2015.20

Operational Plan: Large-Mesh Bottom Trawl Survey of Crab and Groundfish: Kodiak, Chignik, South Peninsula, and Eastern Aleutian Management Districts–Standard Protocol 2015–2019

by

Kally Spalinger

July 2015

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.4K.2015.20

OPERATIONAL PLAN: LARGE-MESH BOTTOM TRAWL SURVEY OF CRAB AND GROUNDFISH: KODIAK, CHIGNIK, SOUTH PENINSULA, AND EASTERN ALEUTIAN MANAGEMENT DISTRICTS–STANDARD PROTOCOL, 2015–2019

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Division of Commerical Fisheries

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PURPOSE

The goal of the large-mesh bottom trawl survey is to provide fishery managers with current stock status information for Tanner crab *Chionoecetes bairdi*, red king crab *Paralithodes camtschaticus*, and commercially important groundfish stocks in the Kodiak, Chignik, South Alaska Peninsula, and Eastern Aleutian Tanner crab districts of Westward Registration Area J. The large-mesh bottom trawl survey utilizes a 400-mesh eastern otter trawl to survey these districts and provide crab abundance estimates, size frequency distributions, density estimates, and spatial distribution of commercially important crab and groundfish to support fisheries management.

Keywords: bottom trawl survey, Tanner crab, Chionoecetes bairdi, red king crab, Paralithodes camtschaticus, groundfish, Kodiak, Area J, stock status, commercial fisheries

BACKGROUND

Alaska Department of Fish and Game (ADF&G) began bottom trawl surveys in the Kodiak District (Figure 1) in 1963. Early surveys focused on red king crab *Paralithodes camtschaticus* and targeted Long Island Bank (Reynolds and Powell 1964), Marmot Flats (McMullen 1967a), Portlock Bank (McMullen 1967b), Albatross Bank (McMullen 1968), and Alitak and Kaguyak bays (Kingsbury and James 1971; Figure 2). Trawl surveys to assess Tanner crab *Chionoecetes bairdi* in the Kodiak District were initiated in 1980 in North Shelikof Strait (Colgate and Hicks 1982) and expanded to other areas of the Kodiak and Chignik districts in 1981 (Colgate and Hicks 1983), and to Pavlof Bay in the South Peninsula District in 1984 (Colgate 1984). The first comprehensive trawl survey of the Kodiak District was conducted in 1987 (Jackson 1990) and in 1988 became the standard Tanner crab stock assessment tool in the Kodiak, Chignik, and South Peninsula districts (Urban and Vining 1999). The Eastern Aleutian District bottom trawl survey was added to the survey program in 1990 and generally continued on a triennial basis until 2003. Beginning in 2004, selected locations of the Eastern Aleutian District have been annually surveyed to support Tanner crab fishery management.

From 1973 to 1986 Tanner crab were surveyed as an adjunct to ADF&G's king crab pot surveys (Colgate and Hicks 1983). The final transition to a trawl survey in 1988 occurred for the following reasons:

1. Trawl gear is assumed to be less size/sex selective in capturing crabs than pot gear and is therefore a better tool to assess abundance and predict future recruitment. Catchability of crabs by pots varies depending on bait characteristics and crab size and sex (Colgate and Hicks 1982).
2. Trawl survey catch per unit effort (CPUE) is a direct measure of crab and fish density which allows for consistent spatial and temporal expansion estimates across survey stations. The catch of sublegal male and female crab by pots does not appear to be proportionate to their abundance in the population and suggests that crab behavior affects pot survey CPUE (Colgate 1984).
3. A trawl net allows faster surveying of an area (Urban 1991), which allows a single trawl vessel to survey the amount of area in one season that previously was surveyed by multiple pot survey vessels, providing cost savings.

4. Trawl surveys allow for collection of species composition and size frequencies of commercially and ecologically important species. National Marine Fisheries Service (NMFS) currently incorporates walleye pollock *Gadus chalcogrammus* abundance estimates and biological information collected from the ADF&G trawl survey into their Stock Assessment and Fishery Evaluation (SAFE) report. NMFS is also developing methods to incorporate ADF&G trawl survey data from Pacific cod *Gadus macrocephalus,* northern rock sole *Lepidopsetta polyxstyra* and southern rock sole *L. bilineata* into the SAFE report for those species.

In 1999, ADF&G developed a Tanner crab harvest strategy for the Kodiak, Chignik, and South Peninsula districts that set minimum abundance threshold levels for opening commercial fishing and brought Tanner crab management into compliance with Alaska Board of Fisheries (BOF) regulation on harvest strategies (5 AAC 35.080[1]; Urban et al. 1999). The abundance threshold to consider opening a section to fishing was defined as half the long-term (1973-1998, Kodiak; 1974-1998, Chignik; 1974-2004, South Peninsula; 1990-2000, Eastern Aleutian) average abundance of mature males (carapace width ≥115 mm; Urban and Vining 1999). Tanner crab guideline harvest levels (GHLs) are primarily determined using trawl survey results to estimate the number of molting mature male crab in a district or section and applying a harvest rate based on composition of the male population. Additional precautionary measures are contained within the harvest strategy to ensure conservative management when stocks are rebuilding (Urban and Vining 1999).

A glossary of terms used in this report are in Appendix A1.

OBJECTIVES

The primary objectives of the crab and groundfish large-mesh bottom trawl survey are as follows:

1. Estimate relative abundance and condition of Tanner and red king crabs for each management unit surveyed.

2. Determine spatial distribution, species composition, size frequency distribution, and density of commercially important groundfish species for each management unit surveyed.

Secondary objectives include the following:

1. Determine size frequency distribution of weathervane scallop *Patinopecten caurinus* in the survey area.

2. Determine sex composition of skate species *Raja* spp. and *Bathyraja* spp. in the survey area.

3. Measure chela height of male Tanner crab in the Kodiak District.

4. Collect otoliths from walleye pollock in the survey area.

[1] Alaska Administrative Code: *Harvest strategy*

METHODS

This report documents standard sampling procedures from 2015 to 2019 applicable to the Kodiak, Chignik, South Peninsula, and Eastern Aleutian districts' trawl survey. Changes to standard sampling procedures, or special projects added to the survey are described in an annual special projects operational plan (Spalinger 2015). Yearly survey schedules and station maps are included in the annual special projects operational plan.

Product names used in this report are included for completeness but do not constitute product endorsement.

SURVEY AREA AND DESIGN

The Kodiak, Chignik, South Peninsula, and Eastern Aleutian Tanner crab districts of Westward Registration Area J (Figure 1) include Pacific Ocean waters south of the latitude of Cape Douglas (58°51.10' N lat), west of 149°W long., and east of 172°W long., and Bering Sea waters south of 54°36.00' N lat and east of 172°W long.

The large-mesh bottom trawl survey is conducted in known Tanner crab habitat, using a fixed grid station design. Fixed grid station design distributes stations uniformly throughout an area to provide information on species distribution in the survey area (Figure 3) and allow for consistent and comparable survey time series data. Survey stations represent approximately 15,500 km^2 (Table 1) of crab and fish habitat greater than 20 fathoms deep. Offshore stations average approximately 74.6 km^2 each and inshore stations average approximately 21.0 km^2 each. Station size variation results from irregular coastline topography and bathymetry.

VESSEL AND FISHING GEAR

The research vessel *Resolution* (28.0 m) has been used to conduct the large-mesh bottom trawl survey annually since 1988. The R/V *Resolution* is a house-forward stern trawler equipped with an aft net reel, telescoping deck crane, and paired hydraulic trawl winches.

The trawl survey net is a 400-mesh eastern otter trawl (Figure 4) designed to sweep a 12.2 m path. The net mouth is constructed with 10.2 cm stretch mesh, net body with 8.9 cm stretch mesh, and the codend with a 3.2 cm stretch mesh liner. The net has a 21.3 m headrope with 18 floats 20.3 cm in diameter. The footrope is 29.0 m long with a 1.0 cm diameter chain attached every 25.4 cm to ensure the footrope tends bottom. The dandylines are 45.7 m long, each consisting of an 18.3 m section of 1.5 cm cable and a pair of 27.4 m sections of 1.3 cm cable, one attached to the top and the other to the bottom of each net wing (Figure 5). Astoria "V" type doors weighing 340 kg and measuring 1.5 m x 2.1 m are used to spread the net.

Within each station, the trawl net is towed on bottom at an average speed of 4.0 to 4.5 km/h for 1.85 km, equivalent to 1 nmi. The haul length provides a representative sample of fishery resources from each survey station without exceeding weight limitations of vessel equipment. Irregular bottom type, net hang ups, or exceptionally large catches may cause haul lengths to differ from 1.85 km. Haul length is determined by Global Positioning System and is assumed to be the distance traveled over ground by the vessel from when the footrope contacts bottom until the footrope leaves bottom. The vessel captain estimates corrections in distance for hauls that are not straight. Haul location within station is limited to trawlable substrate as determined from nautical charts and bottom mapping software on the vessel. All hauls are made during daylight hours. Haul location, distance, time, and depth are recorded on ADF&G skipper trawl record

forms (Appendix B1). Quality of net performance is rated and a haul is discarded and repeated when the skipper and cruise leader determine the net did not adequately sample the bottom.

Temperature and Depth Data Logger

Depths and bottom temperatures are recorded by an XR-420-TD data logger (RBR Ltd., Ottawa, Canada) during each haul. The data logger is attached to the net's headrope and is approximately 2 m above sea floor when fishing. Water temperature and depth are recorded in one-minute intervals for each haul. At the end of survey data from the logger is downloaded; temperatures recorded when the footrope is on bottom are averaged to determine water temperature.

CATCH SAMPLING

Determining Catch Weight

Total catch weight from each haul is determined by weighing the full trawl codend with an electronic crane scale (MSI 9300; Measurement Systems International, Seattle, USA; ±1.0 kg), emptying the codend into on-deck sorting bins, and subtracting the empty codend weight from the full codend weight. Total weight and empty codend weight are recorded on the on-deck sampling form (Appendix B2).

If total catch is too heavy to be lifted by the crane (exceeds scale capacity; 4,500 kg) or sea state does not permit accurate weighing, catch weight is estimated by the cruise leader in consultation with the skipper. Volumetric catch estimation may be used to estimate catch weight (AFSC 2013).

Species Composition Sampling

Prior to emptying trawl catch from the codend, a 1.5 m^2 subsampling net is tied into the on-deck sorting bin. After emptying the entire catch into on-deck sorting bin, selected species (Table 2; whole-haul) are weighed using a motion compensated electronic scale (Marel 1500, Gardabaer, Iceland; ±0.01 kg), counted, and measured (±1.0 cm) when applicable. Species names and weights are recorded on the on-deck sampling form (Appendix B2). A check mark is placed in the 100% column when a species is whole-haul sampled to indicate all organisms present of a species are accounted for either by weight, count, or measurement. As whole-haul species are removed from on-deck sorting bin for sampling, the subsampling net is lifted by crane through remaining catch (subsample) and placed on the sorting table for species composition sampling. Data recorded for organisms in the subsample will be used post survey to expand results to the entire haul catch.

All species on the sorting table are identified, weighed, and recorded on the on-deck sampling form (Appendix B2). In addition to whole-haul sampled crab and groundfish species, other commercially important groundfish in the subsample are measured using a magnetic fish measuring board (Table 3). The cruise leader must be familiar with the species list (Table 4) to ensure remaining organisms are correctly identified, counted, weighed, and recorded. Unknown or unidentifiable species are weighed and recorded on the on-deck sampling form, the specimen retained for post-survey identification, and a specimen collection form (Appendix B3) is completed. Human-made products, kelp, empty shells, regurgitated fish, rocks, etc. in the subsample are classified as "debris", weighed, and recorded.

Animals weighed and measured are recorded in the *measured weights* column of the on deck sampling form. Weights of unmeasured animals are recorded in the *unmeasured weights* column.

Counts of animals weighed and unmeasured are recorded in the *count of unmeasured: weighed* column. Counts are entered in the *unweighed* column when the cruise leader determines too many organisms are present in a whole-haul sample to reasonably sort and weigh. In that case organisms are counted by crew when returned to the water and an average weight is applied using data from the subsample.

Shellfish Sampling

Length or width measurements are taken from selected shellfish species that are typically whole-haul sampled (Table 2). Measurements and biological data are entered directly into the shellfish measurement database located on the on-deck computer.

Crab Measurement

Typically all crab are sorted by sex, weighed, and measured. Tanner, king, and Dungeness crabs have a target sample size per haul of 200 measurements per sex. Large crab tend to be sorted first, so to avoid bias and ensure a representative sample, the cruise leader selects crab for measurement from the first and last baskets sorted. Unmeasured crab are sexed, weighed, and counted when returned to the water.

Tanner crab carapace width (CW) is measured perpendicular to the carapace midline, between the lateral margin spines; however, legal status (meets minimum size requirement to retain in a fishery) is determined including lateral margin spines (Appendix D1). King crab are measured for carapace length (CL) from the right eye socket to the medial posterior edge of the carapace whereas legal status is determined by measuring perpendicular to the carapace midline including lateral margin spines. Dungeness crab are measured for CW and checked for legal status across the carapace immediately anterior to the tenth anterolateral spine (Appendix D1). Explanations of terms used to characterize crabs and minimum legal size requirements are included in Appendix A1.

Measurements are electronically recorded using digital calipers accurate to ±0.01 mm (measurements are rounded to the nearest mm for data analysis) and linked to the shellfish measurement database. Should the on-deck computer fail, data is manually recorded on the trawl survey crab data form (Appendix B4).

Biological Crab Data

In addition to providing size frequency of crab captured in a haul, other biological information is collected to evaluate the condition of the surveyed population. During sorting, sex of crab is determined using abdominal flap shape (Appendix D2).

During measurement crabs are examined free of slime and mud, under adequate lighting and categorized by shell condition (Appendix D3). Crabs exhibiting signs of bitter crab disease, black mat, nemertean worms, or parasitic barnacles (Appendix D4; Jadamec et al. 1999, Donaldson and Byersdorfer 2005) are noted in the shellfish measurement database. Clutch fullness of mature female Tanner, king, and Dungeness crabs is estimated by examining egg clutch and assigning a fractional clutch size relative to the size of the abdominal flap (Appendix D5). Embryo development is noted by the presence or absence of eyed eggs. The amount of dead eggs present or, if eggs are absent, the condition of the pleopods, is recorded as clutch condition. Additionally, from each haul in the Northeast, Eastside, and Westside sections of the Kodiak District (Figure 1) chela height is measured from 50 male Tanner crab with CW greater than 60

mm. Measurement is taken at the greatest height, excluding spines (Appendix D6), on the right chela. Chela height is not measured from crab with a regenerated claw. All biological information is entered on deck using a computer containing the shellfish measurement database.

Crab Sampling Methods

A primary survey objective is to account for number and condition of crabs captured; however, it is critical to return crab to the water quickly. To accomplish both, the following methods may be employed by the cruise leader.

Whole-haul vs. subsample

During sampling, ideally all crab in the catch are accounted for by some combination of measuring, counting, or weighing; however, the cruise leader may use alternate sampling methods to reduce handling time, particularly when large amounts of juvenile crab are captured.

When the subsampling net is placed on the sorting table, but before crew begins sorting crab from the on-deck sorting bin, the cruise leader visually estimates the number of crab on the sorting table. If more than 200 male and 200 female crab of a species are on the sorting table, and if crab size and species composition on the sorting table is representative of total catch, subsample only from the sorting table. When subsampling crab from the sorting table, crab remaining in the on-deck sorting bin are not sampled and returned to the water immediately.

1. When whole-haul sampling crab the methods described below are used while sorting crab from the entire catch, including the sorting table and on-deck sorting bins.

2. When subsampling crab the methods described below are used while sorting crab from the sorting table only, as crab from the on-deck sorting bins are immediately returned to the water prior to sorting.

Preferred method

1. Sex, weigh, and measure 200 male and 200 female crab
2. Sex, weigh, and count unmeasured crab

The preferred method is utilized for whole-haul sampling or subsampling during the vast majority of sampling events; however when large numbers of juvenile crab are caught which require extensive amounts of time to sort and measure, and the cruise leader is concerned about returning crab alive to the water, the following alternate methods can be employed at either the whole-haul or subsample level.

Alternate method 1

-Use with large juvenile crab catches to reduce handling time spent counting crab

1. Sex, weigh, and measure 200 male and 200 female crab, recording weights in *measured weights* column
2. Sex and weigh unmeasured crab, recording weights in *unmeasured weights* column
3. After the haul calculate:
   a. $average\ crab\ weight\ by\ sex = \frac{weight\ of\ measured\ crab\ by\ sex}{number\ of\ crab\ measured\ by\ sex}$

   b. $number\ of\ unmeasured\ crab\ by\ sex = \frac{weight\ of\ unmeasured\ crab\ by\ sex}{average\ crab\ weight\ by\ sex}$

Alternate method 2

-Use with extremely large catches of small, evenly sized juvenile crab to reduce handling time spent sexing and counting

1. Sex, weigh, and measure 200 male and 200 female crab, recording weights in *measured weights* column
2. Weigh unmeasured crab, recording weights in *unmeasured weights* column and noting they are unsexed
3. Determine sex composition of crab by weight:
    a. Sex and weigh crab by sex from a predetermined subset (e.g. sorting table or 1-2 baskets/totes depending on total number of crab. Cruise leader ensures large enough sample size to obtain a representative sex composition).
4. After the haul calculate:
    a. $average\ crab\ weight\ by\ sex = \frac{weight\ of\ measured\ crab\ by\ sex}{number\ of\ crab\ measured\ by\ sex}$
    b. $sex\ composition\ \%\ by\ weight = \frac{weight\ by\ sex\ from\ step\ 3}{male + female\ sex\ composition\ sample\ weight}$
    c. $weight\ of\ unmeasured\ crab\ by\ sex = (sex\ composition\ \%\ by\ weight * total\ unmeasured\ crab\ weight\ from\ step\ 2)$
    d. $number\ of\ unmeasured\ crab\ by\ sex = \frac{weight\ of\ unmeasured\ crab\ by\ sex}{average\ crab\ weight\ by\ sex}$

An accurate count of unmeasured crab in each haul is essential for determining abundance and potential fishery openings. Unmeasured crab counts are recorded in *count of unmeasured: weighed* column.

Weathervane Scallop Measurement

Weathervane scallops caught on trawl wires are not considered part of the haul catch and are discarded. Remaining scallops in the trawl net are whole-haul sampled. All scallops are weighed, shell height measurements from 20 scallops per haul are recorded, and unmeasured scallops are counted. Scallop shell height is measured using calipers accurate to ±0.01 mm (measurements are rounded to the nearest mm for data analysis), taking the straight-line distance from the umbo to the outer shell margin (Appendix C1). Only the top valve is measured, which is shorter in shell height than the bottom valve with narrower radiating ribs. Broken or badly chipped shells are weighed but not measured and are included in the *unmeasured weight* and in the *count of unmeasured: weighed* columns on the on-deck sampling form. Measurements are transmitted directly to the shellfish measurement database using digital calipers and on-deck computer. The numbers of unmeasured scallops are entered in the *count of unmeasured: weighed* column.

Fish Sampling

Length measurements are taken from selected finfish species (Tables 2 and 3). Measurements are recorded on deck directly in the fish measurement database except for Pacific halibut *Hippoglossus stenolepis* and skate measurements which are written on the on-deck sampling

form and entered into the database after the haul. Pacific halibut and skates are often difficult to fit on the scale, so weights are estimated from length data.

Fish Measurement

Commercial finfish species are measured from snout to mid-point of the caudal fin (Appendix C1). Sharks are measured from snout to tip of caudal fin. Skates are measured along the dorsal surface from the snout to the anterior notch of the pectoral fin. All sharks and skates are measured and sexes recorded. Sex is determined by the presence or absence of claspers (Appendix C2). Sharks and skates that are difficult to sex are recorded as unknown.

Measurements are recorded on deck with a magnetic fish measuring board that transmits data directly into the fish measurement database. Target sample size is 30 to 50 measurements per species. To avoid bias and ensure a representative sample the cruise leader collects length samples from a predetermined quadrant of the sampling table. Deviations from standard sampling procedures are described on the on-deck sampling form.

Data collected on walleye pollock, Pacific cod, northern rock sole, and southern rock sole, including abundance, length frequencies, and otoliths, are used annually by NMFS for stock assessment. Data informs fishery managers in 2 ways, it provides an annual time series that complements the NMFS biennial survey by providing information in years when NMFS does not survey, and it provides information on nearshore populations the NMFS survey does not sample.

Adult Walleye Pollock Sampling

Generally, walleye pollock are whole-haul sampled (Table 2); however, there are hauls when pollock are so abundant they cannot all be sampled in a timely manner. In those instances the cruise leader uses the following guidelines to determine the best sampling plan.

1. If less than 30 pollock are brought to the sorting table in the subsampling net pollock are whole-haul sampled. All pollock in the catch must be accounted for by weight or count. Target sample size is 30 to 50 pollock measurements from the sorting table and the on-deck sorting bin. Remaining pollock are weighed and returned to the water (*Unmeasured Weights*), or counted as they are released over the side of the vessel (*Count of unmeasured: unweighed*). Average weight of the measured fish is used to estimate the weight or count of unmeasured fish.

2. If more than 30 pollock are brought to the sorting table in the subsampling net subsampling methods are used. Target sample size is 30 to 50 pollock measurements from the sorting table. Remaining pollock on the sorting table are weighed and returned to the water (*Unmeasured Weights*). Pollock left in the on-deck sorting bin are returned to the water immediately with the rest of the catch.

These guidelines are also used when large catch of Pacific cod, sablefish, rockfish, or other typically whole-haul sampled fish species are encountered.

Juvenile Walleye Pollock and Pacific Cod Sampling

Walleye pollock and Pacific cod <20 cm are considered juveniles and subsampled independently from adult fish >20 cm. Juveniles are sorted strictly from the subsample and up to 50 measurements collected in addition to the 30 to 50 fish sample size of adult fish.

Walleye Pollock Otolith Collection

In 2016 and 2018 approximately 600 walleye pollock otoliths each year are collected for NMFS for age determination. To obtain a sample representative of the surveyed population, 20 walleye pollock otoliths are collected every other day throughout the survey. Sampled fish are measured, sex is determined, and otoliths removed and stored in vials containing a specimen number. Haul number, fish length, and sex is recorded electronically on deck and provided to NMFS in spreadsheet format, or recorded on a specimen form (Appendix B5).

Additional Sampling Considerations

Specimen Collection

Photos of rarely encountered species (Table 5) are used to update the marine fish and invertebrate field guide (Byersdorfer and Watson 2010). Organisms are placed on a white or black background to show contrast, and multiple pictures taken of dorsal, ventral, and lateral views. Fins or legs are spread as much as possible and close-up pictures of distinguishing characteristics taken. If identification of any organism is questionable the animal is photographed and frozen with a completed specimen identification form (Appendix B3) included in the sample bag.

Crab Pots

Crab pots are routinely caught in the survey net, particularly inside bays with a history of crab fishing. The cruise leader and vessel captain determine if fishing ability was compromised by using information about when during towing the pot may have been caught (vessel speed may have changed) and where in the net it was caught or snagged (drag on the wires or net damage). If fishing ability is compromised the haul is considered unsuccessful and will be repeated.

Pots are usually removed from the net as the net is brought onboard, before the codend is weighed. Those pots are emptied before being disposed of and animals inside the pot included with the remainder of the catch. If the pot is retained in the codend it is weighed with the total catch. Upon removal, animals inside the pot are included with the remainder of the catch, and the empty pot weighed separately. The weight is entered on the on-deck sampling form as *Whole-hauled debris weight*.

Large Debris Items

Large debris (rocks, logs, 50-gallon drums, etc.) are sometimes captured in the codend. These items are weighed separately and entered on the sampling form as *Whole-hauled debris weight*. Small debris items in the subsampling net are treated as part of the subsample.

When an item is caught in the net but unable to make it to the codend it is removed and discarded without weighing. The cruise leader and vessel captain determine if fishing ability was compromised and repeat the haul if necessary.

Mud or Shell Hash in Catch

In some survey areas the seafloor is mostly mud and the net can pick up a substantial amount of substrate. If the cruise leader estimates more than 10% of catch is mud, then the proportion of mud in the catch is estimated. This is done by weighing a portion of the catch with mud included,

washing the mud from the catch, and reweighing. The proportion of mud is expanded to the total catch, and subtracted from the total animal weight.

Hauls containing large volumes of shell hash (broken shells) mixed with small invertebrates may require additional subsampling. As an alternative to sorting all the shell hash mixture in the subsample the cruise leader weighs and sorts a representative portion (sub-subsample) of the unsorted mix. All organisms in the sub-subsample are identified, weighed, and counted and broken shells are weighed as debris. The remaining unsorted mixture is weighed. Composition of the sub-subsample is expanded to the unsorted shell hash mixture.

Unrepresentative Subsample

When the subsampling net does not contain a representative sample of total catch, the cruise leader may direct crew to add catch to the subsample. This can be accomplished by using deck shovels to add catch to the subsampling net before it is taken to the table, or by filling baskets with catch from the on-deck sorting bin and adding to the subsample table. The cruise leader supervises this procedure to assure a representative sample is taken. Alternatively the cruise leader directs the crew to sort the entire catch.

Small Total Catch

When the total catch is 250 kg or less the cruise leader may decide to sort the entire catch. The entire contents of the codend are emptied directly onto the sorting table, sorted, weighed, and measured according to standard sampling procedures.

Data Entry

After all catch from each haul has been sorted, identified, weighed, measured, and returned to the water, data not entered into a database during the sampling process must be entered. Halibut and skate lengths written on the on-deck sampling form are manually entered into the fish length database. Once data from the shellfish and fish measurement databases are electronically incorporated into the catch database, species and weight data recorded on the on-deck sampling form are manually entered into the catch database.

Data from skipper forms is manually entered into a haul database at the end of each day.

Upon completion of the season all data is verified, edited as needed, and given to the database manager for incorporation into the large-mesh trawl survey database where it will be summarized and analyzed.

Data Forms and Sample Custody

The cruise leader completes all data forms and removes samples and data from vessel after each survey leg, including making backup copies of electronic data. Data forms and electronic data removed from vessel are taken to the large-mesh trawl survey project leader. Frozen samples are labeled with project, year, location, and contact name and transferred to the freezer at the ADF&G warehouse where samples may be stored until delivered to the appropriate researcher. Samples preserved in formalin are stored in a hazardous material locker or van with adequate ventilation until shipped. The project leader must be notified of the location of all stored samples.

DATA ANALYSIS

Density Estimates

Survey catch data is converted to density estimates for each haul by dividing the number or weight of animals caught in the haul by the area swept by the trawl during the haul. The area swept is the product of the assumed net width of 12.2 m and the distance towed.

$$density = \frac{number\ or\ weight\ of\ animals}{net\ width * distance\ towed}$$

Abundance Indices

Abundance indices for Tanner and king crabs are derived from trawl survey data using the area swept technique (Alverson and Pereyra 1969). Density estimates are multiplied by the station area to estimate station abundance.

$$station\ abundance = density * station\ area$$

The sum of abundances from stations in a geographic area provides a total abundance index for the area.

$$total\ district\ or\ section\ abundance = \sum station\ abundance$$

Size Composition

Length or carapace width compositions are calculated at the population level by applying the sampled length frequency to the total catch for each species by length, sex, and/or shell condition category at each station.

Tanner Crab Fishery Calculations

To determine potential Tanner crab fishery openings mature male abundances from the most recent survey are compared with abundance thresholds (½ the average long-term abundance of mature males) established in regulation (5 AAC 35.507). If abundances are above thresholds additional factors are used to determine the appropriate level of harvest. Those factors include molting mature male abundance (Appendix A1) and legal male abundance. The average weight of legal males captured during the survey is determined using carapace width measurements and is used to convert the proposed harvest of legal males from numbers to pounds.

Survey Limitations

The large-mesh trawl survey operates under the assumption that survey catch rates are proportional to true abundance of the species of interest; however, the survey has limitations in its ability to estimate abundance across all species. Species whose populations extend into areas untrawlable by the survey gear or species whose populations extend beyond the depth range and area covered by the survey may be underrepresented.

Determining abundance from trawl survey data requires fish distribution, fish behavior in relation to the trawl, and trawl performance to be constant over time. By maintaining standardized gear and fishing practices within and between annual surveys we assume that:

1. Trawl performance is constant under various conditions
2. Area swept by the trawl is known and constant under various conditions

3. Species and size selection by the trawl is constant under various conditions.

The large-mesh trawl survey assumes 100% of the population of interest is accessible to survey gear, and all animals in the trawl path are captured. This may not be the case, as smaller animals can pass through the larger net mesh to avoid capture (size selectivity), some animals may be able to outswim the trawl, or escape under the footrope (escapement) and some fish may actually be "herded" into the trawl path by the doors and bridles in front of the net. These limitations may result in biased population estimates; however, standardized fishing gear and fishing practices provide constant and proportional bias allowing estimates to be compared year to year.

Because of these limitations the abundance estimates derived using trawl survey data are best considered relative abundance indices used to monitor changes in populations over time.

SCHEDULE AND DELIVERABLES

Annual schedule of activities for large-mesh trawl survey:

Date	Activity
June	Northeast Kodiak Survey
June–July	Eastside, Southeast, Southwest Kodiak Survey
July–August	Chignik, South Peninsula, Eastern Aleutian Survey
September	Westside, North Mainland Kodiak Survey
September 15	Final data delivered to CFD-Kodiak for editing and analysis
October 15	Final data results for walleye pollock distributed to NMFS
October 31	Final data results and potential Tanner crab fishery openings determined and distributed to fishery managers for consideration.
November 30	Final data results for Pacific cod and rock sole distributed to NMFS
June 1	Draft annual report to management supervisor

Large-mesh trawl survey data is maintained by ADF&G, Commercial Fisheries Division, in Kodiak. Electronic data is stored in a database on a network server in Kodiak, accessible by ADF&G staff and available to the public upon request. An exception is crab abundance information by sampling location which may not be released until the close of the fishing season for which the survey was conducted (AS 16.05.815(c)[1]).

[1] Alaska Statute: *Confidential nature of certain reports and records*

RESPONSIBILITIES

List of personnel and duties:

Fisheries Biologist II: Project leader, manage survey budgets, prepare sampling gear, develop survey schedule, act as cruise leader as needed, and perform data verification/editing, data analysis and report writing. Oversee field activities and assist with sampling, data collection, and data entry.

Fisheries Biologist III: Act as cruise leader as needed, oversee field activities and assist with sampling, data collection, and data entry.

Fisheries Biologist II: Act as cruise leader as needed, oversee field activities and assist with sampling, data collection, and data entry.

Fish and Wildlife Technician V: Act as cruise leader as needed, oversee field activities and assist with sampling, data collection, and data entry.

Fish and Wildlife Technician III: Assist with sampling, data collection, and data entry.

Fish and Wildlife Technician III: Assist with sampling, data collection, and data entry.

Fish and Wildlife Technician II: Assist with sampling, data collection, and data entry.

Boat Officer IV: Operate survey vessel.

Boat Officer III: Vessel engineer, deploy/retrieve survey gear, assist with catch sampling.

Boat Officer II: Deploy/retrieve survey gear, assist with catch sampling.

Analyst/Programmer IV: Program and manage the trawl survey database, load new data and create data verification queries.

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TABLES AND FIGURES

Table 1.–Standard large-mesh trawl survey station areas by district.

Kodiak District

Northeast Section

Chiniak Gully

Station	KM^2	NM^2
369X	150.9	44.0
395	85.8	25.0
420	85.8	25.0
421	85.8	25.0
443	85.8	25.0
444	85.8	25.0
	579.7	169.0

Marmot Bay

Station	KM^2	NM^2
MOEX	36.2	10.6
MOGX	65.9	19.2
MOLX	27.4	8.0
MONX	75.5	22.0
MOPX	27.8	8.1
MOQ	21.4	6.3
MOT	19.9	5.8
MOX	13.0	3.8
MOXX	29.5	8.6
255	68.6	20.0
256	85.8	25.0
257	85.8	25.0
283	65.2	19.0
284	85.8	25.0
285	85.8	25.0
313	85.8	25.0
314	85.8	25.0
255X	60.0	17.5
283X	63.5	18.5
	1,088.4	317.3

Chiniak Bay

Station	KM^2	NM^2
CHA	5.5	1.6
CHB	7.9	2.3
CHE	20.6	6.0
CHF	12.7	3.7
CHG	34.6	10.1
CHJ	11.3	3.3
CHK	8.6	2.5
CHL	14.1	4.1
	115.2	33.6

Kizhuyak Bay

Station	KM^2	NM^2
KZA	11.7	3.4
KZB	2.7	0.8
KZC	12.3	3.6
KZD	23.7	6.9
KZE	27.4	8.0
KZF	20.6	6.0
KZG	21.3	6.2
KZJ	21.4	6.3
KZK	21.4	6.3
KZO	21.4	6.3
KZR	13.7	4.0
KZS	3.1	0.9
	200.8	58.6

Eastside Section

Ugak Bay

Station	KM^2	NM^2
UGAA	16.0	4.7
UGAB	4.7	1.4
UGAC	3.2	0.9
UGB	5.8	1.7
UGC	17.5	5.1
UGD	11.0	3.2
UGE	12.7	3.7
UGF	15.8	4.6
UGG	11.0	3.2
UGI	21.4	6.3
UGJ	21.4	6.3
UGM	16.8	4.9
	157.3	45.9

Kiliuda Bay

Station	KM^2	NM^2
KLA	20.9	6.1
KLB	9.3	2.7
KLC	19.6	5.7
KLD	18.2	5.3
KLE	8.2	2.4
KLF	15.1	4.4
KLG	16.5	4.8
KLH	16.8	4.9
KLI	21.4	6.25
KLL	21.4	6.25
	167.4	48.8

Barnabas Gully

Station	KM^2	NM^2
486A	27.9	8.1
486B	29.4	8.6
510B	63.0	18.4
510C	40.7	11.9
511A	42.9	12.5
511B	42.9	12.5
533A	42.9	12.5
533B	42.9	12.5
534B	21.6	6.3
534D	28.3	8.3
535A	21.4	6.3
535B	21.4	6.3
535C	21.4	6.3
535D	21.4	6.3
559	85.8	25.0
560	85.8	25.0
561	85.8	25.0
587	85.8	25.0
588	85.8	25.0
589	85.8	25.0
619	85.8	25.0
620	85.8	25.0
621	85.8	25.0
654	85.8	25.0
655	85.8	25.0
656	85.8	25.0
695	85.8	25.0
696	85.8	25.0
	1,668.6	486.5

Southeast Section

South Sitkalidak Strait

Station	KM^2	NM^2
THA	15.1	4.4
THC	19.6	5.7
THD	28.6	8.3
THF	22.3	6.5
THG	21.4	6.3
THH	19.2	5.6
THI	21.6	6.3
THJ	17.8	5.2
THK	16.5	4.8
THL	9.3	2.7
THM	10.6	3.1
THN	5.1	1.5
	207.1	60.4

Offshore Twoheaded

Station	KM^2	NM^2
618A	42.9	12.5
585X	94.3	27.5
614	64.1	18.7
615	99.5	29.0
651	85.8	25.0
	386.6	112.7

Horse's Head

Station	KM^2	NM^2
586	85.8	25.0
688	85.8	25.0
725	85.8	25.0
726	85.8	25.0
727	85.8	25.0
728	85.8	25.0
729	85.8	25.0
759	85.8	25.0
760	85.8	25.0
761	85.8	25.0
	857.5	250.0

Southwest Section

Alitak Flats

Station	KM^2	NM^2
645B	34.3	10.0
646A	27.1	7.9
646B	16.5	4.8
646C	29.2	8.5
646D	37.4	10.9
682B	23.0	6.7
683A	23.0	6.7
683B	20.9	6.1
683D	9.3	2.7
684A	23.0	6.7
684B	10.3	3.0
684C	8.6	2.5
	262.4	76.5

Alitak Bay

Station	KM^2	NM^2
ALA	3.1	0.9
ALB	17.8	5.2
ALC	8.1	2.4
ALD	13.0	3.8
ALF	21.4	6.3
ALG	19.9	5.8
ALH	16.1	4.7
ALI	16.6	4.9
ALJ	15.1	4.4
ALK	9.9	2.9
ALL	8.2	2.4
ALM	16.1	4.7
ALO	16.8	4.9
ALP	19.2	5.6
ALQ	14.4	4.2
ALR	13.4	3.9
	229.3	66.9

-continued-

Table 1.–Page 2 of 3.

Kodiak District (continued)

Southwest Section

Offshore Southeast

Station	KM^2	NM^2
608X	171.5	50.0
676X	171.5	50.0
677X	171.5	50.0
678X	171.5	50.0
712X	171.5	50.0
748X	171.5	50.0
750X	171.5	50.0
781X	171.5	50.0
815X	171.5	50.0
816X	171.5	50.0
881X	171.5	50.0
	1,886.5	550.0

Westside Section

Uyak Bay

Station	KM^2	NM^2
UYBX	21.5	6.3
UYEX	29.9	8.7
UYFX	22.1	6.4
UYHX	4.1	1.2
UYKX	13.9	4.0
UYMX	20.8	6.1
UYO	3.4	1.0
UYQX	7.7	2.2
UYSS	6.0	1.8
UYT	2.7	0.8
	132.0	38.5

West Afognak

Station	KM^2	NM^2
RAA	6.7	2.0
PAA	15.1	4.4
MAA	10.6	3.1
	32.4	9.5

Kupreanof-Viekoda

Station	KM^2	NM^2
KUD	27.1	7.9
KUF	11.3	3.3
KUG	15.4	4.5
KUI	6.4	1.9
KUJ	17.0	5.0
KUK	14.1	4.1
KUL	2.7	0.8
KUM	10.5	3.1
KUY	4.1	1.2
KULX	2.1	0.6
KUYX	2.6	0.8
	113.2	33.0

Uganik Bay

Station	KM^2	NM^2
KUNX	10.6	3.1
KUP	13.3	3.9
KUQ	20.6	6.0
KUS	12.1	3.5
KUT	9.4	2.7
KUU	13.7	4.0
KUV	4.1	1.2
KUW	5.2	1.5
KUX	4.1	1.2
KUXX	5.6	1.6
	98.6	28.8

N. Mainland Section

Station	KM^2	NM^2
2	85.8	25.0
3	85.8	25.0
31	83.7	24.4
60	85.8	25.0
61	85.8	25.0
90	80.3	23.4
91	85.8	25.0
117	97.8	28.5
118	85.8	25.0
119	85.8	25.0
120	85.8	25.0
121	85.8	25.0
144	60.7	17.7
145	85.8	25.0
146	85.8	25.0
147	85.8	25.0
171	11.4	3.3
171X	8.1	2.4
171Y	29.1	8.5
172	89.2	26.0
173	85.8	25.0
174	85.8	25.0
198	85.8	25.0
199	85.8	25.0
200	85.8	25.0
222	113.2	33.0
223	85.8	25.0
224	85.8	25.0
	2,202.6	642.2

Kodiak District totals

SECTION	KM^2	NM^2
Northeast	1,984.1	578.5
Eastside	1,993.3	581.2
Southeast	1,451.2	423.1
Southwest	2,378.2	693.4
Westside	376.3	109.7
N. Mainland	2,202.6	642.2
Kodiak District	10,385.8	3,027.9

Chignik District

Chignik Bay

Station	KM^2	NM^2
4256	24.0	7.0
4262	21.4	6.3
4264	20.1	5.9
4265	6.6	1.9
4266	19.6	5.7
4267	21.4	6.3
4270	17.1	5.0
4271	10.3	3.0
4272	15.9	4.6
4274	21.4	6.3
4277	21.4	6.3
4278	21.4	6.3
4282	21.4	6.3
4286	21.4	6.3
4287	29.7	8.7
4312	21.9	6.4
4964	9.6	2.8
	325.0	94.7

Ivanof Bay

Station	KM^2	NM^2
400X	5.6	1.6
4000	15.8	4.6
4007	59.3	17.3
4008	42.1	12.3
4024	65.7	19.2
4900	10.7	3.1
4915	51.7	15.1
	250.8	73.1

Kujulik Bay

Station	KM^2	NM^2
4290	21.4	6.3
4296	10.3	3.0
4298	19.2	5.6
4301	21.4	6.3
4302	21.0	6.1
4308	17.2	5.0
	110.5	32.2

Mitrofania Island

Station	KM^2	NM^2
4025	37.6	11.0
4026	40.1	11.7
4035	68.6	20.0
4036	67.9	19.8
4037	45.2	13.2
4038	41.0	12.0
4043	32.6	9.5
4048	14.7	4.3
4049	57.2	16.7
4063	57.2	16.7
4064	57.2	16.7
4065	80.0	23.3
4066	28.9	8.4
4067	28.9	8.4
4068	28.9	8.4
4095	36.1	10.5
	722.1	210.5

Chignik District totals

SECTION	KM^2	NM^2
Chignik Bay	325.0	94.7
Ivanof Bay	250.8	73.1
Kujulik Bay	110.5	32.2
Mitrofania Island	722.1	210.5
Chignik District	1,408.4	410.6

-continued-

Table 1.–Page 3 of 3.

South Peninsula District

Sanak Island

Station	KM²	NM²
113	77.2	22.5
125	77.2	22.5
126	83.9	24.45
137	85.8	25.0
138A	46.3	13.5
138B	18.4	5.37
138C	56.9	16.6
	445.6	129.9

Morzhovoi Bay

Station	KM²	NM²
87AX	42.9	12.5
87D	22.3	6.5
MOB	19.9	5.8
MOD	16.1	4.7
MOF	21.4	6.25
MOG	21.4	6.25
MOH	16.8	4.9
MOI	21.4	6.25
MOK	21.4	6.25
MOL	21.4	6.25
MOOX	56.1	16.35
MORX	58.7	17.1
MOSX	37.7	11.0
	377.6	110.1

Pavlof/Volcano Bay

Station	KM²	NM²
228	93.5	27.3
245	87.7	25.6
PAEX	41.6	12.1
PAIX	38.3	11.2
PAH	15.1	4.4
PALX	42.9	12.5
PAOA	6.7	2.0
PAP	20.8	6.1
PARA	19.1	5.6
PARB	21.1	6.1
PAU	21.4	6.3
PAV	20.6	6.0
VOA	22.4	6.5
VOBX	43.8	12.8
VOD	20.8	6.1
VOFB	15.5	4.5
VOG	23.0	6.7
VOH	21.7	6.3
VOI	22.1	6.4
VOLX	27.3	8.0
VOMB	16.8	4.9
VON	22.4	6.5
VOP	21.4	6.3
VOQ	15.9	4.6
VOR	21.1	6.2
	723.1	210.8

Cold/Belkofski Bay

Station	KM²	NM²
157A	21.0	6.1
156A	44.2	12.9
BEBX	15.9	4.6
BECX	25.7	7.5
BEE	21.4	6.3
BEF	15.7	4.6
BEG	20.3	5.9
COB	21.1	6.2
COC	15.3	4.5
COE	21.1	6.2
COF	11.5	3.4
COGA	9.8	2.9
COGB	3.6	1.1
COH	7.8	2.3
COM	18.5	5.4
COO	22.4	6.5
	295.5	86.1

West Nagai Strait

Station	KM²	NM²
301	85.8	25.0
318	85.8	25.0
337	85.8	25.0
332B	42.9	12.5
334	85.8	25.0
335	85.8	25.0
353	86.1	25.1
354	85.8	25.0
371	80.6	23.5
373A	41.8	12.2
373B	20.5	6.0
393	47.4	13.8
	833.9	243.1

Stepovak Bay

Station	KM²	NM²
368A	45.6	13.3
STA	21.0	6.1
STB	18.9	5.5
STD	22.7	6.6
STE	15.5	4.5
	123.7	36.1

Beaver/Balboa/Unga

Station	KM²	NM²
278	71.4	20.8
311A	15.5	4.5
311B	20.4	6.0
311C	17.3	5.0
329B	21.4	6.3
329C	21.4	6.3
348	85.8	25.0
BAA	12.0	3.5
BAC	16.9	4.9
BAD	10.4	3.0
BAE	12.7	3.7
BAF	10.8	3.2
BVA	15.3	4.5
BVB	14.0	4.1
BVC	18.9	5.5
	364.2	106.2

S. Peninsula District totals

Section	KM²	NM²
Sanak Island	445.6	129.9
Morzhovoi Bay	377.6	110.1
Cold/Belkofski Bay	295.5	86.1
Pavlof/Volcano Bay	723.1	210.8
West Nagai Strait	833.9	243.1
Beaver/Balboa/Unga	364.2	106.2
Stepovak Bay	123.8	36.1
S. Peninsula District	3,163.7	922.4

Eastern Aleutian District

Unalaska/Kalekta Bay

Station	KM²	NM²
KAA	19.6	5.7
UNC	22.6	6.6
UND	11.7	3.4
UNE	17.8	5.2
UNF	21.6	6.3
UNG	21.6	6.3
UNI	19.9	5.8
UNJ	21.6	6.3
	156.4	45.6

Pumicestone Bay

Station	KM²	NM²
PUA	4.8	1.4
PUB	15.1	4.4
	19.9	5.8

Makushin Bay

Station	KM²	NM²
MKB	15.8	4.6
MKC	18.5	5.4
MKE	29.2	8.5
MKK	37.4	10.9
MKF	20.9	6.1
MKJ	23.7	6.9
MKN	26.1	7.6
MKP	12.3	3.6
	183.8	53.6

Akutan Bay

Station	KM²	NM²
AKA	33.3	9.7
AKC	21.3	6.2
AKD	23.3	6.8
AKG	21.6	6.3
AKL	21.6	6.3
	121.1	35.3

Beaver Inlet

Station	KM²	NM²
BIB	17.5	5.1
BID	18.9	5.5
BIG	22.6	6.6
BIK	13.0	3.8
BIN	17.5	5.1
	89.5	26.1

E. Aleutian District totals

	KM²	NM²
Akutan	121.1	35.3
Beaver Inlet	89.5	26.1
Unalaska/Kalekta	156.4	45.6
Makushin	183.8	53.6
Pumicestone	19.9	5.8
E. Aleutian District	449.7	131.1

Table 2.–Species whole-haul sampled during large-mesh trawl survey.

Common name	Species name	Counted?	Weighed?	Measured?
Alaska skate	*Bathyraja parmifera*			✓
Aleutian skate	*Bathyraja aleutica*			✓
Armhook squid	*Berryteuthis magister*	✓	✓	
Atka mackerel	*Pleurogrammus monopterygius*		✓	✓
Bering skate	*Bathyraja interrupta*			✓
Bering wolffish	*Anarhichas orientalis*	✓	✓	
Big skate	*Raja binoculata*			✓
Box crab	*Lopholithodes foraminatus*	✓	✓	
Dungeness crab	*Metacarcinus magister*		✓	✓
Giant Pacific octopus	*Octopus dofleini*	✓	✓	
Giant wrymouth	*Cryptocanthodes giganteus*	✓	✓	
Golden king crab	*Lithodes aequispinus*		✓	✓
Horsehair crab	*Erimacrus isenbeckii*	✓	✓	
Lingcod	*Ophiodon elongates*		✓	✓
Longnose skate	*Raja rhina*			✓
Pacific cod	*Gadus macrocephalus*	✓	✓	✓
Pacific halibut	*Hippoglossoides stenolepis*			✓
Pacific herring	*Clupea pallasii*		✓	✓
Pacific sleeper shark	*Somniosus pacificus*		✓	✓
Red king crab	*Paralithodes camtschatica*		✓	✓
Red sea cucumber	*Parastichopus californicus*	✓	✓	
Rockfish spp.	*Sebastes* spp. and *Sebastolobus* spp.		✓	✓
Sablefish	*Anoplopoma fimbria*		✓	✓
Salmon spp.	*Onchorynchus* spp.		✓	✓
Salmon shark	*Lamna ditropis*		✓	✓
Sleeper shark	*Somniosus pacificus*		✓	✓
Spiny dogfish	*Squalus acanthius*		✓	✓
Snow crab	*Chionoecetes opilio*		✓	✓
Tanner crab	*Chionoecetes bairdi*	✓	✓	✓
Walleye pollock	*Gadus chalcogrammus*	✓	✓	✓
Weathervane scallop	*Patinopectin caurinus*	✓	✓	✓
Wolf eel	*Anarrhichthys ocellatus*	✓	✓	

Table 3.–Species subsampled and measured on large-mesh trawl survey.

Common name	Scientific name
Alaska plaice	*Pleuronectes quadrituberculatus*
Arrowtooth flounder	*Atheresthes stomias*
Butter sole	*Isopsetta isolepis*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
Flathead sole	*Hippoglossiodes elassodon*
Juvenile Pacific cod	*Gadus macrocephalus*
Juvenile pollock	*Gadus chalcogrammus*
Kelp greenling	*Hexagrammos decagrammus*
Northern rock sole	*Lepidopsetta polyxystra*
Rex sole	*Glyptocephalus zachirus*
Rock sole unidentified	*Lepidopsetta* sp.
Sand sole	*Psettichthys melanostictus*
Slender sole	*Lyopsetta exilis*
Southern rock sole	*Lepidopsetta bilineata*
Starry flounder	*Platichthys stellatus*
White-spotted greenling	*Hexagrammos stelleri*
Yellowfin sole	*Limanda aspera*

Table 4.–List of species identified on the large-mesh trawl survey

Common name	Scientific name
fish larvae unident.	
Sharks	
salmon shark	*Lamna ditropis*
spiny dogfish shark	*Squalus acanthius*
Pacific sleeper shark	*Somniosus pacificus*
Skates	
skate egg case unident.	Rajidae egg case
big skate	*Raja binoculata*
Bering skate	*Bathyraja interrupta*
longnose skate	*Raja rhina*
Alaska skate	*Bathyraja parmifera*
Aleutian skate	*Bathyraja aleutica*
Flatfish	
flatfish larvae	*Pleuronectiformes larvae*
arrowtooth flounder	*Atheresthes stomias*
Pacific halibut	*Hippoglossus stenolepis*
flathead sole	*Hippoglossiodes elassodon*
slender sole	*Lyopsetta exilis*
English sole	*Parophrys vetulus*
Dover sole	*Microstomus pacificus*
rex sole	*Glyptocephalus zachirus*
yellowfin sole	*Limanda aspera*
starry flounder	*Platichthys stellatus*
sand sole	*Psettichthys melanostictus*
rock sole unident.	*Lepidopsetta sp.*
northern rock sole	*Lepidopsetta polyxystra*
southern rock sole	*Lepidopsetta bilineata*
butter sole	*Isopsetta isolepis*
Alaska plaice	*Pleuronectes quadrituberculatus*
Poachers	
tubenose poacher	*Pallasina barbata*
sawback poacher	*Leptagonus frenatus*
spinycheek starsnout	*Bathyagonus infraspinatus*
Poachers continued	
blackfin poacher	*Bathyagonus nigripinnis*
sturgeon poacher	*Podothecus accipenserinus*
Aleutian alligatorfish	*Aspidophoodas bartoni*
fourhorn poacher	*Hypsagonus quadricornis*
Wolf-eel	*Anarrhichthys ocellatus*
Bering wolffish	*Anarhichas orientalis*
sablefish (or black cod)	*Anoplopoma fimbria*
unident. Deep sea smelt	*Bathylagidae*
northern ronquil	*Ronquilus jordani*
searcher	*Bathymaster signatus*
Pacific herring	*Clupea pallasi*
Sculpins	
sculpin unident.	Cottidae
threaded sculpin	*Gymnocanthus pistilliger*
armorhead sculpin	*Gymnocanthus galeatus*
red Irish lord	*Hemilepidotus hemilepidotus*
yellow Irish lord	*Hemilepidotus jordani*
scissortail sculpin	*Triglops forficata*
spectacled sculpin	*Triglops specticua*
ribbed sculpin	*Triglops pingeli*
roughspine sculpin	*Triglops macellus*
great sculpin	*Myoxocephalus polyacanthocephalus*
plain sculpin	*Myoxocephalus jaok*
Pacific staghorn sculpin	*Leptocottus armatus*
soft sculpin	*Gilbertidia sigalutes*
Eunophrys sp.	*Enophrys* sp.
spinyhead sculpin	*Dasycottus setiger*
crested sculpin	*Blepsias bilobus*
silverspotted sculpin	*Blepsias cirrhosus*
grunt sculpin	*Rhamphocottus richardsonii*
bigmouth sculpin	*Hemitripterus bolini*
thorny sculpin	*Icelus spiniger*

-continued-

Table 4.–Page 2 of 4.

Common name	Scientific name
Pacific sandfish	*Trichodon trichodon*
Gadids	
Pacific tomcod	*Microgadus proximus*
Pacific cod	*Gadus macrocephalus*
juvenile cod	*Gadus macrocephalus*
pacific cod-tagged	*Gadus macrocephalus*
saffron cod	*Eleginus gracililis*
walleye pollock	*Gadus chalcogrammus*
juvenile pollock	*Gadus chalcogrammus*
greenling unident.	Hexagrammidae
lingcod	*Ophiodon elongatus*
Atka mackerel	*Pleurogrammus monopterygius*
whitespotted greenling	*Hexagrammos stelleri*
kelp greenling	*Hexagrammos decagrammus*
smooth lumpsucker	*Aptocyclus ventricosus*
Pacific spiny lumpsucker	*Eumicrotremus orbis*
Snailfish	
snailfish unident.	Liparidae
marbled snailfish	*Liparis dennyi*
variegated snailfish	*Liparis gibbus*
blotched snailfish	*Crystallichthys cyclospilus*
monster snailfish (spectral)	*Careproctus phasma*
eulachon	*Thaleichthys pacificus*
capelin	*Mallotus villosus*
rainbow smelt	*Osmerus mordax*
chinook salmon	*Oncorhynchus tshawytscha*
pink salmon	*Ochorhynchus gorbuscha*
chum salmon	*Oncorhynchus keta*
dwarf wrymouth	*Cryptacanthodes aleutensis*
giant wrymouth	*Cryptacanthodes giganteus*
Pricklebacks	
daubed shanny	*Lumpenus maculatus*
slender eelblenny	*Lumpenus fabricii*
snake prickleback	*Lumpenus sagitta*
Pricklebacks continued	
longsnout prickleback	*Lumpenella longirostris*
decorated warbonnet	*Chirolophis decoratus*
whitebarred prickleback	*Poroclunus rothrocki*
prowfish	*Zaprora silenus*
Eelpouts	
eelpout unident.	Zoarcidae
Alaska eelpout	*Bothrocara pusillum*
wattled eelpout	*Lycodes palearis*
shortfin eelpout	*Lycodes brevipes*
Rockfishes	
rockfish unident.	*Sebastes* sp.
shortspine thornyhead	*Sebastolobus alascanus*
rougheye rockfish	*Sebastes aleutianus*
blackspotted rockfish	*Sebastes melanostictus*
Pacific ocean perch	*Sebastes alutus*
silvergray rockfish	*Sebastes brevispinis*
dark rockfish	*Sebastes ciliatus*
dusky rockfish	*Sebastes variabilis*
darkblotched rockfish	*Sebastes crameri*
yellowtail rockfish	*Sebastes flavidus*
quillback rockfish	*Sebastes maliger*
black rockfish	*Sebastes melanops*
tiger rockfish	*Sebastes nigrocinctus*
northern rockfish	*Sebastes polyspinis*
yelloweye rockfish	*Sebastes ruberrimus*
redbanded rockfish	*Sebastes babcocki*
harlequin rockfish	*Sebastes variegatus*
sharpchin rockfish	*Sebastes zacentrus*
jellyfish unident.	Schyphozoa
gorgonian coral unident.	Gorgonacea
Kamchatka coral	*Paragorgia arborea*
orange sea pen	*Ptilosarcus gurneyi*
sea whip unident.	Virgulariidae

-continued-

Table 4.–Page 3 of 4.

Common name	Scientific name
sea anemone unident.	Actinaria
Worms	
polychaete worm unident.	Polychaeta
worm unident.	
tube worm unident.	
sea mouse unident.	Aphroditidae
scale worm unident.	*Eunoe* sp.
isopod unident.	Isopoda
barnacle unident.	Thoracica
Shrimp	
dock shrimp	*Pandalus danae*
pink shrimp (or northern shrimp)	*Pandalus eous*
yellowleg pandalid	*Pandalus tridens*
spot shrimp	*Pandalus platyceros*
humpy shrimp	*Pandalus goniurus*
coonstripe shrimp	*Pandalus hypsinotus*
sidestripe shrimp	*Pandalopsis dispar*
Eualus sp.	*Eualus* sp.
shortscale eualid	*Eualus suckleyi*
candy stripe shrimp	*Lebbeus grandimana*
spiny lebbeid	*Lebbeus groenlandicus*
Crangon sp.	*Crangon* sp.
Arctic argid	*Argis dentata*
Pacific glass shrimp	*Pasiphaea pacifica*
Crabs	
Dungeness crab	*Metacarcinus magister*
pygmy cancer crab	*Cancer oregonensis*
pea crab	*Pinnixa occidentalis*
graceful decorator crab	*Oregonia gracilis*
Tanner crab	*Chionoecetes bairdi*
Pacific lyre crab	*Hyas lyratus*
helmet crab	*Telmessus cheiragonus*
hermit crab unident.	Paguridae
box crab	*Lopholithodes foraminatus*

Common name	Scientific name
Crabs continued	
golden king crab	*Lithodes aequispinus*
rhinocerous crab	*Rhinolithodes wosnessenskii*
red king crab	*Paralithodes camtschaticus*
scaled crab	*Placetron wosnessenskii*
hair crab	*Erimacrus isenbeckii*
hyas unident.	*Hyas* sp.
kelp crab unident.	*Pugettia* sp.
Chitons	
chiton unident.	Polyplacophora
giant Pacific chiton	*Cryptochiton stelleri*
Snails	
snail eggs	gastropod eggs
nudibranch unident.	Nudibranchia
moonsnail	*Cryptonatica* sp.
Colus sp.	*Colus* sp.
left-hand whelk	*Pyrulofusus harpa*
shouldered whelk	*Volutopsius stefanssoni*
Kennicott's beringius	*Beringius kennicottii*
thick-cord whelk	*Beringius crebricostatus*
Beringius undatus	*Beringius undatus*
Neptunea sp.	*Neptunea* sp.
Pribilof neptune (or Prib. whelk)	*Neptunea pribiloffensis*
ribbed neptune	*Neptunea lyrata*
keeled aforia	*Aforia circinata*
hairy triton (or Oregon triton)	*Fusitriton oregonensis*
Buccinum sp.	*Buccinum* sp.
sinuous whelk	*Buccinum plectrum*
silky buccinum (or ladder whelk)	*Buccinum scalariforme*
Alaska volute	*Arctomelon stearnsii*
Bivalves	
bivalve unident.	Bivalvia
mussel unident.	Mytilidae
Chlamys sp.	*Chlamys* sp.

-continued-

Table 4.–Page 4 of 4.

Common name	Scientific name
Bivalves continued	
weathervane scallop	*Patinopecten caurinus*
cockle unident.	
smoothcockle (was Greenland)	*Serripes* sp.
Alaska falsejingle	*Pododesmus macrochisma*
Cephalopods	
giant octopus	*Octopus dofleini*
eastern Pacific bobtail	*Rossia pacifica*
magistrate armhook squid	*Berryteuthis magister*
juvenile armhook squid	*Berryteuthis magister*
Sea Stars	
mottled sea star	*Evasterias troschelii*
giant sea star	*Evasterias echinosoma*
redbanded sea star	*Orthasterias koehleri*
sunflower sea star	*Pycnopodia helianthoides*
long-rayed star	*Stylasterias forreri*
blackspined sea star	*Lethasterias nanimensis*
Henricia sp.	*Henricia* sp.
Leptasterias sp.	*Leptasterias* sp.
Swift's sea star	*Gephyreaster swifti*
pseudarchaster parelii	*Pseudarchaster parelii*
pseudarchaster alascensis	*Pseudarchaster alascensis*
CA spiny star	*Hippasteria californica*
spiny red sea star	*Hippasteria spinosa*
vermilion sea star	*Mediaster aequalis*
red bat (cookie)star	*Ceramaster japonicus*
orange bat (cookie) star	*Ceramaster patagonicus*
CA spiny star	*Hippasteria californica*
spiny red sea star	*Hippasteria spinosa*
vermilion sea star	*Mediaster aequalis*
red bat (cookie)star	*Ceramaster japonicus*
orange bat (cookie) star	*Ceramaster patagonicus*
arctic bat (cookie) star	*Ceramaster arcticus*
Sand star	*Luidia foliolata*
leather sea star	*Dermasterias imbricata*

Common name	Scientific name
Sea Stars continued	
Solaster sp.	*Solaster* sp.
striped sun sea star	*Solaster stimpsoni*
rose sea star	*Crossaster papposus*
tesselated slime star	*Pteraster tesselatus*
pincushion sea star	*Diplopteraster multipes*
purple-orange sea star	*Asterias amurensis*
common mud star (or Ninja star)	*Ctenodiscus crispatus*
Northern sand star	*Dipsacaster borealis*
Fragile star	*Cheiraster dawsoni*
Sea Urchins	
green sea urchin	*Strongylocentrotus droebachiensis*
red sea urchin	*Strongylocentrotus franciscanus*
orange-pink (fragile) sea urchin	*Allocentrotus fragilis*
heart urchin	*Brysaster latifrons*
sand dollar unident.	Clypeasteroida
brittle star unident.	Ophiuridae
basket star	*Gorgonocephalus eucnemis*
Sea Cucumbers	
red (CA) sea cucumber	*Parastichopus californicus*
sweet sea potato	*Molpadia intermedia*
crescent sea cucumber	*Pentamera* sp.
Bathyplotes sp.	*Bathyplotes* sp.
sea football	*Cucumaria fallax*
sponge unident.	Porifera
flatworm unident.	Platyhelminthes
peanutworm unident.	Echiura
bryozoan unident.	Bryozoa
lampshell unident.	Brachiopoda
Tunicates	
tunicate unident.	Ascidiacea
sea potato	*Styela rustica*
bristly tunicate	*Halocynthia (hilgendorfi) igaboja*
sea peach	*Halocynthia aurantium*
sea blob	*Synoicum* sp.

Table 5.–Species collection list of rarely encountered organisms on large-mesh trawl survey.

Common name[a]	Species
Salmon shark	*Lamna ditropis*
Darkblotched rockfish	*Sebastes crameri*
Wolf eel	*Anarchichthys ocellatus*
White-spotted greenling	*Hexagrammas stelleri*
Spectacled sculpin	*Triglops scepticus*
Pacific staghorn sculpin	*Leptocottus armatus*
Thorny sculpin	*Icelus spiniger*
Ribbed sculpin	*Triglops pingelii*
Northern ronquil	*Ronquilus jordani*
Sand sole	*Psettichthys melanostictus*
Barbed eualid	*Eualus barbatus*
Short-scaled eualid	*Eualus suckleyi*
Stefansson's melon snail/ shouldered whelk	*Volutopsius stefanssoni*
Keeled aforia	*Aforia circinata*
Vermillion sea star	*Mediaster aequalis*
Sand star	*Luidia foliolata*
Northern sand star	*Dipsacaster borealis*

Common name[b]	Species
Redstripe rockfish	*Sebaster proriger*
Bocaccio	*Sebastes paucispinis*
Brown Irish lord	*Hemilepidotus spinosus*
Longfin Irish lord	*Hemilepidotus zapus*
Butterfly sculpin	*Hemilepidotus papilio*
Fourhorn sculpin	*Myoxocephalus quadricornis*
Arctic sculpin	*Myoxocephalus scorpioides*
Warthead sculpin	*Myoxocephalus niger*
Frog sculpin	*Myoxocephalus stelleri*
Small-mouth ronquil	*Bathymaster leurolepis*
Polar eelpout	*Lycodes polaris*
Marbled eelpout	*Lycodes raridens*
Black eelpout	*Lycodes diapterus*
Ebony eelpout	*Lycodes concolor*
Twoline eelpout	*Bothrocara brunneum*
Pallid eelpout	*Lycodapus mandibularis*
Bering flounder	*Hippoglossoides robustus*
Giant rock scallop	*Crassadoma gigantes*
Spiny scallop	*Chlamys hastate*
Island scallop	*Chlamys islandica*
Flat-tip piddock	*Penitella penita*
Chimney piddock	*Penitella penita*
Setose hermit crab	*Pagurus setosus*
Bluespined hermit crab	*Pagurus kennerlyi*
Pribilof hermit crab	*Pagurus undosus*
Long-hand hermit crab	*Pagurus tanneri*
Horny-hand hermit crab	*Pagurus cornutus*
Northern sun star	*Solaster endeca*
Morning sun star	*Solaster dawsoni*
Evening sun star	*Solaster paxillatus*
Grooved sun star	*Crossaster borealis*
Greenland sea star	*Leptasterias groenlandica*
Sheathed sea star	*Leptasterias stolocantha*
Knobless 6-rayed star	*Leptasterias hexactic*
White sea urchin	*Strongylocentrotus pallidus*
Purple urchin	*Strongylocentrotus purpuratus*
Bubble jelly	*Aequorea sp.*
Lion's mane jelly	*Cyanea sp.*
Two-spined crangon	*Crangon communis*
Ridged crangon	*Crangon dalli*

[a] These organisms on the large-mesh species list are always identified.

[b] These organisms are not required to be identified to species, but if positive ID is made are photographed and collected.

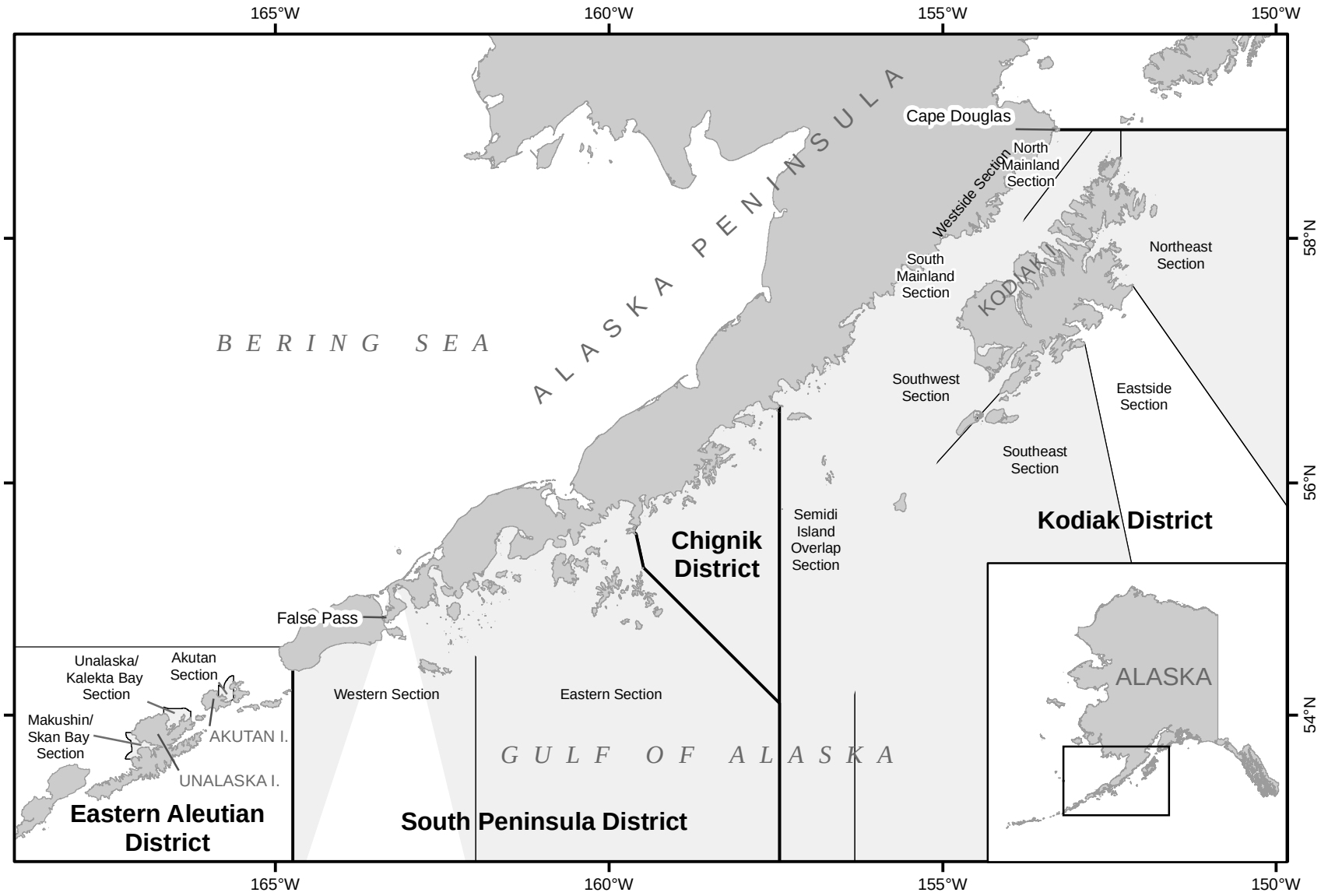


Figure 1.–Tanner crab management districts surveyed during the large-mesh trawl surveys.

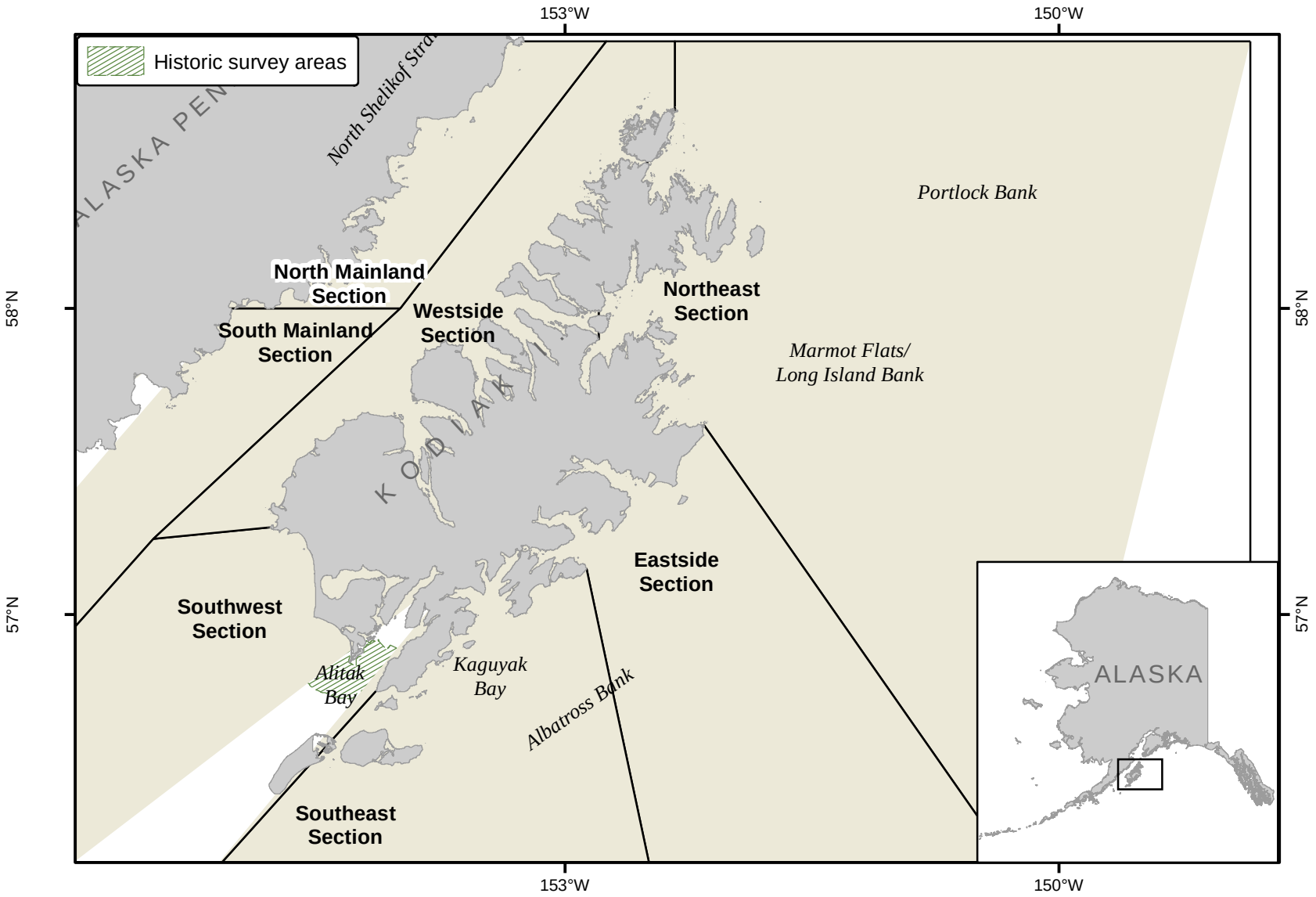


Figure 2.–Historic trawl survey areas (1963-1980) and current Tanner crab management sections in the Kodiak District.

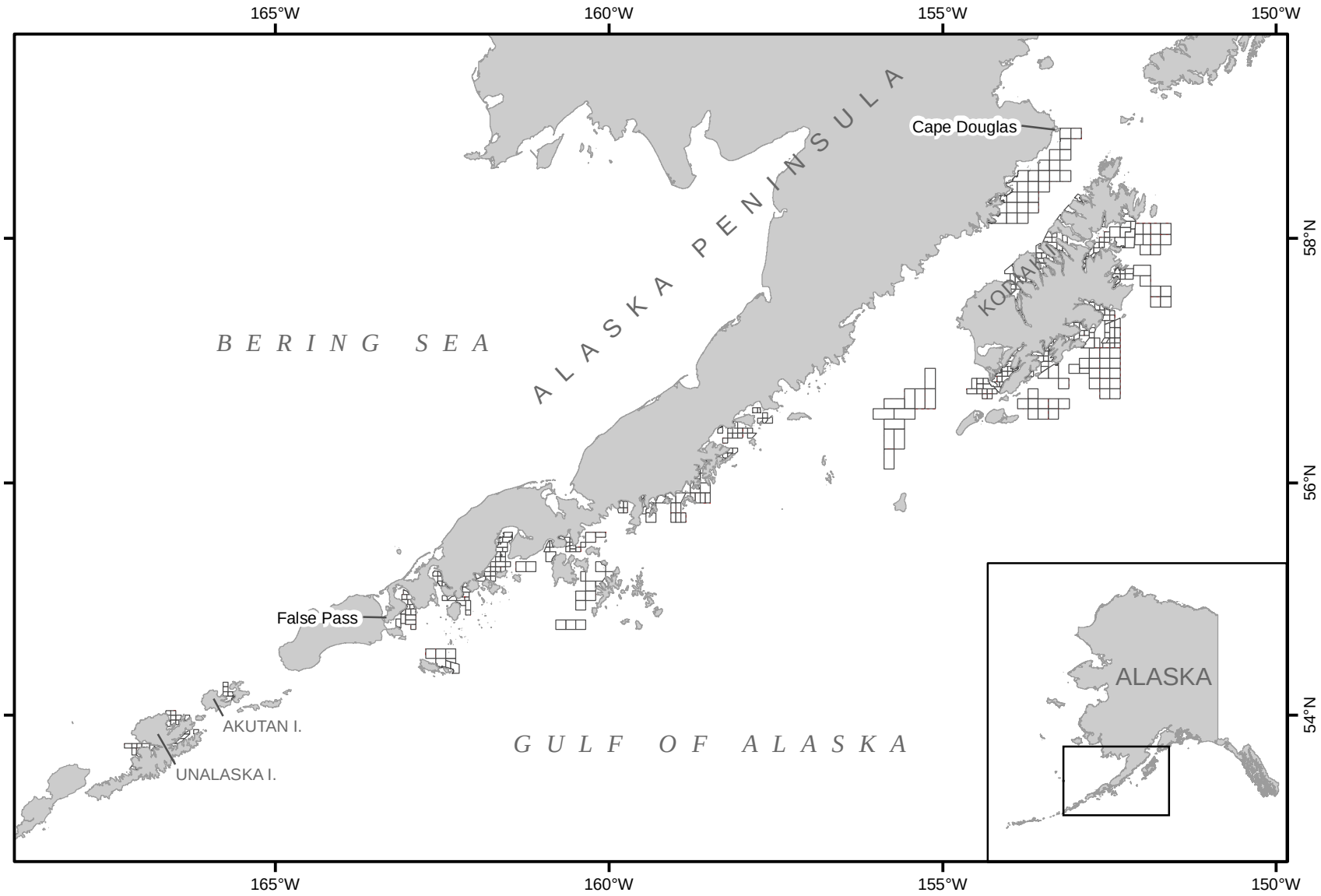


Figure 3.–Standard large-mesh trawl survey stations.

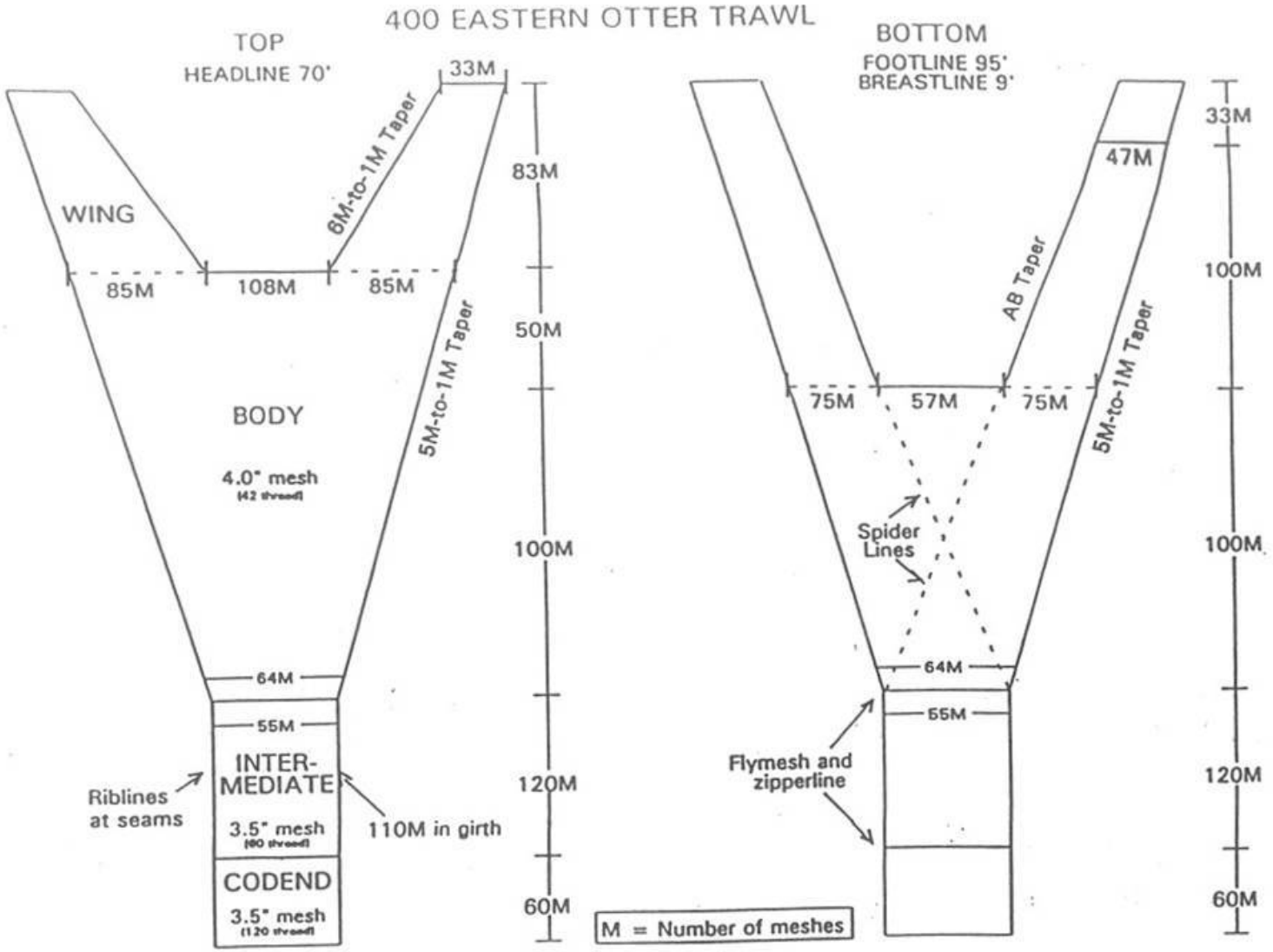


Figure 4.–Diagram of 400 eastern otter trawl used in large-mesh survey.

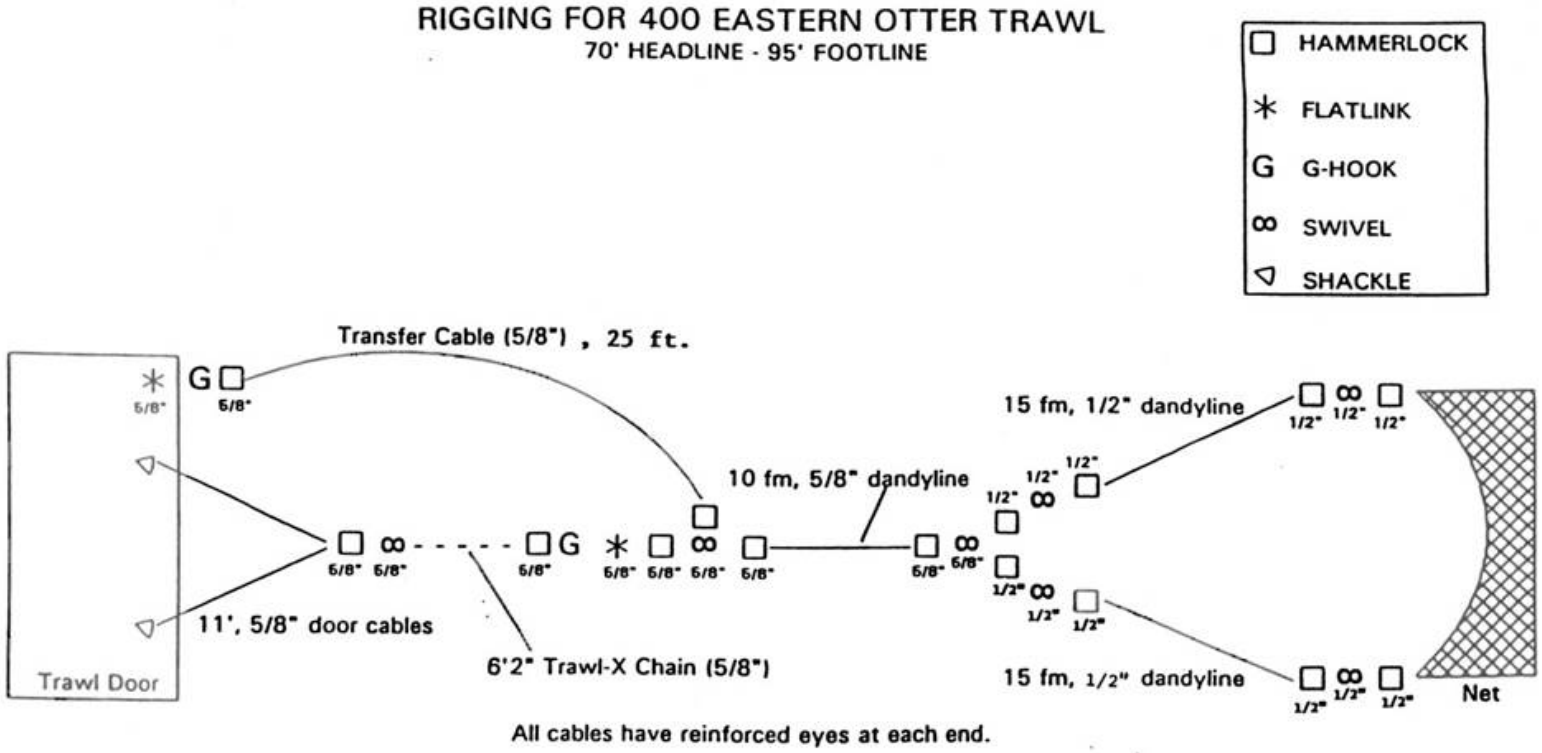


Figure 5.–Diagram of rigging for 400 eastern otter trawl used in large-mesh survey.

APPENDIX A. GLOSSARY

Appendix A1.–Definition of terms in large-mesh trawl survey operational plan.

Large-mesh trawl survey: Definitions of terms

Crab Terms	
abdominal flap	Crab abdomen folded underneath body. From posterior side can be lifted to reveal reproductive appendages. The shape of abdominal flap can be used to determine crab sex. Males have a triangular shaped abdominal flap. Female abdominal flaps are more rounded.
anterolateral spines	Spines on the margin of anterior half of carapace.
carapace	Main part of crab shell which covers body of crab. It is divided into the gastric, branchial, and cardiac regions.
carapace length	The biological size measurement of all species of king crabs taken as the straight-line distance from the posterior margin of the right eye orbit to the medial posterior carapace margin.
carapace width	Crab measurement taken as the greatest straight-line distance perpendicular to a line midway between the eyes to the medial-posterior margin. Biological measurements do not include spines.
chela height	Measurement of the right claw of the crab taken at the greatest height, excluding spines.
clutch	Eggs present beneath a mature female abdominal flap.
eyed eggs	Stage of egg development when dark eyespots are present and visible to the human eye.
juvenile	An animal that has not reached sexual maturity.
lateral margin	The outer edge of the crab shell or carapace.
legal size	The minimum size of an animal that may be retained by regulation. For Tanner crab males legal size is 5.5 inches (140 mm) carapace width including the lateral margin spines. For king crab males it is 7.0 inches (177.8 mm) carapace width in the Kodiak Area and 6.5 inches (165.1 mm) carapace width in the Alaska Peninsula and Aleutian Island areas, including the lateral margin spines. For Dungness crab the minimum legal size is 6.5 inches (165.1 mm) carapace width, immediately anterior to the tenth anterolateral spine.
mature female	A female animal that has reached sexual maturity. For Tanner crab mature females have a circular abdominal flap that covers most of the ventral surface of the crab while juvenile females have an abdominal flap that covers only about ⅔ of the ventral surface.
mature male	A male animal that has reached sexual maturity. For Tanner crab mature males are considered to be all males that are >114 mm carapace width.
medial posterior edge	The middle of the back edge of the carapace.
midline	The median plane of the body of an animal. For crabs this is an imaginary line running along the carapace from between the eyes to the medial posterior edge.
pleopods	Reproductive appendages of female crab to which eggs attach. Under the abdominal flap.
shell condition	A description of the appearance of a crab's exoskeleton, and is determined by examining characteristics that show wear with time.
spines	Pointed processes along the edge of a crab carapace.

-continued-

Trawl Net Terms	
codend	The trailing end of a tapered trawl net where catch accumulates during towing.
dandylines	Also called bridles. Cables between trawl door and side of trawl net.
doors	Steel boards that are attached between the vessel and the trawl net, positioned in such a way that while being towed hydrodynamic forces push them outward and spread the opening of the net.
footrope	The line running along lower mouth of net. Net used during large-mesh trawl survey has footrope weighted with chain to keep it on bottom.
headrope	The line running along upper mouth of net with floats attached to keep the net open.
mesh	An open fabric of line or cord, the intersections of which are looped or knotted into various sized spaces and sewn together to form a net.
net performance	A rating on how the net was fishing during a haul.
sweep	The width net covers when towed over the seafloor.
trawl wires	Cables that attach trawl doors and net to winches on vessel.
wing	The portion of the trawl net forward of the main body of the net.
Sampling Terms	
catch	Quantity of animals caught in trawl net. Measured in numbers or weight of animals.
catch weight database	The onboard database used to enter weights of all species identified during the haul. All information is entered upon completion of catch sampling. Data from the shellfish and fish measurement databases are automatically incorporated.
cruise leader	Biologist in charge of coordinating biological sampling activities during the survey and responsible for the quality of collected data while on the vessel.
debris	Contents of the trawl net that are not alive or an animal, including rocks, empty shells, seaweed, or human made objects.
fish measurement database	The onboard database used to collect fish measurements. Measurements can be entered directly from the magnetic fish measuring board, or entered into the database manually using a networked input program from a network connected device.
haul	From the time the trawl net reaches the bottom and is towed in an attempt to fish to the time the vessel stops moving and begins retrieving the net.
haul database	The onboard database to store information associated with the fishing process for each haul. Data from skipper trawl record forms are manually entered at the end of each day
length to weight regressions	Equations allowing for calculation of expected weight of a given fish species using measured fish length.
onboard databases	Databases in use during the trawl survey include: fish measurement database, shellfish measurement database, catch weight database, and haul database.
on-deck sorting bin	An area located on the back deck of the survey vessel contained by removable boards where the catch from the codend is emptied after every haul, prior to sorting and removal of the subsample.

-continued-

shell hash	Dominated by loose shell accumulations, broken or whole shells, often mixed with small living invertebrates that must be accounted for in the catch.
shellfish measurement database	Onboard database used to collect crab measurements and biological information. Measurements and crab information can be entered directly using electronic calipers and the crab keyboard, or by using a standard keyboard.
sorting table	Table located on the forward part of deck where the subsample is sorted for species composition, weighing, and measuring.
species composition sampling	The sorting, identification, and weighing of organisms in the catch to determine the proportion and total weight of each species in the catch.
species list	Master list of all species that should be identified during the large-mesh trawl survey, including which species are acceptable to group. This list is based on historical survey records.
station	Survey area sampling units. Each station is towed once during the annual survey.
subsample	A representative and random subset of the total sample.
subsampling net	The net used to obtain the subsample. This net is tied into the on-deck sorting bin and the catch is emptied into the bin. The subsampling net is then untied and lifted through the catch to capture a representative subsample that is sorted at the sorting table.
sub-subsample	A subset of the subsample that may be taken in instances where the contents of the subsample still contain too many individual organisms to sort and identify within a reasonable time frame. Data from the sub-subsample is expanded to the subsample, and later to the entire catch. This is a less desirable sampling technique than whole-haul sampling or subsampling.
tare	A setting that is pre-determined and recorded in the platform scale to account for the weight of empty baskets and totes used during the survey so they are not included as part of the animal weight.
whole-haul	When 100% of the trawl catch of a specific species is accounted for by weight, count, or measurement, or a combination. In instances when there is a small total catch, when 100% of the total trawl catch is sorted and weighed.
whole-hauled debris	Large debris items captured in the codend that are weighed separately from debris in the subsample are 100% sampled.
Management Terms	
abundance threshold	Level of mature male Tanner crab abundance described in regulation that must be met in order to consider opening a commercial fishery.
GHL	Guideline Harvest Level. Catch quota established prior to the beginning of each fishing season. GHLs for Tanner crab are based on large-mesh trawl survey data.
legal males	The minimum size crab that may be retained by regulation. Only male crab are considered legal to retain.
long-term average abundance	The average abundance of mature male Tanner crab from 1967-1998 as determined using a combination of trawl survey data, commercial catch history, and pot survey catches, and used to establish regulatory abundance thresholds.

-continued-

management district	Regulatory unit to facilitate resource management.
management section	Management districts are divided into sections to facilitate management of the Tanner crab fisheries and are based on local distributions and migration patterns. Each section has a separate GHL.
molting mature male abundance	Estimated abundance of 100% newshell and 15% oldshell male Tanner crab that are >114 mm carapace width.
Other Biological Terms	
anterior	Toward the front, near the head, or rostral end of a crab.
caudal fin	The tail of a fish.
claspers	A paired organ of male sharks and skates used to assist the transfer of spermatozoa into the body of a female during copulation.
dorsal	The back or part of an organism away from the ground. Refers to the hinge area of a scallop shell.
inclement weather	Severe, rough, harsh, or stormy.
otolith	Bony structures located behind the brain of fishes (often called ear bones) that regulate balance, orientation, and sound detection. As the fish grows the otoliths form ring-like layers that can be used to determine age.
pectoral fin	Either of a pair of fins situated behind the head, one on each side of the body.
posterior	The rear, away from the head.
shell height	The straight-line distance from the umbo the the outer scallop shell margin, perpendicular to the hinge. Scallop shell heights are measured on the left (top) valve.
Umbo	Beak-like projections at the dorsal part of a shell; it is the oldest part of a bivalve shell.
Valve	One of the 2 parts of a bivalve shell, 2 valves make up one shell.
Data Analysis Terms	
area swept	The sea floor area covered by the trawl during a haul.
catchability	The relationship between the proportion of a population available to the survey gear and the proportion of the population in the trawl path retained by the survey net.
density	The number or weight of a species present per unit of area.
distance towed/haul length	Distance the vessel travels between the time the trawl net footrope contacts bottom and the time the center of footrope leaves bottom.
escapement	The act of an organism in the trawl path evading capture by the trawl net.
relative abundance indices	Indices that track changes in population size, but do not estimate the actual population size.
size selectivity	The consequence of fishing gear capturing organisms of different sizes at different rates.
true abundance	The actual number of animals present in the area of interest.

APPENDIX B. FORMS

Appendix B1.–Skipper Trawl Record Form.

ALASKA DEPARTMENT OF FISH AND GAME
2015 TRAWL SURVEY
SKIPPER TRAWL RECORD

Skipper's Name

Survey Area

Cruise Number	Haul Number	Region	Survey Area	Stratum	Station Number	Vessel Code	Date month	Date day	Date year
1501						30			15

(1) Starting Position		Compass Heading (magnetic)	Trawl Time Start	Trawl Time End	Dist-Towed
Latitude	Longitude				
5	1		:	:	
degrees / mins / decimal mins.	degrees / mins / decimal mins.				(nm)

(2) Haul Back Position		Elapsed
5	1	
Position X	Position Y	(minutes)

Depth (fathoms) Maximum	Minimum	Avg.	Weather Cloud	Wind	Swell	Scope (fathoms)	Gear Perf.	Bottom Temp. (°C)

Skipper's Comments (gear problems, snags, weather, tides, etc.):

Cloud Cover	Code
Clear	1
1/8 obscured	2
1/4 obscured	3
3/8 obscured	4
1/2 obscured	5
5/8 obscured	6
3/4 obscured	7
7/8 obscured	8
Completely overcast	9

Wind Speed (Beaufort Scale)	Code
Calm; sea surface smooth and mirror like	0
Light air; scaly ripples, no foam crests	1
Light breeze; small wavelets, crests glassy, not breaking	2
Gentle breeze; large wavelets, crests begin to break, scattered whitecaps	3
Moderate breeze; waves 1-4 ft becoming longer, numerous whitecaps	4
Fresh breeze; waves 4-8 ft, longer form, many whitecaps, some spray	5
Strong breeze; waves 8-13 ft, whitecaps common, more spray	6
Near gale; sea heaps up, waves 13-20 ft, foam streaks off breakers	7
Gale; waves 13-20 ft, greater length, crest edges break, foam streaks	8
Strong gale; waves 20 ft, sea rolls, dense foam streaks, spray	9

Swell (feet)	Code
0 - 2	1
2 - 4	2
4 - 6	3
6 - 8	4
8 - 10	5
10 - 12	6
12 - 14	7
14 - 16	8
Over 16	9

Gear Performance	Code
Good performance	0
Satisfactory ; unspecified minor problems	1
Satisfactory ; minor hangup or rip	2
Satisfactory ; net off bottom for short part of tow	3
Satisfactory ; caught crab pot	4
Unsatisfactory ; unspecified problem	5
Unsatisfactory ; net hung up	6
Unsatisfactory ; ripped net	7
Unsatisfactory ; net off bottom for part/all of tow	8
Unsatisfactory ; caught crab pot	9
Unsatisfactory ; unable to reach bottom due to currents	10
Unsatisfactory ; net not properly configured	11
Unsatisfactory ; crossed doors	12
Unsatisfactory ; net mudded down	13

Initials: _____

-continued-

Skipper Trawl Record Instructions

This form records each haul: area, date, position, time trawled, depth, length of tow, gear performance, and weather conditions.

Cruise Number	Last 2 digits of year followed by sequential cruise number. The large-mesh survey is the first trawl survey of the season, so in 2016 the cruise number is "1601"
Haul Number	Beginning with 1, each haul is numbered sequentially through each cruise regardless of gear performance.
Region	not used
Survey area	not used
Stratum	not used
Station Number	Consult charts provided by cruise leader or special projects operational plan for station name.
Vessel Code	Code for vessel conducting survey. Prefilled with "30"=Resolution.
Date	Month/day/year
Starting Position	
Latitude, Longitude	degrees/minutes/decimal minutes where trawl net reaches bottom
Compass Heading	Direction of tow according to magnetic compass
Trawl time	
Start	Time trawl net reaches bottom, use 24 hour clock
End	Time trawl net retrieval begins, use 24 hour clock
Dist- Towed	Length of the haul in nautical miles, determined by skipper
Haul Back Position	
Latitude, Longitude	degrees/minutes/decimal minutes where trawl net retrieval begins
Elapsed	Amount of time in minutes net was fishing
Depth	
Maximum	Maximum depth of haul in fathoms
Minimum Depth	Minimum depth of haul in fathoms
Avg. Depth	Average depth of haul in fathoms, determined by skipper
Weather	
Cloud,Wind,Swell	Use criteria on data sheet
Scope	Fathoms of trawl wire deployed
Gear Perf.	Use Gear Performance codes on skipper trawl record form. Written explanation should accompany problem tows.
Bottom Temp.	Recorded in database upon download of temperature logger attached to net. Not entered while vessel is at sea.
Initials	Initials of person entering data into the haul database.

Appendix B2.–On-deck Sampling Form – Species Composition.

ON DECK SAMPLING FORM - SPECIES COMPOSITION

Haul _____ Vessel Resolution Cruise _____
Date _____ Location _____
Recorder's Name _____

Total Wt.
Bag (tare) Wt.
Whole-hauled debris weight

Species Name	100% ✓	Measured Weights	Unmeasured Weights (DUMPERS)	Count of unmeasured: weighed	unweighed
Halibut					
♂ ♀					
♂ ♀					
♂ ♀					
Arrowtooth					
Flathead					
Pollock	Y or N				

Species/Sex count: _____ 100% count: _____ *Halibut and Skate entries are lengths!!

Page____of____. Initial here after data has been entered: ◯

-continued-

On-deck Sampling Form - Species Composition Instructions

Header Information:

Haul	Sequential number for current haul
Date	Date of current haul
Recorder's Name	Last name of person recording data on the form
Vessel	Name of vessel conducting survey – prefilled with "Resolution"
Location	Nearest bay, headland, or gully
Cruise	Last 2 digits of the year followed by sequential cruise number. The large-mesh survey is the first trawl survey of the season, so in 2016 the cruise is "1601".
Total Wt.	Weight of catch and codend before it is emptied into sorting bin.
Bag (tare) Wt.	Weight of empty codend after catch is emptied. This weight differs depending on where on the net the crane lifts from.
Whole-hauled debris weight	Weight of large debris items such as crab pots, buckets, rocks, logs, etc. that are in the codend.

Data fields:

Species Name	List species name, common or scientific, for each species in the haul. List males and females separately if sexed. Some of the most common species are prefilled.
100%	Check this column for all species/sexes that are whole-haul sampled. Circle "Y" or "N" for the prefilled "Pollock" row. If Tanner crab are subsampled specify "No" in this column.
Measured Weights	Enter weights of all baskets/totes of measured animals. Halibut and skates do not get weighed, instead record all lengths on this form.
Unmeasured Weights (DUMPERS)	Enter weights of all baskets/totes of animals that are not measured.
Count of unmeasured: weighed	Enter number of individuals that have been weighed, but not measured. All animals, if possible, are to be enumerated if not measured.
Count of unmeasured: unweighed	Enter number of individuals not weighed or measured. This only applies to species such as pollock or Pacific cod that are counted over the vessel from the sorting bins.

Footer Information: This information can be completed during data entry and helps verify that all species recorded on the form are entered into the database.

Species/Sex count	Enter total number of species and sexes recorded during the haul.
100% count	Enter total number of species and sexes whole-haul sampled during the haul.

Initial the circle in the bottom right corner of the form after data has been entered into the catch database.

Appendix B3.–Specimen Collection Form.

Specimen collection form *R/V Resolution*
Species (suspected):
Date:
Haul Number:
General Location:
Collector:
Photo Taken? **yes** **no** file name and location:
Reason for collection: ■ Confirm ID ■ Special Project ■ Guide Inclusion other (specify) _____

Specimen collection form instructions

This form is completed and included in the sample bag of each specimen collected during the trawl survey.

Species (suspected)	Species name or common name if known of animal collected. If the identification is in question, record the name of the possible identification based on preliminary examination.
Date	Date animal was captured
Haul Number	Sequential number for the haul animal was captured
General Location	Nearest bay, headland, or gully
Collector	Name of the person directing collection of the animal
Photo Taken? *Yes/No*	Circle whether a picture was taken
File name and location	Where on the survey computer the picture file is saved.
Reason for collection	Check the box with the reason the sample was collected. If a "Special Project" or "other", specify the project or reason on the bottom line.

ADF&G TRAWL SURVEY CRAB DATA FORM

SPECIES ☐ _____ STATION NUMBER _____

VESSEL TRAWL HAUL NUMBER _____

DATE ☐ ☐☐-☐☐-☐☐ SURVEY NUMBER _____ Page _____ of _____

	SEX CODE	LEGAL CODE	FEM MATURITY	CARAPACE SIZE (0.01 MM)	SHELL	DISEASE	CLUTCH FULL-NESS	CLUTCH CONDITION	CLUTCH EGG DEVEL	BITTER CRAB SAMPLE BCS SLIDE NO. SAMPLER INITIALS	BITTER CRAB SAMPLE PCR WELL NO. SAMPLER INITIALS	PCR TRAY NO	COMMENTS	LAB USE BCS SLIDE RESULT READER INITIALS
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														

SPECIES
2. P. CAMTSCHATICUS
6. C. BAIRDI
9. C. MAGISTER

SEX CODE
1. Male
2. Female

LEGAL CODE
0. Sublegal Male
2. Legal Male (returned to water after sampling)

FEMALE MATURITY
1. Juvenile Female
2. Adult Female

SHELL CONDITION
1. Soft/New Pliable
2. New
3. Old
4. Very Old/Very Very Old

DISEASE CODE
1. Parasitic barnacle
2. Nemertean worms
3. Bitter crab
5. Black Mat

EGG DEVELOPMENT
1. Uneyed eggs
2. Eyed eggs
3. Hatching-eyed eggs and empty egg cases

CLUTCH FULLNESS
0. empty
1. trace to 1/8
2. 1/8 to 1/4
3. 1/4 to 1/2
4. 1/2 to 3/4
5. 3/4 to full

CLUTCH CONDITION
1. Dead Eggs Not Apparent
2. Dead Eggs < 20%
3. Dead Eggs > 20%
4. Barren with Clean/Silky Setae
5. Barren with "Matted" setae empty Egg Cases
6. Barren with no visible setae

◯ Check here when crab data has been entered into crab database

-continued-

ADF&G Trawl Survey Crab Data Form Instructions

Species	Code (at bottom of form) followed by common name or scientific name of crab (one species per form)
Vessel	Name of vessel conducting survey
Date	Month, day, year when information is collected and recorded
Station Number	Number or name assigned to specific location of trawl
Trawl Haul Number	Sequential number for current haul (one haul per form)
Sex Code	Code (at bottom of form) for sex of crab sampled
Legal Code	Code (at bottom of form) applies to male crab only, and represents legal status of crab sampled
Fem Maturity	Code (at bottom of form) applies to female crab only, and represents maturity status of crab sampled
Carapace size	Indicate to nearest 0.01 millimeter. For Tanner and Dungeness crabs measurement is carapace width, for king crab it is carapace length.
Shell	Code (at bottom of form) describes the condition of crab shell, including wear, discoloration, epibionts, etc.
Disease	Codes (at bottom of form) describe the most common parasites/diseases encountered during the survey. Multiple parasites/diseases may be present. Parasites or diseases not listed should be noted in the comments column.
Clutch	
Fullness	Code (at bottom of form) describes the relative amount of eggs in the abdomen of an adult female crab
Condition	Code (at bottom of form) describes the physical condition of eggs in abdomen, or setae if eggs are not present.
Egg Devel	Code (at bottom of form) describes visible signs of egg development in the abdomen if present.
Bitter Crab Sample	
BCS Slide No.	Sequential sample number of slide with blood smear of crab sampled. Include initials of person making blood smear at top.
PCR Well No.	Location of well in PCR tray with blood from crab sampled. Include initials of person injecting blood in wells at top.
PCR Tray No.	Sequential number of PCR tray containing well with blood from crab sampled.
Comments	Record comments related to crab sampled such as parasites, morbidity, lack of blood smear during bitter crab sampling, etc.
Lab Use	BCS Slide Result Results of bitter crab sample blood smear examination under microscope describing degree of parasitization. Include initials of person examining blood smear at top.

SPECIMEN FORM

PAGE ______ OF______

VESSEL [1 2 3] ____________________ CRUISE [5 6 7] HAUL [9 10 11]

STRATUM [13 14 15] SPECIES CODE [17 18 19 20 21] SPECIES NAME ____________________

FREQUENCY [36: 1] SUBSAMPLE TYPE [48] WEIGHT DETERMIN. [49] AGE STRUCTURE [50] AGE DETERMIN. [51]

MATURITY TABLE [59 60] YOUR NAME ____________________ DATE

23	25	28 29 30 31	37 38 39 40 41	45 46	53 54 55 56 57	62 63 64 65 66	68 69 70 71 72
SEX	MAT UR	LENGTH IN MM.	WEIGHT (GRAMS)	AGE	SPECIMEN NUMBER		

-continued-

Specimen Form Instructions

This form records length, sex and corresponding otolith number for walleye pollock otolith sampling.

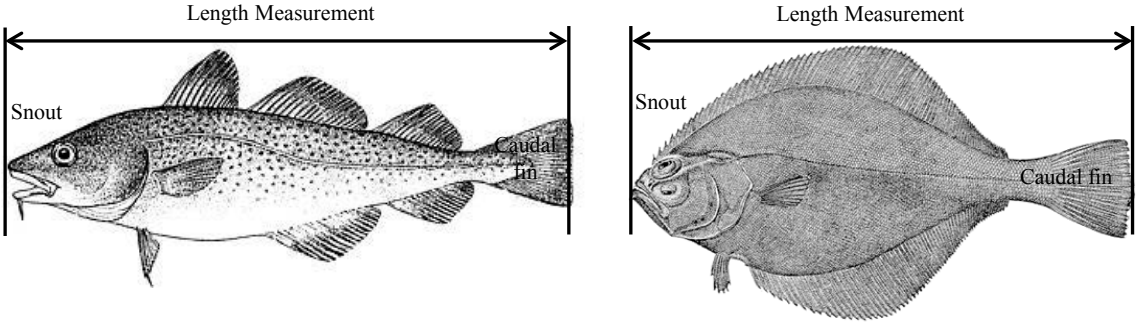
Vessel	Name of vessel conducting survey
Cruise	Last 2 digits of the year followed by sequential cruise number. The large-mesh survey is the first trawl survey of the season, so in 2016 the cruise is "1601"
Haul	Sequential number for current haul. If multiple hauls on one form leave blank
Stratum	Leave blank
Species Code	5 digit species code (walleye pollock=21740; AFSC 2014)
Species Name	Enter common name
Frequency	Leave blank
Subsample Type	Leave blank
Weight Determination	Leave blank
Age Structure	Leave blank
Age Determination	Leave blank
Maturity Table	Leave blank
Your Name	Last name of sampler
Date	Date of the haul when fish were captured. If multiple dates on one form leave blank.
Sex	Enter sex codes (1=male, 2=female)
Maturity	Leave blank
Length	Length from tip of snout to midpoint of caudal fin (cm, convert to mm)
Weight	Leave blank
Age	Leave blank
Specimen Number	Enter sequential number corresponding to label on the specimen vial
Blank 1	Use for haul number if multiple hauls per form
Blank 2	Use for date if multiple days per form

APPENDIX C. FISH SAMPLING

Appendix C1.–Biological measurements for finfish, sharks, skates, and scallops.

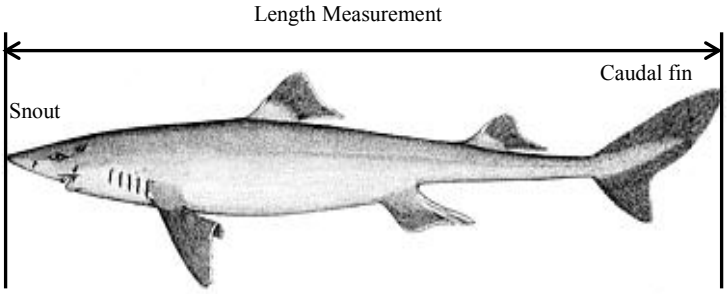
Finfish:

Snout to midpoint of caudal fin



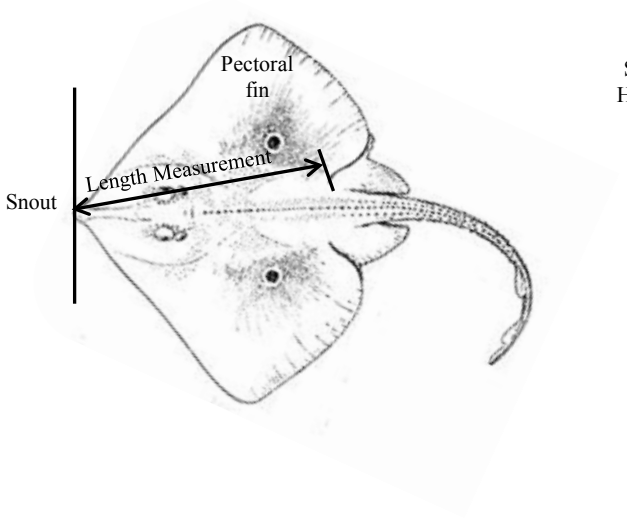
Sharks:

Snout to tip of caudal fin



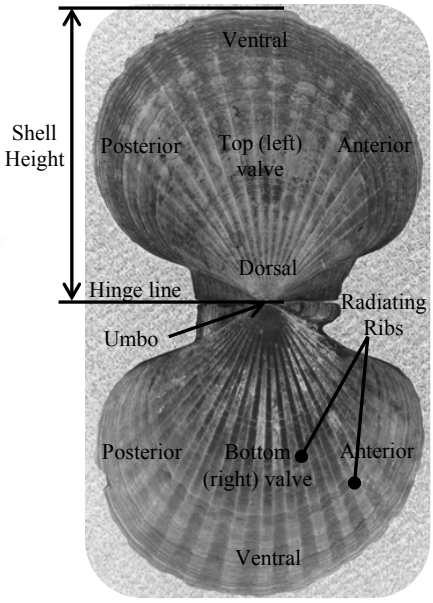
Skates:

Snout to anterior notch of pectoral fin

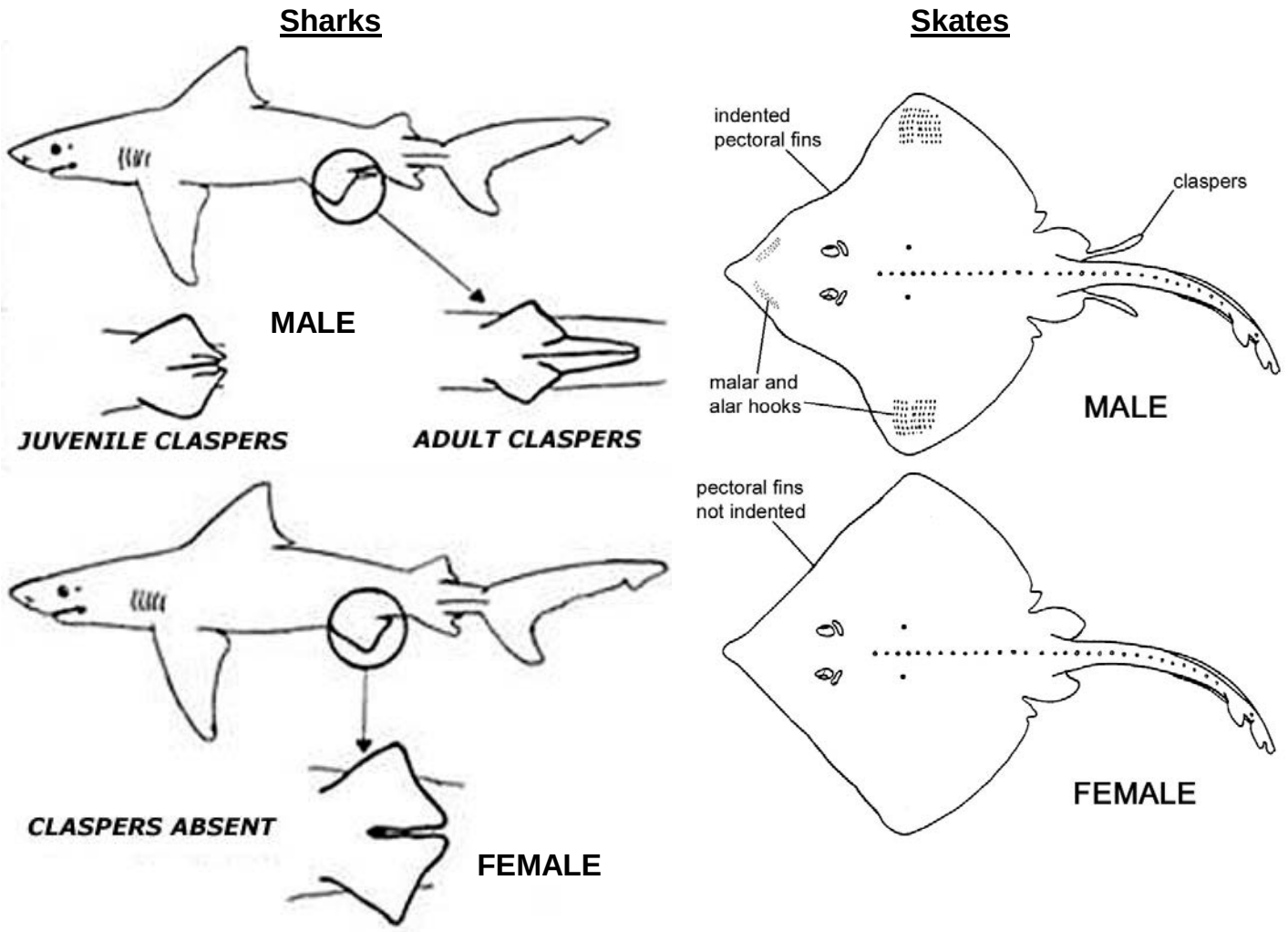


Weathervane Scallops:

Umbo to outer shell margin on top valve



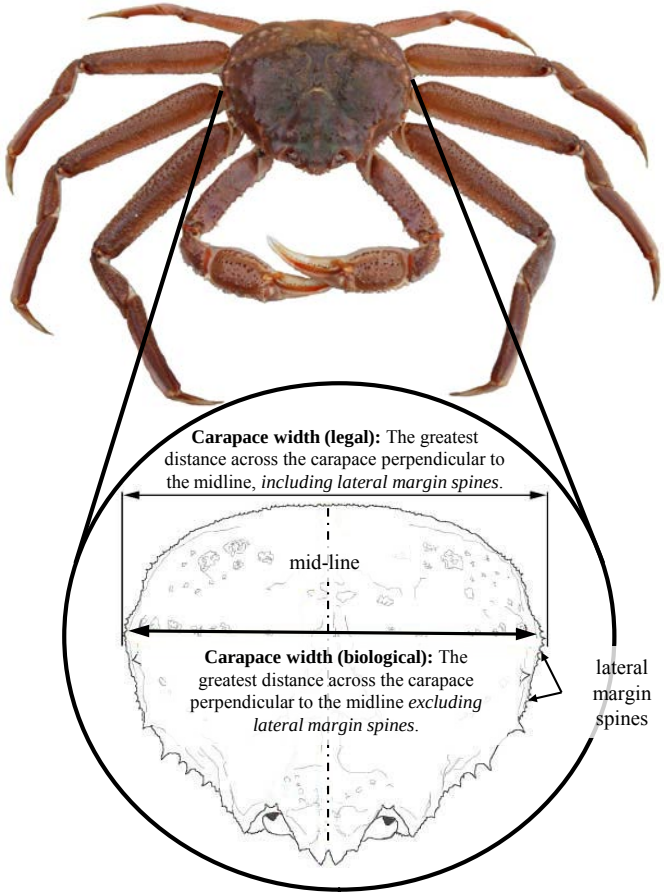
Appendix C2.–Sex determination for sharks and skates.



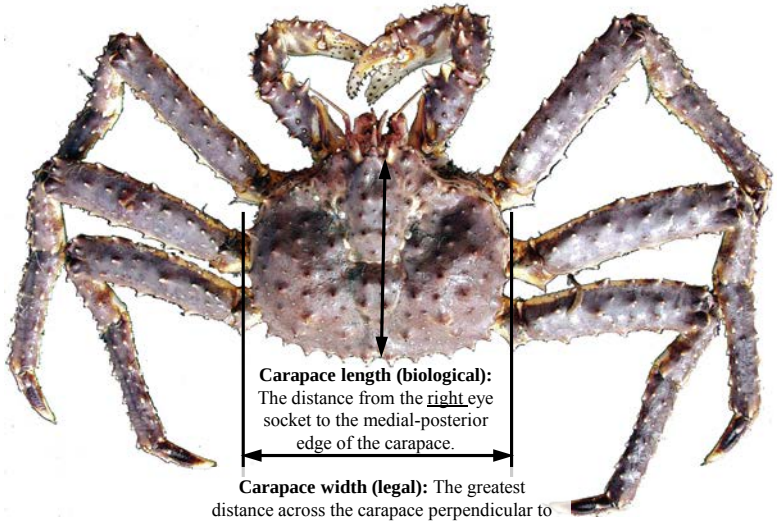
APPENDIX D. CRAB SAMPLING

Appendix D1.–Crab measurements.

Tanner Crab

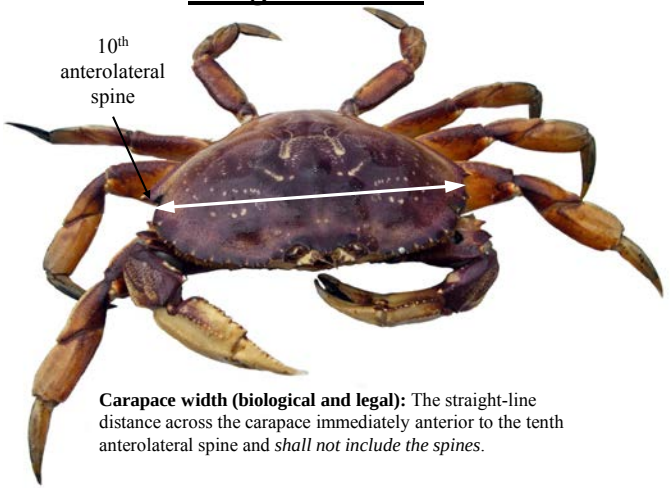


King Crab



Carapace width (legal): The greatest distance across the carapace perpendicular to the midline, *including lateral margin spines*.

Dungeness Crab

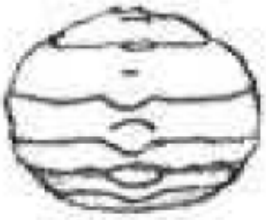


Carapace width (biological and legal): The straight-line distance across the carapace immediately anterior to the tenth anterolateral spine and *shall not include the spines*.

Appendix D2.–Sexual dimorphism of abdominal flaps of mature Tanner, king, and Dungeness crabs.

Tanner Crab

Male



Female

King Crab

Male

Female

Dungeness Crab

Male

Female

Appendix D3.–Shell condition determination.

Shell condition is a general description of the appearance of a crab's exoskeleton and is determined by examining characteristics that show wear with time. Shell rigidity, shell color, spine, chelae, and dactyl wear, the amount of scratching or abrasions, and epibiont growth are all indicators of shell condition. Both the dorsal and ventral sides of each crab should be examined and, using standard definitions, classified into a shell condition. A crab can exhibit characters from more than one shell condition, and it is the sampler's responsibility to determine which characters are more prevalent and classify the crab accordingly.

The ADF&G trawl survey program recognizes 4 shell condition categories. The following are descriptions developed for Tanner crab, but can be adapted to other crab species.

Soft/New Pliable	1) The exoskeleton is soft, flaccid, similar in texture to skin, and loses shape out of water. No scratches, abrasions, or epibionts are present. OR 2) 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 dactyl tips are sharp if not pliable. No scratches, abrasions, or epibionts are present.
New	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. Iridescence, particularly on the chelae, is often visible. Ventral surface can be any variation of white or pink. Spines, chela tips, chela teeth, and dactyl tips are sharp. Abdomen, coxae, and legs have little or no scratches and abrasions. Slight fouling may be present, including but not limited to: leech egg cases, small barnacles, and encrusting bryozoans. On Tanner crab females, subtle grasping mark imprints may be present on the first 2 pairs of legs.
Old	Colors are dull. Iridescence on the chelae may be visible. Ventral surface typically appears yellow to brown. Spines, chela tips, chela teeth, and dactyl tips may show wear. Abdomen, coxae, and legs have few to numerous scratches and abrasions, which may be slightly darker than the shell. Slight fouling may be present, including but not limited to: leech egg cases, barnacles, bryozoans, tubeworm casings, and anemones. On Tanner crab females, grasping marks are often present and discolored on the first 2 pairs of legs.
Very Old/Very Very Old	1) Colors are dull and often dark on the dorsal surface. Ventral surface typically appears yellow to brown with darker areas. Spines, chela tips, chela teeth, and dactyl tips are heavily worn. Legs are commonly damaged or missing. Abdomen, coxae, and legs have numerous scratches and abrasions, which are typically darker than the shell. Slight to moderate fouling is common, including but not limited to: leech egg cases, large barnacles, bryozoans, hydroids, tubeworm casings, and anemones. On Tanner crab females, multiple grasping marks are often present and discolored on the first 2 pairs of legs. OR 2) Carapace may be soft and spongy because of decay. Colors are dark overall. Spines, chela tips, chela teeth, and dactyl tips are heavily worn. Legs are commonly damaged or missing. Moderate to extensive fouling is common.

Appendix D4.–Crab diseases and parasites.

When present, the following diseases and parasites are noted in the crab measurement database.

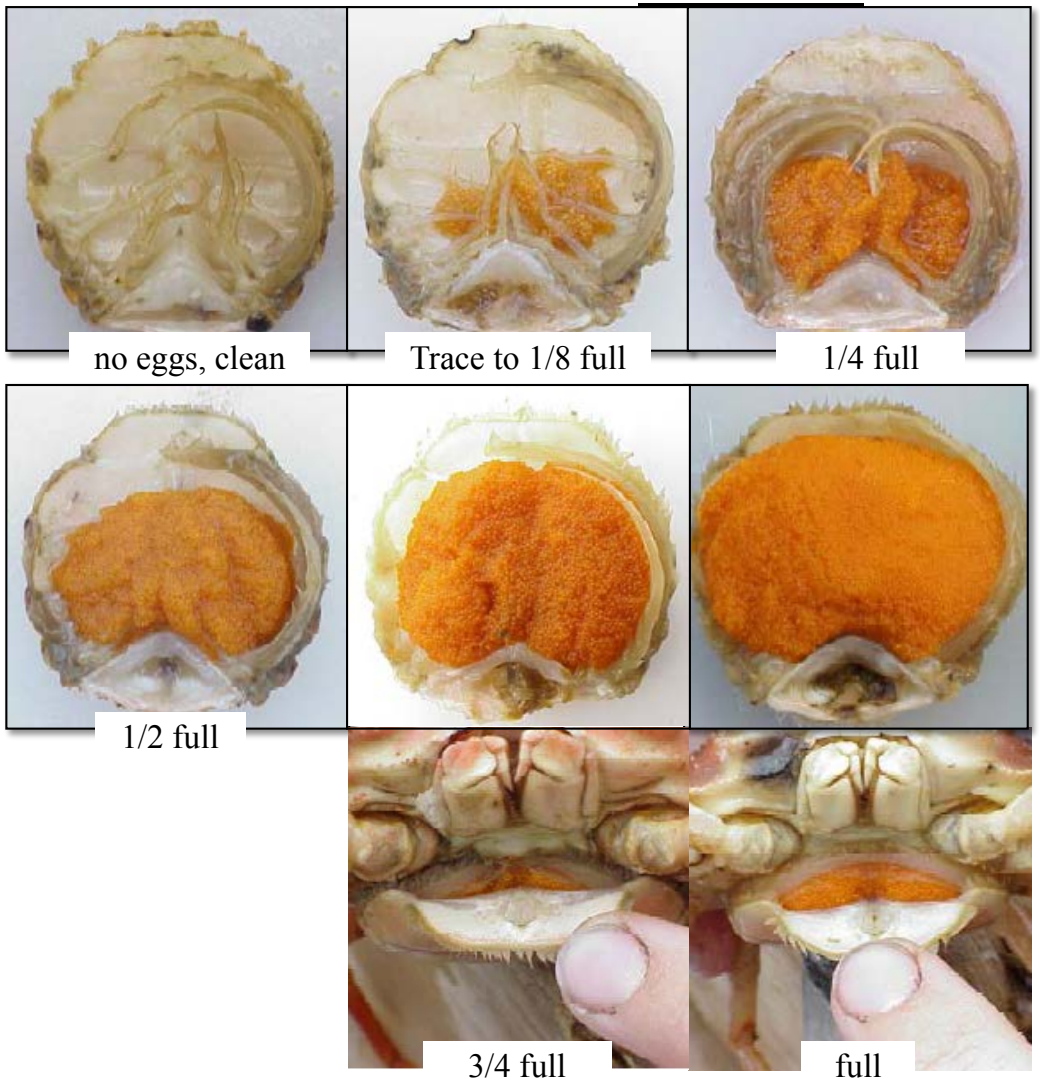
Bitter crab disease	A fatal disease of crustaceans caused by a parasitic dinoflagellate of the genus *Hematodinium* known to infect *Chionoecetes* spp. crabs. Live crabs in the later stages of infection have an exaggerated pink carapace or legs and white opaque hemolymph that can be observed if a leg is cracked. Crabs infected with this parasite are unmarketable because of an astringent aspirin aftertaste.
Black mat	A systemic fungal infection (*Trichomaris invadens*) that forms nondiscrete blotches of a black, tar-like mass on the carapace and legs. It has a fibrous like texture when scraped.
Nemertean worms	Egg parasites in clutches of adult female crabs that prey on developing embryos. Worms are small, red in color, and often 's' shaped during early stages of development and are most obvious in clutches with a high number of dead embryos.
Parasitic barnacle	The rhizocephalan barnacle *Briarosaccus callosus* exclusively parasitizes king crab species. The visible externa of the parasite is located in the abdominal flap of both sexes and varies in size from as small as a jellybean to as large as a chicken egg and in color from pale yellow to deep red. It causes castration in infected crabs and is uncommon around Kodiak and along the Alaska Peninsula.

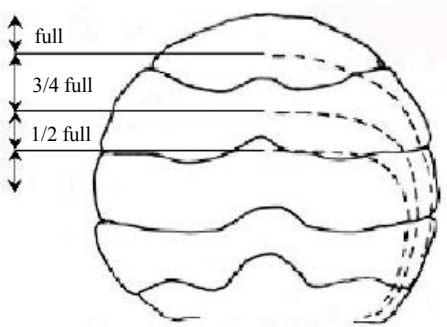
Other diseases and parasites that may be encountered are listed below.

Torch	Caused by a chitin-digesting bacterium that consumes the chitin in the shells of crab and results in dark exoskeletal lesions that pit the exoskeleton and a blackened necrotic region.
'Cottage cheese' disease	A microsporidian infection recognizable by white, large curd cottage cheese-like appearance of the viscera. Obvious when the carapace is removed but is also evident in the swollen abdomens of infected crab.
Pepper crab	Similar in appearance to black mat. Cause is unknown, but is visibly dispersed in discrete black grains across the carapace and legs, as opposed to the nondiscrete blotches of black mat.

Appendix D5.–Clutch fullness for female Tanner, king, and Dungeness crabs.

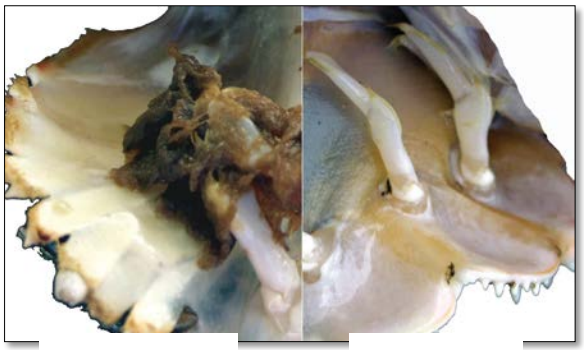
Tanner crab





-continued-

King crab

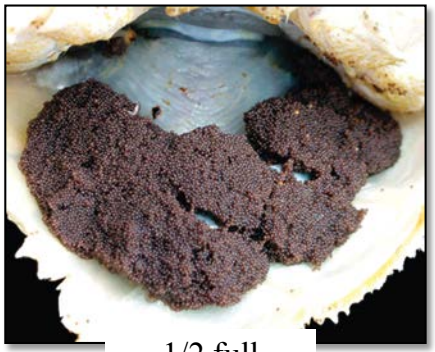


no eggs, matted setae

no eggs, clean

Trace to 1/8 full

1/4 full



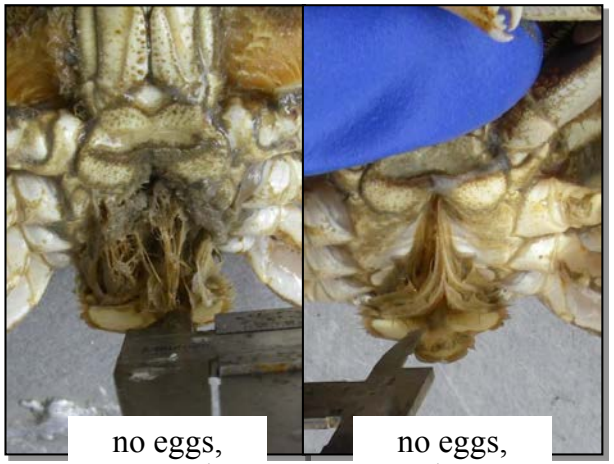
1/2 full

3/4 full

full

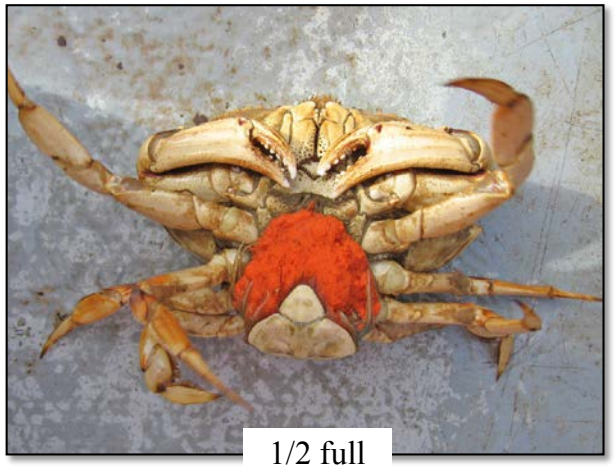
-continued-

Dungeness crab



no eggs, matted

no eggs, clean



1/2 full

3/4 full

full

Note: Not all clutch fullnesses are shown here

Appendix D6.–Tanner crab chela height measurement.