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Bottom Trawl Surveys for Tanner Crab in Prince William Sound, 2022 and 2023

by

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and

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November 2024

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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A BOTTOM TRAWL SURVEY FOR TANNER CRAB IN PRINCE WILLIAM SOUND, 2022 AND 2023

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ABSTRACT

The Alaska Department of Fish and Game, Division of Commercial Fisheries, conducted large-mesh bottom trawl surveys in 2022 and 2023 with the objective of generating Tanner crab *Chionoecetes bairdi* abundance estimates in 2 Tanner crab districts and for the historic survey area in the Prince William Sound Area (PWSA; Registration Area E). The 2022 survey in the Northeastern District estimated an abundance of 45,792 mature-size male crab, which was below the minimum abundance threshold of 217,800 mature-size male crab to open a fishery in 2023. The 2023 survey in the Central District estimated an abundance of 146,755 mature-size male crab, which was below the minimum abundance threshold of 246,700 mature-size male crab to open a fishery in 2024. The 2022 and 2023 mean CPUE (number of crab per nmi^2) of mature-size male Tanner crab in the Northeastern and Central District were some of the lowest in the PWSA bottom trawl survey time series. The 2023 survey in the historical survey area produced a mean CPUE of 100 mature-size male crab per nmi^2, which was a 90.6% decrease from the last time the area was surveyed in 2019.

Keywords: Tanner crab, *Chionoecetes bairdi*, trawl survey, Prince William Sound, Registration Area E

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) Division of Commercial Fisheries (DCF) has the responsibility to sustainably manage Tanner crab *Chionoecetes bairdi* fisheries in the Prince William Sound Area (PWSA; Registration Area E). The first commercial harvest of Tanner crab in PWSA occurred in 1966. The fishery rapidly developed within the first few years (Pirtle et al. 1969). ADF&G DCF over the next 5 decades established a series of Tanner crab management measures and assessment surveys designed to address fluctuations in harvests from the record-breaking harvests of the 1970s, through the decline experienced in the early1980s, up to the fisheries closure in 1989. The fishery remained closed until the 2017 Alaska Board of Fisheries (BOF) meeting, when new PWSA commercial Tanner crab regulations were adopted, and then reopened from 2018–2021 with a commissioner's permit fishery. The commissioner's permit provided the commercial fleet the opportunity to explore areas not sampled by ADF&G's assessment program. In 2022, ADF&G opened up a standard commercial fishery in one District of PWSA to commercial fishing.

COMMERCIAL FISHERIES

In the first years of the Tanner crab fishery in PWSA there were no restrictions on size or sex of crab harvested (Pirtle et al. 1969). The PWSA encompasses both the waters of Prince William Sound and waters in the Gulf of Alaska (Figure 1). At the beginning of the fishery, the commercial fleet was based out of Cordova and through 1971, most of the harvest was conducted inside the waters of PWSA (within Prince William Sound) with a mean of less than 1 million lb annually (Pirtle et al. 1972). In 1972, the harvest increased to 8.5 million lb as the fleet began to move to the outside waters of PWSA into the Gulf of Alaska (GOA). Subsequently, Tanner crab fishing areas and harvest quotas were promulgated by the Alaska Board of Fish and Game for PWSA in 1972. The "Inside" area, composed of the waters of Prince William Sound, had a quota of 3.5 million lb of Tanner crab and the "Outside" area, the waters of the GOA between Cape Suckling and Cape Fairfield, had a quota of 12 million lb (Pirtle and Fridgen 1974). The harvest for the 1972–1973 season (October 15–June 22) remains the largest harvest on record for PWSA Tanner crab at 14 million lb, of which 11.7 million lb was from the Outside area. Although the 1973–1974 season had the second-highest harvest on record at 10 million lb (8.5 million lb from the Outside area), the following 3 years had a substantial decrease in harvest (Pirtle 1978a). From 1972 through 1976 the Tanner crab harvest in the Outside area of PWSA occurred south of Montague Island, south of Hinchinbrook entrance, and south of the Copper River Delta. Concurrent efforts in the

Inside area targeted the Hinchinbrook Entrance, Orca Bay, Port Fidalgo, and just outside Port Valdez. In 1976, the (BOF) adopted harvest regulations to limit PWSA harvest of Tanner crab to males of at least 5.3 in carapace width (CW) including spines, with a guideline harvest level (GHL) of 3–7 million lb (Pirtle 1978b). Following the adoption of harvest regulations in 1976, the Tanner crab commercial fishery effort increased spatially as the fleet looked for larger male Tanner crab and began fishing the entire expanse of the PWSA Outside area from Cape Suckling to Cape Fairfield, as well as the Inside area in Montague Strait. Starting in 1977, Tanner crab harvest in PWSA was reported and managed in 4 districts. The Northern and Hinchinbrook districts were in Prince William Sound, the Eastern District was in the GOA, and the Western District included waters in both Prince William Sound and the GOA (Figure 1). After 1977, most of the harvest occurred in the Eastern and Western districts until harvest began to decline in the early 1980s. District closures occurred during 1984 and 1985 along with limited effort. The final 3 years of the fishery, 1986–1988, yielded smaller harvests of approximately 0.5 million lb (Rumble et al. 2020). In 1989, the PWSA commercial Tanner crab fishery was closed and remained closed until the 2017 BOF meeting when a proposal to allow a commissioner's permit fishery for Tanner crab in Registration Area E was adopted into regulation (5 AAC 35.311). This proposal was adopted after board members received public testimony that supported a regulation to allow commissioner's permits to be issued in PWSA starting in 2018 for the harvest of Tanner crab in the Western and Eastern districts. This fishery did not have an associated harvest strategy or GHL and was conducted from 2018–2021 with the majority of effort and harvest occurring in the Western District (Rumble et al. 2021). The commissioner's permit fishery had similar trends in effort and harvest as the historical fishery in the 1970s. Both fisheries began with high effort and harvest in the inside waters of PWSA and then expanded into the outside waters of the Gulf of Alaska. Due to high effort and low CPUEs, statistical areas within the 2 districts were closed in each of the 3 seasons the commissioner's permit fishery was conducted. The only PWSA Tanner crab commercial fishery that has occurred since the commissioner's permit fisheries was in 2022 in the Northeastern District with a GHL of 61,800 lb and total harvest of 24,630 lb.

LEGAL SIZE AND SIZE AT MATURITY

At the 1976 BOF meeting, statewide Tanner crab commercial harvest regulations were adopted to limit harvest of Tanner crab to males of at least 5.5 in (140 mm) CW except for in PWSA where the legal size was set at 5.3 in (135 mm) CW. At the 1976 BOF meeting, ADF&G biologists testified that male Tanner crab were believed to be sexually mature at 110–115 mm CW, except for in PWSA where the average size at maturity was believed to be 109 mm (Donaldson and Donaldson 1992). ADF&G biologists at the 1976 BOF meeting suggested that sexually mature male crab of 110–139 mm CW would continue to molt and grow and thus be in the population 1 year and up to 2 years before being available to the commercial fishery (Donaldson and Donaldson 1992). Growing via a succession of molts through maturity is an indeterminate growth life history strategy that has been identified in other commercially important crab species such as Dungeness crab *Cancer magister* (Wainwright and Armstrong 1993) and red king crab *Paralithodes camtschaticus* (Zhou et al. 1998). However, since the 1976 BOF meeting, research has indicated that male Tanner crab exhibit a determinate growth life history strategy, where crab cease to molt after morphological maturity, a stage that is referred to as the terminal molt in *Chionoecetes* species (Conan and Comeau 1986; Hartnoll et al. 1993). Male morphological maturity in members of the genus *Chionoecetes* refers to crab in the "large-clawed" morphotype which occurs during the final terminal molt when the chela height (CH) reaches maximum relative

size to the CW (Conan and Comeau 1986; Somerton 1980). The occurrence of a terminal molt at morphological maturity in the genus *Chionoecetes* has been introduced and observed in laboratory studies (Conan and Comeau 1986), refuted in laboratory and field observations (Dawe et al. 1991; Donaldson and Johnson 1988; Paul and Paul 1995), and further debated (Conan et al. 1988). Evidence of a terminal molt at morphological maturity, as indicated by low levels of circulating molting hormones has been found in other *Chionoecetes* species, the Bering Sea snow crab *Chionoecetes opilio* (Tamone et al. 2005), and findings from premolt indicators and molt stage analysis via setagenesis (Rugolo et al. 2005). The concept of a male Tanner crab terminal molt was controversial until more recent data regarding Tanner crab hormone levels in Southeast Alaska confirmed previous analysis (Tamone et al. 2007) and became more widely accepted (Zheng and Pengilly 2011). Those conclusions are now considered in ADF&G annual management reports (Rumble et al. 2020; Rebert et al. 2021), maturity research (Siddon and Bednarski 2010), and harvest strategy recommendations for this species (Daly et al. 2020).

Research on the size at morphological maturity of male Tanner crab in the GOA has been conducted since the 1976 BOF meeting with similar estimates across regions. The CW of male Tanner crab at which there is a 50% probability of being morphologically mature (CW_{50}) was estimated at 113 mm using previously established methods for PWSA Tanner crab collected during the 2007–2014 ADF&G trawl surveys (Goldman et al. 2018). Male Tanner crab caught in the ADF&G Kachemak Bay trawl survey had a CW_{50} estimate of 112 mm[1]. In Southeast Alaska, CW_{50} averaged 117 mm and ranged from 108–135 mm throughout the region (Siddon and Bednarski 2010). In the Kodiak, Chignik, South Peninsula, and Eastern Aleutian districts, ADF&G defines "mature male abundance" as the abundance of crab that are 114 mm CW or greater (Richardson et al. 2020) with more recent studies from the Kodiak District bottom trawl survey indicating that CW_{50} could be as small as 110–111 mm (Knutson 2022).

In 2017, the BOF adopted ADF&G proposals to decrease the legal minimum size of Tanner crab in the PWSA and the Cook Inlet Area (CIA). In the PWSA, the legal size was reduced to 5 in (127 mm) from the historical legal-size of 5.3 in (135 mm) CW. The Cook Inlet Management Area had a larger decrease in the legal size, reducing it to approximately CW_{50} (4.5 in [114 mm]), although only non-commercial fisheries were and are currently active. These were the first changes to the legal size in a GOA Tanner crab management plan since regulations set the legal size at the 1976 BOF meeting. Southeast Alaska Region and the Kodiak, Chignik, South Peninsula, and Eastern Aleutian districts have maintained a legal size of male Tanner crab of 5.5 in (140 mm) CW. The proposed decrease in the legal size by ADF&G in PWSA was supported by an analysis of Tanner crab fishery and survey data suggesting that due to a terminal molt, a majority of males would not reach legal size and would not be available for harvest (ADF&G 2017; Goldman et al. 2018) which is true of other GOA Tanner crab stocks (Spalinger and Silva 2024; Stone 1999). Tanner crab legal size was reduced in the eastern Bering Sea prior to the change in PWSA with the anticipated benefit of reducing bycatch of undersized crab, achieving higher long-term yield, and lowering harvest rates of faster growing larger males (Zheng and Pengilly 2011). For terminal molt stocks, this approach would result in lower bycatches and thus a higher yield over a long term, and lower harvest rates for the faster growing, larger males (Goldman et al. 2018).

[1] Correspondence from Jie Zheng, ADF&G Fisheries Scientist, to Ken Goldman, ADF&G Fisheries Biologist dated November 17, 2016 (Analysis of Harvest Strategy and Legal Size for Cook Inlet Tanner Crab). Unpublished document obtained from Ken Goldman, ADF&G Fisheries Biologist, Homer.

REGISTRATION AREA E TANNER CRAB HARVEST STRATEGY

In 2017, the BOF adopted a department proposal for a Registration Area E Tanner crab harvest strategy (5 AAC 35.308) following traditional ADF&G management policies for Tanner crab, which includes a minimum abundance threshold to open a commercial fishery set at 50% of the estimated mean annual abundance, of a size category of male crab over a defined time range (Bishop et al. 2011). The mean annual abundance estimate serves as a proxy of maximum sustainable yield (MSY_{proxy}). In the absence of a complete surplus production model, or other computer simulations for PWSA Tanner crab stocks, the Registration Area E Tanner crab harvest strategy followed this traditional approach (Goldman et al. 2018). The minimum abundance threshold in the PWSA harvest strategy adopted in 2017 was based on the abundance estimates of historical legal-size crab (≥5.3 in [135 mm]) and would have opened all waters in Registration Area E to commercial fisheries if achieved. The only tool that ADF&G had to assess if the PWSA stock had met the minimum abundance threshold was the bottom trawl survey in the historical survey area, which had a different spatial extent from the harvest data used to calculate the annual mean abundance to estimate MSY_{proxy} (Rhea-Fournier et al. 2022).

At the 2021 BOF, ADF&G presented 2 proposals to establish a PWSA Tanner crab assessment and management plan that would be spatially consistent. The first proposal that was adopted into regulation (5 AAC 35.305) redefined and renamed Tanner crab commercial fishery districts in PWSA (Figure 2; ADF&G 2021). The 5 new commercial fishery districts that were adopted included 3 districts for which a new harvest strategy was proposed in a second ADF&G proposal. The Northeastern, Central, and Southwestern Districts were aligned with historical statistical areas to develop a more accurate time series of statistical area-specific historical harvest and closely aligned to current statistical areas for management purposes (Rhea-Fournier et al. 2022). These 3 districts contain a considerable amount of trawlable Tanner crab habitat and thus allow ADF&G to continue using bottom trawl surveys as the primary Tanner crab assessment method (Rhea-Fournier et al. 2021a). The Northwestern District did not have sufficient trawlable habitat to develop an assessment and thus a management strategy based upon trawl assessments could not be developed. The Southeastern District did not have any substantial harvest during recent commissioner's permit and test fisheries and given the large size of this district, it was not feasible to develop a management strategy based upon trawl survey assessments.

ADF&G originally proposed a harvest strategy at the 2021 BOF that followed the approach in the Registration Area E harvest strategy adopted in 2017 using the abundance estimates of historical legal-size crab to develop minimum abundance thresholds to open a commercial fishery on current legal-size crab (Goldman et al. 2018 and Rhea-Fournier et al. 2022). After the Registration Area E Tanner crab harvest strategy proposal was presented at the 2021 BOF, discussions took place among ADF&G staff, BOF members, and stakeholders to amend it with substitute language (Record Copy 109). Changes that were discussed and implemented at the 2021 BOF included changing the length of the time series and the size of crab used to develop a MSY_{proxy} and the resulting minimum abundance thresholds to open a commercial fishery in 3 new Tanner crab districts (Rhea-Fournier and Russ 2023).

In the amended Registration Area E Tanner crab harvest strategy adopted into regulation, the district specific MSY_{proxy} and minimum abundance threshold to open a commercial fishery were based on a time series of annual abundance of mature-size male Tanner crab (≤113 mm), as detailed in Rhea-Fournier and Russ 2023. Mature male abundance thresholds computed from a

long-term average are also applied in management plans for the Kodiak District (Whiteside 2023a), the South Peninsula District (Whiteside 2023b), and the Chignik District (Whiteside 2022c) of the Westward Region. The mean annual abundance estimate of mature-size male Tanner crab serves as a MSY_{proxy} and the minimum abundance threshold is 50% of the MSY_{proxy} for each of the 3 districts. A stepwise harvest control rule of 10, 15, and 20% of the estimated abundance of mature-size male crab from district specific bottom trawl surveys, set the district specific GHL of legal-size crab (Table 1). A maximum harvest rate of 20% of legal-size Tanner crab is defined for the 3 districts for which the Registration Area E management plan applies.

HISTORICAL ASSESSMENT SURVEYS

From 1977–1991, ADF&G conducted a pot survey in PWSA for Tanner crab. The catch-per-unit-effort (CPUE; number of crab per pot) of legal-size crab from this survey declined in a manner similar to that observed in the commercial fishery (Goldman et al. 2018). The pot survey was distributed across the inside and outside waters of PWSA, to include areas that were fished after the fishery expanded, following the changes adopted by the 1976 BOF and until the fishery declined in the early 1980s. The pot survey covered the inside waters of Hinchinbrook Entrance, Orca Bay, and Port Fidalgo and extended from Montague Strait into the outside waters south of Montague Island. The pot survey also covered the outside waters south of Hinchinbrook Entrance, south of the Copper River Delta, and west of Kayak Island. These surveys produced indices of crab abundance to compare to ensuing commercial harvests (Kimker and Trowbridge 1992).

In 1990, ADF&G replaced the inside waters pot survey with a trawl survey to produce an area-swept abundance estimate, and the outside waters pot survey was terminated and was excluded from the trawl survey (Figure 1). The trawl survey area in inside waters included the eastern portion of the Northern District, the northern portion of the Hinchinbrook District, and the northeastern portion of the Western District (Rhea-Fournier et al. 2023). Selection of the survey areas was based on the historical pot survey area, commercial catch information, and Tanner crab habitat (Kimker and Trowbridge 1992) and was composed of waters 50–155 fathoms in depth. The survey was conducted annually until 1995, biennially until 2013, and annually through 2019 (Table 2). The survey area was divided into a grid composed of core stations that were towed every year and were used to calculate an abundance estimate for the surveyed area. The mean CPUE (number of crab per nmi^2) from each surveyed core station was expanded to the total survey area to generate an abundance estimate for the surveyed area. The historical PWSA trawl survey lacked the scope to estimate or project an abundance estimate of Tanner crab for the entire PWSA that is in accordance with the certainty of models used in other areas by the department.

The historical PWSA trawl survey grid consisted of 43 stations encompassing 249.6 nmi^2 of survey area, resulting in one bottom trawl tow per 5.8 nmi^2 of survey area. ADF&G relied on the historical bottom trawl survey from 1990–2019 to assess the PWSA Tanner crab population, and to provide a reliable index of stock status for informing management and a means to open and close the fishery.

CURRENT ASSESSMENT SURVEYS

The new PWSA Northeastern, Central, and Southwestern districts have historical or recent commercial harvest (or both), considerable trawlable benthic terrain (slope less than 5 degrees), and substantial Tanner crab habitat at depths from 50 to 155 fathoms. The new PWSA trawl survey areas are limited to a depth of 155 fathoms following the methods developed in Trowbridge 1992.

Fishery-dependent data from commissioner's permit, test, and commercial fisheries and fishery-independent data from pot and trawl surveys indicate over 98% of legal-size Tanner crab (≥127 mm) caught occur between 50–155 fathoms in each of these 3 districts (Rhea-Fournier et al. 2022). Depths shallower than 50 fathoms were also excluded from the historical PWSA trawl survey to reduce gear damage and to better represent Tanner crab habitat (Bechtol 1999). Information used to define Tanner crab habitat for this report consists of all data available to ADF&G at the time of this report. Additional information from future fisheries will be analyzed to determine if this definition of Tanner crab habitat is appropriate for these 3 districts. Bathymetry data used to delineate the Tanner crab habitat depth boundaries in each of these 3 districts were obtained from 2 previously compiled digital elevation model (DEM) mosaics. Most of the PWSA pertinent to ADF&G's assessment, was covered by a DEM created by the National Geophysical Data Center for tsunami modeling (Caldwell et al. 2009). This DEM used an 8/3 arc-second grid at an ~60 m resolution and spanned all the PWSA of interest north of 59° 39′N latitude and east of 146° 46′W longitude. Bathymetry for the southernmost portion of interest in PWSA was obtained from a 100 m raster compiled central GOA by the Alaska Fisheries Science Center (Zimmermann and Prescott 2015). Both DEMs were projected to the same coordinate system (UTM 6N, NAD83). The central GOA raster was resampled with an output cell size the same as the 8/3 arc-second grid, and the 2 rasters were then mosaiced to a single DEM. Raster cell values 91.44–283.46 m (50–155 fathoms) were reclassed to a single value to create a spatial layer representing available Tanner crab habitat. The PWSA Northeastern, Central, and Southwestern district boundaries were designed to generally align with current statistical area boundaries to facilitate effective management. Alignment with historical statistical area boundaries was also a priority to calculate historical harvest and estimate historical abundance estimates following Goldman et al. (2018). Bottom trawl survey grids were designed for PWSA Northeastern, Central, and Southwestern districts to spatially distribute trawl tows consistently across the trawlable habitat (Rhea-Fournier et al. 2021a) with a fixed station design following the methods for the ADF&G historical bottom trawl survey (Goldman et al. 2018).

This report summarizes the 2022 and 2023 trawl surveys conducted in the PWSA Northeastern and Central districts. To assess the efficiency of the current bottom trawl assessment surveys relative to the historical survey and to evaluate survey catch statistics, annual mean CPUE variance was compared. The historical bottom trawl survey CPUE and associated variance estimates fluctuated between relatively high and low levels (Rhea-Fournier et al. 2023). Trawl surveys that produced CPUEs that were above the time series mean, when crab may have been more homogeneously distributed across the survey area, had relatively higher precision relative to the mean (i.e., CV). Surveys with CPUEs that were below the time series mean, when crab may have been more heterogeneously distributed, had relatively lower CVs. Current survey CPUEs can be classified as either above or below the historical survey mean, and the appropriate, associated CVs can be compared.

Numerous species of groundfish, shellfish, and other invertebrates are also captured during trawl surveys, many of which have subsistence, commercial, or recreational importance. Area-swept abundance estimates and biological data on these species provide a valuable time series of single species population trends. In addition, the Magnuson–Stevens Fishery Conservation and Management Act requires that all federally managed species caught from all sources, including fishery research surveys, must be accounted for and reported (16 U.S.C. 1851 § 301). Enumeration of these miscellaneous species caught in the PWSA trawl survey has been trending toward a more comprehensive effort since the inception of the survey and sampling methods were modified in

1998 to fully document all species caught (Bechtol et al. 2002). Analysis and subsequent groundfish biomass estimates from PWSA trawl surveys will be reported separately from this report.

OBJECTIVES

PRIMARY OBJECTIVES

1. Estimate the mean CPUE and abundance of mature-size male Tanner crab such that CPUEs above the historical mean have a CV that does not exceed the 90th percentile of historical CVs from CPUEs above the historical mean and that CPUEs below the historical mean have a CV that does not exceed the 90th percentile of historical CVs from CPUEs below the historical mean.
2. Estimate the mean CPUE and abundance of legal-size male Tanner crab.

SECONDARY OBJECTIVE

1. Estimate the mean CPUE and abundance of historical legal-size male, immature and mature male and female, and total Tanner crab.

METHODS

SURVEY DESIGN

The fixed station grid in the PWSA Northeastern District, Central District, and historical survey area spatially distribute trawl tows across Tanner crab habitat. One tow is conducted at each station and the mean CPUE (number of crab per nmi^2) from all stations within a survey area is multiplied by the Tanner crab habitat (nmi^2) defined as 50–155 fathoms, within each district or survey area to produce an abundance estimate (Figure 3).

The survey stations in the Northeastern District cover 320.3 nmi^2 of Tanner crab habitat. This district includes historical survey stations in Port Fidalgo, Port Gravina, and Orca Bay along with stations in the waters surrounding Naked Island. There is a total of 46 stations in the Northeastern District, resulting in 1 trawl tow per 6.9 nmi^2 of Tanner crab habitat.

The survey stations in the Central District encompass 288.6 nmi^2 of Tanner crab habitat. This district includes historical survey stations in Hinchinbrook Entrance and northern Montague Island along with stations in Montague Strait. There are a total of 42 stations in the Central District, resulting in 1 trawl tow per 6.9 nmi^2 of Tanner crab habitat.

The historical survey area has remained consistent and still comprises stations located north of Montague Island, Orca Bay, and Port Fidalgo, and accounts for 249.6 nmi^2 of Tanner crab habitat. There are 43 stations in this area, resulting in 1 trawl tow per 5.8 nmi^2 of Tanner crab habitat.

The 2022 and 2023 surveys were conducted aboard the ADF&G *R/V Solstice* using a 400-mesh Eastern otter trawl with a 23.8 m headrope and 29.9 m footrope. Mesh sizes were 10.2 cm in the wings and body, 8.9 cm in the intermediate, and 3.3 cm in the codend liner. The otter trawl was fished with 363 kg *Nor'Eastern Astoria* V trawl doors measuring 1.5m by 1.8 m. The net was equipped with a bottom contact sensor to measure time the net fished on bottom and a trawl mensuration system with net sensors that provided real-time data on trawl performance. The vessel captain monitored the sensors to determine how the net was performing so that adjustments could be made to ensure the trawl was fishing effectively and avoid net damage. Tow paths were selected

considering bathymetry, current, and vessel capabilities. Target tow length was 1 nmi with a mean tow speed of 2.5 nmi per hour. Mean CPUE of all successfully towed stations was applied to the total Tanner crab habitat area (nmi^2) in each Tanner crab district to produce a district specific abundance estimate to assess if the minimum abundance threshold had been met to open a commercial fishery.

TANNER CRAB CATEGORY DEFINITIONS

Male Tanner crab were grouped into categories of historical legal-size, legal-size, mature-size, or immature (Table 3), and females were grouped as immature or mature. Immature males were defined as CW less than 113 mm, and mature males were defined as CW equal to or greater than 113 mm (Goldman et al. 2018). Female Tanner crab maturity was assessed with reference to the abdominal flap (Jadamec at al. 1999), which on immature females appears completely flat or concave and cannot be lifted easily from the body, whereas on mature females it is convex and can easily be lifted from the body. All crab were assigned shell condition based on visual observation and categorized as soft-shell, new-shell, old-shell, or very old-shell (Jadamec at al. 1999).

The legal size of male Tanner crab CW in Alaska Administrative coded includes spines. However, biological CW excludes spines, and is the measurement collected and reported from all ADF&G stock assessment surveys. Male size categories and survey results presented in this report are based on CW measurements that do not include spines, whereas all references to harvest and management strategies are based on CW measurements including spines.

CATCH SAMPLING

Upon retrieval of the trawl, the codend was weighed to the nearest 0.5 kg with a 5,000 kg capacity hanging electronic scale. The catch was emptied into a checker bin and the codend was reweighed. The catch weight was calculated by subtracting the weight of the empty codend from the initial codend weight.

All Tanner crab were removed from the catch and were sorted by sex, placed into standard sized fish baskets, and weighed to the nearest 0.01 kg on a motion-compensated digital platform scale. All male Tanner crab had biological CW and shell condition recorded. Male Tanner crab that were ≥50 mm CW had the CH measured from the right claw. All female Tanner crab had biological CW, maturity, and shell condition recorded. All length measurements were made to the nearest 0.1 mm using electronic calipers.

TANNER CRAB CPUE AND ABUNDANCE ESTIMATES

The Tanner crab abundance estimates were calculated using area-swept calculations (Gunderson 1993). One tow was conducted at each station and where Tanner crab were captured, the number of individuals within each group (category) were enumerated. The number of crab caught per nmi^2 swept by the bottom trawl (CPUE) was calculated for each station. The mean CPUE of all stations sampled was multiplied by the total amount of Tanner crab habitat in each survey area to produce a district specific abundance estimate. A CPUE at each station was calculated for each group of male Tanner crab categorized by a combination of historical legal-size, legal-size, mature-size, or immature (Table 3) and shell condition. A CPUE at each station was calculated for each group of female crab categorized by a combination of mature or immature and shell condition. For each group (g), the number of crab per nmi^2 (CPUE) was calculated for each station (i) by:

$$CPUE_{gi} = \frac{c_{gi}}{d_i p}. \quad (1)$$

Where

c = number of crab,

d = the distance towed (nmi), and

p = the effective trawl path width (nmi).

Distance towed was calculated as the straight-line distance from the start to the end of the tow. As with all ADF&G bottom trawl surveys that estimate an area swept, the effective trawl path width was equal to the designed net width opening, which is 40 ft, converted to nautical miles.

Mean CPUE from all stations for each Tanner crab group and population abundance ($\widehat{N}$) for the surveyed area (A) were estimated by:

$$\overline{CPUE}_g = \frac{\sum_{i=1}^{n} CPUE_{gi}}{n}, \quad (2)$$

and

$$\widehat{N}_g = \overline{CPUE}_g \, A. \quad (3)$$

Where

n = the number of successfully trawled stations surveyed, and

A = amount of Tanner crab habitat (nmi^2) in the surveyed area.

A non-parametric bootstrap was used to estimate variance for the surveyed population by resampling the standardized station catches $CPUE_{gi}$ 10,000 times with replacement (Efron 1982). The *SE* was estimated as the *SD* of the bootstrap replicate estimates. Upper and lower 90% CIs were estimated using the percentile method (Efron 1987).

Mature-size male Tanner crab CPUE CV for each survey area will be compared to the average CV from the historical survey (Table 4) to determine if Objective 1 in this report is met. The CV 90th percentile from CPUEs that were above the time series mean is 0.29 and the CV 90th percentile from CPUEs that were below the time series mean is 0.37.

RESULTS

SURVEY STATIONS

The 2022 PWSA bottom trawl survey was in the Northeastern District and completed successful tows in 43 of the 46 total stations (Figure 4).

The 2023 PWSA bottom trawl survey began in the Central District and then finished trawl tows at the remaining stations in the historical survey area (Figure 5). The 2023 survey completed successful tows in 38 of the 42 total stations in the Central District and completed successful tows in 43 of the 43 total stations in the historical survey area.

TANNER CRAB CPUE AND ABUNDANCE ESTIMATES

The 2022 PWSA trawl survey in the Northeastern District caught 462 male Tanner crab, of which 41 crab were of mature-size to produce a mean CPUE of 143.6 crab/nmi^2 mature-size crab and an estimated abundance of 45,792 mature-size crab (Table 5). The mean CPUE was below the

historical survey mean and the associated CV of 0.24 did not exceed the 90th percentile (0.37) of CVs from historical CPUEs that were below the mean. The mean CPUE for mature-size male Tanner crab in 2022 was the lowest in the PWSA bottom trawl survey time series since the peak in 2011 and well below the historical survey area mean (Figure 9). This survey abundance estimate failed to meet the minimum abundance threshold of 217,800 mature-size crab to open a fishery in the Northeastern District in 2023.

The 2022 trawl survey in the Northeastern District caught 8 legal-size male Tanner crab to produce a mean CPUE of 25.9 crab/nmi^2 and an estimated abundance of 8,259 legal-size crab (Table 5). The total male Tanner crab abundance estimate was 515,042 crab, of which 45,792 crab (9%) were mature and 469,250 (91%) were immature. Most of the male crab caught in the Northeastern District were of new shell condition, although a higher frequency of old-shell conditions were observed in the larger crab (Figure 6).

The total female Tanner crab abundance estimate in the Northeastern District was 546,279 crab, of which 115,827 (21%) were mature and 430,452 crab (79%) were immature (Table 5). Total male and female Tanner crab abundance estimates were similar, whereas the ratio of mature crab was greater for females as compared to males.

The 2023 PWSA trawl survey in the Central District caught 2,584 male Tanner crab, of which 126 crab were of mature-size to produce a mean CPUE of 504.2 crab/nmi^2 of mature-size crab and an estimated abundance of 146,755 mature-size crab (Table 6). The mean CPUE was below the historical survey mean and the associated CV of 0.38 was slightly above the 90th percentile (0.37) of CVs from historical CPUEs that were below the mean. The mean Central District CPUE for mature-size male Tanner crab in 2023 was a 12.6% decrease from the last Central District estimate in 2020 (Rhea-Fournier et al 2022) and well below the historical survey area mean (Figure 9). This survey abundance estimate failed to meet the minimum abundance threshold of 246,700 mature-size crab to open a fishery in the Central District in 2024.

The 2023 trawl survey in the Central District caught 26 legal-size male Tanner crab to produce a mean CPUE of 101.8 crab/nmi^2 and an estimated abundance of 29,627 legal-size crab (Table 6). The total male Tanner crab abundance estimate was 3.1 million crab, of which 146,755 crab (5%) were mature and 3.0 million (95%) were immature. Most of the male crab caught in the Central District were of new shell condition, although a higher frequency of old-shell conditions were observed in the larger crab (Figure 7).

The total female Tanner crab abundance estimate in the Central District was 2.7 million crab, of which 836,115 (31%) were mature and 1.8 million crab (69%) were immature (Table 6). The estimated abundance of total male crab was greater than total females, whereas the ratio of mature crab was greater for females than males.

The 2023 PWSA trawl survey in the historical survey area caught 1,241 male Tanner crab, of which 29 crab were of mature-size to produce a mean CPUE of 100 crab/nmi^2 mature-size crab and an estimated abundance of 24,971 mature-size crab (Table 7). The mean CPUE was below the historical survey mean and the associated CV of 0.26 did not exceed the 90th percentile (0.37) of CVs from historical CPUEs that were below the mean. The 2023 historical survey area CPUE for mature-size male crab was the lowest since 1999, was a 90.6% decrease from the last historical survey estimate in 2019 (Rhea-Fournier et al. 2023), and was well below the survey time series mean (Figure 9).

The 2023 trawl survey in the historical survey area caught 10 legal-size male Tanner crab to produce a mean CPUE of 34.4 crab/nmi^2 and an estimated abundance of 8,581 legal-size crab (Table 7). The total male Tanner crab abundance estimate was 1.1 million crab, of which an estimated 24,971 crab (2%) were mature and 1.1 million (98%) were immature. Most of the male crab caught in the historical survey area were of new shell condition, although a higher frequency of old-shell conditions were observed in the larger crab (Figure 8).

The total female Tanner crab abundance estimate in the historical survey area was 1.1 million crab, of which 140,969 (13%) were mature and 920,571 crab (87%) were immature (Table 7). Total male and female Tanner crab abundance estimates were similar, whereas the ratio of mature crab was greater for females than males.

TANNER CRAB DISTRIBUTION

During the 2022 survey in the Northeastern District, male and female Tanner crab had a similar frequency of occurrence and immature male and female crab had almost double the frequency of mature male and female crab (Table 5). Mature male and female crab distributions had substantial overlap, although there were more females observed on the western side of the district around Naked Island (Figure 10).

During the 2023 survey in the Central District there were substantially more mature females observed than mature males (Table 6). Mature females were observed more frequently in the northern part of the Northeastern District relative to mature males (Figure 11).

During the 2023 survey in the historical survey area, female Tanner crab had a higher frequency of occurrence than males, immature male frequency of occurrence was almost triple that of mature males, and immature female frequency of occurrence was more than double that of mature females (Table 7). Fewer mature males and females were observed on the eastern part of the survey area relative to the western part (Figure 12).

DISCUSSION

The PWSA bottom trawl survey conducted successful assessments of Tanner crab in 3 districts from 2020–2023. The Central District has now been surveyed twice, in 2020 (Rhea-Fournier et al. 2022) and again in 2023. The Southwest District was surveyed in 2021 (Rhea-Fournier et al. 2021b) and the Northeastern District was assessed for the first time in 2022. The 2023 survey was the first time that the complete historical survey area had been assessed since 2019 (Rhea-Fournier et al. 2023). The CPUE of mature-size male Tanner crab for all surveyed areas has continued to decline since its peak in 2011.

In March of 2022, the first standard (not commissioner's permit) commercial fishery occurred in PWSA since 1988 in the Northwestern District. After the 2022 fishery, the first complete bottom trawl assessment of the Northwestern District was conducted and produced the second-lowest CPUE from a PWSA bottom trawl survey. The 2023 survey of the historical survey area, which included areas within the Northwestern District, also produced a low CPUE that became the second lowest from a PWSA bottom trawl survey (Table 4). In June 2024, the bottom trawl survey will again assess the Southwestern District which had the 6th-lowest CPUE from the PWSA bottom trawl survey conducted in 2021. Although CW histograms from male crab caught in each of the surveyed areas indicate larger counts of smaller crab than older crab, the counts are orders of

magnitude smaller than what was recognized as a recruitment event prior to the peak in mature-size and legal males in previous surveys from 2009–2013 (Rhea-Fournier et al. 2023).

The relatively high harvest rates during the 3 years of the commissioner's permit fishery in the Central and Southeastern Districts occurred when the historical survey area assessment results had a declining trend in Tanner crab CPUE and abundance. Because no commercial harvest had occurred in the historical survey area since 1988, this could suggest that the abundance decline was due to natural environmental or biological factors. If Tanner crab inhabiting the Central and Southeastern District were also exhibiting a natural decline during a time of commercial harvest, it may have contributed to the low abundance estimates in recent surveys in those districts. The low abundance and low CPUE in the Northwestern District in 2023 were expected as the first standard commercial fishery conducted there since 1988 was only able to harvest 40% of the GHL earlier that year. Commissioner's permit and standard commercial fishery performance in combination with fishery-independent survey assessment results suggest that the PWSA Tanner crab stock remains at relatively low abundance levels.

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TABLES AND FIGURES

Table 1.–Registration Area E, Prince William Sound Area, Tanner crab harvest rates and guideline harvest levels (GHL) activated by abundance estimates from the bottom trawl survey.

District	Abundance estimate[a]	Harvest rate	GHL[b]
Northwestern	217,800 – <326,700	10%	21,800 – 32,700
	326,700 – <435,700	15%	49,000 – 65,400
	≥435,700	20%	87,100+
Central	246,700 – <370,100	10%	24,700 – 37,000
	370,100 – <493,500	15%	55,500 – 74,000
	≥493,500	20%	98,700+
Southeastern	327,000 – <490,400	10%	32,700 – 49,000
	490,400 – <653,900	15%	73,600 – 98,100
	≥653,900	20%	130,800+

[a] Number of mature-size (≥113 mm) male Tanner crab

[b] Number of legal-size (≥127 mm) Tanner crab

Table 2.–Chronology of the large-mesh bottom trawl survey in the Prince William Sound Area.

Year	Survey area	Dates	Research vessel	Headrope width (ft)	Stations surveyed	
					For area CPUE	Total
1990	Historical	8/21–8/24	*Pandalus*	70	11	17
1991	Historical	8/20–8/30	*Pandalus*	70	29	43
1992	Historical	8/3–8/13	*Pandalus*	70	37	42
1993	Historical	7/22–8/2	*Pandalus*	70	38	48
1994	Historical	7/19–7/25	*Pandalus*	70	38	45
1995	Historical	7/29–8/3	*Pandalus*	70	32	33
1996	No survey					
1997	Historical	8/16–8/26	*Pandalus*	70	39	53
1998	No survey					
1999	Historical	6/28–7/12	*Pandalus*	70	40	66
2000	No survey					
2001	Historical	7/17–7/28	*Pandalus*	78	40	51
2002	No survey					
2003	Historical	8/10–8/20	*Pandalus*	78	40	44
2004	No survey					
2005	Historical	7/11–7/24	*Pandalus*	78	40	57
2006	No survey					
2007	Historical	7/22–8/1	*Pandalus*	78	32	46
2008	No survey					
2009	Historical	7/9–7/19	*Pandalus*	78	43	54
2010	No survey					
2011	Historical	7/5–7/14	*Solstice*	78	43	49
2012	No survey					
2013	Historical	7/5–7/14	*Solstice*	78	43	48
2014	Historical	6/3–6/12	*Solstice*	78	41	46
2015	Historical	6/20–6/29	*Solstice*	78	43	48
2016	No survey					
2017	Historical	6/9–6/16	*Solstice*	78	43	48
2018	Historical	6/13–8/30	*Solstice*	78	43	44
2019	Historical	6/15–6/22	*Solstice*	78	43	49
2020	Central District	6/11–6/19	*Solstice*	78	37	42
2021	Southwestern District	6/5–6/17	*Solstice*	78	53	57
2022	Northeastern District	8/29–9/5	*Solstice*	78	43	43
2023	Central District & Historical	6/6–6/18	*Solstice*	78	66	66

Note: There were 2 survey trips in 2018.

Table 3.–Male Tanner crab carapace width size categories for Prince William Sound Area bottom trawl surveys.

Size category	Carapace width (mm)
Immature	<113
Mature	≥113
Legal-size	≥127
Historical legal-size	≥135

Table 4.–Mean CPUE (crab per nmi^2), SE, and CV of mature-size (≥113 mm) male Tanner crab for Prince William Sound Area bottom trawl surveys in the historical survey area.

Year	Number of stations	CPUE	SE	CV
1990	11	1,738.5	465.5	0.27
1991	29	1,643.9	464.5	0.28
1992	37	1,547.0	265.9	0.17
1993	38	1,559.3	222.1	0.14
1994	38	954.1	145.6	0.15
1995	32	503.2	113.9	0.23
1996	No survey			
1997	39	182.8	66.5	0.36
1998	No survey			
1999	40	82.0	26.9	0.33
2000	No survey			
2001	40	263.5	80.8	0.30
2002	No survey			
2003	40	424.4	185.0	0.44
2004	No survey			
2005	40	586.5	173.3	0.29
2006	No survey			
2007	32	976.6	264.2	0.27
2008	No survey			
2009	43	1,525.3	322.6	0.21
2010	No survey			
2011	43	3,054.1	895.1	0.29
2012	No survey			
2013	43	2,032.3	319.6	0.16
2014	41	1,860.4	328.6	0.18
2015	43	1,622.8	268.7	0.17
2016	No survey			
2017	43	2,379.2	252.0	0.11
2018	43	1,212.9	140.9	0.12
2019	43	1,063.9	136.6	0.13
Mean	38	1,260.6	256.9	0.23

Table 5.–Prince William Sound Area bottom trawl survey catch statistics and abundances estimates with associated CIs of Tanner crab from the Northeastern District in 2022.

Group	Catch (*n*)	FO (%)	CPUE	CV	SE	Abundance est.	Lower 90% CI	Upper 90% CI
Total males	462	93.0	1,615.3	0.22	349.3	515,042	346,917	708,734
Historical legal-size males	4	9.3	12.7	0.47	6.0	4,048	1,021	7,113
Legal-size males	8	18.6	25.9	0.32	8.3	8,259	4,114	12,595
Mature males	41	48.8	143.6	0.24	34.3	45,792	29,102	65,714
Immature males	421	88.4	1,471.7	0.22	328.3	469,250	308,986	644,672
Total females	500	95.3	1,713.2	0.18	313.8	546,279	396,774	725,218
Mature females	108	46.5	363.3	0.29	104.0	115,827	63,192	173,285
Immature females	392	90.7	1,350.0	0.22	289.4	430,452	279,693	584,512

Note: CPUE is the number of crab per nmi^2. FO is frequency of occurrence. Historical legal-size males are crab ≥135 mm carapace width. Legal-size males are crab ≥127 mm carapace width. Mature males are crab ≥113 mm carapace width. Immature males are crab <113 mm carapace width.

Table 6.–Prince William Sound Area bottom trawl survey catch statistics and abundances estimates with associated CIs of Tanner crab from the Central District in 2023.

Group	Catch (*n*)	FO (%)	CPUE	CV	SE	Abundance est.	Lower 90% CI	Upper 90% CI
Total males	2,584	89.5	10,777.9	0.22	2328.5	3,137,121	2,174,994	4,305,421
Historical legal-size males	5	7.9	21.0	0.64	13.5	6,109	1,158	13,357
Legal-size males	26	26.3	101.8	0.46	46.7	29,627	10,492	54,490
Mature males	126	47.4	504.2	0.38	193.8	146,755	68,876	243,579
Immature males	2,458	89.5	10,273.7	0.23	2310.7	2,990,366	2,009,847	4,157,597
Total females	2,209	92.1	9,168.1	0.19	1698.2	2,668,571	1,947,248	3,533,716
Mature females	705	76.3	2,872.6	0.44	1266.2	836,115	348,578	1,518,663
Immature females	1,504	92.1	6,295.6	0.18	1116.4	1,832,455	1,311,458	2,381,034

Note: CPUE is the number of crab per nmi^2. FO is frequency of occurrence. Historical legal-size males are crab ≥135 mm carapace width. Legal-size males are crab ≥127 mm carapace width. Mature males are crab ≥113 mm carapace width. Immature males are crab <113 mm carapace width.

Table 7.–Prince William Sound Area bottom trawl survey catch statistics and abundances estimates with associated CIs of Tanner crab from the historical survey area in 2023.

Group	Catch (*n*)	FO (%)	CPUE	CV	SE	Abundance est.	Lower 90% CI	Upper 90% CI
Total males	1,214	93.0	4,339.8	0.15	657.3	1,087,579	833,797	1,367,032
Historical legal-size males	3	7.0	10.6	0.56	6.0	2,654	833	5,311
Legal-size males	10	14.0	34.4	0.43	15.2	8,581	2,701	15,301
Mature males	29	32.6	100.0	0.26	26.3	24,971	15,239	36,740
Immature males	1,185	93.0	4,239.8	0.16	691.4	1,058,211	802,312	1,359,155
Total females	1,192	95.3	4,253.1	0.16	679.6	1,061,540	799,385	1,353,195
Mature females	161	41.9	564.8	0.26	147.4	140,969	83,362	204,518
Immature females	1,031	95.3	3,688.3	0.17	625.1	920,571	682,520	1,178,580

Note: CPUE is the number of crab per nmi^2. FO is frequency of occurrence. Historical legal-size males are crab ≥135 mm carapace width. Legal-size males are crab ≥127 mm carapace width. Mature males are crab ≥113 mm carapace width. Immature males are crab <113 mm carapace width.

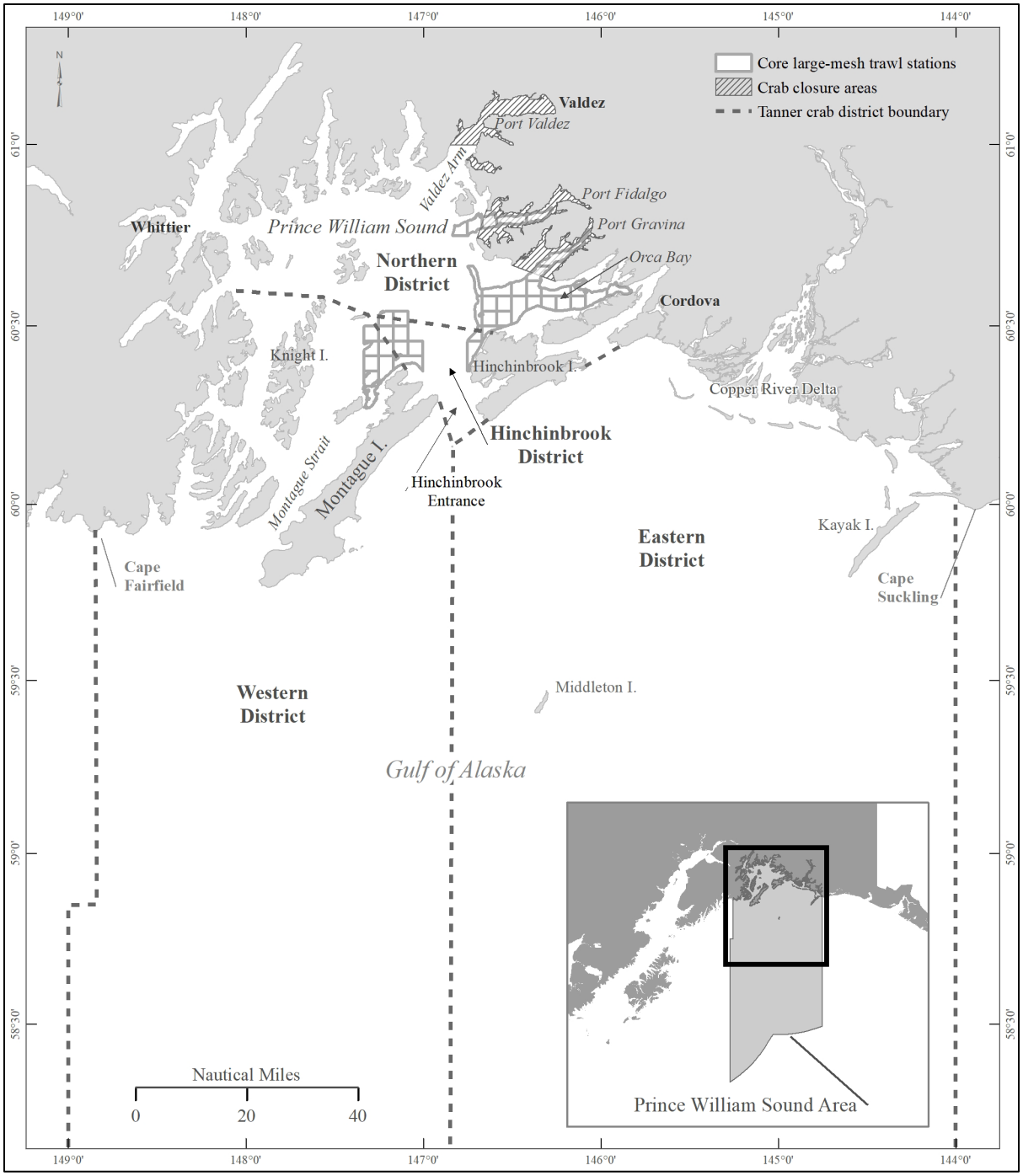

Figure 1.–Prince William Sound Area commercial Tanner crab districts and bottom trawl survey stations, pre-2021.

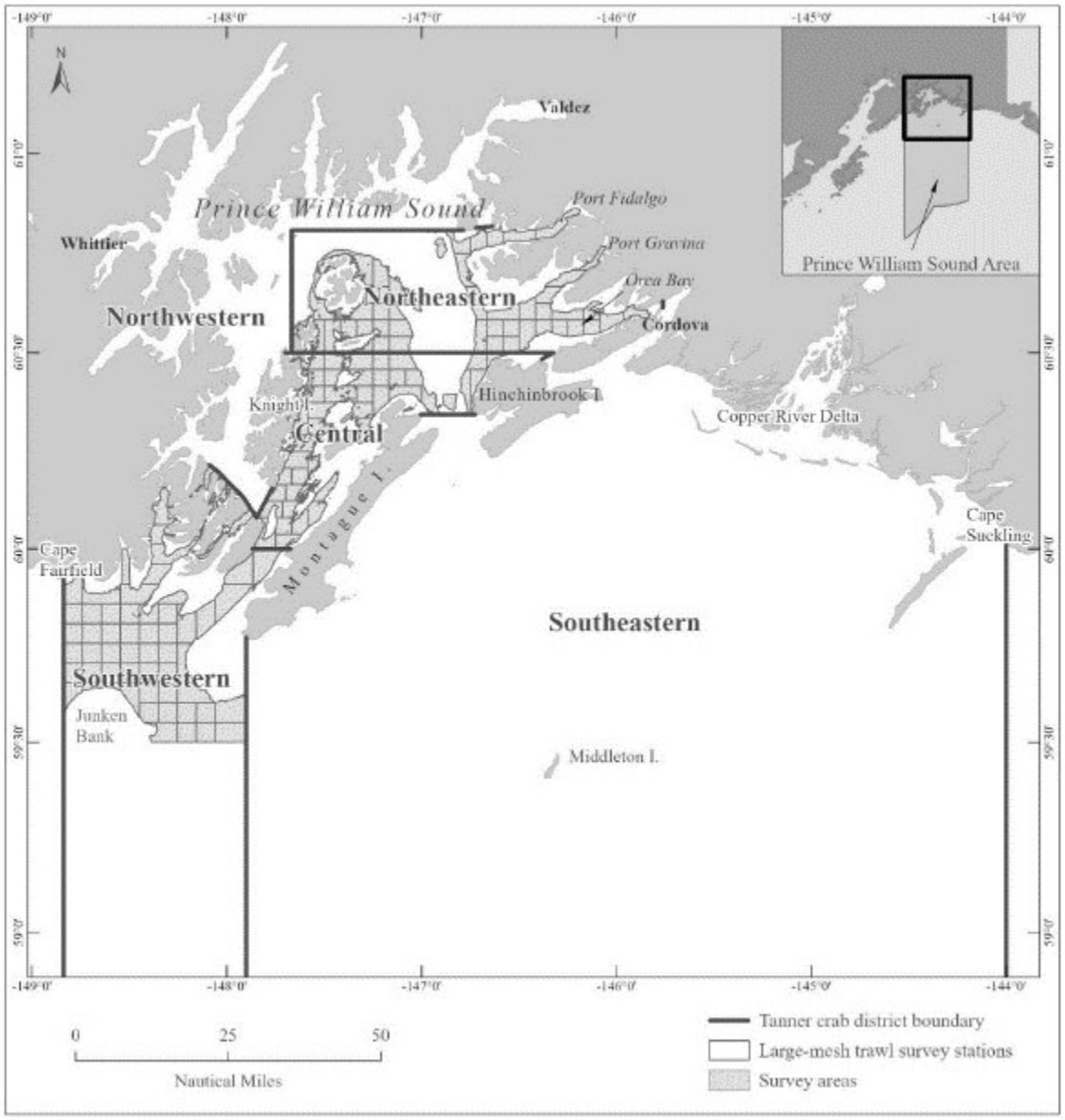

Figure 2.–Prince William Sound Area commercial Tanner crab districts and bottom trawl survey stations, post-2021.

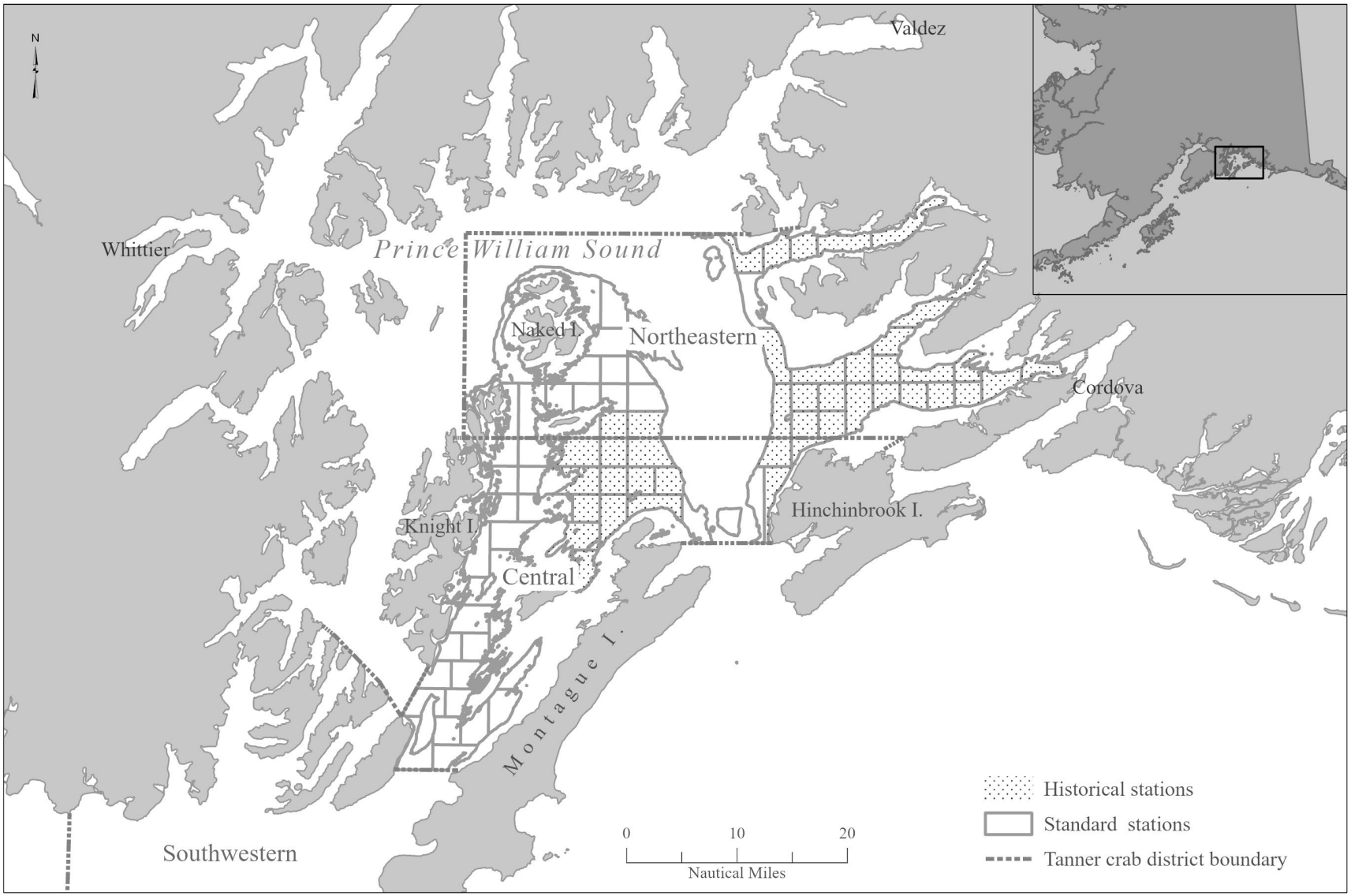

Figure 3.–Prince William Sound Area bottom trawl survey stations in the Northeastern and Central Districts.

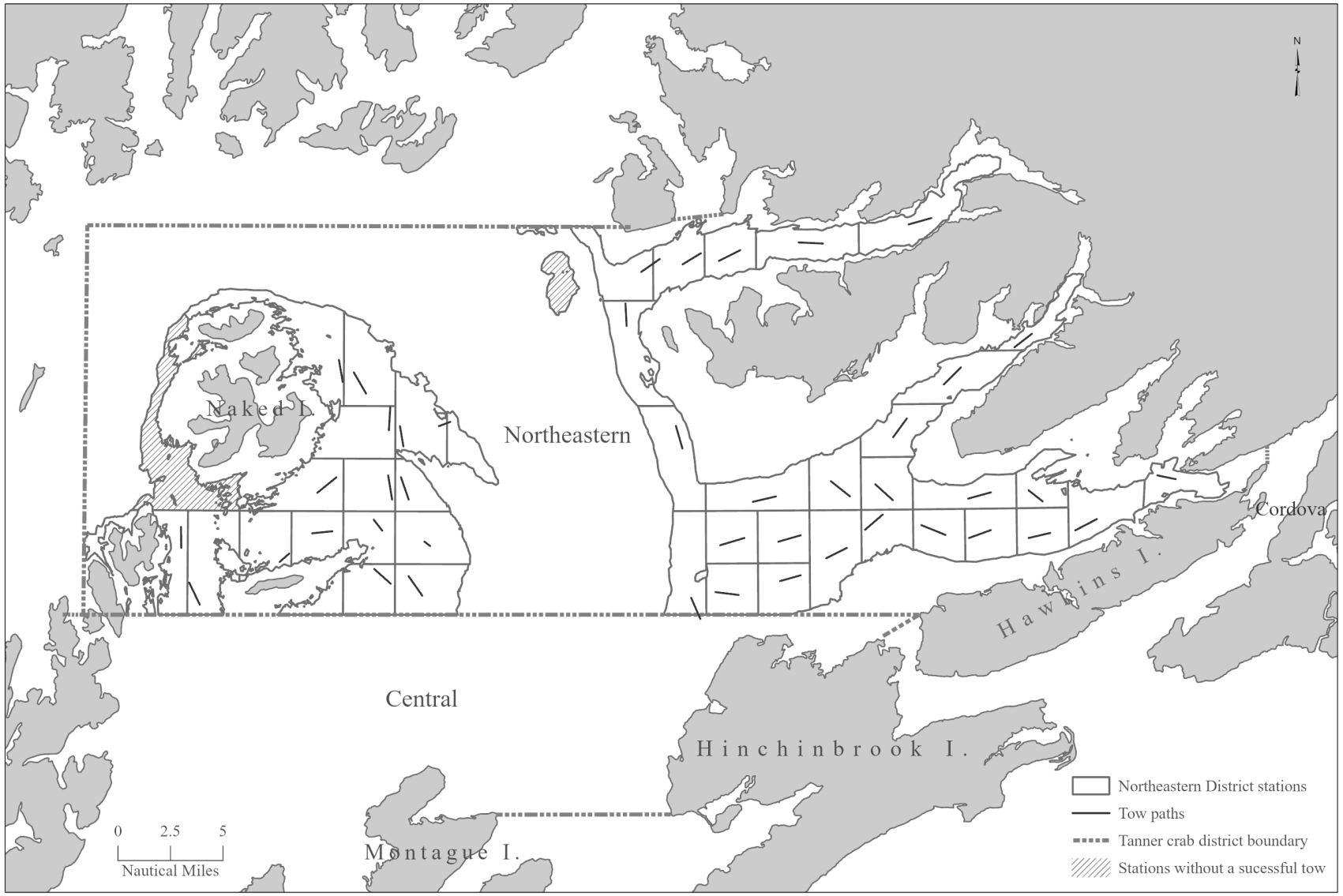

Figure 4.–Prince William Sound Area bottom trawl survey tows in 2022.

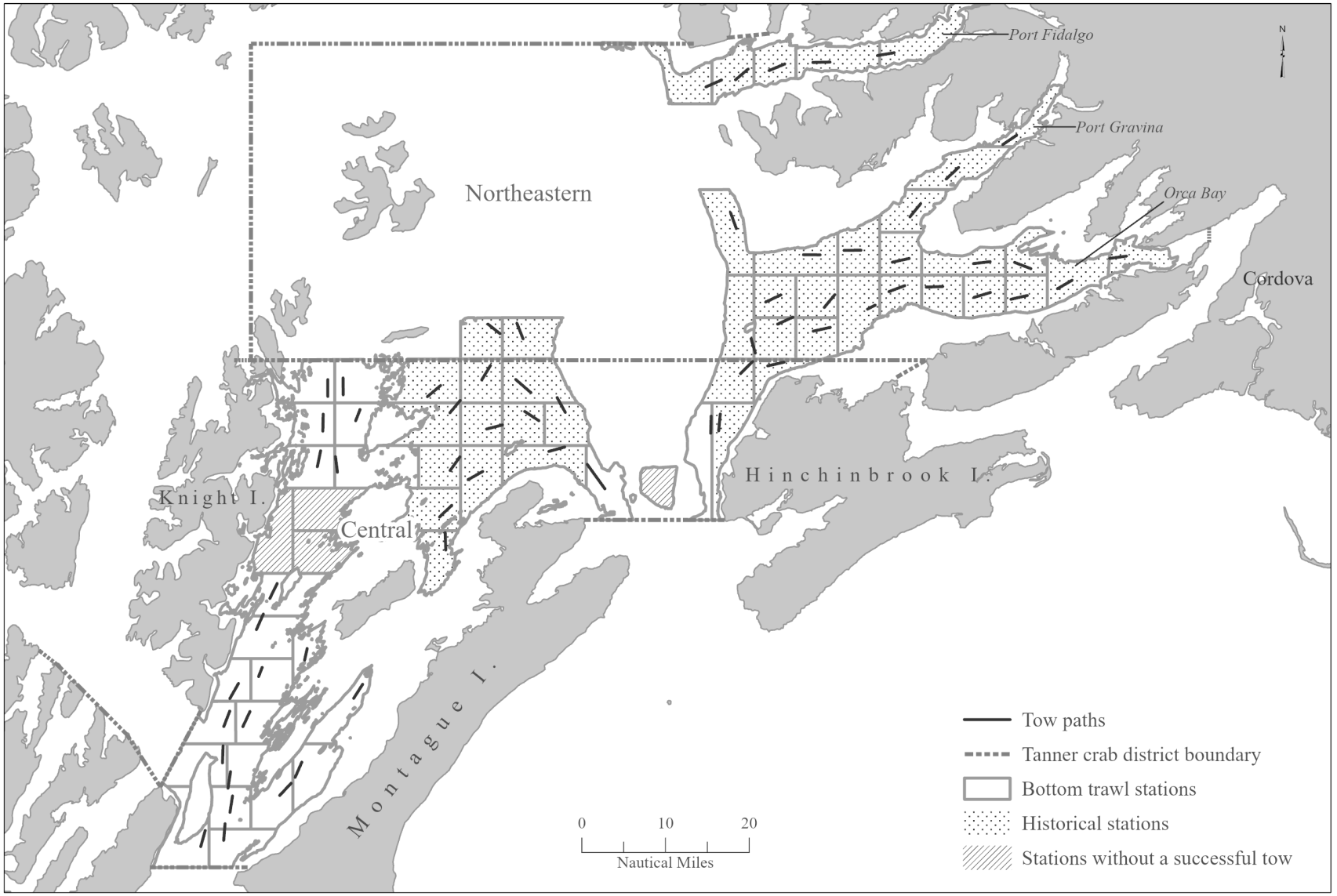

Figure 5.–Prince William Sound Area bottom trawl survey tows in 2023.

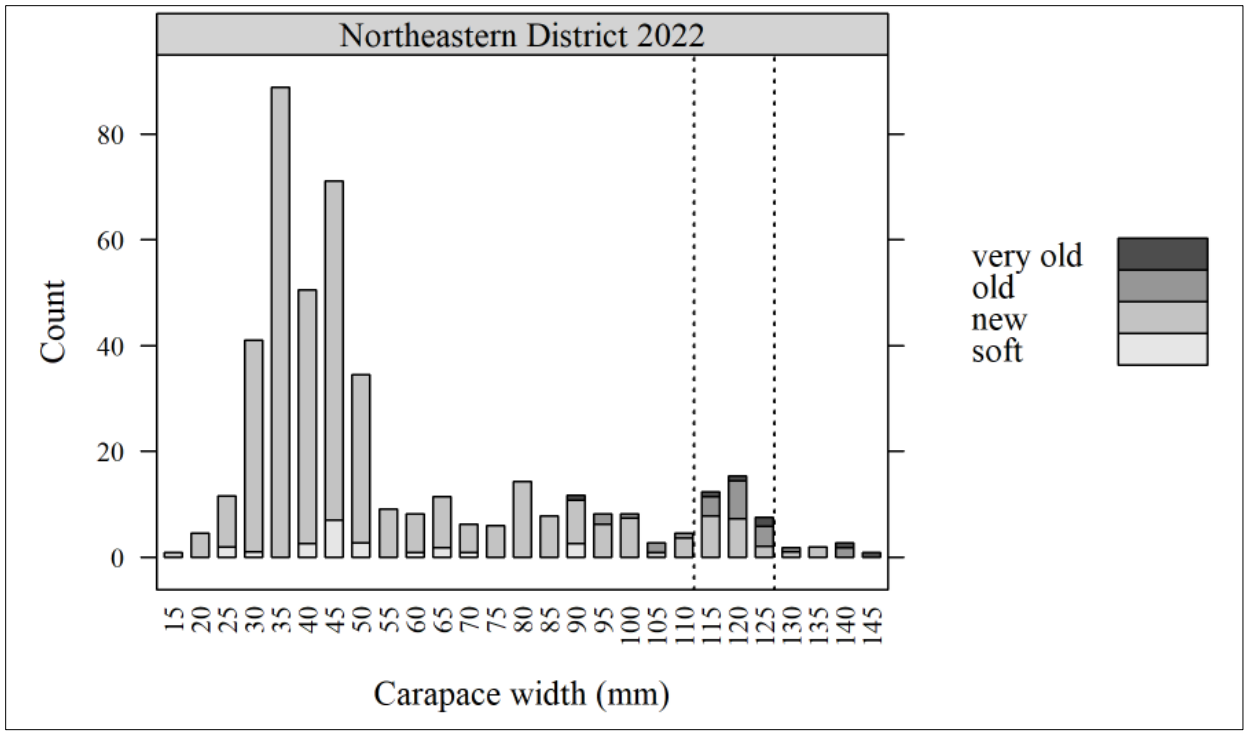

Figure 6.–Shell condition of Tanner crab caught in the 2022 Prince William Sound Area bottom trawl survey in the Northeastern District.

Note: Vertical dotted lines are size at morphological maturity (113 mm) and the legal size (127 mm).

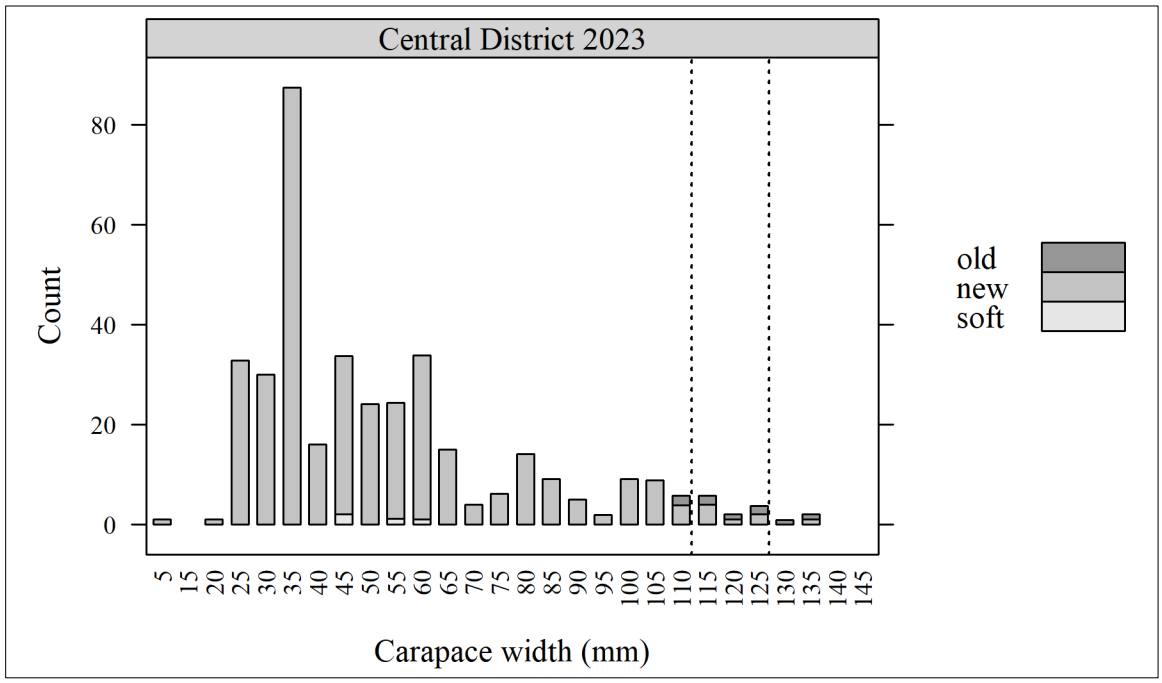

Figure 7.–Shell condition of Tanner crab caught in the 2023 Prince William Sound Area bottom trawl survey in the Central District.

Note: Vertical dotted lines are size at morphological maturity (113 mm) and the legal size (127 mm).

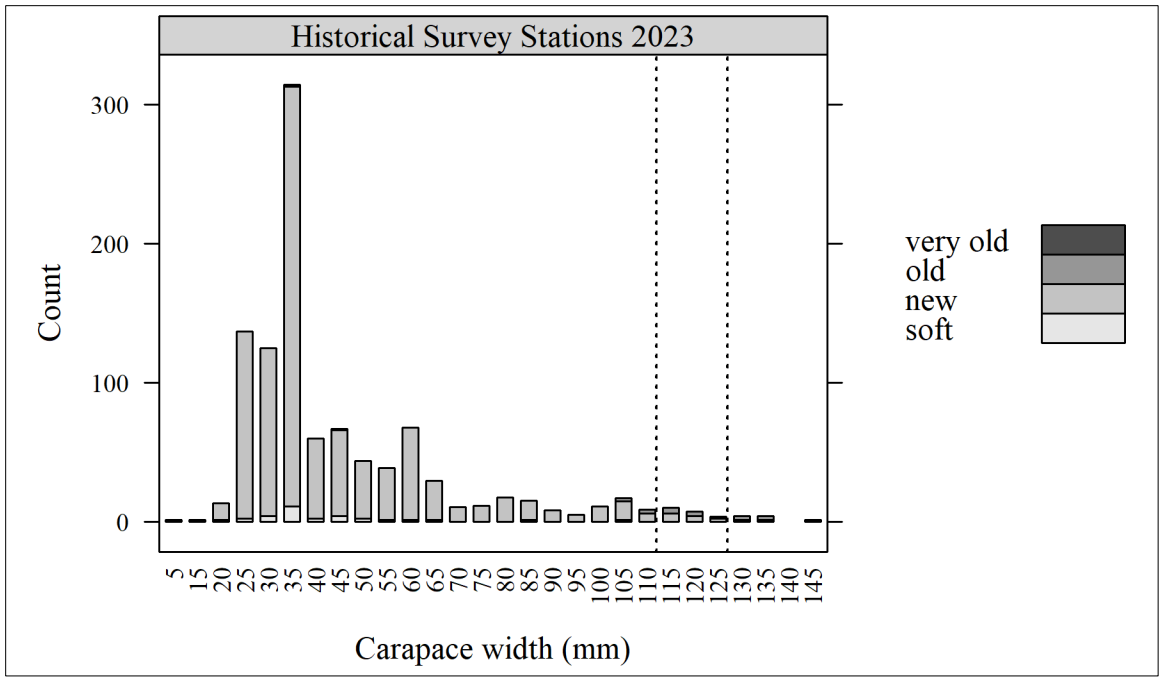

Figure 8.–Shell condition of Tanner crab caught in the 2023 Prince William Sound Area bottom trawl survey in the historical survey area.

Note: Vertical dotted lines are size at morphological maturity (113 mm) and the legal size (127 mm).

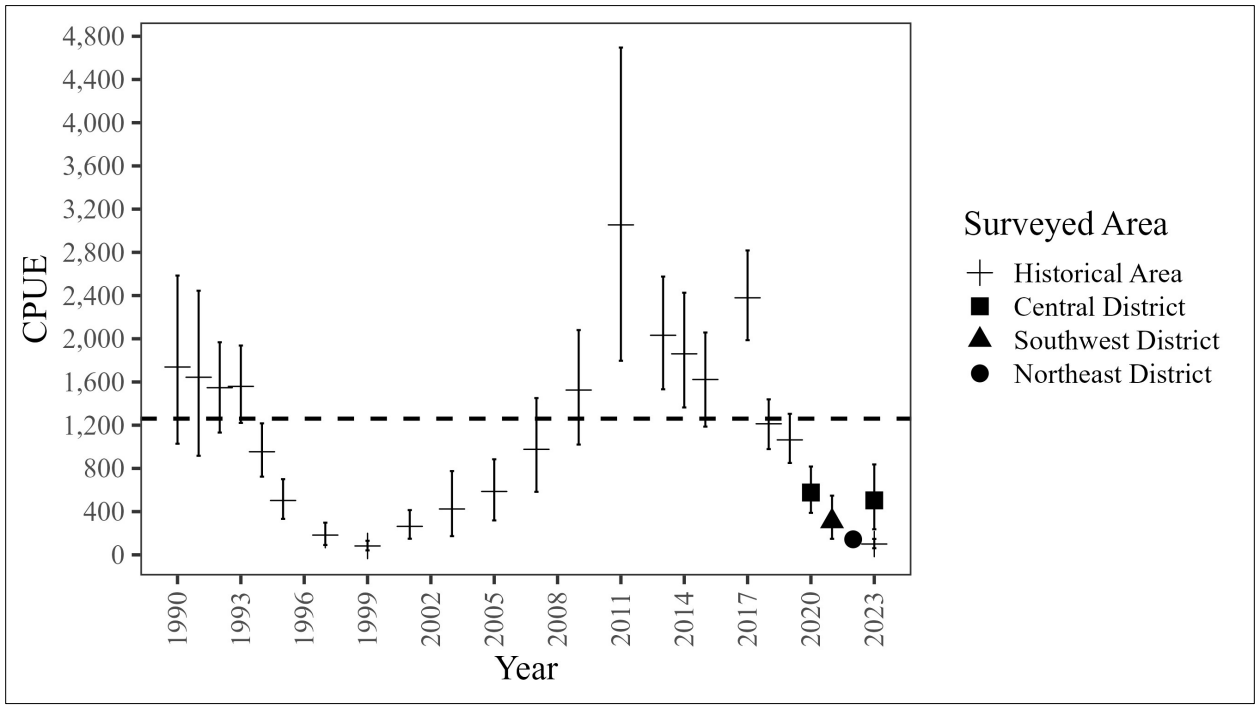

Figure 9.–Prince William Sound Area bottom trawl survey CPUE (crab per nmi2) of mature-size male Tanner crab.

Note: Vertical lines are 90% CI. The horizontal dashed line is historical area survey mean (1990–2019).

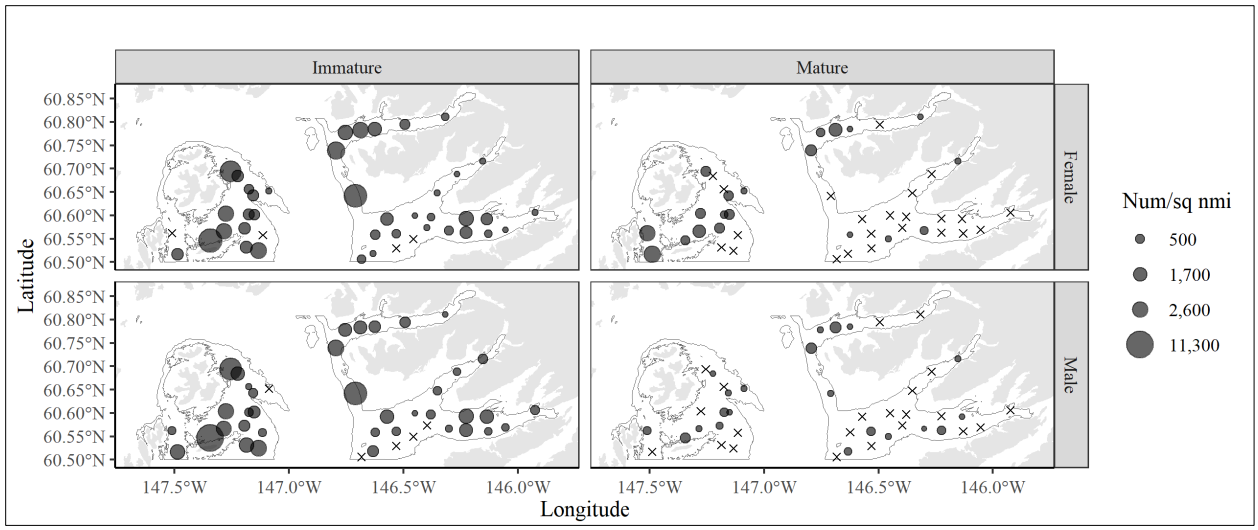

Figure 10.–Distribution of Tanner crab catches in the 2022 Prince William Sound Area bottom trawl survey in the Northeastern District.

Note: x indicates trawl tows with zero crab caught.

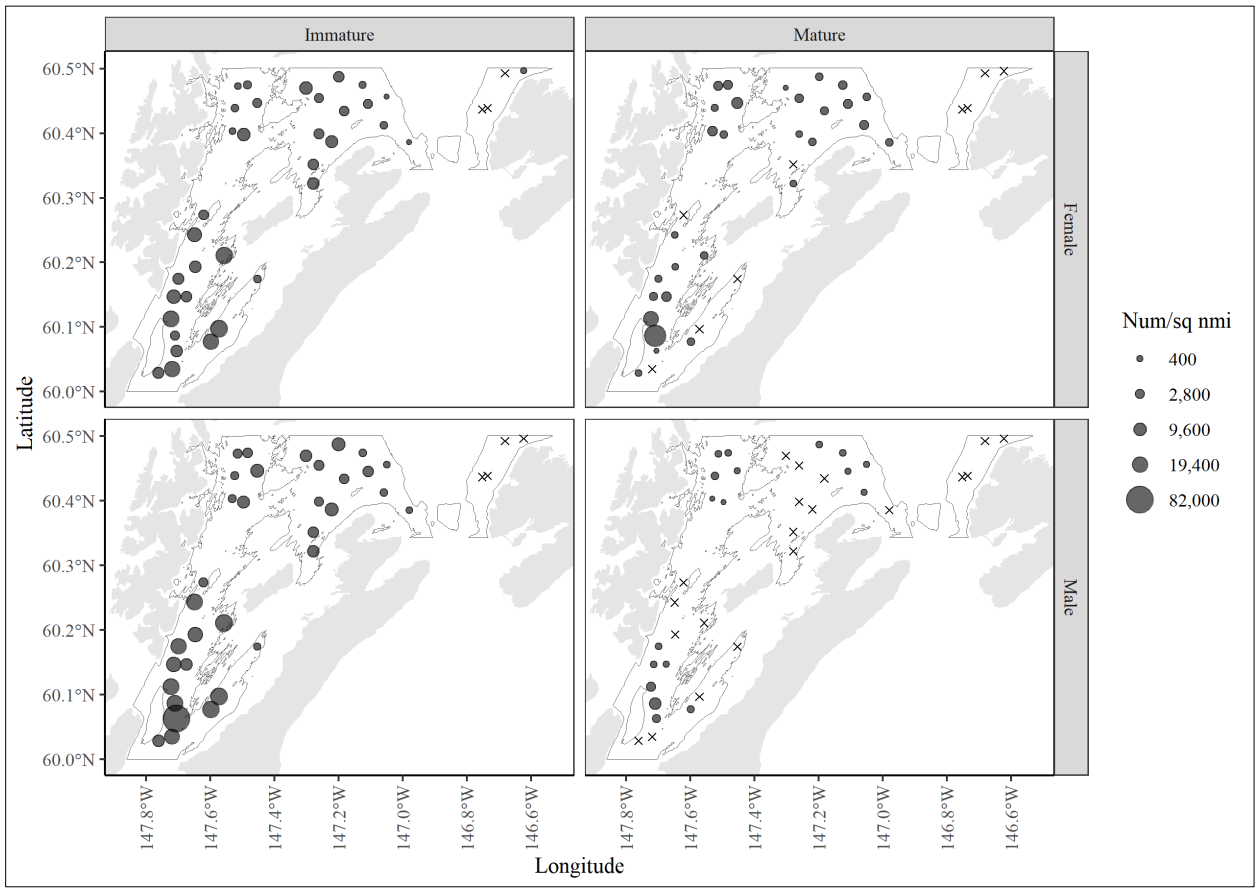

Figure 11.–Distribution of Tanner crab catches in the 2023 Prince William Sound Area bottom trawl survey in the Central District.

Note: x indicates trawl tows with zero crab caught.

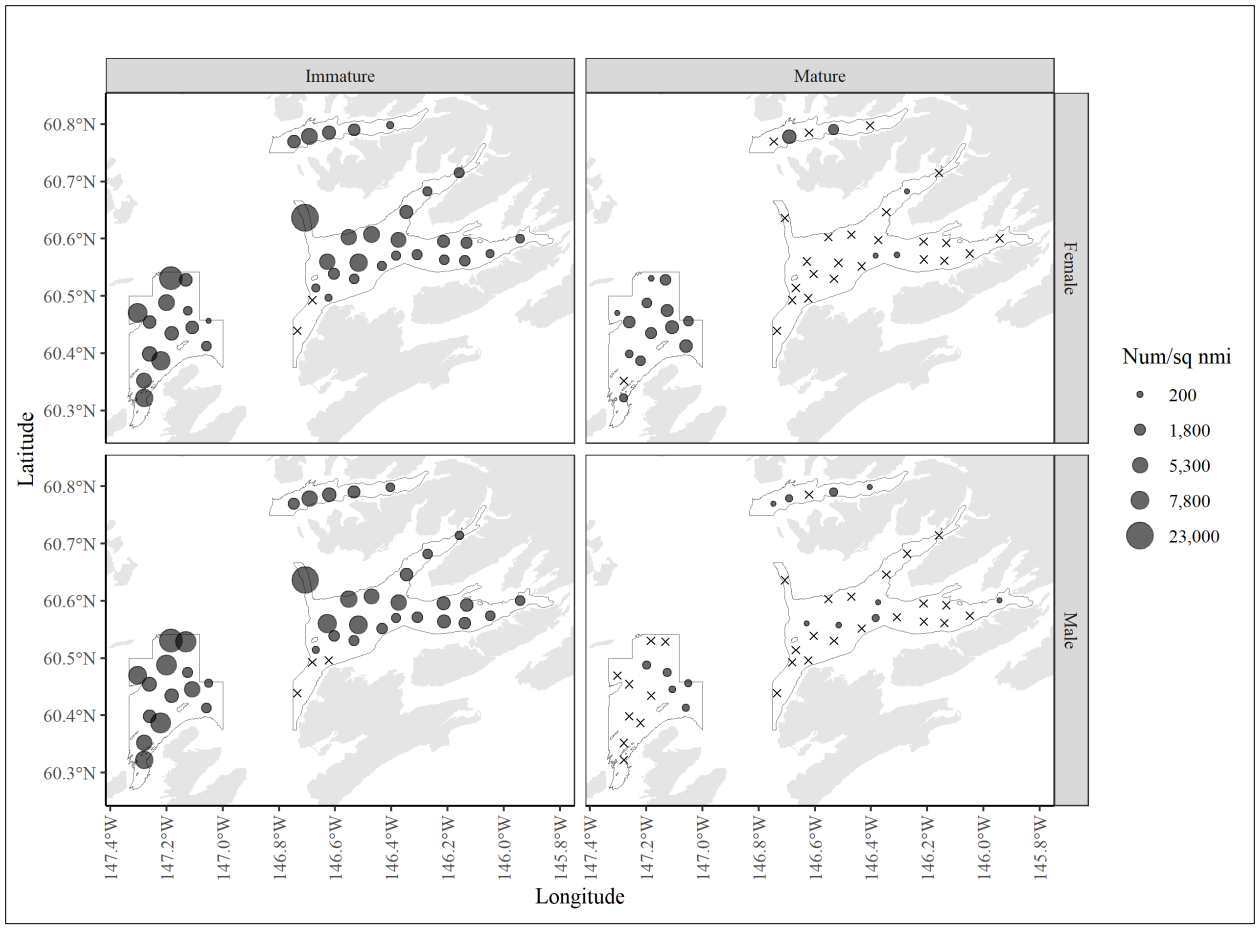

Figure 12.–Distribution of Tanner crab catches in the 2023 Prince William Sound Area bottom trawl survey in the historical survey area.

Note: x indicates trawl tows with zero crab caught.