Fishery Management Report No. 16-24

Cook Inlet Area and Prince William Sound Commercial Fisheries for Dungeness Crab, Shrimp, and Miscellaneous Shellfish through 2014

by

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

FISHERY MANAGEMENT REPORT NO. 16-24

COOK INLET AREA AND PRINCE WILLIAM SOUND COMMERCIAL FISHERIES FOR DUNGENESS CRAB, SHRIMP, AND MISCELLANEOUS SHELLFISH THROUGH 2014

by
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ABSTRACT

This report includes summaries of reported harvest and effort information and management actions for commercial Dungeness crab, shrimp, and miscellaneous shellfish fisheries managed by the Alaska Department of Fish and Game (ADF&G) in the Central Region, which includes the Cook Inlet (Registration Areas H and G) and Prince William Sound (Registration Area E) Management Areas. The Cook Inlet Management Area is bounded on the east by the longitude of Cape Fairfield (148°50.25′W long) and on the south by the latitude of Cape Douglas (58°51′N lat). The Prince William Sound Management Area is bounded on the east at 144°00′W long, near Cape Suckling, to the longitude of Cape Fairfield at 148°50.25′W longitude. ADF&G is responsible for the management of commercial, subsistence, and personal use Dungeness crab *Cancer magister*, weathervane scallops *Patinopecten caurinus*, hardshell clams, blue mussels *Mytilis edulis*, razor clams *Siliqua patula*, all shrimp species, and miscellaneous shellfish, which includes squid, octopus *Octopus dofleini*, green urchin *Stronglyocentrotus droebachiensis*, and sea cucumber *Parastichopus californicus* fisheries.

Key words: assessment, management, commercial, Alaska Board of Fisheries, Dungeness crab *Cancer magister,* spot shrimp *Pandalus platyceros*, coonstriped shrimp *Pandalus hysinotus*, northern shrimp *Pandalus borealis*, weathervane scallops *Patinopecten caurinus,* hardshell clams, littleneck clams *Protothaca staminea*, butterclams *Saxidomas giganteus*, blue mussels *Mytilis edulis,* razor clam *Siliqua patula*, squid, miscellaneous shellfish, octopus *Octopus dofleini*, green sea urchin *Stronglyocentrotus droebachiensis,* sea cucumber *Parastichopus californicus*

INTRODUCTION

This report provides information on Dungeness crab *Cancer magister*, shrimp, and miscellaneous shellfish fisheries in the Cook Inlet and Prince William Sound (PWS) Management Area (Central Region) managed by the Alaska Department of Fish and Game (ADF&G). ADF&G Division of Commercial Fisheries manages all commercial shellfish fisheries within state or territorial waters defined as those waters from the shoreline to 3 nautical miles (nmi) offshore and delegated fisheries within federal waters of the exclusive economic zone (EEZ) located 3–200 nmi offshore (Figure 1). In the EEZ, ADF&G manages fishing for all species not covered under a federal fishery management plan (FMP) developed by the North Pacific Fishery Management Council (NPFMC). Weathervane scallops *Patinopecten caurinus*, are managed by ADF&G in EEZ waters under authority of a federal FMP. The Alaska Board of Fisheries (BOF) establishes management regulations and ADF&G uses its emergency order (EO) authority to adjust fishing time and area. The BOF schedules regular, triennial meetings to consider proposals to change shellfish regulations.

Historically, Cook Inlet and PWS Management Areas have had commercial and personal use fisheries for Dungeness crab, weathervane scallops, hardshell clams, blue mussels *Mytilus edulis*, numerous shrimp species and miscellaneous shellfish. Hardshell clam refers to Pacific littleneck clams *Protothaca staminea* and butter clams *Saxidomus giganteus*. Miscellaneous shellfish includes octopus *Octopus dolfleini*, squid, green sea urchin *Stronglyocentrotus droebachiensis*, and giant sea cucumber *Parastichopus californius*. Many of these species are at the northern portion of their range.

Commercial, sport, and personal use fishing seasons for Cook Inlet Area shrimp fisheries closed by regulation beginning in 1997 due to low abundance, except personal use shrimping in waters of the North Gulf Coast opened in 2008. Similar regulations closed commercial fisheries for green sea urchin, sea cucumber, Dungeness crab, and a directed fishery for octopus.

In the Cook Inlet and PWS Management areas, there has been a shift in the dominant species since the late-1970s. Anderson et al. (1999) documented a regime shift in the Gulf of Alaska epibenthic community, which was once dominated by crustaceans and is now dominated by 2

species of gadid fishes: pollock *Theragra chalcogramma* and Pacific cod *Gadus macrocephalus*. This shift has manifested itself as less shrimp and crabs and more pollock and Pacific cod. Shrimp and other small-mesh trawl surveys conducted since 1953 have documented this shift in species dominance. The information collected from these long time data series provides evidence of a climate-driven regime shift in the Gulf of Alaska to a more groundfish-dominant community (Anderson 1999). There was speculation that in 1999, with the Pacific Decadal Oscillation (PDO) switching back to a cold-cycle combined with a couple of years of La Niña conditions, that there might be a shift back to pre-1977 relative species composition, but this has not occurred.

This report updates information on several commercially important shellfish species in the Cook Inlet and PWS areas through the 2014 calendar year (Trowbridge and Goldman 2006; Wessel et al. 2012). Commercial fisheries include spot shrimp *Pandalus platyceros*, sidestripe shrimp *Pandalopsis dispar*, and weathervane scallops. Subsistence fisheries for razor clams *Siliqua patula* also occur. Commercial fisheries for Dungeness crab are closed at this time due to low levels of abundance. Directed fishing for most other marine invertebrates, including squid, sea cucumbers, and sea urchins, may occur only under the conditions of a commissioner's permit issued by ADF&G. Lacking abundance and status information, any permits ADF&G issues for these species will include an approach for determining a harvestable surplus and obtaining funding for determining abundance. Harvest data for some species, within some years and areas, are confidential because there are less than 3 participants.

CENTRAL REGION MANAGEMENT AREAS

COOK INLET

The Cook Inlet Management Area consists of all waters west of the longitude of Cape Fairfield (148°50.25′W long) and north of the latitude of Cape Douglas (58°51.10′N lat). For all commercial shellfish fisheries, except for shrimp, this area is defined as Registration Area H and is divided into 7 shellfish districts: Northern, Central, Southern, Kamishak Bay, Barren Islands, Outer, and Eastern districts (Figure 2).

Commercial shrimp fisheries in the Cook Inlet Management Area are divided into registration Areas H and G. Area H has a different eastern boundary for shrimp than for other fisheries; the southern boundary is at the latitude of Cape Douglas, and its eastern boundary is a line running from 58°52′N lat, 151°53′W long to the westernmost tip of Cape Elizabeth (59°09.35′N lat, 151°53.13′W long) and ending at the westernmost tip of Point Adam (59°15.31′N lat, 151°58.68′W long; Figure 3). Shrimp Registration Area G, Outer Cook Inlet Area, was specifically established for the shrimp trawl and pot fisheries in coastal waters along the northern Gulf of Alaska and includes all waters of the Cook Inlet Management Area east of shrimp Registration Area H (to Cape Fairfield), and includes the Outer and Eastern districts (Figure 3).

The North Gulf Coast is defined for the personal use shrimp fishery in the Cook Inlet Management Area as the area extending from the longitude of Gore Point (59°12.00′N lat, 150°57.85′W long) to the longitude of Cape Fairfield, including the waters of Resurrection Bay (Figure 4).

PRINCE WILLIAM SOUND

The boundaries of the PWS Management Area (Registration Area E) historically included waters within PWS and territorial waters of Alaska outside of PWS between the longitudes of Cape Fairfield (148°50.25′W long) and Cape Suckling (143°53′W long). In 2001, the eastern boundary was moved to 144°00′W long, making the regulatory boundaries consistent among all state shellfish and groundfish fisheries (Figure 5).

The PWS Management Area is divided into the Inside and Outside Districts. The Inside District is defined as waters enclosed by lines from Point Whitshed to Point Bentinck, from Cape Hinchinbrook to Zaikof Point, and from Cape Cleare to Cape Puget. The Outside District, comprised of the Gulf of Alaska waters 0–3 miles from shore, is further divided into 2 sections, the Western and Eastern. The Western Section includes waters between Cape Fairfield and 147°00′W long and the Eastern Section includes waters between 147°00′W long and 144°00′W long.

MANAGEMENT CONSIDERATIONS

In the 1990s, there were concerns about the decreased abundance of many noncommercial and commercially harvested species of shellfish in the Cook Inlet and PWS areas. In 1997, the BOF adopted regulations that outlined 14 factors that ADF&G must consider prior to establishing management plans that allow for a commercial shellfish harvest. The factors included considering minimum acceptable biomass levels, maximum exploitation rates, stock assessment, operating and reporting requirements, avoiding biologically sensitive times of year, and several other considerations. The regulation outlining the factors to be considered in a management plan was repealed in 2009 with the development of new management plans and regulatory fishery closures.

Miscellaneous shellfish and shrimp fisheries currently prosecuted in the Cook Inlet Management Area are the Kamishak Bay District commercial weathervane scallop fishery, Upper Cook Inlet commercial razor clam fishery, commercial harvest of octopus as bycatch to other directed groundfish fisheries, and the North Gulf Coast personal use shrimp fishery. The commercial weathervane scallop fishery in Kamishak Bay was closed in 2013 and 2014 but was open for many years prior and is open for the 2015 and 2016 seasons in the northern portion of the district. In the Cook Inlet Area, there has been no commercial harvest of hard shell clams since 2006 and no harvest of blue mussels since 1998. Some of the 14 factors were used in the development of ADF&G management plans for Kamishak Bay District scallops, Southern District hardshell clams and mussels, and octopus in the Cook Inlet Area.

Miscellaneous shellfish and shrimp fisheries currently prosecuted in the PWS Management Area are the commercial and non-commercial shrimp pot fisheries, commercial shrimp trawl fishery, and commercial harvest of octopus as bycatch to other directed groundfish fisheries. The commercial weathervane scallop fishery in PWS has been closed in the West Kayak Subsection since the 2010/2011 season and in the East Kayak Subsection since the 2012/2013 season. ADF&G developed a management plan for octopus in PWS in 2012 (5 AAC 38.217).

WEATHERVANE SCALLOPS

The scallop fishery is managed jointly by the National Marine Fisheries Service (NMFS) and ADF&G under the federal FMP for the scallop fishery off Alaska. Most management measures

under the FMP are delegated to the State of Alaska for management under federal oversight. ADF&G management of the weathervane scallop fishery covers both state and federal waters off Alaska.

The current method of setting guideline harvest levels (GHL) for the Central Region commercial weathervane scallop fishery adheres to the recommendation that *F* (fishing mortality) be less than *M* (natural mortality), creating conservative and sustainable harvest levels. Managers typically apply a 0.05 harvest rate to the biomass estimate derived from the ADF&G biennial fishery-independent survey (Gustafson and Goldman 2012). The justification for the use of approximately 0.05 harvest rate is as follows: both survey and commercial fishery catch per unit effort (CPUE) has been low in recent years; however, a small surplus of scallops was still available for harvest. ADF&G's decision to use an exploitation rate that was either below or at the low end of estimates of natural mortality was to provide for fishing yet allow recruitment to increase biomass. Natural mortality estimates for weathervane scallops in Alaska have been reported to range from 0.04 to 0.25 (Kruse 1994; Kruse et al. 2005) with a median of 0.15 (Kruse 1994). Estimates of natural mortality from Kamishak Bay were 0.19 (Bechtol et al. 2009). To accomplish the previously stated goals, ADF&G chose an exploitation rate of approximately 0.05 to apply to survey biomass data to set the GHL and to consistently apply this level of exploitation until biomass levels increase and allow for greater harvest.

The fishery typically remains open until the GHL is achieved. However, through its EO authority ADF&G may close a season or area in response to declines in fishery CPUE or even apparent die-offs as occurred in Kamishak Bay in 2002. Additionally, in setting the GHL, ADF&G may consider other aspects of the survey results, such as a narrow size or age distribution or truncation of sizes observed within an area, to assist in the final management decision.

A comprehensive overview of the Alaska scallop fishery including harvest, survey, and observer data can be found in the *Stock assessment and fishery evaluation (SAFE) report for the weathervane scallop fishery off Alaska* (http://www.npfmc.org/safe-stock-assessment-and-fishery-evaluation-reports/) compiled by the Scallop Plan Team with contributions from Central Region ADF&G staff.

STATE FISHERY DEVELOPMENT

From the inception of the statewide Alaska scallop fishery in 1967 through mid-May 1993, the fishery was passively managed with minimal management measures. Closed waters and seasons were established to protect crabs and crab habitat. When catches declined in 1 bed, vessels moved to new areas. Although this management strategy may have been acceptable for a sporadic and low-intensity fishery, increased participation led to inconsistent harvest (Barnhart 2003).

In the early 1990s, the Alaska weathervane scallop fishery expanded rapidly with an influx of boats from the east coast of the United States. Concerns about overharvest of scallops and bycatch of other commercially important species, such as crabs, prompted the ADF&G Commissioner to designate the weathervane scallop fishery a high-impact emerging fishery on May 21, 1993. This action required ADF&G to close the fishery and implement an interim management plan prior to reopening. The interim management plan contained provisions for king and Tanner crab bycatch limits (CBL) for most areas within the Westward Region. Since then, crab bycatch limits have been established for the Kamishak Bay District of the Cook Inlet Area and for the PWS Area. The commissioner adopted the regulations and opened the fishery

on June 17, 1993, consistent with the measures identified in the interim management plan. The interim management plan included a provision for 100% onboard observer coverage to monitor crab bycatch and to collect biological and fishery data. In March 1994, the BOF adopted the interim regulations identified as the *Alaska Scallop Fishery Management Plan* (5 AAC 38.076).

In May 2000, the North Pacific Scallop Cooperative was formed by 6 of 9 License Limitation Program (LLP) owners under authority of the Fishermen's Cooperative Marketing Act, 48 Stat. 1213 (1934), 15 U.S.C. Sec. 521. The cooperative is self-regulated and is neither endorsed nor managed by ADF&G or NMFS. The cooperative regulates individual vessel allocations within the guideline harvest range (GHR) and crab bycatch caps under the terms of their cooperative contract. Non-cooperative vessels are not bound by any contract provisions. The cooperative does not receive an exclusive allocation of the scallop harvest. Some owners opted to remove their boats from the fishery and arranged for their shares to be caught by other members of the cooperative. Since formation of the cooperative, harvest rates have slowed and fishing effort occurs over a longer time each season.

Alaska's vessel-based limited entry program for weathervane scallops expired on December 30, 2013. In January 2014, the BOF implemented a new state-waters *Weathervane Scallop Management Plan* (5 AAC 38.078) that delineates additional tools needed to manage open-access weathervane scallop fisheries in the state waters of Alaska. The management plan applies to the Yakutat, PWS, Kodiak, and Dutch Harbor scallop registration areas, which all have scallop beds that span both state and federal waters. The new management plan was in addition to the existing *Alaska Scallop Fishery Management Plan* (5 AAC 38.076) that established registration, reporting, gear, and observer coverage requirements.

The state-waters management plan allows ADF&G to manage scallop beds in waters of Alaska separately from beds (or portions of beds) in adjacent federal waters if effort increases in the open-access state-waters fishery. The plan defines the scallop vessel registration year (April 1–March 31) and establishes an annual preseason registration deadline of April 1. It also requires a registered scallop vessel to have onboard an activated vessel monitoring system (VMS), permits ADF&G to establish trip limits, and allows for separate registrations for state and federal-waters fishing. The additional management measures are necessary to prevent overharvest of the weathervane scallop resource during an open-access fishery.

COOK INLET

Fishery Overview, Last 10 years

Data from Central Region's biennial fishery-independent scallop surveys are used to derive biomass estimates from which a GHL can be established, which are then in effect for the 2 subsequent seasons. A harvest rate of approximately 0.05 is applied to the estimated biomass derived from the survey, using whole weight to meat weight conversions to estimate meat weight yield for each bed and area (Gustafson and Goldman 2012). A gear efficiency coefficient of 0.83 is used to calculate an estimate of harvestable biomass for scallop GHL. The Kamishak Bay District has 2 scallop "beds," the north and south beds. Historically, the majority of harvest has occurred in the north bed.

The commercial weathervane scallop fishery in Cook Inlet will be open for the 2015 and 2016 seasons but only in a portion of the north bed, with the GHL set at 10,000 lb, the low end of the GHR in regulation (10,000–20,000 lb). The fishery was closed the past 2 seasons, 2013 and

2014, due to low levels of abundance. Biomass estimated from ADF&G surveys were not high enough to support a commercial fishery and stay within the GHR. In 2012, the most recent year the fishery was opened prior to 2015, only the north bed was opened. There was 11,739 lb of shucked meat harvested (including deadloss) with an average CPUE of 29.9 lb/hr and 392 total hours fished (Table 1).

The last 10 seasons were variable, although all effort and harvest occurred in the north bed. When the fishery was open, GHL ranged between 7,000 lb and 20,000 lb and CPUE ranged from 5 lb/hr to 30.8 lb/hr (Table 1). There were separate survey estimates and GHL for the north and south beds beginning in 2004. The south bed was open for 3 seasons, and then closed 2005 and 2006, opened with a GHL of 5,000 lb in 2007 and 2008, and closed again from 2009 through 2014. The south bed was closed in 2005 and 2006 because a scallop die-off was detected during the 2005 survey. However, the 2005 survey indicated a relatively stable biomass in the north bed, and the north bed GHL was achieved in 2005, but the fishery performance was poor during the 2006 season. There was no participation in the Kamishak Bay District scallop fishery from 2007 through 2009.

Until the closure in 2013, the fishery in the north bed was relatively stable for the prior 3 years. However, CPUE was still considerably lower (29 lb/hr average) than during the peak years of the fishery between 1993 and 2001 when CPUE averaged 54 lb/hr, with a high of 75 lb/hr in 2000. This fishery has been monitored closely with logbooks, shell samples, onboard observations, and skipper interviews.

Fishery Overview, Early Years

In 1983, the first commercial weathervane scallop landing in the Cook Inlet Management Area was recorded. Between 1983 and 2002, with the exception of 1 year, all landings came from the north bed in the Kamishak Bay District (Table 1). In 1987, decreasing CPUE caused concerns about the scallop biomass and abundance prompted ADF&G to issue an EO to close the fishery. The fishery reopened the following year but no fishing occurred; fishermen were concerned that poor performance would result in another emergency closure. There was no effort in this area from 1988 to 1992. In 1993, three fishermen harvested about 20,000 lb and fishery data indicated future potential for the fishery.

In 1995, harvest from a single vessel commercially fishing scallops in the PWS Management Area exploited a regulatory loophole that resulted in all scallop fishing to cease in federal waters, which included Kamishak Bay. Following this, a fishery-independent survey was conducted in Kamishak Bay that resulted in a GHL of 28,000 lb. The GHL was 20,000 lb from 1997 to 2002 and was harvested before the regulatory closure of the season in all of those years except 1998 (an inclement weather year).

One drastic decline in the Kamishak Bay fishery CPUE occurred in 2002 (Table 1) when a large scallop die-off occurred on the Kamishak Bay beds. This was first noticed in the fishery and then in the subsequent survey because large numbers of empty scallop shells were caught with valves still attached (cluckers). A large proportion of the scallops had a condition resulting in mortality; dead scallops were captured and they had valves that were connected and some lacked soft tissues, indicating that some had probably recently died and others may have been dead for some time, allowing for tissue degradation. No conclusive explanation was found for this mortality event, but there has been speculation it may have been caused by a polychaete worm infestation.

ADF&G staff from Homer are working with Dr. Brad Harris at Alaska Pacific University to examine the worm and mud blister levels in Kamishak Bay scallops.

Lower quality fishing in 2002 led vessels to shift effort to the south bed, which had not been previously exploited. Half of the scallops in this bed were older than 11 years (Trowbridge and Goldman 2006). In response to the declining CPUE, unexplained mortality in the traditional bed, and the lack of abundance information from the newly exploited southern bed, ADF&G reduced the 2002 fishery GHL to 9,000 lb during the season. The total harvest was 8,591 lb with a CPUE of 27.6 lb/hr; less than half the previous 3 years (Table 1).

The GHL of 20,000 lb was maintained from 1997 through 2004. Guideline harvests levels for the north and south beds were separated because information showed their abundance trends going in different directions. In 2004, harvest rates were very low in the north bed and ADF&G closed the fishery 4 days after it opened; and closed the south bed September 9 because catch rates were well below the previous season. After separate estimates were made, the north bed had more consistent abundance estimates than the south bed (Table 2).

Management and Regulations

The Kamishak Bay scallop beds are located in federal waters and there has been no fishing activity in state waters; therefore, new open-access state-waters fisheries regulations do not apply to the Cook Inlet Area. Commercial weathervane scallop fishing in federal waters off Alaska is limited by a Federal LLP, but participation in state waters (0–3 nautical miles) is open-access. The LLP limits participation in the statewide scallop fishery conducted in federal waters to 9 vessels.

In the Kamishak Bay District of the Cook Inlet Area, the season is August 15 through October 31. The Southern, Central, and Northern districts are within closed waters to scallop fishing established to protect crab and crab habitat. In the remaining Cook Inlet Area districts, the season is from January 1 through December 31, and to participate a commissioner's permit for exploratory fishing must be issued. In other state registration areas, the regulatory fishing season for weathervane scallops is July 1 through February 15. Scallop fishing may be closed by EO prior to the end of the regulatory season. Scallop GHL and crab bycatch limits are announced about a month before the season opens.

Regulatory GHR for traditional scallop fishing areas were established in the *Alaska Scallop Fishery Management Plan* (5 AAC 38.076) and adopted by the BOF in 1993. The high end of the GHR was determined by averaging historical harvest from 1969 to 1992, excluding some years when there was no effort or if early catches inflated harvest (Barnhart 2003). GHR are established for non-traditional registration areas, which are defined as the maximum sustainable yield (MSY) by the federal FMP. Other changes occurred after 1998, establishing a more conservative definition of MSY (and reduced optimum yield); GHR ceilings were reduced in many areas but not in the Kamishak District of Cook Inlet.

The BOF adopted regulations specific to Cook Inlet Area beginning in 1983 with a 6-foot width restriction for dredge gear, the only area to have this smaller gear size and a single-dredge limit. In 1985, BOF adopted regulations for the Kamishak Bay District including the GHR of 10,000–20,000 lb and season dates. Other regulations for gear are the same as the statewide regulations: rings have to be 4 inches or larger for the inside diameter and include other chafing gear specifications.

In the Kamishak Bay District, the Tanner crab bycatch limit is set at 0.5% of the survey-assessed crab abundance from the most recent dredge survey. The red king crab limit was fixed at 60 crabs in earlier years but has since been reduced to 30 crabs to be in line with the reduction in red king crab catch in trawl and dredge surveys in recent years. In the Kamishak Bay District fishery, vessels are required to collect a shell sample of 100 top valves from each trip for age determination and accommodate an ADF&G observer upon request. ADF&G staff are regularly deployed as onboard observers to collect scallop and crab biological data, catch composition information, and scallop catch data that is used to determine scallop deadloss. Onboard observers also verify fishery location, effort, and harvest data recorded in vessel logbooks and provide some inseason management capability. The Kamishak Bay District scallop fishery was closed in 2013 and 2014, and observer data from the 2012 fishery, including shell height and age distribution, is summarized in the most recent SAFE report published in March 2014 by the NPFMC Scallop Plan Team (NPFMC 2014).

Research

ADF&G has conducted biennial dredge surveys for weathervane scallops in the Kamishak Bay District of the Cook Inlet Management Area (Figure 6) since 1996, and the most recent survey was in 2015. Survey data are used to estimate abundance and biomass and to then set a GHL for 2 scallop beds in Kamishak Bay. Estimated scallop abundance from the north bed surveys has been at lower levels in the past 3 surveys compared to estimates in 1996, 1999, and 2001, which were 10 million scallops and higher (Table 2; Figures 7 and 8). Survey biomass estimates decreased from 5 million scallops to their lowest level of 1.9 million in 2013. Similarly, abundance estimates from the south bed have declined dramatically; the first 3 surveys in 2003, 2005, and 2007 resulted in estimates of between 3.9 million and 9.4 million lb. Recent estimates have been less than 2.8 million, with a low of 1.9 million in the 2013 survey.

In 2007, the Kamishak Bay survey area was standardized (Gustafson and Goldman 2012). The establishment of a standardized survey area was done in a manner that enabled all previous years of survey data to be comparable; all historical survey catch data (from 1996 through 2006) were entered into ArcView GIS and, for each year, a polygon was drawn around all stations where the catch exceeded the previously established threshold of 9.1 kg/nm (20 lb) per tow. Ancillary stations are surveyed outside these standardized areas as time and funding permit, allowing ADF&G to look for changes in bed size or shape.

Age assessment of Central Region scallops was conducted by visually enumerating the annuli. Twenty weathervane scallop shells were collected from each tow for age assessment from research dredge surveys. The first age reading occurred onboard the research vessel and second age reading occurred in the lab. Discrepancies in ages within and between readers are resolved through re-ageing and agreement by multiple age readers. If agreement cannot be reached, the sample is discarded. Scallop shells were also collected from the commercial fishery for age assessment.

Survey data provided whole weight, meat weight, and shell height data, which were used to establish GHL for the next 2 seasons. Some research on survey gear efficiency has been conducted in the Kayak Island scallop survey (which is the other location scallop surveys are conducted in Central Region; see next section of this report) resulting in an estimate of 0.83 (Gustafson and Goldman 2012). This gear efficiency estimate has been applied to Kamishak Bay since 2009.

PRINCE WILLIAM SOUND

Fishery Overview, Last 10 years

PWS harvest occurs in a small portion of the management area off Kayak Island and typically more than 3 miles from shore, placing most fishing effort in federal waters. The open waters were divided into 2 subsections (Figure 9). The commercial weathervane scallop fishery has been closed in the West Kayak Subsection (WKS) since the 2010/2011 season and in the East Kayak Subsection (EKS) since the 2012/13 season. Both subsections will remain closed for the 2015/2016 season because of declining biomass estimates generated from a biennial survey conducted since 2004. The GHL in the EKS declined from 26,000 lb in the 2004/2005 season to 8,400 lb in the 2010/2011 season and in the WKS from 24,000 lb in the 2004/2005 season to 5,000 lb in the 2010/2011 season (Table 3).

Fishery CPUE have ranged from a high of 111 lb/hr in the 2006/07 season to a low of 48 lb/hr during the 2009/10 season (Table 3). This fishery was monitored closely with logbooks, shell samples, onboard observations, and skipper interviews.

Fishery Overview, Early Years

The commercial fishery for weathervane scallops in the PWS registration area began in 1992 near Kayak Island, and its history reflects a continuous progression of regulatory changes, management measures, and fishing practices. The fishery developed during a phase of industry expansion and transition from short trips with iced product to extended trips with product frozen onboard (Barnhart 2000; Shirley and Kruse 1995).

In 1992, fishing began in late February, and the GHL of 64,000 lb of scallop meat was generated inseason using area-swept methods and a 10% harvest rate for the area east of 147°00′W long. (Figure 9). The fishery closed in April with a harvest total of approximately 208,836 lb of meat by 4 vessels (Table 3). The discrepancy between the 1992 GHL and actual harvest was attributed to a lack of timely and accurate catch reporting and insufficient data about the scallop biomass.

In addition to the eastern area GHL, the area west of 147°00′W longitude was given an initial GHL of 5,000 lb to provide opportunity for exploratory fishing.

A Tanner crab bycatch cap was established in 1993 as 0.5% of the Kayak Island Tanner crab commercial harvest implemented during the 1980–1983 crab seasons (500 crab).

The 1993 fishery opened July 15 with a 50,000 lb GHL and closed July 18, and 7 vessels landed 63,068 lb of meat. There was no commercial scallop season in 1994 due to a change of season dates from July 1 to January 10. The 1995 weathervane scallop season opened January 10 and closed by EO January 26 when the 50,000 lb GHL was attained. Subsequent to the 1995 closure, an unlicensed vessel fished the Kayak scallop bed but remained outside territorial waters. This action identified a loophole in the Magnuson Fishery Conservation and Management Act (MFCMA) in which a vessel not licensed or registered by the State of Alaska could not be restricted from fishing scallops managed by the state in federal waters. Federal fisheries managers subsequently closed all scallop fisheries in federal waters off Alaska, but not before an estimated additional 60,000 lb of meat were harvested near Kayak Island (Table 3). Commercial scallop fishing remained closed in federal waters through the 1996 PWS season and federal fisheries regulations were restructured. Similarly, the state-waters season in the eastern area also

remained closed in 1996 to avoid overharvest of the scallop resource near Kayak Island, and no effort occurred in the western area.

The 1997 fishery opened on January 10 and closed on January 19, with a GHL of 17,200 lb and harvest of 18,000 lb. The 1998/1999 season opened July 1; waters east of the longitude of Cape Saint Elias closed on July 2, and waters west of the longitude of Cape Saint Elias closed on July 4, with a harvest total of 19,650 lb. The 1999/2000 weathervane scallop fishery opened on July 1. The eastern area closed July 3 and the western area closed July 4, with a harvest total of 20,410 lb (Table 3). This season and the previous season are notable because they are the shortest on record. Prior to the 2001 regulatory season, the vessel cooperative formed (see *State Fishery Development section*). The formation of the cooperative in the Kayak fishery considerably reduced the race to fish.

Fishery CPUE during the early years (1992–2000) ranged from 99 lb/hour in 1993 to 137 lb/hr between 1999 and 2000 (Table 3).

Management and Regulations

The Kayak Island scallop beds and management area are primarily located in federal waters but do cross into state-waters. Although new open-access state-waters fisheries regulations apply, the fishery has been closed since they were enacted. Commercial weathervane scallop fishing in federal waters off Alaska is limited by a Federal LLP, but participation in state waters (0–3 nautical miles) is open-access. The LLP limits participation in the statewide scallop fishery conducted in federal waters to 9 vessels.

Although vessels were initially given substantial liberty to explore potential fishing areas, waters inside of PWS and adjacent waters of the Gulf of Alaska were closed in 1994 to scallop dredging due to concerns for the bycatch of depressed Tanner and Dungeness crabs (Figure 9). Additionally, in 2000, the BOF adopted a regulation restricting the scallop fishery to the Eastern Section of the Outside District. This measure provided the opportunity for some exploration and protected unassessed areas. Beginning in 2001, Tanner crab bycatch caps were set at 0.5% of the Tanner crab population estimate from the 2000 scallop assessment survey. This resulted in bycatch limits of 2,700 crabs in EKS and 8,700 crabs in WKS. The open season for weathervane scallops is July 1 through February 15 (adopted in 1997), unless closed earlier by EO. Current management measures include the following:

1. area registration requirement (a maximum of 2 valid area registrations at one time under certain conditions),
2. gear restrictions, including 4.0-inch ring size and a maximum of two 15-foot width dredges,
3. an industry-funded observer program, with mandatory observer coverage,
4. a guideline harvest range of 0–50,000 lb of shucked meat,
5. a crew size limit of 12,
6. crab bycatch limits set by ADF&G,
7. ADF&G specified catch reporting, and
8. required logbooks.

Research

In August of 1995, ADF&G initiated a fishery-independent scallop survey in waters east of Kayak Island to assess abundance and biomass and effects of the postseason harvest. ADF&G

returned in 1996 to conduct a systematic area-swept assessment using an 8 ft New Bedford style dredge. The dredge was equipped with a liner to maximize retention of all sizes of scallops so they could be sampled for age and size composition and sexual maturity. Survey results indicated recruitment to the Kayak Island bed was very low with only 11% of sampled scallops younger than age-7, and therefore a conservative GHL of 17,200 lb of scallop meat was warranted for the 1997 season (Bechtol and Bue 1998).

In 1995, ADF&G began conducting scallop surveys around Kayak Island (Bechtol et al. 2009). Scallop beds were determined to occupy fairly discrete and limited areas with the highest concentrations in federal waters. Results of the assessment survey indicated age-9 and age-10 year classes primarily composed the population. Variable recruitment was one determinant in applying the conservative exploitation rates of 4% and 8% to biomass estimates for areas east and west of the longitude of Cape Saint Elias. Using this approach, the calculated The GHL for 1998/1999 and 1999/2000 for these 2 areas were 6,000 lb and 14,000 lb of scallop meat. This survey established the precedent of conducting a biennial survey to establish a GHL for both waters east and west of Cape Saint Elias for 2 consecutive fishing seasons (Table 3; Figure 10).

Although the 2000 assessment survey showed increases in biomass, age composition data from the 2002 survey indicated poor recruitment. The 2002 survey also experienced survey gear difficulties. As a precaution, ADF&G applied the GHL from the 1998 assessment for the 2002/2003 and 2003/2004 seasons. The 2004 survey indicated the highest biomass recorded, and a GHL was established for waters east and west of Kayak Island by applying harvest rates of 5.2% and 5.3% to the respective population estimates. Justification for the increased GHL included evidence of recruitment, relatively low harvest rates, and comparison of dredge and video data (Gustafson and Goldman 2012).

Scallop surveys conducted at Kayak Island between 2006 and 2012 indicated a declining trend in biomass in both beds, although the 2010 survey of the eastern area was incomplete due to weather and equipment failure (Table 4).

The 2014 survey of the WKS and the EKS yielded an estimated abundance of 5.1 million and 2.1 million scallops, respectively (Table 4). The age structure data indicated that 60% of the scallops in the WKS and 37% of the scallops in the EKS were aged-7 or less. Although this suggests the potential for future recruitment to the fishery, there were low numbers of the large, older individuals targeted by the fishery. Although the biomass in the WKS increased since the area was last surveyed in 2012, the biomass in the EKS was at the lowest point in the history of the survey. Commercial scallop fishing was closed for the 2012/2013 and 2013/2014 seasons. Closing both subsections to fishing for 2 seasons should allow the biomass to increase and provide recruitment. The next survey will be spring 2016.

OCTOPUS AND SQUID

COOK INLET

Harvest and Effort

Annual commercial octopus harvest in the Cook Inlet Management Area historically ranged from 435 lb to 48,067 lb, with between 0 and 41 vessels making landings (Table 5). In more recent years, harvest in the Cook Inlet Area occurred mainly as bycatch during the Pacific cod pot fishery.

There has been some interest in a directed fishery, but because there is already a management plan for the fishery and no fishery-independent abundance information is available for the Cook Inlet Management Area, directed harvest has not been permitted.

Management and Regulations

Octopus is considered a shellfish under state regulation; however, octopus is designated as "other groundfish" under federal regulations. In 1997, regulation 5 AAC 38.390 was adopted, which closed all state waters to commercial fishing for octopus until a management plan was adopted. Commercial octopus remained open in adjacent federal waters. Therefore, ADF&G set a 20% bycatch allowance for octopus during groundfish fisheries in state waters.

In 1999, the BOF adopted 5 AAC 38.360. *Cook Inlet Area Octopus Management Plan*, which established octopus as bycatch only but set an annual GHL of 35,000 lb and kept the bycatch allowance at 20% of the targeted harvest. Once the annual GHL is achieved, retention of octopus is not allowed, and octopus must be released. Octopus retention has closed 8 times in the past 10 years.

PRINCE WILLIAM SOUND

Harvest and Effort

There is no directed fishery for octopus in PWS. However, octopus is harvested incidentally to the Pacific cod pot fishery and more recently in the shrimp pot fishery. Octopus harvests first exceeded 1,000 lb in 1992 and attained the highest harvest of 5,798 lb by 7 vessels in 34 landings in 1994. Octopus harvests from 1992 to 1998 averaged 3,400 lb, with no reported harvests between 1999 and 2001 and 2006 and 2009, and averaged approximately 500 lb annually since 2010 (Table 6).

There is no directed fishery for squid in PWS. However, squid is harvested incidentally to the commercial pollock trawl fishery and to some extent in the shrimp trawl fishery (Wessel et al. 2014). Since 1989, the harvest of squid has ranged from 0 lb in some years to 180,250 lb by 3 vessels over 22 landings in 2002 (Table 6). All harvest in 2002 occurred as bycatch in the pelagic trawl fishery for pollock, primarily in Port Bainbridge and waters north of Hinchinbrook Entrance (Figure 11). Although the 2002 squid bycatch level was a dramatic increase over previous years, it was unclear whether the increase resulted from fishing practices or changes in the relative abundance of squid and pollock (Wessel et al. 2014).

Management and Regulations

The PWS *Registration Area E Octopus Management Plan* (5 AAC 38.217), which permits the retention of octopus commercially caught as bycatch to other directed fisheries, was adopted by the BOF in March 2012.

The plan sets an annual GHL of 35,000 lb. In directed fisheries for groundfish, octopus may be retained as bycatch up to 20% by weight of the directed species onboard a vessel. In directed fisheries for shrimp, octopus may be retained in an amount not to exceed 35%, by weight, of the shrimp onboard the vessel.

Subsequent to the 2002 harvest of 180,250 lb of squid, squid bycatch in the pollock fishery was managed to no more than 3% of the round weight of pollock onboard, with no more than 5% bycatch overall, set in regulation to encourage more efficient fishing practices. ADF&G will

continue to monitor squid bycatch in the pollock fishery so that the harvest cap is not exceeded. Squid bycatch has not been utilized for commercial purposes but has become very popular with cannery workers for personal consumption.

RESEARCH

The giant octopus *Enteroctopus dofleini* is found in the waters of the Cook Inlet and PWS Management Areas. Research conducted on this species shows it has a maximum age of 3 to 5 years (Gillespie et al. 1998) and sexual maturity occurs between 1.5 and 2 years. Most octopus species spawn only once because both sexes stop feeding and die within several weeks after spawning; the female protects and maintains water flow over the eggs until her death, which may occur before the eggs hatch.

ADF&G has not conducted directed research on octopus in Alaska, but octopus are caught in the Kachemak Bay, Kamishak Bay, and PWS multi-species large-mesh trawl surveys. The minimum individual weight recorded was 8.8 lb and the maximum weight was 47 lb caught in the Kachemak Bay survey between 1989 and 2013. In the Kamishak Bay trawl survey conducted from 1990 to 2012, the minimum individual weight recorded was 1.2 lb and the maximum weight was 26 lb. In the PWS trawl survey, between 1997 and 2014, the minimum average weight recorded was 1.0 lb and the maximum was 6.0 lb (Table 7). Trawl surveys do not cover octopus habitat or target them. However, catch can be used as an index of abundance within the relatively flat, muddy bottom trawl survey habitat.

In 2006, University of Alaska scientists working in the Cook Inlet Management Area attempted to develop an abundance estimate. The viability of using a mark–recapture study was examined by tagging octopus caught in Pacific cod pots. There were 97 octopus tagged with Peterson discs and visible implant elastomer tags. The data collected from this study suggested that the visible implant elastomer tags were more effective at marking octopus, but no abundance estimate was developed (Barry et al. 2011).

Beginning in 2011, an assessment of the "octopus complex" was conducted by NOAA fisheries because it had previously been included in the "other species" complex. In compliance with the reauthorized Magnuson-Stevens Act, there was a need to establish an annual catch limit specifically for octopus. Knowledge about the octopus in the GOA was poor, but some research was initiated in recent years.

NOAA has been conducting research on capture/tagging methods and determining life history information on the giant Pacific octopus in the Gulf of Alaska. They found that these octopus have a protracted reproductive cycle with peak spawning occurring in the winter to early spring months. Mating occurs several months before spawning and females have the ability to store sperm. Giant Pacific octopus in the Gulf of Alaska mature between 10 kg and 20 kg and have a fecundity of approximately 100,000 eggs per female. Life expectancy for the giant Pacific octopus is 4.5–5 years based on aquarium studies (Conrath and Conners 2014).

One of the goals of Conrath and Conners (2014) study was to find the best method for octopus capture. Different materials were used for the traps, and plywood box pots caught the most octopus and were the easiest to handle. They caught octopus over a wide range of sizes, which included the size range caught during commercial fishing. Tagging with visible implant elastomers was used and found to be effective to mark octopus; there was no evidence of mortality caused by the handling and tagging.

ADF&G has sampled commercial landings of octopus harvested as bycatch to Cook Inlet Area Pacific cod pot fisheries since 2000, and annually since 2005 (Table 8). Octopus are generally landed in gutted condition and the landed weight is converted to whole weight. The average weight has ranged from 10.1 kg (22.2 lb) in 2000 to 15.5 kg (34.1 lb) in 2002 (Table 8). Average weight has been consistent for the past 4 years, at or just below 13.0 kg (28 lb). Sex ratio by percent female appears to be on a decreasing trend; the highest proportion of females were observed in 2000 (62%) and the lowest in 2013 (35%); the proportion of females in 2014 was 39%. Octopus sampling occurs opportunistically and the highest number of samples (n = 265) was collected in 2014.

SHRIMP

COOK INLET NORTH GULF COAST PERSONAL USE FISHERY

Harvest and Effort

The North Gulf Coast personal use (NGC PU) shrimp fishery is the only shellfish fishery that is currently open annually in the Cook Inlet Management Area (Figure 4). The fishery is regulated by annual permits. Harvest information was reported in gallons or numbers and then converted to lb. The conversion used is 1 gallon equals 2.4 lb equals 43 shrimp, developed from a conversion method used by ADF&G PWS area staff in 2012.

From 2008 to 2014, the number of permits issued annually has remained at a similar level. The permit return percentage has been high; email, letter, and phone reminders have helped with compliance. The number of issued permits that fished for shrimp has varied, with a low of 24% in the 2014 season and a high of 75% in 2010 (Table 9).

In 2014, there were 150 permits issued for the NGC PU shrimp fishery, and 93% (139) of the permits were returned (Table 9). Of those returned permits, 37 permits (24%) were fished. There were 457 total pot lifts, with a combined soak time of 2,545 hours yielding a total harvest of 215 lb of whole shrimp and an average CPUE of 0.5 lb/pot (Table 10). In 2013, the total harvest and effort were higher (409 lb total, fishing 602 pots), but the average CPUE was similar at 0.4 lb/pot (Table 10).

In 2013 and 2014, the majority of NGC PU shrimp effort and harvest occurred in Aialik Bay Statistical Areas 495937, 495936, and 495932 (Figure 4). In 2014, 67% (140 lb) of the harvest occurred in the Aialik Bay area, and in 2013, 78% (318 lb) was harvested in these statistical areas. Resurrection Bay had the second highest effort in both 2013 (116 pot lifts) and 2014 (143 pot lifts), but the harvest was low: 30 lb in 2013 and 19.8 lb in 2014.

Management and Regulations

Recreational shrimp fisheries in the Cook Inlet Area were closed since 1997 until the NGC PU shrimp fishery was established by the BOF in 2006. The NGC PU fishery is administered through a fishery-specific permit required to participate. Only Alaska residents possessing a valid Alaska resident sport fishing license or Alaska residents exempt from licensing under AS 16.05.400 may participate in the fishery. No permits were issued in 2006 and 2007.

The original fishery area included waters from Cape Aialik west to Gore Point. However, in 2012, the BOF expanded the NGC PU shrimp fishery area to include additional waters between Cape Aialik and Cape Fairfield, including Resurrection Bay (Figure 2).

The personal use season for shrimping with pot gear in NGC waters is from April 15 through September 15. Legal gear for the fishery is 5 pots per person and a maximum of 5 pots per vessel. Each shrimp pot must meet the tunnel eye, mesh, and biodegradable escape mechanism requirements as described in 5 AAC 77.509, 5 AAC 77.511, and 5 AAC 39.145.

The permit has undergone changes through the years to better define fishing locations. The 2014 permit allowed participants to report either gallons or number of whole shrimp. Reporting shrimp by species was not required, and the harvested species could be a mix of spot shrimp, coonstripe shrimp *P. hypsinotis*, and Northern (pink) shrimp *P. borealis*, although the targeted and primary species was spot shrimp.

Research

There is no current directed research on North Gulf Coast shrimp. Post-fishery monitoring occurs with permit information. Previous research is described in the next section.

COOK INLET HISTORICAL TRAWL FISHERIES (AREAS H AND G)

Harvest and Effort

Currently, commercial trawl harvest of shrimp is closed in shrimp Registration Area H (Cook Inlet inside waters including Kachemak Bay) and shrimp Registration Area G (includes the Outer and Eastern Districts of the Cook Inlet Management Area) (Figures 2 and 3). Fisheries existed in these 2 areas historically.

In shrimp Registration Area H, from the 1969/1970 season through the 1982/1983 season, commercial trawl harvests ranged from 3 million to almost 6 million lb with an average harvest during this period of about 5 million lb. After a significant drop in harvest of nearly 2 million lb in the 1982/1983 season and a dramatic decrease in the 1983/1984 season to 525,508 lb, the fishery continued with low harvests for the next 3 seasons and then was closed by EO beginning in the 1987/1988 season until the BOF closed it by regulation from 1997 to 2014 (Table 11).

In shrimp Registration Area G, commercial trawl harvest of shrimp from the 1977/1978 season to the 1994/1995 season ranged from 0 to approximately 2.0 million lb, with 0 to 11 vessels participating (Table 12). Harvest from the 1982/1983 through 1987/1988 seasons was predominately northern shrimp. From the 1991/1992 season through the 1996/1997 season, the harvest was primarily sidestripe shrimp (Trowbridge and Goldman 2006). In 1997, the fishery was closed and has remained closed to the present.

Management and Regulations

Regulations adopted in 1997 clearly state that there are no open commercial fishing seasons for shrimp in Registration Areas H and G in the Cook Inlet Management Area (5 AAC 31.310 and 5 AAC 31.410).

Research

ADF&G is not currently conducting any shrimp surveys in the Cook Inlet Management Area. However, in Registration Area H, ADF&G conducted small-mesh trawl surveys in Kachemak Bay from 1971 through 2003. These surveys were used to determine the annual GHL for the shrimp trawl fishery; they were discontinued because of low shrimp abundance and reduced research budgets. In 2004, external funding was obtained that allowed these surveys to continue through 2006.

ADF&G conducted surveys annually in May from 1971 to 1975. During the peak of the fishery, surveys were conducted semiannually in May and October from 1975 to 1990. May surveys were conducted annually from 1991 to 1993 and biennially from 1993 to 1997. Surveys from 1997 through 2006 were conducted in April or May. From 1971 to 1974, the survey used a 66-foot Nordby net. Beginning in 1975 the net was changed to a 61-foot high opening shrimp net designed by NMFS. The net was changed because in comparative tows, the 66-foot Nordby trawl net was 50% as efficient as the NMFS net (Davis 1982). Beginning in fall 1988, fish bycatch was also enumerated, which provided valuable information on additional species and served to better document a species composition shift from shrimp to fishes that occurred in the mid-to-late 1980s (Anderson et al. 1997; Anderson and Piatt 1999). Changes in gear, survey design, and analysis (e.g., stratified versus unstratified methods of biomass estimation) did not allow for direct comparison of results from all years. Results from 1971 through 1975 can be found in Hammarstrom (1990), and results from 1977 through 1990 can be found in Gustafson and Bechtol (2001). Although there was an increase of 2 nmi^2 in the total area of the survey between 1988 and 1989, consistency from 1977 through 2006 did provide a solid index for shrimp and fishes in Kachemak Bay (Goldman et al. 2007; Figure 12).

Small-mesh trawl surveys showed a decline in the pandalid shrimp numbers in Kachemak Bay. Along with the decrease in shrimp and other invertebrate numbers was a large, relative increase in fishes, specifically flat fish and gadids (Pacific cod and pollock). These changes were related to shifting climate regimes that caused changes in community structure; from a system dominated by crustaceans to one dominated by groundfishes (Anderson 2000; Anderson and Piatt 1999). However, the general nature of biological reactions to large changes in environmental parameters or large-scale events like the PDO are poorly understood (Litzow 2006).

Small-mesh trawl survey stations were selected from the pool of potential stations with water depth greater than 120 ft. Stations were historically selected at random from the pool of potential stations. In 1984, the survey design was changed to fixed-stations with the same stations sampled each survey in an effort to reduce net damage (Trowbridge and Goldman 2006).

Survey efforts in Kachemak Bay were focused in the central portion of the bay, with the survey design dividing the study area into a grid of approximately 1.0 nmi^2 stations and 4 strata (Figure 13), using the 61 foot high opening shrimp net. Stratified area-swept estimates of biomass were calculated from survey data (Figure 12).

In response to the BOF adoption of a sunset date of July 31, 2006 for the *Outer Cook Inlet Area Shrimp Fisheries Management Plan*, a 3 year grant-funded study was implemented to assess shrimp abundance and biomass in 3 bays on the outer coast of the Kenai Peninsula. The primary goals of this study were to 1) begin gathering data to assess the current distribution and levels of pandalid shrimp abundance and biomass in the area and 2) to assist in establishing a sustainable management strategy for the area. The objective was to begin a time series data set that can later be used (in a stock assessment) to examine the potential for reopening the shrimp trawl fishery.

Survey efforts on the outer coast of the Kenai Peninsula focused on locations where the historical fishery occurred: Resurrection Bay, Aialik Bay, and Harris Bay (Figure 14). The surveys were conducted April 29–May 3, 2005; October 11–15, 2006 (due to inclement weather in May 2006); and May 25–29, 2007.

Survey design, sampling methods and data analysis mimicked the latter years of the small-mesh trawl survey in Kachemak Bay, with 1.0 nmi^2 stations and using the 61-foot high opening shrimp net. One-half of the grid squares were designated as black and one-half as white (i.e., checkerboard style); black or white was randomly selected. If a grid square could not be trawled in (e.g., due to rocky bottom or presence of underwater cables), an adjacent grid square was sampled in its place. Only stations with a depth greater than 20 fathoms (36.6 m) were sampled. There was a substantial glacial influence to the geography and oceanography in the area, including the presence of glacial moraines in most bays; therefore, data from each bay were not expanded to the total area of the bay but to the trawlable area within each Bay (Figure 14). The trawlable area within and immediately adjacent to each grid square setup for each bay was calculated using ArcView GIS so that the expansion of results were restricted to the area surveyed.

Both stratified and unstratified biomass index estimates were evaluated for this study (Cochran 1977). After ADF&G staff examined the data from 2005, it was determined that post-stratifying the data by geographic location reduced the variance and percent error in the shrimp estimates; hence, data from 2006 and 2007 were also analyzed using that method.

Stratified biomass estimates were made for all 3 survey years and all bays (Table 13). Pink shrimp estimates for 2006 were an order of magnitude higher than in 2005, and although sidestripe shrimp estimates increased between 2005 and 2006, they were not nearly to the degree that was observed in pink shrimp. The 2005 and 2006 survey data are not comparable at this time because the 2005 survey was done in the spring and the 2006 survey was done in the fall; therefore, the data cannot account for a possible seasonal component affecting catch rates. This could, however, explain why the catch (total and in lb/nmi) and the biomass estimates are so much higher in the 2006 survey. However, this cannot be tested because there is only a sample size of 1 for each season.

These survey results serve as preliminary estimates of sidestripe shrimp abundance but do not allow for harvest levels to be set. These data represent a 3-year time period from which decisions cannot (and should not) be based. Without additional data, it is hard to detect any trends in relative abundance.

Although pandalid shrimp were distributed throughout the survey area, the majority of the biomass resided in the upper parts of these bays (fjords), which indicated a lack of sustainable harvest due to the small geographic area involved. It was difficult to assess whether this was the case in the commercial fishery because the statistical areas are larger than the survey area.

COOK INLET HISTORICAL POT SHRIMP FISHERIES (AREA H AND G)

Harvest and Effort

Pot shrimp commercial and noncommercial fisheries are currently closed in shrimp Registration Areas H and G (Figure 3). Historically, commercial harvest occurred in the Southern District of Area H with small harvests in Area G. Commercial harvests from the Southern District increased rapidly through the 1970s and declined in the mid-1980s before being closed in 1988 (Table 14). Harvest peaked in the 1973/1974 season at 801,346 lb and decreased dramatically to 5,323 lb in the 1988/1989 season; after which the fishery was closed early and not opened since.

Effort was higher in Area H than Area G during the pot shrimp fishery with the number of vessels in Area H as low as 9 and peaking at 51 in the 1977/1978 season. The primary target of

the fishery in Area H was coonstripe shrimp and spot shrimp were caught in smaller quantities. For Area G, the number of vessels ranged from a high of 13 participating in 1983 to less than 3 for the last 3 seasons of the fishery before closing in 1997 (Table 15). More specific information about the fishery is documented in Trowbridge and Goldman (2006).

Management and Regulations

Regulations adopted in 1997 clearly state that there are no open commercial fishing seasons for shrimp in Registration Areas H and G in the Cook Inlet Management Area (5 AAC 31.310 and 5 AAC 31.410).

Research

Since 1986, no shrimp pot surveys have been conducted in Area H. There is a large-mesh trawl survey in Kachemak Bay, but this has shown no signs of shrimp recovery of any of the marketable species.

Historically, coonstripe shrimp abundance in the Southern District was monitored by 3 separate methods: research via an index based on trawl surveys (1971–1982), harvest of coonstripe shrimp in the commercial shrimp trawl fishery (1970/1971 to 1982/1983), and shrimp pot index surveys (1978–1982). Results from these surveys are documented in a research report by Trowbridge and Goldman (2006).

PRINCE WILLIAM SOUND SHRIMP POT FISHERY

Historical Fishery

Commercial shrimp landings were first documented in 1960 when approximately 5,000 lb were harvested (Table 16). The historical fishery occurred within the Inside District of PWS, primarily in the traditional harvest area, which encompassed the northern and western shores of PWS from Port Valdez to Whittier and the entire southwest portion of PWS (Figure 15). From 1960 to 1977, harvest ranged from 0 in 1961 and 1966 to approximately 25,000 lb in 1974. The shrimp pot fishery expanded rapidly between 1978 and 1982 as local markets were established and major harvest areas located. Early seasons were open year-round with no harvest restrictions.

From 1982 to 1984, seasons were shortened to April 1 through November 30, and the first GHR of 75,000–145,000 lb was adopted. Despite the shortened season, catch increased to approximately 214,000 lb in 1982 and effort increased to 79 vessels in 1984 (Table 16). Beginning in 1985, the BOF established a split season of March 15 through June 30 and August 15 through December 5, with a GHR of 75,000–100,000 lb each season. The split season was intended to reduce harvests during the egg bearing periods. An experimental harvest area in Montague Strait with no closed season was also established. Due to incomplete and late catch reporting, coupled with harvest from the experimental fishing area, harvests substantially exceeded the GHR over the next few years. Total shrimp harvest peaked at approximately 290,600 lb in 1986 and effort increased to 86 vessels in 1987.

Harvest declines beginning in 1988 indicated potential conservation problems. The *Exxon Valdez* oil spill on March 24, 1989, complicated prosecution of the 1989 fishery in which 33 vessels harvested 29,315 lb. In 1990, the year-round harvest in the experimental area was discontinued, this area was included with the traditional harvest area, and the spring season was shortened. Also in 1990, a gear limit of 150 pots was adopted along with mesh size restrictions to encourage the escape of undersized shrimp. In 1991, a limited commercial fishery with a conservative GHR

of 10,000–40,000 lb was closed after 46 days of fishing. The fishery yielded 17,580 lb taken by 15 vessels in 45 landings (Table 16). Fishery performance in 1991 indicated low shrimp abundance. In 1994, the BOF changed the PWS pot shrimp GHR to 0–100,000 lb. The commercial fishery was closed by EO between 1992 and 1999. In 2000, the BOF closed the fishery until the population rebuilt and a new management plan was adopted. The fishery remained closed for 18 years (1992–2009).

Harvest and Effort

The PWS commercial shrimp pot fishery reopened in 2010 and has been prosecuted for 5 seasons. The 2014 PWS commercial shrimp pot fishery was prosecuted in Area 2 and the GHL was set at 66,600 lb (Figure 16). A total of 68,464 lb of shrimp was harvested by 33 permit holders on 32 vessels in 214 landings, and the fishery closed by EO on August 14. Harvest included 64,220 lb spot (93.8%), 4,085 lb coonstripe (6.0%), and 158 lb sidestripe shrimp (0.2%) (Table 17).

Guideline harvest levels in the PWS commercial shrimp pot fishery between 2010 and 2013 ranged between 51,240 lb (2012) and 66,300 lb (2013). The first year after reopening, the fishery had the highest participation (75 vessels), with all other years having participation between 32 and 45 vessels. The majority of harvest and effort occurred during the first 6 weeks of the fishery with an average of 64% of total harvest occurring during this time (2010–2014). Between 82% and 93% of the GHL was taken the 2 years that the fishery occurred in Area 1 (2010 and 2013). The GHL was achieved in the 2 years the fishery occurred in Area 2 (2011 and 2014). In 2012, when the fishery occurred in Area 3, the season closed on July 15 because of a consistently low CPUE and only 42% of the GHL was harvested. Low CPUE and effort being geographically widely spread suggested that shrimp abundance throughout Area 3 was low compared to Areas 1 and 2. In 2015, the fishery occurred in Area 3 again (Table 17).

Management and Regulations

A new management plan for the PWS commercial shrimp pot fishery was adopted by the BOF in March of 2009 with small revisions in subsequent BOF meetings. Specific regulations included the following:

1) A harvestable surplus of more than 110,000 lb must exist before a commercial harvest may occur.
2) Forty percent of the harvestable surplus is allocated to the commercial fishery.
3) The fishery occurs within the Inside District and is rotated on an annual basis between 3 different areas described in 5 AAC 31.210(a) (1), (2), and (3).
4) Each season, ADF&G determines the number of shrimp pots that may be operated from a vessel based on total number of registered vessels, estimated catch per unit effort, and magnitude of the guideline harvest level, with the maximum number of allowable pots set at 100.
5) Shrimp pot gear may only be deployed and retrieved between the hours of 8:00 AM and 4:00 PM, unless modified by EO.
6) Stringent reporting regulations require all shrimp fishermen to contact ADF&G weekly and require catcher-sellers and catcher-processors to contact ADF&G before landing to provide all harvest information.
7) Shrimp pots deployed on a longline consisting of 5 or more pots must have a buoy marking each end.

8) No more than 50% of the guideline harvest level may be harvested from any 1 statistical area (25% restriction adopted in 2012 and increased to 50% in 2015).

Statewide commercial shrimp regulations describe buoy marking, maximum tunnel size, and a biodegradable escape mechanism. Area shrimp pot regulations specify that a pot may not have 1) more than 1 bottom, a vertical height of more than 24 inches, 2) more than 4 tunnel eye openings, or 3) a bottom perimeter exceeding 124 inches. Additionally, a shrimp pot must be entirely covered with net webbing or rigid mesh and at least 2 adjacent sides or 50% of the vertical or near vertical sides must be covered with net webbing or rigid mesh that allows the unaided passage of a seven-eighths inch dowel. The PWS Area was originally designated a superexclusive registration area for vessels fishing for shrimp with pot gear, and it was re-designated as an exclusive registration area at the 2012 BOF meeting when it was determined that superexclusive was not defined for shrimp. A vessel may only fish in 1 exclusive registration area during a registration year. A commissioner's permit is required to fish in the eastern area to allow monitoring of effort and catch with mandatory logbooks and ADF&G contact.

The opening of the commercial fishery is dependent on the results of a surplus production model, which determines the harvestable surplus of spot shrimp in PWS (Wessel et al. 2015). Results of the model are available in early February, when an announcement is made as to whether or not the commercial fishery will occur. If a commercial fishery is allowed, participants must register at area offices by April 1. The registration deadline enables ADF&G to estimate effort in the fishery each season.

Immediately following the registration deadline, ADF&G sets gear limits and initial fishing periods based on the number of vessels registered relative to the GHL, expected CPUE, and likely participation. In 2010, gear limits were set at a maximum of 20 pots per vessel when 155 vessels registered for the fishery, although only 75 vessels participated (Table 17). In subsequent years, fewer vessels registered and even fewer vessels participated; gear limits have varied accordingly. In 2013, ADF&G began using inseason harvest and effort information to increase or decrease gear limits inseason when appropriate. Between 2010 and 2014, initial fishing periods varied between 4 days and 15 days. Short periods at the beginning of the fishery help to limit effort and harvest until the pace of the fishery is evident. At this point, inseason reporting is sufficient for management goals to be met and the season can remain open to harvest.

Hours of gear operation have been consistently relaxed by EO to between 8:00 AM and 8:00 PM in order to allow fishermen to take advantage of the most favorable tide conditions to operate their gear. In 2011, 2013 and 2014, the gear deployment hours were extended to 6:00 AM to 10:00 PM daily late in the season to increase gear efficiency by increasing soak time and allowing fishermen more time to relocate gear.

Stringent reporting requirements have allowed ADF&G to closely monitor harvest and effort. This facilitated meaningful inseason management decisions, such as the closing of Copper Bay to commercial harvest during the 2012 season when a decline in CPUE was detected.

The PWS pot shrimp fishery was open for 5 seasons and conducted twice in Area 1 and Area 2 and once in Area 3. Certain trends have become apparent that are meaningful to management. Typically, about 50% of the registered vessels participate each season. Effort is always highest during the first few periods of the fishery and then effort declines significantly by June. Area 1 has higher participation than Area 2, which has higher participation than Area 3; this may be due

to distances from specific ports. Area 3 has lower catch rates compared to Area 1 and Area 2; a lower abundance was also shown in the ADF&G survey in Area 3 (Wessel et al. 2015).

Research

In 1989, as part of the Exxon Valdez oil spill (EVOS) damage assessment process, ADF&G initiated an annual survey using pot gear to assess spot shrimp in PWS (Trowbridge 1992, 1994). During these first 3 years of the survey, the number of pots set at each survey site was variable. Between 1989 and 1991, six stations were set on the survey: Unakwik, Golden, Culross, Herring Bay, north Chenega, and Green Island (Figure 16). Two depth strata were fished during these 3 years: 20–70 fathoms and 70–120 fathoms. Starting in 1992, two more stations, south Chenega and Prince of Wales, were added to the survey and depths fished were standardized to range from 20 to 80 fathoms because survey catch rates dropped precipitously at depths below 80 fathoms in previous surveys (Trowbridge 1994). In 2009, the Green Island station was eliminated due to regular gear loss from heavy currents, and a new survey site was added at Long Bay. In 2012, another new survey site was added at Bald Head Chris to provide better area coverage, and in 2013 an additional survey site was added in the Valdez Arm area to obtain fishery-independent data in this area of high noncommercial effort and harvest. Beginning in 1992, the survey was standardized with 4 strings of 11 pots each set at each survey site annually (Figure 16). Each string of standardized gear had pots spaced approximately 10 fathoms apart on a groundline with buoys at each end.

Data from the shrimp pot survey, specifically CPUE and sex ratios, were used to make management decisions in the 1991 fishery and subsequent years when the fishery was closed by EO. Sex ratios are important because spot shrimp are protandrous hermaphrodites, first recruiting to the fishery as males and as they get larger, transitioning to females. The majority of harvest are typically larger shrimp, which are females (Trowbridge 1994).

Catches in the PWS shrimp pot index survey produced a CPUE for spot shrimp and showed a decline from 0.71 lb/pot in 1992 to 0.29 lb/pot in 1998 (Table 18). After 1998, survey catches demonstrated a slow but steady increase in abundance and biomass, from 0.29 lb/pot to a high of 2.56 lb/pot for all shrimp in 2008, with an average of 1.97 lb/pot over the last 5 years (2010–2014; Figure 17). Similarly, survey results from the index survey for commercially-marketable shrimp with a carapace length of 32 mm or greater also increased from 0.14 lb/pot in 1998 to a high of 1.68 lb/pot in 2011. The catch of these larger shrimp averaged 1.43 lb/pot over 2010–2014.

Although the ADF&G damage assessment study following the EVOS concluded that PWS spot shrimp may have declined as a result of overfishing, environmental conditions were probably instrumental in both the decline and slow recovery of spot shrimp in PWS, in addition to other shellfish populations throughout the Gulf of Alaska (Trowbridge 1992; Bechtol 1997). Successive area depletion, insufficient harvest records, and transmission of harvest information during the historical PWS shrimp pot fishery probably contributed to CPUE declines, and the result was a widespread decrease in spot shrimp abundance. Spot shrimp are a sedentary species and data indicate they do not migrate out of an area after settling, making them particularly susceptible to serial depletion.

Survey results are currently used to assess the relative abundance of spot shrimp in PWS and these data, along with survey CPUE and total catch weight, are used in combination with harvests from the commercial and noncommercial fisheries each year to model the harvestable

surplus of spot shrimp in PWS. Model results provide the following year's total allowable harvest (TAH) and GHL for both commercial and non-commercial spot shrimp fisheries (Wessel et al. 2015).

PRINCE WILLIAM SOUND SHRIMP TRAWL FISHERY

Harvest and Effort

Historical PWS shrimp trawl landings date to the early 1970s but the fishery did not develop until the late 1970s, when several vessels harvested northern (pink) shrimp from Icy Bay and adjacent waters of southwest PWS. Harvest and effort in the fishery peaked in 1984, with approximately 1.3 million lb and 14 vessels, before declining to 245,870 lb and 3 vessels in 1986 (Table 19). As the fishery for northern shrimp declined due to low abundance, reduced exvessel value, and limited processing capabilities, a fishery targeting sidestripe shrimp began to develop.

Commercial harvests of sidestripe shrimp were first documented in 1983 from Icy Bay and southwest PWS waters, but subsequent effort focused on Port Wells and Wells Passage in northwest PWS (Figure 18). Sidestripe shrimp harvests increased in 1985 as markets developed for a fleet of small vessels fishing in previously unfished areas. The fishery operated primarily from the Port of Whittier. Shrimp tails were sold fresh in PWS communities and Anchorage, although markets for whole, fresh, and frozen sidestripe shrimp existed in both Anchorage and Japan (Trowbridge 1995). ADF&G required logbooks and reporting to help manage the fishery. Harvest in the fishery was apportioned among 4 different management sections within the Inside District: Wells, Central/Southwest, and Northwest Sections (Figure 18).

During the period of 1987 to 1993, sidestripe shrimp fishery harvest and effort increased from less than 100,000 lb landed by 2 vessels to 246,190 lb landed by 7 vessels. Following the rapid expansion, effort decreased to an average of 3 vessels between 1995 and 2006. Between 2007 and 2014, participation has dwindled to 1 or 2 vessels (Table 29).

As the fishery developed, uncertainty increased about sidestripe shrimp abundance levels in the Wells Section (Figure 18). In 1990, ADF&G began placing an observer aboard vessels and using catch data to calculate an area-swept estimate of shrimp abundance in the Port Wells and Wells Passage area. The GHL was determined inseason by applying a 20% harvest rate to the estimated shrimp biomass. Although this management strategy initially seemed conservative, GHL declined from 80,000 lb in 1991 to 19,000 lb in 1999. After 1999, the Wells Section GHL gradually increased to 34,400 lb in 2001 but declined to 23,500 lb in 2002 and then increased to 36,700 lb in 2004. Since 1999, the GHL gradually increased to a high of 104,700 lb in 2010 and since declined to 60,300 lb in 2014. From 1999 to 2006, the GHL was attained between late May and late June; though the GHL was not attained between 2007 and 2012, it was attained in 2013 and 2014 (Table 19).

The GHL for the Perry Passage area of the Northwest Section was established at 16,000 lb in 1995 based on an area-swept biomass estimate and a 20% harvest rate. Effort has historically been low in this area of strong current. The GHL increased to 18,500 lb in 1996 based on increased fishery CPUE. Although the GHL remained at 18,500 into the 1998 season, the fishery was closed before the GHL was attained due to declines in CPUE. Based on the 1998 fishery performance, the 1999 GHL was reduced to 14,000 lb and has remained at that level. From 1999 to 2006, the GHL was attained between late May and late June. Although some effort has occurred, the GHL has not been attained since 2006 (Table 19).

The shrimp trawl fishery in the Central and Southwest Sections of PWS was managed using historical catches and CPUE. During 1992 and 1993, effort in these areas increased sharply and included 2 catcher-processors. Catch and CPUE declined in these areas resulting in reduced harvest levels. Since 1995, the GHL for the Central and Southwest sections have been 33,000 lb, based on the 1994 harvest from these areas. The GHL was attained in 1997 but not in 1998 or 1999, primarily due to low effort. Although the GHL was attained by mid-July or early August between 2000 and 2006, and some effort has occurred in recent years, the GHL has not been attained since 2006 (Table 19).

Management and Regulations

Regulations for shrimp trawling in northwestern PWS were adopted in 1986 and included seasons, a commissioner's permit requirement, cod end specifications including 1⅝ inch mesh hung square to the mouth of the net, and a 10% limit on retention of northern shrimp. In 1990, the cod end mesh size restriction was increased to 1⅞ inch to facilitate release of small sidestripe and pink shrimp. Shrimp trawling regulations were restructured in 1994 when the BOF adopted open season dates of April 15 through August 15 and October 1 through December 31, amended the cod end requirement, and created the Northwest Shrimp Trawl Fishing District (NSTFD). The NSTFD was defined as waters north of 60°27.00′N lat and west of 147°20.00′W long and integrated important harvest areas as Port Wells, Wells Passage, and Perry Passage. The new season dates were based on biological data that indicated egg release was not complete until April 15 and industry reports that soft-shell shrimp were present until October 1.

In 2000, the BOF adopted a regulation that required shrimp trawls be equipped with a finfish excluder device. In 2003, BOF adopted regulations that restructured shrimp trawl management areas. The NSTFD was repealed and the new sections created by this action were the Northwest, Wells, Southwest, and Central sections (Figure 18).

The PWS Area is a nonexclusive registration area for shrimp fishing with trawl gear, and current regulations restrict the retention of northern shrimp or other pandalid species to no more than 20% by weight of the shrimp in possession. They also require catch reporting within 24 hours of landing and that completed logbook sheets are returned with fish tickets within 7 days of landing.

Other regulatory measures for the shrimp trawl fishery include the following:

1. Season dates of April 15 through August 15 and October 1 through December 31.
2. Cod end mesh composed entirely of 1⅞ inch stretched mesh hung horizontal and perpendicular to the mouth of the trawl.
3. A year-round closure in eastern Prince William Sound to minimize indirect fishing mortality on current low levels of abundance of king and Tanner crabs in key production areas (Figure 18).
4. A shrimp trawl must be equipped with a finfish excluder device consisting of a rigid grate with parallel bars spaced not more than 2.5 inch apart, except they may be spaced 4.0 inches apart if the operator of the shrimp trawl also holds a PWS limited entry sablefish permit and is registered for the current year's fishery. Regulations specify how the excluder must be secured within the trawl and define an escapement outlet.

The regulatory spacing of 2.5 inches for excluder bars was adopted as a compromise between ADF&G and the industry in an effort to reduce discard mortalities of finfish and shrimp. With

the exception of the PWS sablefish fishery, nonpelagic or "bottom" trawls are not legal gear for targeting groundfish in PWS.

Research

In addition to fishery performance data collected by ADF&G observers in the Port Wells and Wells Passage area, the sidestripe shrimp harvest is sampled for sex and size composition as indicators of change in abundance (Charnov 1981). Sex composition is important because sidestripe shrimp are protandric hermaphrodites that first recruit to the fishery as males and later transition to females. More intensive fishing pressure typically has the greatest impact on the larger, female, segment of the population. Female proportions in sidestripe shrimp samples from the PWS fishery have varied greatly over the last 2 decades, from a high of 44% in 2003 to a low of 17% in 2010, and have averaged 21% over the last 5 years. The extent of gear selectivity with respect to cod end mesh size and excluder requirements remains unknown. However, the predominant carapace length mode of male, transitional, and female sidestripe shrimp has remained consistent and only varied by a few millimeters between years (Figure 19).

HARD SHELL CLAMS AND MUSSELS

COOK INLET

Harvest and Effort

Commercial harvest of hard shell clams began in the Cook Inlet Management Area in 1986, with the last harvest occurring in 2006. Between 1988 and 1996, annual commercial harvest of hard shell clams ranged between 14,500 lb and 71,000 lb (Table 20). The method of harvest was hand digging and ranged from 2 to 33 harvesters. All of the harvest came from Kachemak Bay in the Southern District (Figure 2).

Beginning in 1997, commercial harvest ranged from 1,222 lb to 31,525 lb and effort ranged from a high of 15 participants in 1997 to a low of 3 in 2006, the last year any commercial harvest occurred (see regulations documented below) (Table 20).

There has been no reported harvest of blue mussels in the Cook Inlet Management Area since 1998 and even then, the average annual harvest rarely exceeded 32,000 lb.

Management and Regulations

In the Cook Inlet Management Area, Pacific little neck and butter clams may now only be commercially harvested under the terms of a commissioner's permit according to 5 AAC 38.310. There are serious conservation concerns about the status of clam abundance in the Cook Inlet Management Area. ADF&G has reduced bag limits and closed certain beaches to the noncommercial harvest of clams and mussels. The last year of hard shell clam surveys in the Kachemak Bay area showed the lowest clam density levels in survey history (Trowbridge and Goldman 2006). At this time, ADF&G will not issue commissioner's permits for commercial littleneck and butter clam harvest due to conservation concerns.

In 1990, the BOF adopted statewide regulations, which included minimum legal sizes of 1.5 inches (38 mm) for Pacific littleneck clams and 2.5 inches (63 mm) for butter clams. In 1994, the BOF adopted the *Southern District Hardshell Clam and Mussel Fishery Management Plan* (5 AAC 38.318). A major component of the plan included opening certified beaches every other year; half of the beaches were open in even-numbered years and half in odd-numbered years.

Other provisions in the plan included commercial harvest only on weekdays from May 15 through September 15. Additional regulations included establishing areas closed to commercial harvest, particularly some important recreational beaches (5 AAC 38.314), and a registration deadline of April 1.

In 1997, the BOF adopted a commercial harvest level of 40,000 lb. Bear Cove, in Kachemak Bay, was closed to commercial clam and mussel harvest and quarterly limits were established each calendar year. Additionally, openings determined by temperature criteria were enacted to reduce clam mortality.

Before clams and mussels can be commercially harvested for human consumption from an area, the area must be certified for water quality by the Alaska Department of Environmental Conservation (ADEC) and animals must be tested for paralytic shellfish poisoning (PSP). In the late 1980s and early 1990s, as interest in commercial harvest increased, many of the bays on the south side of Kachemak Bay were certified for clam harvest and sale.

Research

Currently, ADF&G does not conduct Pacific littleneck and butter clam surveys, and there is no commercial harvest of these clams in the Cook Inlet Management Area. Surveys were conducted in commercial harvest areas from 1990 to 2005 (Gustafson 1995; Gustafson and Bechtol 2000). Abundance estimates were stratified by legal (38 mm or larger) and sublegal size categories. Other biological and abiotic data were also recorded. The longest time series is from Chugachik Island where between 1992 and 2005 Pacific littleneck clam densities ranged from 12 to 67 clams/m^2 and the legal clam density in 2005 was the lowest on record. A second long time series exists for Ismailof Island, where between 1994 and 2002 Pacific littleneck clam densities ranged from 24 to 105 clams/m^2 and were the lowest densities in 2002. Other sites sampled at varied frequencies and intensities include Jakolof Bay, Sadie Cove, Tutka Bay, beaches between Mallard Bay and Glacier Spit (Mallard/Glacier), and Peterson Bay. Trowbridge and Goldman (2006) document results from these clam surveys.

RAZOR CLAMS

COOK INLET

Harvest and Effort

The commercial harvest of razor clams from Upper Cook Inlet (UCI) beaches dates back to 1919 (Table 21). Harvest levels have fluctuated from no fishery to production in excess of 500,000 lb. The sporadic nature of the fishery was more a function of limited market opportunities than limited availability of the resource. Razor clams are present in many areas of Cook Inlet, with particularly dense concentrations occurring near Polly Creek on the western shore and from Clam Gulch to Ninilchik on the eastern shore (Nickerson 1975).

The 2014 harvest, taken primarily from the Polly Creek/Crescent River area, was approximately 348,000 lb in the shell (Table 22), and 19 diggers participated in the fishery. Harvest was reported from 61 different days between May 11 and July 30. Diggers were paid an average of $0.65/lb for their harvest, resulting in an exvessel value of approximately $226,000. The average clam size from the 2014 harvest was 140 mm or 5.4 inches (Figure 20).

Management and Regulations

The eastern shoreline of Cook Inlet has been set aside exclusively for sport harvest since 1959, and all commercial harvests since that time have come from the west shore, principally from the Polly Creek and Crescent River sandbar areas. A large portion of the Polly Creek beach is approved by the ADEC for the harvest of clams for the human food market. Within this approved area, a limit of 10% shell breakage is allowed and broken-shelled clams are required to be dyed prior to being sold as bait clams. No overall commercial harvest levels are in place for any area in regulation. However, ADF&G manages the commercial razor clam fishery to achieve a harvest of no more than 350,000 to 400,000 lb (in the shell) annually. Virtually all of the commercial harvest is by hand-digging, although regulations prior to 1990 allowed the use of mechanical harvesters (dredges) south of Spring Point or within a 1 mile section of the Polly Creek beach. Numerous attempts to develop feasible dredging operations were unsuccessful because of excessive shell breakage or the limited availability of clams in the area open to this gear. Mechanical means of harvesting is no longer permitted in any area of Cook Inlet.

Historically, the commercial razor clam fishery on the west side of Cook Inlet has been confined to the area between Crescent River and Redoubt Creek (Figure 21). All clams harvested in this area are directed, by regulation, to be sold for human consumption, except for the small percentage (less than 10% of the total harvest) of broken clams, which may be sold for bait. Razor clams are present throughout this area, with dense concentrations in the Polly Creek and Crescent River areas. In the remainder of the UCI Management Area, there are no restrictions on the amount of clams that can be sold for bait. Currently, there is no directed effort to harvest razor clams for the bait market. The minimum legal size for razor clams is 4.5 inches (114 mm) in shell length (5 AAC 38.075).

PRINCE WILLIAM SOUND

Harvest and Effort

The community of Cordova once regarded itself as the “razor clam capital of the world.” Annual harvests from the early-1900s through the mid-1950s achieved a maximum of 3.6 million lb in 1917 and frequently exceeded 1.0 million lb. Most of the harvest was canned for human consumption. Although historical fishery data are imprecise, it appears the majority of razor clam harvests occurred in Orca Inlet and the western Copper River Delta (Figure 22). The eastern Copper River Delta, which includes Kanak Island, was not a substantial contributor to early harvests.

From the late 1950s through the early 1980s, Alaska clam markets had declined due to market concerns for PSP and the inability to certify product as being free of PSP (Nickerson 1975). During this period, markets changed to the use of razor clams as Dungeness crab bait. The decline in razor clam harvest in Orca Bay and the western Copper River Delta was also attributed to a variety of factors including a market shift from the U.S. West coast to the East coast clam fishery, substrate change due to a siltation event from the Copper River in 1958, and habitat loss as a result of the 1964 Good Friday Earthquake (Nickerson 1975). The 1958 siltation event may have severely affected juvenile survival, and the 1964 earthquake caused significant uplift in prime razor clam habitat in Orca Inlet. These events contributed to the low harvests in the 1970s and early 1980s and were followed by a shift in clam digging effort to the east side of the Copper River Delta and Controller Bay area.

Demand for PWS razor clams increased again in 1983 when clam harvests for human consumption declined in Washington State. The majority of the PWS clam harvest subsequently occurred at Kanak Island, with lesser harvests coming from Softuk and Katalla beaches (Figure 22). Annual commercial harvests during the 1980s attained a maximum of approximately 168,000 lb in 1984 before declining to less than 7,000 lb in 1988, with an average harvest and effort of 51,611 lb by 20 diggers during 1980–1988 (Table 23). Except for 1993, no commercial harvests have occurred since 1988, and the 1993 data remain confidential because only 2 diggers participated. Reported noncommercial harvests varied widely with a maximum of 6,225 lb by 83 diggers in 1987, with a 5-year average of 7.25 lb by 3 diggers (Table 23).

ADF&G staff in Cordova issued 18 noncommercial razor clam harvest permits in 2014. Three diggers harvested 1.75 lb of razor clams, and 15 individuals receiving a permit did not dig. Harvests occurred on Little Softuk and Kanak Island beaches (Wessel et al. 2012).

Management and Regulations

There is a 4.5 inch (114 mm) minimum legal size for all commercially harvested razor clams in the Copper River Delta. By regulation, clams harvested from Kanak Island must be used for human consumption as food. Commercial harvest beaches need annual certification by ADEC before bivalves can be sold for human consumption. Currently there are no areas within PWS that are certified for commercial clam harvest by ADEC. No harvest of the razor clam resource will be permitted until regulatory requirements of both ADEC and ADF&G are met. ADF&G has historically monitored commercial razor clam harvests via fish ticket information.

A harvest permit must be obtained from ADF&G prior to the noncommercial harvesting (subsistence, sport, and personal use) of razor clams from the Copper River Delta. Regulations further specify a minimum legal size of 4.5 inch (114 mm) for retained razor clams from areas east of 146°W long and south of a line from Point Bentinck to the southernmost tip of Point Whitshed.

Research

Although ADF&G does not directly assess abundance of razor clams in PWS, reports from noncommercial diggers indicate that razor clam abundance in the eastern Copper River Delta, Katalla, and Controller Bay remain at very low levels. This information is supported by the low number of subsistence permits issued in recent years and the complete lack of interest from commercial diggers.

DUNGENESS CRAB

COOK INLET

Harvest and Effort

Commercial and noncommercial Dungeness crab fishing in Cook Inlet Management Area is closed. The commercial fishery in the Southern District was closed by EO beginning in 1991, although other districts remained open until 1997. The noncommercial fishery was closed in 1998. The commercial Dungeness crab fishery was developed in the Southern District during the late 1970s, driven by improved market opportunities caused by fluctuating catches in the Northwest Pacific. The highest annual harvest was 2.1 million lb in 1979 and the most participants was 108 in 1982 (Table 24). Harvests were above 1.0 million lb from 1978 to 1981

but declined in 1990 to 29,000 lb in the Southern District, the last year of the fishery. Although the fishery was closed in the Southern District after 1991, a limited entry program establishing 101 pot and 2 ring net permits was established in 1993. Participation was as low as 1 permit from 1992 to 1996 with crab landed from other districts besides the Southern District.

Management and Regulations

There is no open fishing season for Dungeness crab in the Cook Inlet Management Area according to 5 AAC 32.310. Other regulations are not valid until Dungeness crab populations recover and a fishery is opened.

Research

The Dungeness crab fishery was developed before any abundance levels were determined by a fishery-independent survey. ADF&G conducted annual (except 1999) pot surveys targeting Dungeness crab from 1990 to 2000. The survey area covered east and west of the Homer spit. The survey was discontinued because of the dramatic decrease in survey catch and the closure of the fishery; the last year of the survey yielded 9 total Dungeness crabs, 1 of them a legal male (Trowbridge and Goldman 2006; Figure 23).

After discontinuing the pot survey, the Kachemak Bay trawl survey was used to monitor any recovery of Dungeness crab abundance. There has been no indication of recovery and Dungeness crab levels have remained low. No directed surveys are planned for the near future. More detailed research information about directed Dungeness crab surveys can be found in Trowbridge and Goldman (2006).

In 2008, Dungeness crab appeared in significant numbers as non-targeted catch in the noncommercial Tanner crab fishery in Kachemak Bay. This prompted ADF&G to conduct a pot survey for Dungeness crab in 2009. The Dungeness pot survey was conducted from August 10 to August 13, 2009. In Mud Bay near the harbor mouth, 90 pots were set in the historical survey area and 15 pots were fished; the catch included 10 legal and 55 sublegal males, and 1 female. The 15 pots fished in the deep trench caught 7 females and 1 sublegal male. The pot survey indicated that the abundance of Dungeness crab in Kachemak Bay had not rebounded sufficiently to support a harvest (Trowbridge and Goldman 2006).

No targeted surveys have been conducted since 2008, but large-mesh trawl surveys have noted minimal Dungeness crab in their catch.

PRINCE WILLIAM SOUND

Harvest and Effort

Commercial and noncommercial Dungeness crab fishing in PWS is currently closed but did occur historically. Major Dungeness crab harvests historically occurred in Orca Inlet, the Copper River Delta, and Controller Bay areas (Kimker 1985; Figures 11 and 22). Relatively minor harvests of Dungeness crab also occurred from Orca Bay and from the western portion of the Inside District (Figures 5 and 11).

Orca Inlet, immediately adjacent to Cordova, was a small vessel Dungeness crab fishery because the area is protected from adverse sea conditions. Harvests ranged from approximately 35,000 lb in 1976 to over 1.5 million lb in 1960, but this area has been closed since 1980 due to low crab abundance (Table 25).

The Copper River Dungeness crab fishery occurred along the eastern portion of the Copper River Delta and in the Controller Bay area. Harvest ranged from approximately 70,000 lb in 1991 to 1.5 million lb in 1981. Harvest and effort of averaged 590,000 lb and an average of 12 vessels participated annually from 1983 to 1992, the most recent fishing years (Table 25). The Copper River fishery has been closed since 1992 due to low crab abundance.

Management and Regulations

Statewide Dungeness regulations provide for a male-only harvest with a minimum carapace width of 6.5 inches. Gear requirements include a biodegradable escape mechanism and two 4⅜ inch escape rings. Regulations specific to PWS included superexclusive area registration and pot limits of 250 for the Outside District and 100 for the Inside District. A split regulatory open season with dates of March 20 through May 20 and July 25 through December 31 was implemented in 1987 for the Copper River fishery. The May 21 through July 24 closure was designed to reduce handling mortality during the soft-shell period following the male molt. Additionally, the Controller Bay area is closed by regulation on October 15 to reduce gear loss and consequent mortality from storms in this area of shallow water.

Past management strategies failed to provide for a sustainable fishery, and Dungeness crab abundance remains low despite long-term fishery closures. In 2000, the BOF adopted a regulatory closure of all PWS Dungeness crab fisheries. Although all commercial and non-commercial fisheries targeting Dungeness crab are currently closed, anecdotal information indicates continued bycatch of Dungeness crab by the Copper River salmon gillnet fleet. The population impacts of this bycatch are difficult to quantify but may be significant given the current low levels of abundance.

Research

ADF&G has used standardized Dungeness pot surveys to collect data on size, sex, shell condition, and catch rates of Dungeness crab in the PWS Management Area. An annual survey in Orca Inlet from 1977 to 1994 was changed to a biennial survey in 1995 due to low crab abundance and budget constraints and is now conducted opportunistically. The 2002 survey caught no Dungeness crab in 30 pot lifts. The survey was not conducted in 2004 but resumed in 2005 and produced 2 sublegal Dungeness crab in 25 pot lifts. No Dungeness crab were caught in 2008 (15 pot lifts) and 2013 (13 pot lifts) (Table 26).

The scope of the survey in the Copper River Delta area has changed over time with respect to survey dates and locations fished. Beginning in the late 1970s, ADF&G initiated seasonal closures when soft shell crab were landed. An annual Dungeness pot survey began in 1976 to assess the soft-shell percentage. After adoption of the split season dates in 1987, ADF&G conducted the survey prior to the July 25 opening date. If 10% or more of the crab were in a soft-shell condition, the fishery was delayed and another survey conducted in August. The July survey was discontinued in 1998 due to the prevalence of soft shell crab in most years and budget constraints; the August Dungeness crab survey is now conducted triennially at standard index sites.

ADF&G surveys documented a precipitous decline and continued low abundance of legal males relative to historical population levels. In the Copper River Delta area, survey catches of legal male crab declined from 16.0 per pot in 1986 to a low of 0.1 per pot in 1997. From 1998 through 2003, survey catches averaged 0.9 legal male crab per pot. Yields increased in 2005 and 2006

with 2.3 and 2.2 legal male crab respectively per pot and then markedly declined in 2008, 2010, and 2013 to 0.2, 0.1, and 0.3 legal male crab per pot respectively (Table 26).

The likelihood of a commercial or noncommercial Dungeness crab fishery in the near term is low. The decline in abundance of the Copper River Dungeness crab coincides with the collapse of other shellfish populations in the PWS area and northwest Gulf of Alaska waters (Bechtol 1997). Possible explanations for the decline and failure to recover include overfishing, sporadic recruitment, bycatch, predation, and environmental changes that affect disease, growth, and larval survival. Dungeness crab in PWS exist at the northern extent of the species' geographic range, a factor that may have implications for recruitment, growth, and survival. Because of the need to maximize crab reproductive opportunity when ecological conditions have improved, continued fishery closures are justified because all crab are needed to sustain the limited existing productivity. ADF&G plans to continue monitoring PWS Dungeness crab through pot surveys. When recovery is evident, a management plan will be developed for consideration by the BOF and user groups.

SEA CUCUMBERS AND GREEN SEA URCHINS

COOK INLET

Harvest and Effort

Commercial dive fisheries for sea cucumbers and urchins are currently closed. Commercial harvest occurred in the Cook Inlet Management Area from 1990 through the 1996/1997 season (Tables 27 and 28). When these fisheries were open, commissioner's permits were required to harvest green urchins and sea cucumbers within the management area. These permits required the harvester to fill out logbooks along with other harvest reporting requirements.

The sea cucumber fishery began with 2 divers in 1990 and reached a high of 22 divers in the 1994/95 season. The harvest reached a peak in the 1993/1994 season and 16 divers harvested 30,940 lb (Table 27).

Green sea urchin harvest and effort was also sporadic but did reach a high of 195,403 lb harvested by 29 divers in 1993 (Table 28). The fishery lasted from 1987 through 1996 and was closed by regulation in 1997 with no effort or harvest in the previous season.

Management and Regulations

Similar to shrimp and Dungeness crab, commercial fisheries for green sea urchins and sea cucumbers were also closed by regulation in 1997 when the BOF adopted the *Cook Inlet Miscellaneous Shellfish Management Plan* (5 AAC 38.390). The plan closed all commercial fishing for urchins and cucumbers until such time as the BOF adopts a new management plan. Commissioner's permits were required beginning in the 1993/1994 season when season dates were also established of October 1–April 30.

Research

Survey design

In 2004 and 2005, ADF&G secured 2 years of funding to conduct surveys for green urchins and sea cucumbers with SCUBA and remotely operated vehicles (ROV). The survey area included

Sadie Cove, Peterson Bay, Halibut Cove, China Poot Bay, which are all areas in Kachemak Bay (Table 29).

Previous research efforts by ADF&G in Southeast Alaska served as the basis for successful completion of the proposed research (Hebert et al. 2001). Sampling involved SCUBA transect surveys, similar to that used in southeast Alaska, but also included ROV transects within the selected range of depths and habitats. Specific objectives included 1) determine the distribution of commercially viable green sea urchin and sea cucumber abundance and biomass in several historically harvested areas of Kachemak Bay; 2) investigate potential assessment methods that will provide reasonably precise estimates of abundance and biomass; 3) develop preliminary estimates of appropriate harvest levels; and 4) establish baseline assessment data for monitoring the effects of future harvests (Spahn and Byerly 2007).

Shoreline transects consisting of an outbound and inbound leg were systematically distributed along the shoreline of each study area. For each survey area, the distance between transects equaled the total shoreline length divided by the target number of transects sampled (30). The first transect for each area was located randomly in the first distance interval at 1 boundary of the area. Transects were oriented perpendicular to shore and extended from approximately mean lower low water (MLLW) to a maximum depth of approximately 20 m (65 ft). For each transect, 2 divers swam to depth with the lead diver holding a 2 m rod (2.1 cm diameter white plastic pipe) with a center-mounted compass in a horizontal position, perpendicular to the transect path and following a predetermined compass course. All green sea urchins, regardless of size, within the horizontal length of the rod were counted by the designated species counter. In contrast, sea cucumbers were counted individually along with an estimate of their horizontal distance from the center of the transect line. The lead diver recorded data on substrate type, vegetation type, and percent cover, and both divers estimated the horizontal visibility at 10 m increments. A dive tender recorded the start and end times and GPS locations for each transect. Shoreline length for each assessment area was calculated in ArcGIS 9.1.

ROV transects occurred after the scuba transects while the divers were taking surface interval breaks. Every other scuba transect location was sampled using the ROV. A mid-channel line was drawn in ArcGIS 9.1 using a grid of the available bathymetry. The ROV transect lines extended perpendicularly from the shoreline to the mid-channel line.

Green sea urchin and sea cucumber size information were collected for each area to convert densities to biomass. From each transect, the divers choose an arbitrary location and collected all visible target species until an aggregate of up to 30 green urchins and/or 30 sea cucumbers were obtained. Specimens were placed in mesh bags and brought back to the support vessel for measurement. Green sea urchin outside test (shell, excluding the spines) diameter was measured to the nearest millimeter. Mass for individual urchins (grams) was calculated from a test width-to-weight relationship. Sea cucumbers were eviscerated, drained, and weighed to the nearest gram (Woodby and Rumble 1996; Hebert et al. 2001).

Density, individuals per linear meter of shoreline, average weight in grams, number, and biomass in lb were estimated for each assessment area and target species following Hebert et al. (2001). Variance for each point estimate was estimated using the bootstrap method by resampling the transects and individual weights 1000 times. Variance in shoreline length calculations was not estimated. Ninety-percent confidence intervals were calculated using the percentile method. Potential harvestable surplus was estimated for sea cucumbers using an annual harvest rate of

6.75% by using the lower 90% CI of the estimated biomass (Hebert et al. 2001). Although no estimates were made for the exploratory areas, transect counts and size distribution data were used to compare to the assessment areas and to examine distributions. These species had not been commercially harvested since the mid-1990s, and this Kachemak Bay urchin and sea cucumber project examined the extent to which their abundance may have rebounded. Because this was the first fishery-independent assessment, the project also established a post-fishery baseline of size, density, and biomass estimates for these areas.

Assessment surveys were conducted from August 4 to August 11, 2004, in Sadie Cove; October 19 to October 20, 2004 in China Poot Bay; and August 8 to August 11, 2005 in Tutka Bay. There were 35 SCUBA and 16 ROV transects completed in Sadie Cove and 37 SCUBA and 15 ROV transects completed in Tutka Bay to assess both sea cucumbers and green sea urchins. Seventeen scuba transects were completed in China Poot Bay to assess green sea urchins. An exploratory survey was conducted August 15–16, 2005 and included 3 SCUBA transects in Halibut Cove, 2 in Petersen Bay, and 1 in Sadie Cove. In addition, 9 of the 2004 Sadie Cove transects were sampled again on August 12, 2005.

Survey results

There were only 3 sea cucumbers sighted in the Tutka Bay SCUBA survey (Table 29). Of the cumulative estimated 9,288 m of ROV transect line sampled, no cucumbers were observed in Tutka Bay. Therefore, no analysis was performed on these data.

For Sadie Cove, the distribution of horizontal sighting distances showed a sharp shoulder out to 2 meters, after which detections fell off precipitously. Only 5% of all cucumbers sighted occurred at distances greater than 2 meters. Minimum visibility was 2 meters with 92% of the cumulative transect line have greater than 3 meters of visibility. Therefore, a fixed, 4 meter wide (2 meters either side of the transect line) transect strip width was used to include sea cucumbers in the analysis. Sea cucumbers occurred at 89% of transects sampled, with total counts ranging from 0 to 188. ROV transects ended between 18 m and 15 m in depth. Because scuba transects were run to a depth of 20 m, ROV transect data were truncated to depths greater than 20 m. Of the cumulative estimated 5,790 m of ROV transect lines sampled, only 12 cucumbers were observed in Sadie Cove. Due the very low sample size, no ROV estimates were produced and abundance was assumed to be minimal at depths greater than 20 m. The estimated density of sea cucumbers for the Sadie Cove study area was 4.62 cucumbers per meter of shoreline, with an estimated average weight of 267 g and biomass of 49,399 lb (Table 29). Using the lower 90% CI, the estimated harvestable biomass of sea cucumbers for Sadie Cove would be 1,944 lb.

When the fishery was open, ADF&G managed the fishery by monitoring harvest and effort. The results of the sea cucumber and urchin survey showed extremely low numbers of both species, which would not support a commercial fishery (Table 29).

No discrimination of size was made during the green sea urchin SCUBA transect counts. Therefore, biomass estimates reflect the total biomass of all green urchins. Green urchins were patchily distributed among all survey areas. Green sea urchins occurred on less than 45% of transects within Sadie Cove, and the highest count was 1,100 urchins. The highest urchin count in Tutka Bay was 609, and urchins occurred at 54% of transects. The lowest counts occurred in China Poot Bay, and urchins occurred on only 17% of transects. Density and biomass estimates were low for all areas and Sadie Cove was the highest (Table 29). Variation was high for all surveyed areas due to the patchy distribution and high frequency of zero counts.

Green sea urchins were small in both Sadie Cove and Tutka Bay and all individuals were less than the 60 mm width that are considered commercially valuable. Green sea urchins were larger in China Poot Bay, but the sample size was very low.

The exploratory sea cucumber and urchin survey for green urchins found the largest transect counts in Halibut Cove and a higher percentage of larger individuals than other areas, but the majority of those were less than 60 mm test width.

Nine of the 2004 Sadie Cove SCUBA transects were repeated in 2005. Counts were similar both in relative and absolute numbers of sea cucumbers between both years. However, 2005 green sea urchin counts were much higher at most sites than in 2004 and relative counts were similar among transects in both years.

Survey conclusions

This survey's primary objective was to determine if a sustainable harvestable surplus of sea cucumbers or green sea urchins was available in Kachemak Bay. The Sadie Cove cucumber biomass estimate had relatively high precision (29% CV) and occurred in a historically important harvest area. However, the estimated harvestable surplus of Sadie Cove sea cucumbers was too low to warrant a fishery or provide a sustainable harvest. The Tutka Bay assessment area, another historically important harvest area, was sampled with a high density of transects, but so few sea cucumbers were encountered that a biomass estimate was not feasible.

Green sea urchin estimates for all areas were less precise due to patchy distributions. Even given the lower precision, biomass estimates were well below that considered to provide sustainable harvests. The low level of abundance of both green sea urchins and sea cucumbers observed over the course of the survey was disconcerting, particularly because the fishery had been closed since the mid-1990s. This indicates that there may be little or no recruitment of larvae from areas outside Kachemak Bay. If true, it would mean that these species will be very slow to recover because the only recruitment may only come from the small spawning biomass in Kachemak Bay.

The BOF removed fishing closures in regulation in July 2006 and the original permit fisheries were reestablished. Research results from sea cucumber and urchin surveys provided distribution, size, and abundance data to the area management biologist. The data were used to inform potential harvesters and the BOF of low resource levels and, ultimately, to deny near-term requests for green sea urchin and sea cucumber fisheries in these areas (Spahn and Byerly 2007; Table 29).

PRINCE WILLIAM SOUND

Harvest and Effort

There have been no reported landings of sea cucumbers or sea urchins from PWS nor does ADF&G assess these species. The most recent commercial effort for sea cucumbers occurred in 1992, when 5 permits were issued but no catch reported. This was consistent with anecdotal reports of abundance from both ADF&G and sport divers. No permits have been issued for sea urchin harvest, and anecdotal information indicates few sea urchins of a marketable size occur in PWS.

Management and Regulations

Sea cucumbers and sea urchins may only be taken under the authority of a commissioner's permit. Lacking basic abundance information, any permits ADF&G issues for these species will include an approach for determining a harvestable surplus and obtaining funding for assessments of abundance.

Research

No research has been conducted by ADF&G in PWS on sea cucumbers or sea urchins.

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TABLES AND FIGURES

Table 1.–Kamishak District (Cook Inlet Management Area) scallop fishery summary statistics, 1983–2014.

		North Bed				South Bed				Total (both beds)			
Year	Number of vessels	GHL (lb) meat	Harvest (lb)[a]	Hours[b]	CPUE[c]	GHL (lb) meat	Harvest (lb)[a]	Hours[b]	CPUE[c]	GHL (lb) meat	Harvest (lb)[a]	Hours[b]	CPUE[c]
1983[dfe]	1		2,346	109.1	21.5						2,346	21.5	109.1
1984	3		6,305	248.2	25.4						6,305	25.4	248.2
1985[e]	1	20,000	11,810	299	39.5						11,810	39.5	299
1986	3	20,000	15,364	424.4	36.2						15,364	36.2	424.4
1987[e]	2	20,000	1,488	23.8	15.1						1,488	15.1	98.5
1988-92							no effort						
1993	3	20,000	20,115	528	38.1					20,000	20,115	528	38.1
1994	4	20,000	20,431	458.1	44.6					20,000	20,431	458.1	44.6
1995							closed						
1996	5	28,000	28,228	534	52.9					28,000	28,228	534	52.9
1997	3	20,000	20,336	394	51.6					20,000	20,336	394	51.6
1998[e]	1	20,000	17,246	390	44.2					20,000	17,246	390	44.2
1999	3	20,000	20,315	325	62.5					20,000	20,315	325	62.5
2000	3	20,000	20,516	275.1	74.6					20,000	20,516	275.1	74.6
2001[e]	2	20,000[e]	20,097	325	61.8					20,000	20,097	325	61.8
2002	3	20,000	6,045	235.3	25.7		2,546	76.1	33.5	20,000	8,591	311.4	27.6
2003	2		closed			20,000	15,843	896	17.7	20,000	15,843	896	17.7
2004	3	6,500	4,519	197.7	22.9	13,500	1,598	165.9	9.6	20,000	6,117	363.6	16.8
2005[e]	2	7,000	7,378	372	19.8		closed				7,378	372	19.8
2006[e]	1	7,000	50	10	5		closed				50	10	5
2007	0	7,000				5,000				12,000			
2008	0	7,000				5,000				12,000			
2009	0	14,000								14,000			
2011[e]	1	12,500	9,975	324	30.8					12,500	9,975	324	30.8

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Table 1.–Page 2 of 2.

Year	Number of vessels	North Bed GHL (lb) meat	North Bed Harvest (lb)[a]	North Bed Hours[b]	North Bed CPUE[c]	South Bed GHL (lb) meat	South Bed Harvest (lb)[a]	South Bed Hours[b]	South Bed CPUE[c]	Total (both beds) GHL (lb) meat	Total (both beds) Harvest (lb)[a]	Total (both beds) Hours[b]	Total (both beds) CPUE[c]
2010e[f]	1	14,000	9,460	365	25.9					14,000	9,460	365	25.9
2011[e]	1	12,500	9,975	324	30.8					12,500	9,975	324	30.8
2012	1	12,500	11,739	392	29.9	closed				12,500	11,739	392	29.9
2013						closed							
2014						closed							

[a] Harvest includes retained scallops and estimated deadloss.

[b] Dredge hours equals 1 dredge fished for 60 minutes.

[c] CPUE (catch per unit effort) is pound of scallops per dredge hour.

[d] GHL was amended during the season to 9,000 lb.

[e] Confidential data released by vessel operators.

Table 2.–Kamishak District (Cook Inlet Management Area) scallop summary statistics from dredge surveys, 1996–2013.

Survey Year	Number stations sampled	Mean catch kg/nm	Estimated abundance # of scallops		95% CI	CV	Scallop density (scal/m^2)	Average weight (g/scal)	Estimated biomass q =1.0 (kg meat)	Estimated biomass q =0.83 (kg meat)
				North Bed						
1996	26	60.0	15,674,085	±	4,921,324	0.15	0.05	262	351,141	
1999	41	67.1	12,115,707	±	3,032,424	0.12	0.04	380	300,950	
2001	37	62.9	9,980,638	±	2,708,305	0.13	0.03	432	274,801	
2003	31	26.2	4,120,643	±	948,209	0.11	0.01	435	110,137	
2005	38	22.7	3,535,142	±	795,020	0.11	0.01	439	101,483	
2007	43	26.4	5,094,047	±	978,442	0.10	0.02	354	139,580	
2009	43	20.5	3,701,402	±	808,379	0.11	0.01	379	97,408	117,359
2011	45	17.2	2,885,639	±	540,212	0.09	0.01	409	94,188	113,479
2013	43	12.7	1,937,665	±	371,769	0.10	0.01	447	61,301	73,856
				South Bed						
2003	28	59.7	9,434,220	±	2,467,551	0.13	0.04	327	221,258	
2005	29	16.2	3,935,459	±	1,069,549	0.13	0.02	213	60,881	
2007	31	23.5	5,988,540	±	1,648,559	0.13	0.03	202	97,851	
2009	23	9.2	2,757,557	±	1,179,705	0.21	0.01	172	18,146	21,863
2011	16	13.9	2,799,128	±	1,642,687	0.28	0.01	256	62,428	75,214
2013	32	8.4	1,919,836	±	720,079	0.18	0.01	226	31,105	37,476

Table 3.–Kayak Island commercial harvest of weathervane scallops in Prince William Sound Management Area, 1992–2014.

Year	Fishery area	GHL[a] (lb meat)	No of vessels	Harvest (lb meat)	Dredge hours	CPUE (lb/hr)
1992		64,000	4	208,836	NA	NA
1993		50,000	7	63,068	638	99
1994/95		Closed				
1995		50,000	3	108,000	NA	NA
1996		Closed				
1997		17,200	1 [b]	18,000	171	105
	East	6,000				
1998/99	West	14,000	2 [b]	19,650	179	110
	East	6,000				
1999/00	West	14,000	2 [b]	20,410	149	137
	East	9,000		8,998		
2000/01	West	21,000	3	21,268	221	137
	East	9,000		9,060		
2001/02	West	21,000	1 [b]	21,030	263	114
	East	6,000		1,680		
2002/03	West	14,000	2 [b]	13,961	122	128
	East	6,000		5,910		
2003/04	West	14,000	1 [b]	14,070	216	93
	East	26,000		25,350		
2004/05	West	24,000	2 [b]	23,970	614	80
	East	26,000		24,435		
2005/06	West	24,000	3	24,781	491	100
	East	20,000		20,010		
2006/07	West	17,000	2 [b]	17,005	334	111
	East	20,000		20,015		
2007/08	West	17,000	2 [b]	17,090	428	87
	East	15,000		15,030		
2008/09	West	5,000	1 [b]	5,010	331	64
	East	15,000		15,035		
2009/10	West	5,000	2 [b]	4,980	419	48
	East	8,400		8,445		
2010/11	West	Closed	1 [b]	Closed	161	52
	East	8,400		8,460		
2011/12	West	Closed	1 [b]	Closed	160	53
2012/13-	East		Closed			
2014/15	West		Closed			

[a] Separate guideline harvest levels (GHL) were established for east and west of Kayak Island beginning in 1998.

[b] Confidential data voluntarily released by vessel operators.

Table 4.–Kayak Island scallop summary statistics from dredge surveys, 1996–2014.

Survey year	Number stations sampled	Mean catch kg/nm	Estimated abundance # of scallops		95% CI	CV	Scallop density (scal/m^2)	Average weight (g/scal)	Estimated biomass q =1.0 (kg meat)	Estimated biomass q =0.83 (kg meat)
				East Bed						
1996	38	27.8	7,302,813	±	3,507,901	0.24	0.027	229	132,501	
1998[a]	28	20.5	5,288,624	±	1,393,135	0.13	0.020	232	89,347	
2000	33	37.6	9,535,026	±	1,900,677	0.10	0.035	237	146,181	
2002[b]	20	10.2	2,294,907	±	910,967	0.19	0.008	266	43,367	
2004	31	77.1	17,441,115	±	9,355,190	0.26	0.064	265	278,594	
2006	32	44.4	9,720,639	±	4,263,246	0.22	0.036	274	190,243	229,208
2008	37	36.5	7,114,451	±	2,180,486	0.15	0.026	308	130,480	157,205
2010	12	34.9	[c]		[c]		0.032	244	[c]	[c]
2012	19	13.4	3,997,740	±	2,265,460	0.27	0.015	201	57,380	69,133
2014	40	8.7	2,141,005	±	510,818	0.12	0.008	245	37,617	45,322
				West Bed						
1998[a]	21	33.9	6,382,639	±	2,851,028	0.21	0.038	196	105,132	
2000	20	94.7	17,900,280	±	7,957,941	0.21	0.107	196	302,316	
2002[b]	17	39.6	5,745,859	±	2,428,439	0.20	0.034	255	105,646	
2004	25	84.8	14,502,511	±	5,102,276	0.17	0.087	216	235,274	
2006	20	61.0	10,113,094	±	4,648,662	0.22	0.061	223	167,262	201,520
2008	10	19.7	3,934,444	±	2,811,818	0.32	0.024	185	34,843	41,980
2010	26	9.1	2,025,382	±	745,216	0.18	0.012	166	23,929	28,830
2012	10	8.3	2,830,766	±	2,069,955	0.32	0.017	108	22,116	26,646
2014	26	16.8	5,063,971	±	2,429,407	0.23	0.030	122	40,446	48,730

[a] Smaller New Bedford dredge was used weighing ~800 lb, 8 feet wide, with 3 inch inside diameter ring and 1.5 inch stretch 24 thread nylon mesh liner.

[b] Incorrect scope and smaller liner may have compromised the survey.

[c] Survey estimate was not done because only perimeter stations were sampled.

Table 5.–Commercial octopus harvest in the Cook Inlet Management Area in various fisheries, 1983–2014.

Year	Vessels	Landings	Harvest (whole lb)	Date of commercial closure	Gear group
1983	41	101	32,841		Pre- Venus/Neptune System
1984	36	77	46,698		Pre- Venus/Neptune System
1985	37	70	48,067		D, M, P, T, Z
1986	8	16	435		D, M, P
1987	21	56	4,512		B, D, M, P, Z
1988	17	43	5,569		B,C, D, M, T
1989	0	0	0		
1990	3	6	1,343		O, M
1991	7	16	2,134		M, P, O
1992	18	45	5,581		B, M
1993	11	42	8,660		B, M, O
1994	15	82	14,614		M, O
1995	8	38	8,879		M, O
1996	10	35	7,435		P, M, O
1997	13	144	28,117		B, M, O, P
1998	9	76	12,914		B, M
1999	9	103	22,052		M
2000	11	127	25,104		M
2001	8	103	24,406		M
2002	9	164	38,518		M
2003	8	132	28,922		B, M
2004	11	127	35,981		B, M
2005	9	104	34,977		M
2006	7	107	30,556		M
2007	13	83	36,003	3/22/07	B, M
2008	12	135	35,318	12/10/08	B, M
2009	13	106	37,110	11/21/09	B, M
2010	12	106	33,548		B, M
2011	13	101	37,564	3/04/11	B, M
2012	12	150	34,860	12/20/12	B, M
2013	14	134	35,599	3/21/13	B, M
2014	10	136	35,213	4/21/14	M

Note: Gear CFEC card type: B-Halibut (longline), C-Sablefish (longline), D-Dinglebar, M-Misc Finfish e.g. Pacific cod, pollock (pot, jig, trawl), P-Shrimp (pot or trawl), T-Tanner crab (pot), Z-Marine invertebrate (experimental fishery). Discards at sea not included (e.g. delivery code 98 or disposition code 98).

Table 6.–Reported landings and harvests of octopus and squid from Prince William Sound, 1989–2014.

	Octopus		Squid	
Year	Landings	Weight (lb)	Landings	Weight (lb)
1989	0	0	3	1,467
1990	0	0	9	2,166
1991	0	0	0	0
1992	10	1,230	7	399
1993	45	5,625	3	317
1994	34	5,798	0	0
1995	22	3,779	4	289
1996	4	994	10	168
1997	11	3,547	32	18,316
1998	5	2,928	27	21,461
1999	0	0	35	6,104
2000	0	0	17	5,951
2001	0	0	17	31,101
2002	[a]	[a]	22	180,250
2003	[a]	[a]	16	20,547
2004	[a]	[a]	9	11,175
2005	[a]	[a]	4	6,155
2006	0	0	31	32,758
2007	0	0	17	11,437
2008	0	0	20	31,359
2009	0	0	13	15,622
2010	24	939	11	17,210
2011	0	0	13	16,841
2012	3	105	7	8,123
2013	9	1,095	13	88,155
2014	12	427	19	171,946

[a] Confidential data.

Table 7.–Octopus caught during Kachemak, Kamishak, and Prince William Sound (PWS) large-mesh trawl surveys, 1989–2014.

Survey	Year	Number of octopus	Number of tows	Total wt (lb)	Avg wt per animal (lb)
Kachemak	1989	3	3	26.3	8.8
Kachemak	1998	1	1	14.0	14.0
Kachemak	1999	3	3	82.0	27.3
Kachemak	2000	7	6	155.3	22.2
Kachemak	2001	1	1	12.0	12.0
Kachemak	2002	1	1	20.0	20.0
Kachemak	2003	8	8	268.0	33.5
Kachemak	2004	6	1	74.0	12.3
Kachemak	2005	4	4	132.3	33.1
Kachemak	2006	5	3	163.4	32.7
Kachemak	2007	11	11	371.5	33.8
Kachemak	2008	7	6	195.1	27.9
Kachemak	2009	2	2	60.6	30.3
Kachemak	2011	2	2	43.4	21.7
Kachemak	2012	1	1	47.0	47.0
Kachemak	2013	5	4	56.1	11.2
Kamishak	1990	1	1	26.0	26.0
Kamishak	2000	2	2	16.1	8.1
Kamishak	2003	1	1	22.0	22.0
Kamishak	2004	1	1	1.2	1.2
Kamishak	2005	2	2	15.4	7.7
Kamishak	2012	2	1	5.5	2.8
PWS	1992	2	2	na	Na
PWS	1997	3	3	4.9	1.6
PWS	1999	4	3	9.0	2.2
PWS	2001	28	20	28.4	1.0
PWS	2003	5	5	8.4	1.7
PWS	2005	17	10	45.8	2.7
PWS	2007	9	9	10.5	1.2
PWS	2009	25	17	62.0	2.5
PWS	2011	15	11	90.3	6.0
PWS	2013	8	6	19.5	2.4
PWS	2014	25	20	108.9	4.4

Table 8.–Octopus sampled from Cook Inlet Area commercial fisheries, 2000–2014.

Year	Number sampled	Average Weight (kg)	Average Weight (lb)	Sex Ratio (% female)
2000	78	10.1	22.2	62%
2002	129	15.5	34.1	57%
2005	66	15.3	33.8	47%
2006	143	13.0	28.7	41%
2007	119	12.9	28.5	50%
2008	238	12.9	28.4	57%
2009	75	13.3	29.2	48%
2010	119	13.8	30.5	50%
2011	88	13.0	28.6	38%
2012	154	12.6	27.7	45%
2013	239	12.8	28.1	35%
2014	265	12.7	27.9	39%

Note: Weights were converted from delivery condition (usually gutted) into whole weight.

Table 9.–North Gulf Coast personal use shrimp fishery number of permits issued, returned, and fished, 2008–2014.

Year	Permits issued	Permits returned	% returned	Permits fished	% permits fished	Total Harvest (lb)
2008	123	123	100%	79	64%	120
2009	163	158	97%	114	72%	128
2010	162	151	93%	113	75%	472
2011	121	110	91%	78	71%	585
2012	195	181	93%	118	65%	140
2013	138	124	90%	77	62%	409
2014	150	139	93%	37	24%	215

Table 10.–North Gulf Coast personal use shrimp fishery statistical area(s), common name, pot count, soak time (hours), and harvest in pounds (lb) of whole shrimp, and catch per unit effort (CPUE) for 2013 and 2014.

Year	Stat area	Common name	Pot count	Soak time (hrs)	Harvest (lb)	Avg CPUE (lb/pot)
2013	495935,495934, 505932	Harris Bay, Two Arm Bay	47	165	22.1	0.5
2013	495932,495936,495937	Aialik Bay	320	1,831	318.1	1.0
2013	496001	Day Harbor	12	52	0.0	0.0
2013	495938,496002	Resurrection Bay	116	990	30.0	0.3
2013	505909,505907,505904,505933,505934	Nuka Bay	28	164	13.1	0.5
2013	not recorded		74	337	25.6	0.1
		Total	602	3,549	409	0.4
2014	505932, 495935	Harris Bay, Two Arm Bay	23	103	10.1	0.4
2014	495932,495936,495937	Aialik Bay	226	988	140.0	0.6
2014	496001, 485933	Day Harbor, Whidbey Bay	10	34	4.9	0.5
2014	495938,496002	Resurrection Bay	143	1,078	19.8	0.1
2014	505903,505904,505905,505933,505934	Nuka Bay	55	342	40.2	0.7
		Total	457	2,545	215	0.5

Table 11.–Commercial shrimp trawl harvest and effort in Kachemak Bay (Area H), 1969–2015.

Season	Number of vessels	Harvest (lb)
1969/70	7	3,871,840
1970/71	3	5,905,988
1971/72	7	4,520,906
1972/73	10	4,882,082
1973/74	13	4,825,934
1974/75	4	5,031,912
1975/76	4	4,419,019
1976/77	5	4,998,986
1977/78	7	5,037,946
1978/79	6	6,012,799
1979/80	7	5,797,427
1980/81	15	6,177,129
1981/82	23	4,995,499
1982/83	15	3,020,767
1983/84	10	525,508
1984/85	10	1,566,686
1985/86	5	1,249,728
1986/87	3	504,206
1987/88	0	0
1988/89	0	0
1989/90	0	0
1990/91	0	0
1991/92	0	0
1992/93	0	0
1993/94	0	0
1994/95	0	0
1995/96	0	0
1996/97	0	0
1997-2015	Closed by regulation	

Table 12.–Commercial shrimp trawl harvest and effort in Outer Cook Inlet (Area G), 1977–2015.

Season	Number of vessels	Harvest (lb)
1977/78	2	26,556
1978/79	1	1,245
1979/80	0	0
1980/81	1	4,000
1981/82	2	19,454
1982/83	4	239,584
1983/84	7	760,430
1984/85	11	1,957,959
1985/86	4	421,063
1986/87	2	297,762
1987/88	1	22,231
1988/89	1	4,878
1989/90	0	0
1990/91	0	0
1991/92	2	6,196
1992/93	2	111,709
1993/94	2	218,854
1994/95	3	32,591
1995/96	1	[a]
1996/97	1	[a]
1997-2015	Closed by regulation	

[a] Confidential.

Table 13.–North Gulf Coast shrimp stratified biomass estimates for pink and sidestripe shrimp from 2005 to 2007 trawl surveys.

		Pink (northern) shrimp			Sidestripe shrimp		
	Year	2005	2006	2007	2005	2006	2007
Harris Bay	Biomass estimate (lb)	63,931	726,429	449,587	20,698	288,010	253,303
	SE	9,459	245,170	157,343	6,338	79,700	16,260
	95% CI ($\pm$)	26,259	680,591	436,783	17,594	221,247	45,139
	CV	0.15	0.34	0.35	0.31	0.28	0.06
Aialik Bay	Biomass estimate (lb)	26,575	575,665	74,015	95,854	184,491	187,618
	SE	7,744	28,385	22,554	11,855	61,053	41,303
	95% CI ($\pm$)	24,641	90,320	62,610	37,723	194,270	114,658
	CV	0.29	0.05	0.30	0.12	0.33	0.22
Resurrection Bay	Biomass estimate (lb)	454,316	626,278	438,674	547,290	570,597	903,273
	SE	98,765	136,422	168,273	120,599	189,144	387,168
	95% CI ($\pm$)	253,926	378,707	467,125	310,061	525,065	1,074,778
	CV	0.22	0.22	0.38	0.22	0.33	0.43

Table 14.–Commercial shrimp pot harvest and effort in Cook Inlet Management Area (Area H), 1970–2015.

Season	Number of vessels	Harvest (lb)
1970/71		11,208
1971/72		79,437
1972/73		259,477
1973/74		801,346
1974/75		170,122
1975/76		374,523
1976/77	26	251,674
1977/78	51	597,449
1978/79	41	170,314
1979/80	49	237,890
1980/81	30	313,359
1981/82	45	153,836
1982/83	40	155,622
1983/84	15	21,438
1984/85	22	76,105
1985/86	25	72,097
1986/87	37	75,289
1987/88	30	31,632
1988/89	9	5,323
1989/90	Closed	
1990/91	Closed	
1991/92	Closed	
1992/93	Closed	
1993/94	Closed	
1994/95	Closed	
1995/96	Closed	
1996/97	Closed	
1997–2015	Closed by regulation	

Table 15.–Commercial shrimp pot harvest and effort in Kachemak Bay (Area G), 1977–2015.

Season	Number of vessels	Harvest (lb)
1977	6	1,776
1978	11	10,157
1979	5	4,211
1980	3	2,911
1981	5	2,031
1982	7	2,805
1983	13	18,679
1984	5	5,504
1985	6	3,305
1986	4	2,967
1987	9	12,458
1988	7	13,445
1989	8	20,500
1990	5	8,853
1991	8	7,315
1992	3	2,804
1993	3	8,356
1994	1	[a]
1995	0	0
1996	2	[a]
1997–2015	Closed by regulation	

[a] Confidential.

Table 16.–Effort and harvest in the commercial shrimp pot fishery of Prince William Sound, 1960–2009.

Year	Vessels	Landings	Spot harvest (lb)	Coonstripe harvest (lb)	Other	Total
1960						4,988
1961						–
1962						3,576
1963						1,101
1964						4,248
1965						4,356
1966						–
1967						749
1968						6,866
1969						5,146
1970						19,776
1971						13,073
1972						6,949
1973						6,370
1974						24,978
1975						4,150
1976						2,410
1977						7,516
1978	9	17	ND	ND	ND	15,466
1979	17	98	ND	ND	ND	52,208
1980	23	155	84,787	5,174	67	90,028
1981	51	509	153,017	20,055	465	173,537
1982	57	397	205,746	7,250	784	213,781
1983	71	646	198,719	14,119	583	213,420
1984	79	513	198,729	7,911	640	207,280
1985	78	528	271,928	3,919	860	276,707
1986	80	540	286,105	3,715	812	290,632
1987	86	498	265,707	3,795	151	269,653
1988	76	433	191,630	764	48	192,442
1989	33	69	28,884	431	0	29,315
1990	23	59	36,378	358	0	36,737
1991	15	45	17,302	278	0	17,580
1992-2009			Fishery Closed			

Table 17.–Prince William Sound commercial shrimp pot fishery guideline harvest levels (GHL), effort, gear limits, harvest, and catch per unit, 2010–2014.

Year	Area	GHL (lb)	Vessels	Landings	Pot lifts	Gear limits begin	Gear limits close	Spot harvest (lb)	Coonstripe harvest (lb)	Other harvest (lb)	Total harvest (lb)	% of GHL caught	CPUE (lb/pot)
2010	1	55,000	75	232	18,025	20	20	45,076	263	10	45,349	82%	2.52
2011	2	52,760	45	183	29,580	40	40	51,302	1,204	44	52,550	99.6%	1.78
2012	3	51,240	35	106	19,644	50	50	18,097	3,428	36	21,561	42%	1.10
2013	1	66,300	43	214	34,804	30	50	59,376	2,266	2	61,644	93%	1.77
2014	2	66,600	32	214	41,027	40	50	64,220	4,085	158	68,464	103%	1.67

Table 18.–Prince William Sound spot shrimp survey results, 1992–2014.

Year	No of pots	Harvest (lb)	Avg lb/pot	No of shrimp	% Male	% Female	% Egg bearing
1992	349	249	0.71	5,009	88.2	11.8	11.4
1993	325	121	0.37	2,434	80.6	19.4	19
1994	355	145	0.41	4,128	95.1	4.9	4.7
1995	350	206	0.59	5,053	95.7	4.3	3.9
1996	350	182	0.52	4,618	94.9	5.1	NA
1997	345	142	0.41	3,835	94.1	5.9	5.6
1998	264	76	0.29	2,252	94.6	5.4	5.3
1999 [a]	346	165	0.48	4,392	94.3	5.7	5.6
2000	349	245	0.7	6,545	95.1	4.9	4.7
2001	351	331	0.94	7,034	92.7	7.3	7.3
2002 [b]	304	377	1.24	8,797	91	9	8.9
2003	352	398	1.13	9,333	92	8	8
2004	352	502	1.43	12,593	91.5	8.5	8.3
2005	349	481	1.38	14,453	95	5	4.7
2006	346	553	1.6	14,203	91.6	8.4	7.7
2007	349	838	2.4	24,152	94.2	5.8	4.8
2008	348	893	2.56	23,004	93.4	6.6	5.4
2009	351	825	2.35	17,622	86.2	13.8	12.1
2010	350	478	1.37	8,585	81.8	18.2	17
2011	350	687	1.96	11,627	74.8	25.2	24.9
2012	392	834	2.13	15,928	84.7	15.3	13.9
2013	392	744	1.9	14,453	85.7	14.3	12.5
2014	393	752	1.91	16,051	89.2	10.8	10.1

Note: NA means not available.

[a] Sex interpolated for 452 lost data points.

[b] Sex interpolated for 192 lost data points.

Table 19.–Prince William Sound shrimp trawl harvest and effort, 1972–2014.

	GHL (lb)					Harvest (lb) [a]				
Year	Vessels	Wells	NW	Central/SW	Landings	Northern	Sidestripe	Other	Deadloss	Total
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA	5,153
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,243
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,345
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	26,961
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	134,115
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	170,757
1978	8	NA	NA	NA	NA	NA	NA	NA	NA	440,684
1979	4	NA	NA	NA	NA	NA	NA	NA	NA	634,518
1980	6	NA	NA	NA	NA	NA	NA	NA	NA	557,328
1981	4	NA	NA	NA	NA	NA	NA	NA	NA	70,560
1982	9	NA	NA	NA	NA	NA	NA	NA	NA	346,517
1983	13	NA	NA	NA	46	420,275	1,058	2,345	NA	423,678
1984	14	NA	NA	NA	55	1,292,643	8,842	1,155	NA	1,302,640
1985	6	NA	NA	NA	44	432,514	15,696	440	NA	448,650
1986	3	NA	NA	NA	44	218,156	27,701	13	NA	245,870
1987	2	NA	NA	NA	109	[b]	[b]	[b]	NA	[b]
1988	4	NA	NA	NA	99	497	111,898	52	NA	112,447
1989	1	NA	NA	NA		[b]	[b]	[b]	[b]	[b]
1990	4	60,500	NA	NA	89	3,348	105,795	15	18,303	127,461
1991	5	80,000	NA	NA	67	3,453	84,483	193	51,429	139,558
1992	5	65,000	NA	NA	70	651	196,467	28	49,097	246,243
1993	7	46,000	NA	NA	72	23	190,976	51	55,140	246,190
1994	6	33,500	NA	NA	47	749	85,980	0	24,134	110,863
1995	4	35,000	16,000		39	0	73,706	0	24,189	97,895
1996	3	49,000	18,500	33,000	42	0	89,551	0	21,704	111,255
1997	3	48,700	18,500	33,000	63	0	70,026	0	22,060	92,086
1998	2	25,000	18,500	33,000	39	[b]	[b]	[b]	[b]	[b]
1999	3	19,000	14,000	33,000	47	0	56,386	0	7,754	64,140

-continued-

Table 19.–Page 2 of 2.

	GHL (lb)					Harvest (lb) [a]				
Year	Vessels	Wells	Northwest	Central/SW	Landings	Northern	Sidestripe	Other	Deadloss	Total
2000	3	25,000	14,000	33,000	46	0	61,566	0	12,377	73,943
2001	3	34,388	14,000	33,000	45	0	59,736	0	21,765	81,501
2002	3	23,565	14,000	33,000	43	0	54,736	0	14,532	69,268
2003	3	31,954	14,000	33,000	46	612	61,269	106	18,236	80,223
2004	3	36,700	14,000	33,000	44	1,371	54,437	423	29,002	85,238
2005	3	32,000	14,000	33,000	41	0	61,130	413	23,028	84,571
2006	3	47,000	18,500	33,000	40	0	66,552	0	32,485	99,037
2007	2	59,500	14,000	33,000	24	[b]	[b]	[b]	[b]	[b]
2008	2	92,300	14,000	33,000	29	[b]	[b]	[b]	[b]	[b]
2009	2	71,423	14,000	33,000	32	[b]	[b]	[b]	[b]	[b]
2010	1	104,700	14,000	33,000	32	[b]	[b]	[b]	[b]	[b]
2011	1	67,649	14,000	33,000	24	[b]	[b]	[b]	[b]	[b]
2012	1	65,957	14,000	33,000	19	[b]	[b]	[b]	[b]	[b]
2013	2	61,928	14,000	33,000	28	[b]	[b]	[b]	[b]	[b]
2014	2	60,300	14,000	33,000	22	[b]	[b]	[b]	[b]	[b]

[a] Catches converted from tail weight to whole weight using a conversion factor of 1.67.

[b] Confidential data.

Table 20.–Commercial hardshell clam harvest from the Southern District of the Cook Inlet Management Area, 1986–2015.

Year	Permits	Landings	Littleneck clams	Butter clams	Cockles	Total
1986	5	18	17,303	0	0	17,303
1987	8	69	12,214	206	2,347	14,767
1988	2	32	[a]	[a]	[a]	[a]
1989	9	41	2,584	13,675[b]	3,581[b]	19,840
1990	19	62	35,744	0	0	35,744
1991	19	78	47,486	85	0	47,571
1992	21	117	54,631	0	0	54,631
1993	33	159	63,676	0	0	63,676
1994	32	104	44,291	0	0	44,291
1995	21	93	66,723	4,267	35	71,025
1996	25	102	53,524	233	0	43,757
1997	15	67	31,525	0	0	31,525
1998	12	40	23,465	0	0	23,465
1999	12	22	19,345	0	0	19,345
2000	11	66	20,798	0	0	20,798
2001	8	45	20,575	0	0	20,575
2002	9	33	14,310	0	0	14,310
2003	9	55	17,956	0	0	17,956
2004	8	49	11,114		0	11,114
2005	10	34	8,525	0	0	8,525
2006	3	6	1,026	196	0	1,222
2007-2015			closed by regulation			

[a] Confidential data, less than 3 participants.

[b] Includes clams sold as otter food as a result of the Exxon Valdez oil spill.

Table 21.–Commercial harvest of razor clams in Upper Cook Inlet, 1919–2014.

Year	Harvest (lb)	Year	Harvest (lb)
1919	76,963	1967	0
1920	11,952	1968	0
1921	72,000	1969	0
1922	510,432	1970	0
1923	470,280	1971	14,755
1924	156,768	1972	31,360
1925	0	1973	34,415
1926	0	1974	0
1927	25,248	1975	10,020
1928	0	1976	0
1929	0	1977	1,762
1930	0	1978	45,931
1931	ND	1979	144,358
1932	93,840	1980	140,420
1933	ND	1981	441,949
1934	ND	1982	460,639
1935	ND	1983	269,618
1936	ND	1984	261,742
1937	8,328	1985	319,034
1938	ND	1986	258,632
1939	ND	1987	312,349
1940	No RD	1988	399,376
1941	0	1989	222,747
1942	0	1990	323,602
1943	0	1991	201,320
1944	0	1992	296,727
1945	15,000	1993	310,481
1946	11,424	1994	355,165
1947	11,976	1995	248,358
1948	2,160	1996	355,448
1949	9,672	1997	366,532
1950	304,073	1998	371,877
1951	112,320	1999	352,910
1952	0	2000	369,397
1953	0	2001	348,917
1954	0	2002	338,938
1955	0	2003	411,403
1956	0	2004	419,697
1957	0	2005	371,395
1958	0	2006	368,953
1959	0	2007	283,085
1960	372,872	2008	390,999
1961	277,830	2009	361,388
1962	195,650	2010	379,547
1963	0	2011	189,172
1964	0	2012	307,409
1965	0	2013	380,912
1966	0	2014	348,294

Table 22.–Daily commercial harvest of razor clams, Upper Cook Inlet, 2014.

Date	Harvest (lb)	No. diggers	Date	Harvest (lb)	No. diggers
5/11/2014	4,890	17	6/27/2014	5,010	18
5/12/2014	6,396	19	6/28/2014	4,933	18
5/14/2014	7,878	19	6/29/2014	4,122	17
5/15/2014	8,246	19	6/30/2014	5,313	18
5/16/2014	7,147	19	7/1/2014	6,398	18
5/17/2014	7,233	19	7/2/2014	4,211	18
5/18/2014	7,361	18	7/3/2014	3,631	18
5/19/2014	7,440	19	7/8/2014	1,873	12
5/20/2014	6,387	19	7/9/2014	6,247	18
5/21/2014	6,183	19	7/10/2014	4,142	15
5/24/2014	5,172	19	7/11/2014	2,084	9
5/25/2014	6,076	19	7/12/2014	6,193	18
5/26/2014	6,409	19	7/13/2014	5,719	18
5/27/2014	7,228	19	7/14/2014	6,192	18
5/29/2014	6,961	19	7/15/2014	6,165	18
5/31/2014	3,938	19	7/16/2014	7,149	18
6/2/2014	5,280	19	7/17/2014	4,070	17
6/3/2014	7,568	19	7/18/2014	3,277	18
6/4/2014	4,680	19	7/21/2014	2,039	13
6/9/2014	4,247	18	7/22/2014	4,989	18
6/10/2014	7,372	19	7/23/2014	3,960	16
6/11/2014	8,537	19	7/24/2014	4,648	18
6/12/2014	8,492	18	7/25/2014	4,950	18
6/14/2014	9,349	18	7/26/2014	5,907	18
6/15/2014	6,306	18	7/27/2014	6,796	18
6/16/2014	6,267	18	7/28/2014	5,967	18
6/17/2014	5,484	18	7/29/2014	6,965	18
6/18/2014	4,343	17	7/30/2014	5,809	18
6/19/2014	5,507	18			
6/23/2014	6,433	18			
6/24/2014	5,380	18			
6/25/2014	4,352	18			
6/26/2014	4,993	18			
Total for year	348,294				

Table 23.–Commercial and noncommercial razor clam harvest in Prince William Sound, 1979–2014.

	Commercial		Noncommercial	
Year	Diggers	Pounds	Diggers	Pounds
1979	26	12,904		
1980	21	5,881		
1981	7	28,970		
1982	12	15,275		
1983	41	124,835		
1984	41	168,426		
1985	25	60,274	37	4,930
1986	17	13,122	38	4,831
1987	12	40,954	83	6,225
1988	4	6,766	52	2,768
1989	0	0	50	2,903
1990	0	0	50	2,641
1991	0	0	77	1,484
1992	0	0	92	2,403
1993	[a]	[a]	37	1,131
1994	0	0	28	459
1995	0	0	14	92
1996	0	0	19	381
1997	0	0	10	145
1998	0	0	4	32
1999	0	0	5	29
2000	0	0	4	27
2001	0	0	9	86
2002	0	0	7	71
2003	0	0	6	69
2004	0	0	11	74
2005	0	0	17	130
2006	0	0	11	11
2007	0	0	3	3
2008	0	0	1	1
2009	0	0	2	2
2010	0	0	3	3
2011	0	0	2	2
2012	0	0	2	5.5
2013	0	0	3	24
2014	0	0	3	1.75

[a] Confidential data.

Table 24.–Commercial Dungeness crab harvest and effort in Cook Inlet Management Area, 1961–2015.

Year	Vessels	Landings	Harvest (lb)
1961	12	189	193,683
1962	15	269	530,770
1963	50	1,360	1,677,204
1964	22	341	423,041
1965	14	105	74,211
1966	5	28	129,560
1967	2	13	7,168
1968	7	224	487,859
1969	9	41	49,894
1970	10	50	209,819
1971	22	136	97,161
1972	24	206	38,930
1973	54	625	310,048
1974	38	619	721,243
1975	34	402	362,815
1976	19	123	119,298
1977	18	94	74,705
1978	49	668	1,215,779
1979	72	1,485	2,130,963
1980	54	1,183	1,875,281
1981	88	2,047	1,850,977
1982	108	2,310	818,885
1983	71	1,194	747,419
1984	102	1,687	800,208
1985	106	1,768	1,402,402
1986	83	1,069	563,862
1987	100	1,377	793,176
1988	84	1,305	719,275
1989	43	455	178,064
1990	23	112	29,502
1991	0	0	0
1992	1	1	7,108
1993	1	36	9,652
1994			[a]
1995	1		[a]
1996	1		[a]
1997–2015		Closed by regulation	

[a] Confidential data.

Table 25.–Commercial Dungeness crab harvest and effort in Prince William Sound, 1960–2015.

	Outside		Inside				
			Orca Inlet		Other Areas		
Year	Vessels	Harvest (lb)	Vessels	Harvest (lb)	Vessels	Harvest (lb)	Total harvest (lb)
1960				1,524,326			1,524,326
1961				990,242			990,242
1962				1,353,190			1,353,190
1963				1,216,846			1,216,846
1964				1,290,929			1,290,929
1965				1,240,372			1,240,372
1966				999,341			999,341
1967				ND			NA
1968				579,279			579,279
1969		336,696		541,822			878,518
1970		78,223		660,411			738,634
1971		78,848		430,976			509,824
1972		437,865		286,808			724,673
1973		458,613		347,764			806,377
1974		290,149		269,015			559,164
1975		654,410		163,631			818,041
1976	4	254,933	3	35,399			290,332
1977	4	506,751	23	228,858			735,609
1978	12	1,319,451	34	648,439	17	49,571	2,053,461
1979	19	504,770	32	123,245	16	20,924	652,924
1980	10	659,667		closed	5	31,152	690,819
1981	18	1,503,574		closed	5	5,683	1,509,257
1982	16	757,911		closed	2	4,221	762,182
1983	9	379,094		closed	2	511	379,605
1984	10	826,778		closed	2	150	826,938
1985	17	1,006,196		closed	1	[a]	1,007,429
1986	16	1,090,477		closed		0	1,090,477
1987	13	887,713		closed	2	[a]	893,174
1988	8	602,969		closed		0	602,969
1989	9	635,976		closed		0	635,976
1990	17	397,913		closed		0	397,913
1991	14	70,259		closed		0	70,259
1992	2	[a]		closed		0	[a]
1993–2015				Fishery closed			

[a] Confidential data.

Table 26.–Copper River Dungeness crab survey results, 1986–2014.

Year	Number of pots	Legal crab	New shell recruits	% New shell recruits	Sublegal crab	New shell sublegal	% New shell sublegal	Female crab per pot
1986	65	16	12.1	76	10.8	3.8	35	3.1
1987	80	9.9	4.3	43	13.1	5.9	45	10.5
1988	80	8	4.8	60	11.8	4.1	35	9.2
1989				No Survey				
1990	80	8.3	3	36	8.6	1.9	22	8
1991	80	3.5	2.2	63	12.6	3.2	25	6.8
1992	80	1.1	0.3	27	10	3.4	34	2
1993	37	3.5	1.6	46	15.8	4.5	28	3.7
1994	78	1.4	0.3	21	9.2	3.1	34	1.4
1995	80	1.5	0.3	20	9.9	3	20	0.7
1996	80	1.1	0.3	24	3.5	1.3	37	0.1
1997	45	0.1	0	0	3.3	1	29	0.4
1998	65	0.3	0.1	31	7.4	3.8	52	0.3
1999	80	0.7	0.5	64	9.7	2.9	30	0.6
2000	80	0.7	0.5	34	5.6	3.2	46	0.4
2001	80	0.7	0.2	40	3.9	1.8	70	0.2
2002	80	1.7	0.6	34	10.8	5	47	0.6
2003	80	1.5	0.2	14	9.3	3.5	33	0.2
2004				No Survey				
2005	80	2.3	0.3	14	7.5	2.8	29	0.8
2006	79	2.2	0.51	23	3.5	1.8	51	0.25
2007				No Survey				
2008	65	0.2	0	0	0.5	0.2	39	0.02
2009				No Survey				
2010	70	0.1	0.03	25	0.8	0.6	75	0.01
2011				No Survey				
2012				No Survey				
2013	60	0.3	0.3	100	9.9	8.8	96	0.78
2014				No Survey				

Table 27.–Commercial sea cucumber harvest from the Cook Inlet Management Area, 1990–2015.

Season	Number of divers	Number of landings	Harvest (lb)
1990	2	14	22,525
1991	0	0	0
1992	0	0	0
1993/94	16	40	30,940
1994/95	22	93	26,575
1995/96	0	0	0
1996/97	3	6	1,528
1997–2015	Closed by regulation		

Table 28.–Commercial green sea urchin harvest from the Cook Inlet Management Area, 1987–2015.

Season	Number of divers	Harvest (lb)
1987	1	224
1988	0	0
1989	1	15,181
1990	0	0
1991	4	20,445
1992	7	6,119
1993	29	195,403
1994	2	80
1995	9	3,295
1996	0	0
1997–2015	Closed by regulation	

Table 29.–Estimated average density, average weight, number of samples or transects, biomass estimates for green urchin and sea cucumber surveys conducted in 2004 and 2005 in Sadie Cove, Tutka Bay and China Poot Bay.

Area	Species	Avg density (no/m)	Transects	Avg weight (g)	No of samples	Biomass estimate (lb)
Sadie Cove	Sea cucumber	4.62	35	267.46	383	49,399
Sadie Cove	Green Urchin	30.03	35	13.54	231	16,250
Tutka Bay	Green Urchin	10.74	37	12.66	254	8,157
China Poot Bay	Green Urchin	1.24	17	73.79	29	782

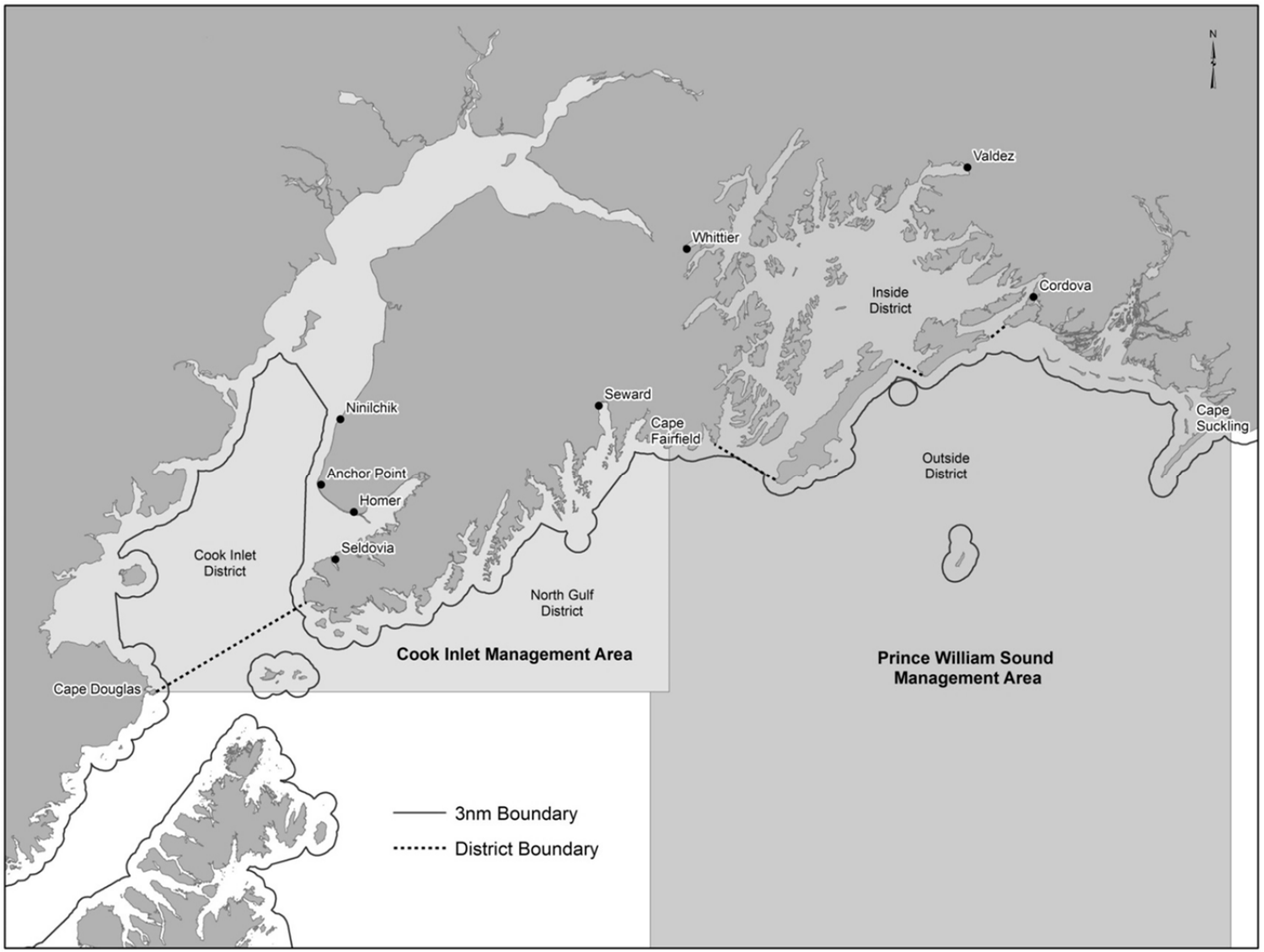

Figure 1.–Region 2 shellfish management areas, Cook Inlet and Prince William Sound.

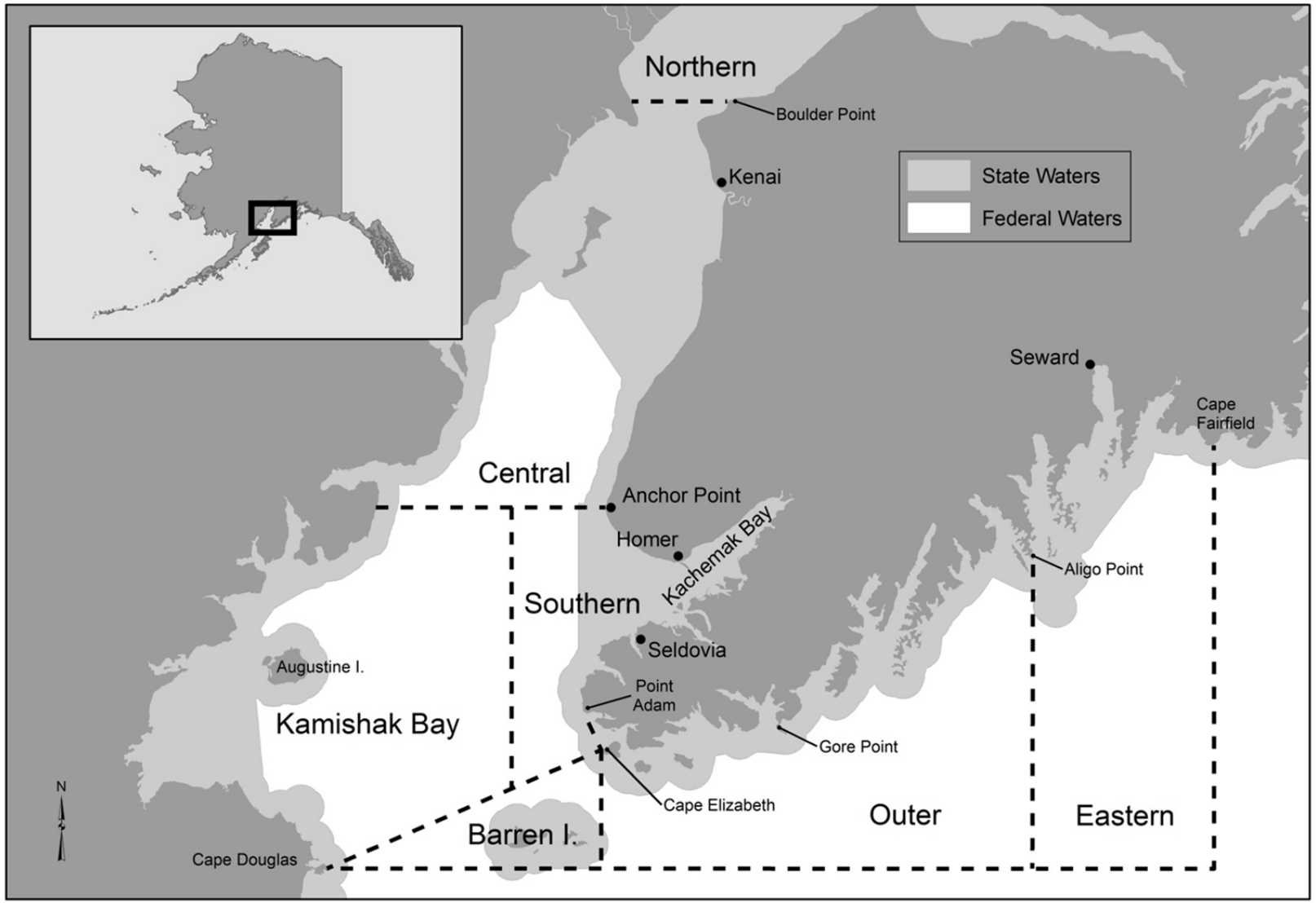

Figure 2.–Cook Inlet Management Area and its 7 shellfish districts: Northern, Central, Southern, Kamishak Bay, Barren Islands, Outer and Eastern districts.

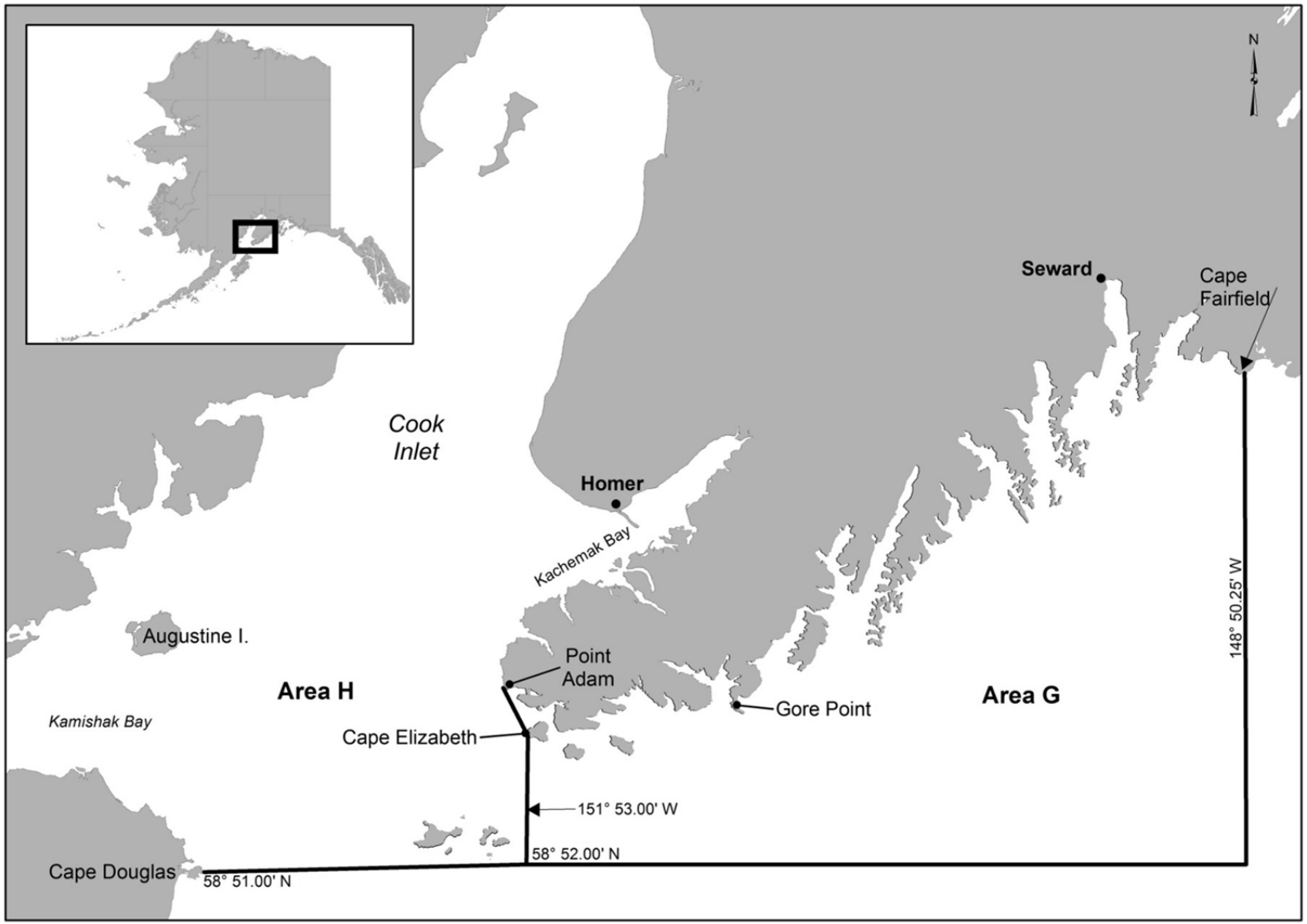

Figure 3.–Area G (established only for the commercial shrimp trawl and pot fisheries) and Area H in the Cook Inlet Management Area.

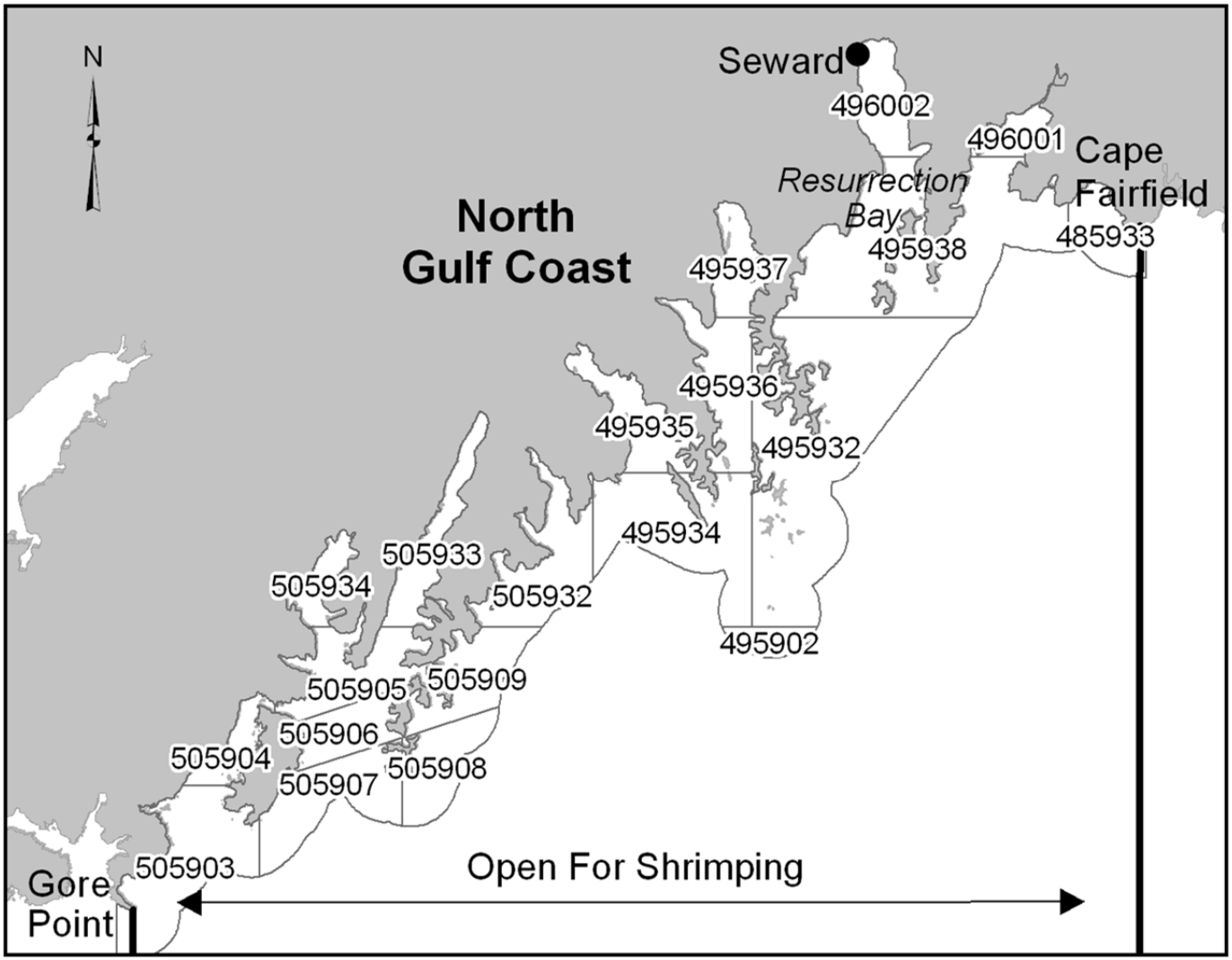

Figure 4.–North Gulf Coast area defined for the personal use shrimp fishery in the Cook Inlet Management Area with statistical areas used for permit reporting.

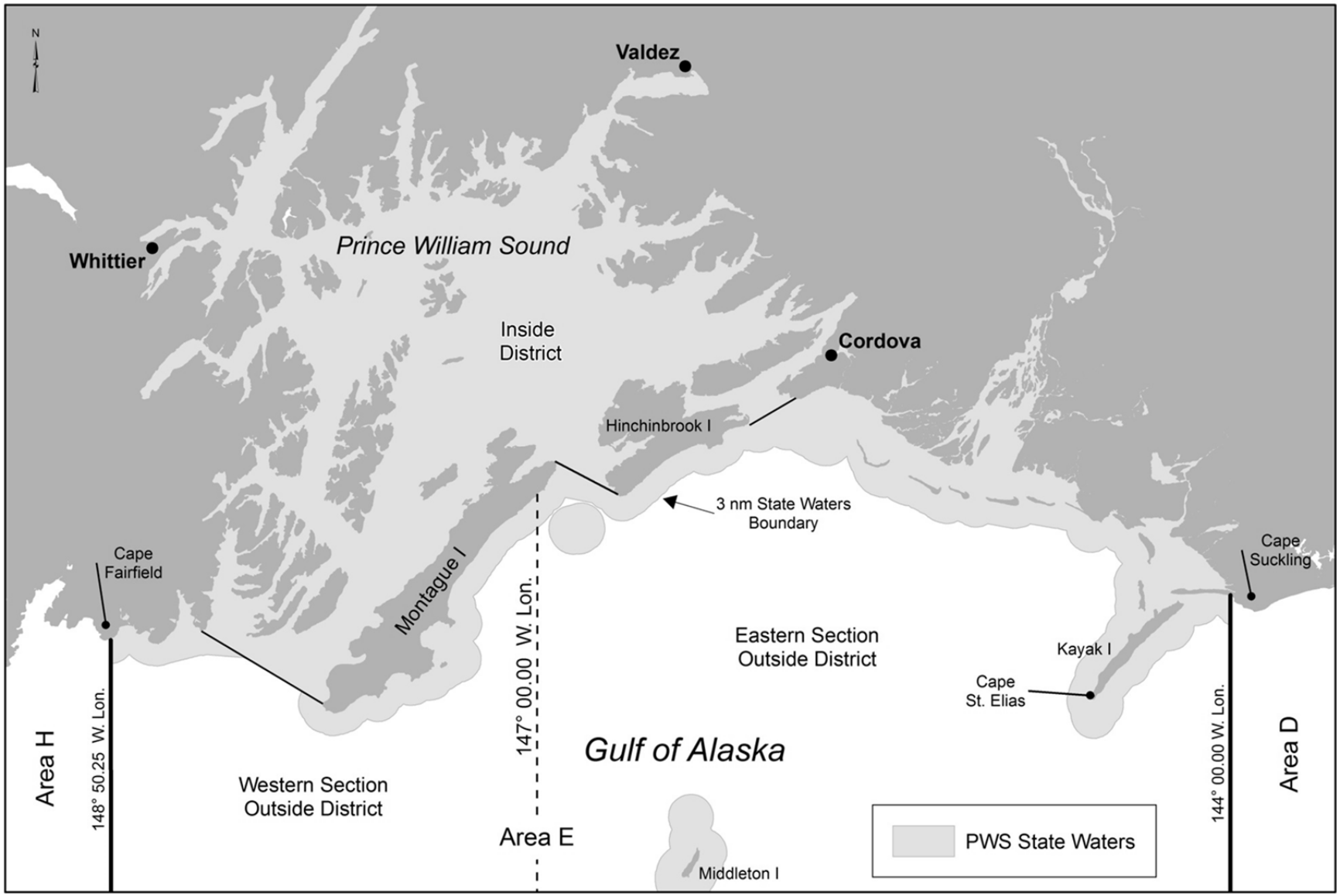

Figure 5.–Prince William Sound shellfish management districts and sections within, Registration Area E.

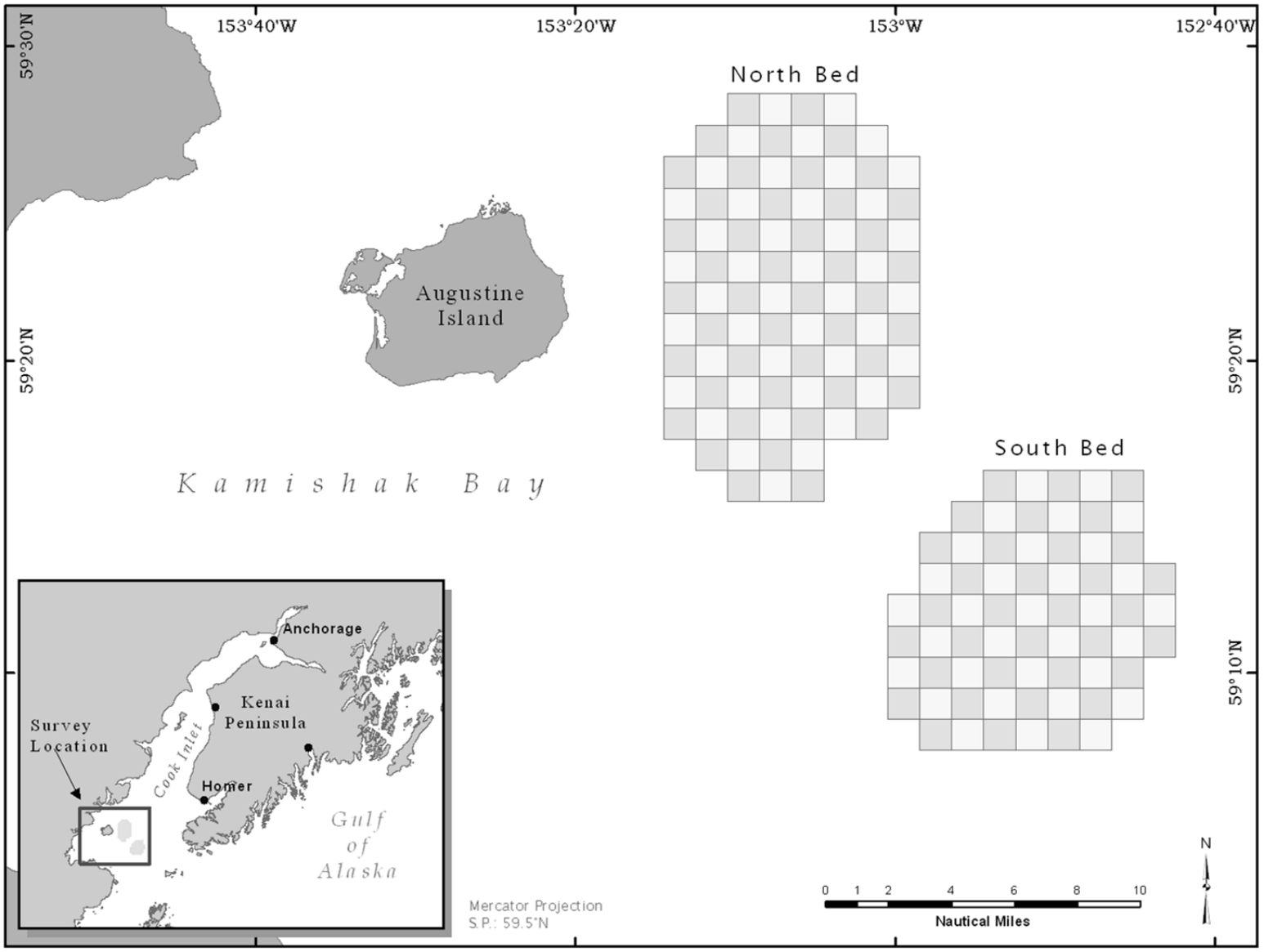

Figure 6.–Kamishak Bay weathervane scallop survey station locations in Cook Inlet Management Area.

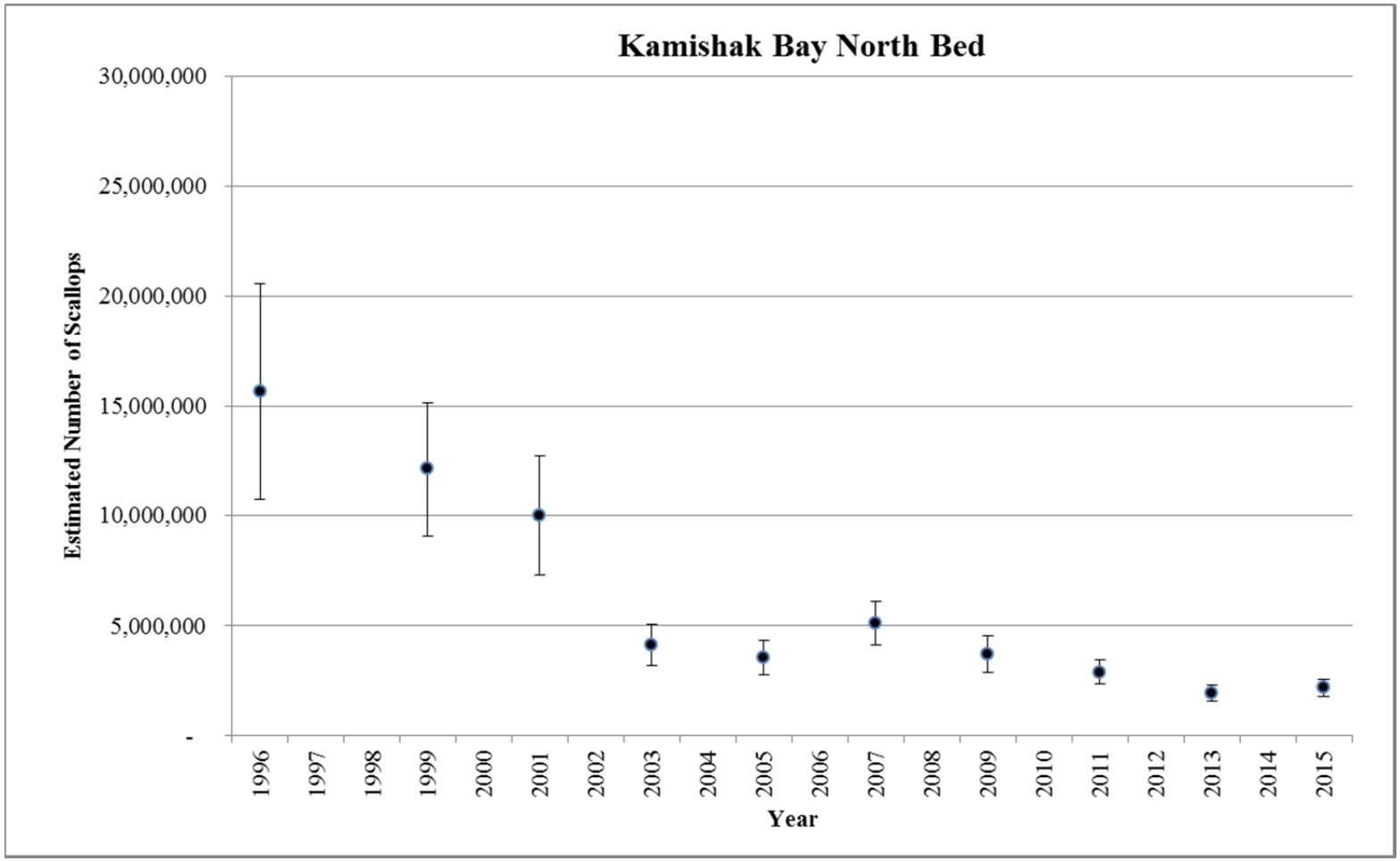

Figure 7.–North bed of Kamishak Bay estimated scallop abundance from biennial dredge survey from 1996 to 2015.

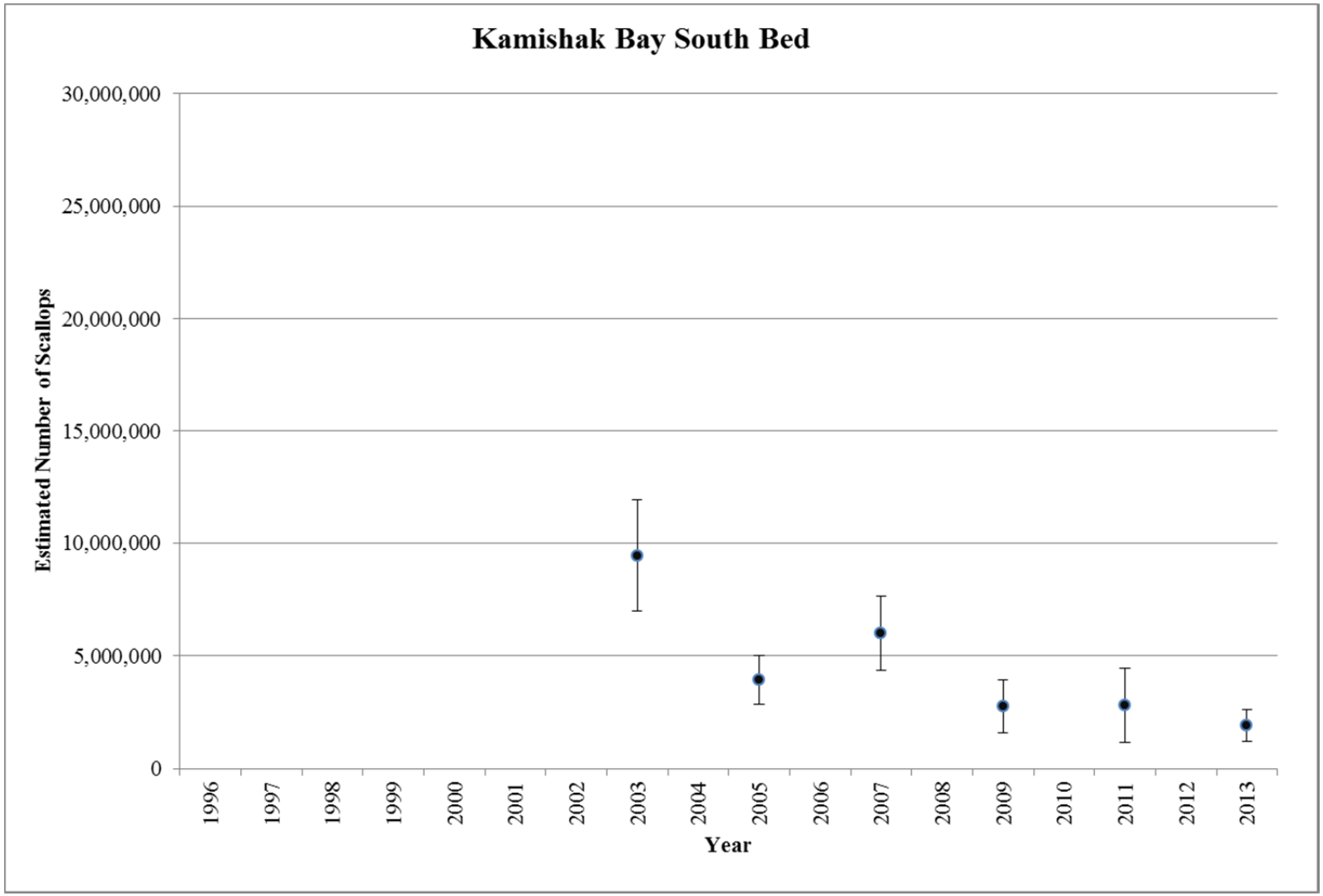

Figure 8.–Estimated scallop abundance estimate from the south bed of Kamishak Bay, biennial dredge survey from 1996 to 2015.

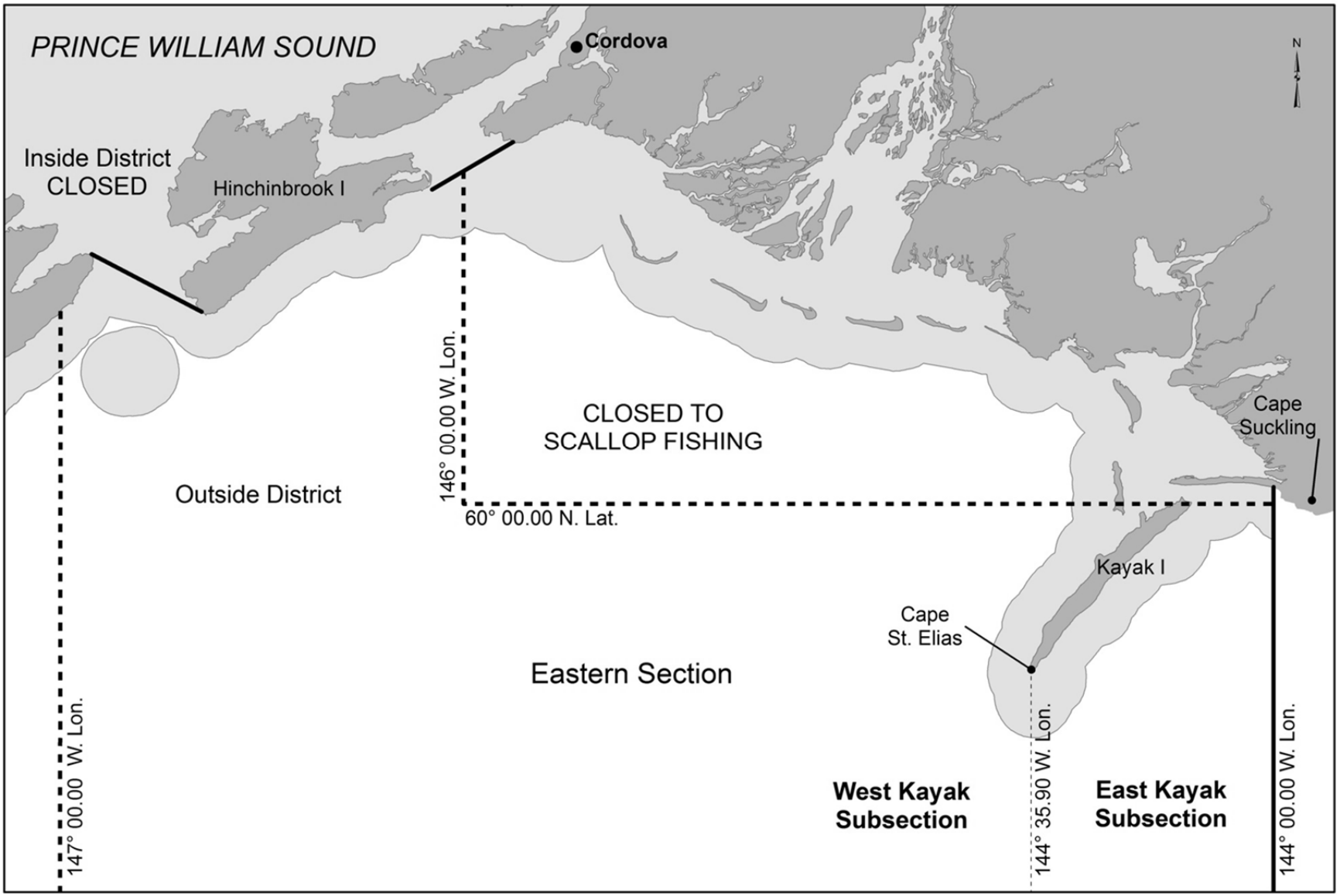

Figure 9.–Prince William Sound weathervane scallops fishing areas.

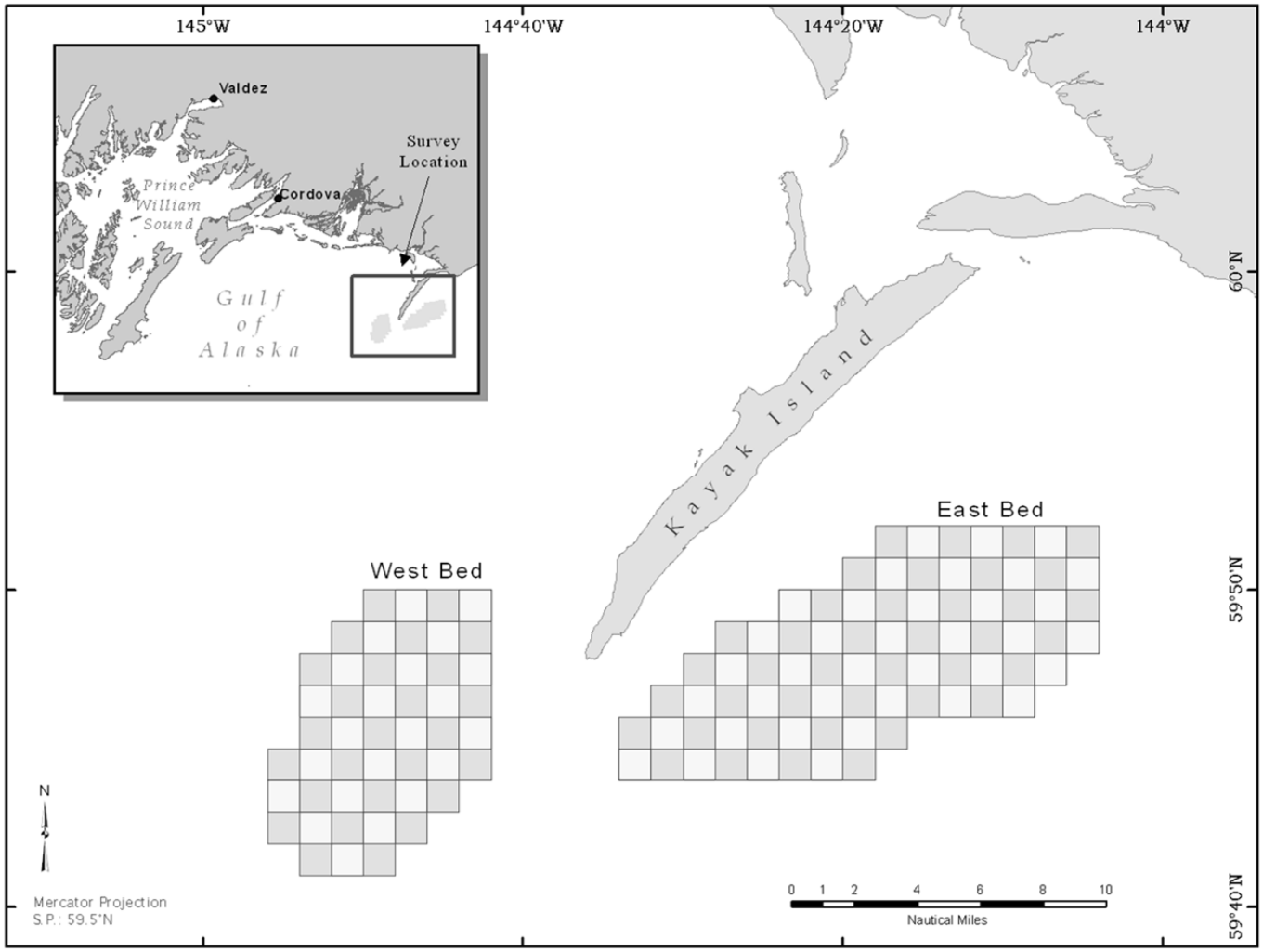

Figure 10.–Kayak Island weathervane scallop survey station locations in Prince William Sound Management Area.

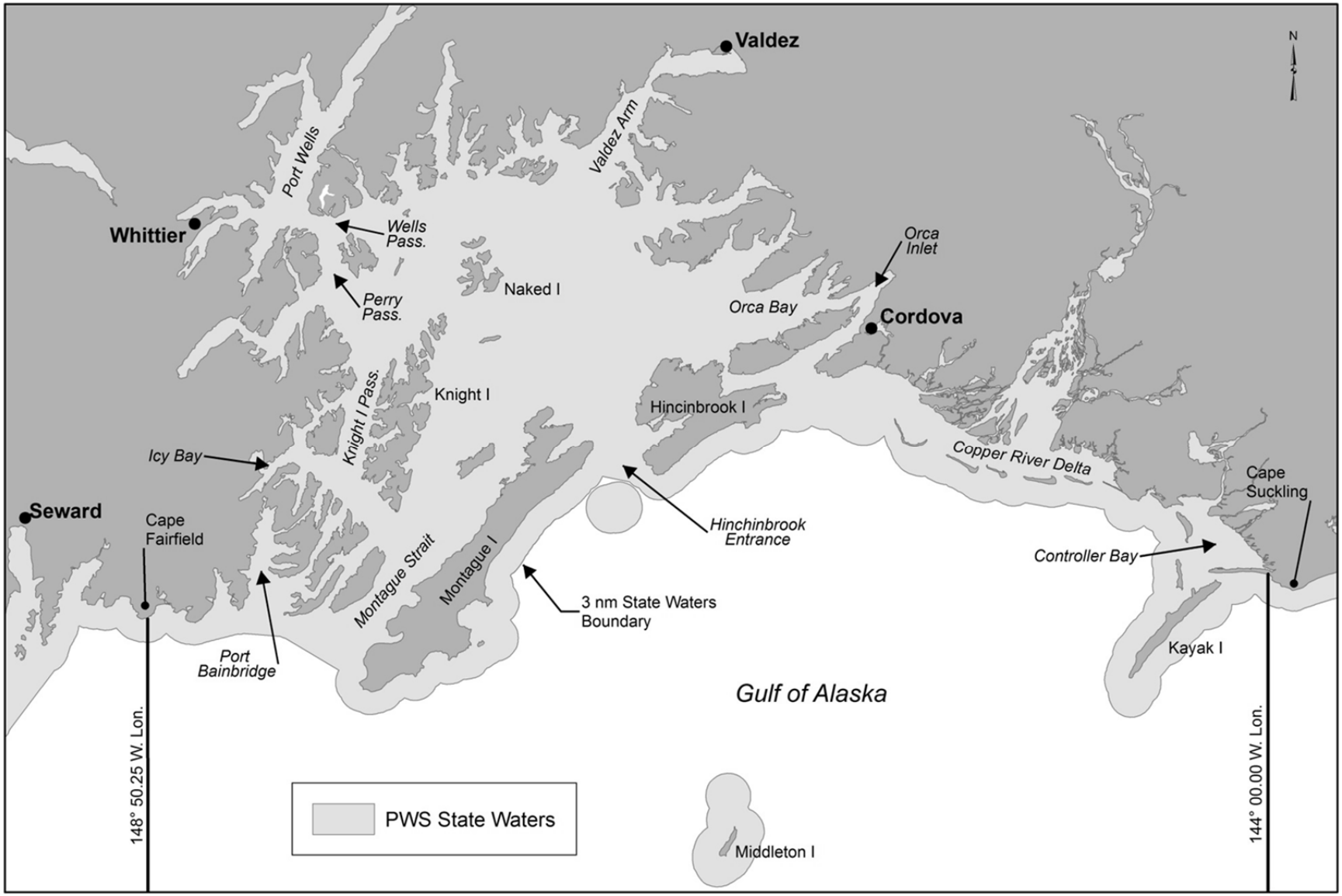

Figure 11.–Prince William Sound Management Area boundaries, cities, landmarks and water bodies.

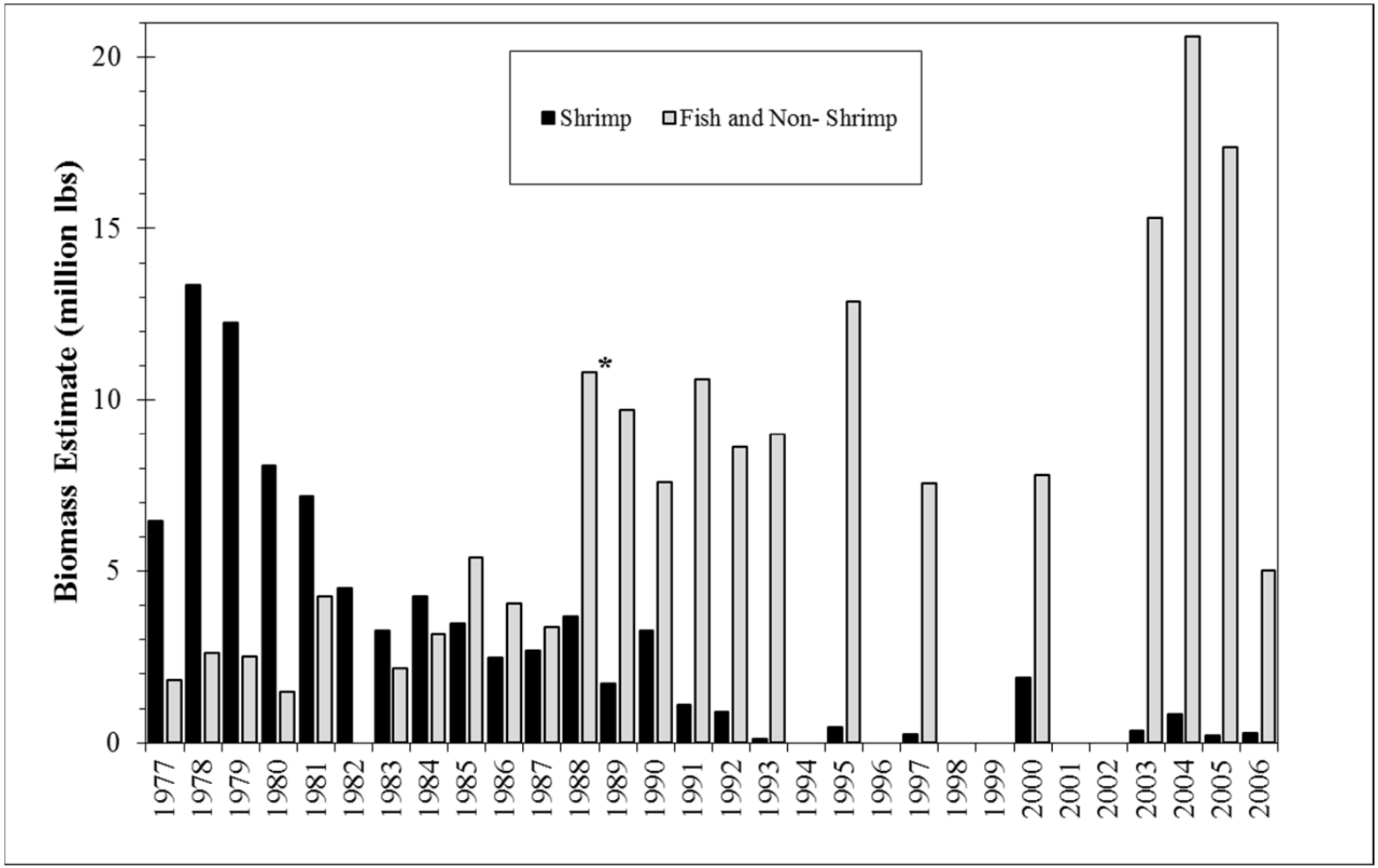

Figure 12.–Stratified biomass estimates for shrimp and non-shrimp species and fishes from small-mesh trawl spring surveys in Kachemak Bay, 1977–2006. Asterisk indicates increase of 2 square nautical miles to survey area.

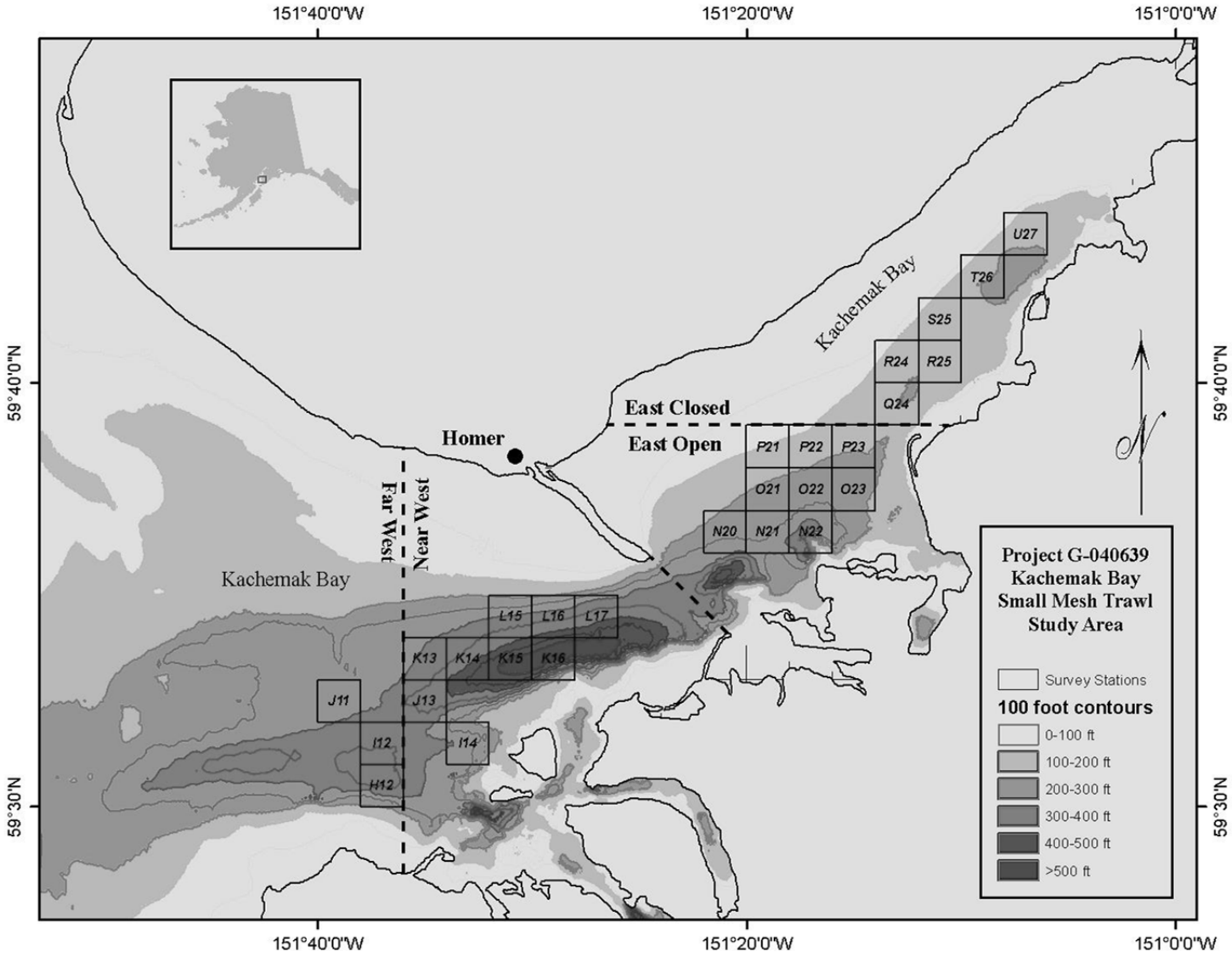

Figure 13.–Trawl station locations from the Kachemak Bay shrimp surveys showing survey coverage and geographic stratification.

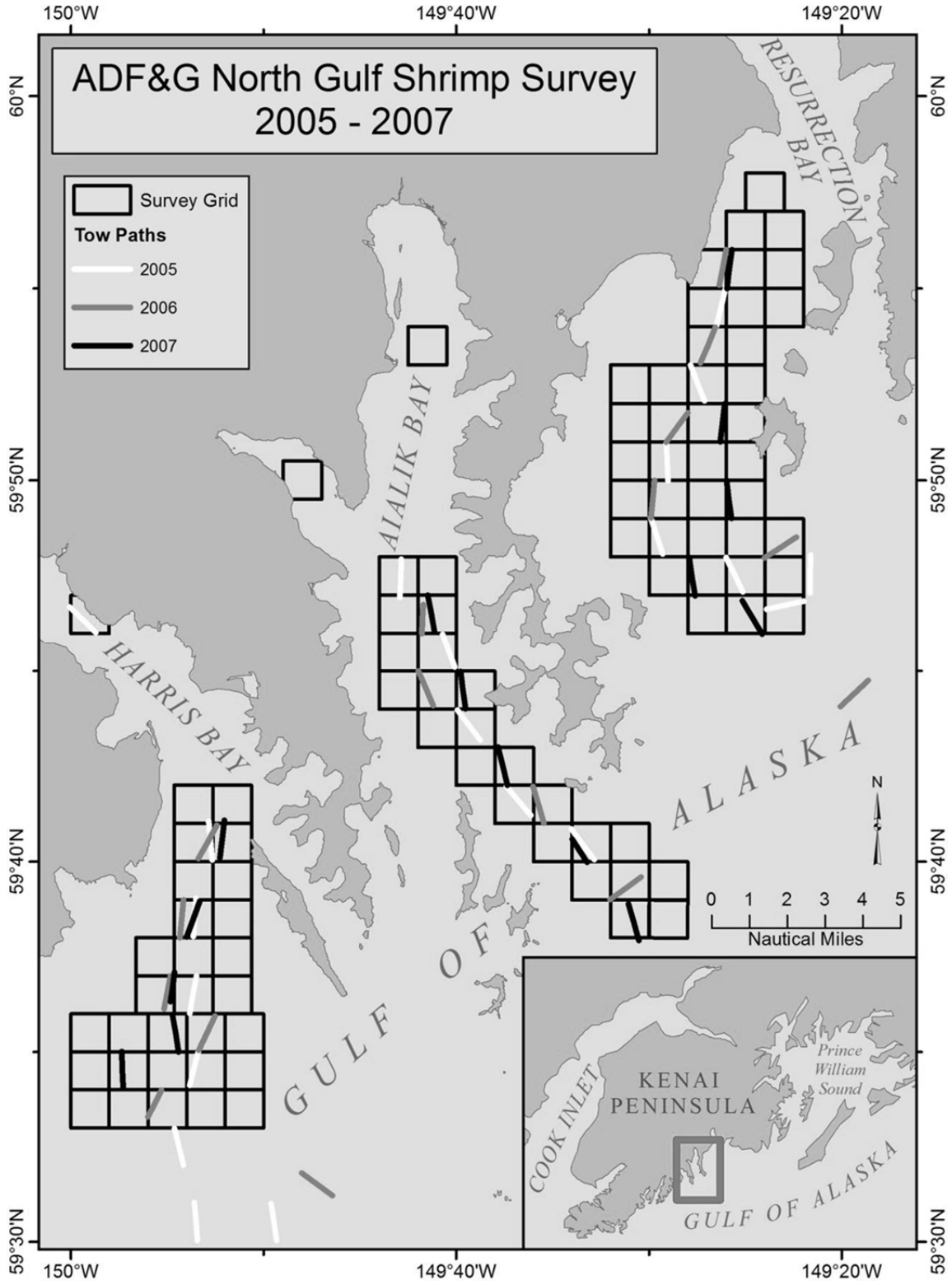

Figure 14.–North Gulf Coast shrimp trawl survey locations in Resurrection Bay, Aialik Bay, and Harris Bay; 2005–2007.

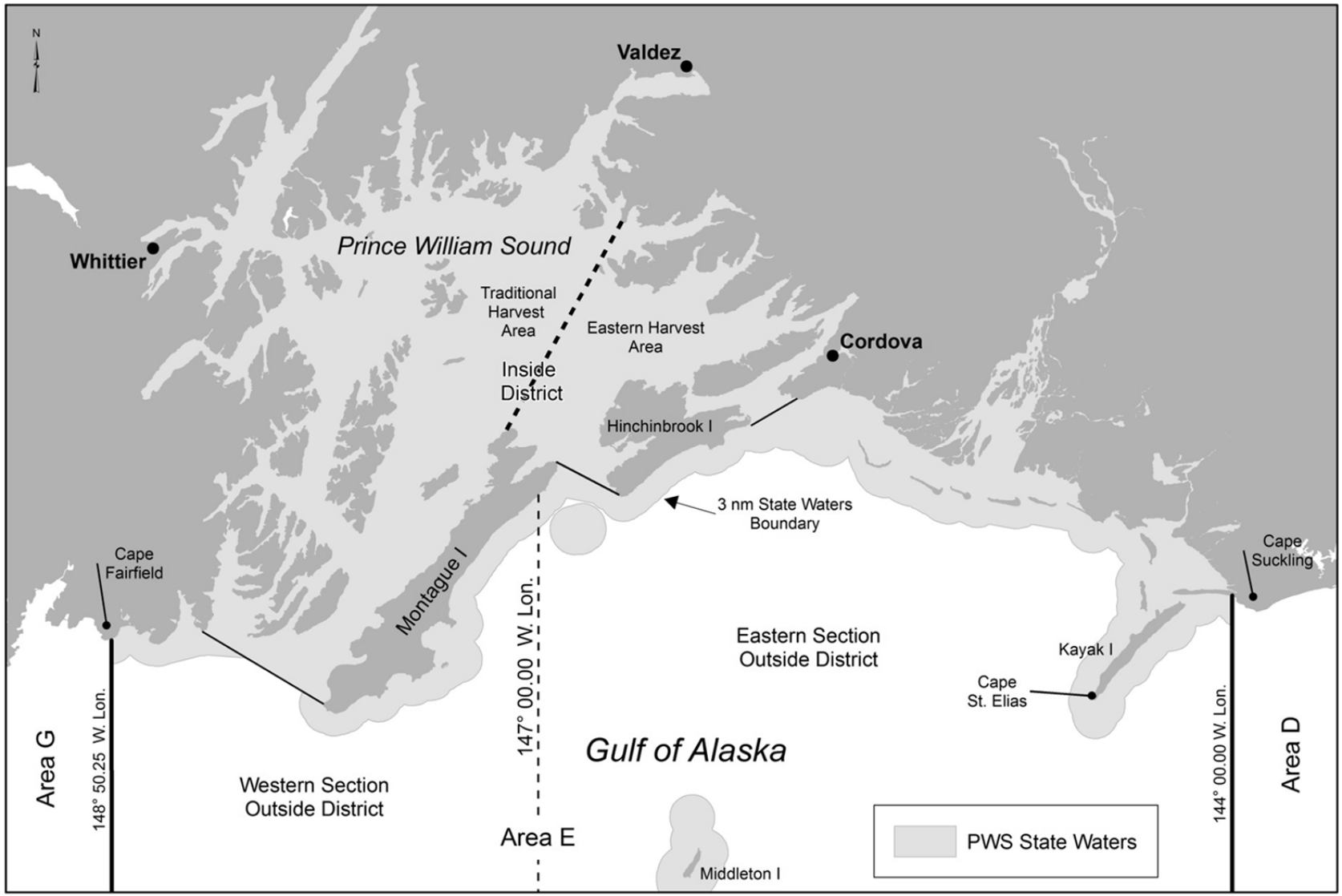

Figure 15.–Prince William Sound Management Area historical shrimp pot fishery areas.

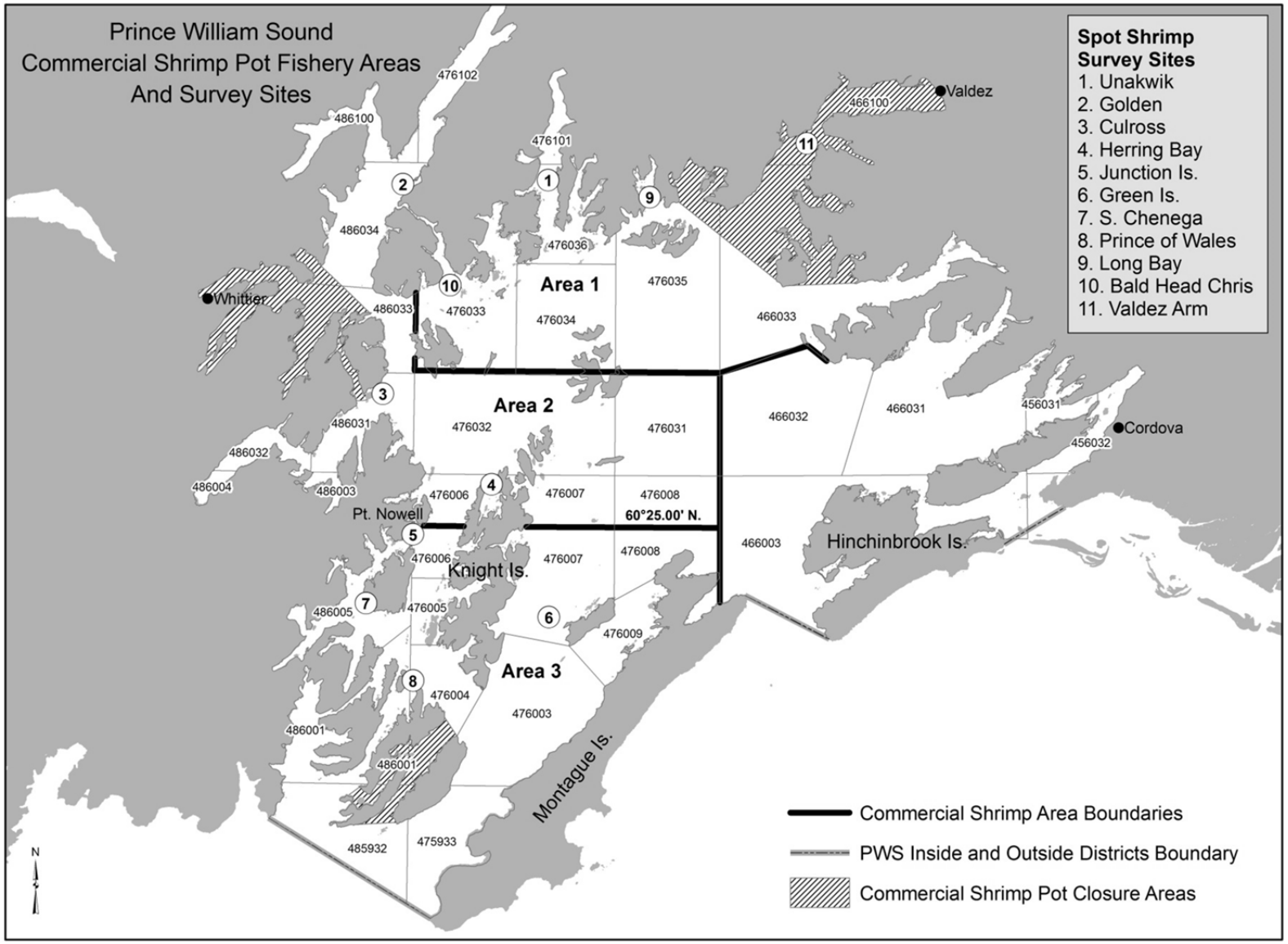

Figure 16.–Prince William Sound management area and index survey sites for shrimp pot fishery.

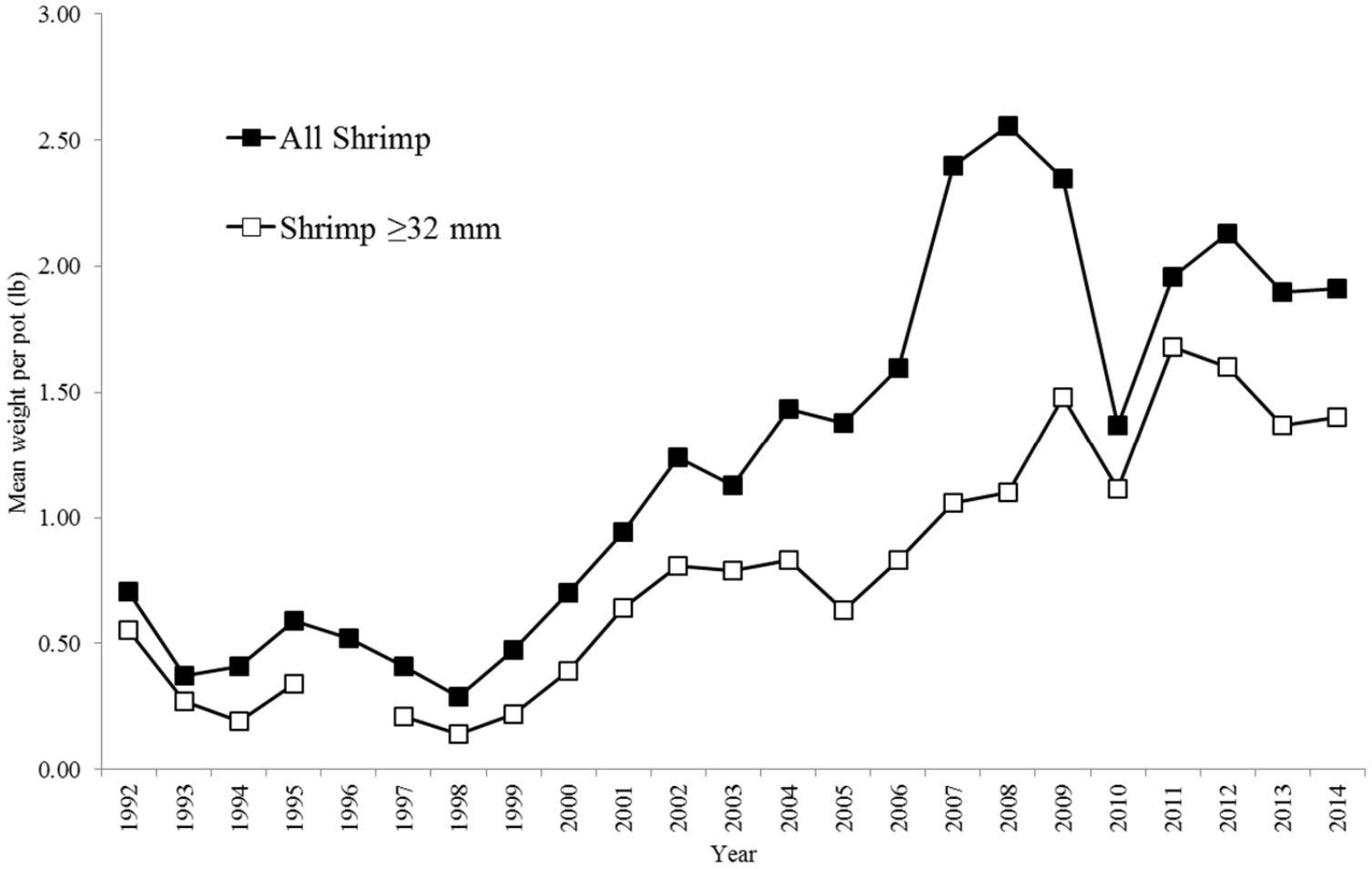

Figure 17.–Prince William Sound spot shrimp survey mean (average) weight of all spot shrimp and commercially marketable spot shrimp per pot (those equal or greater than 32 mm in carapace length).

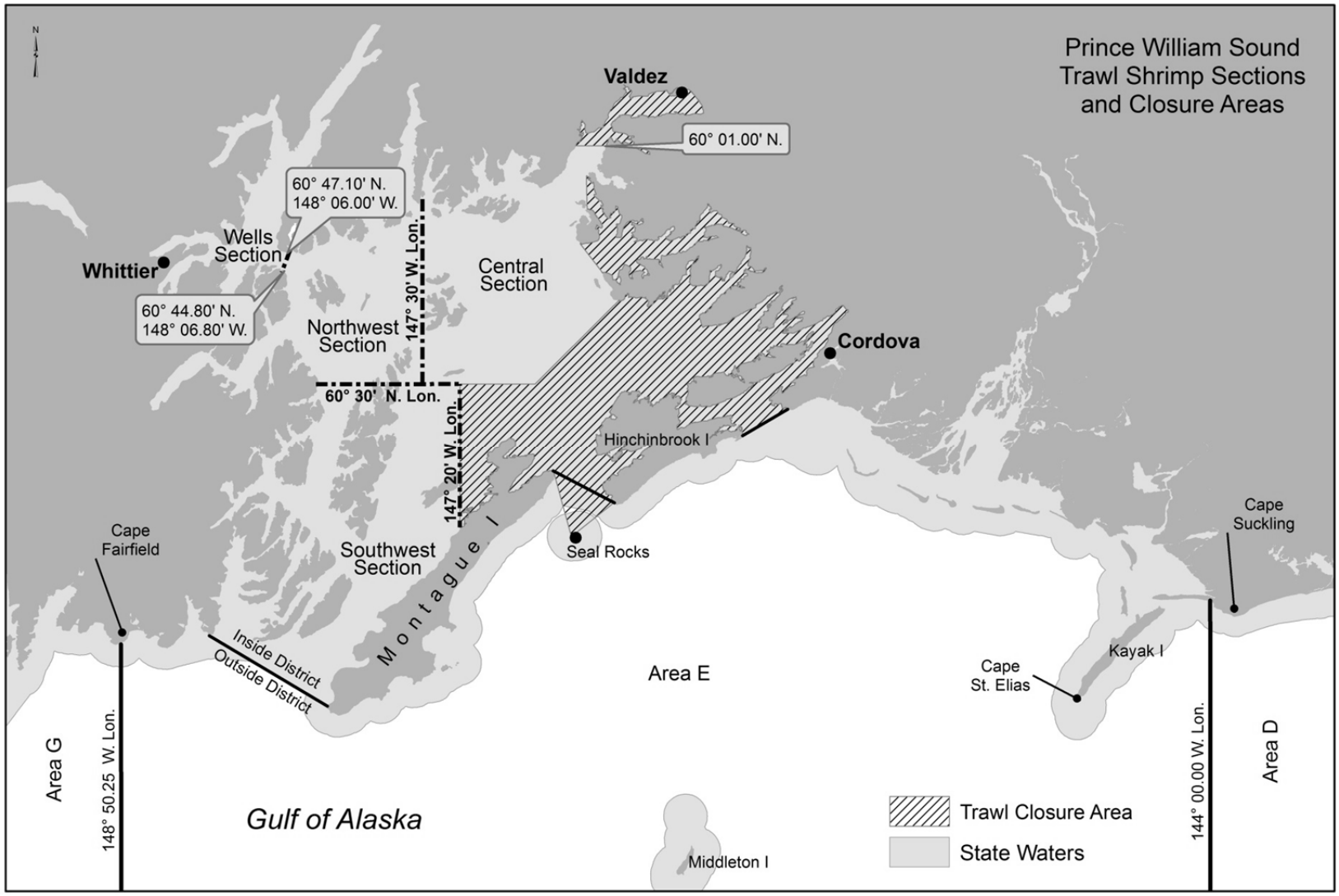

Figure 18.–Prince William Sound shrimp trawl fishing sections and closure areas.

Figure 19.–Predominate carapace mode length of sidestripe shrimp sampled from commercial trawl harvests in Port Wells and Wells Passage, 1990–1996 and 1998–2014.

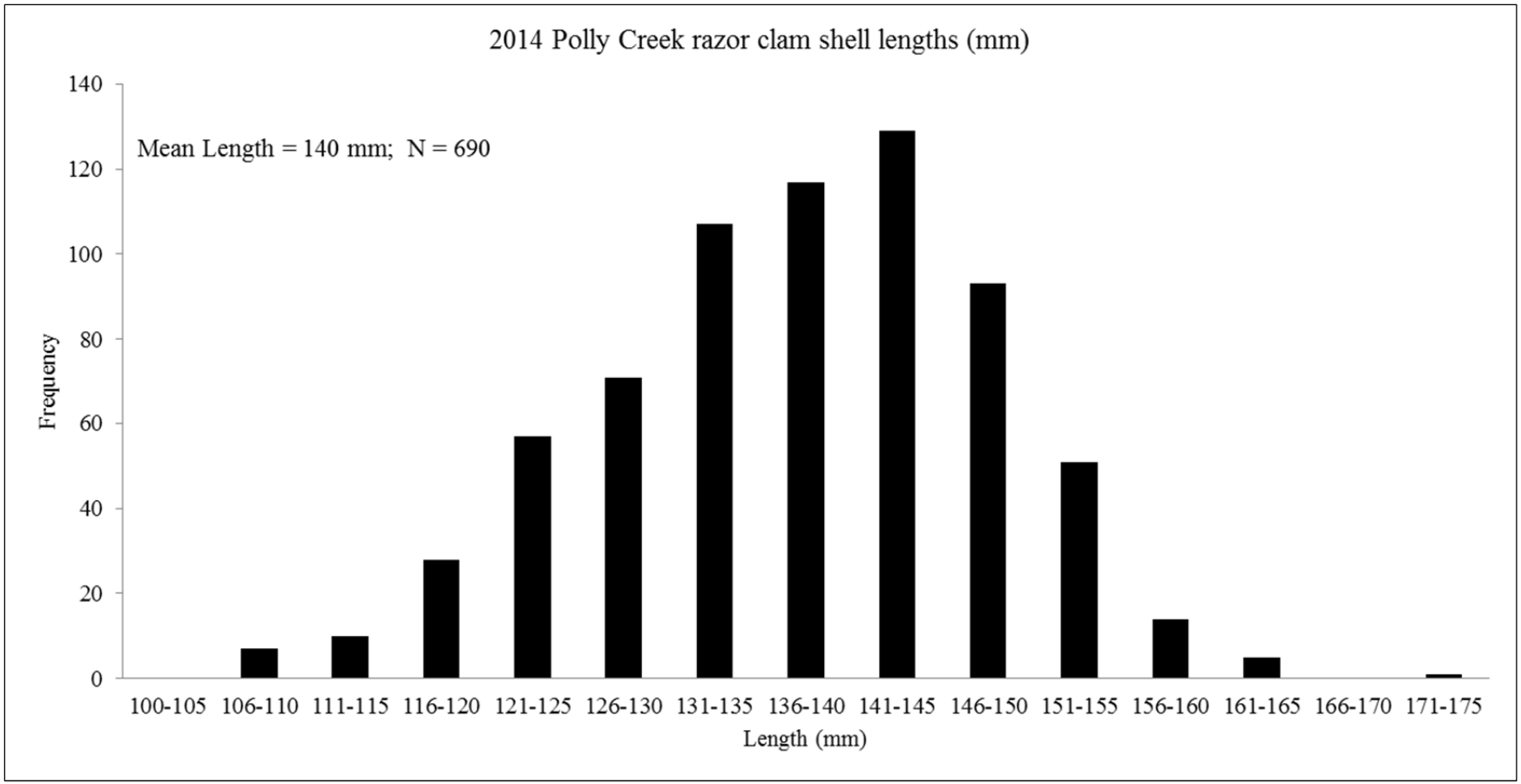

Figure 20.–Length frequency of razor clam shells sampled from the 2014 Polly Creek commercial razor clam fishery.

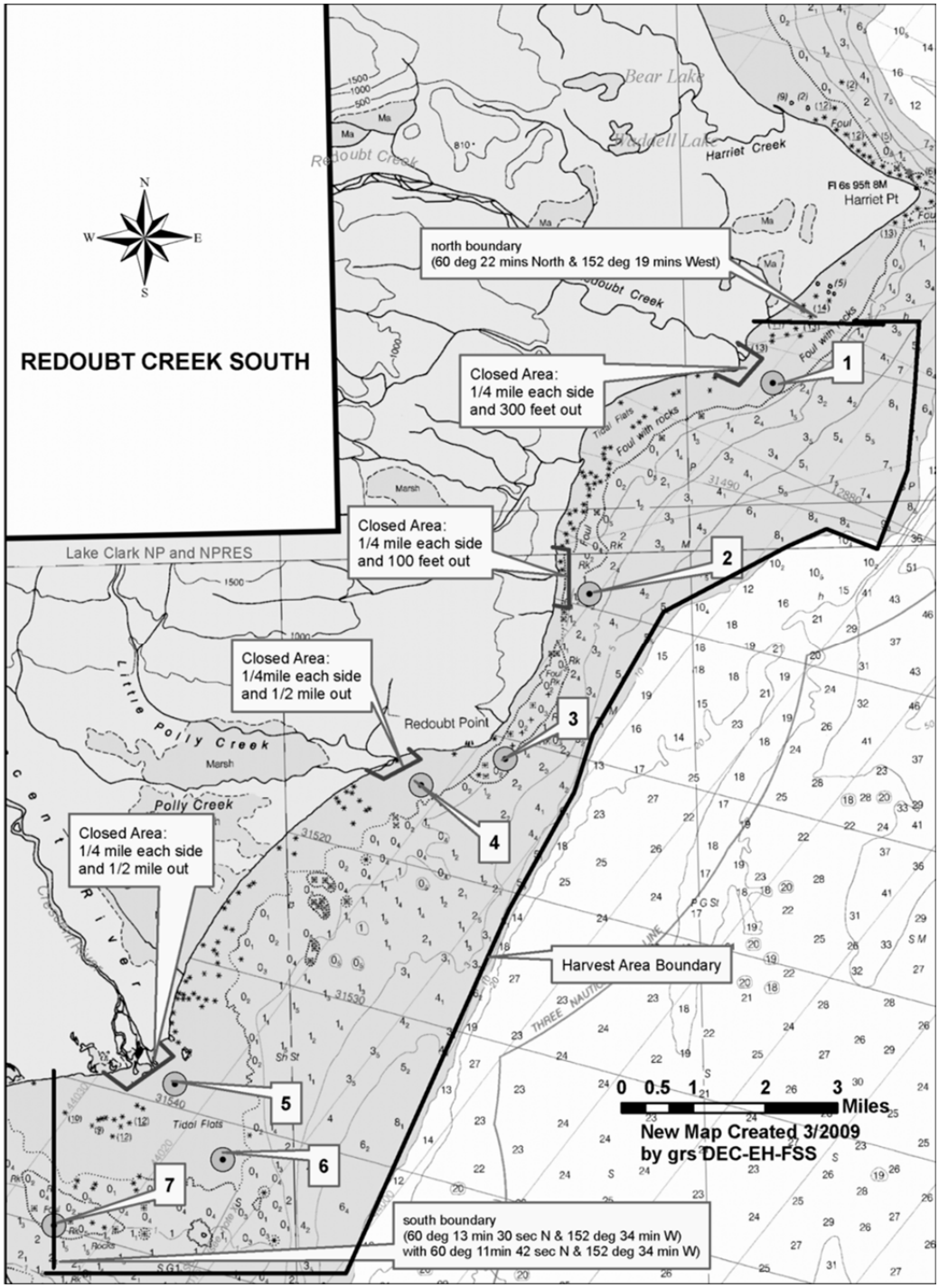

Figure 21.–Area open to the commercial razor clam fishery on the west side of Cook Inlet.

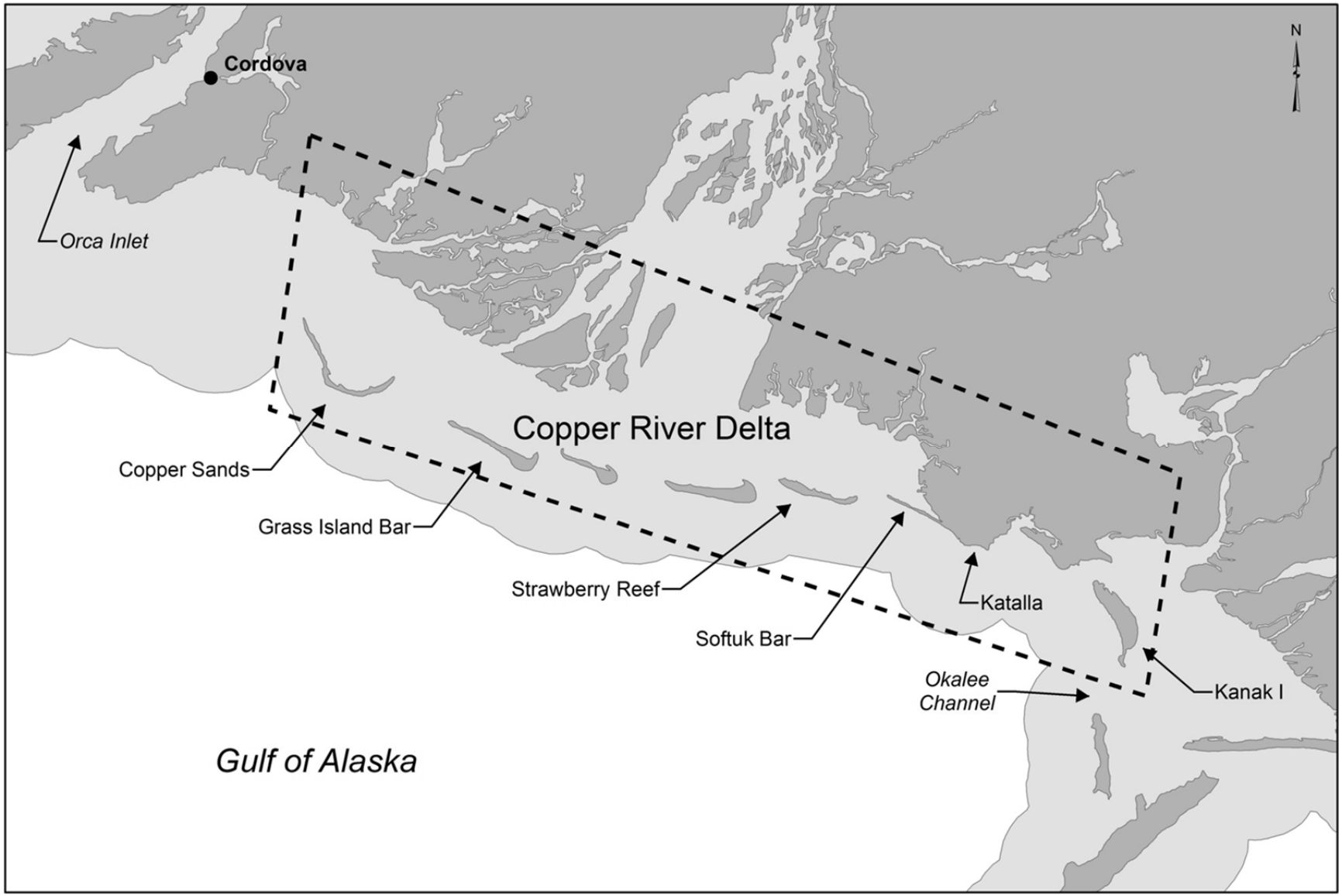

Figure 22.–Traditional harvest locations for Dungeness crab and razor clams in the Prince William Sound Management Area.

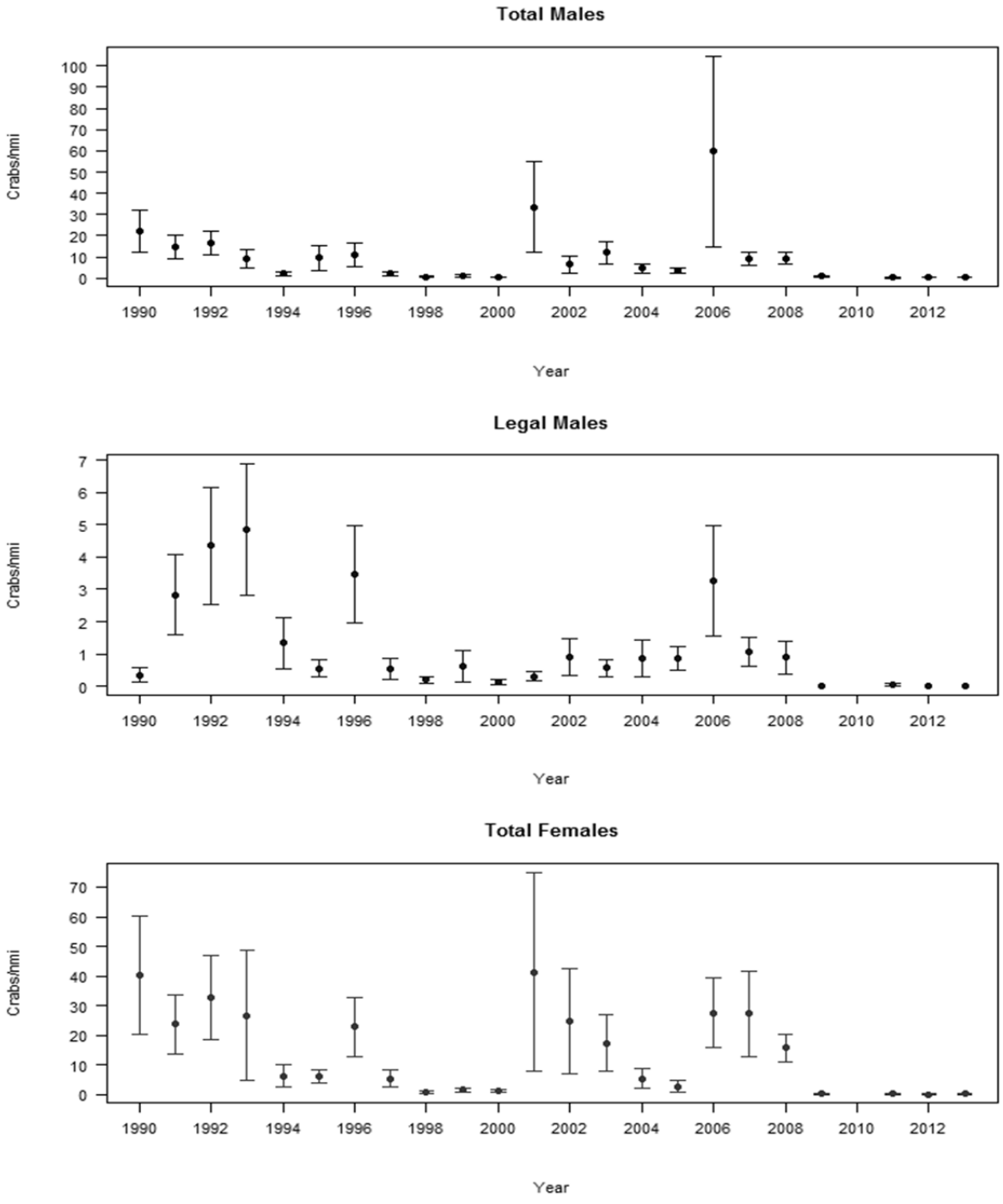

Figure 23.–Catch per unit of effort of Dungeness crab males, legal males, and females captured in the Kachemak Bay large-mesh trawl survey.

APPENDIX A

Appendix A1.–Prince William Sound shrimp pot and scallop fishery emergency orders (EO), 2012–2014.

Emergency Order	Effective Date	Explanation
2014 Calendar Year		
2-SF-E-01-14	4/15/2014	Established first commercial fishing period 8:00 am April 15 – 8:00 pm April 24, set maximum gear limit at 40 pots per vessel, and set hours of gear operation 8:00 am to 8:00 p.m.
2-SF-E-02-14	4/29/2014	Set second commercial fishing period 8:00 am April 29 – 8:00 pm May 8 and increased gear limit to 50 pots per vessel
2-SF-E-03-14	5/13/2014	Set third commercial fishing period 8:00 am May 13 – 8:00 pm May 22.
2-SF-E-04-14	5/27/2014	Set fourth commercial fishing period 8:00 am May 27 – 8:00 pm September 15 unless closed earlier by EO, and closed statistical area 486034 at 8:00 pm June 9.
2-SF-E-05-14	7/1/2014	Closed the commercial season for weathervane scallops for the 2014/15 season.
2-SF-E-06-14	6/14/2014	Extended hours of gear operation to 6:00 am to 10:00 pm daily.
2-SF-E-07-14	8/2/2014	Closed the commercial shrimp trawl season in the Wells Section.
2-SF-E-08-14	8/14/2014	Closed commercial shrimp pot fishery for the 2014 season.
2013 Calendar Year		
2-SF-E-01-13	4/15/2013	Established first three commercial fishing periods 8:00 am April 15 – 8:00 pm April 18, 8:00 am April 22 – 8:00 pm April 25, and 8:00 am April 29 – 8:00 pm May 2, set the maximum gear limit at 30 pots per vessel, and closed statistical area 476036 to commercial harvest after 8:00 pm April 18.
2-SF-E-02-13	4/29/2013	Increased the maximum gear limit to 40 pots, opened statistical area 476036 to commercial harvest, and set a fourth commercial fishing period beginning 5/6/2013 – 8:00 pm September 15 unless closed earlier by EO.
2-SF-E-03-13	5/6/2013	Closed statistical area 476036 to commercial harvest.
2-SF-E-04-13	6/12/2013	Increased the maximum gear limit to 50 pots and extended the hours of gear operation to between 6:00 am and 10:00 p.m.
2-SF-E-05-13	7/1/2013	Closed the commercial season for weathervane scallops for the 2013/14 season.
2-SF-E-06-13	7/12/2013	Closed the commercial shrimp trawl season in the Wells Section.
2-SF-E-07-13	8/26/2013	Closed statistical area 476101 for the 2013 season.
2012 Calendar Year		
2-SF-E-01-12	4/15/2012	Established first fishing period 8:00 am April 15 – 8:00 pm April 29, established hours of gear operation between 8:00 am and 8:00 pm., and set the maximum gear limit at 50 pots per vessel.
2-SF-E-02-12	4/29/2012	Extended the first fishing period from 8:00 pm April 29 – 8:00 pm September 15 unless closed earlier by EO.
2-SF-E-03-12	7/1/2012	Closed the commercial season for weathervane scallops for the 2012/13 season.
2-SF-E-04-12	6/14/2012	Closed the waters of Copper Bay to commercial harvest.
2-SF-E-05-12	7/15/2012	Closed the commercial shrimp pot fishery for the 2012 season.