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2006 Review of Cook Inlet Area Commercial Fisheries for Dungeness Crab, Shrimp, and Miscellaneous Shellfish Fisheries

A Report to the Alaska Board of Fisheries

by

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and

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February 2006

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative		fork length	FL
deciliter	dL	Code	AAC	mideye-to-fork	MEF
gram	g	all commonly accepted		mideye-to-tail-fork	METF
hectare	ha	abbreviations	e.g., Mr., Mrs., AM, PM, etc.	standard length	SL
kilogram	kg			total length	TL
kilometer	km	all commonly accepted			
liter	L	professional titles	e.g., Dr., Ph.D., R.N., etc.	Mathematics, statistics	
meter	m			<i>all standard mathematical</i>	
milliliter	mL	at	@	<i>signs, symbols and</i>	
millimeter	mm	compass directions:		<i>abbreviations</i>	
		east	E	alternate hypothesis	H _A
		north	N	base of natural logarithm	<i>e</i>
		south	S	catch per unit effort	CPUE
		west	W	coefficient of variation	CV
		copyright	©	common test statistics	(F, t, χ^2 , etc.)
		corporate suffixes:		confidence interval	CI
		Company	Co.	correlation coefficient	
		Corporation	Corp.	(multiple)	R
		Incorporated	Inc.	correlation coefficient	
		Limited	Ltd.	(simple)	r
		District of Columbia	D.C.	covariance	cov
		et alii (and others)	et al.	degree (angular)	°
		et cetera (and so forth)	etc.	degrees of freedom	df
		exempli gratia		expected value	<i>E</i>
		(for example)	e.g.	greater than	>
		Federal Information		greater than or equal to	≥
		Code	FIC	harvest per unit effort	HPUE
		id est (that is)	i.e.	less than	<
		latitude or longitude	lat. or long.	less than or equal to	≤
		monetary symbols		logarithm (natural)	ln
		(U.S.)	\$, ¢	logarithm (base 10)	log
		months (tables and		logarithm (specify base)	log ₂ , etc.
		figures): first three		minute (angular)	'
		letters	Jan, ..., Dec	not significant	NS
		registered trademark	®	null hypothesis	H ₀
		trademark	™	percent	%
		United States		probability	P
		(adjective)	U.S.	probability of a type I error	
		United States of		(rejection of the null	
		America (noun)	USA	hypothesis when true)	α
		U.S.C.	United States	probability of a type II error	
			Code	(acceptance of the null	
		U.S. state	use two-letter	hypothesis when false)	β
			abbreviations	second (angular)	"
			(e.g., AK, WA)	standard deviation	SD
				standard error	SE
				variance	
				population	Var
				sample	var
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	pH				
(negative log of)					
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

SPECIAL PUBLICATION NO. 06-09

**2006 REVIEW OF COOK INLET AREA COMMERCIAL FISHERIES
FOR DUNGENESS CRAB, SHRIMP AND MISCELLANEOUS
SHELLFISH FISHERIES**

A REPORT TO THE ALASKA BOARD OF FISHERIES

by

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ABSTRACT

The Cook Inlet Management Area (Area H) 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°51.10' N. lat.) and includes the territorial waters of Alaska to 3 nautical miles offshore. The Alaska Department of Fish and Game (ADF&G) is responsible for the management of commercial and personal use Dungeness crab *Cancer magister*, shrimp, weathervane scallops *Patinopecten caurinus*, hardshell clams, blue mussels *Mytilus edulis*, and miscellaneous shellfish which includes octopus *Octopus dofleini*, green urchin *Stronglyocentrotus droebachiensis*, and sea cucumber *Parastichopus californicus* fisheries.

Key words: assessment, management, commercial, Dungeness crab, *Cancer magister*, spot shrimp, *Pandalus platyceros*, coonstriped shrimp, *Pandalus hypsinotus*, northern shrimp, *Pandalus borealis*, weathervane scallop, *Patinopecten caurinus*, littleneck clams, *Protothaca staminea*, butter clams, *Saxidomus giganteus*, mussels, *Mytilus edulis*, octopus, *Octopus dofleini*, sea urchin, *Stronglyocentrotus droebachiensis*, sea cucumber, *Parastichopus californicus*, Alaska Board of Fisheries, Cook Inlet, Outer Cook Inlet.

INTRODUCTION

The Cook Inlet Management Area, (Area H), as it applies to commercial and personal use fisheries, is divided into 6 shellfish districts: Central, Southern, Kamishak, Barren Islands, Outer, and Eastern (Figure 1).

A discrete reporting area, Area G, was established specifically for the shrimp trawl and pot fisheries in coastal waters along the northern Gulf of Alaska. Area G encompasses the Outer and Eastern Districts and is delineated on the east by Cape Fairfield and on the west by lines from Point Adam to the westernmost tip of Cape Elizabeth and south along 151°53.00' W. long. (Figure 1).

This report updates data on the commercial harvests and stock assessments of Dungeness crab *Cancer magister*, shrimp, weathervane scallops *Patinopecten caurinus*, hardshell clams, blue mussels *Mytilus edulis*, and miscellaneous shellfish (Trowbridge and Bechtol 2003). Hardshell clams refers to Pacific littleneck clams *Protothaca staminea* and butter clams *Saxidomus giganteus*; miscellaneous shellfish includes octopus *Octopus dofleini*, green urchin *Stronglyocentrotus droebachiensis*, and sea cucumber *Parastichopus californicus*.

Commercial, sport, and personal use fishing seasons for Area H and Area G shrimp fisheries were closed by regulation beginning in 1997 due to low abundance. Similar regulations closed commercial fisheries for green urchin, sea cucumber, Dungeness crab, and the directed fishery for octopus. Within this report, some catch data are masked due to confidentiality of harvests including fewer than 3 permit holders.

DUNGENESS CRAB

FISHERY MANAGEMENT AND HARVEST HISTORY

The commercial Dungeness crab fishery was fully developed in the Southern District during the late 1970s and the annual harvest from 1978–1991 averaged approximately 1.0 million pounds. In comparison, harvest from other districts, predominantly the Central District, averaged approximately 7,000 pounds over the same period. Both effort and fishing intensity increased during this time and in 1993, a limited entry program established 101 pot and 2 ring net permits for the Cook Inlet Dungeness crab fishery. Similar to other areas around the northeastern Gulf of Alaska, catches declined in the late 1980s. Although other districts remained open, the commercial

Dungeness crab fishery in the Southern District was closed, by emergency order beginning in 1991 due to low abundance (Figure 1; Appendix A1). All commercial Dungeness fishing was closed in the Cook Inlet Area by board action in 1997 due to low crab abundance throughout the area. These fisheries are closed until stocks recover and a management plan is adopted that considers 14 criteria specified in the regulation (5 AAC 32.390).

ASSESSMENT AND STOCK STATUS

The Alaska Department of Fish and Game (ADF&G) conducted an annual pot survey from 1990 -2000, excluding 1999, to monitor Dungeness crab stock status. The 2000 pot survey yielded one female crab and one legal and eight sublegal male crab in 90 pots (Table 1). This is a dramatic decline from survey catches exceeding 1,000 crab in the early 1990s (Kimker 1996). Similarly, catches of male Dungeness crab in ADF&G's annual Southern District trawl survey declined from 317 in 1990 to fewer than 20 crab from 1997–2000. The 2004 and 2005 trawl surveys caught 62 and 50 male Dungeness crab. These were comprised of 12 and 13 legal sized crab, respectively. Although the trawl survey typically captures more sublegal than legal Dungeness crab, weak cohort strength, combined with natural mortality, has failed to provide sufficient recruitment to support a fishery.

The pot and trawl surveys have documented the decline in Dungeness crab since 1990, and the stock remains depressed at this time. Due to the combination of survey expense and the low likelihood of a substantial increase in abundance, ADF&G has not conducted a Dungeness crab pot survey since 2000. Crab abundance will continue to be indexed from the trawl surveys until there is evidence of sustained recruitment to legal size. When substantial stock recovery is evident, research will again be aimed at estimating absolute abundance and sustainable yields for non-commercial and commercial harvest.

AREA H SHRIMP TRAWL FISHERY

FISHERY MANAGEMENT AND HARVEST HISTORY

From 1970 through 1980, annual commercial trawl harvests of shrimp averaged over 5 million pounds (Davis 1982; Appendix A2). The fishery primarily targeted pink shrimp, *Pandalus borealis*, (hereafter referred by their new common name; northern shrimp) within Kachemak Bay in the Southern District (Figure 1). Due to low shrimp abundance, the Area H commercial shrimp trawl fishery was closed by emergency order beginning in 1987. The Alaska Board of Fisheries, citing concerns for the lack of information, adopted a regulatory closure in 1997 (5 AAC 31.390) that also stipulated 14 criteria that must be considered in any subsequent management plan adopted by the board.

ASSESSMENT AND STOCK STATUS

Standardized small-mesh trawl surveys have been conducted in Kachemak Bay since the early 1970s (Davis 1982; Gustafson 1994; Gustafson and Bechtol 2001, 2005). Area-swept population estimates involved 1 nautical mile tows at depths greater than 36.6 m (20 fathom). During the survey, the catch from each tow is weighed, sorted, and subsampled for species composition and abundance. Although the survey method has been consistent over time, survey frequency has changed in response to stock status, the long-term closure of the shrimp fishery, and limited ADF&G resources. From the 1970s to 1990, spring and fall surveys occurred annually. This was reduced to a spring survey conducted annually during 1991–1992, biennially from 1993–1997, and

was then triennial until 2003. In spring 2004, the funding obtained through the Gulf of Alaska Ecosystem Monitoring program (GEM) enabled ADF&G to continue the spring survey.

The surveys, which were historically used to determine each season's guideline harvest level (GHL), have indicated ecological changes may be playing a role in the significant declines in abundance and distribution of all pandalid shrimp stocks in Kachemak Bay since the late 1970s (Figure 2; Bechtol 1997). The pandalid shrimp population biomass was estimated to be 1.9 million lb in 2000. A dramatic decline to 365,000 lb in 2003 was followed by a small increase to 820,000 lb in 2004, but biomass declined again to its lowest level of 219,000 lb in 2005. In contrast, fish populations (particularly flatfish and gadids) peaked at 20.5 million lb in 2004, declining to 15.4 million lb in 2005. Pandalid shrimp biomass estimates remain well below the 2.4 million lb level when the fishery closed in 1986 and the 6.5 million lb average estimates between 1977 and 1986 during the peak of the trawl fishery. The next survey is scheduled for May 2006 under a GEM funded grant. When stocks recover to a level that may again support a directed fishery, additional research activities will be considered and a new management plan will be developed for board review.

AREA G SHRIMP TRAWL FISHERY

FISHERY MANAGEMENT AND HARVEST HISTORY

Statistical Area G is a shrimp registration area that encompasses the Outer and Eastern Districts of Cook Inlet (Figure 1). Significant shrimp trawl harvests targeting northern shrimp occurred during 1982–1987, peaked at approximately 2.0 million pounds in the 1984–1985 season and then declined rapidly due to low abundance and loss of processing facilities (Appendix A3). Trawl catch per unit of effort (CPUE) in the fishery was relatively low, rarely exceeding 1,000 lb per hour. From 1992 through 1996, the landings were comprised entirely of sidestripe shrimp *Pandalopsis dispar* as the fishery targeted these larger, more valuable animals. Management was based upon CPUE, derived from fish tickets, logbook data, catch samples, and dockside interviews. Effort remained low, ranging from one to three vessels. Logbook information collected over time indicated that fishermen in Area G made long tows, often with extremely low catch results.

Prior to 1985, shrimp trawling in Area G was open year around. The Board of Fisheries adopted a regulatory season of June 1–February 28 for Area G in the spring of 1985. The most recent Area G shrimp trawl season opened by regulation June 1, 1996 and remained open for the entire season. The catch is confidential due to participation by two or fewer fishermen. Harvest occurred in both the Outer and Eastern Districts. Catch rates were comparable to previous years and indicated a low but stable stock status. In 1997, the Board of Fisheries, expressing concern for the lack of available fishery independent information and low abundance, closed the fishery by regulation (5 AAC 31.490) and identified 14 criteria that must be considered in any subsequent management plan.

ASSESSMENT AND STOCK STATUS

ADF&G attempted a limited shrimp trawl survey in 1982, which was incomplete due to gear damage. ADF&G conducted shrimp trawl surveys in summer 1994 in Harris and Resurrection Bays and in spring 2005 in Aialik, Harris, and Resurrection Bays (Figure 3). In 1994, stratified biomass estimates with 95% confidence limits (CL) for pandalid shrimp were approximately 419,000 lb for Harris Bay and 344,000 lb for Resurrection Bay, totaling 762,000 lb (Table 2). Fish biomass totaled 2,256,015 lb. Shrimp species composition in Harris Bay was 71% northern and 29% sidestripe, and in Resurrection Bay, 52% northern and 48% sidestripe (Table 2; Figure 4).

In 2005 stratified biomass estimates for pandalid shrimp were approximately: 114,000 lb for Aialik Bay, 122,000 lb for Harris Bay and 1.3 million lb for Resurrection Bay, totaling 1,513,740 lb for all three bays. Shrimp species composition was: Aialik Bay 22% northern, 77% sidestripe, 1% spot; Harris Bay 75% northern, and 25% sidestripe; and Resurrection Bay 45% northern, and 55% sidestripe.

The increased estimated pandalid biomass in the 2005 survey and the relatively high sidestripe components identified for Harris and Resurrection Bays, suggest that shrimp stocks in Area G have recovered. However, the current estimate represents a single assessment data point and provides no indication of a stock trend. Additionally, the high relative fish biomass estimate for the 2005 survey suggests that fish bycatch would be quite high. Consideration of discard levels of unsalable or small shrimp and fish bycatch mortality is paramount in future fishery development. ADF&G will conduct a second survey during spring 2006 and has requested funding for an additional 2 years of surveys.

AREA H AND AREA G POT SHRIMP FISHERIES

FISHERY MANAGEMENT AND HARVEST HISTORY

Historically the major shrimp pot fisheries occurred in the Southern District of Area H, with minor harvests occurring in Area G fisheries. Commercial harvests from the Southern District increased rapidly through the 1970s, then declined during the mid-1980s before being closed in 1988 (Appendix A4). Although the Area H fishery targeted coonstripe shrimp *Pandalus hypsinotus*, spot shrimp *Pandalus platyceros* were caught to a lesser degree. Harvests in Area H peaked at approximately 801,000 lb in 1973–1974 and averaged 358,000 lb during 1972–1980.

In contrast, commercial shrimp harvests by pot gear in Area G never exceeded 21,000 lb in any year (Appendix A5). This fishery targeted primarily spot shrimp. In 1997, the board adopted regulation 5 AAC 31.390 to close all Cook Inlet shrimp fisheries until stock abundance improves, and a conservation-based management plan is adopted by the board.

ASSESSMENT AND STOCK STATUS

Prior to 1986, ADF&G conducted annual shrimp pot surveys in the Southern District. ADF&G trawl surveys, which provide an index of coonstripe shrimp abundance, continue to indicate that this species remains depressed in the Southern District. No surveys have been conducted in Area G.

WEATHERVANE SCALLOPS

FISHERY MANAGEMENT AND HARVEST HISTORY

The commercial Pacific weathervane scallop fishery in the Cook Inlet Management Area dates to 1983. With the exception of a single landing from the Outer District in 1987, the “north” scallop bed, located east of Augustine Island in the Kamishak District produced all harvests from 1983 through 2001 (Figures 1 and 4; Appendix A6). ADF&G closed the Kamishak scallop fishery by emergency order in 1987 when the stock declined dramatically. Although the fishery reopened in 1988, no commercial effort occurred in Cook Inlet from 1988 through 1992 because fishermen anticipated poor fishery performance would result in further closure of the fishery. In 1993, the fishery “redeveloped” when three boats harvested 20,115 lb. Logbooks, shell samples, and fishery performance data revealed a small, but healthy, stock of scallops in the Kamishak District.

In early 1995, efforts of a single vessel commercially fishing scallops off the Prince William Sound Management Area exposed a regulatory loophole that resulted in a scallop fishing closure in all federal waters for the balance of 1995. This action effectively closed the Kamishak Bay fishery, which occurs almost exclusively in federal waters. Based on the 1995 closure and results of a 1996 survey, ADF&G set a 1996 fishery GHL of 28,000 lb. Subsequent fishery GHLs from 1997–2002 remained at the maximum 20,000 lb level and with the exception of 1998, when inclement weather restricted fishing by the single participating vessel, have been achieved prior to the regulatory closure date. ADF&G has monitored the fishery via logbooks, shell samples, onboard observations, and skipper interviews. Fishery CPUE in pounds of shucked scallop meats caught per hour towed (lb/hr), increased steadily from approximately 50 lb/hr in 1996–1998 to a high of 75 lb/hr in 2000 and declined to 50 lb/hr again in 2001. Effort has ranged from one to five vessels (Appendix A6). Tanner crab bycatch caps, equal to 0.5% of the estimated Tanner crab abundance, have been set annually and have ranged from 20,000 to 35,000 crab. For king crab, the annual bycatch level has been set at 60, due to continued depression of those stocks. Annual crab bycatch has ranged from 205 to 10,200 Tanner crab and 9 to 53 king crab. Overall, crab bycatch levels have been similar between observed and unobserved trips.

During the 2002 fishery, CPUE declined dramatically to 25 lb/hr and the incidence of “cluckers”, dead scallops with the valves connected but lacking soft tissues, increased to a level previously unobserved in Cook Inlet. Ages of sampled cluckers ranged from 2 to 16 years with the majority being age 6 to 8 years. Although age distributions of cluckers compared to live samples appeared similar, a Chi-square test showed a statistically significant difference ($\chi^2 < .01$, 15 d.f.). This difference may be partially attributable to the small sample size of cluckers ($n = 110$) relative to the live scallop sample size ($n = 476$) and natural mortality.

Scallops sampled from the 2002 fishery and analyzed by ADF&G’s pathology laboratory provided no conclusive explanation for the increased mortality in the stock but did suggest infestation by a polychaete worm *Polydora sp.* that can burrow through the scallop shell and cause toxic mortality. Typically, this occurs through formation of a “mud blister” or pustular abscess along the inner layer of the shell. Anecdotal information suggests that fishermen observed a greater incidence of mud blisters during the 2002 season. Salinity, water temperature, and substrate composition appear to be the determining factors in worm abundance.

Due to a low fishery CPUE and the time-intensive process of sorting live from dead scallops, fishery participants shifted to the “south” bed, located southeast of Augustine Island. Still within the Kamishak District, but previously unsurveyed by ADF&G, the new bed yielded a slightly higher CPUE of 33 lb/hr and a lower incidence of cluckers, reducing the catch sorting time. Age structure in the newly fished area was older with 50% of the scallops being older than age 11. In response to the decline in CPUE, the unexplained mortality in the traditional fishing area, and the lack of assessment data for the new bed, ADF&G reduced the 2002 fishery GHL to 9,000 lb.

Following a survey and stock assessment of both beds in May 2003, ADF&G announced the entire 20,000 lb GHL would be harvested from the south bed (Table 3). This harvest level equated to approximately a 5.5% harvest rate. Although harvest data are confidential, catch rates in the fishery were approximately half those observed in 2002. In 2004, the fishery was also managed for a 20,000 lb GHL. Although both beds were open to fishing, a maximum allowable harvest of 6,500 lb of meat was set for the north bed. In the preseason news release, ADF&G announced intent to use this opportunity to assess the status of scallops in the north bed. Harvest rates in the north bed were less than half those observed in 2002 and fishing closed on August

19, approximately 4 days after opening. Fishing in the south bed closed September 9 due to catch rates below those observed in the 2003 fishery. Total harvest was 6,117 lb from 3 vessels with a fishery CPUE of 17 lb/hr.

In 1993, the board adopted a statewide scallop harvest management plan that established distinct scallop registration areas and limited registration to one area a time, restricted scallop vessel crew size to 12, gave ADF&G the ability to require vessels to carry contract onboard observers, and limited dredge width to 15 feet and ring size to 4.0 inches. Regulations specific to Cook Inlet scallop management date to 1983 when the Board of Fisheries adopted a 6-foot width restriction for dredge gear. In 1985, the board adopted regulations for scallops in Cook Inlet. These included a season in the Kamishak District from August 15 through October 31, a GHF of 10,000 to 20,000 lb of shucked meat, and a commissioner's permit requirement. The commissioner's permit stipulates requirements such as logbooks, daily catch reporting, retention of shell samples, prior notice of both landing and departure, a single dredge aboard a vessel, and accommodation of an ADF&G observer.

The Southern District is closed to scallop fishing by regulation to protect crab stocks, while the Outer and Eastern Districts are open to exploratory fishing under a permit issued by ADF&G.

A federal license limitation program (LLP) for scallop fishing in federal waters was adopted in February 1999 resulting in a total of nine vessels being eligible to fish scallops in Alaskan waters. Although all nine vessels qualify to fish in the Cook Inlet Area, it is unlikely that effort will increase due to the 6-foot dredge restriction. In 1997, the Alaska Legislature established a similar scallop vessel moratorium; 10 vessels currently qualify. In May 2002, the state moratorium was extended to June 30, 2004. Prior to expiration of the moratorium, the Commercial Fisheries Entry Commission adopted a vessel permit program. Applicable only to state waters, the program established two vessel size classes, vessels greater or less than 80 feet in overall length. Eight permits have been issued.

ASSESSMENT AND STOCK STATUS

Fishery-independent surveys of the Kamishak Bay population were conducted in 1984, 1996, 1998, 1999, 2001, 2003, and 2005 using 1 nautical mile tows of an 8-foot scallop dredge equipped with a 38-mm (1½-inch) liner (Bechtol and Gustafson 2002). This is scheduled as a biennial survey with the next survey in 2007. Survey depths typically range from 20–40 fathoms. The survey involves an adaptive systematic sample design using a grid of 1.0 by 1.0 nautical mile squares placed over a chart of the northern and southern weathervane scallop beds located directly east of Augustine Island (Figure 5). Initial grid placement was based on historical fishery and survey information. Based on the presence or absence of a significant scallop catch, stations are added or deleted along the margin to continuously define changes in the size of the beds over time. The 2005 scallop biomass estimate for the north bed was 2.7 million lb and for the south bed, 1.37 million lb. Meat recoveries were 6.9% of whole scallop weight.

The steep decline in biomass experienced by Kamishak District scallops has been reflected in both ADF&G's survey and fishery CPUE. The north bed declined by approximately 67% between the 2001 and 2003 surveys and appeared to stabilize based upon the 2005 survey. Similarly, the south bed declined by approximately 75% between the 2003 and 2005 surveys.

Harvest data collected from the weathervane scallop fishery in Kamishak Bay includes the weight of harvested meats and shell size and age composition. Shell age data documented the

recruitment and progression of strong year classes through the fishery. With limited exceptions, age frequencies in commercial catches have been multimodal with a primary peak in abundance for 5 to 7 year-old scallops and a secondary peak for age-11 to age-13 scallops (Table 4). Survey age composition has ranged from young-of-the-year age zero+ to age 24 (Bechtol 2000; Bechtol and Gustafson 2002). Although the progression of strong cohorts can be seen growing across calendar years, ages 4 to 6 tend to be the most abundant age classes in the survey and ages 6 to 8 in the fishery. Weighted age composition data from the survey usually indicated approximately half of the surveyed population was younger than age 7. Such diversity in the age composition of survey as well as the fishery is seen as indicating relatively strong resilience to population disturbances because: (1) the population is supported by a variety of age classes; and (2) the fishery is not strictly dependent upon recruitment pulses. Size-at-age indicates asymptotic growth for the Kamishak Bay scallop population (Figure 4). The greatest annual growth in height occurs during the first 5 years of life, with growth rates decreasing rapidly to less than 1% per year after about age 13. Annual growth in weight is greatest from about age 2 to age 5.

The regulatory maximum GHL for the Kamishak Bay scallop fishery is 20,000 lb of meats. A retrospective analysis using an age-structured model suggested that harvest rates of the Kamishak Bay population ranged from 2.6–4.7% of the model-estimated population (Bechtol 2000). These harvest rates are substantially less than the instantaneous natural mortality rate of 14% estimated by the age-structured model, and also less than the median natural mortality estimate of 15% calculated by several methods for weathervane scallops off Alaska (Kruse 1994). Thus, the 20,000 lb GHL established in regulation is moderately conservative, which is probably appropriate for a long-lived species such as weathervane scallops with a maximum age in excess of 20 years.

2005 SEASON SUMMARY

The 2005 scallop season opened at noon August 15 with a 7,000 lb GHL and figure that equated to a 4% harvest rate. Fishing was restricted to the north bed based upon the May 2005 survey results that indicated a stable biomass for this area from the previous survey. Bycatch caps of 35,000 Tanner crab and 60 king crab were set. Two vessels participated and catch data are confidential. The season closed at 0730 hours August 31 based upon catch projections indicating the GHL would be achieved at that time.

2006 MANAGEMENT OUTLOOK

The Kamishak District fishery for weathervane scallops will open by regulation on August 15. ADF&G will set the fishery GHL based on the 2005 survey. Fishery management is expected to be similar to 2005; however, the ultimate harvest level may be amended using information that is collected inseason. Tanner crab bycatch limits will be based on the Kamishak District trawl survey scheduled for May 2006. ADF&G plans to place at least one observer aboard a vessel during the fishery.

Although regulation provides for a permit fishery in the Outer and Eastern Districts, it is unlikely ADF&G would issue a permit for exploratory fishing without first obtaining information on scallop abundance. ADF&G does not anticipate any interest in fishing these districts.

HARDSHELL CLAMS AND MUSSELS

FISHERY MANAGEMENT AND HARVEST HISTORY

Recent commercial hardshell clam and mussel harvests in the Cook Inlet Management Area began in 1986. From 1986 through 1996, annual commercial harvests of hardshell clams ranged from approximately 14,500 lb to 71,000 lb and effort ranged from 2 to 33 hand diggers (Appendix A7). In 1989, most of the commercial clam harvest was used as sea otter food for a rehabilitation project resulting from the *Exxon Valdez* oil spill. However, in most years the majority of the harvest was Pacific littleneck clams distributed to Kenai Peninsula and Anchorage markets. All documented commercial hardshell clam harvests have come from Kachemak Bay in the Southern District (Figure 6).

Statewide regulations adopted by the board in 1990 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 board adopted the Southern District Hardshell Clam Fishery Management Plan (5 AAC 38.318). A key plan component was an alternate year commercial harvest strategy that opened half of the certified beaches on even-numbered years and the other half on odd-numbered years. Other features included the following commercial digging restrictions:

- 1) Areas of high recreational value are closed;
- 2) Weekends are closed from May 15 through September 15; and
- 3) A registration deadline of April 1.

The board adopted this plan to distribute catch and effort over a larger area, provide alternate years for unfished growth and recruitment, reduce potential user group conflicts, and permit ADF&G to anticipate effort.

In 1997, the board adopted a commercial harvest cap of 40,000 lb, a closure of Bear Cove to commercial clam harvest, a provision for quarterly clam allocations each calendar year, and criteria for temperature dependent openings during the November 1 through March 15 period when clams are most susceptible to exposure mortality due to cold air.

Following adoption of regulatory changes in 1997, reported harvest and effort have ranged from 11,114 lb from 8 diggers in 2004 to 31,525 lb from 15 diggers in 1997 (Appendix A7). Most harvest occurs during mid-March to late July when temperatures are mild and tidal exchange is at its greatest. Due to participation by less than 3 diggers in 1999 and 2000, harvests are confidential. Although fishery catch rates have remained fairly stable within areas and consistent with expectations based on assessment surveys, interest in prosecuting the fishery during the November to March period has declined. As a result, ADF&G has attempted to adjust quarterly fishing GHLs to account for the lack of winter harvesting effort (see below). During some years, areas have been closed by emergency order to distribute fishing effort throughout the subdistricts. In general, GHLs have not been achieved due to management plan elements such as quarterly harvest allocation and reduced interest attributable to market loss due to competition with farmed clam product that can meet any market size requirement.

Only 102 lb of blue mussels were commercially harvested prior to 1989 (Appendix A8). In 1989, however, the catch exceeded 167,000 lb when mussels were targeted for use as otter food in a rehabilitation project following the *Exxon Valdez* oil spill. Harvests declined following the

rehabilitation project termination. Harvests rarely exceeded 2,000 lb from 1990–1998, and declined to zero during 1999–2004 due to the lack of a market.

In accordance with the National Shellfish Sanitation Program, an area must be certified for water quality by the Alaska Department of Environmental Conservation (ADEC) before clams or mussels may be commercially harvested for human consumption and any clams harvested from those areas must be tested for paralytic shellfish poisoning (PSP). DEC has used lot sampling to test for PSP. In 1986, DEC permitted the use of lot sampling for Chugachik Island (near Bear Cove) in Kachemak Bay. As commercial harvests increased, certified harvest areas were expanded to include Chugachik Island, Halibut Cove Lagoon, Kasitsna Bay, and Jakalof Bay in 1988 and Tutka Bay in 1990, all in Kachemak Bay. In 1994, DEC certified all the Southern District hardshell clam subdistricts on the south side of Kachemak Bay between Bradley River and Barabara Point, with some local or seasonal exceptions near human dwellings (Figure 6).

ASSESSMENT AND STOCK STATUS

In addition to harvest reports, the primary assessment tool for hardshell clams has been fishery independent surveys of commercial harvest areas (Gustafson 1995; Gustafson and Bechtol 2000). Surveys in Kachemak Bay date to 1990 and have typically been conducted during low tides between approximate elevations of the minus-3 foot (-1.2 m) and plus-5 foot (1.5 m) tide levels. Because harvest areas open on an alternate year schedule, potential clam habitat in harvest areas is surveyed biennially, with the survey conducted one year prior to the commercial opening. Population estimates are stratified by legal (38 mm or larger) and sublegal size categories. Other survey statistics include available habitat, mean annual recruitment abundance, mean annual recruitment biomass, and size-at-age.

Chugachik Island represents ADF&G's longest time series, from 1992–2005 (Table 5; Figure 6). In the early 1990s, limited survey effort likely affected the precision of the biomass estimates. In recent years, survey effort has been increased. Littleneck clam densities among years ranged from 12 to 67 legal clams/m², with the legal clam density in 2005 being the lowest on record. Densities of sublegal clams have ranged from 5 to 50 clams/m², with a sublegal density of 5 to 14 clams/m² observed in the last 3 years. The 2005 Chugachik Island abundance estimates with 95% confidence intervals were 744,000 ±221,000 legal clams and 309,000 ±158,000 sublegal clams.

A second time series 1994–2002 is available for Ismailof Island (Table 5; Figure 6). Densities of legal littleneck clams at Ismailof Island have ranged from 24 to 105 clams/m², with the lowest observed densities in 2002. Densities of sublegal clams ranged from 16 to 96 clams/m². The 2002 Ismailof Island abundance estimates with 95% confidence intervals were 43,000 ±19,000 legal clams and 107,000 ±94,000 sublegal clams (Table 5).

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.

In addition to maintaining annual surveys for hardshell clams, ADF&G is increasing survey coverage of clam habitat in the Southern District including estimating exploitation rates, aerial non-commercial digger surveys and exploring alternate assessment techniques. Staff has also surveyed mariculture application sites to assess existing, site-specific, resource levels.

2005 SEASON SUMMARY

The 2005 hardshell clam GHL of 17,800 lb was based on 2004 stock assessment surveys with applied harvest rates equal to 2.5% (8,400 lb overall) of legal clam biomass for Chugachik, Sadie Cove, and Tutka; 3.8% (7,000 lb) for Mallard/Glacier; and 10% of the lower range (2,400 lb) for beaches between Bear Island and Mallard Bay. The allowable harvest was divided into 3 quarterly allocations of 5,500 and a fourth quarter allocation of 1,300. Subdistricts 1 and 3b were open to harvest (Figure 6).

Although Chugachik Island beaches were closed by emergency order May 1 when harvest projections indicated the GHL would be achieved, total harvest for the area was 1,544 lb. The closure proved premature when anticipated effort failed to develop. The greatest harvest, 6,515 lb came from beaches in the Mallard/Glacier area. Smaller harvests occurred in other areas and the total fishery harvest was 8,525 lb from 34 landings by 10 diggers. Except for single landings in July and August, all harvest occurred between March 26 and June 23. Similar to recent years, the fishery harvest was well below the GHL.

2006 MANAGEMENT OUTLOOK

Subdistricts 2, 3a, and 4 will open in 2006 with a preseason GHL based upon conservative harvest rates applied to biomass estimates from surveyed areas. Management strategies will again include quarterly harvest limits and temperature dependent openings. The quarterly harvest limit has been somewhat effective by allowing ADF&G adequate time to receive fishery information and adjust fishery management. However, as digger and market interest in the fishery decline, managing for beach-specific GHLs has become easier. Harvest allocations will be set disproportionately among quarters such that a relatively small portion of the GHL is allocated to the fourth quarter when low temperatures offer few harvest opportunities.

OCTOPUS

MANAGEMENT AND HARVEST HISTORY

Cook Inlet octopus harvests have been reported since 1983 and ranged from 435 lb to 48,067 lb and effort fluctuated from 3 to 41 boats (Appendix A9). The harvest of octopus in the Cook Inlet area historically occurred incidental to other directed fisheries, such as the commercial Tanner crab, groundfish pot, longline, and trawl fisheries. Although interest in targeting octopus persists and permits were issued in earlier years, little success was reported. Many different gear types have been tried to date, but the resultant harvest has been low. Most of the harvest has come from Kachemak Bay, primarily occurring from December through March. The high harvest years resulted from bycatch to shellfish pot fisheries with recent harvests exclusively bycatch to the Pacific cod pot fishery. Harvest during 2000–2004 peaked at 38,518 lb in 2002 and averaged 32,600 lb over the same period.

Octopus is considered a shellfish under state regulation, but designated “other groundfish” in federal regulation. Adoption of regulation 5 AAC 38.390 in 1997 closed all commercial octopus fishing in state waters. Because octopus remained open to directed fishing in adjacent federal waters, ADF&G set a 20% bycatch allowance for octopus during groundfish fisheries in state waters. In 1999 the board adopted 5 AAC 38.360 COOK INLET AREA OCTOPUS MANAGEMENT PLAN establishing a bycatch-only octopus fishery at the 20% retention level and an annual GHL of 35,000

lb with a provision for fishery closure when the GHL is attained. The annual GHL was achieved in 2002 and 2004.

STOCK ASSESSMENT

The predominant octopus species in Cook Inlet is the giant Pacific octopus and the remainder of this section will focus on this species. Although no reliable aging method has been found, captivity studies and length-weight frequency data suggest a maximum age of 3 to 5 years (Gillespie et al. 1998). Sexual maturity may be achieved in 1.5 to 2 years and maximum size may be attained in 2 to 3 years. Growth likely varies among geographic locations, but size-at-maturity is reported as 17 lb (7.5 kg) for males and 35 lb (16.0 kg) for females, with a maximum reported size of 110 lb (50 kg). Most species spawn only once, and both sexes cease feeding and die within weeks or months after spawning. Eggs are laid on substrate and the female protects and maintains water flow over the eggs until her death, which may occur before the eggs hatch.

ADF&G has little fishery-independent data on octopus abundance. ADF&G has opportunistically sampled commercial landings of octopus since 2000. Average weight of sampled octopus ranged from 22 lb in 2000 to 34 lb in 2002 with 43% female and 57% male (n = 275). Octopus are sometimes caught in ADF&G bottom trawl surveys in the Southern District of Cook Inlet (Figure 1). Although not summarized, data collected include total weight, sex, and when applicable, dressed weight. The extent of the octopus resource in Cook Inlet is undetermined.

2005 SEASON SUMMARY

The 2005 harvest of octopus came as bycatch in the Pacific cod pot fishery and totaled 34,977 lb from 104 landings by 9 vessels (Appendix A9).

2006 MANAGEMENT OUTLOOK

Under 5 AAC 38.360 and 5 AAC 38.390 the bycatch fishery for octopus will remain open on a bycatch-only basis and the directed octopus fishery will remain closed until the board adopts a conservation-based management plan. ADF&G plans to continue commercial catch sampling efforts and monitoring the fishery via fish tickets. If the harvest approaches the regulatory GHL, the fishery will close for the balance of the year.

GREEN SEA URCHINS AND SEA CUCUMBERS

Historic harvests of green urchins and sea cucumbers were managed via a commissioner's permit which stipulated logbooks and catch reporting requirements (Appendices A10 and A11). Harvest areas were divided and an alternate year harvest scheme was adopted with ultimate harvest levels based upon logbook and CPUE data. Green urchin harvest peaked at 195,403 lb in 1993 and never exceeded 21,000 lb in any other year. Sea cucumber harvest never exceeded 31,000 lb and totaled 1,528 lb in 1996–1997, the last year of the fishery.

Similar to shrimp and Dungeness crab, commercial fisheries for green urchins and sea cucumbers were also closed by regulation in 1997 when the board adopted the Cook Inlet Miscellaneous Shellfish Management Plan (5 AAC 38.390). The plan closed all commercial fishing for urchins and cucumbers until the board adopts a new management plan. ADF&G secured 2 years of external funding to conduct surveys for green urchins and sea cucumbers in 2004 and 2005. In 2004, surveys were conducted in Sadie Cove and China Poot Bay located within Kachemak Bay. Surveys

utilized SCUBA divers (from 60 ft to the surface) and a remotely operated vehicle (ROV) (from depth to 60 ft) to count green urchins and sea cucumbers along transects in the two survey areas. Thirty-five SCUBA transects and 13 ROV transects in Sadie Cove produced a total count of only 2,065 green urchins, virtually all of them small in size. Seventeen transects in China Poot Bay (the main area of historical commercial harvest) produced a total count of only 29 green urchins. A total count of 651 sea cucumbers was obtained from all transects in both areas combined. The 2005 survey expanded in geographic area; SCUBA transects were conducted in Tutka Bay (37), Sadie Cove (9), Halibut Cove (3), Peterson Bay (2) and China Poot Bay (2). Data analyses are not complete, but the total count of sea cucumbers appears to be similar to the 2004 survey, however, fewer sea cucumbers and green urchins were seen in Tutka Bay than in Sadie Cove. With the observed low numbers of both green urchins and sea cucumbers, these fisheries are expected to remain closed into the foreseeable future.

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TABLES AND FIGURES

Table 1.—Southern District Dungeness crab survey catches in numbers of crabs by location east or west of the Homer spit, 1990–2000.

Year	Dates	Bay Location	Pots Pulled ^a	Females	Sublegal Males	Legal Males	Total Males	Soft-shell Males (%)
1990	5/15-17	East	90	53	47	17	64	8 (13)
	6/19-21		90	54	65	23	88	9 (10)
1991	6/04-06	East	89	6	116	110	226	21 (9)
	7/09-11		90	21	388	263	651	36 (6)
	8/06-08		90	85	625	475	1,100	47 (4)
	9/12-14		90	30	615	492	1,107	5 (<1)
	7/02-06	West	82	9	6	5	11	2 (18)
	8/14-16		95	9	7	11	18	0 (0)
1992	5/31-6/04	East	89	27	276	180	456	2 (1)
	6/30-7/2		89	76	583	578	1,161	31 (3)
	7/27-29		90	65	621	531	1,152	50 (4)
	8/11-13		90	47	849	792	1,641	14 (1)
	8/25-27		88	47	853	737	1,590	24 (2)
	9/10-12		89	47	621	749	1,370	4 (<1)
	10/07-09		90	19	516	349	865	2 (<1)
	7/05-07	West	96	30	7	14	21	1 (5)
	8/05-07		78	59	49	59	108	0
1993	5/17-19	East	90	18	105	120	225	2 (1)
	6/15-17		90	60	226	203	429	5 (1)
	7/20-22		90	95	297	448	745	25 (3)
	8/16-23		90	84	352	555	907	35 (4)
	9/22-24		86	78	148	280	428	5 (1)
	7/13-15	West	70	11	6	3	9	0
	8/09-11		80	25	9	34	43	0
1994	5/23-25	East	90	18	9	7	16	1 (6)
	6/21-23		90	119	28	48	76	0
	7/19-21		90	113	39	93	132	0
	8/22-24		88	37	58	119	177	3 (2)
	7/12-14	West	70	17	0	3	3	0
	8/16-18		77	13	3	8	11	0
1995	5/23-25	East	90	0	5	3	8	0
	6/27-29		90	14	22	8	30	0
	7/25-27		90	88	20	9	29	0
	8/29-31		90	49	18	13	31	2
	7/18-20	West	77	31	3	10	13	0
	8/16-18		74	41	8	51	59	0

-continued-

Table 1.–Page 2 of 2.

Year	Dates	Bay Location	Pots Pulled ^a	Females	Sublegal Males	Legal Males	Total Males	Soft-shell Males (%)
1996	6/12-14	East	89	5	16	6	22	3
	7/13-15		90	20	39	20	59	4
	8/11-13		90	64	55	19	74	0
1997	6/21-23	East	90	2	15	8	23	1 (4)
	7/21-23		89	11	19	8	27	1(<1)
	8/20-22		90	21	58	5	63	0
1998	8/16-18	East	90	0	11	3	14	0
2000	8/14-16	East	90	1	8	1	9	1

^a 33% of the survey pots had the escape rings closed.

Table 2.—Biomass estimates, in pounds (lb) and 95% confidence limits (CL) for pandalid shrimp and fish from small mesh trawl surveys in Outer Cook Inlet Area (G).

Year	Bay	No. of Tows	Northern		Sidestripe		Pandalid		Fish	
			Estimate	95% CL (+)	Estimate	95% CL (+)	Estimate	95% CL (+)	Estimate	95% CL (+)
1994	Harris	7	295,667	188,871	122,884	23,610	418,551	202,681	1,356,460	284,917
	Resurrection	6	126,950	7,500	116,746	14,199	343,696	16,070	899,555	235,881
	Total	13	422,617	196,371	239,630	37,809	762,247	218,751	2,256,015	520,798
2005	Aialik	5	24,542	5,851	87,334	9,734	113,941	6,318	716,705	133,965
	Harris	7	91,396	15,217	30,790	8,206	122,187	15,788	4,376,938	602,505
	Resurrection	7	570,925	41,758	706,686	71,386	1,277,612	96,661	3,218,235	296,567
	Total	19	686,863	62,826	824,810	89,326	1,513,740	118,767	8,311,878	1,033,037

Table 3.–Weathervane scallop biomass estimates in millions of pounds with 95% confidence limits (CL) and coefficient of variations (CV %) from dredge surveys in the Kamishak District of Cook Inlet, 1984–2005.

Year	North Bed						South Bed					
	Defined Bed (nm ²)	Stations Sampled	CPUE (lb/nm)	Biomass (million lb)	95% CL (±)	CV (%)	Defined Bed (nm ²)	Stations Sampled	CPUE (lb/nm)	Biomass (million lb)	95% CL (±)	CV (%)
1984	56	47	48	2.07								
<u>No surveys 1985 through 1995</u>												
1996	52	26	139	5.48	2.02							
1997												
1998	58	14	140	6.18	3.48	29						
1999	56	28	220	9.34	2.50	14						
2000												
2001	52	25	203	8.02	2.30	14	<u>First survey of south bed in 2003</u>					
2002												
2003	40	20	87	2.63	0.57	10	44	22	87	5.48	1.63	6
2004												
2005	46	23	78	2.69	0.72	13	26	13	69	1.37	0.61	21
Mean	51	26	131	5.20	1.93	16	35	18	78	3.43	1.12	14

Table 4.–Weathervane scallop age composition in commercial fisheries and surveys of Kamishak Bay, 1984–2005.

			Scallop Age (Years) ^a																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18+
Sample			Number of Scallops																	
Year	N	Bed	Commercial Fishery Samples																	
1985	197	N	0	0	0	10	27	13	6	12	6	6	10	7	3	1	1	0	0	0
1986	295	N	0	0	3	13	31	28	3	1	4	5	6	4	1	1	0	0	0	0
1987	168	N	0	0	0	1	21	17	20	5	7	10	7	8	2	1	1	0	0	0
1993	727	N	0	0	0	3	4	7	13	22	22	14	6	3	2	2	1	1	1	0
1994	613	N	0	0	4	3	7	5	10	13	17	16	10	6	3	2	1	2	1	1
1996	1,004	N	0	1	20	15	15	4	7	4	6	8	8	7	3	2	0	0	1	1
1997	984	N	0	1	4	20	13	13	4	4	5	6	8	7	8	4	2	1	0	1
1998	1,006	N	0	1	8	11	20	15	11	4	2	3	4	6	5	6	3	1	1	1
1999	288	N	0	0	2	22	12	22	18	4	1	1	3	4	3	5	2	1	1	0
2000	170	N	0	0	1	2	34	26	55	22	5	3	1	5	4	7	2	2	1	0
2001	377	N	0	0	7	13	15	102	59	84	28	17	4	10	13	9	10	4	2	0
2002 ^b	476	N	0	0	7	30	23	50	143	67	74	22	7	11	7	5	12	7	7	4
“	601	S	0	0	25	26	18	6	26	18	56	57	53	97	80	37	36	39	18	9
2003	1,438	S	0	0	22	136	92	58	38	53	77	114	172	123	130	136	98	189	0	0
2004	180	N	0	0	0	5	4	18	16	37	47	29	11	1	3	3	3	3	0	0
“	115	S	0	0	64	10	21	14	9	3	8	13	14	14	18	12	11	4	3	4
2005	1,018	N	0	0	2	23	45	48	81	115	244	247	93	46	15	15	15	7	13	9

-continued-

Table 4.–Page 2 of 2.

Sample			Scallop Age (years) ^a																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18+
			Number of Scallops																	
Year	N	Bed	ADF&G Survey Samples																	
1984	1,989	N	13	15	40	5	0	1	4	3	1	2	3	5	4	3	1	1	ND	ND
1996	1,512	N	12	5	7	17	10	4	5	9	6	6	5	6	4	2	1	2	ND	ND
1998	2,767	N	1	1	14	6	21	17	6	2	2	4	4	8	4	5	2	1	0	1
1999	565	N	2	0	1	17	6	15	11	7	3	5	5	3	8	6	5	3	1	2
2001	585	N	8	28	24	14	22	131	38	78	41	30	13	20	36	28	26	24	17	11
2003	1,874	N	105	145	52	81	69	82	150	250	193	125	84	100	130	127	59	44	47	20
“	3388	S	306	568	115	345	187	147	208	416	307	248	311	219	146	329	326	344	213	225
2005	600	N	N/A																	
“	420	S	N/A																	

^a Only a portion of the available samples have been aged from the 1999–2002 commercial fisheries and the 1999–2001 surveys.

^b Commercial samples for 2002 were separated into north and south bed catches.

Table 5.—Survey effort and design with resultant density, abundance, and biomass with 95% confidence intervals (CI) of littleneck clams at commercially harvested beaches in Kachemak Bay, 1992–2005.

Year	Survey Effort/Type ^a			Clam Density (clams/m ²)			Clam Abundance (clams x 1,000)						Clam Biomass (lb x 1,000) ^b		
	No.	No.	Design	Legal	Sublegal	Total	Legal	95% CI	Sublegal	95% CI	Total	95% CI	Legal	Sublegal	Total
SUBDISTRICT 1															
Chugachik Island															
1992	1	12	Rand.	67	50	118	4,124	1,422	3,083	1,862	7,207	3,284	250	52	302
1993	1	16	Rand.	41	49	90	2,511	739	2,986	1,182	5,497	1,921	166	62	228
1994	1	33	Rand.	36	43	79	2,227	642	2,628	1,183	4,855	1,825	132	49	180
1995	1	35	Rand.	34	19	53	2,072	559	1,190	462	3,262	1,021	126	22	147
1996	1	33	Rand.	63	25	88	3,876	473	1,529	1,413	5,405	1,886	226	30	255
1997	1	40	Rand.	60	22	83	3,687	851	1,372	534	5,059	1,385	197	24	221
1998	1	49	Rand.	50	11	61	3,030	842	680	237	3,710	1,079	170	15	185
1999	1	52	Rand.	42	9	51	2,573	718	542	196	3,115	914	141	11	152
2000	1	51	Rand.	45	13	57	2,729	606	788	287	3,517	893	156	13	169
2001	1	52	Rand.	48	13	60	2,921	549	763	195	3,684	744	186	9	195
2002	1	54	Rand.	29	13	42	1,792	611	785	340	2,577	951	121	NA	NA
2003	1	51	Rand.	31	14	45	1,902	685	874	288	2,777	973	120	NA	NA
2004	1	48	Rand.	20	6	26	1,215	390	362	132	1,577	522	77	NA	NA
2005	1	57	Rand.	12	5	17	744	221	309	158	1,053	379	46	NA	NA
Mean		42		41	21	62	2,529	665	1,278	605	3,807	1,270	151	28	203
SUBDISTRICT 2															
Ismailof Island															
1994	1	8	2stage	78	96	174	144	110	180	149	324	258	7	3	11
1996	1	16	2stage	105	68	173	188	129	134	141	322	270	8	3	10
1997	1	32	2stage	60	19	78	112	39	34	13	146	52	5	1	6
1998	1	33	2stage	71	48	119	109	21	69	23	177	44	5	1	6
1999	1	27	2stage	50	33	84	77	32	52	33	139	65	4	1	5
2000	1	27	2stage	45	16	61	81	24	27	16	107	40	4	0	4
2002	1	27	2stage	24	53	76	43	19	107	94	150	113	3	2	5
Mean		25		62	48	109	109	53	86	66	195	120	5	2	7

-continued-

Table 5.–Page 2 of 2.

Year	Survey Effort/Type ^a			Clam Density (clams/m ²)			Clam Abundance (clams x 1,000)						Clam Biomass (lb x 1,000) ^b		
	No. Sites	No. Quad.	Design	Legal	Sublegal	Total	Legal	95% CI	Sublegal	95% CI	Total	95% CI	Legal	Sublegal	Total
SUBDISTRICT 3a															
Sadie Cove - East Shore															
1999	10	255	3stage	11	8	18	1,763	1,366	1,017	158	2,780	1,524	136	17	153
2001	19	322	3stage	13	12	25	1,827	672	1,381	634	3,208	1,306	111	22	133
2003	18	331	3stage	13	13	25	2,039	943	1,781	979	3,820	1,922	128	27	155
SUBDISTRICT 3b															
Sadie Cove - West Shore															
1998	6	117	3stage	15	13	28	1,777	930	1,606	849	3,383	1,779	118	27	145
2000	11	210	3stage	11	11	22	1,819	880	2094	1,199	3,913	2,079	102	42	144
2002	16	297	3stage	19	17	36	2,280	1,010	1,638	897	3,918	1,907	149	22	171
Tutka Bay - West Shore															
1999	17	264	Syst.	9	12	20	2,816	1,845	3,114	1,967	5,930	3,812	158	38	196
SUBDISTRICT 4															
Jakolof Bay															
1992	6	42	Syst.	22	2	24	4,233	1,836	808	446	5,041	2,282	299	15	314
1993	11	53	Syst.	26	10	37	4,877	1,925	2,503	1,668	7,380	3,593	290	41	354
1998	7	187	Syst.	20	4	23	5,460	1,081	1,072	416	6,532	1,497	358	23	408
2001	13	242	3stage	17	5	22	3,480	1,507	1,181	808	4,661	2,315	234	25	259
2003	17	347	3stage	12	4	16	2,566	1,065	1,328	1,317	3,893	2,382	180	26	207
Mean	8	174		19	5	24	4,123	1,483	1,378	931	5,501	2,414	272	26	308

^a Survey Effort and Type:

No. Sites = The number of sites samples within a bay or beach section.

No. Quad = The number of total quadrat samples from a bay or beach in a year.

Design = The type of statistical design used for a survey.

^b Biomass estimates designated NA are under review.

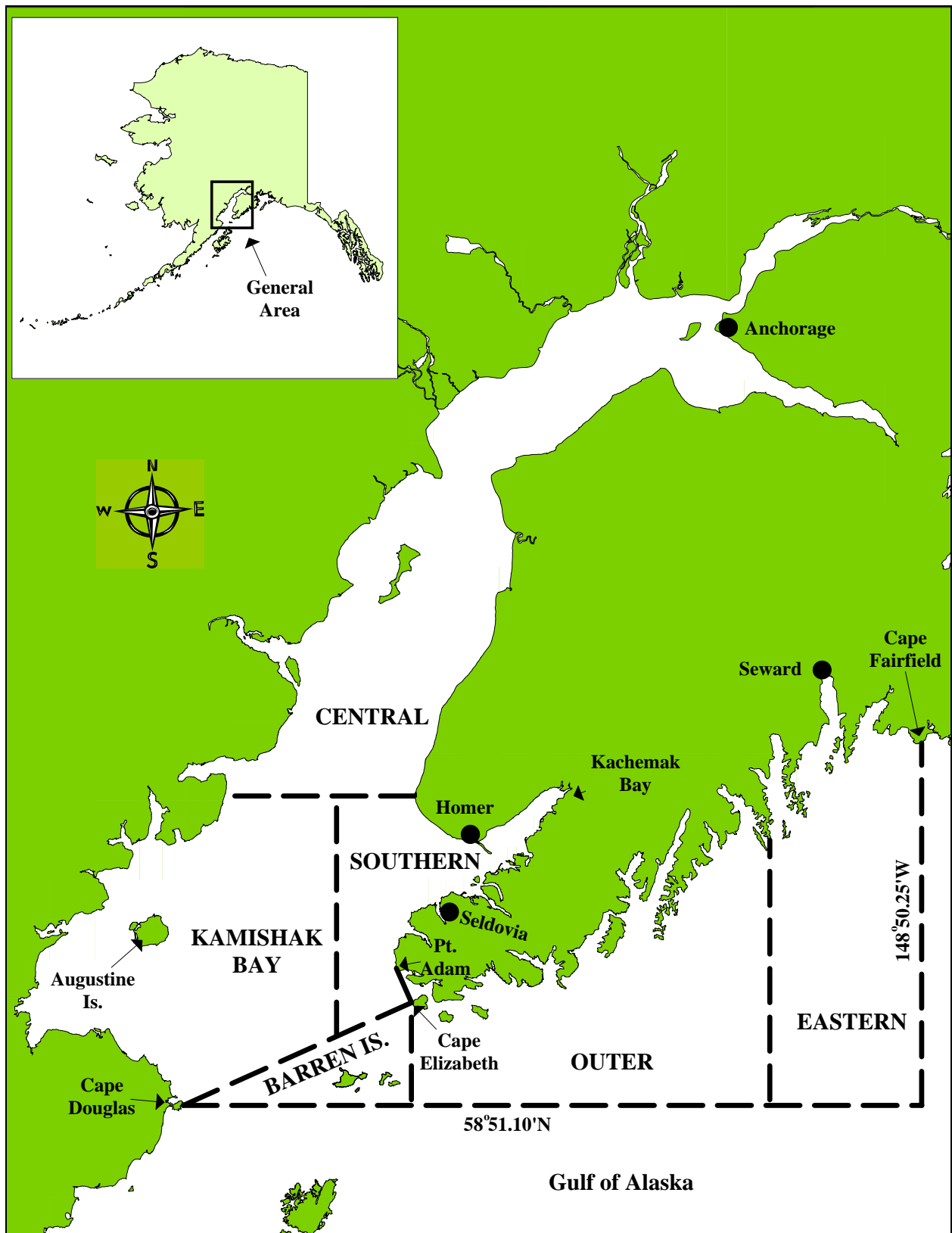


Figure 1.—Cook Inlet Management Area shellfish management districts, 2005.

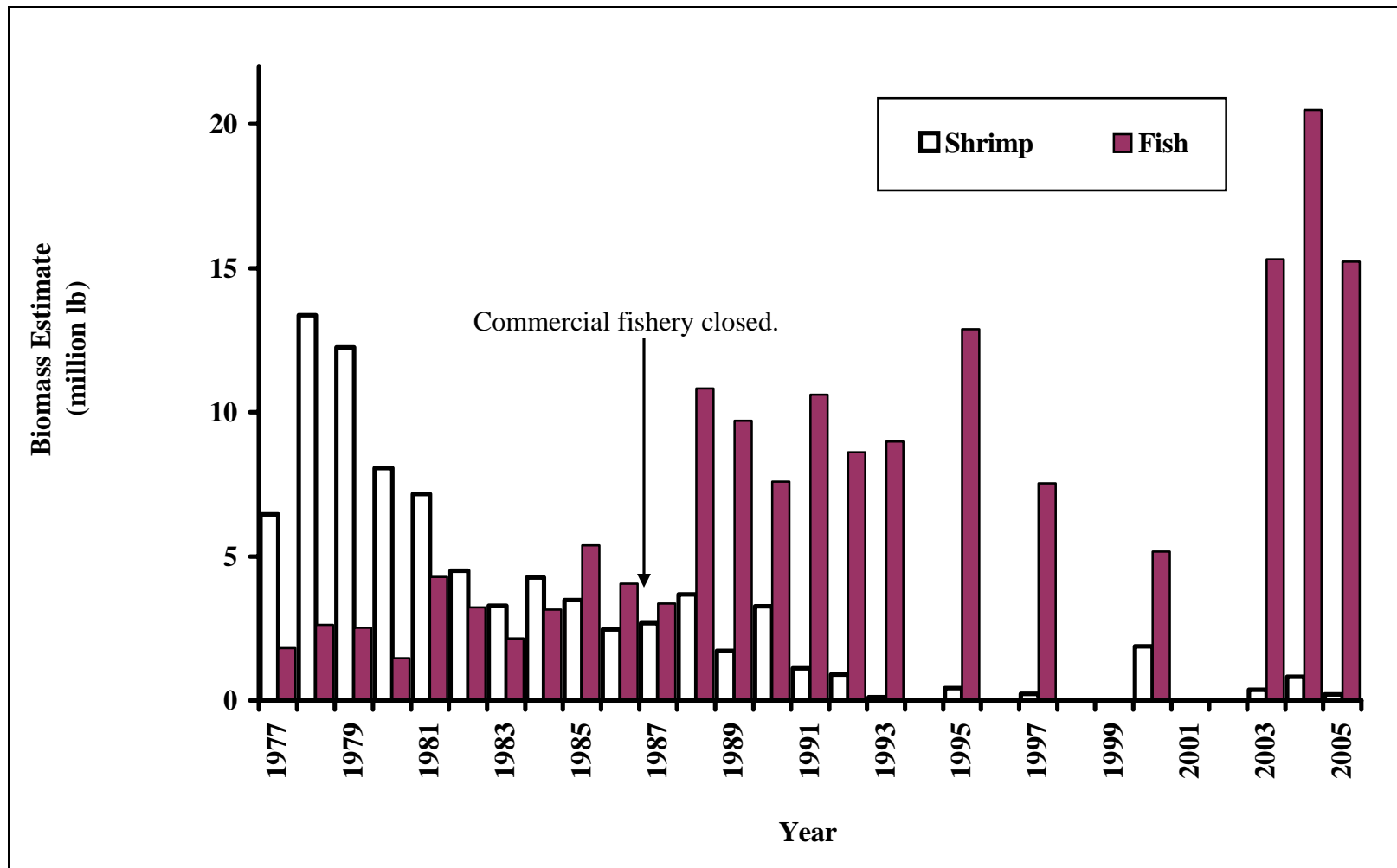


Figure 2.—Population biomass estimates of pandalid shrimp and combined fish and non-shrimp invertebrates based on small-mesh trawl surveys in the Southern District (Kachemak Bay) of Cook Inlet, 1977–2005.

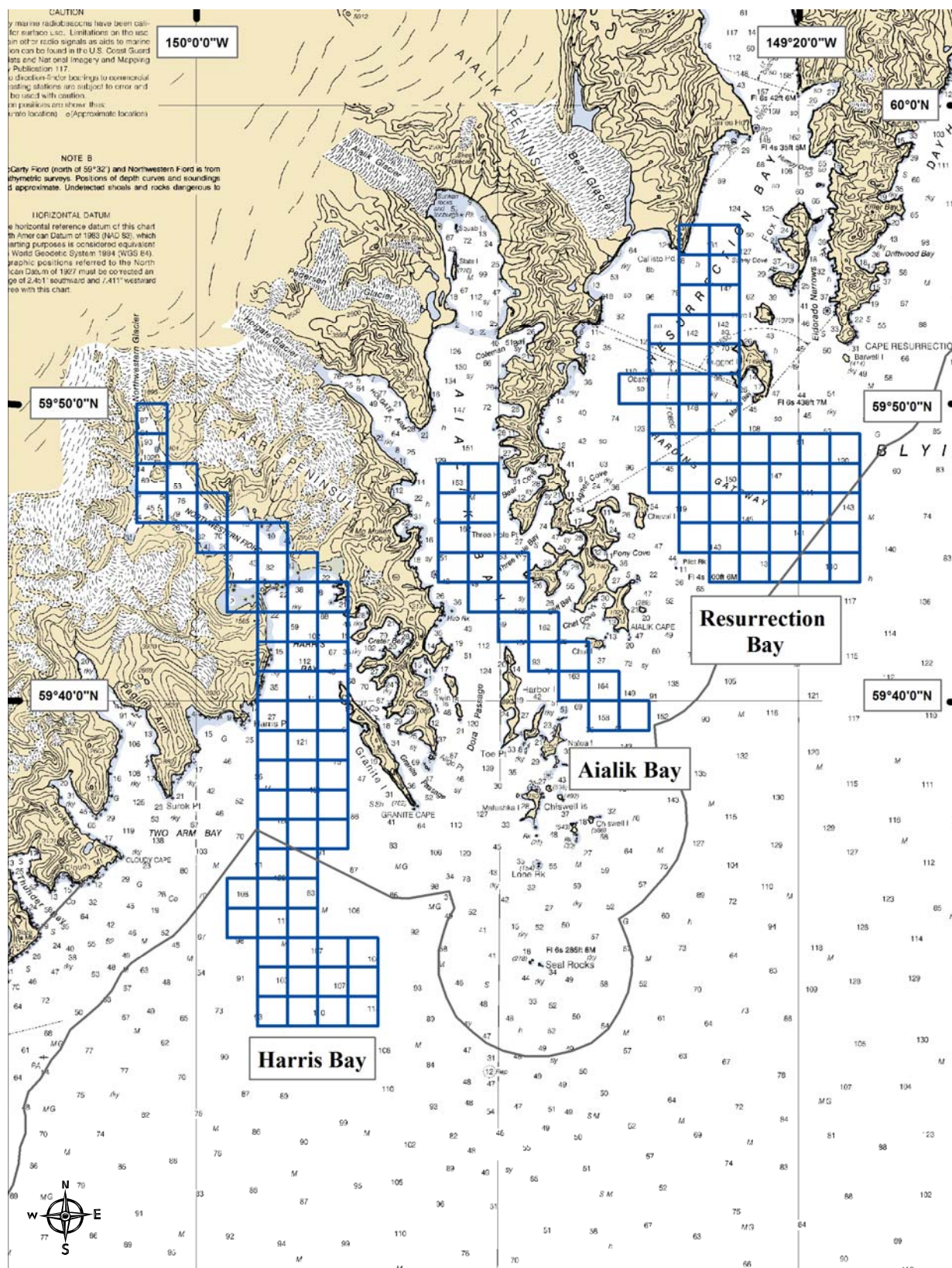


Figure 3.—General survey grid of 1.0 square nautical mile showing potential sample stations for the small mesh shrimp trawl survey in Resurrection, Aialik, and Harris Bays in 2005.

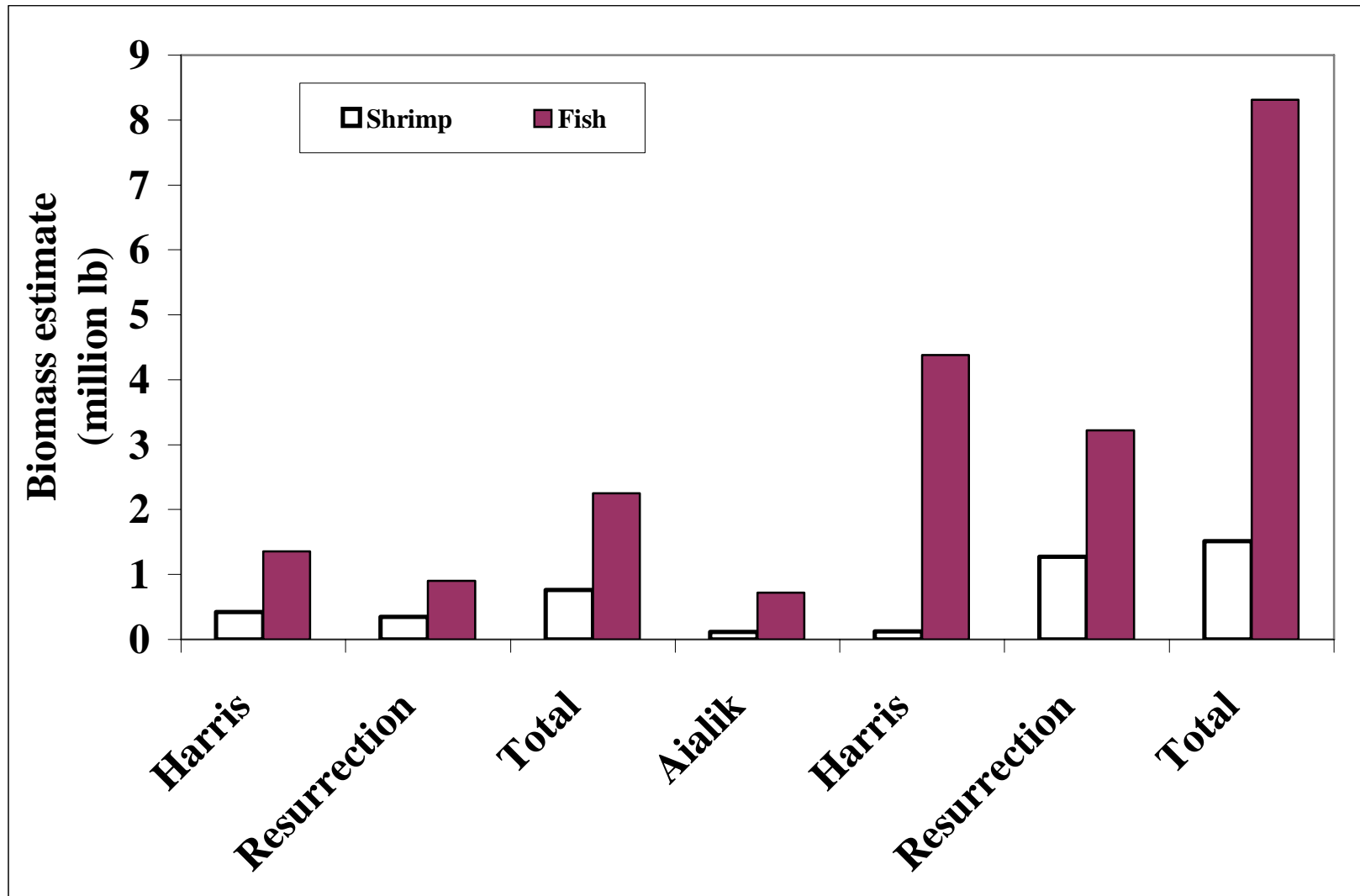


Figure 4.—Population biomass estimates of pandalid shrimp and fish, based on small-mesh trawl surveys in Outer Cook Inlet (Area G).

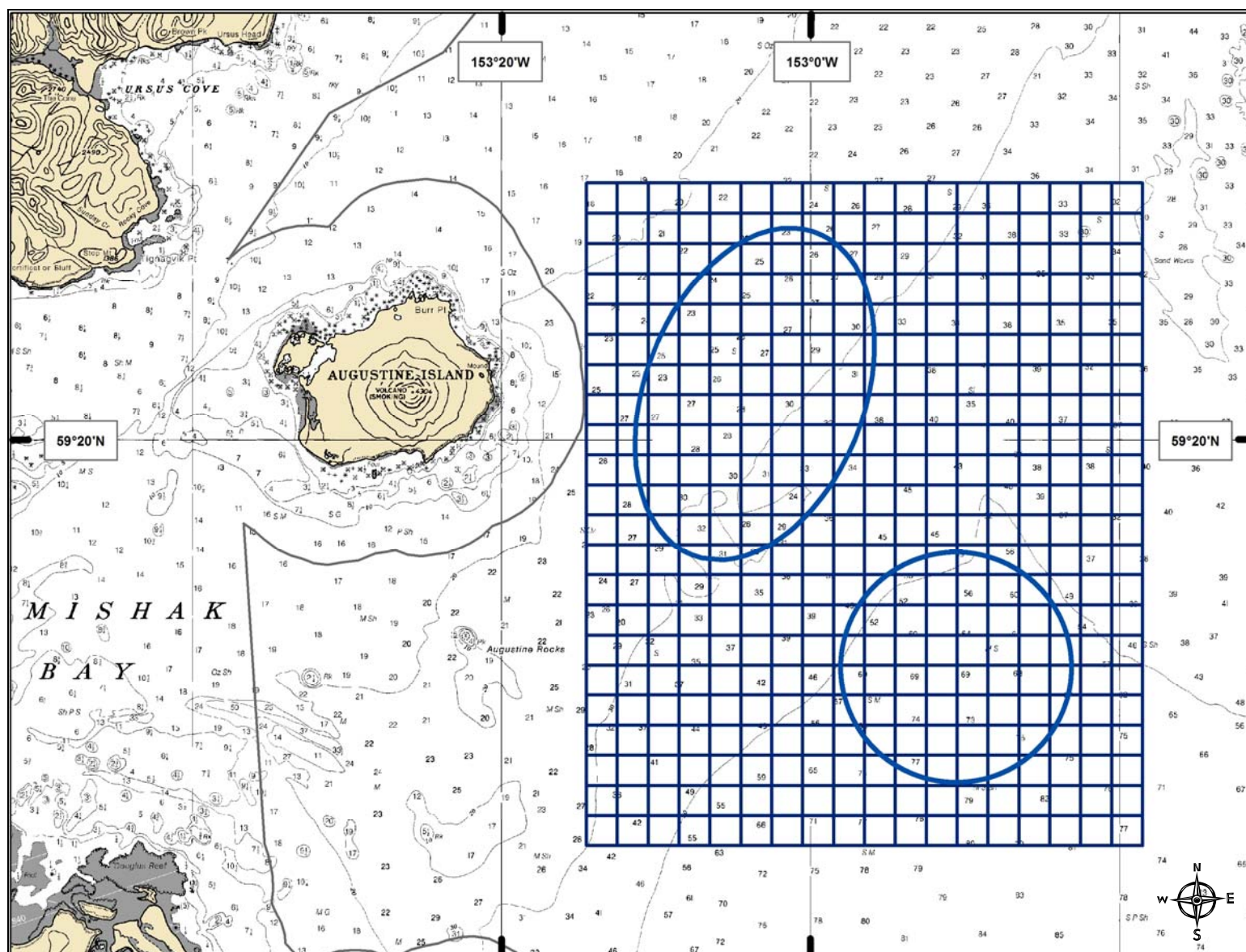


Figure 5.—General survey grid of 1.0 square nautical mile showing potential sample stations (depth in fathoms) for a scallop survey in the Kamishak District of the Cook Inlet Area.

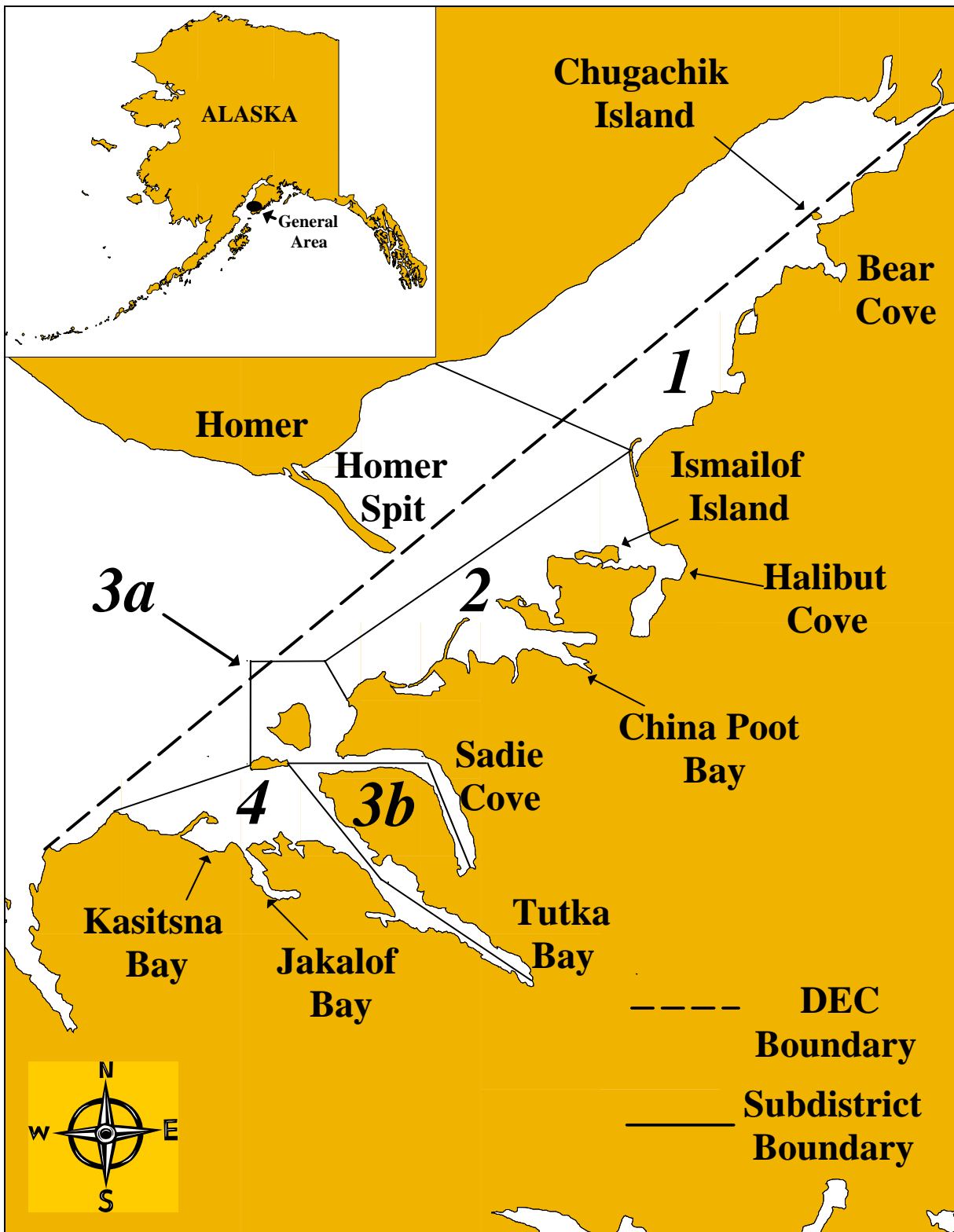


Figure 6.—Commercial hardshell clam fishery subdistricts in the Cook Inlet Southern District (Kachemak Bay).

APPENDIX A

Appendix A1.—Dungeness crab harvests from the Cook Inlet Management Area, 1961–2005.

Year	Southern District Harvest (lb)	Other District Harvest (lb)	Total Harvest (lb)	Number of Vessels	Number of Landings
1961	193,683	0	193,683	12	189
1962	530,770	0	530,770	15	269
1963	1,665,599	11,605	1,677,204	50	1,360
1964	417,005	6,036	423,041	22	341
1965	74,211	0	74,211	14	105
1966	12,523	117,037	129,560	5	28
1967	7,168	0	7,168	2	13
1968	484,452	3,407	487,859	7	224
1969	49,894	0	49,894	9	41
1970	209,819	0	209,819	10	50
1971	97,161	0	97,161	22	136
1972	38,930	0	38,930	24	206
1973	308,777	1,271	310,048	54	625
1974	718,729	2,514	721,243	38	619
1975	361,893	922	362,815	34	402
1976	118,903	395	119,298	19	123
1977	74,195	510	74,705	18	94
1978	1,212,571	3,208	1,215,779	49	668
1979	2,130,963	0	2,130,963	72	1,485
1980	1,875,281	0	1,875,281	54	1,183
1981	1,850,977	0	1,850,977	88	2,047
1982	818,380	505	818,885	108	2,310
1983	746,585	834	747,419	71	1,194
1984	799,638	570	800,208	102	1,687
1985	1,389,891	12,511	1,402,402	106	1,768
1986	550,968	12,894	563,862	83	1,069
1987	761,423	21,753	783,176	100	1,377
1988	677,334	41,941	719,275	84	1,305
1989	170,266	7,798	178,064	43	455
1990	28,938	564	29,502	23	112
1991	Closed	0	0	0	0
1992	Closed	7,108	7,108	1	1
1993	Closed	9,652	9,652	1	36
1994	Closed	Confidential ^a	Confidential ^a		
1995	Closed	Confidential ^a	Confidential ^a	1	
1996	Closed	Confidential ^a	Confidential ^a	1	
1997 to present		Closed by regulation			

^a Two or fewer participants.

Appendix A2.—Shrimp harvests from the Kachemak Bay shrimp trawl fishery in the Cook Inlet Area, 1969–2005.

Season	Number of Vessels		Catch (lb)			Total
			Jun 1–Oct 31	Nov 1–Mar 31	Apr 1–May 31	
1969-1970	^a	7	1,289,656	1,692,854	889,330	3,871,840
1970-1971	^a	3	3,211,924	2,076,228	617,836	5,905,988
1971-1972	^a	7	2,618,630	1,761,569	140,707	4,520,906
1972-1973	^a	10	2,772,422	2,109,660		4,882,082
1973-1974	^b	13	2,502,154	2,323,780		4,825,934
1974-1975		4	2,512,764	2,519,148		5,031,912
1975-1976		4	1,997,563	2,421,456		4,419,019
1976-1977		5	2,545,885	2,453,101		4,998,986
1977-1978		7	2,490,969	2,546,977		5,037,946
1978-1979		6	2,952,733	3,060,066		6,012,799
			Jul 1–Sep 30	Oct 1–Dec 31	Jan 1–Mar 31	Total
1979-1980		7	2,013,298	2,052,646	1,731,483	5,797,427
1980-1981		15	1,780,677	2,691,746	1,704,706	6,177,129
1981-1982		23	1,614,868	1,686,781	1,693,850	4,995,499
1982-1983		15	998,522	1,012,388	1,009,857	3,020,767
1983-1984		10	Closed	Closed	525,508	525,508
1984-1985		10	519,651	528,506	518,529	1,566,686
1985-1986		5	488,606	257,782	503,340	1,249,728
1986-1987		3	504,206	Closed	Closed	504,206
1987-1988		0	Closed	Closed	Closed	0
1988-1989		0	Closed	Closed	Closed	0
1989-1990		0	Closed	Closed	Closed	0
1990-1991		0	Closed	Closed	Closed	0
1991-1992		0	Closed	Closed	Closed	0
1992-1993		0	Closed	Closed	Closed	0
1993-1994		0	Closed	Closed	Closed	0
1994-1995		0	Closed	Closed	Closed	0
1995-1996		0	Closed	Closed	Closed	0
1996-1997		0	Closed	Closed	Closed	0
1997 to present			Closed by regulation			0

^a Catches listed for comparative purposes by seasons established in 1973.

^b June 1–October 31 and November 1–March 31 seasons with respective guidelines established.

Appendix A3.—Shrimp trawl harvests from Outer Cook Inlet (Area G), 1977–2005.

Season	Number of Vessels	Harvest (lb) ^a
1977-1978	2	26,556
1978-1979	1	1,245
1979-1980	0	0
1980-1981	1	4,000
1981-1982	2	19,454
1982-1983	4	239,584
1983-1984	7	760,430
1984-1985	11	1,957,959
1985-1986 ^b	4	421,063
1986-1987	2	297,762
1987-1988	1	22,231
1988-1989	1	4,878
1989-1990	0	0
1990-1991	0	0
1991-1992	2	6,196
1992-1993	2	111,709
1993-1994	2	218,854
1994-1995	3	32,591
1995-1996	1	Confidential
1996-1997	1	Confidential
1997-present	Closed by regulation	

^a Catches from 1982-1987 predominated by northern shrimp. From 1991–1996 catches were primarily sidestripe shrimp.

^b Regulatory season of 1 June through 28 February adopted by the Alaska Board of Fisheries in spring 1985.

Appendix A4.—Commercial shrimp catches by pot gear from the Cook Inlet Management Area (Area H), 1970–2005.

Season	Number of Vessels	Harvest (lb)			
		Jun 1–Sep 30	Oct 1–May 31	Total	
1970-1971		3,606	7,602	11,208	
1971-1972		8,836	70,601	79,437	
1972-1973		75,247	184,230	259,477	
1973-1974		63,181	738,165	801,346	
1974-1975		43,650	126,472	170,122	
1975-1976		100,765	273,758	374,523	
1976-1977	26	52,115	199,559	251,674	
1977-1978	51	85,511	511,938	597,449	
1978-1979	41	49,080	121,234	170,314	
1979-1980	49	59,963	177,927	237,890	
		Jun 1-Sep 15	Nov 1-Dec 21	Feb 1-Mar 31	
1980-1981	30	74,368	134,275	104,716	313,359
1981-1982	45	56,092	47,859	49,885	153,836
1982-1983	40	54,153	49,130	52,339	155,622
1983-1984	15	21,438	Closed	Closed	21,438
1984-1985	22	25,874	28,151	22,080	76,105
		Jun 1-Sep 15	Oct 1-Dec 31	Feb 1-Mar 31	
1985-1986	25	27,312	20,737	24,048	72,097
1986-1987	37	24,844	20,188	30,257	75,289
1987-1988 ^a	30	26,216	5,416	Closed	31,632
1988-1989	9	5,323	Closed	Closed	5,323
1989-1990		Closed	Closed	Closed	0
1990-1991		Closed	Closed	Closed	0
1991-1992		Closed	Closed	Closed	0
1992-1993		Closed	Closed	Closed	0
1993-1994		Closed	Closed	Closed	0
1994-1995		Closed	Closed	Closed	0
1995-1996		Closed	Closed	Closed	0
1996-1997		Closed	Closed	Closed	0
1997 to present		All areas closed by regulation.			

^a Closures during 1988–1997 were for waters of the Southern District east of a line from Anchor Point to Point Pogibshi.

Appendix A5.—Commercial shrimp pot catch and effort in Outer Cook Inlet (Area G), 1977-2005.

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 ^a	8	20,500
1990	5	8,853
1991	8	7,315
1992	3	2,804
1993	3	8,356
1994	1	Confidential
1995	0	0
1996	2	Confidential
1997 to 2005	Closed by regulation	

^a Season closed from April 30 through July 7 due to Exxon Valdez Oil Spill.

Appendix A6.—Pacific weathervane scallop harvests from the Kamishak District of the Cook Inlet Management Area, 1983–2005.

Year	Number of Vessels	Catch in Pounds of Shucked Meats
1983	1	2,346
1984	3	6,305
1985 ^a	1	11,810
1986	3	15,364
1987 ^b	2	360
1988–1992	No effort	
1993	3	20,115
1994	4	20,431
1995 ^c	0	0
1996	5	28,228
1997	3	20,336
1998	1	Confidential
1999	3	20,312
2000	3	20,516
2001	2	20,095
2002	3	8,591
2003	2	Confidential
2004	3	6,117
2005	2	Confidential

^a Season and harvest guideline set by regulation.

^b Season closed by emergency order on August 21, 1987, 1 week after opening due to low catch per unit of effort.

^c Only state waters open.

Appendix A7.—Hardshell clam harvest from the Southern District of the Cook Inlet Management Area, 1986–2005.

Year	Number of Permits	Number of Landings	Harvest (lb)			Total
			Littleneck Clams	Butter Clams	Cockles	
1986	5	18	17,303	0	0	17,303
1987	8	69	12,214	206	2,347	14,767
1988	2	32	14,449	0	0	14,449
1989	9	41	2,584	13,675 ^a	3,581 ^b	2,584
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	53,757
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	Confidential	0	11,114
2005	10	34	8,525	0	0	8,525

^a Includes 13,348 lb sold as otter food as a result of Exxon Valdez oil spill.

^b Includes 1,981 lb sold as otter food as a result of Exxon Valdez oil spill.

Appendix A8.—Blue mussel harvest from the Southern District of the Cook Inlet Management Area, 1986–2005.

Year	Number of Permits	Number of Landings	Harvest (lb)
1986	0	0	0
1987	1	2	102
1988	0	0	0
1989	9	98	167,243 ^a
1990	2	10	10,600
1991	3	11	16,485
1992	3	11	2,501
1993	2	4	1,083
1994	2	3	570
1995	4		3,485
1996	3	7	2,450
1997	1	2	Confidential
1998	1	2	Confidential
1999–2005	0	0	0

^a Includes 165,268 lb sold as otter food as a result of the Exxon Valdez oil spill.

Appendix A9.—Octopus harvest from the Cook Inlet Management Area, 1983–2005.

Year	Number of vessels	Number of landings	Harvest (lb)
1983 ^a	41	101	32,841
1984 ^a	36	77	46,698
1985 ^a	40	70	48,067
1986	8	16	435
1987	21	57	4,512
1988	17	43	5,569
1989		No reported landings	
1990	3	6	1,343
1991	8	21	2,088
1992		No directed fishery	
1993 ^b	3	6	475
1994 ^b	3	9	1,064
1995 ^b	8	46	8,550
1996 ^b	13	68	9,802
1997 ^c	13	190	27,667
1998	9	96	12,914
1999	9	127	21,846
2000	11	127	25,104
2001	8	103	24,406
2002	10	164	38,518
2003	8	132	28,922
2004	11	127	35,981
2005	9	104	34,977

^a Bycatch from shellfish pot fisheries.

^b Directed fishery catch and effort only.

^c Bycatch-only to Pacific cod pot fishery, 1997 to present.

Appendix A10.—Green sea urchin harvest from the Cook Inlet Management Area, 1987–2005.

Year	Number of Divers	Harvest (lb)
1987	1	224
1988		No effort
1989	1	15,181
1990		No effort
1991	4	20,445
1992	7	6,119
1993	29	195,403
1994	2	80
1995	9	3,295
1996		No effort
1997 to present		Closed by regulation

Appendix A11.—Sea cucumber harvest by permit season from the Cook Inlet Management Area, 1990–2005.

Permit Season	No. Divers	No. Landings	Harvest (lb)
1990	2	14	22,525
1991			No catch ^b
1992			No catch ^b
1993-1994 ^a	16	40	30,940
1994-1995 ^a	22	93	26,575
1995-1996 ^a			No catch ^b
1996-1997 ^a	3	6	1,528
1997 to present			Closed by regulation

^a Permit season established 10/1–4/30.

^b Divers did not find commercial quantities of sea cucumbers.