2A00-13

REVIEW OF COMMERCIAL, SPORT AND PERSONAL USE FISHERIES FOR MISCELLANEOUS SHELLFISH IN LOWER COOK INLET

REPORT TO THE ALASKA BOARD OF FISHERIES

by
Charles Trowbridge, Nicole Szarzi, and William R. Bechtol

Regional Information Report No. 2A00-13

Alaska Department of Fish and Game
Division of Commercial Fisheries and
Sport Fish Division
333 Raspberry Road
Anchorage, AK 99518-1599

March 2000

[1] Contribution from the Homer area office. The Regional Information Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries Management & Development.

TABLE OF CONTENTS

Page

LIST OF TABLES iv

LIST OF FIGURES v

LIST OF APPENDICES vi

INTRODUCTION 1

DUNGENESS CRAB 1
- Commercial Fishery Management and Harvest History 1
- Non-commercial Fishery Management and Harvest History 2
- Stock Assessment 3
- Stock Status 3

AREA H SHRIMP TRAWL FISHERY 3
- Stock Assessment 4
- Stock Assessment 4

AREA G SHRIMP TRAWL FISHERY 4
- Fishery Management and Harvest History 4
- Assessment and Stock Status 5

AREA H AND AREA G SHRIMP POT FISHERIES 5
- Fishery Management and Harvest History 5

WEATHERVANE SCALLOPS 6
- Management and Harvest History 6
- Stock Assessment 7
- 1999 Season Summary 8
- Management Outlook 9

HARDSHELL CLAMS AND MUSSELS 9
- Commercial Fishery Management and Harvest History 9
- Non-commercial Hardshell Clam Fisheries 10
- Stock Assessment 11
- 1999 Season Summary 13
- 2000 Management Outlook 13

OCTOPUS 14
- Fishery Management and Harvest History 14
- Stock Assessment 14
- 1999 Season Summary 14
- 2000 Management Outlook 15

SEA URCHINS AND SEA CUCUMBERS 15

LITERATURE CITED 16

LIST OF TABLES

Page

Table 1. Kachemak Bay and Lower Cook Inlet shellfish sport and personal use fishery harvest and participation estimated from the Statewide Harvest Survey, 1981 – 1998. 17

Table 2. Combined sport and personal use effort directed at crab and harvests of crab in Cook Inlet reported on permits 1996-1998. 18

Table 3. Southern District Dungeness crab survey catches in numbers of crabs by bay location (east or west of Homer spit) 1990 - 1998 19

Table 4. Small mesh trawl survey estimates of population biomass of pandalid shrimp and fish in Kachemak Bay, 1977 – 1999. 21

Table 5. Weathervane scallop age composition in commercial fishery and surveys of Kamishak Bay, 1984-1999 22

Table 6. Sport and personal use effort directed at hardshell clams and harvests of clams in Kachemak Bay reported on permits 1996-98. 23

Table 7. Survey effort and design with resultant density, abundance, and biomass of littleneck clams at commercially harvested beaches in Kachemak Bay, 1992-99. 24

LIST OF FIGURES

Page

Figure 1. Cook Inlet Area shellfish management districts in 2000 26

Figure 2. Cook Inlet/Resurrection Bay sport and personal use management areas. 27

Figure 3. Sport and personal use crab harvest reporting areas for Cook Inlet. 28

Figure 4. Commercial hardshell claming subdistricts in Kachemak Bay. 29

Figure 5. Sport and personal use reporting areas for hardshell clam harvests in Kachemak Bay. 30

LIST OF APPENDICES

Page

Appendix A. Dungeness crab catch (pounds) by year, Cook Inlet Management Area, 1961 - 1999 31

Appendix B. Shrimp catches (pounds) from the Kachemak Bay trawl shrimp fishery in the Cook Inlet Area, 1969-1999. 32

Appendix C. Trawl shrimp catches (pounds) in Outer Cook Inlet (Area G), 1977 - 1999. 33

Appendix D. Shrimp pot harvest (pounds) Cook Inlet Management Area (Area H), 1970-1999 34

Appendix E. Shrimp pot catch (pounds) and effort in Outer Cook Inlet (Area G), 1977-1999 35

Appendix F. Pacific weathervane scallop catches, Cook Inlet Management Area, 1983-1999 36

Appendix G. Harvest (pounds) of hardshell clams, Cook Inlet Management Area, 1986-1999 37

Appendix H. Harvest (pounds) of blue mussels, Cook Inlet Management Area, 1986-1999. 37

Appendix I. Octopus harvest (pounds) in the Cook Inlet Management Area (H) 1983-1999 38

Appendix J. Green sea urchin harvest (pounds), Cook Inlet Management Area, 1987-1999. 38

Appendix K. Sea cucumber catch (pounds) by permit season, Cook Inlet Management Area, 1990-1999. 39

INTRODUCTION

The Cook Inlet Management Area, (Statistical Area H), as it applies to commercial and personal use fisheries is bounded on the east by the longitude of Cape Fairfield (148° 50' W. long.) and on the south by the latitude of Cape Douglas (58° 52' N. lat.). The management area is divided into six shellfish districts: Southern, Kamishak, Barren Islands, Outer, Eastern, and Central (Figure 1).

A discrete area, Outer Cook Inlet (Statistical Area G), has been established specifically for the trawl and pot shrimp fisheries in the Outer and Eastern Districts. Area G has its eastern boundary at the longitude of Cape Fairfield and western boundary at a line drawn from the westernmost tip of Point Adam to the westernmost tip of Cape Elizabeth and south along 151° 53' W. longitude.

For sport fisheries, the Cook Inlet/Resurrection Bay Saltwater Area is defined as waters enclosed by a line extending south from Cape Puget and a line extending east from Cape Douglas (Figure 2).

This report covers the sport, and personal use fisheries for Dungeness crab *Cancer magister* and hardshell clams. In addition, commercial fisheries for weathervane scallops *Patinopecten caurinus*, hardshell clams, and octopus *Octopus dofleini* retained as bycatch during Cook Inlet Area groundfish fisheries are reported here as well. Commercial, sport, and personal use fishing seasons for Areas H and G shrimp trawl and pot fisheries were closed by regulation beginning in 1997. Similar regulations closed commercial fisheries for green urchin *Stronglyocentrotus droebachiensis*, sea cucumber *Parasitichopus californicus*, Dungeness crab *Cancer magister*, and the directed fishery for octopus. Within this report, commercial catch information is masked due to confidentiality for harvests including fewer than three permits.

DUNGENESS CRAB

Commercial Fishery Management and Harvest History

The commercial Dungeness fishery in the Southern District was closed by emergency order beginning in 1991, although other districts remained open (Appendix A). Commercial Dungeness fishing was closed in all Cook Inlet Areas by board action in 1997. This action, which recognized a need for additional information, closed the fishery until stocks recover and a management plan is adopted that considers 14 criteria specified in the regulation (5 AAC 32.390). The department is not prepared to present a new management plan at this time.

Non-commercial Fishery Management and Harvest History

Sport and personal use shellfish harvest and effort data have been collected since 1981 via the Statewide Harvest Survey (SHS), a mail survey of randomly selected sport fishing license holders (Table 1). Estimates of crab harvest and effort for Kachemak Bay and Cook Inlet are also available from permits, first required in 1996 (Table 2). The sport and personal use fisheries for Dungeness crab in lower Cook Inlet were closed by emergency order in 1991 for resource conservation, but reopened from 1992 to 1998. In 1998, the waters of Kachemak Bay were closed by emergency order; the continued poor catches of Dungeness crab in department surveys indicated that sport and personal use harvests of Dungeness crab could be affecting the maintenance and recovery of this stock.

Average recreational Dungeness harvest estimated by the SHS was nearly 21,000 crab through 1994 (Table 1). The average harvest dropped by more than half, to nearly 9,000 crab from 1995 until the fishery was closed in May of 1998. The harvest reported on permits was similar to estimates from the SHS (Table 2).

The SHS estimates sport and personal use effort for all shellfish species combined. Average effort for shellfish in Kachemak Bay and lower Cook Inlet from 1981 through 1998 was approximately 16,306 days of fishing (Table 1). Total effort estimates from the shellfish permits are lower than estimates from the SHS. This is likely due to the errors in the 1996 and 1997 SHS estimates which are in the process of being corrected; catch and effort reporting for species that are listed on the SHS but not included on the shellfish permits and differential non-response rates in each survey.

Effort was reported on permits as trips in 1996 rather than the number of people who fished. A total of 2,896 trips were made for crab in 1996. Only Dungeness crab were caught on 55% of those trips. Both trips and days fished were recorded on permits in 1997. From a total of 3,764 trips made in 1997, crabs (both Dungeness and Tanner crab) were targeted on 2,348 trips and clams on 1,582 trips. Approximately 6,893½ days of total effort was reported on shellfish permits in 1997; 4,250 days were spent crabbing and 2,989 days were spent clamming. People who caught only Dungeness crab accounted for approximately 20% of the effort for crab, whether effort was measured in days fished or trips. Approximately 15% of the effort was attributed to persons who caught both Dungeness and Tanner crabs. The remainder was people who caught only Tanner crab or caught nothing. Effort directed at Dungeness crab in areas that remained open to fishing was insignificant after Kachemak Bay was closed to Dungeness fishing in May of 1998.

Most of the Dungeness crab were harvested in Kachemak Bay east of the Homer Spit. Fewer were caught west of Homer Spit. The remainder was taken in Cook Inlet and from outer Gulf Coast waters (Figure 3).

Prior to the closure, Dungeness crab seasons in Kachemak Bay were from July 15 through December 31, and from January 15 or the beginning of the commercial Tanner crab season, whichever is later, through March 15. The fishery remains open in waters west of a line from Anchor Point to Point Bede (Figure 3). Open season dates are June 1 through March 31 with a daily bag and possession limit of 5 male crab per day.

Stock Assessment

The department conducts a biennial Dungeness crab survey to monitor changes in stock status. The most recent survey in 1998 indicated that Dungeness crab remain depressed in the Southern District. Survey catches were 3 legal, 11 sublegal, and no female Dungeness crab in 90 pots (Table 3). This is a dramatic decline from survey catches in earlier years. For example, in the 1992 survey, 1,600 males were captured in 90 pots. Similarly, trawl survey catches of all male Dungeness crab declined from 317 in 1990 to fewer than 20 crab since 1997. Although department trawl surveys have typically caught more sublegal that legal Dungeness crab, cohort strength has failed to yield sufficient recruitment to support a fishery.

Stock Status

In 1998, the pot survey program was expanded to document Dungeness crab concentrations at greater depth to determine the relationship between pot catches and trawl catches so that abundance of Dungeness crabs could be estimated rather than indexed. Additional pots were fished in strings parallel to historic ADF&G pot survey strings but at greater depths. The additional pots were fished within two areas encompassed by the ADF&G trawl survey that estimates crab abundance. Some of the additional pots were fished directly along two of the trawl survey paths. A portion of the traditional pot survey area was trawled as well. All captured crab were marked with Floy brand modified T-bar numbered tags and released. A total of three female and one male Dungeness crab was caught in 84 pot sets. Two additional Dungeness crab were captured with the trawl in the area where the two gear types overlapped. None of the captured crabs had tags. The supplemental survey confirmed that the Dungeness crab populations are at low levels over a broader range than the area traditionally surveyed.

Crab abundance will continue to be indexed with pot surveys in the nearshore waters and trawl survey in deeper waters of Kachemak Bay until there is evidence of sustained recruitment to legal size. At that time research will again be aimed at estimating absolute abundance and sustainable yields for non-commercial and commercial harvest. The department plans to conduct the next Dungeness pot survey in August 2000 and the next trawl survey in July 2000. It is unlikely these surveys will indicate a significant recovery of Southern District Dungeness crab.

AREA H SHRIMP TRAWL FISHERY

The Area H commercial shrimp trawl fishery was closed by emergency order due to low abundance beginning in October 1987 and closed by regulation in 1997. Regulation 5 AAC 31.390 COOK INLET SHRIMP FISHERIES MANAGEMENT PLAN, in addition to closing the fishery, adopted 14 criteria that must be addressed in any subsequent management plan adopted by the board. Historic harvest data are presented in Appendix B.

Stock Assessment

Standardized small-mesh trawl surveys have been conducted in Kachemak Bay since the early 1970s (Davis 1982; Gustafson 1994; Bechtol 1997). Area-swept population estimates were made from one nautical mile tows at depths greater than 36.6 m (20 fathom). Initially, survey stations were randomly selected using a grid of one nautical mile squares placed over a chart of Kachemak Bay. Beginning in 1984, survey stations were replicated each year in order to reduce potential damage to the survey net from high relief structures. The survey area has since been stratified to improve precision in the population estimate. Although the survey method has been relatively consistent over time, the frequency of the survey has changed dramatically. Through 1990, this survey was conducted semiannually with both spring and fall surveys. This was reduced to a spring survey conducted annually from 1991-1992, biennially from 1993- 1997, and then triennially with the next survey scheduled for 2000. This change was effected because of the long-term closure to the shrimp trawl fishery in Kachemak Bay. During the survey, the catch from each tow is weighed, sorted, and subsampled for species composition and abundance. All measures of shrimp abundance have continued to indicate that the shrimp resource has not recovered (Bechtol 1997).

Stock Assessment

The surveys, which were used to determine each season's guideline harvest level, have indicated significant declines in abundance and distribution of all pandalid shrimp stocks in Kachemak Bay since the late 1970's (Table 4). The population biomass estimate of 240,000 lb in the 1997 survey is less than 5% of the estimates during the 1970's. To put these survey data into perspective the commercial shrimp trawl fishery averaged over 5 million lb annual harvest during its peak years. Despite some shift in size composition and distribution, all information collected during the 1997 survey indicated that the stocks remained depressed by historical standards. The department will conduct the next Southern District trawl shrimp survey during May, 2000. Although the fishery remains closed by regulation, the survey is recognized as an important monitoring tool. When stocks recover and a new management plan is adopted, the fishery may open.

AREA G SHRIMP TRAWL FISHERY

Fishery Management and Harvest History

Statistical Area G is a nonexclusive shrimp registration area encompassing the Outer and Eastern Districts of Cook Inlet (Figure 1). The first year of significant shrimp trawl harvest occurred in the 1982-83 season when 4 vessels caught 239,584 lb (Appendix C). The catch increased steadily for the next 2 seasons to a peak harvest of just under 2.0 million lb taken by 11 vessels during the 1984-85 season. Prior to 1992, pink shrimp *Pandalus borealis* comprised 90 percent of the annual harvests; the remaining 10 percent were sidestripe shrimp *Pandalopsis dispar*. Trawl CPUE was relatively low, rarely exceeding 1,000 lb per hour. Logbook information collected over time indicated that fishermen in Area G made long tows, often with extremely low catch

results. From 1992 through 1996 the landings were comprised entirely of sidestripe shrimp as the vessels targeted these larger, more valuable animals. Once again, long tows and low CPUE characterized this fishery.

Prior to 1985, shrimp trawling in Area G was open year-round. 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 on June 1, 1996 and remained open for the entire season. The catch is confidential due to participation by 2 or less fishermen. Harvest occurred in both the Outer and Eastern Districts. Catch rates were comparable to previous years and indicated little change in stock status.

Assessment and Stock Status

In 1982 and again in 1994, the department conducted a series of survey tows in shrimp trawl areas of the Eastern District. Although population estimation was restricted to specific bays, survey catch and bycatch were similar to that reported by the commercial fleet. The department has no plans to conduct additional shrimp assessments in Area G. In light of this, it is unlikely that the department will develop a management plan that addresses the criteria listed in 5 AAC 31.390 COOK INLET AREA SHRIMP FISHERIES MANAGEMENT PLAN.

AREA H AND AREA G SHRIMP POT FISHERIES

Fishery Management and Harvest History

Historically the major shrimp pot fishery occurred in the Southern District of Area H with lower level fisheries occurring in Area G. Commercial harvest data show that the Southern District fishery suffered steep declines in annual harvests until the 1988 closure (Appendix D). Although the Area H target species was coonstripe shrimp *Pandalus hypsinotus*, spot shrimp *Pandalus platyceros* were also caught to a lesser degree. Commercial harvests in Area G never exceeded 21,000 lb, primarily spot shrimp, in any year (Appendix E).

In 1997 the board closed all shrimp fisheries in both areas until stock abundance improves and a new, more comprehensive management plan is adopted.

Prior to 1986, the Department conducted annual shrimp pot surveys in the Southern District. No assessments have been conducted in Area G. Department shrimp trawl surveys continue to indicate that the stock of coonstripe shrimp in the Southern District remains depressed.

WEATHERVANE SCALLOPS

Management and Harvest History

The commercial Pacific weathervane scallop fishery in the Cook Inlet Management Area (H) dates to 1983 when a 6-foot dredge requirement was first established. In 1985, the board adopted regulations for scallops in Cook Inlet. Regulations included a season in the Kamishak District from August 15 through October 31, a guideline harvest level (GHL) of 10,000 to 20,000 lb (changed to 0 to 20,000 lb in 1994) of shucked meats, and a commissioner's permit requirement which stipulated the following:

1) A minimum dredge ring size of 4 inches inside diameter.
2) Only 1 unit of gear allowed on board at any one time.
3) Mandatory logbook completion.
4) Contact with the Homer office prior to and at the completion of each trip.
5) An agreement to carry department observers on board if requested.

Except for some brief exploratory fishing elsewhere in the Kamishak District in 1984 and in the Outer District in 1987, a single bed of scallops near Augustine Island in the Kamishak District has produced virtually all harvests since 1983 (Figure 1; Appendix F).

The Southern District has been closed by regulation to scallop fishing to protect crab stocks, while the Outer and Eastern Districts are open to exploratory fishing under a permit issued by the department. The department closed the Kamishak scallop fishery in 1987 when the stock declined dramatically subsequent to reports of illegal fishing. Although the fishery reopened in 1988, no commercial effort occurred in Cook Inlet from 1988 through 1992 because fishermen anticipated poor fishery performance that would result in further closure of the fishery. In 1993 the fishery was essentially redeveloped when three boats harvested 20,115 lb. Logbooks, shell samples, and fishery performance data indicated a small but healthy stock of scallops once again existed 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 closure of all federal waters. This action essentially closed the Kamishak Bay fishery which occurs almost exclusively in federal waters. Subsequent efforts to close this regulatory loophole ultimately resulted in state management of all scallop fisheries in Alaska. Fisheries in federal waters reopened in August 1996.

Based on the 1995 closure and results of a survey in 1996, the department set a 1996 fishery GHL of 28,000 lb. Subsequent fishery GHL's have remained at the 20,000 lb level. Vessel effort has been 5 in 1996, 3 in 1997, and 1 in 1998. Tanner and king crab bycatch levels have ranged from highs of 10,164 and 29 and lows of 205 and 9. Department staff has made at least one observer trip each year. Overall, crab bycatch levels have been comparable between observed and unobserved trips.

A combination of inclement weather and mechanical problems resulted in a request to extend the 1998 season beyond the October 31, regulatory closure date. Because crab bycatch was relatively low and the identified biological season for scallops extends from July 1 to February 15, the department extended the season to December 15. Harvest data for the 1998 fishery are confidential.

A federal license limitation program (LLP) for scallop fishing in federal waters has been in progress since March 1997. The LLP was adopted in February 1999 resulting in a total of 9 vessels 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 gear restriction of a single, 6-foot dredge. In a similar vein, the Alaska Legislature established a scallop vessel moratorium in 1997. Currently 10 vessels qualify to fish under this program. The state moratorium expires in June 2001 if no limited entry program is established.

Stock Assessment

Fishery-independent surveys of the Kamishak Bay population were conducted in 1984, 1996, 1998, and 1999 using a 1.0-nm tow of an 8-ft scallop dredge equipped with a 38-mm (1.5-inch) liner (Bechtol and Gustafson *under review*). Survey depths typically range from 20-40 fathom. The current strategy is to establish this as a biennial survey with the next survey in the summer of 2001. The survey involves a systematic sample design using a grid of 1.0 nm x 1.0 nm squares placed over a chart of the weathervane scallop bed located directly east of Augustine Island; initial grid placement was based on historical fishery and survey information. The survey starts by systematically sampling every fourth square after the initial square is determined with a random number generator. After completing an initial coverage of the entire bed, if weather and time allows, stations in between the initial squares are sampled such that every other square, or half of the available survey stations, is ultimately sampled. Based on the presence or absence of a significant scallop catch, stations are added or deleted along the margin while maintaining the alternate square pattern. Scallop biomass estimates for 1996 and 1998 were 5.5 million lb and 7.0 million lb, however, the 1998 survey was not completed due to the loss of the survey gear. Meat recovery among survey years ranged from 6.54-8.54% of whole scallop weight.

Harvest data collected from the weathervane scallop fishery in Kamishak Bay includes the weight of harvested meats and shell size and age composition. Shell data has 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 -13 scallops (Table 5). Survey age composition has ranged from young-of-the-year age 0+ to age 24 (Bechtol 2000; Bechtol and Gustafson *under review*). Weighted age composition data from the 1996 survey indicated age-4 scallops were the most abundant cohort (15%) and 51% of the surveyed population was younger than age 6. 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. The greatest annual growth in height occurs during the first five years of life.

Annual height growth rates decreased rapidly to less than 1% per year after about age 13. Annual growth in weight was greatest from about age 2 to age 5.

Catches in the 1999 survey ranged from 0-606 lb of whole scallops per tow, with a mean catch of 138.4 lb (unpublished data). Based on an assumed, but unvalidated, catchability estimate of 1.0, the estimated total population is 9.4 million lb of weathervane scallops in the Kamishak Bay bed. The regulatory maximum GHL for the Kamishak Bay scallop fishery is 20,000 lb of meats. Achievement of this maximum GHL would have equated to a harvest rate of 3.24% of the 1999 survey population estimate. An age-structured model of the Kamishak Bay population suggested that commercial harvest rates 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 (Bechtol 2000), 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. This approach appears to have provided for long-term sustainability in the weathervane scallop population of Kamishak Bay.

1999 Season Summary

The 1999 commercial scallop season opened at 12:00 noon August 15 and closed at 23:00 hours on August 23 with a total harvest of 20, 312 lb (Appendix F) from 3 vessels. The department monitored the 1999 fishery via logbooks, shell samples, and skipper interviews. Although interviews occurred at the end of each trip, few trips were made due to both the short season and the use of freezer units aboard vessels. Freezing onboard was a relatively late development in Cook Inlet, beginning in 1996, although some vessels continue to ice the product in the traditional manner. Catch, CPUE data and shell samples indicated the distribution, density, and age of the stock compared favorably to historic levels. The 1999 CPUE of 61 lb per hour towed is a historic high for the fishery. Although aging is incomplete, scallops in the shell samples indicated that age classes between 4 and 7 comprise approximately 75% of the catch. This is comparable to fishery samples since 1996.

Tanner crab bycatch limits were reduced from 25,000 to 6,000 crab due to continued declines in Tanner crab stock abundance, particularly in the northern portion of the Kamishak District. However, the king crab limit remained at 60. Tanner crab limits were a function of 1/2 of one percent of the population estimate from the department's 1998 trawl survey in Kamishak whereas the king crab limit was the same as in the 1998 fishery. Crab bycatch in the 1999 scallop fishery totaled 85 Tanner crab and 18 king crab.

No fishing occurred in the Outer and Eastern Districts of the Cook Inlet Area. Historically, only a single documented landing of approximately 1,100 lb has occurred from these areas. Most recently, exploratory fishing by two scallop vessels in 1994 yielded a catch of 11 scallops.

Management Outlook

The Kamishak District fishery will open by regulation on August 15, 2000. The preseason guideline harvest level will be 20,000 lb. Management of the fishery will be similar to previous years and the ultimate harvest level will be determined based upon information collected inseason. Crab bycatch limits will be based upon the department's Kamishak District trawl survey. The department 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 the department would issue a permit for exploratory fishing without first obtaining information on scallop abundance. The department does not anticipate any interest in fishing these districts.

HARDSHELL CLAMS AND MUSSELS

Commercial Fishery Management and Harvest History

Recent commercial hardshell clam and mussel harvests in the Cook Inlet Management Area began in 1986. The generic term, hardshell clams, generally refers to littleneck *Protothaca staminea* and butter clams *Saxidomus giganteus*. From 1986 through 1995, annual commercial harvests of hardshell clams ranged from 14,500 lb to 71,025 lb (Appendix G). Effort ranged from 2 to 33 hand diggers.

In 1989, the bulk of the commercial clam harvest went to 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 that went to Kenai Peninsula and Anchorage markets. The entire documented commercial harvest has come from Kachemak Bay.

Before harvest of clams or mussels for human consumption occurs, an area must be certified for water quality by the Alaska Department of Environmental Conservation (DEC) in accordance with the National Shellfish Sanitation Program. DEC must also test for paralytic shellfish poisoning (PSP). Lot sampling had been the method that DEC used to test for PSP. In 1986, DEC permitted the use of lot sampling for Chugachik Island (near Bear Cove) in Kachemak Bay. Through 1989, Chugachik Island, Halibut Cove Lagoon, Kasitsna Bay, and Jakalof Bay, all in Kachemak Bay, were certified for lot sampling. At the end of 1989, Tutka Bay was also certified. The most recent certification occurred in 1994 when DEC departed from the lot sampling strategy and certified all the Southern District hardshell clam subdistricts on the south side of Kachemak Bay between Bradley River and Barabara Point (Figure 4).

Only 102 lb of blue mussels were commercially harvested prior to 1989. Annual mussel harvest rarely exceeds 2,000 lb. In 1989, however, the catch rose to over 167,000 lb as the mussels were used for food in an otter rehabilitation project following the Exxon Valdez oil spill (Appendix H).

Early regulations for the Kachemak Bay hardshell clam fishery included minimum sizes of 1.5 inches for Pacific littleneck clams and 2.5 inches for butter clams established by the Board in 1990. In 1994, the board adopted the Southern District Hardshell Clam Fishery Management Plan (5 AAC 38.318), a management strategy to guide long-term, sustainable use of the hardshell clam resource in Kachemak Bay. A key plan component was an alternate year commercial harvest strategy that opens half of the certified beaches on even-numbered years and the other half on odd-numbered years. Other features included the following commercial restrictions:

1) areas of high recreational value will be closed,
2) weekends will be closed from May 15 through September 15, and
3) a registration deadline of April 1.

The board adopted this plan to spread the catch and effort over a larger area, to allow for a year of unfished growth and recruitment, reduce potential user group conflicts, and permit the department to anticipate effort.

In 1997 the board adopted additional regulations affecting the clam fishery. These included a commercial harvest cap of 40,000 lb, a closure of all of Bear Cove, a provision for quarterly clam allocations each calendar year, and more conservative criteria for temperature dependent openings during the November 1 through March 15 period.

This latter restriction, in combination with the quarterly harvest requirement, resulted in harvests below the GHL during 1997 and 1998. For example, the 1997 GHL was 40,000 lb. However, harvest opportunities were limited due to temperatures below the threshold during low tide periods, and the harvest totaled 31,525 lb. In 1998, the GHL was reduced to 30,000 lb based upon a 5% harvest rate applied to densities indicated by department assessment efforts. The 1998 harvest totaled 23,465. There were no open periods during the temperature dependent harvest period. In both years, the combined effect of the new regulations resulted in a harvest total of approximately 75% of the GHL.

Non-commercial Hardshell Clam Fisheries

Sport and personal use harvests of hardshell clams have been estimated since 1981 by the SHS. The hardshell clam harvest in Kachemak Bay and Lower Cook Inlet has ranged from 5,135 gallons in 1982 to 26,597 gallons in 1988 (43,648 to 226,075 pounds; one gallon is approximately equal to 8.5 pounds) and has averaged 14,229 gallons (120,946 pounds) (Table 1). The harvest is almost entirely from the Kachemak Bay area.

Permits have been required for digging clams for sport and personal use in Kachemak Bay since 1997. The reported harvest from permits is considerably less than the harvest estimated from the SHS (Table 6, Table 1). This is likely due to diggers who don't obtain permits and consequently don't report their harvests. The distribution of the effort reported on the permits matches the distribution of diggers observed on aerial digger surveys, so the permits probably reflect the true distribution of both diggers and harvest (Table 6). The permit reporting areas are shown in Figure 3. Most of the harvest is reported from Sadie Cove, China Poot, Jackalof and Kasitsna

bays and the east side of the Homer Spit (Table 6). Littleneck clams comprised 54% of the harvest in 1997 and 86% of the harvest in 1998. Butter clams made up most of the remaining harvest. Nine and seven percent of the clams reported in 1997 and 1998, were not identified to species.

The SHS estimates effort expended on all shellfish species harvested at a particular location rather than estimating the effort directed at individual species (Table 1). Effort for hardshell clams has also been estimated from permits required of recreational clam diggers in Kachemak Bay since 1997 (Table 6). Approximately 6,893 days of total effort were reported on shellfish permits in 1997; 4,250 days were spent crabbing and 2,989 days were spent clamming. Some harvesters took both crabs and clams on the same day so the estimate of total effort is less than the individual estimates for crabs and for clams added together. In 1998, effort for shellfish dropped by more than half; effort for clams also decreased. Total effort for crabs and clams estimated from returned permits was 3,018 days. Slightly less than half of the effort, 1,298 digger-days, was directed at hardshell clams. Nearly 43 percent of the 1999 permits are unreturned to date so the data are too preliminary to report here.

From aerial surveys and permit reports, most diggers concentrated in Sadie Cove, China Poot Bay, Jackalof and Kasitsna bays (grouped as Little Tutka to Barabara Point in Table 6) and the east side of the Homer Spit (grouped under north side Kachemak Bay in Table 6). Participation in the clam fishery appears to be correlated with the opportunity to harvest Dungeness crab

The board adopted the following department proposals governing recreational fisheries in Kachemak Bay in 1994:

1) a minimum legal size for littleneck and butter clams of 1.5 and 2.5 in shell length, respectively (both of these are the same as the commercial size limits), and

2) a bag and possession limit of 1,000 littleneck clams and 700 butter clams.

The regulations are liberal enough that they probably have little to no effect on the harvest. They allow clams to reach reproductive maturity before harvest and facilitate the enforcement of commercial closures by preventing commercial diggers from claiming they are recreational harvesters to avoid commercial regulations.

A guideline harvest level of 160,000 lb was established for the non-commercial fishery in 1997 based on the average harvest in the fishery from 1981 – 1995.

Stock Assessment

In addition to harvest reports, the department's primary assessment tool for hardshell clams has been fishery-independent surveys of commercial harvest areas (Gustafson 1995; Gustafson and Bechtol *under review*). Surveys in Kachemak Bay date to 1990 and have typically been conducted during low tides between approximate elevations of the –4 ft (–1.2 m) tide level and the blue mussel beds at around 5 ft (1.5 m). Areas approved for commercial harvests by the Department of Environmental Conservation open on an alternate year schedule. Potential clam

habitat in these areas is surveyed biennially, with the survey conducted the year prior to a commercial opening. Population estimates are stratified by legal and sublegal size categories. Littleneck clams measuring 38 mm or larger may be legally harvested. Other estimated statistics for individual clam survey areas include mean annual recruitment abundance, mean annual recruitment biomass, and size-at-age.

The longest time series of department surveys has been from Chugachik Island during 1992-1999 (Table 7). In the early portion of the time series, limited survey effort likely affected the precision of the biomass estimate. In more recent years, more survey effort has been applied at Chugachik Island. Littleneck clam densities among years ranged from 33.8-67.2 legal clams/m^2. The legal clam density of 42.0 clams/m^2 in 1999 was below the long-term average density of 48.0 legal clams/m^2. Densities of sublegal clams have ranged from 8.8-50.4 clams/m^2, with a general decline observed in the last four years. The 1999 Chugachik Island survey yielded abundance estimates with 95% confidence intervals of 2.5million ±0.7 million legal clams and 0.5 million ±0.2 million sublegal clams. Estimated biomass was 141,000 lb of legal clams and 11,000 lb of sublegal clams. A second time series is available for Ismailof Island (Table 7). Densities of legal littleneck clams at Ismailof Island have ranged from 50.1-104.5 clams/m^2, with the lowest observed densities in 1999. Densities of sublegal clams ranged from 18.5-96.4 clams/m^2. The 1999 Ismailof Island survey yielded abundance estimates with 95% confidence intervals of 77,000 ±28,000 legal clams and 46,000 ±29 sublegal clams. Estimated biomass was 3,700 lb of legal clams and 2,700 lb of sublegal clams. A third time series, Jakalof Bay was sampled in 1992, 1993, and 1998. For both legal and sublegal littleneck clams, densities were highest in 1993. The 1998 Jakalof Bay survey yielded abundance estimates with 95% confidence intervals of 5.8 million ±1.2 million legal clams and 1.1 million ±0.4 million sublegal clams. Estimated biomass was 320,000 lb of legal clams and 16,000 lb of sublegal clams.

The department also developed an age-structured population model developed for the Chugachik Island population using data from 1992 to 1996 (Bechtol and Gustafson 1998). Data among all survey years indicates few clams at Chugachik Island recruited to legal size prior to age 5, whereas age 7 was the mean age at which 50% of the population recruited to legal size. Estimates of annual recruitment to legal size at Chugachik Island ranged from 5.7-11.9% of the annual abundance, with a mean recruitment rate of 9.9%. Based on a technique developed by Hoenig (1983) that estimates natural mortality as a function of maximum age, the annual mortality rate was estimated to be 23% for littleneck clams with a maximum observed age of 16 years in Kachemak Bay.

In addition to maintaining annual surveys for hardshell clams, the department is increasing survey coverage of clam habitat in the Southern District including estimating exploitation rates, pinpointing non-commercial digger distribution, and exploring alternate assessment techniques. Staff has also surveyed mariculture application sites to assess existing, site-specific resource levels. Finally, the staff are working with the National Estuarine Reserve Research (NERR) program to place available clam survey data in a GIS format to facilitate evaluation of total habitat and hardshell clam abundance within the Southern District.

1999 Season Summary

The 1999 hardshell clam GHL was set at 25,000 lb, based on a 5% harvest rate applied only to assessed areas and the lack of recruitment in some areas. Dividing the allowable harvest equally into each quarter of the year set quarterly harvest limits of 6,250 lb.

Total 1999 hardshell clam harvest was 18,530 lb of littleneck clams hand dug by 12 permit holders (Appendix G). The areas open to harvest were subdistrict 1, which included significant clam beaches including Chugachik, Aurora Lagoon, and Glacier Spit and subdistrict 3b which included the southern shore of Sadie Cove and the northern shore of Tutka Bay. Most of the harvest occurred during the second quarter when 14,180 lb of clams were landed. This amount accounted for the remainder of the first quarter allocation, the full second quarter allocation, and a part of the third quarter harvest allocation. The Chugachik Island area was closed by emergency order at 12:00 noon May 20 to spread the harvest over a greater area. By the time the entire fishery closed May 28, it was obvious that the Chugachik closure was effected too late to achieve its goal and the harvest had exceeded the second quarterly allocation. The fishery remained closed until October 1. Similar to 1998, no commercial openings occurred during the months when openings are restricted by the temperature dependent regulations.

The late closure and resultant high harvest during the second quarter was a result of uncharacteristically high effort during a single tide period and the one-week lag time in receiving fish tickets. Additionally, illegal harvests occurred during the second quarter when commercial digging occurred during one of the regulatory weekend closures from May 15 to September 15. Two of these participants were also unregistered. All of these complaints were turned over to Division of Fish and Wildlife Protection.

2000 Management Outlook

Subdistricts 2, 3a, and 4 will open in 2000 with a preseason guideline harvest level of 30,000 lb based upon assessed areas. Management strategies will again include quarterly harvest limits and temperature dependent openings. The quarterly harvest limit was effective by allowing the department adequate time to receive fishery information and adjust annual management of the fishery. However, harvest allocations will be set disproportionately among quarters such that a relatively small portion of the GHL is allocated to the fourth quarter when temperatures offer few fishing opportunities. The Alaska Board of Fisheries will consider several proposals that could close additional portions of Kachemak Bay to commercial clam harvesting. If these proposals are adopted, it is possible that the harvest guideline will be further reduced to provide for a sustainable fishery.

OCTOPUS

Fishery Management and Harvest History

The harvest of octopus in the Cook Inlet area has historically occurred incidentally to other directed fisheries, such as the commercial Tanner crab, groundfish pot, longline, and trawl fisheries. Although permits have been issued to target octopus, little success has been reported. Cook Inlet octopus harvests have been reported since 1983 and have ranged from 435 to 48,000 lb with effort fluctuating from 8 to 41 boats (Appendix I). The high harvest years were the result of bycatch from shellfish pot fisheries. In the past 5 years, interest has increased in specifically targeting octopus. Many different gear types have been tried to date, but the resultant harvest has been negligible. Most of the effort has focused on Kachemak Bay.

Stock Assessment

The department has little fishery-independent data on octopus abundance. Octopuses are sometimes caught in department bottom trawl surveys in the Southern District of Cook Inlet. The predominant species in Cook Inlet is the giant Pacific octopus *Octopus dofleini* 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 3-5 years (Gillespie et al. 1998). Sexual maturity may be achieved in 1.5-2 years and maximum size may be attained in 2-3 years. Growth and size-at-maturity likely varies among geographic locations, but is reported as 17 lb (7.5 kg) for males and 35 lb (16.0 kg) for females, with a maximum reported size of 50 kg (110 lb). 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 be before the eggs hatch.

1999 Season Summary

Although the octopus fishery was closed by board action in 1997, octopus has remained open as bycatch. Octopus is considered a shellfish under state regulation, but is designated "other groundfish" in federal regulation. Because octopus is open to directed fishing in adjacent federal waters, the department set a bycatch level of 20% for octopus during groundfish pot fisheries. The 1999 harvest of octopus from groundfish pot fisheries was 21,846 lb from 9 vessels in 127 landings.

2000 Management Outlook

The extent of this resource in Cook Inlet outside Kachemak Bay is undetermined and could ultimately affect any directed fishery. Under 5 AAC 38.390 COOK INLET AREA MISCELLANEOUS SHELLFISH FISHERIES MANAGEMENT PLAN, the directed octopus fishery will remain closed until the board adopts a conservation-based management plan.

SEA URCHINS AND SEA CUCUMBERS

Historic harvests of green urchins and sea cucumbers are presented in Appendices J and K. 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. The plan closed all commercial fishing until the board adopts a new conservation-based management plan. It is unlikely the department will be able to conduct the assessments necessary to complete a management plan, therefore, these fisheries are expected to remain closed into the future.

LITERATURE CITED

Bechtol, W.R. 1997. Changes in forage fish populations in Kachemak Bay, Alaska, 1976-1995. pp: 441-455, In: Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report 97-01. University of Alaska, Fairbanks.

Bechtol, W.R. 2000. Preliminary evaluation of multiple data sources in an age-structured model for weathervane scallops in Kamishak Bay, Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A00-03, Anchorage, 23 p.

Bechtol, W.R., and R.L. Gustafson. 1998. Abundance, recruitment, and mortality of Pacific littleneck clams *Protothaca staminea* at Chugachik Island, Alaska. Journal of Shellfish Research 17(4):1003-1008.

Bechtol, W.R., and R. Gustafson. *Under review.* Assessment of weathervane scallops in Kamishak Bay, Alaska, 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A00-**, Anchorage.

Gillespie, G.E., G. Parker, and J. Morrison. 1998. A review of octopus biology and British Columbia fisheries. Canadian Stock Assessment Secretariat Research Document 98/87, Fisheries and Oceans, Canada.

Gustafson, R. 1994. Trawl shrimp fishing index in the Southern District of the Cook Inlet Management Area, Spring 1992 and 1993. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 2A94-23, Anchorage.

Gustafson, R. 1995. Kachemak Bay littleneck clam assessments, 1990-1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 2A95-19, Anchorage.

Gustafson, R.L., and W.R. Bechtol. *Under review.* Kachemak Bay littleneck clam assessments, 1995-1997. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A00-XX, Anchorage.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate natural mortality rates. Fishery Bulletin 82(1):898-903.

Kruse, G.H. 1994. Fishery management plan for commercial scallop fisheries in Alaska. Draft Special Publication 5, Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Juneau.

Table 1. Kachemak Bay and Lower Cook Inlet shellfish sport and personal use fishery harvest and participation estimated from the Statewide Harvest Survey, 1981 – 1998.

Year	Participation All Species		King Crab	Dungeness Crab	Tanner Crab	Shrimp	Hardshell Clams	Razor Clams	Other Shellfish
	(angler days)	(trips)	(numbers)	(numbers)	(numbers)	(gallons)	(gallons)	(numbers)	(numbers)
1981	25,391		6,178	22,928	4,320	7,117	8,132		38,560
1982	15,712		1,981	9,956	4,234	5,009	5,135		1,782
1983	20,334		409	15,083	3,084	3,577	16,110		2,633
1984	25,162	17,089	62	15,113	2,332	2,419	8,891	37,476	349
1985	16,732	12,556	[a]	29,530	3,502	3,260	10,334	16,205	2,982
1986	21,755	13,203	[a]	34,217	7,926	4,771	20,212	40,937	128
1987	20,710	15,176	[a]	51,279	8,988	7,788	23,577	25,855	9,080
1988	13,306	12,687	[a]	32,053	4,669	2,090	26,597	18,374	3,474
1989	9,594	6,922	[a]	10,075	[a]	1,199	18,195	15,954	13,015
1990	10,342	7,375	[a]	7,034	[a]	2,038	11,821	21,701	11,707
1991	6,690	5,051	[a]	[a]	1,142	613	10,476	7,963	1,513
1992	15,727	10,866	[a]	10,050	4,165	1,547	9,993	11,358	13,327
1993	13,741	9,158	[a]	15,198	9,206	656	8,350	10,692	7,995
1994	18,187	13,101	[a]	19,155	9,648	2,087	13,279	13,974	2,384
1995	17,682	12,133	[a]	8,957	10,936	1,654	20,311	14,669	7,708
1996	14,564	7,950	[a]	7,701	3,763	301 [b]	17,652	16,090	10,310
1997	11,577	8,215	[a]	9,775	3,219	[a]	14,304	4,454	1,019
1998	4,663	2,878	[a]		2,456	[a]	12,751	5,282	0
Average	16,306		2,158	8,811	5,224	2,883	14,229	17,399	7,109

[a] Fishery closed.

[b] Fishery closed by Emergency Order April 15.

Table 2. Combined sport and personal use effort directed at crab and harvests of crab in Cook Inlet reported on permits 1996-1998.

1996 Report area	Effort (trips)	Harvest Dungeness (numbers)	Harvest Tanner (numbers)
Cook Inlet north of Anchor Point (Area A)	33	12	300
Cook Inlet remainder (Area B)	6	0	0
North Gulf Coast (Area C)	19	15	6
Kachemak Bay east of Homer Spit (Area D)	2,132	7,337	2,495
Kachemak Bay west of Homer Spit (Area E)	651	341	9,112
Unknown	55	167	146
TOTAL	2,896	7,872	12,059

1997 Report area	Effort (trips)	Effort (Crab days)	Harvest Dungeness (numbers)	Harvest Tanner (numbers)
Cook Inlet north of Anchor Point (Area A)	29	58	146	5
Cook Inlet remainder (Area B)	30	65	42	791
North Gulf Coast (Area C)	21	46	6	19
Kachemak Bay east of Homer Spit (Area D)	1,674	3,057	6,977	2,856
Kachemak Bay west of Homer Spit (Area E)	560	956	475	7,559
Unknown	34	68	128	146
TOTAL	2,348	4,250	7,774	11,376

1998 Report area	Effort (trips)	Effort (Crab days)	Harvest Dungeness (numbers)	Harvest Tanner (numbers)
Cook Inlet north of Anchor Point (Area A)	12	12	40	0
Cook Inlet remainder (Area B)	31	44	7	220
North Gulf Coast (Area C)	3	4	0	0
Kachemak Bay east of Homer Spit (Area D)	214	393	17	2,360
Kachemak Bay west of Homer Spit (Area E)	863	1,219	490	13,336
Unknown	46	89	1	700
TOTAL	2,439	1,761	555	16,616

Table 3. Southern District Dungeness crab survey catches in numbers of crabs by bay location (east or west of Homer spit) 1990 - 1998.

Year	Dates	Bay Location	Pots pulled	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 3. continued.

Year	Dates	Bay Location	Pots pulled	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

33% of escape rings closed

Table 4. Small mesh trawl survey estimates of population biomass of pandalid shrimp and fish in Kachemak Bay, 1977 – 1999.

	Biomass Estimate (million lb)		
Year	Shrimp	Fish	Total
1976			
1977	6.45	1.83	8.28
1978	13.36	2.63	15.99
1979	12.26	2.53	14.79
1980	8.06	1.47	9.53
1981	7.17	4.28	11.45
1982	4.5		4.5
1983	3.28	2.16	5.44
1984	4.26	3.15	7.41
1985	3.49	5.38	8.87
1986	2.47	4.06	6.53
1987	2.69	3.37	6.06
1988	3.67	10.83	14.5
1989	1.73	9.71	11.44
1990	3.27	7.59	10.86
1991	1.11	10.6	11.71
1992	0.9	8.62	9.52
1993	0.12	8.99	9.11
1994			
1995	0.44	12.87	13.31
1996			
1997	0.24	7.54	7.78
1998			
1999			

Table 5. Weathervane scallop age composition in commercial fishery and surveys of Kamishak Bay, 1984-1999.

	Commercial Fishery Samples									Survey Samples			
	1985	1986	1987	1993	1994	1996	1997	1998	1999	1984	1996	1998	1999
Age	Percent of Total Sample Size[a]												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	12.9	12.4	1.0	2.1
2	0.0	0.0	0.0	0.0	0.0	1.1	0.5	0.5	0.0	15.2	4.8	1.0	0.2
3	0.0	2.7	0.0	0.4	4.2	19.5	3.7	7.8	2.1	39.6	6.7	14.2	1.4
4	10.2	13.2	1.2	2.5	2.6	14.7	20.1	10.7	22.2	4.6	16.9	5.7	17.3
5	26.9	30.5	20.8	3.9	6.5	14.5	12.8	20.1	11.5	0.2	10.2	20.7	5.7
6	12.7	28.1	17.3	7.0	5.2	4.3	12.8	15.0	22.2	0.7	4.4	16.9	15.4
7	5.6	3.1	19.6	12.5	9.8	6.5	4.2	11.1	17.7	4.1	5.2	6.4	10.8
8	12.2	1.0	5.4	22.3	13.1	4.1	3.6	3.8	3.5	3.3	8.9	2.1	6.7
9	5.6	3.7	6.5	21.5	16.8	5.6	5.4	2.1	1.0	0.9	6.1	1.9	3.2
10	5.6	4.7	10.1	13.6	15.7	8.3	6.1	2.7	1.4	2.1	6.1	3.6	4.6
11	10.2	6.1	7.1	6.3	9.5	7.6	8.0	4.2	3.1	2.6	5.4	3.8	4.8
12	6.6	4.1	7.7	3.3	6.2	6.7	6.7	5.9	3.5	5.0	5.5	8.2	3.2
13	3.0	1.4	2.4	2.1	2.9	3.1	7.9	4.6	2.8	4.3	3.8	4.0	8.1
14	0.5	1.4	1.2	1.7	2.4	1.7	3.9	5.5	5.2	2.9	1.8	5.0	5.7
15	1.0	0.0	0.6	1.1	1.3	0.4	1.5	3.2	2.1	0.9	0.6	2.4	4.8
16	0.0	0.0	0.0	0.8	1.5	0.3	1.4	1.3	0.7	0.9	1.5	1.3	2.8
17	0.0	0.0	0.0	0.7	1.0	0.6	0.3	1.0	0.7	ND	ND	0.3	1.1
18+	0.0	0.0	0.0	0.4	1.3	0.9	1.1	0.7	0.3	ND	ND	1.4	2.1
Sample n	197	295	168	727	613	1,004	984	1,006	288	1,989	1,512	2,767	565

[a] Only a portion of the available samples have been aged from the 1998 and 1999 commercial fisheries and the 1999 survey.

Table 6. Sport and personal use effort directed at hardshell clams and harvests of clams in Kachemak Bay reported on permits 1996-98.

		Effort		Harvest		
Clam reporting area	1997	(trips	(digger days)	Littleneck clams (gallons)	Butter Clams (gallons)	Othe Clam (gallons
Chugachik Island Area (Area F)		15	33	17	14	
Bear Cove(Area G)		97	199	237	77	
Aurora Lagoon to Glacier Spit (Area H)		11	24	71	18	
Halibut Cover Area (Area J)		123	256	208	230	2
Peterson Bay (Area K)		71	121	106	38	
China Poot Bay (Area L)		208	415	431	399	2
Neptune Bay (Area M)		2	3	2	1	
Sadie Cove Area (Area N)		243	458	594	372	1
Tutka Bay (Area P)		90	139	157	101	
Little Tutka Bay to Barabara Point (Area Q)		252	429	479	571	1
Barabara Point to Pt. Pogibshi (Area R)		3	13	2	12	
Pt. Pogibshi to Pt. Adam (Area S)		2	3	2	20	
North side of Kachemak Bay (Area T)		366	725	599	516	36
Unknown		99	171	122	160	3
TOTAL		1,582	2,989	3,027	2,529	49

		Effort		Harvest		
Clam reporting area	1998	(trips	(digger days)	Littleneck clams (gallons)	Butter Clams (gallons)	Othe Clam (gallons
Chugachik Island Area (Area F)		13	24	25	4	
Bear Cove (Area G)		88	124	373	13	1
Aurora Lagoon to Glacier Spit (Area H)		3	5	8	10	
Halibut Cover Area (Area J)		46	93	101	43	2
Peterson Bay (Area K)		37	56	132	4	
China Poot Bay (Area L)		78	126	285	83	
Neptune Bay (Area M)		1	1	0	0	
Sadie Cove Area (Area N)		167	260	544	81	5
Tutka Bay (Area P)		45	93	73	16	1
Little Tutka Bay to Barabara Point (Area Q)		119	239	326	14	3
Barabara Point to Pt. Pogibshi (Area R)		5	11	46	0	
Pt. Pogibshi to Pt. Adam (Area S)		1	1	0	0	
North side of Kachemak Bay (Area T)		91	152	207	49	2
Unknown		68	113	164	48	2
TOTAL		2,032	1,298	2,284	365	19

Table 7. Survey effort and design with resultant density, abundance, and biomass of littleneck clams at commercially harvested beaches in Kachemak Bay, 1992-99.

	Survey Effort and			Clam Density (clams/m$^{2)}$			Clam Abundance (clams x 1,000)						Clam Biomass (lb x 1,000)		
	No. of	No. of	Survey												
Year	Sites	Quad.	Design	Legal	Sublegal	Total	Legal	95% ci	Sublegal	95% ci	Total	95% ci	Legal	Sublegal	Total
SUBDISTRICT 1															
							Chugachik Island								
1992	1	12	Rand.	67.2	50.4	117.6	4,124	1,422	3,083	1,862	7,207	3,284	249.9	51.6	301.5
1993	1	16	Rand.	41.0	48.8	89.8	2,511	739	2,986	1,182	5,497	1,921	166.0	61.8	227.8
1994	1	33	Rand.	36.4	42.8	79.2	2,227	642	2,628	1,183	4,855	1,825	131.5	48.6	180.1
1995	1	35	Rand.	33.8	19.4	53.2	2,072	559	1,190	462	3,262	1,021	126.0	21.5	147.5
1996	1	33	Rand.	63.3	25.0	88.3	3,876	473	1,529	1,413	5,405	1,886	225.7	29.6	255.3
1997	1	40	Rand.	60.2	22.4	82.6	3,687	851	1,372	534	5,059	1,385	196.6	24.2	220.7
1998	1	49	Rand.	49.5	11.1	60.6	3,030	842	680	237	3,710	1,079	170.2	14.5	184.7
1999	1	52	Rand.	42.0	8.8	50.8	2,573	718	542	196	3,115	914	141.1	10.6	151.7
Mean		33.8		49.2	28.6	77.8	3,013		1,751		4,764		175.9	32.8	208.7
SUBDISTRICT 2															
							Ismailof Island								
1994	1	8	Syst.	77.6	96.4	174.0	144	110	180	149	324	259	7.0	3.5	10.5
1996	1	16	Syst.	104.5	68.3	172.8	188	129	134	141	322	270	7.7	2.6	10.3
1997	1	32	Syst.	59.5	18.5	78.0	112	39	34	13	146	52	5.1	0.6	5.7
1998	1	33	Syst.	71.0	48	119.0	109	21	69	23	178	44	5.0	1.1	6.1
1999	1	27	Syst.	50.1	33.2	84.2	77	28	46	29	123	57	3.7	0.7	4.4
Mean		23.2		72.5	52.9	125.6	126.0		92.6		218.6		5.7	1.7	7.4
SUBDISTRICT 3a															
							Sadie Cove - East Shore								
1999	12	270	Syst.	11.2	8.0	19.2	1,763	1,366	1,017	158	2,780	1,524	136.0	17.0	153.0

-continued-

Table 7. Continued.

Year	Survey Effort and No. of Sites	No. of Quad.	Surve Desig	Clam Density (clams/$m^{2)}$ Legal	Sublegal	Total	Clam Abundance (clams x 1,000) Legal	95% ci	Sublegal	95% ci	Total	95% ci	Clam Biomass (lb x 1,000) Legal	Sublegal	Total
SUBDISTRICT 3b															
							Sadie Cove - West Shore								
1998	6	117	Syst.	14.7	12.8	27.5	1,777	930	1,606	849	3,383	1,779	118.0	27.0	145.0
							Tutka Bay - West Shore								
1999	17	264	Syst.	8.7	11.6	20.3	2,816	1,845	3,114	1,967	5,930	3,812	158.0	38.0	196.0
SUBDISTRICT 4															
							Jakalof Bay								
1992	6	42	Syst.	22.1	2.2	24.3	4,538	1,965	856	479	5,394	2,444	320.0	16.0	336.0
1993	11	53	Syst.	26.2	10.4	36.6	5,229	2,066	2,698	1,797	7,927	3,863	310.0	44.0	354.0
1998	7	187	Syst.	19.7	3.5	23.2	5,862	1,157	1,157	446	7,019	1,603	384.0	24.0	408.0
Mean	8.0	94.0		22.7	5.4	28.0	5,210	1,729	1,570	907	6,780	2,637	338.0	28.0	366.0

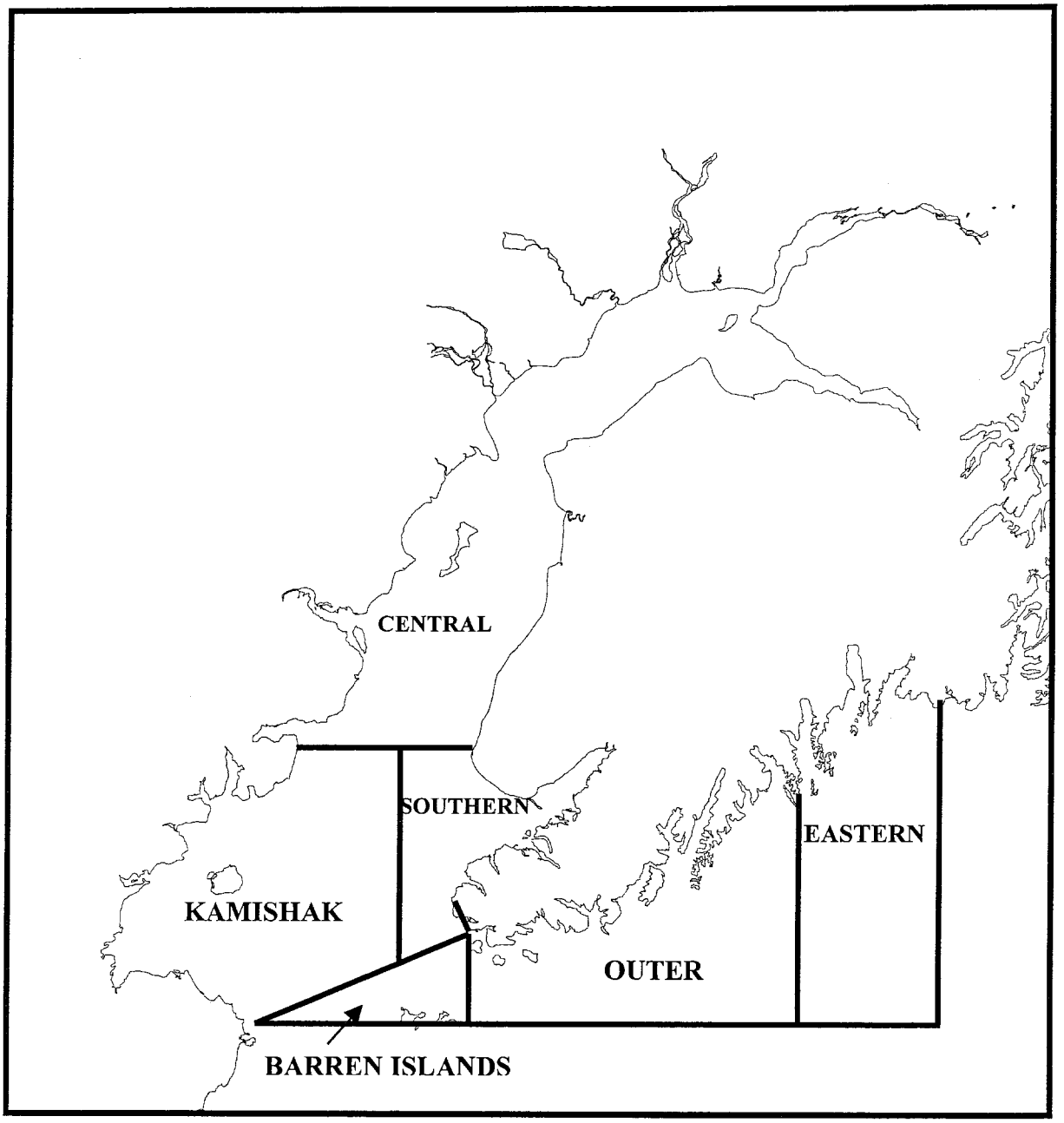

Figure 1. Cook Inlet Area shellfish management districts in 2000.

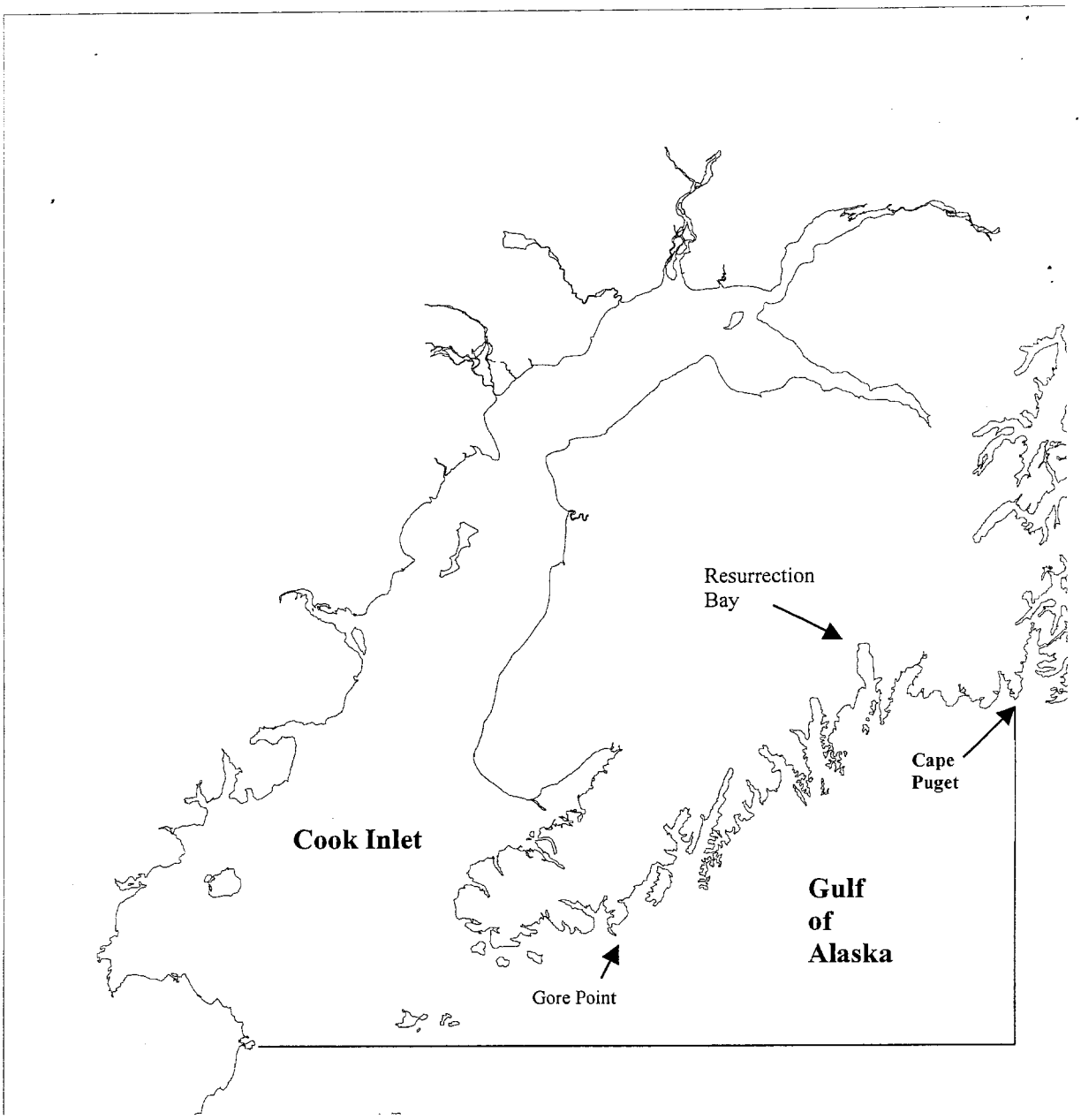

Figure 2. Cook Inlet/Resurrection Bay sport and personal use management areas.

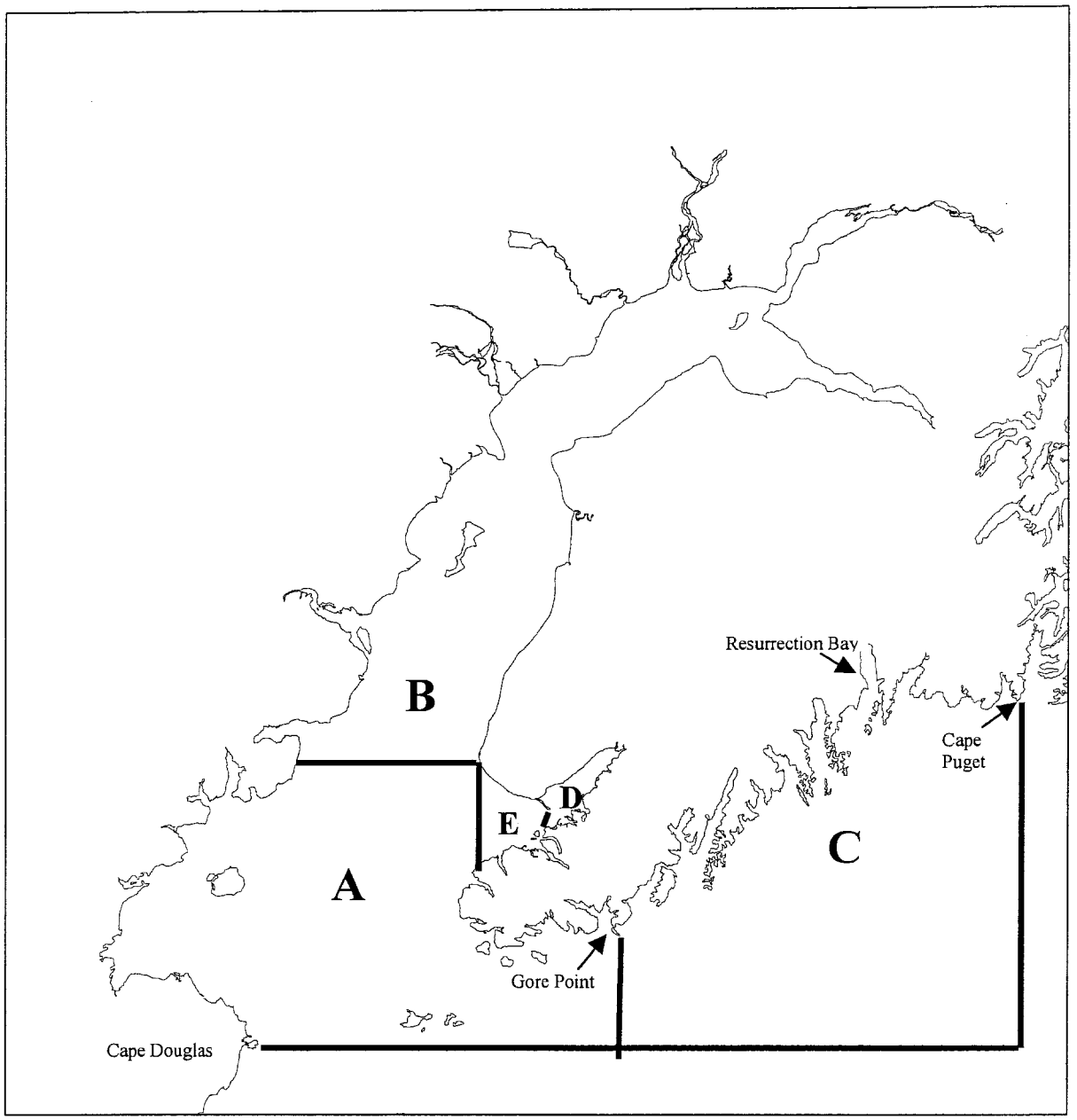

Figure 3. Sport and personal use crab harvest reporting areas for Cook Inlet.

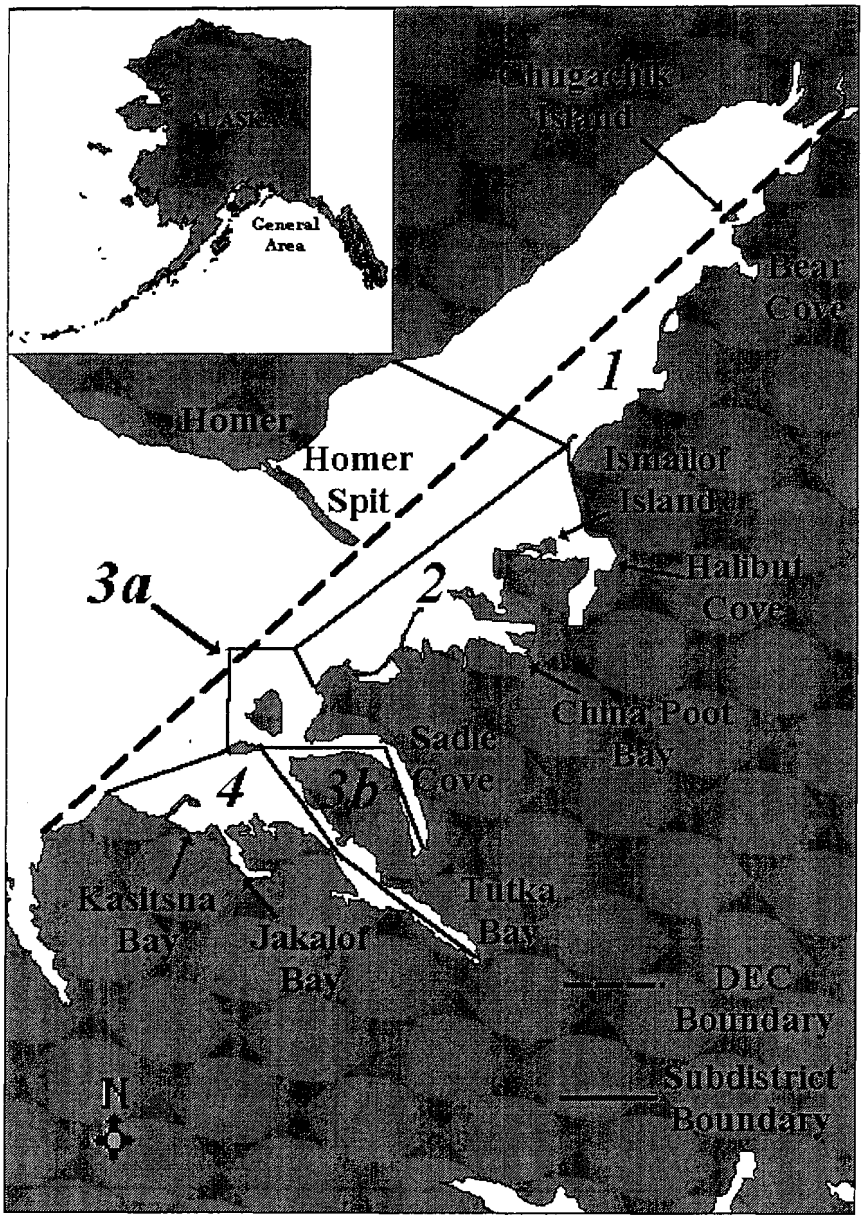

Figure 4. Commercial hardshell claming subdistricts in Kachemak Bay.

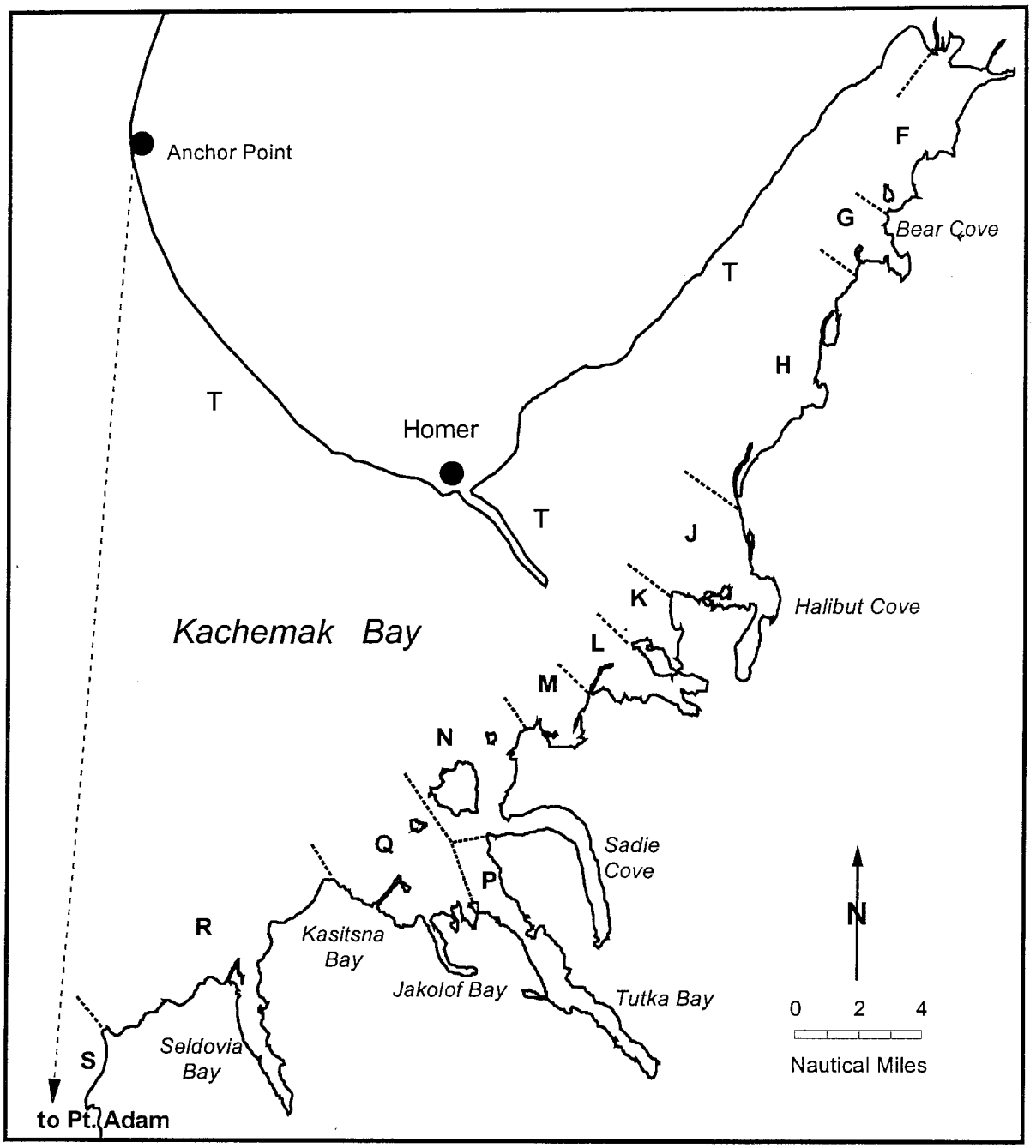

Figure 5. Sport and personal use reporting areas for hardshell clam harvests in Kachemak Bay.

Appendix A. Dungeness crab catch (pounds) by year, Cook Inlet Management Area, 1961 - 1999.

Year	Southern District catch	Other District catch	Total catch	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	Season	0	0	0	0
1992	Season	7,108	7,108	1	1
1993	Season	9,652	9,652	1	36
1994	Season	Confidential[a]	Confidential		
1995	Season	Confidential	Confidential	1	
1996	Season	Confidential	Confidential	1	
1997		SEASON CLOSED BY REGULATION			
1998		SEASON CLOSED BY REGULATION			
1999		SEASON CLOSED BY REGULATION			

Note: Average catch 1978-1990 = 1.01 million pounds per year.
a/ Two or less participants.

Appendix B. Shrimp catches (pounds) from the Kachemak Bay trawl shrimp fishery in the Cook Inlet Area, 1969-1999.

Season	Number of vessels	Catch			Total
		Jun 1 – Oct 31	Nov 1 – Mar 31	Apr 1 – May 31	
1969-70 [a]	7	1,289,656	1,692,854	889,330	3,871,840
1970-71 [a]	3	3,211,924	2,076,228	617,836	5,905,988
1971-72 [a]	7	2,618,630	1,761,569	140,707	4,520,906
1972-73 [a]	10	2,772,422	2,109,660		4,882,082
1973-74 [b]	13	2,502,154	2,323,780		4,825,934
1974-75	4	2,512,764	2,519,148		5,031,912
1975-76	4	1,997,563	2,421,456		4,419,019
1976-77	5	2,545,885	2,453,101		4,998,986
1977-78	7	2,490,969	2,546,977		5,037,946
1978-79	6	2,952,733	3,060,066		6,012,799
		Jul 1 – Sep 30	Oct 1 Dec 31	Jan 1 – Mar 31	
1979-80	7	2,013,298	2,052,646	1,731,483	5,797,427
1980-81	15	1,780,677	2,691,746	1,704,706	6,177,129
1981-82	23	1,614,868	1,686,781	1,693,850	4,995,499
1982-83	15	998,522	1,012,388	1,009,857	3,020,767
1983-84	10	CLOSED	CLOSED	525,508	525,508
1984-85	10	519,651	528,506	518,529	1,566,686
1985-86	5	488,606	257,782	503,340	1,249,728
1986-87	3	504,206	CLOSED	CLOSED	504,206
1987-88	0	CLOSED	CLOSED	CLOSED	0
1988-89	0	CLOSED	CLOSED	CLOSED	0
1989-90	0	CLOSED	CLOSED	CLOSED	0
1990-91	0	CLOSED	CLOSED	CLOSED	0
1991-92	0	CLOSED	CLOSED	CLOSED	0
1992-93	0	CLOSED	CLOSED	CLOSED	0
1993-94	0	CLOSED	CLOSED	CLOSED	0
1994-95	0	CLOSED	CLOSED	CLOSED	0
1995-96	0	CLOSED	CLOSED	CLOSED	0
1996-97	0	CLOSED	CLOSED	CLOSED	0
1997-98	0	CLOSED BY REGULATION			0
1998-99	0	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 respecitive guidelines established.

Appendix C. Trawl shrimp catches (pounds) in Outer Cook Inlet (Area G), 1977 - 1999.

Season	Number of Vessels	Catch[a]
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 [b]	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	CONFIDENTIAL
1996-97	1	CONFIDENTIAL
1997-98	CLOSED BY REGULATION	
1998-99	CLOSED BY REGULATION	

a/ Catches from 1982-1987 were predominantly pink shrimp. Catches from 1991-1996 were mostly sidestripes.

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

Appendix D. Shrimp pot harvest (pounds) Cook Inlet Management Area (Area H), 1970-1999.

Season	Number of vessels		Jun 1-Sep 30	Oct 1-May 31	Total
1970-71			3,606	7,602	11,208
1971-72			8,836	70,601	79,437
1972-73			75,247	184,230	259,477
1973-74			63,181	738,165	801,346
1974-75			43,650	126,472	170,122
1975-76			100,765	273,758	374,523
1976-77	26		52,115	199,559	251,674
1977-78	51		85,511	511,938	597,449
1978-79	41		49,080	121,234	170,314
1979-80	49		59,963	177,927	237,890
		Jun 1-Sep 15	Nov 1-Dec 21	Feb 1-Mar 31	
1980-81	30	74,368	134,275	104,716	313,359
1981-82	45	56,092	47,859	49,885	153,836
1982-83	40	54,153	49,130	52,339	155,622
1983-84	15	21,438	CLOSED	CLOSED	21,438
1984-85	22	25,874	28,151	22,080	76,105
		Jun 1-Sep 15	Oct 1-Dec 31	Feb 1-Mar 31	
1985-86	25	27,312	20,737	24,048	72,097
1986-87	37	24,844	20,188	30,257	75,289
1987-88	30	26,216	5,416	CLOSED	31,632
1988-89	9	5,323	CLOSED	CLOSED	5,323
1989-90		CLOSED	CLOSED	CLOSED	0
1990-91		CLOSED	CLOSED	CLOSED	0
1991-92		CLOSED	CLOSED	CLOSED	0
1992-93		CLOSED	CLOSED	CLOSED	0
1993-94		CLOSED	CLOSED	CLOSED	0
1994-95		CLOSED	CLOSED	CLOSED	0
1995-96		CLOSED	CLOSED	CLOSED	0
1996-97		CLOSED	CLOSED	CLOSED	0
1997-98		ALL AREAS CLOSED BY REGULATION			
1998-99		ALL AREAS CLOSED BY REGULATION			

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

Appendix E. Shrimp pot catch (pounds) and effort in Outer Cook Inlet (Area G), 1977-1999.

Season	Number of vessels	Catch
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		CLOSED BY REGULATION
1998		CLOSED BY REGULATION
1999		CLOSED BY REGULATION

a/ Season closed from April 30 through July 7 due to Exxon Valdez oil spill.

Appendix F. Pacific weathervane scallop catches, Cook Inlet Management Area, 1983-1999.

Year	District	Number of vessels	Catch in pounds of shucked meats
1983	Kamishak	1	2,346
1984	Kamishak	3	6,305
1985 [a]	Kamishak	1	11,810
1986	Kamishak	3	15,364
1987	Outer	1	1,128
	Kamishak[b]	2	360
	'87 Total	2	1,488
1988		NO EFFORT	
1989		NO EFFORT	
1990		NO EFFORT	
1991		NO EFFORT	
1992		NO EFFORT	0
1993	Kamishak	3	20,115
1994	Kamishak	4	20,431
1995 [c]	Kamishak	0	0
1996	Kamishak	5	28,228
1997	Kamishak	3	20,336
1998	Kamishak	1	CONFIDENTIAL
1999	Kamishak	3	20,312

[a]/ Season and harvest guideline set by regulation.
[b]/ Season closed by emergency order on August 21, 1987, one week after opening due to low catch per unit of effort.
[c]/ Only state waters open.

Appendix G. Harvest (pounds) of hardshell clams, Cook Inlet Management Area, 1986-1999.

Year	Number of permits	Number of landings	Pacific 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	14,449	0	0	14,449
1989	9	41	2,584	13,675a	3,581b	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	17	18,530	0	0	18,530

[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 H. Harvest (pounds) of blue mussels, Cook Inlet Management Area, 1986-1999.

Year	Number of permits	Number of landings	Total
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	0	0	

[A]/ Includes 165,268 lb sold as otter food as a result of the Exxon Valdez oil spill.

Appendix I. Octopus harvest (pounds) in the Cook Inlet Management Area (H) 1983-1999.

Year	Number of vessels	Number of landings	Total
1983	41	101	32,841[a]
1984	36	77	46,698[a]
1985	40	70	48,067[a]
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	13	190	27,667
1998	9	96	12,914
1999	9	127	21,846

[a]/ Bycatch from shellfish pot fisheries.
[b]/ Directed fishery catch and effort only.

Appendix J. Green sea urchin harvest (pounds), Cook Inlet Management Area, 1987-1999.

Year	Number of divers	Total
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		CLOSED BY REGULATION
1998		CLOSED BY REGULATION
1999		CLOSED BY REGULATION

Appendix K. Sea cucumber catch (pounds) by permit season, Cook Inlet Management Area, 1990-1999.

Permit season	No. divers	No. landings	Total
1990	2	14	22,525
1991			NO CATCH[b]
1992			NO CATCH[b]
1993-94[a]	16	40	30,940
1994-95[a]	22	93	26,575
1995-96[a]			NO CATCH[b]
1996-97[a]	3	6	1,528
1997-98		CLOSED BY REGULATION	
1998-99		CLOSED BY REGULATION	

[a]/ Permit season established 10/1 – 4/30.
[b]/ Divers did not find commercial quantities of sea cucumbers.