

The Sea Urchin and Sea Cucumber Fisheries  
in the Westward Region:

Report to the Alaska Board of Fisheries

by

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## INTRODUCTION

Sea urchins and sea cucumbers belong to the Phylum Echinodermata which also includes such familiar marine invertebrates as starfish and sand dollars. Echinoderms, particularly sea urchins and sea cucumbers, have been harvested for thousands of years from many nearshore temperate and tropical waters. These are generally small-scale fisheries with inaccurate or unreported landings. Annual world-wide landings are now estimated to be approximately 176 million pounds (Conand and Sloan 1989). In the Westward Region, echinoderm harvests have consisted of the green sea urchin *Strongylocentrotus droebachiensis* and the red sea cucumber *Parastichopus californicus*. In recent years harvests have averaged 37,000 pounds for sea urchins and 146,000 pounds for sea cucumbers

Despite their relatively minor size, these dive fisheries provide welcome economic activity in the late fall and winter. Sea urchins are harvested for their roe which is known as uni. Sea cucumbers are harvested for their muscle strips and body wall. The dried body is sometimes known as trepang or bêche-de-mer (Conand and Byrne 1993).

The phylum is entirely marine, mostly bottom dwelling, and is characterized by pentamerous radial symmetry--that is, the body can usually be divided into five parts arranged around a central axis. A peculiar feature of the echinoderms is their water vascular system which is used to extend or withdraw the echinoderm tube feet, allowing for locomotion or feeding. Sea urchins and sea cucumbers reproduce through broadcast spawning. An aggregate of both sexes forms and there is a synchronized release of the gametes. Fertilization is followed by a free-swimming larval period. The individuals then settle on the bottom and metamorphose to their adult shape (Barnes 1987).

## SEA URCHIN FISHERY

### *Biological Background*

Green sea urchins have a circumpolar range and are found over a considerable range of latitudes. They occur from the intertidal zone down to depths of at least 425 feet but are especially abundant down to 40 feet (Barr and Barr 1983). The growth rate of the Kodiak green sea urchin is one of the highest reported. Kodiak green sea urchins reach maturity in two or three years at a size of roughly one inch in diameter inside the spines (Munk 1992). Green sea urchins feed largely on kelp and through intense grazing can turn a kelp forest into relatively barren ground (Breen and Mann 1976, Himmelman et al 1983). Young sea urchins on these barren grounds have been shown to have virtually no growth from year to year (Himmelman 1986). In addition to kelp, green sea urchins eat mussels, barnacles, snails, and dead fish (Himmelman 1971). Divers have reported spawned out pink salmon being entirely covered with feeding sea urchins. In the laboratory they have also exhibited cannibalism. Besides man, green sea urchins have a variety of predators including sea otters, ravens, common eiders, herring gulls, sculpins, plaice, flounders, crabs and lobsters.

Sea urchins are harvested for their roe which varies seasonally both in quality and as a percentage of body weight. Generally the gonads begin filling in early summer and continue filling until mid- to late winter when the spawning period begins. Immediately before spawning the roe becomes "over mature", soft and of lesser quality, making them uneconomical to purchase (Jack McMann, personal comm.). Figure 1 shows the seasonal relationship between gonad growth and ripeness in male and female sea urchins.

Green sea urchin sampling in Kodiak (Munk 1992, Figure 2) and in Newfoundland and British Columbia, Canada (Himmelman 1978, Keats et al 1984) all showed considerable variation in both the onset and duration of the spawning period. A Kodiak study conducted from 1985 to 1988 found the duration of spawning varied from 3 weeks to almost 10 weeks. The onset varied from March to May (Munk 1992). Samples collected mid-way through the spawning period contain a mix of sea urchins in various stages of spawn-out. The prime period for harvest in the Kodiak area seems to be between October and January. Industry in Kodiak reported a load of sea urchins being of marginal quality as early as January 28 while some sea urchin beds can be of prime quality in mid-February or later.

Besides the spawning cycle, roe quality and quantity has been found to be affected by diet, the influence of freshwater, and the age of the sea urchin (Keats et al 1984, Himmelman et al 1983). Industry has reported "old" sea urchins to have unacceptable brown-colored roe.

### *Stock Status and Management Strategy*

No assessment work is currently being done in the Westward Region. Fishery information indicates the resource biomass is not large when compared to other areas on the Pacific coast and when compared to a world-wide sea urchin harvest estimated at 100 million pounds (Conand and Sloan 1989). The 1994/1995 harvest for the state of Maine reached 41 million pounds and the 1997 quota for Southeast Alaska is set at 4.6 million pounds. Although the Westward Region is a very small player in this fishery, in recent years Kodiak green sea urchins have had a reputation for high quality.

Fishermen participate under the terms of a miscellaneous shellfish permit as authorized in 5 AAC 38.062. Sea urchins are fragile creatures and the terms of the permit are designed to limit handling of the resource and optimize the period of harvest. Currently the fishing period in the Region is set at October 1 to January 31. While marketable roe may be available in February and later, it is felt that after January, the potential is high for increased sorting and handling mortality of unmarketable sea urchins. ADF&G in Dutch Harbor has issued special exploratory permits during the summer and early fall to check the quality of the roe but divers have found little marketable product during these periods.

A previous Board of Fisheries action limited the fishermen to hand picking with dive gear only. It was felt that pot gear and rakes would result in unacceptable handling of unmarketable sea urchins. Enforcement concerns were also raised for pot gear. The prime sea urchin season coincided with the historical Tanner crab fishery and it was feared that under the guise of sea urchin pot fishing, fishermen could prospect for Tanner crab. Size limits are currently set by the market. Buyers will only purchase sea urchins 2 or 2 ¼ inches or greater in diameter.

### *Historic Harvest of Green Sea Urchins*

The green sea urchin *Strongylocentrotus droebachiensis* was not harvested commercially in the Westward Region until 1980 when a small amount was taken in the Kodiak area to test marketability. There was little further interest in sea urchins in Kodiak until 1985 when a small harvest occurred. In 1986 the harvest increased with more divers participating (Table 1). Peak harvest occurred in 1988 at 190,500 pounds. In recent years the Kodiak harvest has been in the 30-40 thousand pound range. There have been very limited green sea urchin harvests in the Dutch Harbor area during the years 1985, 1986, and 1996 but the poundage remains confidential. Green sea urchins are shipped live to Japan for processing.

### *1996 Sea Urchin Fishery*

Interest in harvesting sea urchins remained roughly at 1995 levels. Seven divers participated landing 36,147 pounds. During 1996, activity in the fishery occurred during two periods. In January and February, several divers continued with the season which started on October 1, 1995 and continued until registrations expired on February 15, 1996. Although the Department would have issued permits beginning October 1, there was little activity in the sea urchin fishery until the close of the sea cucumber fishery. Landings began in mid-November and continued through the end of the year. Five divers re-registered to continue diving until the end of the registration period on January 31, 1997 making nine landings, but the poundage landed in January remains confidential.

## **SEA CUCUMBER FISHERY**

### *Biological Background*

The red sea cucumber ranges along the west coast of North America from Baja to the Gulf of Alaska. The western edge of the range has not been exactly determined. The farthest west reported landing of *P. californicus* comes from Kuiu Bay near Chignik with observations reported as far west as the Shumagin Islands. The species has been reported from intertidal waters to a depth of 820 feet off Kodiak Island (Cameron and Fankboner 1989, Lambert 1986). *P. californicus* mature at ages 4-8 in British Columbia, reaching an estimated maximum age in southeast Alaska of 14 years (Cameron and Fankboner 1988, Imamura and Kruse 1990). Sea cucumbers are deposit feeders who sweep the bottom with their feeding tentacles. The tentacles are covered with an adhesive secretion which picks up sediments and organic particles. The tentacles are then inserted into the cucumber mouth and wiped clean (Barnes 1987). Adult sea cucumbers are reported to be eaten by kelp greenling (Bingham 1986), and the juveniles by starfish and occasionally by hermit crabs (Cameron and Fankboner 1988).

*P. californicus* has a reproductive cycle similar to the green sea urchin with the spawning aggregates forming in late spring and summer, although the exact timing of the spawning event appears protracted and variable from year to year (Imamura and Kruse 1990, McEuen 1988). Diver reports and logbooks indicate that the spawning period for the sea cucumber in Kodiak waters takes place from May to August.

### *Historical Harvest of Sea Cucumbers*

Sea cucumbers were not harvested commercially in the Westward Region until 1991. In 1991 and 1992 processors recruited divers to gather small numbers of *P. californicus* in the Kodiak and Chignik areas to test marketability. In spring 1993, several processors recruited divers to commercially pick sea cucumbers in the Kodiak and Chignik areas. The fishery was allowed to develop under the terms of a permit authorized by 5 AAC 38.062. The Department specified dive gear as the only legal gear and required dive logs (Figure 3) to be submitted with fish tickets. Each diver was required to have a CFEC permit card. Harvests were monitored to determine abundance and distribution. As the harvest reached levels where department felt there was a potential for overfishing, the various fishing areas were closed.

The Department announced in February of 1994 several management measures intended to prevent the overharvest of the resource. A seasonal closure from May 1 through September 30 was established to protect the spawning aggregates of cucumbers. In addition, guideline harvest levels (GHLs) were established for the Kodiak and Chignik Districts. A total of 200,000 pounds was announced for Kodiak with the Chignik GHL set at 50,000 pounds. Management areas based on the Tanner crab fishing sections were utilized in Kodiak in an effort to spread the harvest around the island and prevent localized depletions (Figure 4). A GHL was set for each of the individual areas based on historic production and fisheries performance. Other Districts in the Westward Region would remain open without established guideline harvest levels. Registration permit provisions included a weekly fishing period of 5 days and daily dive logs submitted by the divers with their fish tickets. The next open fishing period would extend from April 1 - 30, 1994.

Eighty divers registered to fish during the April opening. Preseason GHL's were attained or exceeded in the Northeast, Eastside, Southeast, and Westside Sections by the close of the first 5 day fishing period. The Southwest Section was allowed to reopen for an additional 3 day period. Some exploratory effort occurred in the Chignik and South Peninsula Districts after the Kodiak District closed but little evidence of marketable quantities of sea cucumbers was found.

Following the May 1 to September 30 closure, the Department reopened the Westward Region to sea cucumber fishing. Guideline harvests for the Kodiak and Chignik Districts totaled 225,000 pounds with 3 day weekly fishing periods. The shortened fishing periods were set to allow the Department a better opportunity to assess inseason fishery performance. Twenty-five divers registered to fish at the start of the fishery. The Southeast, Southwest and Eastside Sections all reached their GHL's in October and were closed. By mid-November inclement weather had stifled any further fishing activity for the year although there were harvest areas left open. The number of active divers dwindled to about six and they shifted into sea urchin production. The harvest in 1994 with the spring and fall fisheries combined totaled 413,576 pounds taken by 86 divers.

The 1995/1996 sea cucumber fishing season opened on October 1, 1995. Evaluation of another year of fishery performance resulted in a decreased guideline harvest level. The GHL for the Kodiak and Chignik Districts totaled 160,000 pounds. Effort once again concentrated on the Eastside, Southeast, Southwest and Westside Sections of Kodiak. Those areas remained open for 4, 6, 9, and 10 days of fishing respectively. Once again, although outlying areas remained open to fish along the Alaska Peninsula, divers were reluctant to cross the Shelikof Strait in the face of

stormy weather and the expectation of marginal returns. There were no further reported landings before the end of the season in April 1996. The harvest for the October 1995 fishing period was 138,721 pounds taken by 19 divers at the ex-vessel value of \$1.25 per pound bringing the total for the year to 147,843 pounds.

### *1996/1997 Fishery*

The 1996/1997 fishery opened on October 1, 1996 with guideline harvest levels the same as the previous season. Terms of the permit were also similar with three day fishing periods Tuesday through Thursday followed by a closed period from Friday to Monday to allow the Department the opportunity to assess the fishery performance and announce any area closures. As in previous fisheries, dive gear was specified as the only legal gear and dive logs were required.

During the first fishing period, October 1-3, 23 divers participated with most of the effort concentrated in the Eastside and Southeast Sections. Ten divers in the Southeast Section harvested 29,072 pounds, well over the 20,000 pound GHF, so it was announced that this section would not reopen during the next fishing period. The second fishing period, October 8-10, 31 divers made landings. The Eastside Section harvest reached 52,679 pounds. This harvest exceeded the preseason harvest level of 40,000 pounds. In addition, the Southwest Section harvest of 19,635 approached the 20,000 GHF so it was decided to close both of these sections to further fishing. During the third and fourth periods, 19 and 8 divers participated respectively, mostly diving in the Westside Section but no further closures were announced.

Following the fifth period, October 29-31, closures of the Northeast and Westside Sections were announced. These were the final two Sections open in waters adjacent to Kodiak Island. As in previous years, inclement weather convinced the divers to switch to the sea urchin fishery. No further landings were recorded for 1996. As of February 1997, no divers had registered to fish for cucumbers in the remainder of the 1996/1997 season. The total harvest landed in October and November 1996 totaled 147,843 pounds from 31 divers. A small harvest came from the Chignik District, but the total remains confidential.

### **MANAGEMENT CONSIDERATIONS FOR SEA CUCUMBERS AND SEA URCHINS**

Sea cucumbers and sea urchins have many life history parameters which characterize a species that is particularly vulnerable to overfishing (Adams 1980, Imamura and Kruse 1990). In addition, once an area is depleted, the low mobility of these species and the indication that larvae may prefer to settle in areas where adults are present (Imamura and Kruse, 1990, Barnes 1987) means that local stock depletions will persist for extended periods. Given vulnerability to overfishing, likelihood of poor recruitment into depleted areas, and the non-surveyed status of these stocks, a conservative approach to the management is mandated in order to insure the health of the fisheries.

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Table 1. Historic harvest of sea urchins in the Kodiak area, 1980-1996.

Year	Number of Permits	Number of landings	Pounds Harvested	Average Price per pound
1980		Confidential		
1985		Confidential		
1986		Confidential		
1987	12		104,139	.69
1988	28		190,509	.80
1989	29		44,862	.82
1990	25		84,004	.84
1991	6		29,947	.92
1992		Confidential		
1993		Confidential		
1994		Confidential		
1995	8	50	38,437	1.34
1996	7	31	36,147	1.10

Table 2. Historic harvest of sea cucumbers in the Kodiak and Chignik Districts, 1991-1996.

Year	Number of Permits	Number of landings	Pounds Harvested	Average Price per pound
1991		Confidential		
1992		Confidential		
1993	50	487	564,516	.93
1994	86	269	413,576	1.20
1995	21	60	145,092	1.25
1996 <sup>a</sup>	31	93	147,843	1.25

<sup>a</sup>Excluding the Chignik District.

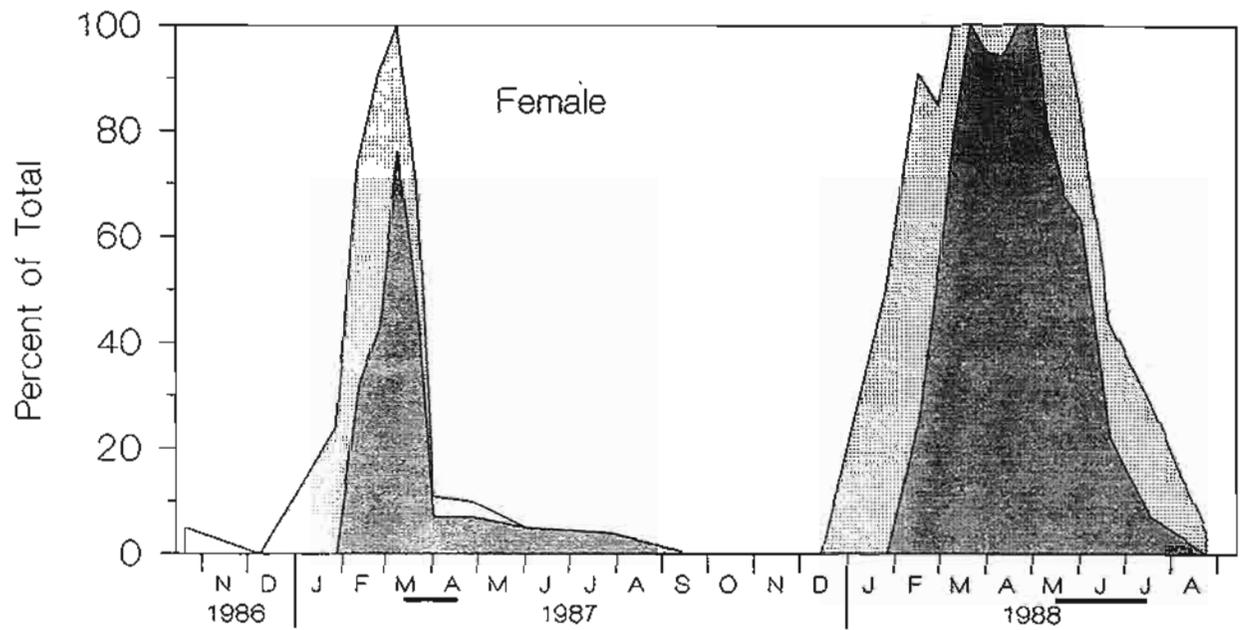
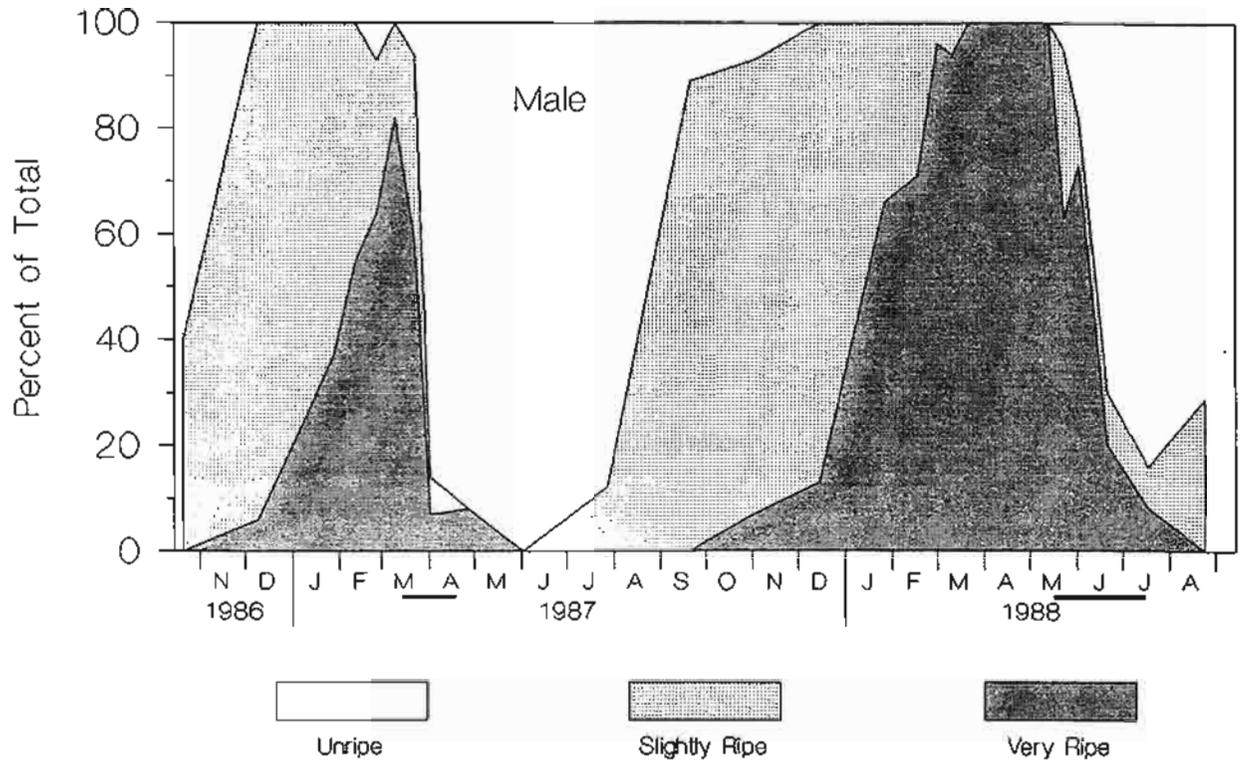


Figure 1. Seasonal ripeness of green sea urchin gonads. Sample sizes per collection averaged 16.9 and 21.5 for males and females, respectively (from Munk, 1992).

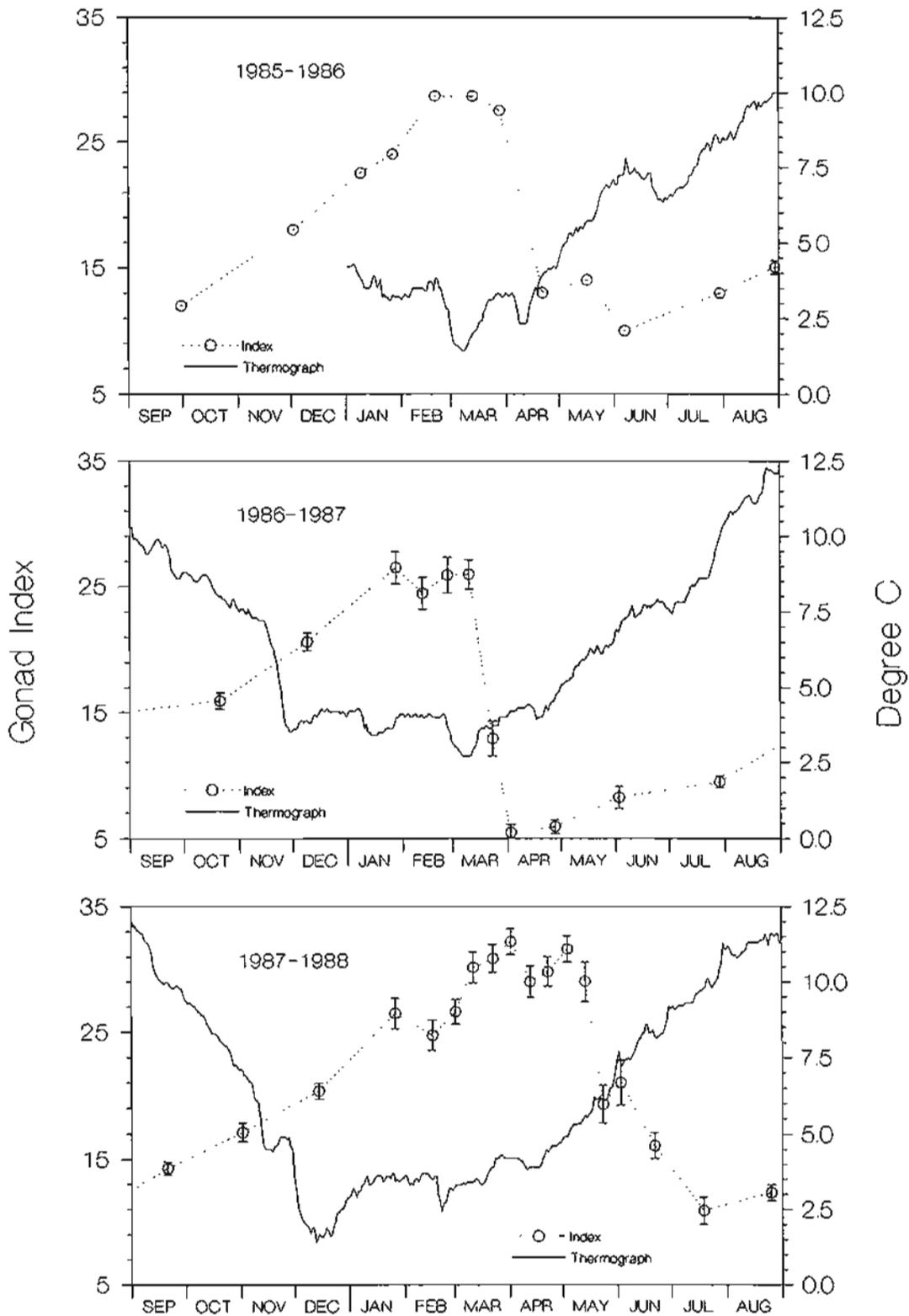


Figure 2. Seasonal gonad index (gonad weight divided by total weight) of green sea urchins from Kodiak, Alaska. Temperatures are daily mean at a depth of 8 meters (from Munk, 1992).

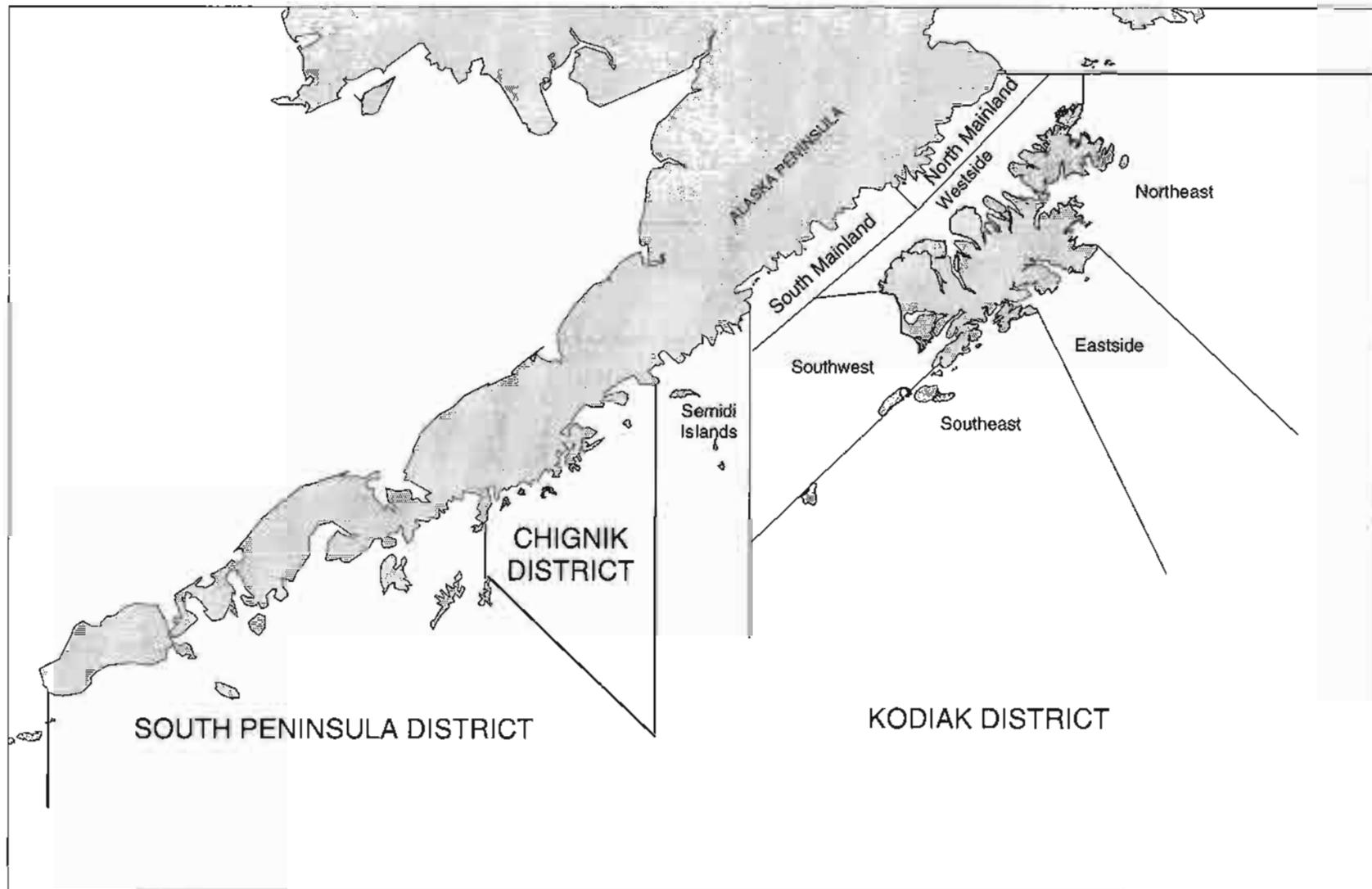


Figure 4. Commercial Tanner crab management Districts and Sections used to manage sea cucumbers in the Westward Region.

STATE OF ALASKA DEPARTMENT OF FISH AND GAME							FOR OFFICE USE ONLY
COMMERCIAL DIVE LOG							FISH TICKET NUMBER
Permit Holder _____ Permit Number _____			ADF&G No. _____ Vessel Name _____		Species <input type="checkbox"/> Sea urchins of <input type="checkbox"/> Sea Cucumbers Harvest <input type="checkbox"/> _____ Other		
#	DATE MM/DD/YY	Harvest Location Bay, Distance to Landmark(, Etc.)	Stat Area	Qty. of Harvest	Min/Max Depth in Feet	Bottom Time in Minutes	Remarks (Optional) Fishing Conditions , Etc
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
X			For Office Use Only				STATE COPY
Signature of Permit/License Holder			Total Lbs. From Fish Ticket				

Figure 3. Example of the dive log used for sea cucumbers and sea urchins in the Westward Region.

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