SCALLOP RESOURCE ASSESSMENT

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by

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ABSTRACT

Results of a November 1981 cooperative research cruise off the Oregon coast aboard the National Marine Fisheries Service vessel the R/V Chapman indicated that weathervane scallops (*Pecten* [*Patinopecten*] *caurinus*) off Coos Bay, Oregon had significantly different ($P \leq 0.05$) population characteristics than scallops off Tillamook Head, Oregon.

One strong year-class dominated the Coos Bay beds whereas recruitment was more uniform off Tillamook Head. Scallops in the Coos Bay area were younger and larger than scallops in the Tillamook area. Coos Bay scallop mean age was 5.7 ± 1.5 yrs and mean height was 119.9 ± 10.0mm. Tillamook scallops were 6.8 ± 1.8 yrs old with a mean height of 109.0 ± 7.7mm.

Relative abundance of scallops was greatest in 45-60 fm in both areas. Population characteristics of males and females were not significantly different ($P > 0.05$) and all scallops were dioecious. Miscellaneous invertebrates and small fish comprised almost 50% of the total weight of the incidental catch.

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INTRODUCTION

Surveys performed by the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) in 1963 and 1967 identified two areas containing weathervane scallops (*Pecten* [*Patinopecten*] *caurinus*) in commercially harvestable quantities. Although groundfish and shrimp trawlers had incidental catches of scallops, few Oregon boats had attempted to fish for scallops prior to the 1963 survey. Several subsequent attempts to target on scallops (the most recent being 1979) failed to produce a viable fishery because of small catches and lack of interest from processors.

In late April, 1981, two 29m (94 ft) vessels enroute to Alaska scallop grounds fished off Coos Bay, Oregon and landed large quantities of scallop meats. In the first 11 fishing days, the two boats landed 19,846 lbs of shucked meats and received a price of $5.00 per lb. With these large landings it was readily apparent that scallop concentrations were much greater than the 1963 or 1967 surveys revealed, and boats rapidly entered the fishery. By the ninth week of the new fishery 69 vessels had landed 7,488,737 lbs (round wt).

Faced with a rapidly expanding fishery we encountered numerous questions regarding the nature, extent, and harvest of the resource, market conditions, and management strategies. We needed quick answers to the questions posed to develop a fair and sound management plan for weathervane scallops in Oregon. In an attempt to answer some of the foremost resource questions we placed logbooks on all scallop fishing vessels, collected market samples, and conducted a cooperative research cruise aboard the National Marine Fisheries Service (NMFS) R/V Chapman. The NMFS and Oregon State University (OSU) also participated in the cruise. From our initial efforts we developed a research program designed to:

(1) describe those aspects of the population and life history of *P. caurinus* which are crucial to the development of a management plan;

(2) evaluate the commercial harvest of scallops to determine harvest rates, gear selectivity, efficiency, and incidental catch; and

(3) describe the social and economic variables influencing the fishery.

Our objectives and tasks of this initial phase of our PL 88-309 contract were aimed at establishing a foundation for future research efforts. Specifically, our objectives for FY 1982 were to:

(1) collect and consolidate existing information pertaining to scallop life history and management;

(2) develop a scallop information retrieval and data analysis system;

(3) begin analysis of data from the R/V Chapman research cruise; and

(4) test gear and techniques for the suitability of catching subadults for year-class assessment.

We accomplished all the objectives we outlined for FY 1982. Our literature review and purchase of an Apple III microcomputer established a reference base and the data storage/analysis capacity we needed to study scallop life history. We used the Apple microcomputer to analyze data from the R/V Chapman cruise. Late in FY 1982 we conducted gear trials to determine if we could identify a suitable technique for catching juveniles. We chartered the F/V Granada to test how different tow speeds and scopes, liner sizes, and dredge hoods influenced the catch of juvenile scallops.

Data and Reference Systems

One of our first tasks was to collect existing scallop information.

We obtained fishery management plans for the Alaskan weathervane scallop fishery (North Pacific Fishery Management Council 1976) and for the Atlantic sea scallop (*Placopecten magellanicus*) fishery (New England Fishery Management Council 1982). We also discussed management strategies with biologists from the Washington Department of Fisheries, California Department of Fish and Game, and Alaska Department of Fish and Game.

Two excellent reports helped us obtain scientific references. Mottet's (1979) review of the fishery biology of scallops (a PL 88-309 funded project) provided a comprehensive summary of world scallop resources. Mottet briefly described and thoroughly documented existing information about scallop fisheries, scallop life history, population characteristics, scallop culture, and scallop processing. Kopinski (1978) also prepared a valuable annotated bibliography of commercially exploited scallops. We used many of his citations to locate reference material.

Our data handling needs grew immensely with the onset of the scallop fishery. We quickly accumulated large volumes of data comprised of research cruise findings, logbook data, and landing information. We decided we needed a method to rapidly access our data and summarize the data into graphical or report form to meet fishery management demands.

Our options for data processing were limited to the Oregon State University (OSU) CYBER computer, the Oregon Department of Fish and Wildlife (ODFW) EVOLUTION computer, or a microcomputer; our staff size precluded processing the large data bases by hand. The microcomputer proved to be our best option, as the ODFW computer does not have the statistical capability we need, and the OSU computer is more expensive to operate. We purchased an Apple III microcomputer after considering several comparable microcomputers. The hardware we purchased consists of an Apple III with 256K RAM, an Apple Monitor III CRT, an extra disk drive, and a Houston

Instruments DMP-4 plotter. The software package selected includes Visicalc III, Pascal III, Access III, and Business Graphics.

R/V CHAPMAN CRUISE

Two areas were selected for the 1981 scallop survey, one west of Coos Bay and one west of Tillamook Head (Fig. 1). In each area two transects were established perpendicular to the depth contours. Survey stations were designated every 5 fm on the transect and tows were completed at each station parallel to the depth contours (Fig. 2, 3). The survey areas were chosen to coincide with areas fished commercially in 1981 and the tow locations (stations) duplicated those of the 1963 and 1967 R/V Cobb scallop investigations (Pereyra and Hitz 1969).

Methods

We completed dredge hauls at each of the R/V Cobb stations, then proceeded to tow in both deeper and shallower water, in 5 fm increments, until no live scallops were collected in two successive tows. We also completed 13 "special" tows next to the commercial vessel F/V Joan Carol to compare catches. The special commercial comparative tows (CCT) were all located in 50-52 fm off Tillamook Head in the established commercial fishing grounds (Fig. 3).

A 2.5m (8 ft) wide New Bedford scallop dredge without rock chains was the primary sampling device; it was the same type of dredge the R/V Cobb used. The dredge had a bag of 102mm (4 in) steel rings with a 32mm (1.25 in) stretch mesh liner attached to the sweep chain. Additional sampling tools included OSU's 7m (23 ft) semi-balloon otter trawl with a 13mm (0.5 in) stretch mesh liner, NMFS' 18.6m (61 ft) high opening shrimp trawl with a 32mm (1.25 in) stretch mesh liner, and OSU's 3m (10 ft) beam trawl with

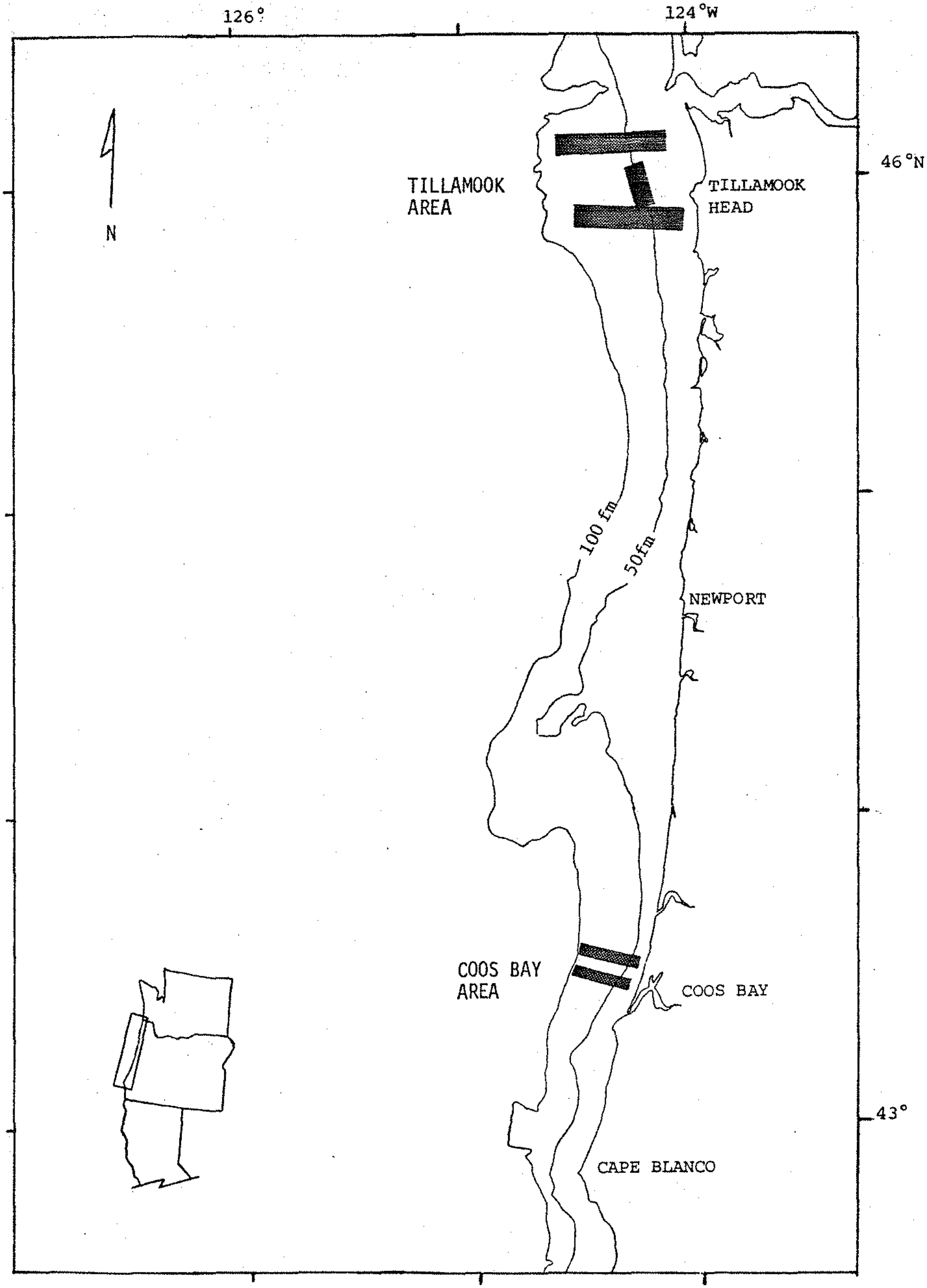


Figure 1. Location of scallop dredge areas for R/V Chapman cruise, Nov. 1981.

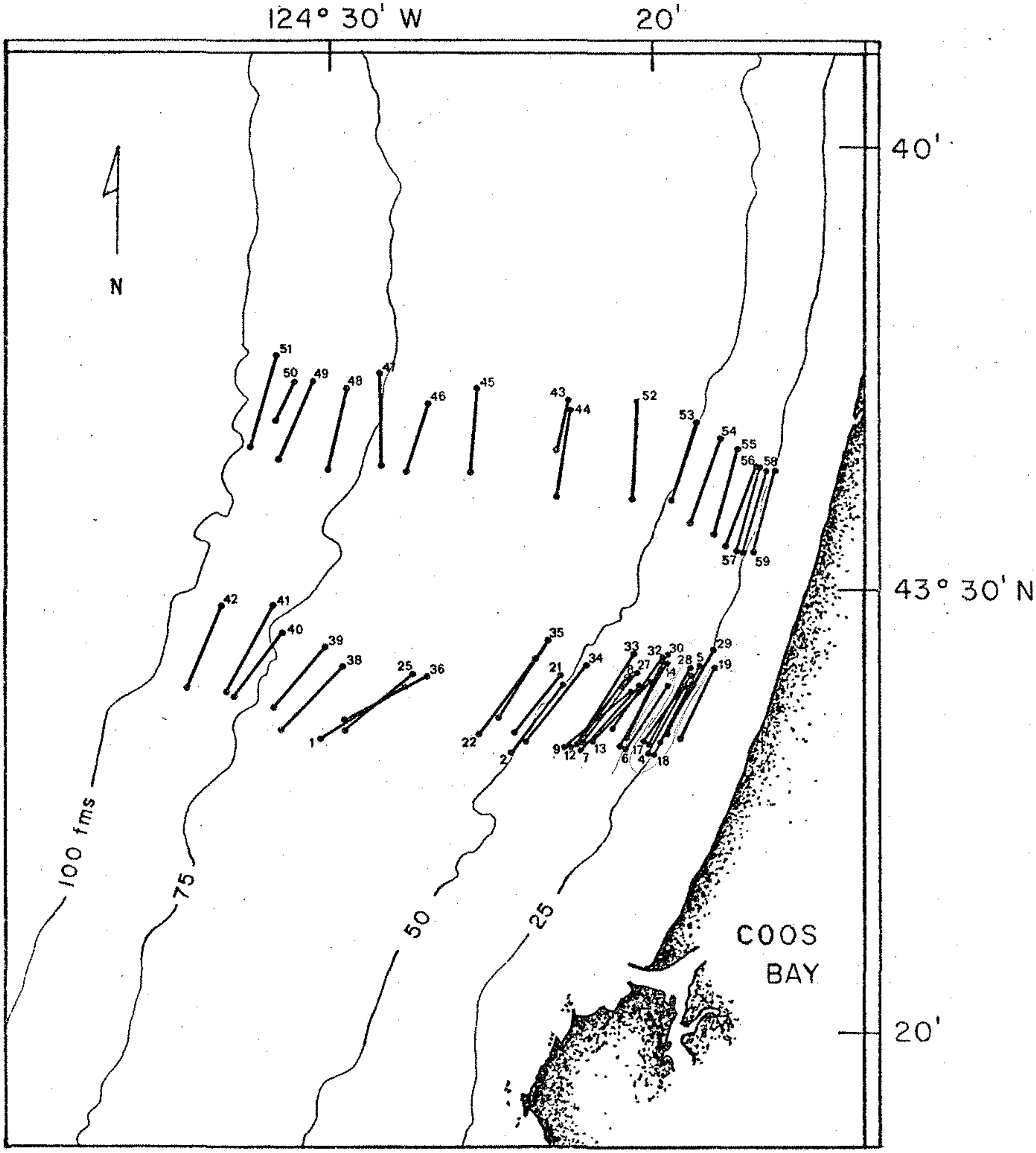


Figure 2. Location of Nov. 1981 R/V Chapman scallop dredge transects and tows—Coos Bay area (base map courtesy Gene Ruff, OSU).

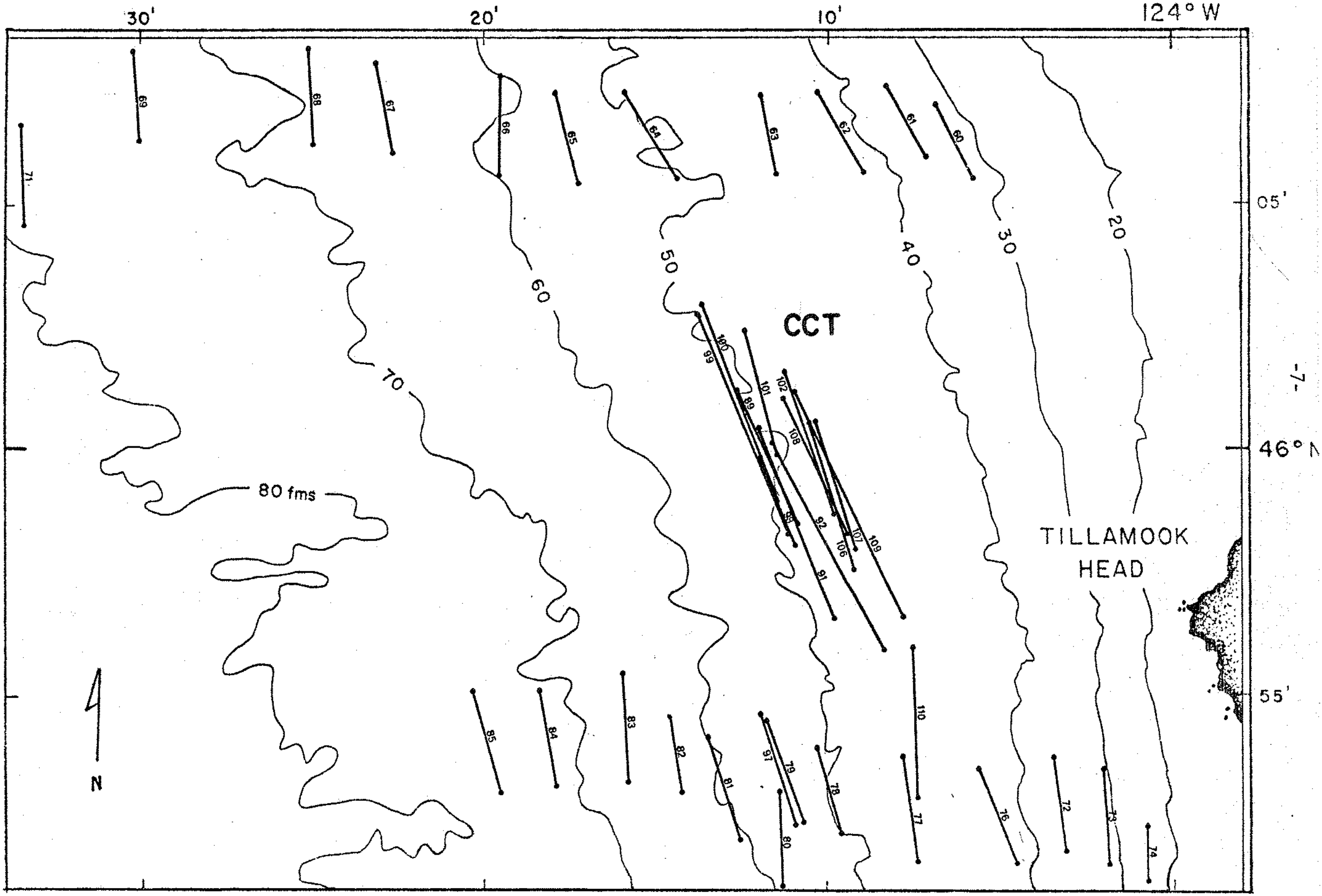


Figure 3. Location of Nov. 1981 R/V Chapman scallop dredge transects and tows—Tillamook area (base map courtesy Gene Ruff, OSU).

a 13mm (0.5 in) stretch mesh liner. We also used OSU's Edgerten Deep Sea Camera system mounted on their beam trawl (towed), and on a rectangular steel frame (drift mode) to take underwater photographs in selected locations.

Bottom samples and temperature profiles were collected at each station with a 0.1m^2 Smith-McIntyre bottom grab and an expendable bathythermograph (XBT) prior to the start of a dredge tow. We then towed the dredges at 4 knts with a 3:1 scope for 0.5 hr, except for the commercial comparative tows which were completed at 4 knts with 3:1 scope or 5 knots with 4:1 scope for various time periods ranging from 0.5 hr to 1.3 hr. Extra bottom grabs were collected in the same area as the comparative tows.

After the crew brought the dredge aboard, we shoveled the catch into baskets, searched the liner for animals, then carried the baskets into the wet lab for sorting. We sorted and weighed the entire catch (to the nearest 0.1 lb) of each tow by major species groups with a Morris platform beam scale. We counted adult and juvenile live scallops, large and small scallop shells, all fish, and selected invertebrate species. We looked at all shell, vegetation, and debris for attached juvenile scallops. We also measured scallop shell heights and Dungeness crab carapace widths to the nearest mm. Carapace width was measured just in front of, but not including, the lateral spines. Scallop shell measurements were the maximum distance from the hinge to the ventral margin of the <u>right</u> (bottom) valve. All weights and measurements were recorded on the R/V <u>Chapman's</u> on board computer.

We preserved all juvenile scallops (defined as scallops <70mm in shell height) in formalin for OSU's laboratory analysis, and placed live scallops in circulating sea water for tagging and laboratory studies. We took samples of live scallops for laboratory analysis from each transect from three depth strata: shallow (<45 fm), mid depth (45-60 fm), and deep (>60 fm). We tagged extra scallops with a plastic spaghetti tag attached to the upper valve by marine epoxy. Tagged scallops were released at the end of the cruise in 56 fm off Tillamook Head.

Scallops returned to the laboratory were remeasured, weighed to the nearest gm, and shucked. We then weighed the adductor and auxillary adductor muscle to the nearest 0.5 gm and noted the sex of each animal. Later we washed the shells and measured both the left and right valves. Since the left valves were heavily infested with boring organisms we used the right valve for aging. We marked all annuli and measured the distance from the hinge to each annulus for each individual.

We delivered scallop gonad samples to Anja Robinson and Wilbur Breese (OSU) for histological analysis. They determined scallop sex and gamete maturity by microscopic examination (Robinson and Breese 1982).

Aging

Various methods of determining age in scallops have been described by other investigators. While different shell structures are utilized in these different methods, they are all based on the theory that annual alternating periods of fast and slow growth cause a "check" to be formed during the periods of slowest growth.

Haynes and Hitz (1971) aged scallops using the shell surface of *P. caurinus* from the Washington coast, and Stevenson and Dickie (1954) similarly aged *Placopecten magellanicus* from the Bay of Fundy. Stevenson and Dickie showed that the rings visible on the shell surface are formed in winter when water temperatures are at a minimum for the year. They concluded the clearest annual rings occurred in the left (upper) valve.

Other shell structures have been used when the rings on the valves were weak, many shock rings had formed, or the shell surface was covered with fouling organisms. Merrill et al. (1966) found the calcareous part of the resilium to be useful with *P. magellanicus* from Georges Bank. They noted that the resilium is better protected and less exposed to injury than the ventral margin of the shell. Because of this, they found annual rings and shock marks more easily distinguishable on the resilium than on the shell surface.

Johannessen (1973) used the lines on the ligaments of *Chlamys islandica* from Norway. The author found that the shell and ligament grow at the same relative rate, so both would be equally useful as a growth parameter. Some researchers have cut mollusk shells to examine growth lines in the inner shell (MacDonald and Thomas 1980). We tried this method, but did not find it more reliable than surface aging techniques.

We chose to age scallops using the marks on the shell surface. The use of the ligaments or resilium was more time consuming and required special equipment. Aging the shell was faster and the rings were usually easily distinguishable. The only preparation needed of the shells was to soak them a few minutes in warm water. We then easily scrubbed off any surface dirt. We verified our aging using shell height-frequency histograms.

Haynes and Hitz (1971) and Stevenson and Dickie (1954) used the left (upper) valve for aging because they believed the rings on the left valve were more distinct and had fewer chips than the right valve. We used the right valve because the left valve of *P. caurinus* in our coastal waters is very heavily infested with boring organisms which obscure the annual rings. We did not notice more chipping on the right valve than on the left valve.

We shucked a sample of scallops, separated the valves, and measured each valve. We found a significant difference ($P \leq 0.05$) between the heights of the right and left valves with the right valve larger by an average of 2.1 ± 1.4mm (N=767). In a smaller sample of cluckers (both valves still attached) we noticed that the right valve was larger in all cases. This difference should be noted when comparing our data with other investigators which use the left valve for aging (Haynes and Hitz 1971, Haynes and McMullen 1970, Hennick 1970, 1972).

Distinguishing Location of Annuli. We first used shell color pattern to determine the location of the annual rings. The slower growth periods leave a darker color on the shell creating a pattern of alternating lighter and darker bands. Wetting the shells prior to reading increased the contrast between these bands and made annuli delineation easier. We secondly used shell contours to locate annuli. Visible dips in the curvature of the shell appeared when the shells were viewed from the side. These dips corresponded to the location of an annulus. Another method we used to distinguish an annulus was to hold a shell up to a bright light and view it from the inside. Dark bands indicated the annuli locations.

We had some difficulty identifying annuli at the outer edge of the shells. Some of the older shells showed very slow growth and crowding of the annuli at the edge. Also, some younger shells appeared to have an annulus on the very edge. Yet, because the shells were collected in November we expected to see some evidence of growth after the last annulus. The animals should have just finished the 1981 growing season but not had time to form a prominent check from reduced growth.

In the younger shells we noted a brownish coloration on the inside of the shell from the ventral margin back to the position of the last observable annulus. We determined that this brownish colored area was the current summer's growth. When the position of the last annulus was in question we used the amount of brownish coloration to identify its location.

Results and Discussion

Survey stations were located in preselected areas off the northern and southern Oregon coast in depths ranging from 23 to 95 fm (Fig. 2, 3). Each area was divided into transects and data from the transects were grouped by depth regime. We looked for similarities and differences in the data between depths, transects, and areas. Data were not lumped for a statewide average because scallops from the Tillamook and Coos Bay areas had vastly different characteristics. We determined it more appropriate to analyze the areas separately.

Distribution and Relative Abundance

Table 1 summarizes the scallop catch on a per tow basis. In all transects, large scallops (>70mm) were most abundant in the mid-depth tows (45-60 fm). Small scallops were more abundant in the mid-depth and deep water regimes than in shallow water (<45 fm).

We calibrated our gear with the commercial gear of the F/V Joan Carol to allow us to estimate what our catch would have been using commercial gear. These results should be useful to commercial fishermen. In the commercial comparative tows we calculated that the two 3.7m (12 ft) New Bedford dredges on the F/V Joan Carol caught an average of 9.2 times more scallops per tow than the R/V Chapman's 0.3m (8 ft) New Bedford dredge (Table 2). This is slightly higher than the findings of Hitz (1969), who

Table 1. Number of scallops caught in successful dredge hauls, R/V Chapman cruise, Nov. 1981.

Area	Tow #	Depth fms	No. Scallops Large	No. Scallops Small	Area	Tow #	Depth fms	No. Scallops Large	No. Scallops Small
Tillamook North	62	44	51	2	Coos Bay North	57	34	1	0
	63	48	71	0		56	39	14	0
	64	51	87	1		55	44	16	0
	65	55	1	0		54	48	21	0
	66	60	2	1		53	51	26	0
	68	71	1	2		44	60	0	1
						45	65	0	2
South	72	39	1	0		47	76	0	5
	76	44	30	0		48	80	0	2
	77	50	34	5		49	86	0	3
	78	55	104	3					
	80	57	1	0	South	17	30	1	0
	79	58	15	2		14	36	1	0
	83	69	0	1		30	37	1	0
						32	40	18	0
Commercial Comparative	89	50	113	39		13	41	13	0
	91	50	94	11		11	43	1	0
	92	50	184	53		12	44	12	0
	97	58	5	0		27	44	33	0
	98	50	125	12		33	44	32	0
	99	51	118	43		34	50	11	0
	100	50	215	19		21	53	10	0
	101	50	1	0		25	61	0	2
	102	49	137	43		38	66	0	6
	106	50	156	36		39	70	0	3
	107	50	83	31		40	76	0	1
	108	50	111	26					
	109	49	169	50					
	110	46	71	2					

Table 2. Comparison of commercial catches of F/V Joan Carol* with research catches of R/V Chapman, Nov. 1981.

	11-8-81		11-9-81		11-10-81		Total	
	Joan Carol	Chapman	Joan Carol	Chapman	Joan Carol	Chapman	Joan Carol	Chapman
No. Tows	6	3	6	5	5	4	17	12
No. Scallops	7960	392	6368	587	6368	595	20,696	1574
Ave. tow duration (hrs)	0.8	0.8	0.8	0.7	0.8	0.9	0.8	0.8
No. scallops/tow	1327	130.7	1061	117.4	1273	148.8	1217	131.2
No. scallops/hr	1658	163.3	1327	158.6	1592	170.0	1522	164.0

* The number of scallops is estimated from meat weights landed by the F/V Joan Carol. The estimate is based on mean meat weights of scallops from the research tows.

estimated a single commercial dredge to catch about four times more scallops than the 0.3m (8 ft) research dredge used aboard the R/V Cobb.

Sex Composition

Of the 574 mature scallops we sexed, the ratio of males to females was nearly 1:1 (Table 3). This was expected, since Hennick (1970) noted the same relationship in Alaskan scallops, as did Robinson and Breese (1982) for a sample of scallops from Coos Bay. All the scallops we examined were dioecious, again similar to the Alaska situation and confirming the work of Robinson and Breese.

We calculated mean ages of scallops by sex for different areas, transects, and depth regimes. We observed no significant differences ($P > 0.05$) between sexes when we compared mean ages using a students-t test (Table 4). We also compared mean shell heights, meat weights, and meat yields of males and females for different areas, transects, and depths (Appendix Tables 1-3). From these data we concluded that the population characteristics of males and females are essentially identical, and the rest of our analyses were completed without regard to sex.

The only difference between sexes we noted was the mean meat weight of animals in the Tillamook area. The mean meat weight of females was greater than the males in all areas. This difference in meat weight may be an error caused by incomplete shucking. More likely, however, the mean meat weight difference we observed was due to differences in gonad condition.

In the Tillamook area almost all of the males sampled for gonad condition were full of sperm. Conversely, the females were only about 70% full of ova (Table 5). Quite possibly the mean meat weight of males was smaller than the females because at that time a greater proportion of

Table 3. Percentage of male and female *P. caurinus* in catch, R/V Chapman cruise, Nov. 1981 (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
Coos Bay-North				
Males	65.4 (34)	46.2 (12)	-	59.0 (46)
Females	34.6 (18)	53.9 (14)	-	41.0 (32)
Coos Bay-South				
Males	50.0 (38)	55.0 (11)	-	51.0 (49)
Females	50.0 (38)	45.0 (9)	-	49.0 (47)
Tillamook-North				
Males	53.2 (58)	46.7 (35)	-	50.5 (93)
Females	46.8 (51)	53.3 (40)	-	49.5 (91)
Tillamook-South				
Males	36.7 (11)	50.3 (79)	55.2 (16)	49.1 (106)
Females	63.3 (19)	49.7 (78)	44.8 (13)	50.9 (110)
TOTAL				
Males	52.8 (141)	49.3 (137)	55.2 (16)	51.2 (294)
Females	47.2 (126)	50.7 (141)	44.8 (13)	48.8 (280)

Table 4. *P. caurinus* mean age (yrs ± SD) by sex, R/V Chapman cruise, Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
Coos Bay - North				
Males	5.8 ± 1.6 (34)	4.7 ± 0.9 (12)	-	5.5 ± 1.5 (46)
Females	5.7 ± 1.4 (18)	4.6 ± 0.5 (14)	-	5.2 ± 1.3 (32)
Coos Bay - South				
Males	6.5 ± 1.4 (38)	4.5 ± 0.5 (11)	-	6.1 ± 1.5 (49)
Females	6.6 ± 1.4 (38)	4.6 ± 0.5 (9)	-	6.2 ± 1.5 (47)
Tillamook - North				
Males	5.6 ± 2.1 (58)	7.2 ± 1.5 (35)	-	6.2 ± 2.0 (93)
Females	6.3 ± 2.3 (51)	7.1 ± 1.7 (40)	-	6.6 ± 2.1 (91)
Tillamook - South				
Males	4.5 ± 1.2 (11)	7.3 ± 1.5 (79)	8.1 ± 0.5 (16)	7.1 ± 1.7 (106)
Females	5.6 ± 1.7 (19)	7.2 ± 1.4 (78)	8.1 ± 0.8 (13)	7.0 ± 1.5 (110)

* None of the between sex differences are significant at the $P > 0.05$ level.

Table 5. Female gonad condition (%), R/V <u>Chapman</u> cruise, Nov. 1981*.

	Depth 1 (<45f)				Depth 2 (45-60f)				Depth 3 (>60f)			
	Stage 1	Stage 2	Ova	N	Stage 1	Stage 2	Ova	N	Stage 1	Stage 2	Ova	N
COOS Bay												
North transect	17.0	7.8	75.3	17	18.2	6.0	75.8	12	-	-	-	-
South transect	32.1	12.2	55.7	20	20.2	7.5	72.3	10	-	-	-	-
Overall	24.6	10.0	65.5	37	19.2	6.8	74.1	22	-	-	-	-
TILLAMOOK												
North transect	19.6	15.0	65.5	28	26.4	11.9	61.8	14	-	-	-	-
South transect	18.9	7.8	73.3	16	19.1	4.1	76.8	15	19.1	6.1	74.0	13
Overall	19.3	11.4	69.4	44	22.8	8.0	69.3	29	19.1	6.1	74.0	13

* Data courtesy of Anja Robinson, OSU

Stage 1: Small oocytes attached to follicle wall

Stage 2: Larger oocytes being released from the follicle wall

Ova: Fully developed ova filling the lumen their energy was expended in gonad development than in muscle tissue development.

Age Composition

We plotted the results of our scallop aging in a frequency histogram (Fig. 4) and obtained mean ages for each area (Table 6). The Coos Bay area was dominated by one year-class whereas the Tillamook area displayed a more even age structure. The predominance of the 1975 year-class in the Coos Bay area was probably the reason for the large 1981 commercial harvest. A strong year-class was concentrated in one depth regime, and allowed high CPUE's.

The more even age structure in the Tillamook area combined with more evenly distributed research catches indicates that recruitment was more constant in the Tillamook area than in the Coos Bay area. In both areas the age distribution changed with depth regime. This indicates that scallop spat settle out in different areas each year. Dow (1962) suggested that water temperature was a significant factor influencing spatfall success in Maine waters. Dickie (1955), Dickie (1958), and Dickie and Medcof (1963) also suggested that annual water temperature variation influences spatfall success. Dickie (1955) further concluded that changes in scallop abundance are attributable to the combined action of temperature and circulation on the pelagic larvae. Quite probably coastal upwelling variations off Oregon determine larval survival and spatfall location.

Dow (1962) suggested that shell and debris play an important role in spat settlement and indicated that old scallop shell may stimulate heavy spatfall. We scrutinized every shell (live and dead) and all debris for juvenile scallops. We did not find spat attached to any surface. Thus we have no evidence to indicate that shell are necessary for *P. caurinus* spatfall

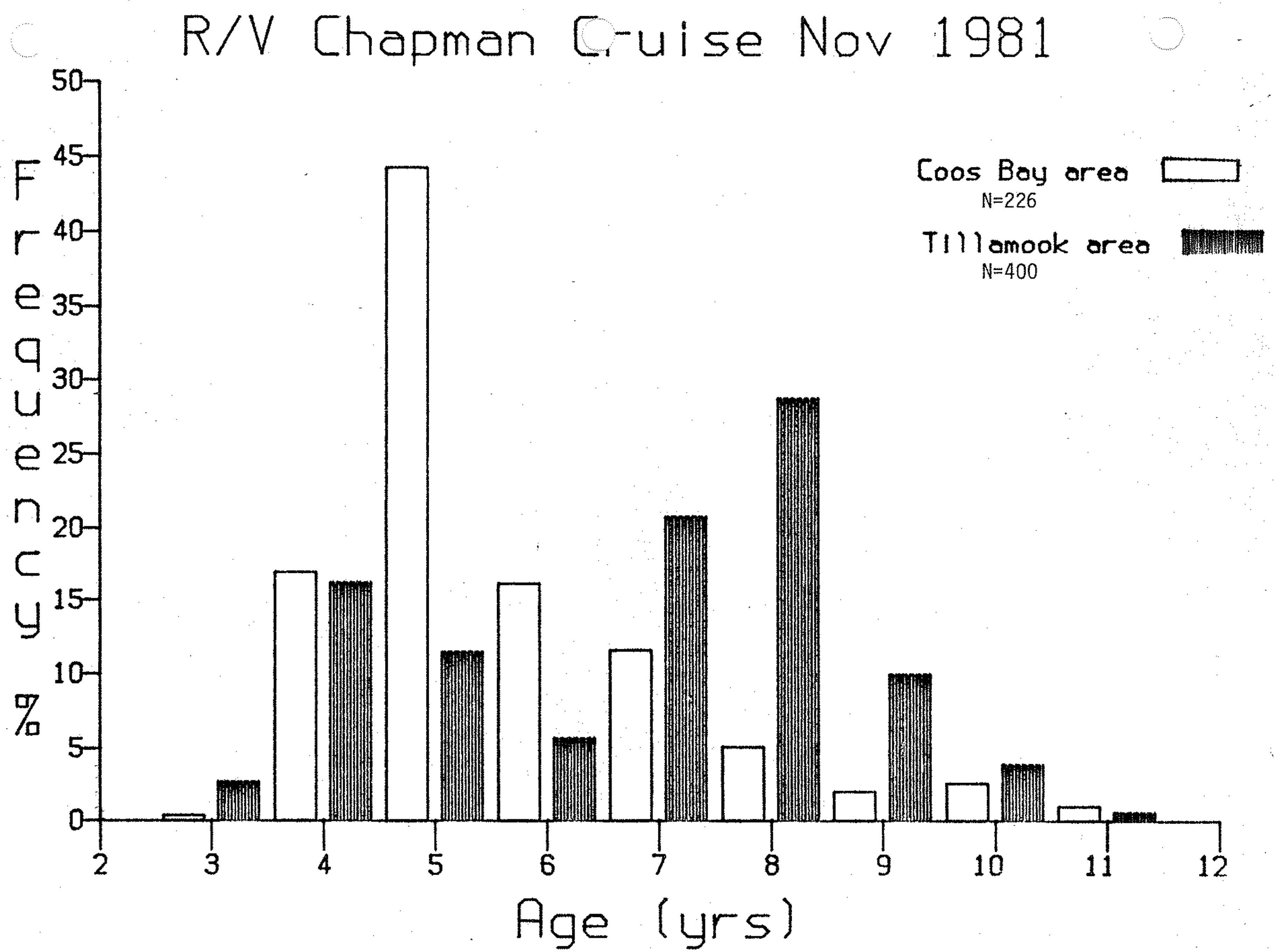


Figure 4. Age composition of scallops, R/V Chapman cruise, Nov. 1981.

Table 6. Mean age (yrs ± SD) of *P. caurinus* by depth, transect, and area, R/V Chapman cruise, Nov. 1981. (N)*

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
COOS BAY:				
North transect	5.8 ± 1.5 (52)	4.6 ± 0.7 (26)	-	5.4 ± 1.4 (78)
South transect	6.1 ± 1.5 (127)	4.6 ± 0.5 (20)	-	5.9 ± 1.5 (147)
Overall	6.0 ± 1.5 (179)	4.6 ± 0.6 (46)	-	5.7 ± 1.5 (225)
TILLAMOOK:				
North transect	5.9 ± 2.2 (109)	7.1 ± 1.6 (75)	-	6.4 ± 2.0 (184)
South transect	5.2 ± 1.6 (30)	7.2 ± 1.4 (157)	8.1 ± 0.6 (29)	7.1 ± 1.6 (216)
Overall	5.8 ± 2.1 (139)	7.2 ± 1.4 (232)	8.1 ± 0.6 (29)	6.8 ± 1.8 (400)

* All of the differences by depth are significant ($P \leq 0.05$). In an area, none of the differences between transects are significant ($P > 0.05$).

success. Year-class success is probably influenced primarily by water temperatures during the scallop pelagic period, and secondarily by location at which spatfall occurs. If the juveniles settle out in a favorable area they probably thrive. If not, high mortalities occur.

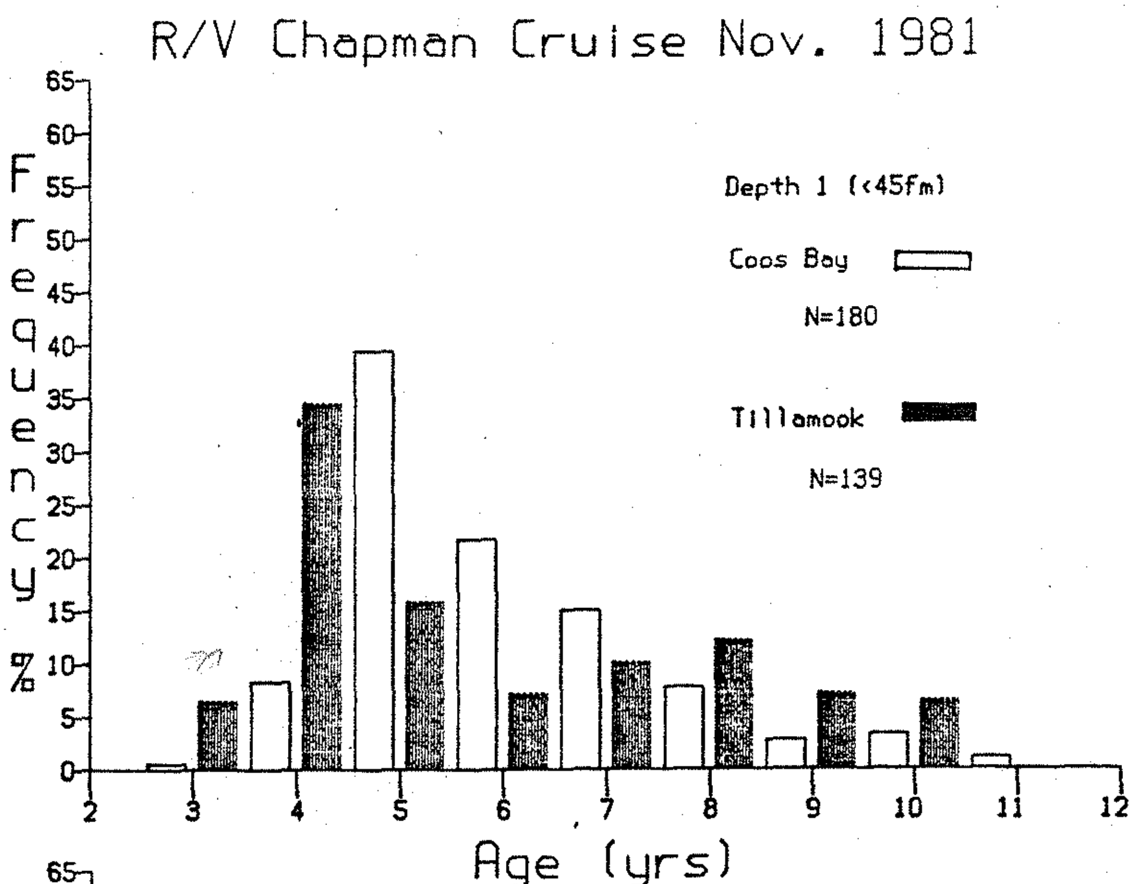
Migration

Many scallop fishermen believe that juveniles settle out in deep water, then migrate to shallow water. The distribution of large and small shell in the by-catch would lead one to believe that this is indeed the case (Table 7). However, there are several other possible explanations. The sediments in shallow water contained more sand and were coarser than the sediments in deeper water. This indicates a higher energy area in the shallower water. Quite possibly all small shell are quickly ground up or buried in shallow water and remain intact on top of the substrate in deep water. Another plausible explanation for large amounts of small shell in deep water is that larvae settled out in deep water but environmental conditions were not suitable for survival. This idea for year-class failure would also explain the lack of small live scallops in research catches.

We found no other evidence to substantiate the hypothesis that juvenile scallops migrate. The frequency histograms of age by depth regime (Fig. 5, 6) exhibit no gradient in age with depth. More importantly, we found no young scallops in deep water. We also examined the distribution of scallops by depth for individual year-classes (Fig. 7). If scallops settled out in deep water then migrated to shallow water, we would expect that for a given year-class, the relationship of percentage of individuals in each depth range would be similar to all other year-classes. Our data indicate that the relationship between percentage of a given age animal in each depth range is different for different year-classes. Also, the younger year-classes

Table 7. Distribution of shell, by percentage, in by-catch of R/V _Chapman_ cruise, Nov. 1981. (N)

	Coos Bay				Tillamook			
	North transect		South transect		North transect		South transect	
	Lg. Shell	Sm. Shell	Lg. Shell	Sm. Shell	Lg. Shell	Sm. Shell	Lg. Shell	Sm. Shell
Depth 1 (<45 f)	62 (329)	38 (198)	86 (431)	14 (70)	81 (271)	19 (52)	83 (30)	17 (6)
Depth 2 (45-60 f)	22 (184)	68 (666)	19 (176)	81 (757)	35 (133)	65 (250)	82 (228)	18 (60)
Depth 3 (>60 f)	1 (7)	99 (743)	0	100 (1,642)	14 (25)	86 (158)	23 (73)	67 (249)



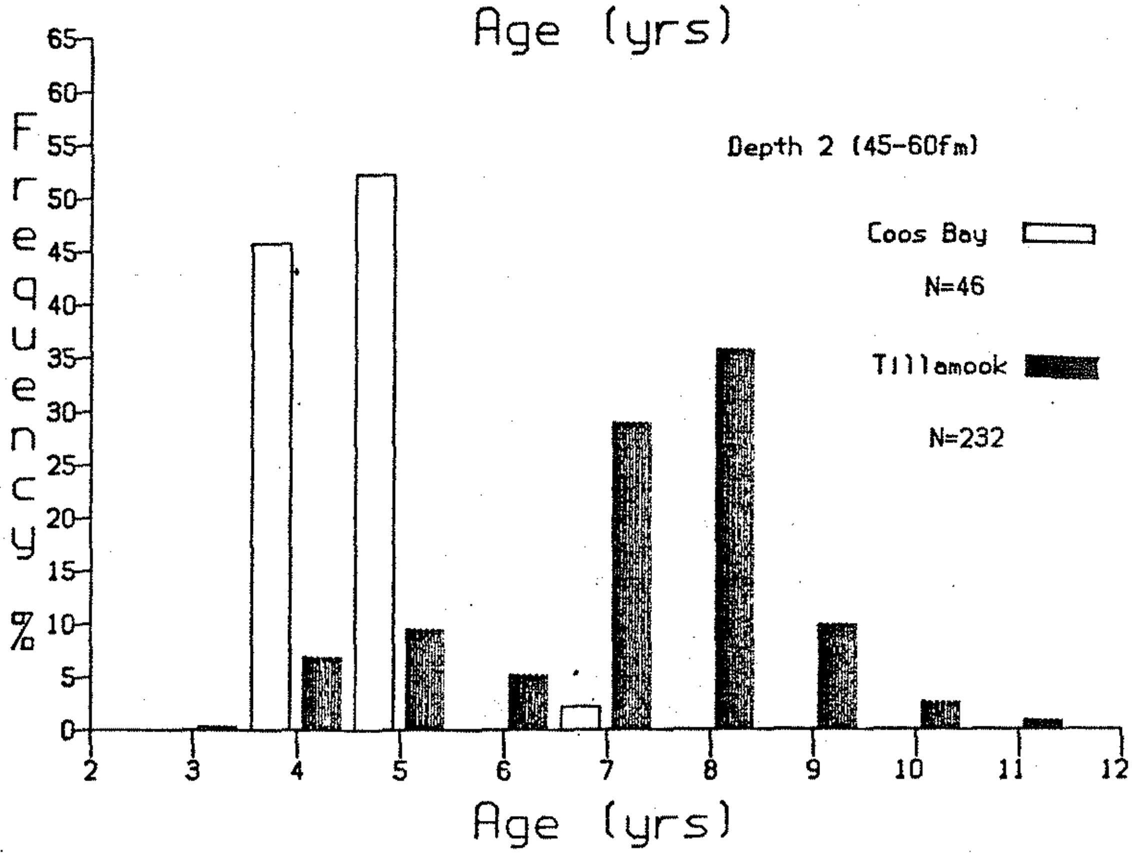


Figure 5. Scallop age composition in depth regimes 1 and 2, R/V Chapman cruise Nov. 1981.

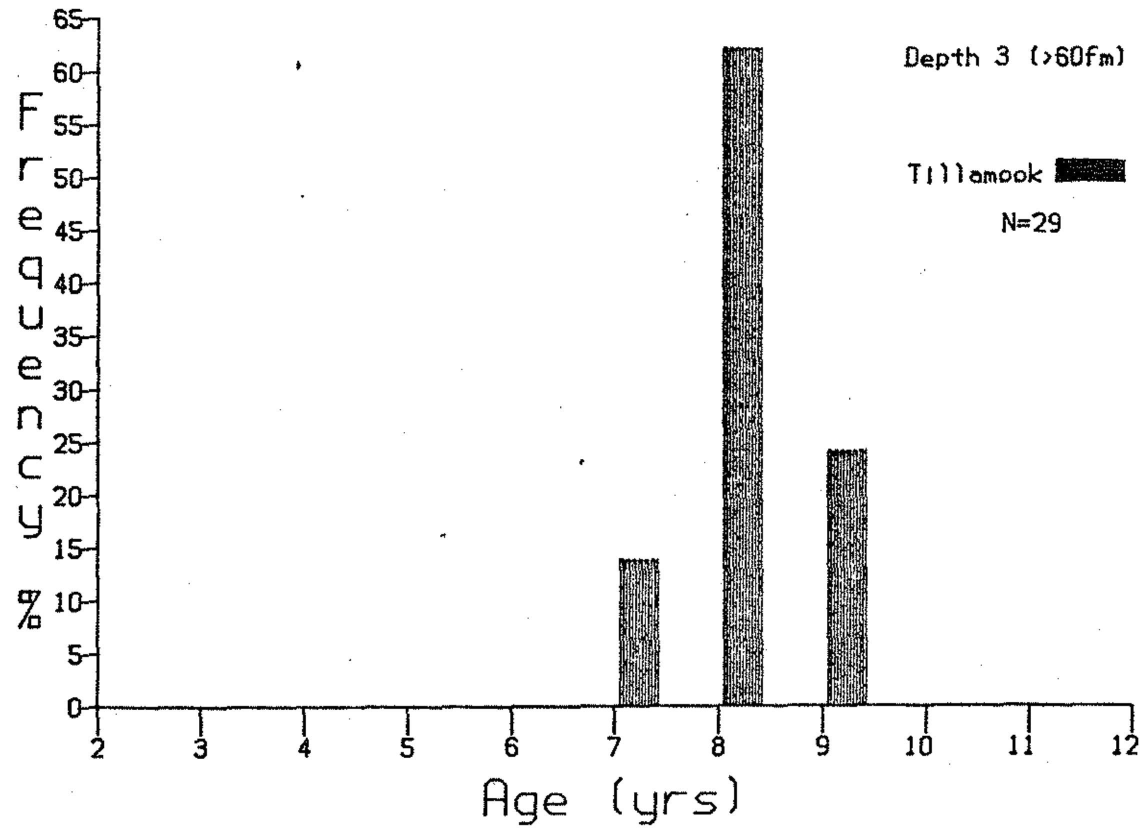


Figure 6. Scallop age composition in depth regime 3, R/V Chapman cruise, Nov. 1981.

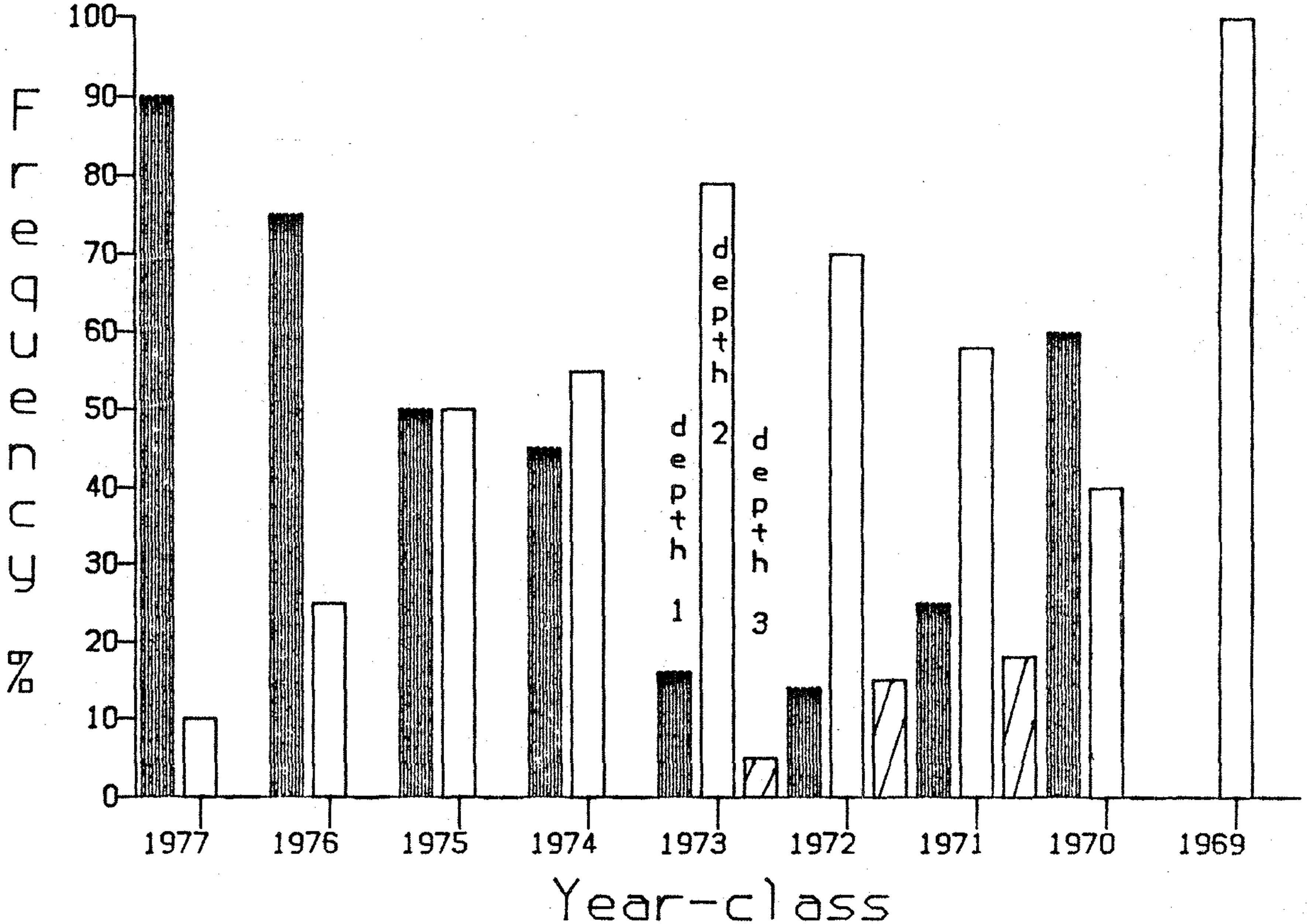


Figure 7. Frequency of occurrence, by depth, of individual year-classes, R/V Chapman cruise, Nov. 1981.

seem to have more individuals in shallow water than most of the older year-classes. These data all seem to refute the hypothesis that juveniles migrate from deeper water.

Age Verification

We verified our estimates of annuli locations using shell height-frequency histograms. We were only able to use height frequencies for early ages since the histograms showed no distinct categories for scallops larger than 70mm. The size ranges of larger scallops overlapped so much that scallops over 70mm could not be reliably aged by modes in height frequency. For scallops with shell heights less than 70mm, the height histogram of scallops caught on the R/V Chapman cruise exhibited a large peak in height frequency between 20-30mm (Fig. 8). Few scallops were caught in the shell height range of 30-80mm, and we caught no scallops less than 15mm in shell height.

The histogram of the F/V Granada cruise, 9.5 months later, exhibited another strong peak in height frequency between 20-30mm, and one other noticeable peak at 50-60mm (Fig. 8). Again, we found no juveniles smaller than 15mm. We believe the 20-30mm peak represents age 1+ scallops, and the secondary peak between 50 and 60mm represents age 2+ scallops.

Our age determination is somewhat different than that presented by Haynes and Hitz (1971) from their study of *P. caurinus* from the Washington coast. The authors measured the shell height at the first observable circuli to be 8.6 ± 3.1mm for 135 scallops. Since other investigators (Hennick 1970, Haynes and Powell 1968) did not observe 0 age circuli in Alaskan scallops, Haynes and Hitz assumed that the circuli they measured at 8.6mm was formed when the scallops were 1½ years old.

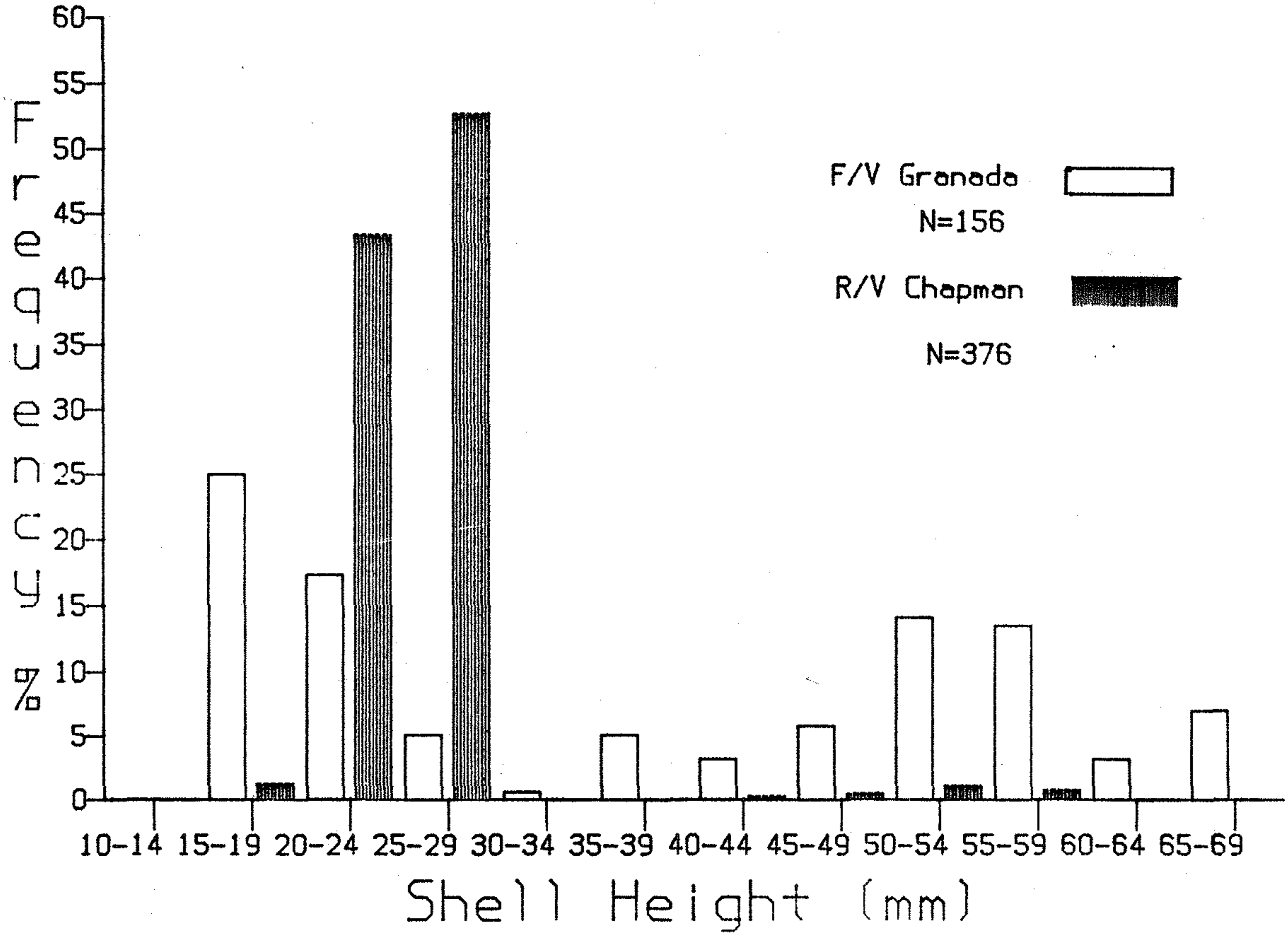


Figure 8. Shell height-frequency of juvenile scallops, R/V Chapman and F/V Granada cruise samples, Tillamook area.

They strengthened their hypothesis by assuming that the spawning time of *P. caurinus* in Washington was the same as Hennick (1970) described for Alaskan scallops. Given a summer spawning season, and a 3-4 week planktonic larval period, they reasoned that even the small amount of growth to the first circuli could not be accomplished before the scallops' first winter. Thus they deduced that scallops with shell heights of 20-30mm are 2½ years old.

We believe Haynes and Hitz overaged Washington scallops by one year. Our age determination is based on the spawning time defined by Robinson and Breese (1982) and on height measurements of juveniles caught on our research cruises. Robinson and Breese (1982) determined that spawning begins several months earlier in Oregon than in Alaska. In 1982 they found spawning already underway in February in the Coos Bay beds. Data from the same year in Tillamook indicated that spawning was well on its way with only 50% ova remaining in April (Robinson and Breese 1982).

We measured the first circuli we could identify from a sample of 189 scallops. The shell height of this first circuli was 8.2 ± 2.7mm, not significantly different ($P > 0.05$) from the 8.6 ± 3.1mm measured by Haynes and Hitz (1971). Scallops spawned in the spring, several months earlier than was previously known, could easily be 8-9mm by winter, given average growth described for *P. caurinus* and *P. yessoensis*, a species closely related to *P. caurinus* (Mottet 1979).

We have not finished computing growth rates for Oregon scallops, but the juvenile shell height frequency histograms provide a rough estimate of growth (Fig. 8). If we assume that scallops in a mode of a height frequency histogram are a given age-class, then we can estimate growth of that age-class by measuring the increase in mean height of that height-frequency mode. The mean height of the 15-30mm size mode in August 1982 was 20.4mm. The mean height of the same size mode in November 1981 was 29.9mm.

Assuming similar growth conditions for the two years, we expect that the mean height of scallops caught in 1982 would have been 2.5mm larger if we had caught them in November, 2½ months later. This expected growth of 1mm/mo would have occurred in the fall when growth has slowed. If we assume summer growth is larger than the predicted 1mm/mo fall growth, then we can easily believe that scallops spawned in April are 9mm by January, and 20-30mm by December of the following year. This would make 20-30mm scallops 1½ years old, which more closely corresponds to the work of other authors (Hennick 1972, Haynes and Powell 1968) and to the work of Haynes and Hitz (1971) in the Strait of Georgia.

Shell Height

Table 8 displays mean shell height by age for scallops collected on the R/V *Chapman* cruise. Scallops are described in this table by year-class (yc) to avoid any confusion by describing the height and age of a scallop collected near the end of the calendar year. For example, the 1977 year-class scallops in Tillamook are 3 years old and have a mean shell height of 97.6mm. If they were collected 2 months later, they probably would not be significantly larger, but would be classified as 4 year olds. Therefore, Table 8 is intended to only describe differences of a year-class between transects and areas.

In both the Coos Bay and Tillamook areas there is no significant difference between shell height at age for the north and south transects, except for the 1972 yc in Coos Bay. This discrepancy is probably due to

Table 8. Mean shell height (mm ± SD) of *P. caurinus* by year-class, R/V Chapman cruise Nov. 1981*. (N)

Year-class	Coos Bay			Tillamook		
	North transect	South transect	Overall	North transect	South transect	Overall
1977	-	98.0 (1)	98.0 (1)	97.3 ± 7.2 (8)	99.0 ± 7.1 (2)	97.6 ± 6.8 (10)
1976	114.0 ± 5.8 (16)	111.6 ± 4.6 (20)	112.7 ± 5.3 (36)	101.4 ± 5.1 (36)	105.4 ± 6.9 (28)	103.1 ± 6.2 (64)
1975	117.0 ± 6.2 (41)	116.6 ± 5.4 (54)	116.8 ± 5.7 (95)	103.8 ± 4.5 (31)	105.9 ± 7.1 (13)	104.4 ± 5.4 (44)
1974	119.0 ± 5.2 (10)	117.7 ± 7.5 (29)	118.1 ± 6.9 (39)	107.9 ± 8.4 (15)	109.0 ± 6.3 (7)	108.2 ± 7.6 (22)
1973	124.1 ± 8.2 (7)	126.9 ± 7.5 (21)	126.2 ± 7.7 (28)	109.4 ± 7.1 (27)	110.1 ± 5.0 (58)	109.9 ± 5.7 (85)
1972	147.0 (1)	130.5 ± 5.1 (13)	131.7 ± 6.6 (14)	110.2 ± 7.0 (36)	112.8 ± 5.2 (82)	112.0 ± 5.9 (118)
1971	142.0 (1)	135.5 ± 9.3 (4)	136.8 ± 8.5 (5)	113.8 ± 8.3 (19)	113.8 ± 5.3 (21)	113.8 ± 6.8 (40)
1970	139.5 ± 10.6 (2)	143.8 ± 10.0 (4)	142.3 ± 9.4 (6)	121.9 ± 8.5 (10)	120.4 ± 7.3 (5)	121.4 ± 7.9 (15)
1969	162.0 (1)	150.0 (1)	156.0 ± 8.5 (2)	115.0 ± 2.8 (2)	-	115.0 ± 2.8 (2)

* In the Coos Bay area there is no significant difference ($P > 0.05$) between year-classes except for 1972.

In the Tillamook area there is no significant difference ($P > 0.05$) between year classes except for 1976 and 1972 which are not significant at $P > 0.01$.

At a given age the scallops in Coos Bay are significantly larger ($P \leq 0.05$) than the scallops in Tillamook, except for year-class 1977 scallops.

the small sample size and possibly caused by an aging error of the one 1972 yc scallop collected in the Coos Bay North transect. There is, however, a difference between Coos Bay and Tillamook. For all scallops older than the 1977 yc, the scallops in Coos Bay are significantly larger ($P \leq 0.05$) at a given age than the scallops in Tillamook. This indicates that scallop growth is greater in the Coos Bay area than in the Tillamook area. We will investigate growth differences in our next project period.

Our results closely correspond with results from the R/V Cobb cruises in the 1960's. We calculated mean shell height to be 120mm in the Coos Bay area and 109mm in the Tillamook area (Table 9). Mean shell heights from the R/V Cobb cruises for the Tillamook and Coos Bay areas were 107mm and 117mm, respectively (Ronholt and Hitz 1968, Pereyra and Hitz 1969). The R/V Cobb results may be even closer to ours if they measured the left valve, which we calculated to average 2mm smaller than the right valve.

Tables 9 and 10 display shell height differences by depth, transect, and area; and by year-class and depth. These data show that at each age scallops are larger in shallower water than in deeper water. Again, our future growth analysis may provide some insight to the causes of these differences.

Weight

Appendix Tables 4, 5, 6 display mean whole weights, meat weights, and meat yields by depth, transect, and area. The mean values indicate that scallops in shallow water are heavier than scallops in deeper water. These data are compatible with age and height differences between depths. We will investigate these potential growth differences in our next project period.

Table 9. Mean shell height (mm ± SD) of *P. caurinus* by depth, transect, and area, R/V Chapman cruise, Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
COOS BAY:				
North transect	121.3 ± 11.4 (52)	115.0 ± 3.2 (26)	-	119.2 ± 9.9 (78)
South transect	121.0 ± 10.5 (127)	115.1 ± 3.2 (20)	-	120.2 ± 10.0 (147)
Overall	121.1 ± 10.7 (179)	115.0 ± 3.2 (46)	-	119.9 ± 10.0 (225)
TILLAMOOK:				
North transect	109.0 ± 10.1 (117)	105.0 ± 4.6 (89)	-	107.3 ± 8.4 (206)
South transect	113.4 ± 7.1 (30)	110.1 ± 6.6 (157)	111.4 ± 4.1 (29)	110.7 ± 6.5 (216)
Overall	109.9 ± 9.7 (147)	108.3 ± 6.4 (246)	111.4 ± 4.1 (29)	109.0 ± 7.7 (422)

* In the Coos Bay area only the between depth differences are significant ($P \leq 0.05$). In the Tillamook area all between depth and between transect differences are significant ($P \leq 0.05$) except for the overall difference between depths 1 and 2.

Table 10. Mean shell height (mm ± SD) of *P. caurinus* by year-class and depth, R/V Chapman cruise Nov. 1981*. (N)

Year-class	Depth 1 (<45f)		Depth 2 (45-60f)		Depth 3 (>60f)	
	Coos Bay	Tillamook	Coos Bay	Tillamook	Coos Bay	Tillamook
1977	98.0 (1)	98.0 ± 7.0 (9)	-	94.0 (1)	-	-
1976	111.3 ± 7.1 (15)	104.3 ± 5.9 (48)	113.6 ± 3.3 (21)	99.6 ± 6.0 (16)	-	-
1975	117.0 ± 6.5 (71)	106.3 ± 5.4 (22)	116.3 ± 2.7 (24)	102.6 ± 4.9 (22)	-	-
1974	118.1 ± 6.9 (39)	114.5 ± 6.5 (10)	-	103.0 ± 3.4 (12)	-	-
1973	126.7 ± 7.4 (27)	117.3 ± 6.3 (14)	114.0 (1)	108.4 ± 4.4 (67)	-	108.0 ± 4.4 (4)
1972	131.7 ± 6.6 (14)	117.7 ± 6.2 (17)	-	111.1 ± 5.6 (83)	-	111.1 ± 4.0 (18)
1971	136.8 ± 8.5 (5)	121.7 ± 6.0 (10)	-	110.2 ± 4.7 (23)	-	114.3 ± 2.8 (7)
1970	142.3 ± 9.4 (6)	123.7 ± 6.8 (9)	-	118.0 ± 8.8 (6)	-	-
1969	156.0 ± 8.5 (2)	-	-	115.0 ± 2.8 (2)	-	-

* In the Tillamook area scallops in depth 1 are significantly larger ($P \leq 0.05$) than scallops in depth 2 except for year-class 1977 and 1970.

Incidental Catch

Table 11 summarizes all the species caught by percent of total weight. Appendix Table 7 is a species list of incidental catch. Appendix Tables 8 and 9 summarize the catch for each transect and area by depth regime. We calculated a Shannon index of general diversity ($\bar{H}$) (Odum 1971) for each tow in order to compare the catch between transects and depth regimes (Table 12). We did not attempt to analyze the catch data at the species level using more sophisticated analytical methods (e.g. cluster analysis).

We observed no significant difference ($P > 0.05$) in mean diversity index between depths within a transect, except between depth 2 and depth 3 in the Tillamook South, Coos Bay North, and combined transects. There was also no significant difference ($P > 0.05$) between transects or areas except between the total of Tillamook north and south. These differences were probably due to the higher catches of heart urchins in the deeper areas. We noted that, although the difference was not always significant, depth regime 2 had a higher mean diversity index than depths 1 or 3 in each transect.

Fish. Table 13 lists the fish species caught in all tows by percent of total fish weight. Appendix Tables 10 through 13 list the fishes caught in each transect by depth range. As with the total incidental catch, a Shannon index of general diversity ($\bar{H}$) was calculated for each tow. Table 14 displays the average diversity for each area by depth regime.

We found no significant difference ($P > 0.05$) in mean diversity index between north and south transects from either area. There was a significant difference ($P \leq 0.05$) between depth regimes within a transect. The two factors which make up the Shannon index are the number of species and the proportionment of those species. The greater the numbers of species and/or

Table 11. Summary of total catch, R/V _Chapman_ cruise, Nov. 1981.

	Percent by Weight
miscellaneous invertebrates	25.83
fish	21.75
heart urchin	11.03
debris	8.58
sea stars & brittle stars	7.81
adult scallops	5.37
large scallop shell	4.89
sea cucumbers	3.89
basket stars, sea pens, and sea whips	3.58
Dungeness crab	3.37
algae	2.99
small scallop shell	0.35
pink shrimp	0.27
other crabs	0.14
octopus	0.10
juvenile scallops	0.06
squid	0.01

Table 12. Average diversity index ($\bar{H}$) of species caught, by depth range, R/V *Chapman* cruise, Nov. 1981 (number of tows)*.

	Coos Bay			Tillamook		
Depth	North	South	Overall	North	South	Overall
1	1.42 ± 0.36 (6)	1.47 ± 0.31 (13)	1.46 ± 0.32 (19)	1.47 ± 0.19 (4)	1.36 ± 0.25 (4)	1.42 ± 0.22 (8)
2	1.77 ± 0.14 (3)	1.58 ± 0.25 (5)*a*/	1.65 ± 0.23 (8)*b*/	1.76 ± 0.16 (3)	1.59 ± 0.14 (3)*c*/	1.67 ± 0.16 (6)*d*/
3	1.21 ± 0.26 (7)	1.37 ± 0.32 (6)*a*/	1.29 ± 0.29 (13)*b*/	1.47 ± 0.17 (5)	0.97 ± 0.57 (6)*c*/	1.20 ± 0.49 (11)*d*/
Total	1.40 ± 0.34 (16)	1.47 ± 0.30 (24)	1.44 ± 0.31 (40)	1.54 ± 0.20 (12)	1.23 ± 0.48 (13)	1.38 ± 0.40 (25)

* None of the differences between transects or areas are significant ($P > 0.05$) except for a, b, c, and d.

Table 13. Summary of fish catch of all dredge tows, R/V Chapman cruise, Nov. 1981.

	Percent by Weight
Dover sole	24.70
slender sole	20.53
rex sole	18.22
Pacific sanddab	12.12
poacher sp.	4.70
sculpin sp.	3.60
butter sole	3.30
sand sole	1.98
English sole	1.41
shiner perch	1.39
eelpout sp.	1.06
Pacific hake	0.89
longnose skate	0.76
warty poacher	0.71
Pacific tomcod	0.66
gray starsnout	0.63
skate sp.	0.60
Pacific staghorn sculpin	0.59
snailfish sp.	0.47
juvenile rockfish sp.	0.42
spotted ratfish	0.30
smelt	0.28
petrale sole	0.17
big skate	0.12
northern spearnose poacher	0.09
curlfin sole	0.04
rougheye rockfish	0.04
sturgeon poacher	0.04
arrowtooth flounder	0.03
shortfin eelpout	0.03
sablefish	0.03
Pacific hagfish	0.01
Pacific electric ray	0.01
northern anchovy	0.01
prickleback	0.01
yelloweye rockfish	0.01
tubenose poacher	0.01
spinycheek starsnout	0.01
Total	99.98

Table 14. Average diversity index ($\bar{H}$) for fish species caught in dredge hauls by depth range R/V Chapman cruise, Nov. 1981 (number of tows).

	Coos Bay			Tillamook		
Depth	North	South	Overall	North	South	Overall
1	1.74 ± 0.37 (6)	1.31 ± 0.53 (13)	1.45 ± 0.88 (10)	1.45 ± 0.09 (4)	1.49 ± 0.23 (4)	1.23 ± 0.14 (8)
2	1.63 ± 0.28 (3)	1.54 ± 0.14 (5)	1.49 ± 0.25 (6)	1.09 ± 0.20 (3)	1.34 ± 0.09 (3)	1.22 ± 0.20 (6)
3	1.33 ± 0.28 (7)	1.35 ± 0.13 (6)	1.37 ± 0.25 (13)	1.58 ± 0.14 (5)	1.43 ± 0.34 (6)	1.50 ± 0.27 (11)
Total	1.54 ± 0.14 (16)	1.37 ± 0.41 (24)	1.49 ± 0.29 (29)	1.42 ± 0.24 (12)	1.43 ± 0.25 (13)	1.42 ± 0.24 (25)

the more evenly distributed the proportions, the higher the index. Depth 2 (45-60 fm) in Tillamook north, and depth 3 (>60 fm) in both Coos Bay transects had significantly lower ($P \leq 0.05$) diversity indices that other depth regimes in their respective areas because of one or two species with a high percentage of the total weight. In the Coos Bay areas the dominant fish species was slender sole and in the Tillamook north transect Dover and rex soles dominated the fish catch.

A more detailed analysis of these differences could be done but was not one of our primary objectives. Steiner et al. (1982) found an association between sea scallops (*P. magellanicus*) and juvenile red hake (*Urophycis chuss*). The juvenile hake utilized shell and live scallops for shelter. We found no such association with any fish species.

Dungeness crab. Table 15 summarizes the numbers of Dungeness crab caught per tow by depth regime. There is some indication that sexes are segregated by depth, perhaps due to migrations. In both areas males were found only in shallow depths. In the Tillamook areas, females were found in all depth regimes but the catch rate was higher in deeper areas. However, in Coos Bay areas the female catch rate was highest in depth 1 (<45 fm). This may indicate that a movement of female crabs to deeper water started earlier in the Tillamook area and was just beginning in the Coos Bay area.

The Dungeness crabs off the Oregon coast molt annually during late summer and early fall. As indicated by shell conditions (Table 16), the crabs in the survey areas finished molting by the time of the November 1981 cruise. Most were in condition #1 (hard shell) and none were found in condition #3 (soft shell). The Tillamook area had a higher percentage of crabs in condition #1 than did the Coos Bay area (81.8% vs 72.3%), which may indicate a slightly earlier molting period in the Tillamook area.

Table 15. Number of Dungeness crab caught per tow by depth range, R/V *Chapman* cruise, Nov. 1981.

Transect		North					South					Total				
				#/tow					#/tow					#/tow		
Area	Depth	#tows	#crabs	M	F	Total	#tows	#crabs	M	F	Total	#tows	#crabs	M	F	Total
Tillamook	1	4	3	0.5	0.25	0.75	4	-	-	-	-	8	3	0.3	0.1	0.4
	2	3	-	-	-	-	3	1	-	0.3	0.3	6	1	-	0.2	0.2
	3	5	4	-	0.8	0.8	6	3	-	0.5	0.5	11	7	-	0.6	0.6
	Total	12	7	0.2	0.4	0.6	13	4	-	0.3	0.3	25	11	0.1	0.3	0.4
Coos Bay	1	6	149	21.8	3.0	24.8	13	17	0.8	0.5	1.3	19	166	7.4	1.3	8.7
	2	3	1	-	0.3	0.3	5		-	-	-	8	1	-	0.1	0.1
	3	7	1	-	0.1	0.1	6	1	-	0.2	0.2	13	2	-	0.2	0.2
	Total	16	151	8.2	1.2	9.4	24	18	0.4	0.3	0.7	40	169	3.5	0.7	4.2

Table 16. Number and percentage of Dungeness crab caught by shell condition, R/V Chapman cruise, Nov. 1981.

	Males			Females			Total		
Shell condition	1	2	3	1	2	3	1	2	3
Coos Bay north	88	41	-	15	4	-	103	45	-
south	10	-	-	7	1	-	17	1	-
Total	98	41	-	22	5	-	120	46	-
Tillamook north	-	2	-	5	-	-	5	2	-
south	-	-	-	4	-	-	4	-	-
Total	-	2	-	9	-	-	9	2	-
				By percent					
Coos Bay north	68.2	31.8	-	78.9	21.1	-	69.6	30.0	-
south	100.0	-	-	87.5	12.1	-	94.4	5.6	-
Total	70.5	29.5	-	81.5	18.5	-	72.3	27.7	-
Tillamook north	-	100.0	-	100.0	-	-	71.4	28.6	-
south	-	-	-	100.0	-	-	100.0	-	-
Total	-	100.0	-	100.0	-	-	81.8	18.2	-

Condition 1: hard shell

Condition 2: medium shell

Condition 3: soft shell

This molting difference may be associated with the earlier migration of females to deeper water off Tillamook Head.

Data were collected and analyzed concerning mortalities of Dungeness crab by sex, depth regime, and shell condition, but were insufficient to draw conclusions.

Summary

We designed a research program to answer questions arising from the large 1981 scallop fishery. A major task after the initial literature review was to analyze data from the cooperative research cruise aboard the R/V Chapman. Results of the R/V Chapman cruise showed that distribution and relative abundance in 1981 was similar to the 1963 and 1967 surveys. Scallops were most abundant in the 45-60 fm range. We calculated from commercial comparative tows that the scallop catch of two 3.7m (12 ft) commercial New Bedford scallop dredges averaged 9.2 times more per tow than the 0.3m (8 ft) research dredge used aboard the R/V Chapman.

The ratio of male to female scallops was nearly 1:1, and all were dioecious; similar to Alaskan *P. caurinus* stocks. Population characteristics of males and females were not significantly different ($P > 0.05$).

Scallops in the Coos Bay area had different population characteristics than scallops off Tillamook Head. There were few differences between transects within each area, but all differences between areas were significant ($P \leq 0.05$).

In both areas scallops were larger and younger in shallow water, but scallops in the Coos Bay area were significantly larger ($P \leq 0.05$) at each age than in the Tillamook area. Therefore, growth appears to be faster in the Coos Bay area than in the Tillamook area. The Coos Bay scallop beds were dominated by one strong year-class, whereas recruitment was more constant off Tillamook Head as evidenced by the more even age distribution. The mean age of scallops in Coos Bay beds was significantly younger ($P \leq 0.05$) than off Tillamook Head.

Miscellaneous invertebrates and fish comprised almost 50% of the

total weight of the incidental catch. Species diversity was significantly ($P \leq 0.05$) different between depth regimes. Most Dungeness crabs were hard shell and male crabs were caught only in shallow water (<45 fm).

F/V GRANADA CRUISE

We chartered the F/V Granada, a 23m (75 ft) double rigged shrimper for a scallop research cruise in August 1982. The vessel had high catch-per-unit-effort (CPUE) statistics during the 1981 scallop fishery. Since our primary objective was to test methods of catching juvenile scallops, we planned to return to the CCT area off Tillamook Head where the most juveniles were caught in the 1981 R/V Chapman survey (Fig. 9). We chose the CCT area because we decided our gear trials would be most effective in areas where juveniles were abundant.

Methods

The principal sampling tools were two 3.7m (12 ft) wide New Bedford dredges with tickler chains and 90mm (3.5 in) polypropylene mesh bags. One dredge bag was lined with 25mm (1 in) stretch mesh made from #18 nylon seine twine. A catch net of 13mm (0.5 in) stretch mesh on the outside of the dredge bag covered one-fourth of the circumference of the codend. The other dredge bag was lined with 38mm (1.5 in) stretch mesh made from #18 nylon seine twine. A similar catch net covered one-fourth of the circumference of the codend. We also built hoods for the dredge and net to determine if scallops escaped over the dredge. OSU's 3m (10 ft) beam trawl with 13mm (0.5 in) stretch-mesh bag and their $0.5m^2$ ($5.4\ ft^2$) epibenthic sled completed the array of tools used for sampling scallops. We took OSU's stereoscopic camera and Smith-McIntyre bottom grab, but

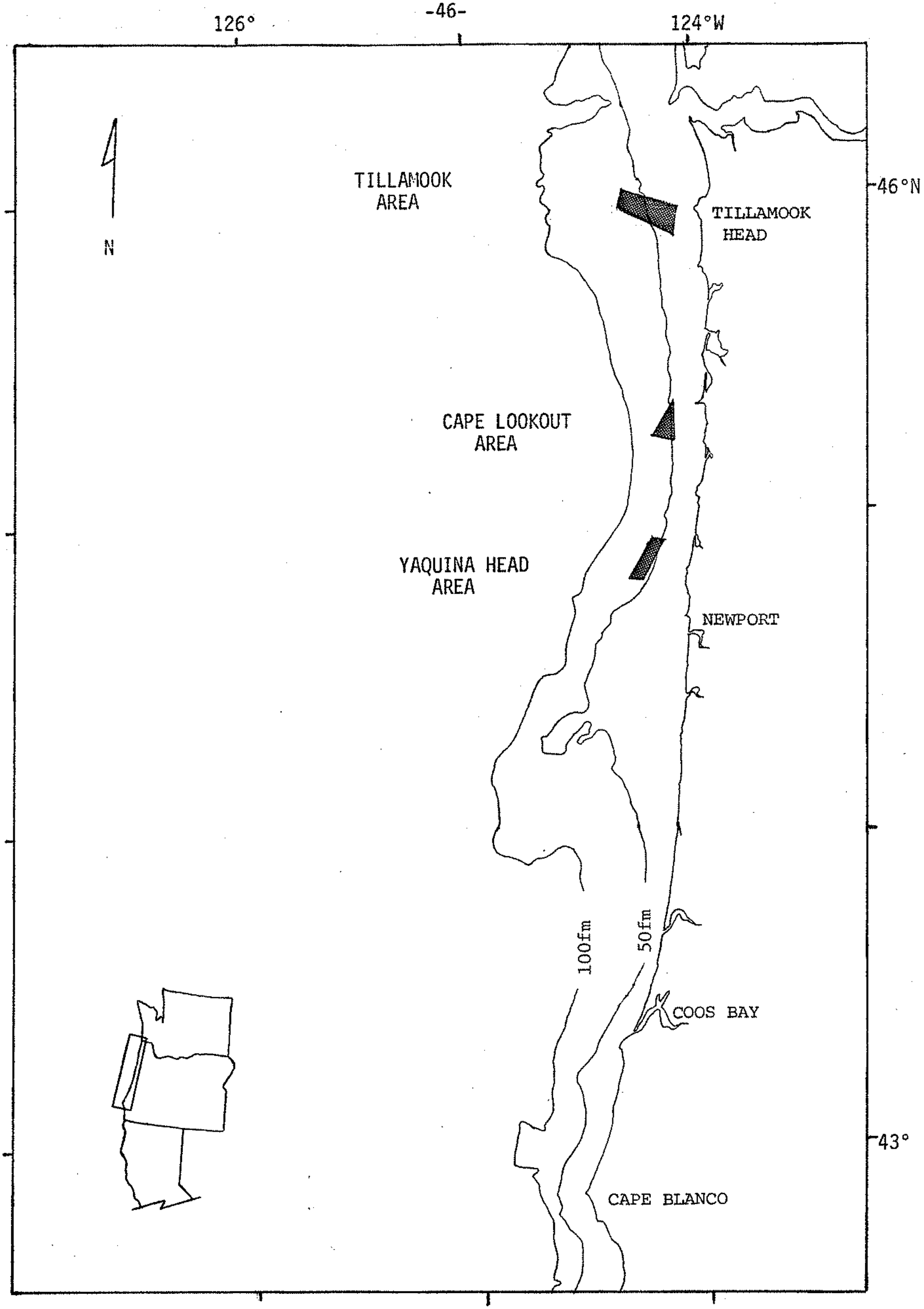


Figure 9. Location of scallop dredge areas for F/V *Granada* cruise, Aug. 1982.

collected only 5 bottom grabs, and did not employ the camera.

We planned to conduct the gear trials in sets of ten tows. Each tow was planned to last 0.5 hr. Table 17 shows the intended sampling design.

Table 17. Intended sampling design for F/V Granada cruise, August 1982.

Set	Number Tows	Speed (knts)	Scope		Gear
1	10	4	3:1	A.	Dredge with 25mm mesh liner (catch net on end)
				B.	Dredge with 38mm mesh liner (catch net on end)
2	10	5	4:1	A.	Dredge with 25mm mesh liner
				B.	Dredge with 38mm mesh liner
3	10	6	5:1	A.	Dredge with 25mm mesh liner
				B.	Dredge with 38mm mesh liner
4	9-12	4-6	3:1-5:1	A.	Dredge with liner
				B.	Dredge with liner and hood (13mm mesh bag)
5	9-12	1½	4½:1	C.	OSU Epibenthic sled OSU Beam Trawl w/camera
6	As needed			C.	Transects across range of juvenile distribution

We suspended our gear trials because we did not locate enough juvenile scallops in the CCT area to adequately test our gear. We decided to search elsewhere for juveniles and resume our tests when we encountered enough juveniles to make our tests statistically valid.

Since we did not locate many juveniles in the CCT area in Tillamook we moved both shallower and deeper and sampled with the dredges at two speed and scope settings at each station until we were beyond the range in which we located adult scallops in 1981. As we still did not locate many juvenile scallops, we moved south and continued searching off Cape Lookout, Cascade Head, and Yaquina Head (Fig. 9). We completed transects across the range of scallops from shallow to deep water between Cascade Head and Cape Lookout, but still found few juveniles. We encountered larger concentrations of juveniles off Yaquina Head and resumed our gear tests.

After each tow the codend of the dredge nets was brought on board. We first checked the catch nets to see what passed through the liner and dredge bag. We then opened the codend of each net and placed the catch in separate bins on the sorting table. We identified the by-catch by major species groups as either present (number <5% of the total catch) or abundant (number >5% of the total catch). We counted all juvenile scallops and placed them in labeled jars for OSU's analysis. We counted, measured, and weighed adult scallops and Dungeness crabs. Scallop shells were counted and checked for spat. We saved samples of adults from each transect for age, height, weight, and gonad analysis.

Results

Appendix Tables 14 through 17 summarize the catch of our August 1982 research cruise. We will analyze the data during the FY 83 fiscal year. The data were collected in such a way to maximize their usefulness for comparison with the R/V Chapman cruise results.

ACKNOWLEDGMENTS

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APPENDIX

Table 1. *P. caurinus* mean shell height (mm ± SD) by sex, R/V Chapman cruise, Nov. 1981.* (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
Coos Bay - North				
Males	120.3 ± 11.3 (34)	114.8 ± 3.9 (12)	-	118.9 ± 10.2 (46)
Females	123.3 ± 11.5 (18)	115.1 ± 2.6 (14)	-	119.7 ± 9.6 (32)
Coos Bay - South				
Males	122.8 ± 9.0 (38)	114.3 ± 3.3 (11)	-	120.9 ± 8.8 (49)
Females	123.8 ± 10.4 (38)	116.1 ± 3.0 (9)	-	122.4 ± 9.9 (47)
Tillamook - North				
Males	107.6 ± 10.0 (58)**	103.8 ± 4.4 (35)	-	106.2 ± 8.6 (93)**
Females	111.8 ± 10.0 (51)	105.5 ± 4.4 (40)	-	109.0 ± 8.6 (91)
Tillamook - South				
Males	110.4 ± 6.7 (11)	109.4 ± 7.1 (79)	111.3 ± 4.1 (16)	109.8 ± 6.7 (106)**
Females	115.1 ± 6.9 (19)	110.7 ± 6.1 (78)	111.6 ± 4.3 (13)	111.6 ± 6.2 (110)

* None of the between sex differences are significant at the P > 0.05 level, except for
** which are not significant at P > 0.01.

Table 2. *P. caurinus* mean meat weight (gm ± SD) by sex, R/V Chapman cruise, Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
Coos Bay - North				
Males	19.3 ± 8.1 (34)	13.8 ± 1.6 (12)	-	17.8 ± 7.4 (46)
Females	21.9 ± 8.5 (18)	14.3 ± 1.4 (14)	-	18.6 ± 7.4 (32)
Coos Bay - South				
Males	19.8 ± 5.5 (38)	14.5 ± 1.8 (11)	-	18.6 ± 5.4 (49)
Females	22.2 ± 7.3 (38)	15.0 ± 1.7 (9)	-	20.8 ± 7.1 (47)
Tillamook - North				
Males	11.1 ± 5.1 (58)	9.5 ± 2.2 (35)	-	10.5 ± 4.3 (93)
Females	15.1 ± 4.8 (51)	10.5 ± 1.9 (40)	-	13.1 ± 4.4 (91)
Tillamook - South				
Males	13.5 ± 3.2 (11)	12.3 ± 2.5 (64)	11.9 ± 1.5 (16)	12.4 ± 2.5 (91)
Females	17.2 ± 4.0 (19)	12.5 ± 2.5 (64)	11.7 ± 1.8 (13)	13.3 ± 3.4 (96)

* None of the between sex differences were significant at $P > 0.05$.

Table 3. *P. caurinus* mean meat yield (percentage of whole weight ± SD) by sex, R/V Chapman cruise, Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
Coos Bay - North				
Males	10.1 ± 1.5 (34)	9.6 ± 1.0 (12)	-	9.9 ± 1.4 (46)
Females	10.6 ± 0.8 (18)	9.4 ± 0.7 (14)	-	10.1 ± 0.9 (32)
Coos Bay - South				
Males	10.9 ± 1.3 (38)	10.2 ± 1.0 (11)	-	10.7 ± 1.3 (49)
Females	11.5 ± 1.8 (38)	9.8 ± 0.6 (9)	-	11.2 ± 1.8 (47)
Tillamook - North				
Males	9.4 ± 2.8 (58)	8.8 ± 1.3 (35)	-	9.2 ± 2.4 (93)**
Females	11.5 ± 2.8 (51)	9.4 ± 0.8 (40)	-	10.6 ± 2.4 (91)
Tillamook - South				
Males	10.6 ± 0.8 (11)**	10.3 ± 1.4 (64)	8.6 ± 0.8 (16)	10.0 ± 1.4 (91)
Females	11.7 ± 1.0 (19)	10.2 ± 1.5 (64)	8.7 ± 1.3 (13)	10.3 ± 1.7 (96)

* None of the between sex differences are significant at the P > 0.05 level except for **.

Table 4. Mean whole weight (gm ± SD) of *P. caurinus* by depth, transect, and area, R/V Chapman cruise Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
COOS BAY:				
North transect	194.3 ± 68.8 (52)	148.2 ± 12.1 (26)	-	178.9 ± 60.5 (78)
South transect	186.4 ± 48.5 (76)	147.2 ± 14.2 (20)	-	178.3 ± 46.4 (96)
Overall	189.6 ± 57.5 (128)	147.8 ± 12.9 (46)	-	178.6 ± 53.0 (174)
TILLAMOOK:				
North transect	124.9 ± 43.0 (109)	109.3 ± 16.9 (75)	-	118.5 ± 35.6 (184)
South transect	140.4 ± 32.7 (30)	121.9 ± 23.0 (128)	136.6 ± 13.3 (29)	127.1 ± 24.8 (187)
Overall	128.2 ± 41.4 (139)	117.2 ± 21.8 (203)	136.6 ± 13.3 (29)	122.9 ± 30.9 (371)

* In the Coos Bay area only the between depth differences are significant ($P \leq 0.05$). In the Tillamook area all the differences are significant ($P \leq 0.05$).

Table 5. Mean meat weights (gm ± SD) of *P. caurinus* by depth, transect, and area, R/V Chapman cruise Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
COOS BAY:				
North transect	20.2 ± 8.3 (52)	14.0 ± 1.4 (26)	-	18.1 ± 7.4 (78)
South transect	21.0 ± 6.5 (76)	14.7 ± 1.7 (20)	-	19.7 ± 6.4 (96)
Overall	20.7 ± 7.2 (128)	14.3 ± 1.6 (46)	-	19.0 ± 6.9 (174)
TILLAMOOK:				
North transect	13.0 ± 5.3 (109)	10.0 ± 2.1 (75)	-	11.8 ± 4.5 (184)
South transect	15.9 ± 4.1 (30)	12.4 ± 2.5 (128)	11.8 ± 1.6 (29)	12.9 ± 3.0 (187)
Overall	13.6 ± 5.2 (139)	11.5 ± 2.6 (203)	11.8 ± 1.6 (29)	12.3 ± 3.9 (371)

* In the Coos Bay area the between depth difference is significant ($P \leq 0.05$) and the between transect differences are not significant ($P > 0.05$). In the Tillamook area all between transect and depth differences are significant ($P \leq 0.05$) except for the difference between depths 2 and 3.

Table 6. Mean meat yield (percentage of whole weight ± SD) of *P. caurinus* by depth, transect, and area, R/V Chapman cruise, Nov. 1981*. (N)

	Depth 1 (<45f)	Depth 2 (45-60f)	Depth 3 (>60f)	Total
COOS BAY:				
North transect	10.3 ± 1.3 (52)	9.5 ± 0.8 (26)	-	10.0 ± 1.2 (78)
South transect	11.2 ± 1.6 (76)	10.0 ± 0.8 (20)	-	10.9 ± 1.5 (96)
Overall	10.8 ± 1.5 (128)	9.7 ± 0.9 (46)	-	10.5 ± 1.5 (174)
TILLAMOOK:				
North transect	10.4 ± 3.0 (109)	9.1 ± 1.1 (75)	-	9.9 ± 2.5 (184)
South transect	11.3 ± 1.0 (30)	10.3 ± 1.5 (128)	8.7 ± 1.0 (29)	10.2 ± 1.5 (187)
Overall	10.6 ± 2.7 (139)	9.8 ± 1.4 (203)	8.7 ± 1.0 (29)	10.0 ± 2.1 (371)

* In both areas all between depth and between transect differences are significant ($P \leq 0.05$).

Table 7. Species list of catch of R/V Chapman cruise, Nov. 1981.

Common Name	Scientific Name
sea pen, sea whip	Pennatulacea
sea star	Asteroidea
sea cucumber	Holothuroidea
brittle star	Ophiuroidea
basket star	*Gorgonocephalus eucnemis*
heart urchin	*Brisaster latiforns*
weathervane scallop	*Patinopecten caurinus*
market squid	*Loligo opalescens*
octopus	Octopodidae
pink shrimp	*Pandalus jordani*
Dungeness crab	*Cancer magister*
other crab	Brayura
Pacific hagfish	*Eptatretus stouti*
Pacific electric ray	*Torpedo californica*
big skate	*Raja binoculata*
longnose skate	*Raja rhina*
other skates	Rajidae
spotted ratfish	*Hydrolagus colliei*
northern anchovy	*Engraulis mordax*
smelt	Osmeridae
Pacific hake	*Merluccius productus*
Pacific tomcod	*Microgadus proximus*
shortfin eelpout	*Lycodes brevipes*
other eelpout	Zoarcidae
shiner perch	*Cymatogaster aggregata*
prickleback	Stichaeidae
rougheye rockfish	*Sebastes aleutianus*
yelloweye rockfish	*Sebastes ruberrimus*
juvenile rockfish	Scorpaenidae
sablefish	*Anoplopoma fimbria*
Pacific staghorn sculpin	*Leptocottus armatus*
other cottids	Cottidae
northern spearnose poacher	*Agonopsis vulsa*
sturgeon poacher	*Agonus acipenserinus*
gray starsnout	*Bathyagonus alascanus*
spinycheek starsnout	*Bathyagonus infraspinatus*
warty poacher	*Occella verrucosa*
tubenose poacher	*Pallasina barbata*
other poachers	Agonidae
snailfish	Cyclopteridae
Pacific sanddab	*Citharichthys sordidus*
arrowtooth flounder	*Atheresthes stomias*
petrale sole	*Eopsetta jordani*
rex sole	*Glyptocephalus zachirus*
butter sole	*Isopsetta isolepis*
slender sole	*Lyopsetta exilis*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
curlfin sole	*Pleuronichthys decurrens*
sand sole	*Psettichthys melanostictus*

Table 8. Summary of by-catch, Tillamook area by percent of total weight, R/V Chapman cruise, Nov. 1981.

North Transect	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
debris	23.12	6.80	12.83	31.42
fish	21.81	28.82	37.20	14.75
heart urchin	13.42	0.00	5.26	20.15
sea cucumbers	12.90	0.00	0.00	20.97
sea stars	7.24	12.47	8.40	5.26
P. caurinus	5.77	19.28	10.65	0.06
misc. invertebrates	4.99	14.01	8.53	1.09
large *P. caurinus* shell	4.72	16.28	7.31	0.35
basket stars, sea pens, sea whips	3.60	0.00	6.41	3.81
C. magister	1.16	2.00	0.00	1.27
pink shrimp	0.53	0.00	2.69	0.00
other crabs	0.47	0.00	0.00	0.76
small *P. caurinus* shell	0.23	0.27	0.58	0.10
P. caurinus juveniles	0.05	0.07	0.13	0.02
Total weight	794.1	149.90	155.9	488.3
No. tows	12	4	3	5
$\bar{H}$	1.54	1.47	1.76	1.47

South Transect	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
heart urchin	28.99	0.00	0.00	58.10
fish	24.23	29.26	29.05	19.31
P. caurinus	10.69	8.79	29.20	0.03
sea stars	9.69	25.99	6.53	5.32
miscellaneous invertebrates	8.16	5.14	15.01	5.11
debris	7.19	23.89	3.73	2.84
large *P. caurinus* shell	4.55	2.18	10.60	1.75
basket stars, sea pens, sea whips	4.39	2.33	4.91	4.86
C. magister	0.84	0.00	0.49	1.39
pink shrimp	0.48	0.00	0.00	0.97
algae	0.41	2.10	0.00	0.00
small *P. caurinus* shell	0.23	0.16	0.15	0.30
P. caurinus juveniles	0.12	0.00	0.34	0.03
other crabs	0.03	0.16	0.00	0.00
Total weight	663.3	128.5	203.8	331.0
No. tows	13	4	3	6
$\bar{H}$	1.23	1.36	1.59	0.97

Table 9. Summary of by-catch, Coos Bay area by percent of total weight, R/V Chapman cruise, Nov. 1981.

North Transect	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
miscellaneous invertebrates	38.99	47.60	28.49	34.80
fish	20.73	10.16	22.18	30.08
heart urchin	9.73	0.00	11.61	18.14
C. magister	7.65	18.29	1.04	0.15
debris	6.08	4.95	6.70	6.90
sea stars	5.57	8.95	6.30	2.14
large *P. caurinus* shell	3.30	5.29	6.95	0.09
basket stars, sea pens, sea whips	2.79	0.00	5.76	4.30
P. caurinus	2.51	4.33	4.71	0.00
sea cucumbers	1.55	0.00	4.17	2.03
small *P. caurinus* shell	0.35	0.14	0.84	0.37
octopus	0.30	0.00	0.00	0.70
pink shrimp	0.19	0.00	0.60	0.22
other crabs	0.11	0.08	0.50	0.00
algae	0.10	0.22	0.05	0.00
P. caurinus juveniles	0.05	0.00	0.10	0.07
Total weight	1258.4	510.7	201.5	546.2
No. tows	16	6	3	7
$\bar{H}$	1.40	1.42	1.77	1.21

South Transect	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
miscellaneous invertebrates	32.79	33.41	18.42	39.54
fish	22.95	22.14	20.51	25.75
sea stars	9.86	13.01	6.51	6.03
algae	9.65	8.61	29.98	0.38
large *P. caurinus* shell	5.49	8.06	7.09	0.00
P. caurinus	4.99	8.14	3.83	0.00
basket stars, sea pens, sea whips	4.66	0.00	4.94	12.86
sea cucumbers	3.04	0.00	0.00	10.16
debris	2.42	2.96	4.13	0.51
C. magister	1.96	3.49	0.00	0.29
heart urchin	1.43	0.00	3.83	2.67
small *P. caurinus* shell	0.57	0.11	0.76	1.30
pink shrimp	0.09	0.00	0.00	0.29
squid	0.05	0.05	0.00	0.06
P. caurinus juveniles	0.04	0.00	0.00	0.13
other crabs	0.01	0.02	0.00	0.00
ocotpus	0.01	0.00	0.00	0.03
Total weight	1051.2	564.2	172.1	314.9
No. tows	24	13	5	6
$\bar{H}$	1.47	1.47	1.58	1.37

Table 10. Fish species caught in Coos Bay north transect by percent of weight, R/V Chapman cruise, Nov. 1981.

	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
slender sole	33.54	2.16	17.19	53.82
Dover sole	16.43	20.63	21.09	13.08
rex sole	12.22	12.18	35.94	6.14
Pacific sanddab	7.45	23.38	2.73	0.50
poacher sp.	8.93	0.59	0.78	15.29
sculpin sp.	3.98		8.59	4.83
sand sole	2.73	9.43		
longnose skate	2.16		6.25	2.21
eelpout sp.	2.16		4.69	2.62
butter sole	1.93	6.68		
shiner perch	1.82	6.29		
Pacific tomcod	1.36	4.72		
Pacific staghorn sculpin	1.08	3.73		
warty poacher	1.08	3.73		
snailfish	0.97	3.14	0.39	
English sole	0.74	2.55		
skate sp.	0.45		0.39	0.70
Pacific hake	0.45		1.17	0.50
juv. rockfish sp.	0.23		0.78	0.20
petrale sole	0.06	0.20		
sablefish	0.06	0.20		
big skate	0.06	0.20		
northern anchovy	0.06			0.10
smelt	0.06	0.20		
Total weight (lbs)	260.9	51.9	44.7	164.3
Number of species	24	17	12	12

Table 11. Fish species caught in Coos Bay south transect by percent of weight, R/V Chapman cruise, Nov. 1981.

	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
slender sole	27.76	1.18	25.56	49.85
Dover sole	19.21	22.80	29.71	13.86
Pacific sanddab	11.99	27.25	6.39	0.88
rex sole	10.43	4.09	27.80	11.58
butter sole	6.50	16.35		
poacher sp.	6.25	0.27	0.64	12.39
sculpin sp.	4.33	2.27	4.79	5.90
sand sole	2.96	7.45		
Pacific hake	1.91	4.09		0.59
gray starsnout	1.73		0.32	3.47
English sole	1.55	3.91		
skate sp.	0.90	1.45	0.64	0.52
Pacific tomcod	0.87	2.18		
warty poacher	0.61	1.54		
snailfish	0.58	1.18	0.96	
shiner perch	0.47	1.18		
Pacific staghorn sculpin	0.47	1.18		
petrale sole	0.22	0.54		
eelpout	0.22			0.44
longnose skate	0.18		0.64	0.22
northern spearnose poacher	0.18	0.09	1.28	
curlfin sole	0.11	0.27		
big skate	0.11	0.27		
rougheye rockfish	0.11		0.96	
shortfin eelpout	0.07			0.15
arrowtooth flounder	0.04	0.09		
Pacific hagfish	0.04			0.07
spotted ratfish	0.04			0.07
smelt	0.04	0.09		
juv. rockfish sp.	0.04		0.32	
sablefish	0.04	0.09		
tubenose poacher	0.04	0.09		
spinycheek starsnout	0.04	0.09		
Total weight (lbs)	241.3	124.9	35.3	81.1
Number of species	33	25	13	14

Table 12. Fish species caught in the Tillamook north transect by percent of weight, R/V *Chapman* cruise, Nov. 1981.

	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
Dover sole	34.83	33.68	42.96	27.22
rex sole	27.60	23.09	45.35	14.12
Pacific sanddab	12.55	26.74	3.82	
slender sole	8.78	2.95	2.39	25.56
sculpin sp.	2.73		1.67	8.33
eelpout sp.	1.70		0.48	5.83
poacher sp.	1.62	0.69	1.19	3.61
English sole	1.62	3.82		
spotted ratfish	1.33			5.00
juv. Rockfish sp.	1.33	0.17	0.72	3.89
butter sole	1.03	2.43		
longnose skate	0.89			3.33
shiner perch	0.81	1.91		
warty poacher	0.73	1.56	0.24	
sand sole	0.52	1.21		
skate sp.	0.52		0.48	1.39
smelt	0.37	0.17	0.24	0.83
Pacific staghorn sculpin	0.30	0.69		
petrale sole	0.15	0.17	0.24	
big skate	0.15	0.35		
northern spearnose poacher	0.15			0.56
snailfish	0.15	0.17	0.24	
prickleback	0.07			0.28
sturgeon poacher	0.07	0.17		
Total weight (lbs)	173.2	43.2	58.0	72.0
Number of species	24	17	13	13

Table 13. Fish species caught in the Tillamook south transect by percent of weight, R/V Chapman cruise, Nov. 1981.

	Total	Depth 1 (<45fm)	Depth 2 (45-60fm)	Depth 3 (>60fm)
Dover sole	33.99	11.83	41.40	43.27
rex sole	29.42	10.97	41.30	28.16
Pacific sanddab	16.76	46.45	7.48	3.27
slender sole	4.91	2.58	2.84	10.41
shiner perch	2.89	9.03	1.03	
sculpin sp.	2.72		2.58	5.51
English sole	1.68	6.02	0.13	
butter sole	1.32	4.95		
sand sole	0.81	3.01	1.16	
smelt	0.81			1.02
eelpout sp.	0.81	0.22	0.13	2.45
juv. rockfish sp.	0.52		0.39	1.22
Pacific staghorn sculpin	0.52	1.29	0.39	
warty poacher	0.46	1.51		0.20
Pacific hake	0.40			1.43
skate sp.	0.35	0.22	0.39	0.41
poacher sp.	0.35			1.22
petrale sole	0.23	0.65	0.13	
spotted ratfish	0.23			0.82
big skate	0.17	0.43	0.13	
longnose skate	0.17		0.13	0.41
Pacific tomcod	0.12	0.22	0.13	
sturgeon poacher	0.12	0.22	0.13	
arrowtooth flounder	0.06			0.20
Pacific electric ray	0.06		0.13	
yelloweye rockfish	0.06	0.22		
snailfish	0.06	0.22		
Total weight (lbs)	160.7	37.6	59.2	63.9
Number of species	27	18	18	15

Table 14. Summary of dredge hauls, F/V Granada cruise Aug. 1982, Tillamook Head.

Depth (fm)	Scope, Speed (knts)	Station	Shell		Scallops		Dungeness crabs
			Large	Small	Adult	Juvenile	
35	3½:1, 4	Stbd	6	3	37	1	1
		Port	3	2	12	-	-
40	3½:1, 4	Stbd	19	4	132	-	7
		Port	27	3	108	-	3
40	5:1, 6	Stbd	14	3	176	-	10
		Port	11	6	108	-	5
43	3½:1, 4	Stbd	25	9	127	-	3
		Port	19	3	182	1	7
43	4:1, 4½	Stbd	18	1	87	-	5
		Port	18	1	161	-	9
44	5:1, 6	Stbd	31	5	337	-	7
		Port	23	5	212	1	4
47	3½:1, 4	Stbd	19	3	81	1	5
		Port	28	4	112	-	6
47	5:1, 6	Stbd	45	11	184	1	10
		Port	27	4	83	1	9
50	3½:1, 4	Stbd	13	3	24	-	6
		Port	17	-	32	-	2
50	4½:1, 5	Stbd	19	7	70	2	4
		Port	21	6	91	-	4
50	5:1, 6	Stbd	23	1	78	2	5
		Port	22	4	105	-	12
52	3½:1, 4	Stbd	30	2	78	-	10
		Port	20	2	49	-	16
52	5:1, 6	Stbd	40	15	231	3	16
		Port	29	3	152	-	10
55	3½:1, 4	Stbd	11	8	8	1	3
		Port	26	8	31	-	6
55	5:1, 6	Stbd	14	5	43	-	5
		Port	23	3	62	-	10
58	3½:1, 4	Stbd	12	14	2	-	16
		Port	9	9	3	-	10

Table 14. Continued.

Depth (fm)	Scope, Speed (knts)	Station	Shell		Scallops		Dungeness crabs
			Large	Small	Adult	Juvenile	
58	5:1, 6	Stbd	5	31	-	1	5
		Port	1	8	2	-	8
61	3:1, 4	Stbd	20	105	7	1	11
		Port	9	33	7	-	21
61	5:1, 6	Stbd	4	38	3	-	-
		Port	3	8	-	-	6
64	3:1, 4	Stbd	6	36	1	-	4
		Port	12	25	1	-	11
64	5:1, 6	Stbd	12	129	5	1	9
		Port	7	17	1	-	5
69	3½:1, 4	Stbd	73	25	7	1	6
		Port	62	29	6	-	4
69	5:1, 6	Stbd	27	12	3	-	1
		Port	11	-	-	-	-

Table 15. Summary of dredge hauls, F/V Granada cruise Aug. 1982, Cape Lookout.

Depth (fm)	Scope, Speed (knts)	Station	Shell		Scallops		Dungeness crabs
			Large	Small	Adult	Juvenile	
45	4:1, 4	Stbd	15	3	48	-	1
		Port	29	-	93	1	-
46	4:1, 4	Stbd	12	2	48	-	1
		Port	5	-	14	-	2
50	4:1, 4	Stbd	41	2	111	-	3
		Port	79	5	171	-	2
51	3½:1, 4	Stbd	18	7	41	-	5
		Port	*	*	*	*	*
55	3½:1, 4	Stbd	6	2	17	-	-
		Port	2	-	1	-	-
60	4:1, 4	Stbd	46	62	274	2	5
		Port	29	49	170	-	5
60	4:1, 4	Stbd	70	177	457	4	6
		Port	90	197	723	3	5
60	5:1, 6	Stbd	66	143	482	2	9
		Port	3	4	5	-	1
60	4:1, 4.2	Stbd	51	99	267	2	8
		Port	56	125	258	-	7
63	4:1, 4	Stbd	41	142	244	1	5
		Port	8	45	41	-	1
65	4:1, 4	Stbd	75	598	5	3	9
		Port	92	460	10	-	8
70	4:1, 4	Stbd	135	838	1	1	2
		Port	**	**	**	**	**
75	4:1, 4	Stbd	79	694	-	4	2
		Port	105	469	1	-	-
80	4:1, 4	Stbd	2	16	-	-	-
		Port	2	18	-	-	-

* Did not fish

** Did not sample

Table 16. Summary of epibenthic sled and beam trawl hauls, F/V Granada cruise Aug. 1982, Tillamook Head.

Depth (fm)	Scope, Speed (knts)	Station	Shell		Scallops		Dungeness crabs
			Large	Small	Adult	Juvenile	
52	4½:1, 1½	Beam Trawl	1	-	-	-	-
		Epibenthic sled	-	3	2	-	-
52	4½:1, 2	Beam Trawl	1	-	-	-	-
		Epibenthic sled	-	-	1	-	-

Table 17. Summary of dredge hauls, F/V Granada cruise Aug. 1982, Siletz River Mouth-Yaquina Head.

Depth (fm)	Scope, Speed (knts)	Station	Shell		Scallops		Dungeness crabs
			Large	Small	Adult	Juvenile	
50	4:1, 4	Stbd	5	-	35	-	4
		Port	2	-	30	-	5
55	4:1, 4	Stbd	2	1	53	2	1
		Port	14	2	119	-	2
57	4:1, 4	Stbd	12	62	521	4	-
		Port	*	*	1156	8	2
60	4:1, 4	Stbd	*	*	1379	27	3
		Port	*	*	2269	12	1
60	5:1, 6	Stbd	1	3	7	-	-
		Port	1	4	8	-	-
60	4:1, 4	Stbd	*	*	920	14	-
		Port	*	*	1257	17	-
60	4:1, 4	Stbd	*	*	7	1	-
		Port	*	*	45	2	-
60	4:1, 4	Stbd	*	*	1510	22	1
		Port	*	*	2055	17	5

* Not counted due to excessive volume of catch.