NORTHWEST & ALASKA FISHERIES CENTER PROCESSED REPORT

INITIAL ASSESSMENTS OF THE DISTRIBUTION, ABUNDANCE, AND QUALITY OF SUBTIDAL CLAMS IN THE S.E. BERING SEA

by
Steven E. Hughes
Richard W. Nelson
Robert Nelson

A Cooperative Industry-Federal-State of Alaska Study
sponsored by
New England Fish Company
Snow Food Products, Borden, Inc.
Campbell Soup Company
Gorton Division, General Mills
National Marine Fisheries Service
Alaska Department of Fish and Game
Alaska Department of Commerce
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Alaska Sea Grant
Food and Drug Administration

NOVEMBER 1977

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest and Alaska Fisheries Center
2725 Montlake Boulevard East
Seattle, Washington 98112

NOTICE

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November 1977

1/ National Marine Fisheries Service, Seattle, Washington
2/ Alaska Department of Fish and Game, Dutch Harbor, Alaska

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INTRODUCTION

This report provides information resulting from a joint industry/government venture which was conducted to assess subtidal clam resources in the S.E. Bering Sea. Major goals of the venture were to (1) determine if resource potential and quality exists to support a fishery on the Alaska "surf" or "pink neck" clam (*Spisula polynyma*); (2) obtain biological data required for management and regulatory decisions; and (3) examine some possible short-term effects that such a fishery might place on the environment.

Primary impetus for the venture was the need for additional clam meat supplies due to shortages faced by the U.S. chowder and strip industries. This shortage stems from the recent deterioration of the Atlantic surf clam resource and commensurately decreased landings. Over the past 10 years, that fishery has accounted for 69% of all U.S. clam landings (Ritchie, 1977). Its recent decline is exemplified by contrasting the 96 million pound landings obtained in 1974 with 1976 landings of 45 million pounds. Beginning in 1978 under new management authority, landings will be regulated at about 30 million pounds of meats per year for several years. Supply shortages of whole surf clams have also reflected in ex-vessel prices which increased from \$2.25 per 80-pound bushel in October 1975 to \$11.00 per bushel in October 1976.

In seeking sources to supplement the reduced Atlantic surf clam landings, the Alaskan surf clam was considered as one possibility. Knowledge of resource quantity and quality was limited to the fact that they do occur in Alaskan waters and appeared of similar quality to the Atlantic species. Thus the primary needs pointed to a comprehensive resource assessment survey and analysis of food quality, including testing for paralytic shellfish poisoning.

Such needs were addressed in industry/NMFS preliminary meetings and solidified in later meetings involving the Alaska Departments of Fish and Game (ADF&G), Health and Social Services, and Commerce; The University of Alaska (U of A) via Sea Grant, and the U.S. Food and Drug Administration. A steering committee composed of industry, Federal, and State members was formed to organize research, obtain fishing gear, funding, and personnel requirements. Four industry members provided about 70% of a \$180,000 budget for the project, a vessel for a 45-day period in July and August, and much expertise in all facets of the venture. Project funds were administered by ADF&G. NMFS designed the research operations (Hughes, unpublished manuscript), conducted the scientific investigations with assistance from ADF&G and U of A personnel, and analyzed data for this reporting.

VESSELS AND SURVEY GEAR EMPLOYED

Early in the planning stages, it was determined that the survey would be conducted in the S.E. Bering Sea, using a West Coast vessel and an East Coast style hydraulic clam harvester. The 96-foot Smaragd (Fig. 1), a former East Coast scallop vessel presently engaged in Alaskan king and snow crab fisheries was provided for the survey. The vessel is a house-forward type and has a diesel-propulsion engine of 765-hp continuous rating, with a Kortz nozzle which delivers 27% additional thrust at 650 rpm. The fish-hold area consisted of two circulating-seawater tanks. One tank, a 3,000-cubic-foot unit capable of exchanging water volume every 20 minutes, was used to determine survival rates of tanked clams. Gear-handling deck equipment consisted of twin scallop booms, A-frames, two hydraulic-powered reels for the clam harvester's supply hose and towing hawser, and a trawl winch with 300 fms of 1 inch diameter wire rope. Electronic fishing and navigation aids included radar, loran A and C, automatic pilot, echosounders, and radios.

The clam harvester (fig. 2) was of steel construction, measured 7 feet wide by 18 feet long, and weighed 13,000

Figure 1. The 96 ft. fishing vessel Smaragd rigged for the Bering Sea subtidal clam survey.

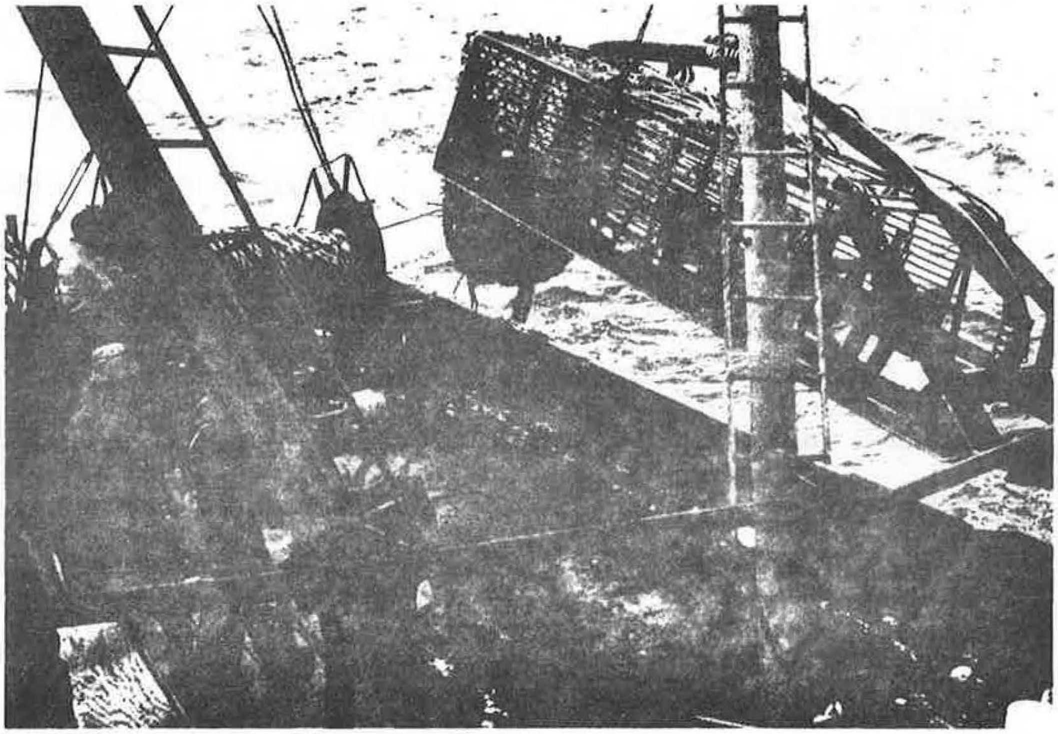

Figure 2. East Coast style hydraulic jet, cage clam harvester employed in the Bering Sea subtidal clam survey.

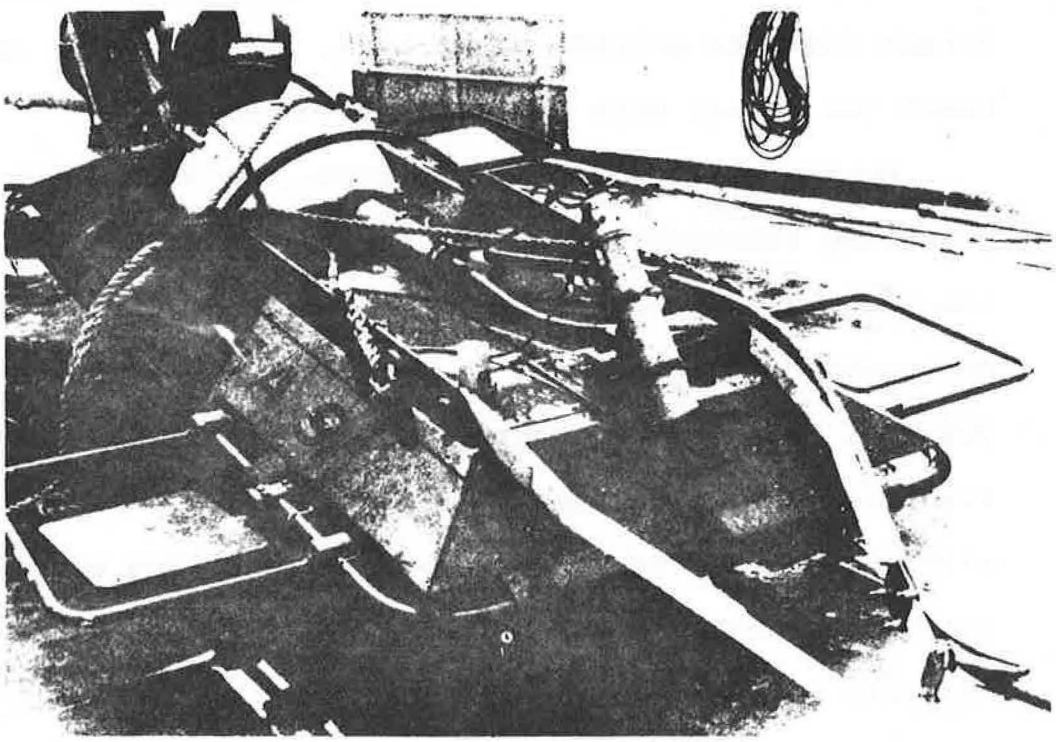

Figure 3. Remote Underwater Fisheries Assessment System (RUFAS), a towed underwater sled used to photographically document short-term impacts resulting from clam harvesting.

pounds. The knife width was 3 feet, compared with most commercial harvesters which have fishing or knife widths ranging from 5 to 10 feet. The cage was constructed of 3/4-inch-diameter bars spaced at 2-1/2-inch intervals, and the clam bag was constructed of 3-inch-diameter metal rings. Surface water was supplied to the jet manifold via a 6" diameter rubber hose from a 3,000-gpm pump which was driven by a deck-mounted 350-hp diesel motor. This water supply was distributed through the harvester's hydraulic manifold, which contained 15 cutting jets and two washout jets. Maximum water pressure at the pump was 140 psi.

The clam harvester was set and retrieved from the starboard side of the vessel with the trawl winch, towed with a 3-inch diameter polypropylene line, and lifted on and off board the vessel with the scallop booms.

During early planning meetings, the importance of gathering information for use in evaluating the effects of the clam harvesting process on the benthic environment was addressed. In an attempt to document such phenomena, the 303-foot NOAA R/V Discoverer using a remote underwater fisheries-assessment system (RUFAS), worked in conjunction with the Smaragd to photograph a sea-bed area where harvesting was conducted. RUFAS I (Fig. 3) is a towed vehicle remotely controlled from the surface. Photographic records were obtained with two independently operated systems: a TV monitor which records continuously on video tape and a 35-mm. still camera operated at one-second intervals with a capacity for 16,000 individual pictures per roll of film. Photographs were taken in a marked area along the Alaskan Peninsula where four tows were completed on previously located surf clam grounds. The photographic transects over this area were initiated 2 hours after harvesting was completed and repeated 24 hours later.

The Discoverer also assisted in the venture by deploying bottom core samplers to determine substrate composition in portions of the survey area, and by providing laboratory facilities for bacteriological analysis of clam samples by FDA and NMFS scientists.

SURVEY AND SAMPLING METHODS

Resource Assessment Survey

The clam survey was conducted in two phases. The first was designed to cover a wide geographic and bathymetric zone in areas where surf clams or their shells had been obtained during 1969-76 NMFS otter-trawl surveys. Each trawl grid where clams had been located (Fig. 4) was divided into quarters. The resulting station pattern consisted of 180-100 square-mile blocks. The first survey phase was designed

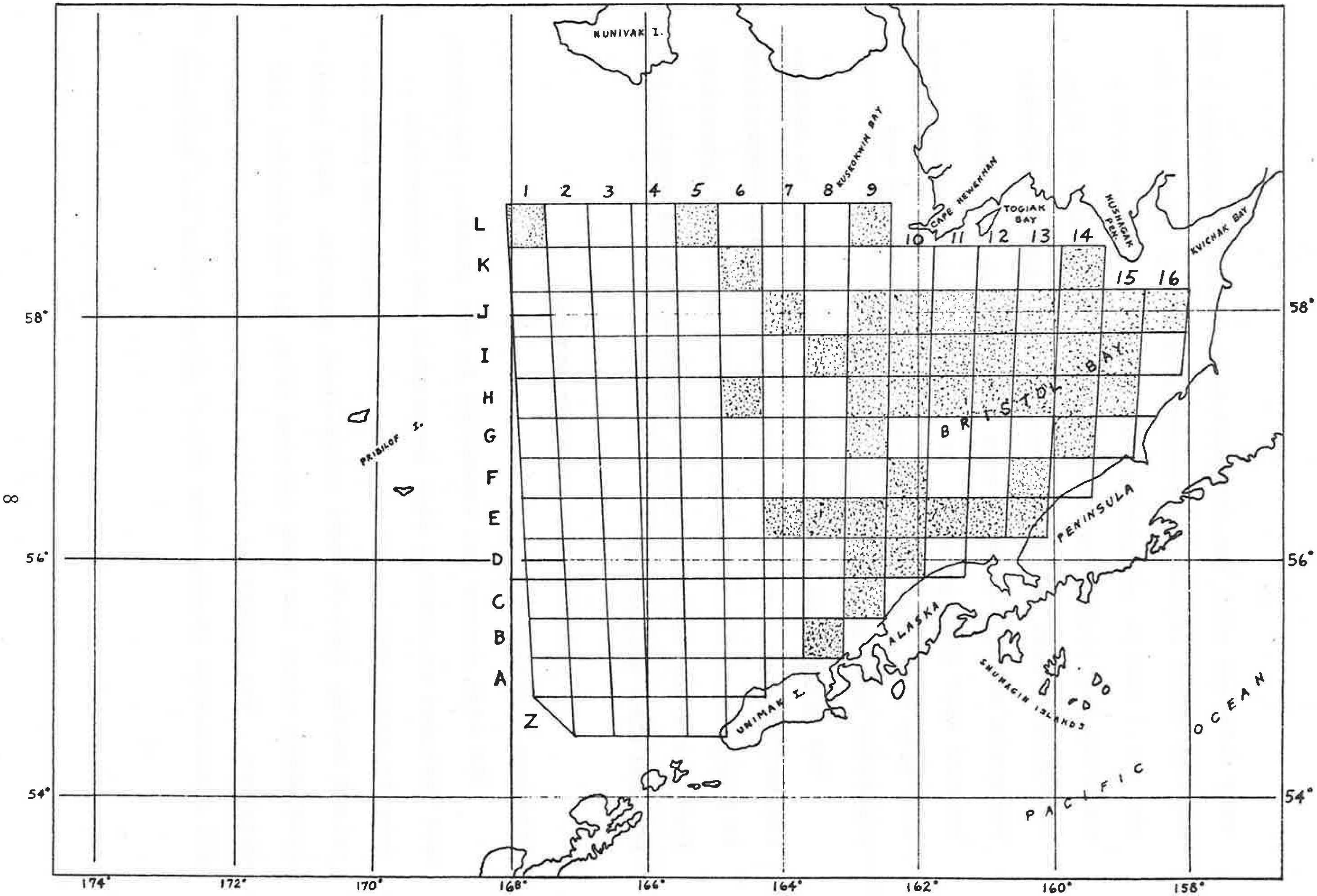

Figure 4. NMFS Bering Sea trawl survey pattern showing locations of 400 square mile areas (shaded) where Alaska surf clams or their shells were obtained in the 1969-76 otter trawl surveys.

to complete one tow of 10 to 30 minutes duration in each block. The second phase was designed for more comprehensive coverage of blocks where clams were located during phase I. To accomplish this, numerous tows of 10 to 15 minute duration were completed throughout selected blocks.

Collection of Biological Data

Catch handling and processing techniques were identical during the two survey phases. The total catch in each haul was sorted by species, weighed, and counted. When catches were composed of less than 200 individual clams per species, each specimen's length was measured to the nearest mm to determine size composition. Larger catches were randomly subsampled to produce about a 200-clam sample for measurements. Stratified samples of surf clams were collected for age analysis (25 individuals/5-mm length interval) and for length-width-weight analysis (10 individuals/5-mm length interval). For the age studies, clams exceeding 70 mm in length were shucked, and the hinged shells were frozen for annual ring counts. Smaller clams were frozen whole, as were all clams in the length-width-weight samples. Surf clams were also preserved for later studies to determine size at maturity and reproductive activity.

Surf-clam survival rates were determined by dumping 25 bushels of live clams into the vessel's circulating-seawater tank. Samples were removed daily and examined for condition and dead loss over a 7-day period. Bushel baskets of surf clams were also held on deck, out of direct sunlight, to determine dry-storage survival rates over a 3-day period.

Collection of Samples for PSP Determination

Clams were frozen at sea for later use in analyses for paralytic shellfish poisoning (PSP). The usual procedure for sampling consisted of obtaining 12 clams from the catch. Six of the 12 were shucked immediately, washed gently with sea water to remove sand or mud, then placed in a polyethylene bag and frozen. The remaining 6 clams were frozen whole. During the latter part of the survey, freezer space became a problem. To conserve space, both 6-clam samples were shucked. They were frozen in separate bags to facilitate later handling.

Samples were collected from catches representative of each fishing area designated by the arbitrary block numbers.

Paralytic shellfish poison analyses were done by the biological method (mouse assay) according to the procedure in AOAC Methods, 12th Edition, 1975. Results are converted to ug poison/100g sample using mouse weight correction factors and dilution factors when appropriate. Any value > 80 mg/100g is considered hazardous.

Collection of Samples for Bacterial Analyses

Analyses of clams to determine the number of type of microorganisms present was done cooperatively by FDA and NMFS. A temporary laboratory for the project was set up aboard the NOAA R/V *Discoverer*. During the period August 1 to August 7 samples were collected from representative catches and transferred daily to the *Discoverer* for immediate analysis.

The technique used to obtain clams from the catch was designed to prevent contamination. The individual clams were retrieved from the catch using a polyethylene bag inverted over the collector's hand so that only the sterile inside of the bag came in contact with the clam. Each sampling consisted of 12 individual clams when surf clams were sampled. When Alaskan Tellin clams were sampled the sample size was increased from 12 to 24 because of their smaller size. Samples were stored in the ship's refrigerated food locker until transferred to Seattle for analysis.

Collection of Clams for Quality Evaluation

The most promising potential for commercial harvesting of clams was generally in the area north of the Alaska Peninsula between Port Moller and Ugashik Bay. As time permitted, samples of clams from catches in these areas were frozen for use in evaluating the quality and potential as products. Samples of whole surf clams and shucked meats were prepared. When Alaskan Tellin clams were sampled, they were frozen whole.

The procedure for preparing surf clam meats consisted of shucking, followed by a vigorous rinse in sea water to remove mud or sand. Some samples were frozen by placing approximately 5 pounds of meats in a metal pan to form a block. Freezing at -20°F in the ship's food locker required about 6 hours. After freezing, each block was glazed with fresh-water ice and wrapped with aluminum foil. Additional samples of meats were frozen in polyethylene bags.

RESULTS

Performance of Sampling Gear

Sampling gear effectiveness is a major factor in evaluating results of resource assessment surveys. That factor was of particular concern during this study due to unknown substrate conditions and vessel/gear interactions which can effect efficiency. Therefore, the following information should be considered in evaluating results.

Substrate hardness did not prove to be a problem and the gear operated well. Optimum fishing depth of the knife was determined to be between 8 1/2 and 8 3/4 inches. Shallower knife settings resulted in broken and sheared clams and deeper setting proved unnecessary due to clam depth. A factor which did prove to be a problem was vessel/gear interactions; more specifically the vessel was over-powered for the harvester's size, often resulting in excessive towing speed and poor gear operation. Furthermore, steering control was reduced as a result of towing at minimum engine speed and the clam harvester was often towed partially sideways, due to tidal influence on the vessel.

Tests were conducted which indicated that surf clam catches were reduced 2 to 6 fold when the vessel towed with the tide, as opposed to against the tide, or at slack tide. When the harvester was not being pulled directly astern due to tidal action turning the vessel, catches were reduced, often 1 to 2 fold. Such results indicate that gear sampling efficiency throughout the survey was probably poor during strong tidal action. Accordingly, average catch rates should be viewed as conservative and biomass estimates as very conservative, since the harvester was assumed to be 100% efficient at all times.

Resource Assessment Survey

A total of 230 fishing tows were completed between July 10 and August 8, 1977. Thirty-five were invalid due to gear malfunction or damage. Sixty-five valid tows were completed in the phase I survey, 105 during the phase II survey, 22 outside the predetermined survey pattern, and 3 tows were of a non-survey, production-fishing mode.

Figure 5 identifies 66 numbered blocks in the south-eastern Bering Sea, where assessment work was completed. During the phase I survey, sampling was conducted in 59 blocks. Catches indicated very low clam abundance in offshore blocks (1 to 30) and a possible surf clam resource along the Alaska Peninsula between Ugashik Bay and Port Moller (blocks 40 to 66). Accordingly, the phase II survey was concentrated in the Ugashik Bay-Port Moller region. In addition to more intensive surveys of those blocks fished initially, seven blocks were added to the surveyed area.

Appendix A lists the position, date, depth, and duration of each tow completed with their respective catches by species.

Alaska Peninsula Region--The surf clam resource encountered

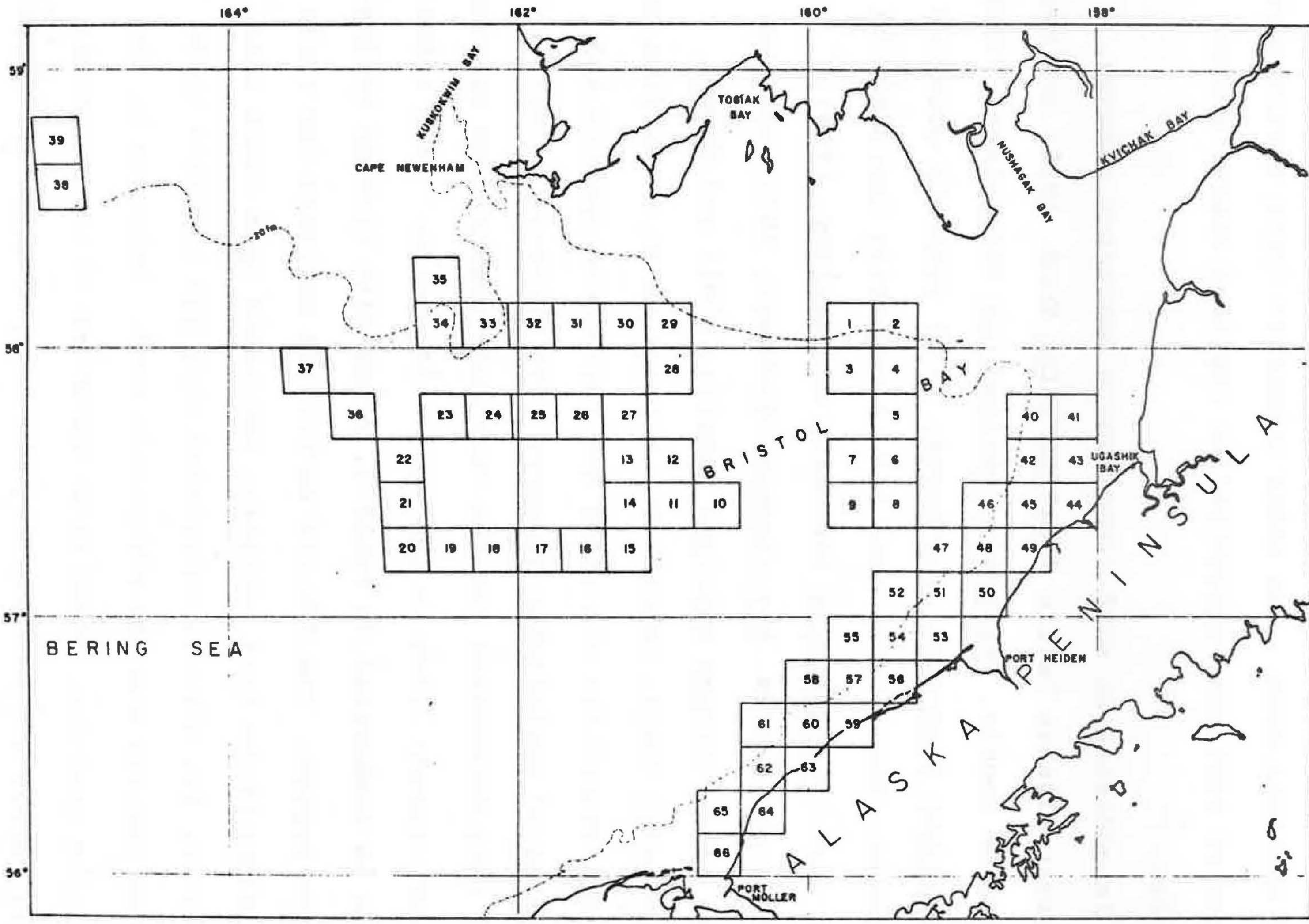

Figure 5. Location of 66-100 square mile blocks in the southeastern Bering Sea when the subtidal clam resource assessment survey was conducted.

in the Peninsula region extends along 120 miles of coast line and occupies a 1600-square-mile area. Within this area, the sea bed is composed primarily of coarse-grained, black volcanic sand. Two other substrate types encountered in area of surf clam concentration included coarse gravel and peat.

In addition to surf clams, which dominated catches, the Great Alaskan Tellin (Tellina lutea Wood, 1828) and two species of cockle, Serripes groenlandicus (Bruguiere, 1789) and Serripes laperousii (Deshayes, 1839) commonly occurred in catches. Other clams obtained infrequently included the razor clam, Siliqua alta (Broderip and Sowerby, 1929), the soft-shell clam, Mya elegans (Eichward, 1871, and the macoma clams, Macoma calcarea (Gmelin, 1791) and Macoma middendorfii (Dall, 1884). The average catch rates (lbs/hr) were determined for all clams and incidental species and estimates of exploitable resource size (biomass in metric tons) were determined for the four most common clam species for each survey block in the Peninsula region. This information is summarized in Table 1, along with biomass estimates for the region. The 286,184 metric ton estimate for whole surf clams is the best estimate, and based upon catch data available, its size is calculated with 95% accuracy to be between 248,294 and 324,074 metric tons. Relative to the surf clam resource, other clam resources in the Peninsula survey region are considerably smaller; however, the 82,000

Table 1. Average catch (lbs.) per hour and estimates of exploitable biomass (metric tons) of the clams S. polynyma, T. lutea, S. laperousii, and S. groenlandicus by sampling block along the Alaska Peninsula, July-August, 1977.

ALASKA PENINSULA REGION

			Spisula polynyma		Tellina lutea		Serripes laperousii		Serripes groenlandicus	
Block No.	Area Sq. Miles	No. of Tows	Mean Catch lbs./hrs.	Biomass MT	Mean Catch lbs./hr.	Biomass MT	Mean Catch lbs./hr.	Biomass MT	Mean Catch lbs./hr.	Biomass MT
40	100	1	29.4	2,703	4.1	378	--	--	--	--
42	100	2	19.1	1,757	57.4	5,271	--	--	2.4	216
45	100	22	634.2	58,279	12.8	1,175	0.3	25	0.1	12
46	100	3	68.0	6,249	360.0	33,083	0.7	61	--	--
48	100	9	120.1	11,037	57.5	5,281	--	--	6.1	564
49	77	4	122.8	8,792	11.0	789	--	--	1.0	72
50	97	10	596.4	53,530	55.3	4,966	0.4	36	--	--
51	100	2	0.3	27	7.5	685	--	--	--	--
54	100	2	15.3	1,409	10.9	1,003	8.6	789	0.6	57
55	100	1	4.1	378	58.8	5,406	--	--	--	--
57	100	15	200.0	18,361	49.3	4,533	5.0	458	1.3	116
58	100	1	251.5	23,114	184.8	16,987	--	--	15.2	1,392
59	54	7	323.0	16,026	19.8	983	1.2	60	--	--
60	96	21	350.3	31,194	11.5	1,025	17.3	1,540	0.1	13
61	100	12	361.9	33,255	2.8	260	7.9	722	--	--
62	86	18	250.6	19,803	--	4	15.0	1,190	--	--
65	100	2	2.9	270	5.9	541	8.8	811	67.6	6,217
TOTAL	1,610	132		286,184		82,370		5,692		8,659

metric ton, Great Alaska Tellin resource is substantial. All biomass estimates are regarded as conservative, due to the assumption that the harvester was 100% efficient in capturing clams within the area swept. This factor could have resulted in a substantial underestimate of the Great Alaska Tellin resource in particular, due to the small size of this species and its ability to easily pass through the cage and bag of the harvester.

The clam catch rates by species were also examined over this region by 2 fathom depth intervals to detect changes in the abundance index (lbs/hr) with depth. Results (Fig. 6) indicated surf-clam abundance to be highest at 13 to 18 fms, with a peak at 15 to 16 fms and substantial declines at depths less than 13 fms or greater than 18 fms. Alaska Tellin catch rates increased steadily with increasing depth and peaked at the greatest depth surveyed in the region (21 to 22 fathoms). The two cockle species, S. laperousii and S. groenlandicus, were most abundant at the shallowest depths surveyed (10 to 12 fathoms).

Information on the size composition of clams obtained in the Peninsula region is shown in Figure 7. An important factor in the size composition of surf clams was that typically three or four distinct modes of sizes were present in any given catch. Such results indicate that clam beds are not composed of one year class, but are typically composed of several year classes. A similar, but less

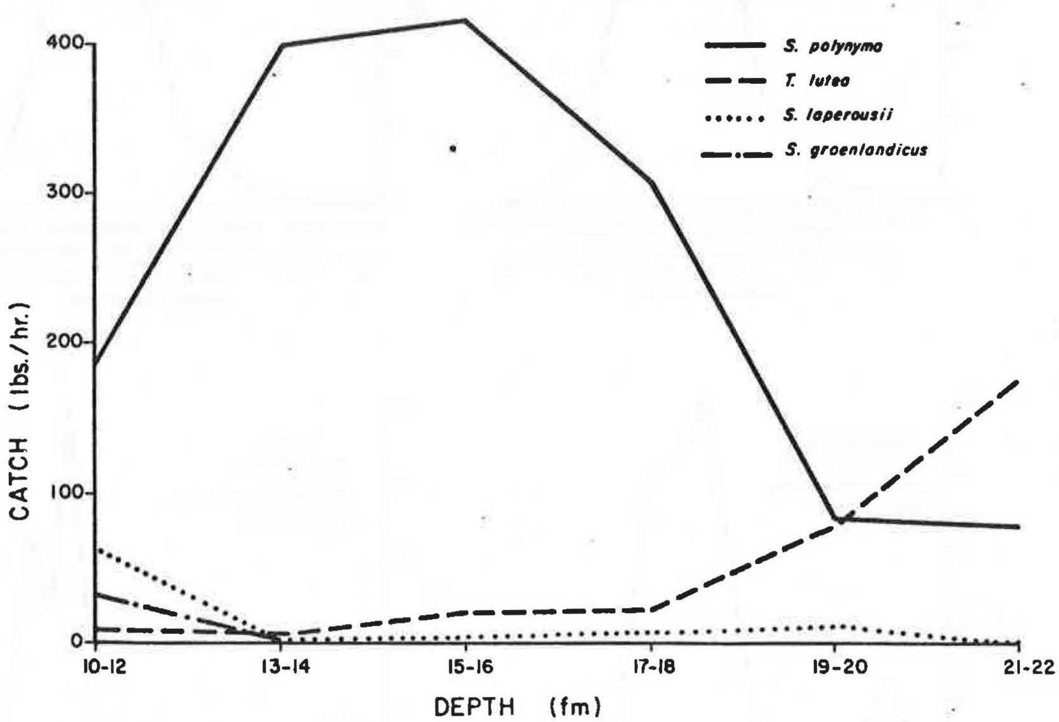

Figure 6. Influence of depth on catch rates of four commercially important clams obtained along the Alaska Peninsula, 10-22 fms.

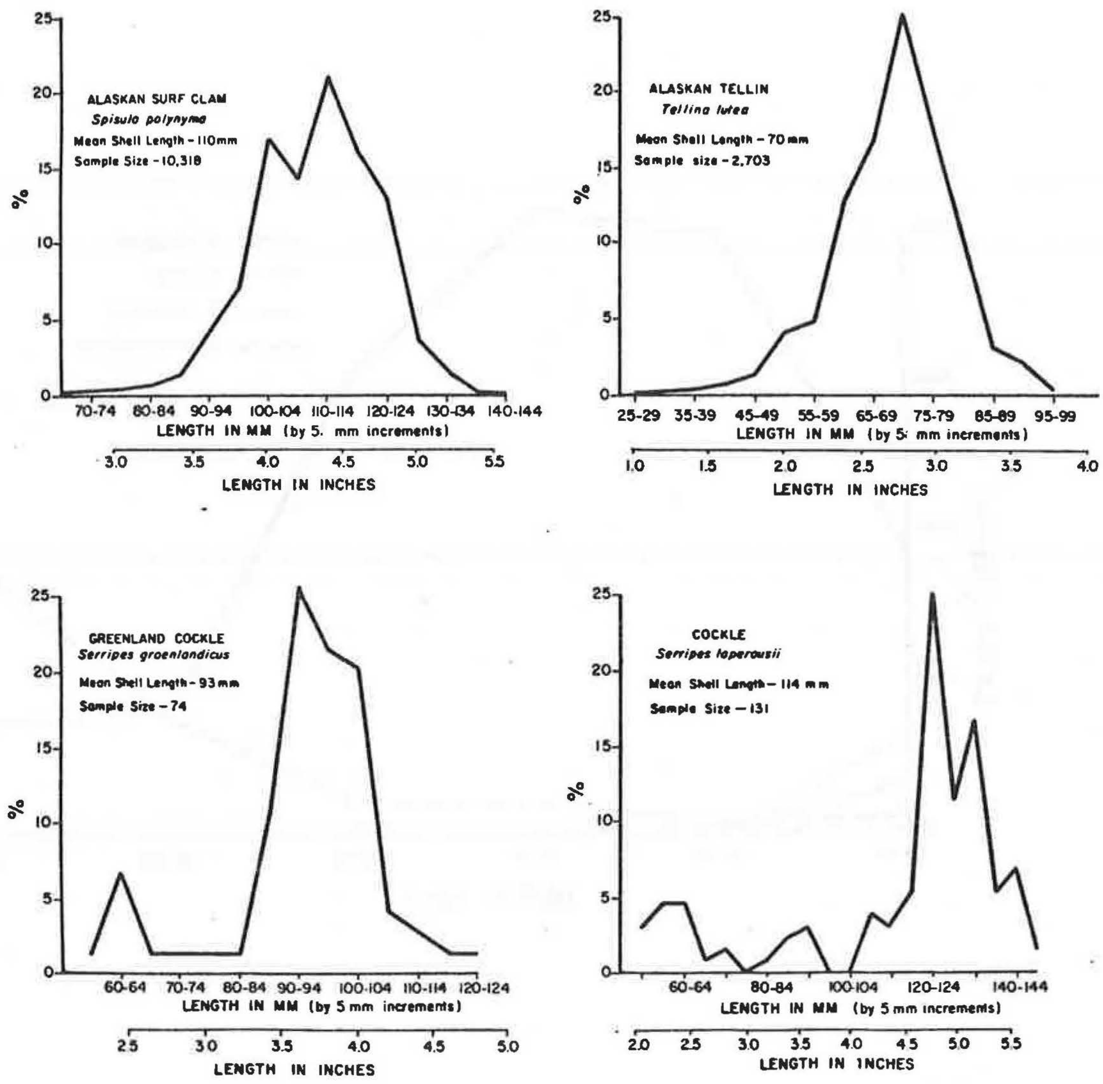

Figure 7. Length composition of commercially important clams obtained at depths of 10-22 fms. along the Alaska Peninsula in the southeastern Bering Sea, July-August, 1977.

distinct pattern was noted in the size composition of the Great Alaskan Tellin. Contrary to the surf clam and Tellin, only small numbers of the cockles S. groenlandicus and S. laperousii were obtained and their length distributions may be of limited value.

Alaska surf and Tellin shell length-round weight relationships were determined from individual clams representing all sizes obtained (Fig. 8). The empirical relationship for surf clams was $W = 1.03X10^{-4}L^{3.058284}$ where W is round weight in grams, and L is shell length in millimeters. The same relationship for the Great Alaskan Tellin was $W = 9.5X10^{-5}L^{2.975840}$.

Three samples of surf clams were retained for age determination and growth studies. Preliminary age analysis of one sample collected along the Alaska Peninsula has been completed to date. Clams aged ranged from 11 to 135 mm in shell length, and were 2 to 16 years old. Table 2 shows the range of sizes at age. Based upon the size distribution of surf clams obtained in this region (Fig. 7), the majority of the stock sampled was 8-13 years of age.

Southeastern Bering Sea Region--The abundance of clam species in the offshore southeastern Bering Sea region was considerably different than along the Alaska Peninsula. Substrate type appeared very similar; however, most areas surveyed were deeper, primarily in depth ranges at 20-30 fms.

Table 3 summarizes catch rate and biomass estimates

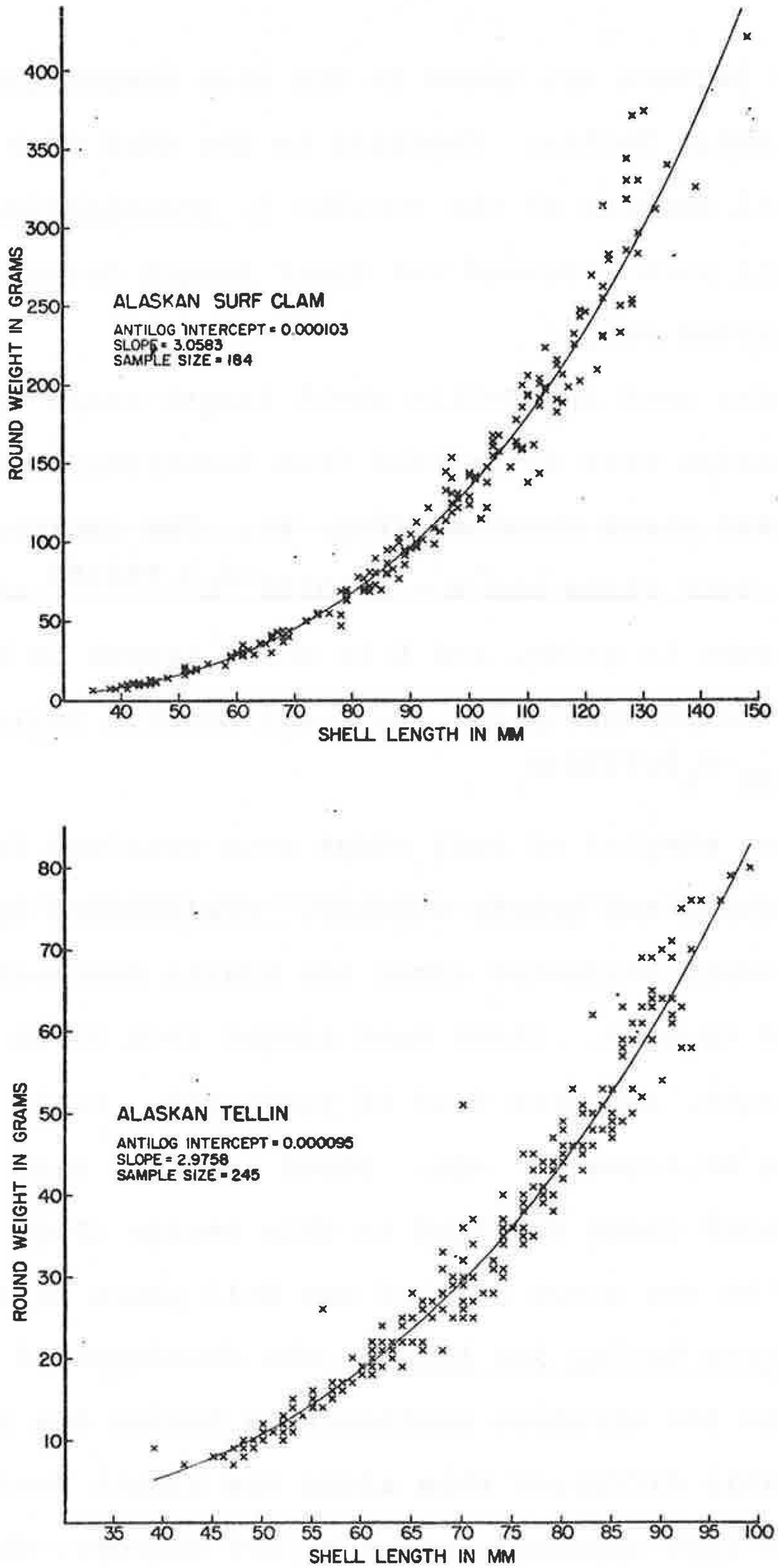

Figure 8. Shell length - round body weight relationships of the Alaska surf clam (Spisula polynyma) and the Great Alaskan Tellin (Tellina lutea), obtained at depths of 10 - 22 fms. along the Alaska Peninsula, July - August, 1977.

Table 2. Preliminary ranges of length at age for the Alaska surf clam, Spisula polynyma, obtained in the Alaska Peninsula Region, July - August, 1977.

Age (yrs)	Range of lengths at age (mm)
2	11 - 14
3	16 - 34
4	24 - 46
5	37 - 59
6	49 - 67
7	59 - 80
8	73 - 94
9	70 - 103
10	80 - 121
11	84 - 118
12	98 - 128
13	107 - 130
14	113 - 135
15*	119
16*	127

* One individual

Table 3. Average catch (lbs.) per hour and estimates of exploitable biomass (metric tons) of the clams S. polynyma, T. lutea, S. laperousii, and S. groenlandicus by sampling block in the offshore southeastern Bering Sea, July-August, 1977.

SOUTHEAST BERING SEA REGION

Block No.	Area Sq. Miles	No. of Tows	*Spisula polynyma* Catch/hr.	*Spisula polynyma* Biomass MT	*Tellina lutea* Catch/hr.	*Tellina lutea* Biomass MT	*Serripes laperousii* Catch/hr.	*Serripes laperousii* Biomass MT	*Serripes groenlandicus* Catch/hr.	*Serripes groenlandicus* Biomass MT
2	100	1	0.6	54	2.9	270	--	--	--	--
3	100	1	1.5	139	1.5	139	--	--	1.5	139
4	100	1	--	--	0.6	54	--	--	--	--
5	100	1	0.9	84	0.6	56	--	--	--	--
7	100	1	15.2	1,392	66.7	6,126	--	--	--	--
8	100	2	12.9	1,184	28.8	2,646	--	--	--	--
9	100	1	0.9	80	--	--	--	--	--	--
11	100	1	--	--	--	--	--	--	5.4	501
12	100	1	0.3	28	--	--	--	--	1.5	139
13	100	1	--	--	--	--	--	--	10.6	975
14	100	2	5.4	501	--	--	--	--	42.3	3,885
15	100	1	--	--	--	--	--	--	9.1	835
16	100	1	--	--	--	--	--	--	3.0	278
17	100	1	55.6	5,105	1.1	102	--	--	--	--
18	100	1	14.7	1,351	--	--	--	--	61.8	5,676
19	100	1	1.5	139	--	--	--	--	51.5	4,734
20	100	1	--	--	--	--	--	--	71.2	6,544
21	100	1	--	--	--	--	--	--	4.5	418
22	100	1	--	--	--	--	--	--	24.2	2,228
24	100	2	2.1	193	0.1	9	--	--	18.0	1,654
25	100	1	0.2	18	--	--	--	--	5.0	459
26	100	1	2.0	184	--	--	--	--	28.0	2,573
27	100	1	7.0	643	1.0	92	--	--	7.0	643
28	100	1	2.0	184	0.2	18	--	--	15.0	1,378
29	100	1	--	--	0.4	37	--	--	--	--
30	100	1	1.0	92	9.0	827	--	--	4.0	368
33	100	1	--	--	94.0	8,638	--	--	--	--
34	100	1	--	--	--	--	--	--	3.0	276
36	100	1	0.9	84	0.3	28	--	--	12.1	1,114
37	100	1	0.6	56	0.3	28	--	--	28.8	2,646
38	100	1	0.9	84	--	--	--	--	--	--
39	100	1	1.2	111	--	--	--	--	2.4	223
TOTAL	3,200	35		11,706		19,070		--		37,686

by species for each sampling block (Fig. 2, Nos. 2-39) in the region. The cockle S. groenlandicus was the most abundant and frequently encountered species, followed in order of abundance by the Great Alaska Tellin and the Alaska surf clam. The cockle S. laperousii was not obtained in this region. Those three obtained were rather dispersed over the region and no substantial concentrations of clams were located. Catch rates of each species were examined by 2 fms depth intervals within 15-32 fms; however, contrary to the Peninsula region, no clam distributional patterns were apparent.

The size composition of clams obtained in the offshore southeastern Bering Sea is shown in Figure 9. Compared to the Peninsula region, the mean lengths of southeastern Bering Sea surf and Tellin clams were considerably smaller, while the cockle (Serripes groenlandicus) was slightly larger.

Additional Areas Surveyed - Explorations conducted outside the predetermined survey area were not productive. Sampling was conducted in the Dutch Harbor area, in Dublin and Urilia Bays on the north side of Unimak Island and at scattered locations along the lower Alaska Peninsula southwest of Port Moller.

Surf clams were obtained at all of the above locations except Urilia Bay, however catches were extremely low and never averaged more than 22 pounds per hour. Much of the substrate south of Port Moller was rocky and unsuitable

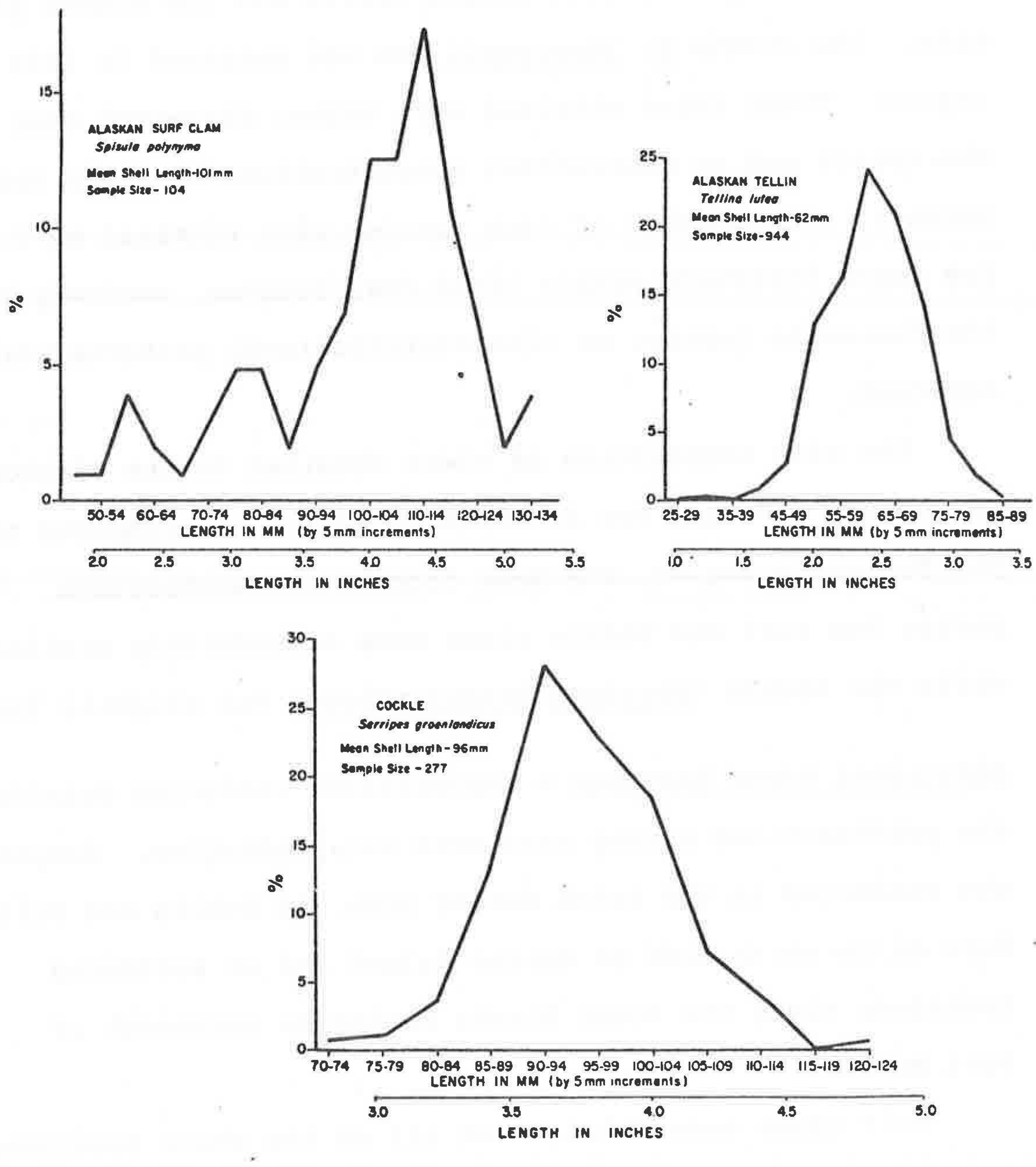

Figure 9. Length composition of commercially important clams obtained at depths of 15-32 fms. in offshore areas of the southeastern Bering Sea, July-August, 1977.

for sampling. Dublin Bay was an exception, the seabed being composed of black volcanic sand. Dublin Bay surf clams averaged 104 mm. in length compared to 110 mm. along the northerly portion of the Alaska Peninsula and 101 mm. in the offshore S.E. Bering Sea region.

Environmental Concerns and Impacts

From early planning stages of the venture, it was considered essential that studies be conducted to evaluate immediate impacts of clam harvesters on the benthic and epibenthic environment and to gather information required for the planning of more detailed studies which would address long-term impacts as development progressed. Special efforts expended on this portion of the research have resulted in extensive television and still photographic records of the seabed where sampling occurred. While analysis and use of these recordings has only begun, some obvious factors can be reported.

The first photographic records were obtained two hours after fishing was completed, and at that time no unusual turbidity occurred in the area. The undisturbed substrate was quite barren of observable life and composed of rippled sand. Immediately after fishing, the harvester's path was easily discernable by both about an 8-inch depression in the seabed and by the abundance of predators (yellowfin sole, king crab, and starfish) feeding in the track areas. Clam shells were also commonly observed in and around the track areas. The dredge track had filled in after 24-36 hours but remained easily discernable due to the presence of predators and uncovered shells and lack of ripples in the sand. The four plates shown in Figure 10 are typical of: 1) the undisturbed seabed, 2) an area adjacent to a harvester's track where shells and other material have apparently settled, 3) in the track immediately after fishing and 4) 24 hours thereafter.

Additional impact data were obtained by complete identification of the catch components. The four species of commercially important clams represented 65.7% of the total catch by weight. *Spisula polynyma*, the surf clam, accounted for 57.9%, *Tellina lutea* 5.7%, *Serripes laperousii* 1.1%, and *Serripes groenlandicus* 1.0%. The remainder of the catch (34.3%) was composed of 24.3% starfish, 6.7% sea onion, 1.3% king crab, and 0.03% snow crab, with fifty-six species of fish and benthic invertebrates represented in the final 2.0% of total catches.

Due to special concern for incidental catches of king crab, those data were analyzed further. In the S.E. Bering Sea region where sampling was conducted at 15-32 fms., 90 king crab were caught in 12.2 hours of fishing effort. Sampling along the Alaska Peninsula at depths of 10-22 fms. resulted in 33 king crab being caught in 30.2 hours of

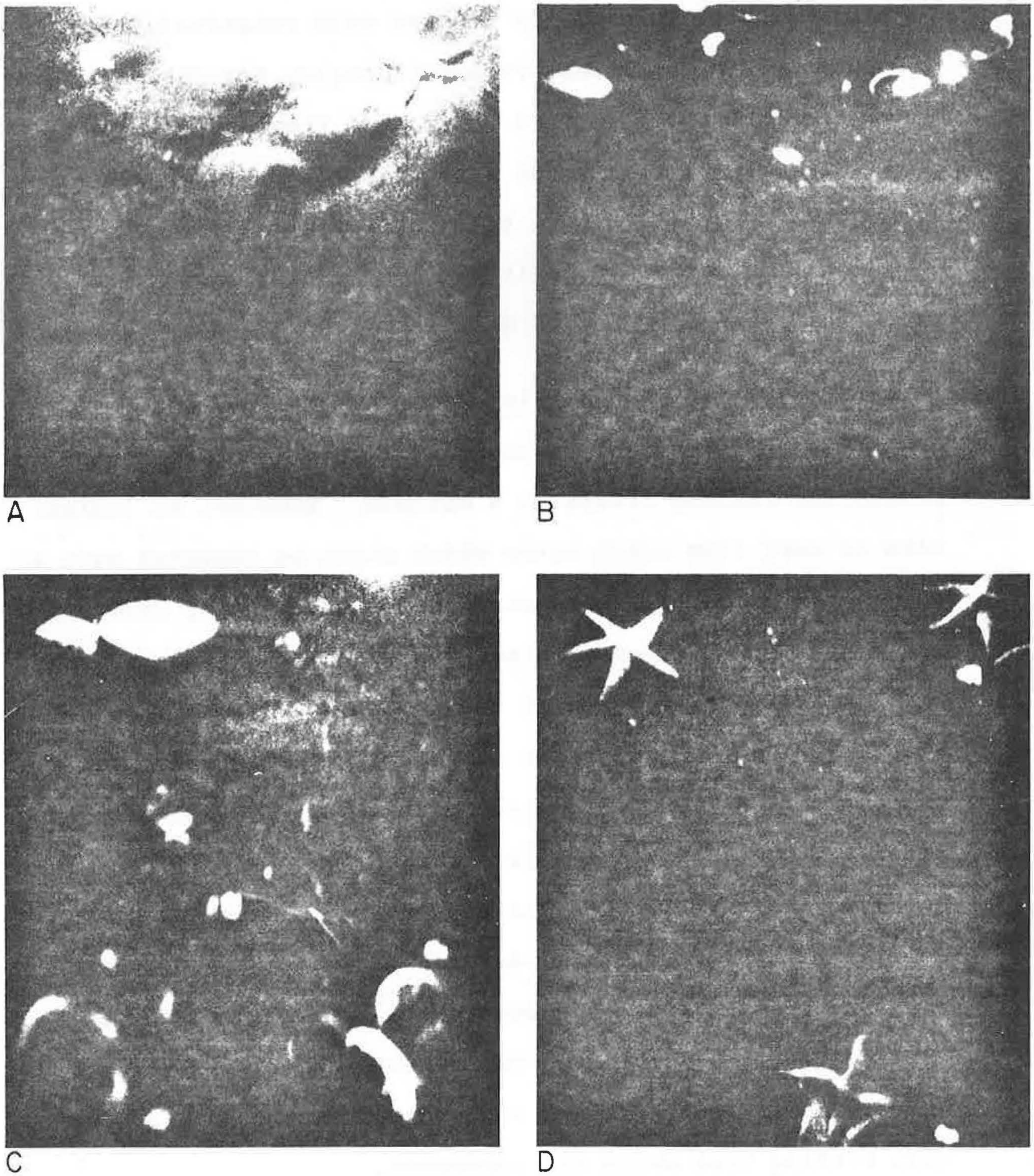

Figure 10. Typical S.E. Bering Sea benthic environment: (a) undisturbed, (b) adjacent to clam harvester track, (c) in clam harvester track 3 hours after fishing, and (d) in clam harvester track 24-30 hours after fishing.

fishing effort. This factor coupled with relatively high clam catches in the Alaska Peninsula region resulted in a 0.4% king crab catch in that portion of the survey.

King crab viability was also determined. Over 90% captured were alive and active but, when examined more closely, were found to contain deposits of sand grains which were presumably caused by action of the harvester's water jets.

Production Fishing Potentials of the Alaska Surf Clam

Time and previously noted gear limitations restricted production fishing trials to a minimum. However, an indication of surf clam catch rates which might be expected with a commercial-sized clam harvester can be obtained by examining the better catch rates obtained during the assessment survey.

Accordingly, in each of the ten survey blocks in the Alaska Peninsula region, the average of the highest three catch rates obtained in a particular block was used as the potential commercial catch rate for the three-foot clam harvester in that block. The rate for each block was then multiplied by 3.3 under the assumption that the catch rate obtained by a 10-foot-wide commercial harvester would be increased proportionately. The results of this exercise are summarized in Table 4 along with data from the only production fishing test which was conducted.

Table 4. Projected catch rates of Alaska surf clams with a 10-foot-wide clam-harvester based upon the best three resource-assessment tows obtained in each survey block with a 3-foot-wide clam-harvester. Average catch rates obtained during three production fishing tows with the 3-foot harvester are shown with an *. (Bushel = 80 lbs.)

Survey Block No.	Observed catch rate with 3-ft. harvester		Projected (observed x 3.3) catch rate with 10-ft. harvester	
	lbs/hr	bu/hr	lbs/hr	bu/hr
45	1,104	13.8	3,643	45.5
48	272	3.4	898	11.2
49	216	2.7	713	8.9
50	984	12.3	3,247	40.6
57	464	5.8	1,531	19.1
*57	1,585	19.8	5,230	65.3
58	832	10.4	2,746	34.3
59	600	7.5	1,980	24.8
60	824	10.3	2,719	34.0
61	752	9.4	2,480	31.0
62	424	5.3	1,400	17.5

Results of Holding Live Clams

In order to estimate the length of time clams survive after capture, samples were held in sea water and on deck. Surf clams with tightly closed shells were placed in burlap bags and suspended in the seawater live-holding well aboard the Smaragd. These clams remained alive and in good condition for up to 3 days. Based on this result, a larger-scale test was initiated. In this test about 25 bushels of surf clams taken randomly were placed in a live-holding well in bulk. These were held for a period of 7 days. When the well was pumped down, a strong odor indicated that some of the clams were decomposed. Three bushels of clams were sampled to determine the number of live, dead, and decomposed clams. A total of 375 clams were examined. Live clams numbered 333; dead, 26; and decomposed, 16. On a percentage basis dead and decomposed clams amounted to 11 percent of the total. Samples of live clams were shucked and submitted for bacterial evaluation aboard the Discoverer. The bacteria count results were in the same range as counts on clams taken directly from the catch.

Samples of surf clams were held on deck in wire baskets for 3 days. After a few hours many clams began to gape but remained alive and responded readily to touch. After 2 days 4 dead clams and an additional 2 decomposed clams were found in a bushel container of 128 clams. After 3 days of dry holding the total loss was 18 clams from the original 128--a loss of 14%.

Results of Quality Studies

Yield of edible meats is an important factor in evaluating the commercial potential of a resource. During shucking operations to obtain samples, 4 lots of clams with a total weight of 222 pounds were carefully weighed during each step. Whole meats and liquid recovered weighed 121 pounds. Drained whole meats weighed 81-1/2 pounds or 36.7% of the weight of the whole, shell-on clams.

One 50-pound lot of whole clams was eviscerated after shucking. The yield of eviscerated, drained meats was 29% of the weight of the whole, shell-on clams. A further check on the yield of eviscerated meats was made at the laboratory using frozen clams. The yield of eviscerated meats from 6.5 kg of shucked clams was 77%. This corresponds to a yield of 28% based on whole clams.

Samples of the surf clam meats were canned at the laboratory using the time and temperature recommendations of the National Canners Association laboratory in Seattle. The clams were thawed, eviscerated, minced, washed with about 5% NaCl brine, rinsed with fresh water, then placed in 1/2-pound-size cans (207x200.25). One-quarter teaspoon of salt was added to each can, and the can was flooded with approximately 15 ml. fresh water. The pack was processed 75 minutes at 240°F. The quality of the product was excellent. The red color of the neck meat and the red-brown color of the foot meat faded to a soft pink color due to heat processing. The texture of the minced meat was good. The pH of the canned product was 6.5.

Results of PSP Analyses

A total of 54 samples from 42 hauls were analyzed for the presence of paralytic shellfish poison (PSP). These samples represent 27 blocks in the survey. Results of analyses for the presence of saxitoxin in whole, raw clam meats are presented in the appendix. The Food and Drug Administration maximum acceptable level for saxitoxin in the edible portion is 80 μg/100g.

Further analysis of the edible portion (viscera-free) of surf clams, tellins or cockles and of the visceral mass of each was done. No toxin was found in the viscera-free portion of the clams. Also, surf clams did not contain toxin in the viscera, which included the ingested food. However, the presence of toxin in the visceral mass, including ingested food of tellin clams and cockles indicates that *Gonyaulax* occurs in the area, and may represent a problem at certain times and places. Fourteen of 20 samples of tellins contained toxin in the visceral mass. These samples represent 20 hauls in 14 blocks plus 3 areas outside the designated block areas. The level of toxin ranged from 24 to 158 μg/100g of whole (with viscera and food), shucked animal.

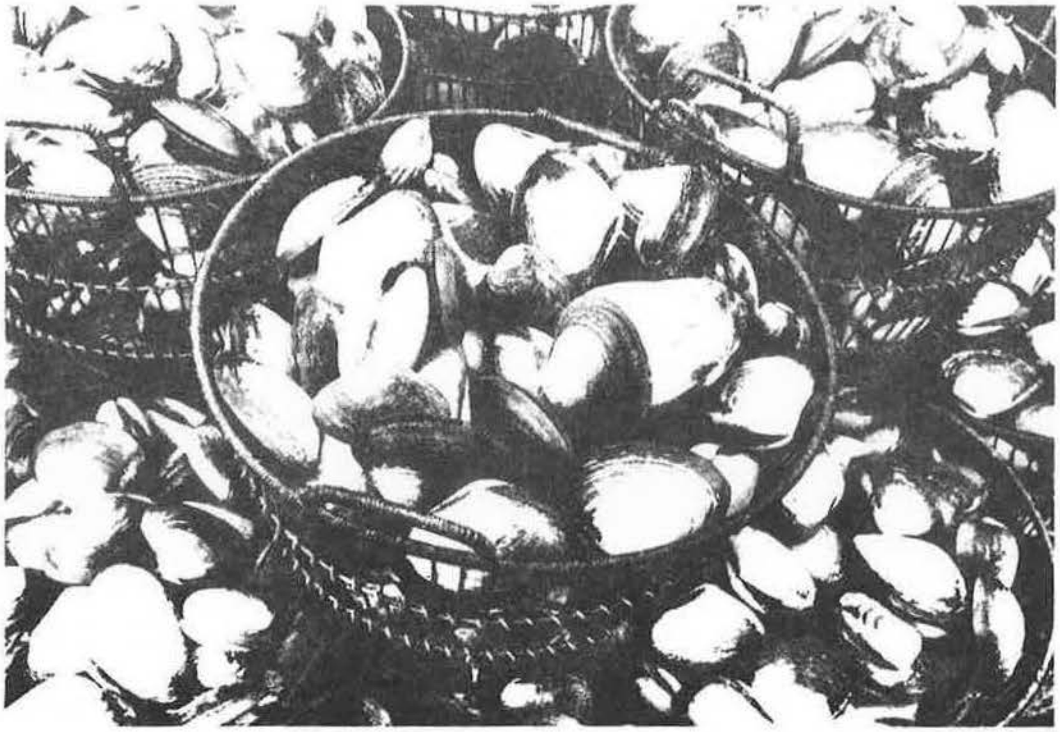

Figure 11. Catch of Alaska surf clams, Spisula polynyma.

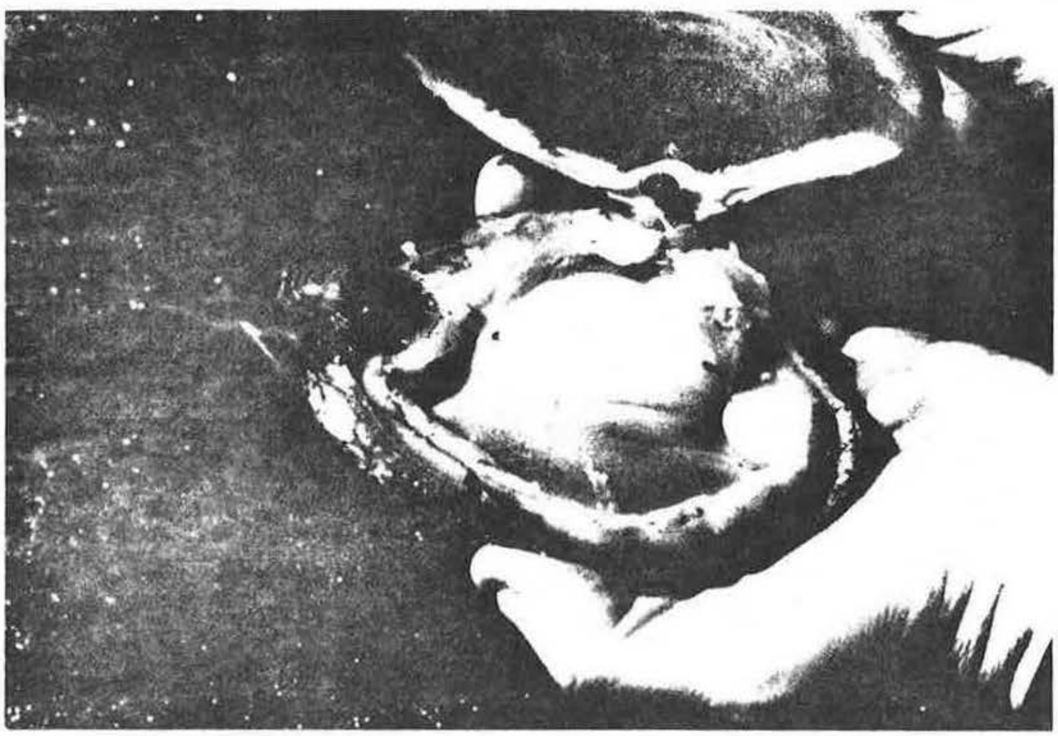

Figure 12. Typical Alaska surf clam, Spisula polynyma.

Fourteen samples of cockles (*Serripes groenlandicus*) were analyzed. Four contained toxin in the visceral mass. The two samples of cockles (*Serripes laperousii*) analyzed for toxin were negative.

Results of Microbiological Analyses

Samples were analyzed according to "Recommended Procedures for the Examination of Sea Water and Shellfish," Fourth Edition, 1970, The American Public Health Association, Inc.

A total of 45 clam samples were analyzed, including 33 surf clams, 7 tellins, 3 cockles, and 2 macoma. The total plate counts ranged from <100 to 2400 organisms/g. Total coliforms were detected in 18 of 45 samples (40.0%) ranging from 20 to 230 most probable number (MPN)/g. Fecal coliforms were detected in 4 of 45 samples (8.9%) ranging from 36 to 230 MPN/g. *Enterobacter* spp. and *E. coli* were the most commonly detected organisms.

Thirty-eight sediment samples were analyzed. The total plate counts ranged from <10 to 3300 organisms/g. Total coliforms were detected in 18 of 38 samples (47.4%) ranging from 30 to 2100 MPN/g. Fecal coliforms were detected in 2 of 38 samples (5.3%) at the 36 MPN/g level. *Enterobacter*, *Klebsiella*, and *E. coli* were the most commonly isolated organisms.

A total of 70 seawater samples were analyzed. Total coliforms were detected in 17 of 70 samples (24.3%) ranging from 3 to 240 MPN/g. Fecal coliforms were detected in 7 of 70 samples (10.0%) ranging from 3 to 93 MPN/g. Fourteen surface samples were analyzed with total coliforms detected in 6 of 14 (42.9%) ranging from 3 to 93 MPN/g. Fecal coliforms were detected in 3 of 14 (21.4%) ranging from 9.1 to 93 MPN/g. A total of 56 deep-water samples were collected 1 meter from the bottom and analyzed. Total coliforms were detected in 11 of 56 (19.6%) ranging from 3 to 240 MPN/g. Fecal coliforms were detected in 4 of 56 (7.1%) ranging from 3 to 75 MPN/g. Enterobacter, Klebsiella, and E. coli were again the most commonly isolated organisms.

These analyses show that the clams and marine environment meet Food and Drug Administration standards.

DISCUSSION AND CONCLUSIONS

Operations progressed at a slow pace during the first portion of the survey, primarily due to gear problems typically associated with new activities, and due to the lack of clams in the initial survey areas. The latter factor indicated that the gear might not be working properly; however, this fear proved to be unfounded. Operations progressed well during the last half of the survey, resulting in the completion of nearly all objectives and the locating of a substantial surf clam resource along the Alaska Peninsula.

In evaluating the resource assessment data presented, it is important to understand how limited the sampling effort was relative to available grounds. For example, there are about 3.37 billion square feet in each 100 square mile survey block shown in figure 5. During the average 15-minute tow, the clam harvester covered about 4,300 square feet, or slightly over 1 millionth of a blocks area. Obviously, major clam resources in the surveyed areas probably remain undetected.

Results of the phase I survey indicated low clam abundance in the off-shore southeastern Bering Sea survey area where survey depths were primarily 20-30 fms, while the possible surf clam resource detected along the Alaskan Peninsula was at depths of 10-20 fms. The more detailed phase II survey of the Peninsula area indicated the surf clam resource to occur over a 1,600 square mile area, primarily at depths of 13-18 fms. Thus it may be that much of the offshore southeastern Bering Sea is not a desirable habitat for surf clams, due at least partly to excessive depth.

The surf clam resource magnitude (whole clams) in the 1,600 square mile Peninsula area has been estimated at 286,184 metric tons ±37,890 metric tons or between 248,294 and 324,074 metric tons. Conversion of whole clams to total meats based upon the observed 35% yield value indicates the total meat biomass to be between 86,900 and 113,000 metric tons or about 191-248 million pounds. These estimates are regarded as very conservative due to the assumption of 100% harvesting efficiency and knowledge of inefficiency due to undesirable towing speeds.

For planning purposes in this reporting, it is valuable to indicate a preliminary estimate of annual sustained yield. Data collected during the survey to determine surf clam growth and mortality which are needed to determine yield are not yet available. However, following methods described by Alverson and Pereyra (1969) to estimate yield of latent stocks, and assuming that the natural mortality (M) of the southeastern Bering Sea surf clam is similar to that of the Atlantic surf clam, a preliminary indication of yield can be obtained. This analysis indicates the annual yield could reach 10% of the biomass or between 24,800 and 32,400 metric tons of whole clams or 19-25 million pounds of meat. If the Bering Sea natural mortality coefficient (M) is less than 0.25 (Atlantic coast value), the yield should be adjusted downwards.

The magnitude of the Alaskan tellin resource along the Alaska Peninsula has probably been badly underestimated due to their ability to pass through the clam harvester. Better estimates of this resource potential would require substantial changes in the size selectivity of fishing gear. Other clam species encountered appear to have little if any commercial potential, primarily due to low abundance and scattered distribution.

The average size of surf clams obtained along the Alaska Peninsula (110 mm.) was larger than that of surf clams encountered in other areas but considerably smaller than that of the Atlantic surf clam (about 140 mm.). However, the approximate 35% meat yield of Alaskan surf clams is considerably higher than that of the Atlantic species, which averages about 21%. The difference is due in part to the relatively thin shell of the Alaskan species.

The potential for commercial development of the surf clam in the Bering Sea appears excellent based on the quality and availability of clams observed during this study. The flavor is a typical and desirable flavor combined with sweetness. The texture of the fresh and frozen clam is firm but may become tough if the meat is overcooked. The flavor and texture of the canned, minced clam meat are excellent. The texture and flavor of the fresh and frozen tellin clam are also excellent. The surf clam in the Bering Sea is unusual in that the neck and foot are pigmented. The effect of pigmentation on market potential would appear to be slight. Since the pigment fades substantially during heat processing, we feel that the problem, if any, is minimal. The yield of shucked meats from the surf clam was better than expected.

The water quality tests and sanitary survey of clams conducted in conjunction with this project indicate the area is suitable for clam harvesting. The bacterial counts of the clams and the growing area were low and meet standards set by the Food and Drug Administration.

On the basis of our finding no saxitoxin in the edible portions of the clams tested, which, of course, are limited to the conditions existing along the Alaska Peninsula at the time of the survey, we are inclined to be optimistic. However, the presence of saxitoxin in the visceral masses including ingested food of tellins and cockles suggest need for more information. It is known, for example, that certain species of clams ingest the causative Gonyaulax organism selectively and that the uptake, storage, and elimination of the toxin varies from species to species. Specifically, the East Coast surf clam (Spisula polynyma) ingests the toxic organism and retains the toxin for significant periods of time. Consequently, more information and samples of surf and tellin clams should be obtained from as many survey blocks as possible, with as much frequency as possible, for at least one, and preferably two, year(s). Such sampling would permit more definitive conclusions as to whether saxitoxin is a factor to be considered in the use of this resource and should be conducted beforehand or during early development of the fishery.

In summary, results of the 1977 clam survey indicate that the potential for a surf clam fishery exists along the Alaskan Peninsula. The east coast-style hydraulic clam harvester operated effectively in the Bering Sea substrates. A surf clam resource in this area has been defined over a 1600 square mile area and the depth distribution established. While detailed production fishing tests were not conducted, catch rates obtained with the three-foot wide harvester indicate commercial potential with a ten-foot wide harvester. The resource biomass has been conservatively calculated at 248,000-324,000 metric tons of whole clams with an annual potential yield of about 19-25 million pounds of meats. The average size of Alaskan surf clams was found to be smaller than the east coast species; however, the meat yield was considerably higher. Tests have indicated that surf clams can be held live aboard ship either tanked or dry without excessive dead loss and bacteriological tests indicated that clams and the environment meet FDA requirements. Results of PSP tests indicated that no saxitoxin was detected in the edible portion of surf clams, their visceral mass including stomach contents or in the edible meats of tellin clams and cockles. Low levels of saxitoxin were present, however, in the visceral mass including stomach contents of tellin clams and cockles. Food quality studies have indicated both surf clam and tellin clam flavor and texture to be excellent. And, for further study, an excellent set of motion and still photographic records of the environment have been obtained in an area where harvesting was conducted.

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APPENDIX

List of haul and catch data resulting from a survey of subtidal clam resources in the S.E. Bering Sea, July-August, 1977.

HAUL DATA									CATCH DATA															
									CLAMS												CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper		S. groen.		S. alta		M. elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
1*	7-10	0	12	18	32546.9	45212.7	58 25 45	157 48 10																
2*	7-11	0	24	10	33191.7	46537.8	57 47 50	161 13 23																
3*	7-11	0	23	30	33195.3	46545.6	57 47 42	161 14 33																
4*	7-11	0	24	17	33193.5	46549.6	57 48 12	161 15 11																
5*	7-12	0	24	0	33194.3	46548.0	57 47 59	161 14 56																
6	7-14	27	23	30	33193.2	46552.3	57 48 24	161 15 36	13	3.5	13	0.5			11	3.5								
7	7-14	26	25	15	33259.0	46680.3	57 45 06	161 34 46	2	0.5					21	7.0							1	0.5
8	7-14	25	23	30	33312.3	46803.6	57 43 42	161 53 17	1	0.1					8	2.5					1	0.5		
9	7-14	24	22	30	33347.6	46906.3	57 44 07	162 08 50	1	0.1	1	0.1			23	9.0					1	0.5		
10	7-14	24	22	30	33394.8	46983.8	57 41 12	162 20 16	5	2.0					21	9.0					1	4.0		
11	7-15	34	20	30	33286.0	47033.6	58 01 03	162 29 47							6	1.5								
12	7-15	35	17	30	33228.8	47055.3	58 10 43	162 34 13																
13	7-15	33	18	30	33206.8	46921.5	58 06 42	162 13 12			785	47.0					11	1.0						
14*	7-15	32	24	13	33156.0	46789.5	58 07 10	161 52 59																
15*	7-15	31	19	30	33125.9	46683.5	58 06 04	161 36 38																
16	7-15	30	22	30	33095.5	46523.6	58 02 14	161 11 57	4	0.5	76	4.5			8	2.0	1	0.1			2	1.5		
17	7-15	29	20	15	33066.2	46413.5	58 00 58	160 55 05			4	0.1												
18	7-15	28	23	30	33116.6	46407.5	57 52 42	160 53 52	12	1.0	3	0.1			24	7.5					1	5.5		
19	7-16	49	14	18	33052.6	45502.8	57 12 48	158 37 00	84	38.0	39	2.0					1	0.1						
20	7-16	50	15	7	33124.9	45619.3	57 05 44	158 54 06	77	30.0	180	10.0					4	0.4						
21	7-16	51	16	30	33173.1	45701.8	57 01 22	159 06 12			1	0.1	30	8.0										

*Nonassessment tows

APPENDIX (Cont.)

									CATCH DATA															
HAUL DATA									CLAMS												CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs	No.	lbs.	No.	lbs.	No.	lbs.
22*	7-16	53	14	10	33208.9	45740.3	56 56 39	159 11 40																
23*	7-16	53	13	30	33236.0	45751.9	56 51 54	159 13 06																
24	7-16	57	12	10	33332.6	45898.3	56 41 47	159 34 16	70	40.0	43	4.5	7	3.5			10	1.0			4	4.0		
25*	7-16	56	12	16	33329.9	45887.2	56 41 34	159 32 35																
26	7-16	57	14	10	33354.9	45942.0	56 40 10	159 40 41	14	5.0	30	1.0	1	0.8			3	0.2						
27	7-16	60	13	10	33407.7	46040.4	56 36 01	159 55 06	284	108.0	11	0.5	1	0.5										
28	7-16	61	17	10	33475.7	46180.9	56 31 51	160 15 51	74	29.0			2	2.2					1	0.6				
29	7-17	62	16	10	33534.0	46260.4	56 25 12	160 27 19	23	9.5			1	0.5										
30	7-17	65	12	10	33619.8	46338.0	56 11 58	160 38 03	3	1.0	33	2.0			59	23.0					1	1.0		
31	7-17	65	14	10	33636.4	46382.5	56 11 51	160 44 46					4	3.0										
32	7-17	66	8	10	33653.7	46365.4	56 06 17	160 41 48																
33	7-17	66	4	10	33653.3	46337.2	56 03 54	160 37 31																
34*	7-17	64	9	10	33623.3	46300.0	56 07 53	160 32 01																
35**	7-17	62	10	3	33483.9	46152.3	56 27 51	160 11 16	41	16.5			17	11.5										
36	7-18	60	12	16	33409.0	46037.6	56 35 32	159 54 39	110	46.0	3	0.2												
37	7-18	60	15	13	33410.6	46046.2	56 35 49	159 55 58	172	70.0	75	6.5			1	0.1	1	0.1			1	1.0		
38	7-18	60	20	7	33401.2	46050.2	56 38 08	159 56 44	82	33.0	17	0.4	3	3.0	1	0.1	1	0.1						
39	7-18	57	17	10	33343.5	45945.8	56 42 51	159 41 27	280	98.0	19	0.5												
40	7-18	55	22	10	33303.4	45924.3	56 49 42	159 38 43	6	0.7	134	10.0									2	2.2		
41	7-18	54	20	10	33273.3	45861.0	56 51 34	159 29 23	12	5.0	2	0.1									2	4.7	1	0.1

**Cockle - C. nuttallii, 1 ind./0.1 lb.

APPENDIX (Cont.)

					HAUL DATA				CATCH DATA																	
									CLAMS														CRAB			
Haul	Date	Block	Depth	Dura-tion	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
42**	7-18	54	20	5	33220.1	45806.6	56 58 43	159 21 42	4	0.1	27	1.7			1	0.1			18	3.0				
43	7-18	51	21	10	33128.6	45687.0	57 09 10	159 04 22	1	0.1	59	2.5	1	0.2					2	0.1				
44	7-18	48	20	10	33033.3	45544.6	57 18 55	158 43 25	32	16.0	398	24.0												
45	7-18	45	18	10	32984.4	45480.7	57 24 27	158 33 56	86	42.0	165	10.0												
46	7-19	42	19	10	32917.1	45432.8	57 34 08	158 26 44	4	2.0	90	6.0			2	0.8								
47	7-19	42	16	10	32889.9	45385.0	57 36 30	158 19 30	11	4.5	230	13.5												
48	7-19	40	17	10	32874.6	45411.0	57 40 35	158 23 18	9	5.0	40	0.7												
49*	7-19	41	18	5	32835.0	45381.3	57 46 00	158 18 36																
50	7-19	0	18	10	32831.4	45602.2	57 57 33	158 51 31	2	0.8	3	0.1												
51	7-22	4	19	10	32924.8	45816.4	57 52 47	159 24 13			2	0.1									1	0.1		
52	7-22	2	19	10	Loran Out		57 53 00	159 31 00	1	0.1	18	0.5					2	0.1			3	6.5		
53	7-22	1	20	10	Loran Out		57 52 00	159 36 00													2	4.5		
54	7-22	3	20	20	32966.8	45941.9	57 52 18	159 43 15	5	0.5	12	0.5			1	0.5					1	0.1		
55	7-22	5	23	20	32991.2	45851.2	57 43 26	159 29 35	1	0.3	10	0.2												
56	7-22	7	26	20	33077.8	45918.9	57 32 09	159 39 41	28	5.0	502	22.0									1	0.1		
57	7-22	8	29	20	33079.2	45852.2	57 28 07	159 29 37	5	1.5	157	8.0									2	10.0	1	1.0
58	7-22	8	28	20	33090.6	45844.6	57 25 38	159 28 25	26	7.0	218	11.0												
59	7-22	9	28	14	33128.2	45923.5	57 23 25	159 40 11	4	0.2											8	17.0	1	0.2
60	7-23	10	31	20	33256.0	46331.5	57 24 55	160 41 18													4	5.5	2	1.0
61	7-23	11	32	20	33278.1	46405.9	57 25 34	160 52 28							5	1.8					2	1.0	1	0.3

**Cockle - C. nuttallii, 2 ind./0.1 lb.

APPENDIX (Cont.)

HAUL DATA									CATCH DATA																	
									CLAMS														CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
62	7-23	12	29	20	33277.5	46491.3	57 30 51	161 05 31	2	0.1					2	0.5					3	6.0		
63	7-23	13	28	20	33271.0	46528.0	57 34 10	161 11 12							6	3.5					4	8.0		
64	7-23	14	27	20	33331.4	46595.7	57 27 58	161 21 01	1	0.3					39	25.0					15	21.5	1	0.5
65	7-23	14	28	15	33346.6	46611.6	57 26 20	161 23 19	10	2.5					7	2.2					1	1.5		
66	7-23	15	30	20	33396.5	46614.3	57 17 44	161 23 14							11	3.0					2	2.5		
67	7-23	16	28	20	33446.0	46705.6	57 14 51	161 36 42							3	1.0							1	0.2
68	7-23	17	24	11	33492.0	46813.7	57 13 48	161 52 47	22	10.0	7	0.2												
69	7-23	18	26	10	33544.4	46942.6	57 13 10	162 11 59	7	2.5					21	10.5					17	49.5		
70	7-24	19	26	20	33580.7	47031.4	57 12 48	162 25 13	2	0.5					32	17.0					14	44.0		
71	7-24	20	26	20	33613.3	47164.7	57 16 15	162 45 22							56	23.5							1	0.3
72**	7-24	21	24	20	35575.8	47173.7	57 23 22	162 47 16							4	1.5					4	16.5		
73	7-24	22	24	20	33554.4	47223.9	57 30 18	162 55 24							19	8.0							1	0.3
74	7-24	36	23	20	33527.2	47314.4	57 40 33	163 10 05	1	0.3	1	0.1			8	4.0								
75	7-24	37	23	20	33507.8	47423.4	57 50 22	163 27 51	1	0.2	1	0.1			27	9.5								
76	7-25	38	21	20	33485.4	48053.9	57 30 44	162 29 56	1	0.3														
77	7-25	39	15	20	33356.8	48032.1	57 44 55	165 17 46	1	0.4					2	0.8								
78§	7-29	0	5	15	34858.2	48432.1	53 56 25	166 38 09	3	0.5					1	0.3								
79§§	7-29	0	22	13	34857.4	48428.8	53 56 11	166 37 36																
80	7-29	0	14	5	34823.1	48352.4	53 59 38	166 21 14																
81	7-29	0	18	15	34825.4	48354.5	53 58 48	166 21 59	29	6.0									2	0.1			1	0.4

§Cockle - C. nuttallii, 23 ind./15.5 lb.
§§Cockle - C. nuttallii, 5 ind./ 4.0 lb.
**Tanner crab - C. opilio, 3 ind./ 2.5 lb.

APPENDIX (Cont.)

HAUL DATA									CATCH DATA															
									CLAMS												CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
82	7-29	0	19	15	34825.1	48354.3	53 58 56	166 21 54	16	3.0														
83	7-29	0	18	15	34825.6	48354.5	53 58 41	166 22 02															6	3.1
84**	7-29	0	18	15	34542.1	47886.7	54 43 09	164 44 27	11	2.8														
85	7-29	0	7	15	34539.7	47874.9	54 42 15	164 42 40																
86	7-29	0	10	15	34542.8	47880.3	54 41 55	164 43 38	6	0.8														
87	7-29	0	14	15	34544.2	47886.6	54 42 21	164 44 36	81	22.5														
88	7-30	0	21	15	34548.3	47903.4	54 43 23	164 47 13	29	6.0					1	0.2							1	0.2
89	7-30	0	23	15	34546.9	47907.2	54 44 30	164 47 37																
90§	7-30	0	15	15	34546.6	47891.0	54 42 07	164 45 23	42	13.0														
91§§	7-30	0	17	15	34542.4	47886.1	54 42 57	164 44 23	64	17.0											1	1.0		
92§§§	7-30	0	15	48	34538.1	47878.5	54 43 24	164 43 01	30	10.0														
93*	7-30	0	15	20	34511.4	47854.6	54 49 37	164 37 46																
94*	7-30	0	9	15	34445.2	47738.0	54 56 04	164 17 22																
95*	7-30	0	10	15	34440.8	47729.6	54 56 23	164 15 56																
96	7-30	0	11	15	34441.4	47731.8	54 56 29	164 16 17																
97*	7-30	0	14	5	34442.4	47740.6	54 57 23	164 17 35																
98	7-31	0	16	10	34336.6	47561.5	55 07 57	163 47 10			1	0.1												
99	7-31	0	19	15	34331.0	47558.1	55 09 17	163 46 29																
100	7-31	0	9	3	34276.9	47415.8	55 08 02	163 23 52																
101	7-31	0	17	15	34127.5	47223.5	55 29 15	162 52 20	1	0.3			1	0.5							5	9.0		

**Cockle - *C. nuttallii*, 8 ind./5.0 lb.
§Cockle - *C. nuttallii*, 6 ind./4.0 lb.
§§Cockle - *C. nuttallii*, 6 ind./4.0 lb.
§§§Cockle - *C. nuttallii*, 7 ind./5.0 lb.

APPENDIX (Cont.)

Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M elegans		King		Snow	
					HAUL DATA				CATCH DATA				CLAMS								CRAB			
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
102	7-31	0	20	15	34119.2	47227.1	55 31 58	162 52 48	2	0.6	22	1.0			7	3.0					5	9.0	7	1.0
103	7-31	0	20	15	34077.6	47169.5	55 37 01	162 43 44	1	0.1											1	0.1	2	0.5
104*	7-31	0	18	3	33994.4	47023.3	55 43 39	162 21 10																
105	8-1	61	15	15	33457.3	46149.2	56 33 26	160 11 13	95	35.0											1	1.5		
106	8-1	61	17	18	33468.3	46168.0	56 32 28	160 13 58	98	41.0			15	13.0										
107	8-1	61	16	6	33474.3	46170.2	56 31 20	160 14 13	230	88.0	5	0.1												
108	8-1	61	16	13	33469.3	46157.6	56 31 27	160 12 20	435	175.0	97	7.0					1	0.2						
109**	8-1	61	17	20	33466.0	46149.5	56 31 34	160 11 08	108	39.5	2	0.1	5	2.0										
110	8-1	60	15	15	33456.6	46133.0	56 32 22	160 08 43	39	17.0			24	23.5							1	2.0		
111	8-1	60	14	5	33446.3	46120.1	56 33 37	160 06 52	176	63.0														
112	8-1	60	16	17	33441.9	46116.5	56 34 18	160 06 23	214	102.0	9	0.8	4	3.0										
113	8-1	60	20	16	33434.2	46107.5	56 35 17	160 05 06	84	40.0			27	25.0			1	0.1						
114	8-1	60	19	16	33425.5	46086.4	56 35 36	160 01 58	6	2.0	67	6.0			3	0.5								
115	8-1	60	17	15	33416.8	46064.8	56 35 52	159 58 45	288	132.0	20	1.5	2	1.5			1	0.1						
116	8-1	60	15	16	33413.6	46053.1	56 35 41	159 56 59	130	52.0			2	1.5							1	1.5		
117	8-1	60	16	16	33401.5	46027.1	56 36 23	159 53 08	18	8.0	71	10.0												
118	8-1	59	14	15	33386.0	45990.0	56 36 59	159 47 38	46	21.0	21	1.5					4	1.5						
119	8-1	59	16	15	33378.3	45979.9	56 37 54	159 46 11	102	45.0	50	4.2	6	1.3			14	2.5			2	3.0		
120	8-1	59	17	15	33377.3	45994.6	56 39 11	159 48 29	43	20.5	39	2.0					1	0.1						
121	8-1	59	17	15	33375.0	45988.5	56 39 14	159 47 34	189	89.0	440	22.0	1	0.5			5	0.2						

**Cockle - *C. nuttallii*, 1 ind./0.1 lb.

HAUL DATA									CATCH DATA																	
													CLAMS								CRAB					
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow			
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.		
122	8-1	57	18	18	33371.3	45983.8	56 39 41	159 46 54	62	32.0	480	24.0			5	3.5	3	0.5								
123**	8-1	57	17	17	33367.1	45981.2	56 40 23	159 46 34	146	71.0	360	18.0	5	3.0			3	1.5			3	4.0				
124§	8-1	57	18	15	33363.7	45980.8	56 41 05	159 46 34	212	108.0	180	9.0	7	5.5	1	0.1										
125	8-1	57	18	16	33350.5	45966.6	56 42 51	159 44 34	62	26.5	245	17.0	1	0.8	2	1.0	1	0.2								
126	8-1	57	18	16	33345.2	45952.5	56 42 58	159 42 28	60	22.5	144	12.0														
127	8-1	60	17	10	33415.6	46062.0	56 35 55	159 58 20	30	12.0	100	5.0														
128	8-2	57	22	15	33346.6	45993.1	56 45 33	159 48 43	16	4.0	66	3.3	1	0.5												
129	8-2	57	19	15	33349.6	45973.8	56 43 33	159 45 41	47	20.0	400	22.0	2	1.5	1	0.1										
130	8-2	57	16	15	33342.6	45945.0	56 42 59	159 41 20	88	37.0	25	1.0														
131	8-2	57	16	17	33343.6	45939.5	56 42 23	159 40 28	304	120.0	68	7.5	1	1.0												
132*	8-2	57	17	5	33334.1	45930.0	56 43 44	159 39 11																		
133	8-2	57	16	15	33331.3	45921.8	56 43 44	159 37 55	158	64.0	120	8.0					2	0.8								
134	8-2	56	16	15	33308.6	45880.6	56 48 36	159 32 55	32	13.0	105	7.0									2	4.0				
135	8-2	54	17	15	33270.9	45837.9	56 50 30	159 25 51											3	1.0						
136*	8-2	54	17	15	33274.9	45851.1	56 30 34	159 27 50																		
137	8-3	62	14	5	33482.0	46170.6	56 29 41	160 14 09	105	28.0																
138	8-3	62	16	15	33488.9	46186.0	56 29 21	160 16 26	195	56.0																
139	8-3	61	15	15	33490.9	46197.2	56 29 47	160 18 09	159	44.5																
140	8-3	61	16	15	33492.5	46205.0	56 30 02	160 19 20	392	115.0																
141	8-3	61	16	15	33487.6	46199.4	56 30 40	160 18 33	147	40.5																

**Cockle - C. nuttallii, 1 ind./0.2 lbs.
§Cockle - C. nuttallii, 1 ind./0.1 lbs.

HAUL DATA									CATCH DATA																	
									CLAMS														CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
142	8-3	61	17	15	33488.2	46205.1	56 30 58	160 19 25	390	164.0	3	0.1	1	1.0										
143*	8-3	61	17	15	33493.0	46209.8	56 30 17	160 20 05																
144	8-3	61	18	15	33497.3	46221.3	56 30 14	160 21 48	162	67.0			8	7.0					1	0.3				
145	8-3	61	17	15	33495.6	46210.6	56 29 47	160 20 10	288	94.0	1	0.1												
146	8-3	62	16	15	33493.6	46202.3	56 29 35	160 18 54	173	60.0														
147	8-3	62	16	14	33497.0	46202.2	56 28 49	160 18 50	160	52.0														
148	8-3	62	17	15	33501.1	46212.9	56 28 45	160 20 26	152	60.0			2	1.5										
149	8-3	62	17	15	33502.1	46217.8	56 28 55	160 21 11	103	36.0														
150	8-3	62	17	15	33506.4	45221.6	56 28 16	160 21 42	173	68.0			4	3.0										
151	8-3	62	14	10	33508.0	46217.4	56 27 34	160 21 01	187	49.0														
152	8-3	62	15	15	33511.9	46220.0	56 26 55	160 21 22	194	60.0														
153*	8-3	62	16	9	33519.4	46239.5	56 26 47	160 24 17																
154	8-3	62	16	15	33521.7	46242.1	56 26 29	160 24 39	182	68.0														
155	8-3	62	16	15	33520.2	46241.2	56 26 45	160 24 32	158	64.0														
156	8-3	62	15	15	33523.5	46246.0	56 26 23	160 25 14	78	25.0	4	0.1												
157	8-3	62	17	15	33527.4	46256.9	56 26 23	160 26 52																
158	8-3	62	17	15	33528.7	46252.0	56 25 43	160 26 05	3	1.0	1	0.1	1	1.0										
159	8-3	62	13	10	33509.7	46215.5	56 27 03	160 20 42	233	68.0														
160	8-3	62	15	15	33510.0	46222.9	56 27 34	160 21 51	343	132.0			1	1.0										
161	8-3	62	16	15	33512.7	46231.8	56 27 40	160 23 12	195	85.0			3	3.0										

APPENDIX (Cont.)

HAUL DATA									CATCH DATA																	
									CLAMS														CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long. - W	*Spisula*		*Tellina*		*S. laper.*		*S. groen.*		*S. alta*		*M. elegans*		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
162	8-4	60	17	15	33402.2	46033.8	56 36 43	159 54 10	193	81.0	143	12.0												
163	8-4	60	17	15	33395.1	46028.2	56 37 50	159 53 25	449	203.0	2	0.1	7	6.0							2	4.0		
164	8-4	60	17	15	33398.9	46030.0	56 37 09	159 53 38	13	5.0	86	10.0	4	4.0			1	0.1						
165	8-4	60	17	15	33396.0	46028.3	56 37 39	159 53 25	2	0.3	5	0.3	14	11.0							2	3.0		
166	8-4	60	17	15	33395.9	46028.4	56 37 40	159 53 26	348	186.0	20	1.0	3	2.5							2	3.0		
167	8-4	60	17	15	33395.1	46027.4	56 37 46	159 53 17	238	130.0	2	0.1	5	5.0										
168	8-4	60	17	15	33392.8	46024.3	56 38 02	159 52 51	282	113.0	17	1.0	1	1.0			1	0.2			2	5.0		
169**	8-4	60	17	15	33391.3	46018.9	56 37 58	159 52 02	405	210.0	30	2.0	2	2.0			1	0.2						
170	8-4	58	21	20	33381.7	46019.2	56 40 02	159 52 14	189	83.0	895	61.0			10	5.0	2	0.4						
171	8-4	57	16	15	33336.3	45916.4	56 42 17	159 37 01	55	25.0	336	21.0	6	1.5			20	1.5			1	2.0		
172	8-4	57	16	20	33330.5	45909.5	56 43 02	159 36 02	32	12.0	106	10.0					8	1.0			2	4.0		
173	8-4	57	18	15	33323.6	45916.6	56 44 59	159 37 14	23	10.0	1081	47.0	1	0.3	3	1.0	3	1.0			1	2.0		
174*	8-4	56	17	12	33299.5	45877.0	56 47 15	159 31 29																
175*	8-5	50	14	6	33127.2	45621.5	57 05 25	158 54 25																
176	8-5	50	15	6	33119.1	45612.4	57 06 27	158 53 06	159	55.0	216	12.0					1	0.1						
177	8-5	50	15	15	33114.9	45607.2	57 06 57	158 52 21	574	257.0	1380	60.0	1	1.0										
178	8-5	50	14	15	33120.2	45613.2	57 06 17	158 53 13	212	106.0									1	0.3				
179*	8-5	57	15	13	33111.0	45601.7	57 07 23	158 51 33																
180	8-5	50	16	10	33103.9	45598.6	57 08 35	158 51 08	25	8.0	200	10.0												
181*	8-5	48	16	4	33100.4	45600.2	57 09 22	158 51 25																

**Cockle - *C. nuttallii*, 1 ind./0.1 lbs.

APPENDIX (Cont.)

HAUL DATA									CATCH DATA															
									CLAMS												CRAB			
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long. - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M elegans		King		Snow	
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
182	8-5	48	17	15	33096.1	45598.5	57 10 06	158 51 11	145	67.0	495	16.5					1	0.4						
183	8-5	48	16	15	33094.7	45591.1	57 09 55	158 50 05	210	94.5	40	1.5												
184	8-5	50	15	15	33098.3	45589.2	57 09 06	158 49 46	236	101.5	270	9.0												
185	8-5	48	16	15	33093.6	45583.8	57 09 42	158 48 59	78	31.0	350	10.0												
186	8-5	48	17	15	33088.7	45580.6	57 10 27	158 48 32	95	40.0														
187**	8-5	48	16	15	33072.6	45544.0	57 11 23	158 43 06	5	4.5	180	6.0			29	12.5								
188	8-5	49	15	15	33056.2	45507.8	57 12 24	158 37 44			20	1.0					4	0.2						
189	8-5	49	14	15	33047.9	45492.6	57 13 06	158 35 29			20	1.0			3	1.0	2	0.4						
190	8-5	48	18	15	33056.4	45521.0	57 13 08	158 39 43	1	0.2					3	1.0	1	0.1						
191	8-5	48	20	15	33045.7	45534.4	57 15 59	158 41 49	12	5.5	250	10.0			1	0.3								
192	8-5	48	21	15	33039.0	45554.2	57 18 24	158 44 50	8	4.0	1500	50.0												
193	8-5	46	21	15	33035.8	45570.1	57 19 55	158 47 15	2	1.0	2400	80.0												
194	8-5	46	21	15	33012.7	45542.5	57 22 40	158 43 10	67	49.0	1750	70.0					1	0.2						
195	8-5	46	20	15	33002.9	45522.2	57 23 20	158 40 08	3	1.0	3000	120.0	1	0.5										
196	8-6	57	17	11	33393.7	46021.3	56 37 37	159 52 22	736	348.5	20	1.0	1	1.0										
197§	8-6	57	17	19	33393.2	46023.1	56 37 52	159 52 39	803	398.5														
198	8-6	57	17	10	33393.5	46020.0	56 37 34	159 52 10	154	76.5			1	1.0							1	1.5		
199*	8-6	57	17	0	33393.8	46023.1	56 37 44	159 52 39																
200	8-6	57	17	13	33393.4	46022.4	56 37 46	159 52 32	726	394.5														
201	8-6	59	16	15	33392.8	46015.8	56 37 25	159 51 32	400	158.0							6	0.6						

**Cockle - C. nuttallii, 1 ind./0.1 lbs.
§Cockle - C. nuttallii, 1 ind./0.1 lbs.

HAUL DATA									CATCH DATA																
									CLAMS												CRAB				
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long. - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow		
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	
202	8-6	59	15	15	33394.1	46014.0	56 37 00	159 51 14	400	205.0							1	0.3							
203	8-7	49	18	10	33023.2	45496.5	57 18 04	158 36 12	144	62.0	100	5.0													
204*	8-7	49	17	10	33021.7	45481.4	57 17 28	158 33 56																	
205	8-7	45	17	10	32994.0	45456.9	57 21 19	158 30 20	446	205.0															
206	8-7	45	16	10	32994.5	45456.8	57 21 13	158 30 19	379	175.5	100	5.0			1	0.3	1	0.4							
207	8-7	45	16	15	32993.5	45455.6	57 21 20	158 30 09	421	199.0	100	5.0					1	0.4							
208	8-7	45	15	10	32988.8	45444.2	57 21 34	158 28 27	234	115.0	80	4.0													
209	8-7	45	16	15	32988.9	45466.5	57 22 49	158 31 48	424	204.0															
210	8-7	45	17	17	32980.7	45475.7	57 24 51	158 33 12	291	117.0							1	0.3							
211	8-7	45	19	17	32977.7	45475.5	57 25 24	158 33 10	149	70.5	300	15.0			1	0.3									
212	8-7	45	17	14	32974.2	45476.2	57 26 05	158 33 17	95	53.0															
213	8-7	45	18	15	32962.1	45472.7	57 28 05	158 32 41	68	31.0	200	10.0													
214	8-7	45	16	15	32960.3	45444.9	57 26 55	158 28 35	206	96.5			1	1.0											
215	8-7	45	15	15	32964.8	45431.1	57 25 19	158 26 31	356	170.0															
216	8-7	45	16	15	32969.0	45431.0	57 24 32	158 26 30	177	84.5															
217	8-7	45	15	9	32971.1	45416.4	57 23 20	158 24 18	223	110.0															
218	8-7	45	16	15	32971.2	45425.8	57 23 50	158 25 43	248	120.0	80	4.0													
219	8-8	45	17	15	32992.7	45458.0	57 21 37	158 30 31	289	151.5															
220	8-8	45	16	15	32995.1	45457.7	57 21 09	158 30 27	620	273.0															
221	8-8	45	16	15	32994.8	45456.3	57 21 08	158 30 15	325	142.0															

HAUL DATA									CATCH DATA																	
													CLAMS								CRAB					
Haul	Date	Block	Depth	Duration	Loran C		Lat. - N	Long - W	Spisula		Tellina		S. laper.		S. groen.		S. alta		M. elegans		King		Snow			
No.		No.	fm	Min.	Y	Z	° - ' - "	° - ' - "	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.		
222	8-8	45	16	15	32994.8	45455.7	57 21 06	158 30 10	467	223.0			1	0.5			1	0.3								
223	8-8	45	16	15	32994.4	45457.0	57 21 15	158 30 21	317	165.0																
224	8-8	45	15	15	32996.0	45456.4	57 20 54	158 30 16	408	183.0	200	10.0					1	0.3								
225	8-8	45	15	15	32993.9	45454.0	57 21 10	158 29 54	537	259.0							3	0.5	2	0.3						
226	8-8	50	16	15	33112.8	45606.9	57 07 21	158 52 20	374	176.0																
227	8-8	50	14	15	33113.9	45608.0	57 07 12	158 52 29	621	287.0																
228	8-8	50	14	20	33113.3	45605.5	57 07 10	158 52 07	610	275.5	100	5.0					1	0.1								
229	8-8	50	16	15	33115.9	45614.5	57 07 12	158 53 27	351	143.0							3	1.0								
230*	8-8	50	15	15	33112.0	45603.1	57 07 16	158 51 45																		

APPENDIX

Results of PSP tests on whole raw clam meats

Haul No.	Date	Block No.	Depth fm.	Saxitoxin, µg/100g meats		
				Surf clam (Spisula)	Tellin (Tellina)	Cockle (Serripes)
3	7-11	0	23	—	54	—
4	7-11	0	24		—	
6	7-14	27	23	—	—	—
7	7-14	26	25			—
13	7-15	33	18		—	
18	7-15	28	23			
19	7-16	49	14	—		—
20	7-16	50	15	—		
24	7-16	57	12	—		
25	7-16	56	12			—
26	7-16	57	14	—		
27	7-16	60	13	—		
28	7-16	61	17	—		
29	7-17	62	16	—		
30	7-17	65	12			—
35	7-17	62	10	—		—
36	7-18	60	12	—		
38	7-18	60	20	—	94	
40	7-18	55	22		113	
41	7-18	54	20	—		
43	7-18	51	20		68	
44	7-18	48	20	—	—	
45	7-18	45	18	—	55	
46	7-19	42	19	—	24	
47	7-19	42	16		—	
48	7-19	40	17	—		
50	7-19	0	18	—		
52	7-22	2	19		—	
56	7-22	7	26	—	134	
58	7-22	8	28	—	158	
63	7-23	13	28			48
64	7-23	14	27			51
65	7-23	14	28	—		
66	7-23	15	30			47
69	7-23	18	26	—		—
70	7-24	19	26			32
71	7-24	20	26			—
74	7-24	36	23			—
78	7-29	0	5			—
81	7-29	0	18	—		
84	7-29	0	18	—		

APPENDIX

Results of PSP tests on whole raw clam meats (continued)

Haul No.	Date	Block No.	Depth fm	Saxitoxin, µg/100g meats		
				Surf clam (Spisula)	Tellin (Tellina)	Cockle (Serripes)
86	7-29	0	10	—		
87	7-29	0	14	—		
90	7-30	0	15	—		
102	7-31	0	20	—	53	
105	8-1	61	15	—		
109	8-1	61	17		92	—
118	8-1	59	14	—		
121	8-1	59	17	—	70	
126	8-1	57	18		109	
138	8-3	62	16	—		
140	8-3	61	16	—		
148	8-3	62	17	—		
152	8-3	62	15	—		
162	8-4	60	17	—	74	
171	8-4	57	16	—	61	
176	8-5	50	15	—		
181	8-5	48	16	—		
194	8-5	46	21	—		
203	8-7	49	18	—		
209	8-7	45	16	—		
213	8-7	45	18	—		