SHELLFISH INVESTIGATION

PROGRESS REPORT NO. 32

April 1, 1956 - March 31, 1959

Oregon Fish Commission

Research Division

June 1962

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INTRODUCTION

In an attempt to bring delinquent progress reports up to date, report number 32 covers a 3-year period. It also appears in an abbreviated form, covering only the outstanding phases of the shellfish program for this period. Completed reports are on file for all projects that appear in this report and are available for reference.

PERSONNEL CHANGES

The principal change in personnel was the promotion of Dean Marriage to Water Resources Analyst. His departure left the shellfish investigation without a project leader since October 1956. This vacancy accounts in part for the delinquency in progress reports. Other changes in personnel appear in Table 1.

TIME DISTRIBUTION

The approximate time spent on various projects at the Newport Laboratory appears in Table 2. The shellfish personnel stationed at Astoria devoted approximately 90% of their time to razor clams and 10% to crabs and shrimp.

BAY CLAMS

Bay clam work during this period was confined to the annual clam bed surveys, age and growth work on the gaper clam in Yaquina Bay, and one major transplanting of softshell clams into Siuslaw Bay in an attempt to increase productivity. Also, the usual number of dredging and log boom sites were investigated for possible clam bed damage.

Table 1. Personnel Changes, April 1, 1956--March 31, 1959.

Name	Date Employed	Date Terminated or Transferred
Erland Juntunen	June 1956 January 1959	September 1956 ----------
Gerald Davis	June 1956	March 1957
L. Dean Marriage	----------	October 1956
James Warren	June 1957	January 1958
Dave Maskett	June 1957	September 1957
Stanley Wilkes	January 1957 January 1958	September 1957 May 1958
Ross MacIntyre	June 1958	September 1958
Mark DeCew	June 1958	September 1958

Table 2. Time Spent at Newport On Various Projects, April 1, 1956—March 31, 1959.

Project	Time Spent in Per Cent of Total
Crabs	34
Bay Clams	33
Hydrography	13
Oysters	9
Razor Clams	5
Abalone	4
Crawfish, Mussels, Kelp	2
Total	100

Clam Bed Surveys

Annual surveys were conducted on all 7 major clam-producing bays, and one of marginal importance, at least once during this period. The object of these surveys was to obtain information on abundance, distribution, size range, and condition of the clam populations. The bays surveyed, year of survey, and adjudged condition of the stocks are shown in Table 3.

Clam Bed Damage

In March 1958, complaints were received from residents of the Reedsport-Gardiner area that spoil deposition was taking place on the clam beds on Steamboat Island, just below Gardiner. Subsequent investigation revealed that a local dredging company had transported about 3,000 cubic yards of spoil by barge and dumped it on the clam beds on the lower end of Steamboat Island. Surveys in 1949, 1954, 1955, and 1957 indicated that clams were quite numerous in this area. Surveys after the deposition revealed very few clams. It was concluded that the elevation of the flat had been raised and that probably the clams had been buried. A report was submitted and the company involved was instructed to submit plans in the future for any spoil deposition within the estuary.

Gaper Clam Growth Study

In 1956 the distinct possibility of paper-mill waste being dumped into Yaquina Bay existed. It was, therefore, felt that growth studies of the various species of clams in Yaquina Bay should be started in order to establish the normal growth pattern of clams prior to the addition of industrial wastes. If the normal growth pattern could be established, then this rate of growth could be used for comparison of growth after pollutants were added to the water.

In August 1956, 156 gaper clams of various sizes were dug, weighed, measured, and numbers inscribed on the valves with a drill. These clams were again replanted in the bay and periodically recovered and replanted in order to

Table 3. Summary of Bay Surveys, Showing Evaluation of Bay as a Clam Producer.

Bay	Principal Species Involved	Year of Survey and Condition 1/ 1956	1957	1958	Remarks
Coos	Cockle Gaper	N.S.	G	N.S.	Slightly below maximum level
Umpqua	Softshell	N.S.	G	G	Stocks at maximum level
Siuslaw	Softshell	P	P	F	Stocks improving since closure in 1957
Yaquina	Softshell Gaper Cockle	N.S.	G	G	Maximum level
Nestucca	Softshell	N.S.	P	P	Stocks probably at maximum level.
Tillamook	Softshell	G	G	N.S.	Stocks at maximum level
Netarts	Cockle Gaper	N.S.	G	G	Stocks at maximum level
Nehalem	Softshell	G	N.S.	G	Stocks at maximum level

1/ N.S.; No survey. G; Good. F; Fair. P; Poor.

determine growth. The results of this study were inconclusive. It appears that several things occurred to throw doubt upon the validity of the work: (1) injury to the mantle edge on some clams induced an abnormal growth rate and shell formation; (2) too frequent handling possibly shocked the animals and inhibited growth; and (3) we were unable to recover all marked clams each time we sampled. The clams that we were able to dig out on several occasions showed a growth of only 1-2 mm in one year. This experiment is being repeated with minor variations.

Siuslaw Bay

Prior to 1953 the Siuslaw Bay softshell clam stocks underwent a sharp decline in numbers (reported in Progress Reports 28 and 31). The cause of the decline is unknown. A gradual but slow increase in stocks of this animal began in 1955. The beds have been sampled each year since 1953 to determine the relative abundance of clams and Table 4 shows the results of this sampling. Because the natural rehabilitation was proceeding so slowly, the Fish Commission acted in June 1957 to close Siuslaw Bay to clam digging east of the Highway 101 bridge for the period June 25, 1957, to October 1, 1959 (General Order V, amended June 25, 1957).

In order to further accelerate the rehabilitation of these stocks, 17,000 adult softshell clams from under-utilized beds in Nehalem Bay were transplanted to Siuslaw Bay to increase the seed stock. In 1956, prior to this transplant, 200 adult clams were transplanted from Nehalem Bay into Siuslaw Bay in order to determine the feasibility of transplanting clams. From this transplanting a 75% survival was obtained of all clams recovered and all showed new growth. This survival and growth was the determining factor in our decision to transplant clams.

In addition to transplanting the 17,000 clams from Nehalem (400 were marked and planted in control plots) 1,200 clams from Tillamook Bay were

Table 4. Relative Abundance of Softshell Clams in Siuslaw Bay, 1953-58.

Year	Clams Per Square Foot
1953	0.009
1954	N.S. 1/
1955	0.027
1956	0.077
1957	0.075
1958	0.075

1/ N.S.; No Survey

measured and marked with opaque ink and planted in the bay. The results of these plantings will appear in a future progress report.

OYSTERS

Oyster work during this period was confined to investigating oyster lease site applications, oyster pest inspections and completion of the growth and mortality experiment in Yaquina Bay.

Oyster Pest Meetings

In cooperation with the Pacific Marine Fisheries Commission and the Washington Department of Fisheries shellfish staff, public meetings were held in Coos Bay and Tillamook to discuss with the Oregon oyster growers plans for oyster drill inspection in Japan. These meetings were well attended by the growers in both areas and, in general, all growers were opposed to the Oregon biologists participating in this inspection program. The reason for the opposition stemmed from an anticipated cost increase in oyster seed if Oregon were to participate. No further action by PMFC or OFC has been taken on this problem.

Oyster Pest Inquiry

At the request of the Washington Department of Fisheries, inquiries were made as to the source of oysters being processed by the Lighthouse Oyster Company in Portland. This inquiry was brought about by a request from a Washington grower wanting to return shell from the Lighthouse plant to his grounds which were drill free. The inspection of the plant was made and report submitted to the Washington Department of Fisheries.

Oyster Drill Survival Experiment

In 1956 the Oregon Oyster Company proposed to introduce 80,000 spat collectors from Oyster Bay, Washington, into Yaquina Bay. Oyster Bay was known

to be highly infested with the Japanese oyster drill (Ocenebra japonica). Yaquina Bay is free of this pest, therefore, we agreed to run some short-term experiments designed to eliminate drills from any transplantings. Consequently, a trip was made to Olympia where both drills and oysters for experimental work were collected. The drills and oysters were subjected to fresh water for periods of 5 and 9 days. In the 5-day treatments all drills survived and about 75% of the oysters survived. However, in the 9-day treatments all of the 1-year-old oysters died and 85% of the older oysters failed to survive while 50% of the drills survived. Oregon Oyster Company, when confronted with this data, decided against bringing the spat collectors to Oregon.

Oyster Growth and Mortality Studies

A study set up in 1956 1/ to determine oyster growth and shipping and natural mortality was completed. This study was designed to determine mortality by counting the number of oyster spat per shell face and periodically recounting. Any decrease in numbers in subsequent countings would be considered mortality from shipping within the first 30 days, mortality thereafter would have been considered natural. Theoretically this was workable, however, the first 4 countings of spat showed a marked increase in spat per shell face. This increase in numbers was attributed to the presence of spat that were not large enough to be detected when the original counts were made. We were, however, able to follow both individual and collective growth for 18 months. At the end of this period the study was terminated because the oysters had reached a marketable size and corrosion was starting to break up the trays. The Pacific oysters (Crossostrea gigas) were averaging 20 per pint and the Kumamotos were running 60 per pint.

1/ Reported in Progress Report Number 31.

Oyster Mortality

In 1958 an excessive mortality of adult oysters was reported by the Oregon Oyster Company. Upon investigation it was found that about 23% of the oysters brought up by tonging or crossing the shucking table were either dying, or recently dead. Laboratory examination revealed what appeared to be a bacterial infection, however, the exact cause of this mortality was never determined.

CRABS

Crab activities undertaken during the period of this report included: (1) sampling commercial catches in the Columbia River to determine the per cent of legal, softshell male crabs taken; (2) conducting a tagging study to determine movement of crabs caught and released in the Columbia; (3) completion of the Yaquina Bay tagging program; and (4) following the trend of the crab fishery by pot counts and I.B.M. reports.

Condition Sampling

Sampling to find the average size and the shell condition of crabs taken in the Columbia River was accomplished aboard commercial crab boats. The sampling method employed was to measure, sex, and determine the shell condition of all the crabs in a pot. The shell condition of a crab was measured by pressing the shell with the thumb in front of the last anterolateral spine. Three categories of shell condition were used: shell very soft (condition 3); shell still pliable but creaking and showing signs of hardness (condition 2); completely hard (condition 1). At least a 3% sample was taken on each trip. Table 5 summarizes the results of shell condition sampling in the Columbia River during 1957. These data show that more than 10% of the legal-sized male crabs were not in prime condition during the ocean closure (Sept. 15-Dec. 15.)

Table 5. Per Cent Softshell Dungeness Crabs in the Columbia River, August-December 1957.

Date	No. Pots Observed	No. Males Observed	Width Of Males	Legal Males Observed	No. Softshelled Legal Males	Per Cent Softshelled
8/3/57	3	42	152.9mm	12	6	50.0
9/1/57	3	70	142.6	14	4	28.6
10/1/57	43	414	164.5	284	94	33.1
10/3/57	51	498	165.1	357	86	24.1
10/10/57	48	385	162.6	268	37	13.8
10/30/57	18	434	168.5	321	38	11.8
11/22/57	61	727	170.5	589	47	8.0
12/12/57	57	1,049	168.4	859	66	7.6
12/23/57	63	589	162.0	349	40	11.5

Movement Studies

A total of 98 legal, soft shelled male crabs were tagged to study the movement of crabs caught and released in the Columbia River. This tagging was accomplished during condition sampling trips. Of the 98 crabs tagged, 19 or 19.4% were recovered. The average time at liberty was 69 days. One crab was at liberty 335 days. The crabs had traveled from 0 to 25 miles before recovery and were taken from Gearhart to Willapa Bay. A total of 42% of the recoveries were made in the ocean after the ocean season opened. If it can be assumed that the crabs caught and landed would have migrated in the same manner as the tagged crabs then a significant number of crabs caught in the river during the ocean closed period would have been available to the ocean fishery later in the season.

Tagging--Yaquina Bay

In 1955 a crab-tagging program was conducted in Yaquina Bay 1/ to determine the proper release pattern for tagged crabs. In the 1955 study all of the crabs were released at a single release point over a period of several weeks. When the data for this study was analyzed, it was concluded that this was not the proper release pattern for a bay-ocean interchange study. In 1957 another tagging program was conducted in Yaquina Bay using a different release pattern. In this study 1,000 legal-sized crabs (over 5 3/4-inches shoulder width) were tagged and released at 10 different stations (100 crabs per station). The 10 stations were located equi-distance throughout the bay fishing area (Newport to 4 miles up-bay). All of the crabs at a station were released within a 45-minute period. A full-time commercial bay crab fishery was not operating in Yaquina Bay which necessitated our fishing in order to recover the tags. Fishing was conducted from January 1957 through May 1957. By doing our own fishing we were able to obtain information on

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1/ Reported in Progress Report Number 31.

movement, population density, efficiency of escape rings, size differences in portions of the bay, and effect of pot design. Upon completion of the program the data was sent to Dr. Richard Link at Oregon State University for statistical analysis.

Pot Counts

Coastwide pot counts and pounds of crabs landed on the Oregon coast are shown in Table 6.

Miscellaneous Crab Work

A number of routine projects involving crab were conducted during the period of this report. Work of most importance was: (1) design and testing of a plastic crab pot buoy marker identifying pot ownership; (2) study on water quality at the Point Adams Packing Company live tanks in Newport; (3) collecting meat yield figures from packing plants; and (5) collecting and shipping crabs to the University of Oregon for physiological studies involving ecdysis and neural development.

SHRIMP

A fishery for small pink shrimp (Pandalus jordani) was initiated off the Oregon coast in 1957. The history of this fishery has been previously reported and will not be discussed here. The shellfish staff was responsible for collecting biological information on this fishery until mid-1958 when these duties were assigned to Otter Trawl Investigations. Information was collected on the size, age, and sex composition of the shrimp caught. Data on the length of the egg-bearing period and the fecundity of the animal were also compiled.

Table 6. Crab Landings and Estimated Numbers of Pots Fished on the Oregon Coast for the 1955-58 Crab Years (November-October).

Crab Year (Nov.-Oct.)	Pounds Landed	Estimated Maximum Number of Pots Fished
1955-56	8,910,000	18,923
1956-57	11,737,800	19,206
1957-58	10,103,000	21,307

Size, Age, and Sex Composition

The size composition, relative age, and sex composition of the shrimp were tabulated from samples taken from each landing made. The samples consisted of from 300 to 500 shrimp each and were collected at the processing plants. Each shrimp was measured and the sex noted. The size and sex composition of samples taken from September to November 1957 are shown in Figure 1. The male shrimp were distributed bimodally during this period indicating two year classes. The females exhibit only one mode, implying one year class.

Initially the shrimp were measured from the base of the eye stalk to the tip of the telson. This was termed total length, and small measuring boards were used to take this dimension. This method was not satisfactory because many of the shrimp were broken in the process of being caught and landed. Other methods of demonstrating size were considered and carapace length was chosen. This part seemed to withstand the rigors of handling well, was easily measured, and adequately appraised the size of the animals. This length was measured from the base of the eyestalk to the posterior margin of the carapace with a vernier caliper calibrated in tenths of millimeters.

In November 1957, 624 shrimp were measured by both of the above methods

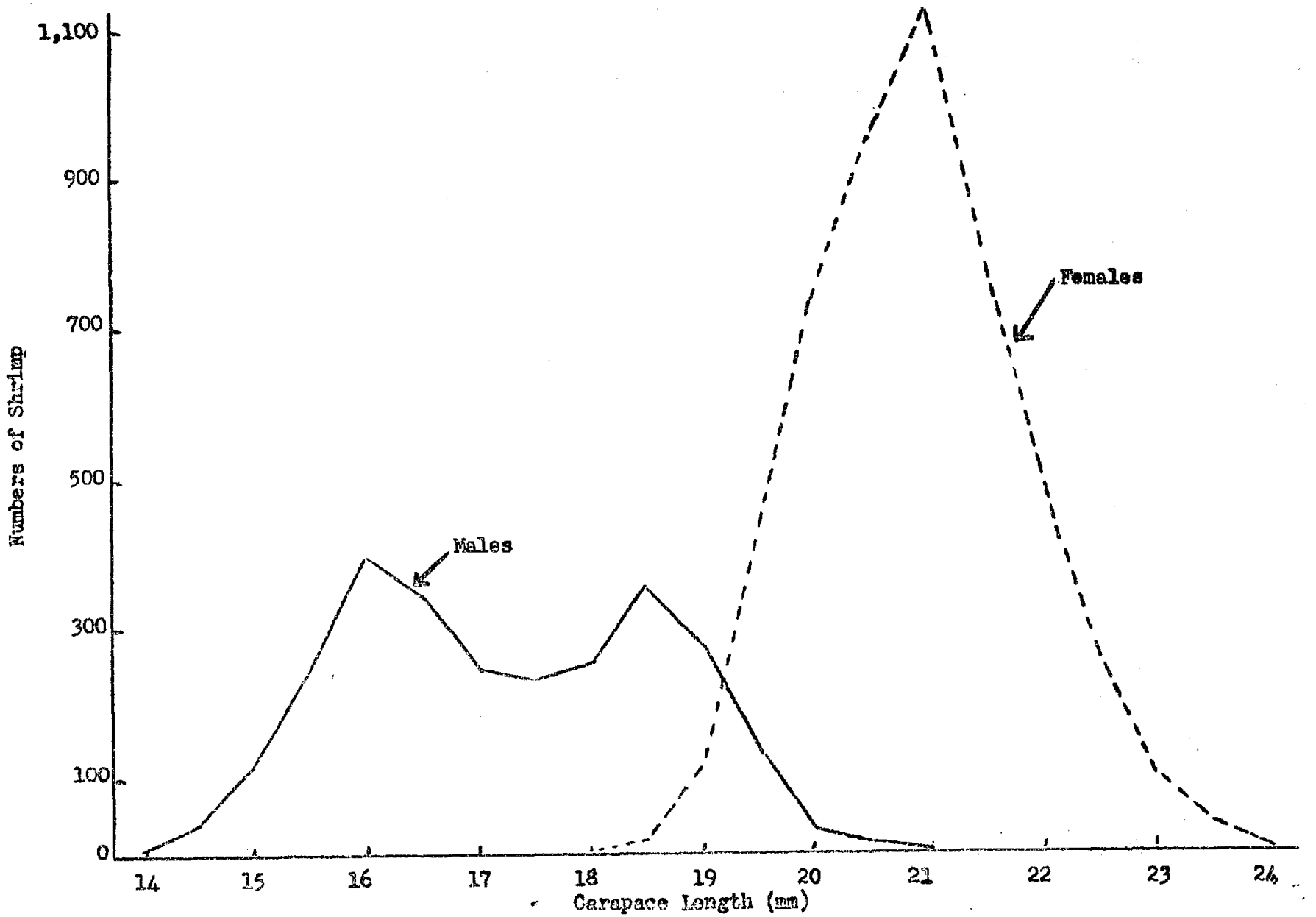

Figure 1. Size Distribution by Sex of Pink Shrimp Sampled at Astoria, September-November 1957.

to determine the relationship of the two characteristics. These data were subjected to linear regression analysis and a coefficient of r=.986 obtained. A line of regression was calculated to allow conversion of total length to carapace length. Figure 2 illustrates this line of regression.

The size distribution, by sex, of shrimp landed in February and March 1958 is shown in Figure 3. The females are still grouped in one mode. A trimodal distribution of males is present. Males in the largest mode are changing sex; transitional males are appearing and the largest mode is decreasing in size. The smallest mode are probably shrimp in the second year and are just being recruited into the fishery. Each successive mode is one year older, but more than one year class is probably present in the single mode of females.

Egg-Bearing Period and Fecundity

The time period that female shrimp carry eggs attached under the abdomen is much longer for pink shrimp than for these species taken along the Gulf coast. This is of some interest since the yield per pound of raw shrimp is much lower during this period. The relative number of gravid females exceeded the number of barren females early in November 1957. No shrimp were taken during December and January, but the majority of females were still gravid when fishing resumed. This relationship persisted until mid-March. This is illustrated in Figure 4.

A study of the reproductive potential of pink shrimp was started in the fall of 1957. A small sample of females with an undamaged egg mass was selected. An attempt was made to include the entire size range, but this was not possible because large females with an undamaged egg mass were difficult to find. Tweezers were used to strip the eggs from the pleopods of the females. The eggs were separated with a teasing needle and the entire number counted. Shrimp eggs are fairly small and this method was quite time consuming. This fact in

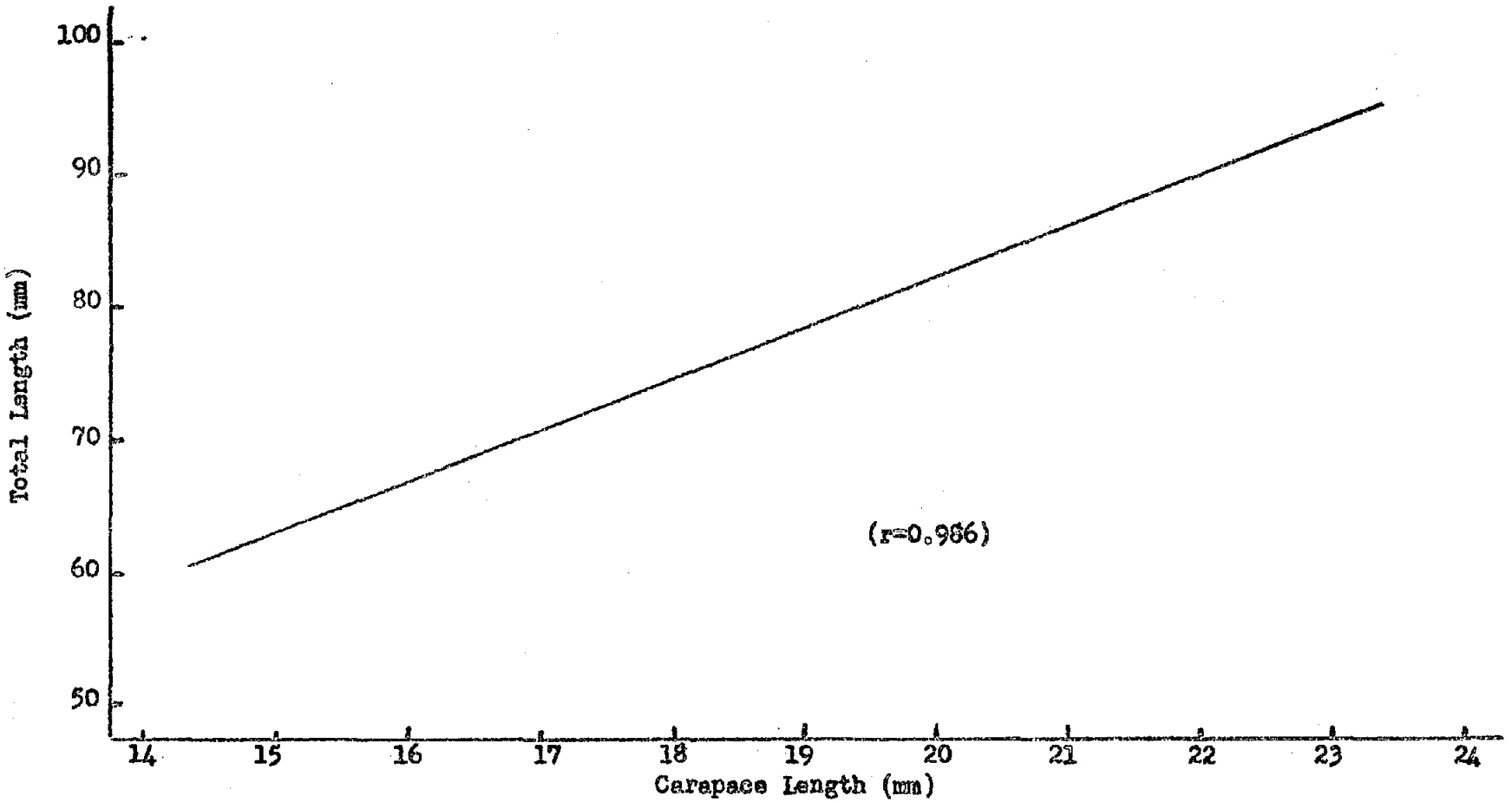

Figure 2. Relationship of Pink Shrimp Total Length to Carapace Length, Winter 1957-58.

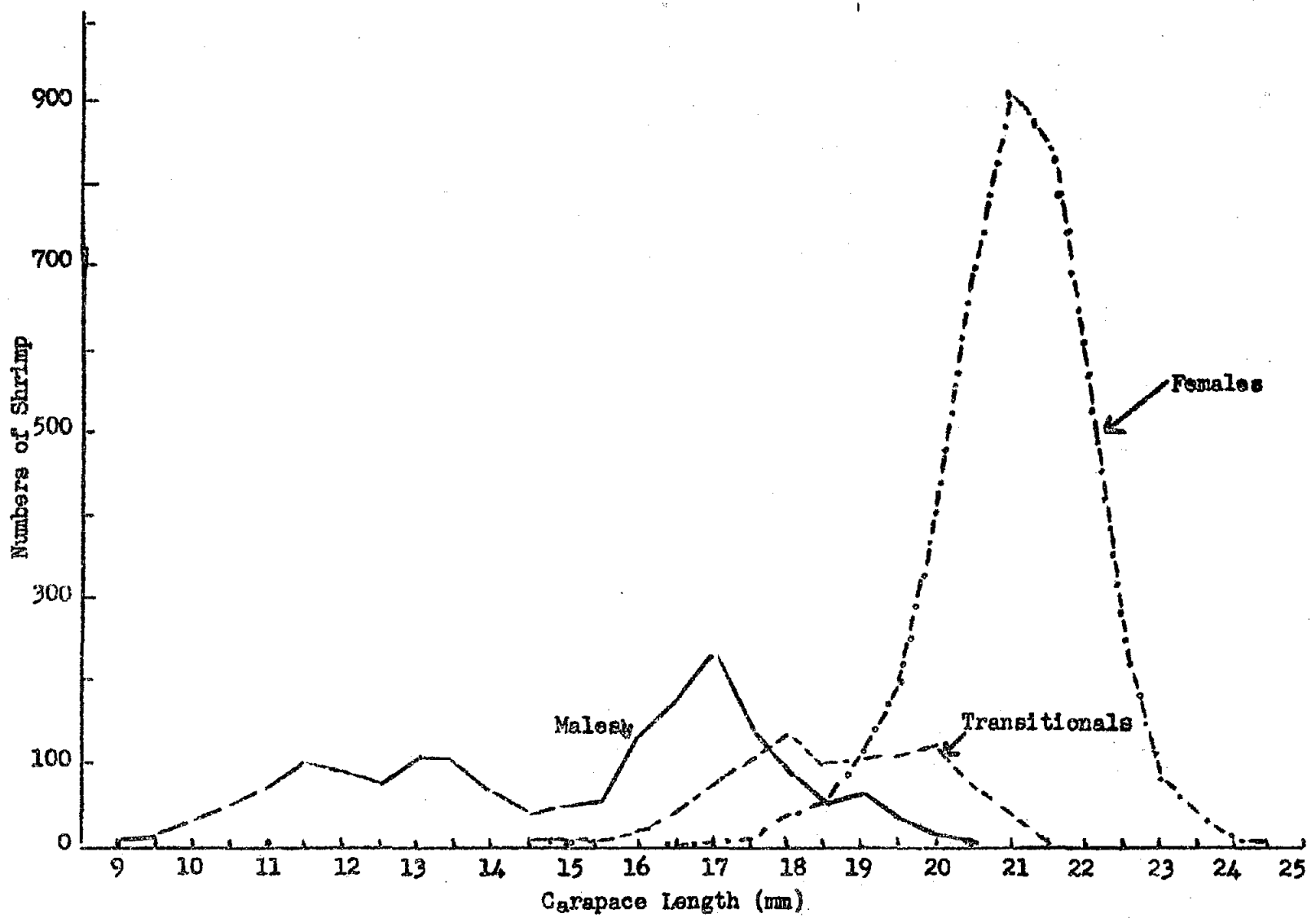

Figure 3. Size Distribution by Sex of Pink Shrimp Sampled at Astoria, February-April 1958.

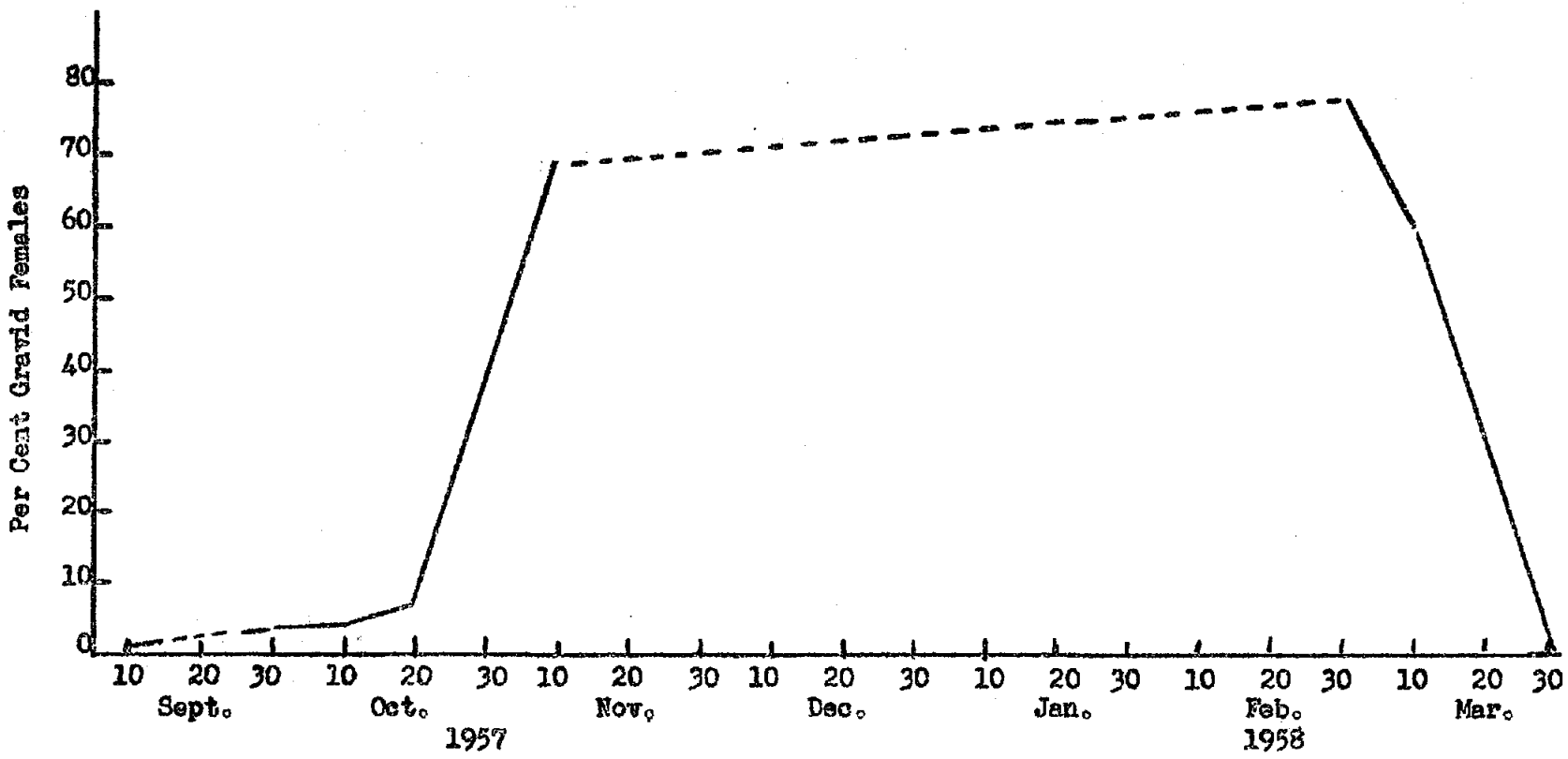

Figure 4. Gravid Female Pink Shrimp Landed at Astoria Expressed as a Percentage of the Total Females Sampled, September 1957 - March 1958.

part explains the small sample size. Figure 5 shows the number of eggs per female. The individual shrimp were grouped by 5-mm length intervals and the average number of eggs for each size group was plotted. The number of eggs increases as the size of the female increases, but irregularly. This irregularity may be the result of the small sample size.

RAZOR CLAM

The primary effort during this period was directed toward improvement of the quantity of data being collected on the personal-use fishery and to reduce the time required to gather these data. A method was devised whereby counts of diggers utilizing the beach north of the Necanicum River could be made mechanically. Sampling of catches from this area is now accomplished by stopping cars on the access roads rather than contacting the diggers on the beach, making it possible to collect a larger, more representative sample with less effort. A study designed to measure the wastage of clams by personal-use diggers was also initiated.

Sampling of commercial catches was continued as in past years except that proportionately less time was devoted to this activity with greater emphasis being placed on personal-use catches. The catch statistics of both fisheries were tabulated and analyzed.

Personal-Use Fishery

Razor clam field activities pertaining to the personal-use fishery were conducted from April to September. Activities undertaken during this period included: (1) a digger enumeration program; (2) catch age-composition sampling; (3) digger success; (4) total harvest; (5) wastage sampling; and (6) screening to measure the annual set.

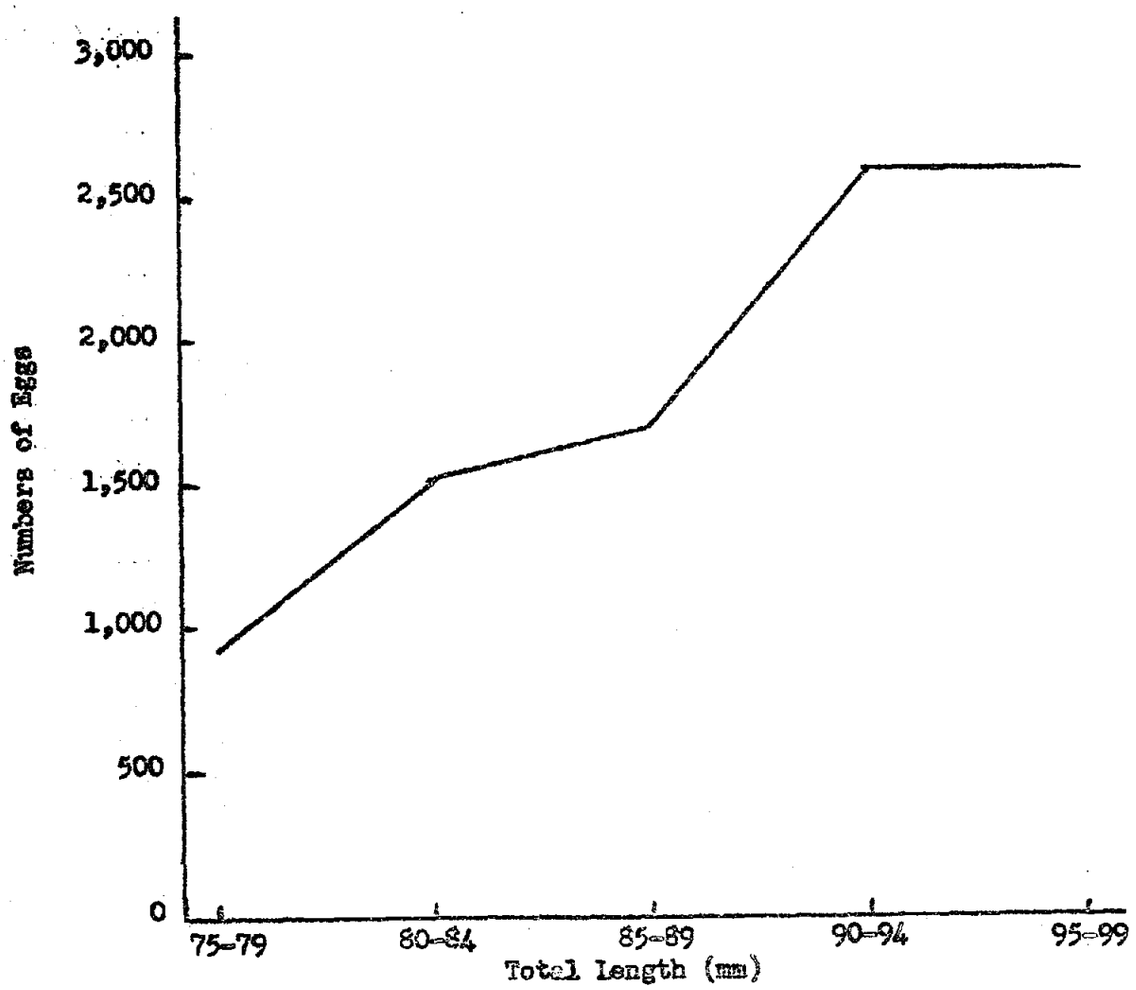

Figure 5. Mean Number of Eggs per Female Pink Shrimp by Size Group, Winter 1957-58.

based for by persons walking onto the beach at various places. The car counters' total was expanded by the average number of persons per car, as determined from the manual counts, and a total number of diggers derived.

Digger Counts

The digger enumeration program was conducted during the April-August sampling period and consisted of counting clam diggers on the beach. During 1956 and 1957 this was accomplished by driving the entire beach from Tillamook Head to the south jetty of the Columbia River and counting each digger. Table 7 summarizes the calculated number of diggers by area and time period for 1956-58. The number of personal-use diggers utilizing Clatsop Beaches during the sampling period has increased each year. The 1957 total of 72,283 is 22% greater than the 1956 total, and the 1958 total is 10% higher than 1957.

Since the above-described method of counting diggers was quite time consuming and had to be carried out at a time when other activities should have been in progress, a new method of estimating personal-use diggers was devised. Three one-way car counters with time clocks were purchased in August 1957 to count the number of cars using the three northern beach (Area I-IV) approaches during minus tides.

With the cooperation of the Marine Fisheries staff, a series of manual counts were made on the three roads from before daylight until well after low tide. The number of cars, the number of people in each car, and the time of ingress was tabulated. From these counts it was determined that the maximum number of cars containing clam diggers could be counted if the mechanical counters were set to tally only cars going on to the beach from three hours before to one hour after low tide. The error caused by non-clam diggers crossing the counters was found to be small, and would be more than compensated for by persons walking onto the beach at various places. The car counters' total was expanded by the average number of persons per car, as determined from the manual counts, and a total number of diggers derived.

Table 7. Calculated Numbers of Personal-Use Diggers on Clatsop Beaches by Sub-Area, May-August 1956-58.

Area 1/	May	June	July	August	Total
1956					
Area I-IV	12,895	6,572	9,288	5,559	34,314
Area V	4,600	2,356	3,436	3,725	14,117
Cove 2/	--	--	--	--	--
Total	17,495	8,928	12,724	9,284	48,431
1957					
Area I-IV	15,449	14,459	11,321	5,240	46,469
Area V	6,070	4,311	4,329	2,151	16,861
Cove	--2/	4,489	3,336	1,128	8,953
Total	21,519	23,259	18,986	8,519	72,283
1958					
Area I-IV	16,945	17,175	14,015	7,927	56,062
Area V	4,662	5,826	4,145	2,724	17,357
Cove	1,730	1,920	1,539	1,580	6,769
Total	23,337	24,921	19,699	12,231	80,188

1/ Area I-IV: Columbia River South Jetty to Necanicum River.
Area V: Necanicum River to Ave. T, Seaside.
Cove: Ave. T, Seaside to Tillamook Head.
2/ All diggers on Seaside Beach were included in Area V.

The number of commercial deliveries tabulated by the Portland office IBM section was subtracted to provide an estimate of personal-use diggers.

The utilization of mechanical counters has increased the accuracy of the estimate of personal-use diggers, and decreased the time required

during the low tide period to collect these data. The time saved by the counters will allow better samples to be taken of catch-age composition, digger success, and wastage.

1959 Sampling Schedule

The sampling for 1959 was further systematized to allow more precise data to be collected and to increase the efficiency of field work. These changes are here briefly described.

A minus-tide day is defined as one on which a minus tide occurs not earlier than 30 minutes before sunrise. This is little different than the practice during previous years, but establishes a definite criteria for planning the schedule. All estimates will be minimal, however, since digging is not entirely confined to these days.

Area V (Seaside). Minus-tide days were divided into two strata--week-days and weekend days. It was decided that beach counts would be made on half of the minus-tide days. This 50% sample, which corresponds closely to The number of counts made in past years, was randomly selected for each strata. Time of counting was set at 45 minutes before low water. Adjust-ments were necessary when this conflicted with samples scheduled on the northern beach roads. The stratification and random selection of days on which counts are to be made will allow measuring the precision of the estimates of diggers and catch at Seaside. This can be accomplished with no increase in the number of observations taken.

Area I-IV (North of the Necanicum River). Car counters will operate on all minus-tide days, as defined above, from three hours before to one hour after low tide.

Samples will be taken of digger success and age composition of catches on the middle day of each minus-tide series. If there are an even number of

days, the day before or the day after the middle will be used alternately. A sample will also be taken the second day previous to and the second day following the day initially selected, making a total of three samples per tide series.

Samples will be taken by stopping cars coming off the beach on the selected road during the selected time period. If too many cars are involved, causing a delay of more than two or three minutes, then only those cars which can be accomodated will be stopped. In any case, as large a sample as possible will be taken.

The total period selected for sampling was 1-1/2 hours before low water to 1-1/2 hours after low water, based on the results of the manual road counts. This was divided into three one-hour periods. A one-hour sampling period was randomly selected for each day, without replacement, so each period will be represented each tide series. Counter totals for last year show that the roads are not equally utilized. The relative importance was 20.2% at Gearhart, 15.3% at Sunset Beach, and 64.6% at the Peter Iredale. The random selection of the road on which the sample is to be made was weighted by the expected probability of the proportion of the cars which will use each road.

The day and time when samples will be taken was selected to allow determination of the nonrandom variation within a tide series. This will involve approximately a 50% reduction in time expended in sampling personal-use catches in Areas I-IV, but it is expected that increased efficiency will actually increase the sample size. Analysis of these data may possibly indicate that the number of samples taken may be reduced without sacrificing the precision of the estimates of average digger success and age-composition.

Digger success samples will be taken on the basis of the clams per car this year in Areas I-IV instead of clams per person. This will permit direct

use of counter totals when calculating the catch per time period instead of first estimating the number of persons per car. Persons per car will be tabulated during sampling to allow conversion to clams per person for comparison with previous years.

Harvest

Individual catches were sampled on the beach during 1956 and 1957 and on the access roads in 1958 to measure the personal-use harvest and average catch per digger. These data are summarized in Table 8. The personal-use harvest for May through August 1957 totaled 1,532,320 clams, or 256,542 pounds. This was 35.4% greater than the 1956 harvest. This increase was primarily due to an increase in number of personal-use diggers utilizing the resource.

Table 8. Total Calculated Harvest of Razor Clams on Clatsop Beaches by Personal-Use Diggers, in Numbers of Clams, Pounds of Clams, and Average Catch per Digger, May-August 1956-58.

Year	Number Clams	Pounds	Average Catch per Digger
1956	990,382	159,319	20.4
1957	1,532,320	256,542	21.2
1958	1,620,664	288,437	20.2

An average catch per day of 21.2 clams in 1957 was a moderate increase over the 1956 average catch of 20.4 clams. The average bag in 1958 was 20.2 clams per digger. Since razor clams were apparently as plentiful in 1958 as in 1957, it is felt that the change in the method of sampling previously mentioned may have been partly responsible for the apparent slight decrease in the average catch.

Age Composition

Age composition samples of personal-use catches show an increase in the relative numbers of 2nd-, 3rd-, and 4th-year classes taken since 1956. These data are shown in Table 9.

Table 9. Per Cent Age Composition of Razor Clams Taken from Clatsop Beaches by Personal-Use Diggers, May-August 1956-58.

Year	Age						Total
	0	1	2	3	4	5	
1956	37.7	47.4	11.3	2.8	.8	—	100
1957	26.4	51.5	15.4	5.7	1.0	—	100
1958	7.4	76.1	12.1	3.6	.7	.1	100

The numbers of razor clams harvested during 1956-58 by age group have been calculated and are compiled in Table 10. The number of 2nd-year class in the catch has increased each year. First-year clams contributed 26.4% or 405,909 clams to personal-use catches in 1957 and again contributed heavily in 1958 as 2nd-year clams, indicating a strong year class.

The catch of first-year clams has shown a gradual decrease since 1955. This was predicted in 1954 when the bag limit was reduced from 36 to 24 clams, and the commercial minimum size increased from 3-1/2 to 4-1/4 inches. This has resulted in an increase in the average size of the clams harvested. It would be desirable to reduce the harvest and wastage of first-year clams to a minimum, allowing capture later on when they are at least a full year old. A much greater yield in pounds of clams would be realized. One method of achieving this would be to close the entire beach to digging from the middle of July through September each year. First-year clams become more prominent in the catch during this period. This would allow a greater number of clams to be taken after the period of rapid growth has been completed.

Clams would be lost to natural causes during such a closure, but this loss would be negligible when compared to the gain in size of the surviving individuals.

Table 10. Personal-Use Harvest of Razor Clams From Clatsop Beaches, in Numbers of Clams by Age Group, May-August 1956-58.

	Age						Total Catch
	0	1	2	3	4	5	
1956							
May	76,641	217,212	30,071	3,653	673	—	328,250
June	93,837	71,188	30,524	5,075	727	—	201,351
July	134,639	102,021	36,894	5,118	473	53	279,198
August	68,482	79,248	14,393	13,793	5,315	352	181,583
Total	373,599	469,669	111,882	27,639	7,188	405	990,382
1957							
May	25,780	275,180	89,122	45,019	9,089	570	444,560
June	82,537	308,853	88,644	27,832	3,305	301	511,472
July	150,056	171,925	49,298	10,871	1,445	—	383,595
August	146,717	33,674	9,327	2,975	—	—	192,693
Total	405,090	789,632	236,391	86,697	13,839	671	1,532,320
1958							
May	13,321	394,037	74,478	25,229	5,204	475	512,744
June	23,074	450,118	75,504	19,009	4,622	386	572,713
July	35,424	282,413	32,306	8,374	1,058	—	359,575
August	48,407	107,449	13,875	5,339	562	—	175,632
Total	120,226	1,234,017	196,163	57,951	11,446	861	1,620,664

Wastage

Many small or broken clams are thrown back into the holes by the diggers. A sampling program was initiated in 1957 to measure the numbers of clams discarded, and consequently wasted, by personal-use diggers. This was done by feeling in shovel holes where an attempt had been made to dig a clam. A sample 50 to 100 holes was taken in each sub-area of the beach during each tide series. The total number of clams wasted was calculated by applying the percentage of clams found in these samples to the calculated personal-use harvest for the appropriate time period and area. This method is believed to provide a minimum estimate of wastage because: (1) the method of sampling is probably not completely accurate, (2) gulls will have found some of the clams left on or near the surface before the sample is taken, and (3) a clam was not necessarily harvested or wasted in each hole dug on the beach, although this is assumed when the sample percentage was calculated.

The estimated number of clams wasted for 1957 and 1958 is shown in Table 11. The wastage from May through August 1957 was 283,225 or 15.6% of the total clams dug by personal-use diggers. This exceeds the total number sold by commercial diggers during the same period by approximately 100,000 clams.

Table 11. Calculated Wastage of Razor Clams on Clatsop Beaches by Personal-Use Diggers, May-August 1957-58.

Year	Per Cent	Number Clams
1957	15.6	283,225
1958	10.1	182,077

Commercial Fishery

Razor clam studies pertaining to the commercial fishery were continued with little change from the 1956 activities as reported in past progress reports. IBM and dealer records of the commercial catch were compiled to determine the total commercial harvest and catch-per-unit effort.

Age Composition

Commercially taken razor clams were sampled at the various dealer establishments to obtain the age composition of the catch and the average weight. The results are shown in Tables 12 and 13. These data indicate that the first-year group contributed negligible numbers of clams to commercial catches in 1957 and 1958. Only 0.4 and 0.7% of the harvest respectively were clams less than one year old. This probably represents only an incidental catch of this age group. Since very few razor clams reach 4-1/4 inches in length by the end of the first year the reduction in harvest from this year class since 1955 is apparently due to the gradual acceptance by commercial diggers of the 4-1/4-inch minimum size as well as greater effort toward enforcement.

Harvest

The 1957 commercial harvest was determined to be 67,118 pounds from IBM data obtained from the Portland office. This was 157,567 pounds below the last ten-year average and the lowest since 1946.

Table 14 shows the total harvest of razor clams by commercial and personal-use diggers for the years 1951, 1953, and 1955-58. It can be seen that the commercial catch exhibits a marked decline since 1953. The personal-use catch has shown a marked increase, and the total harvest has remained relatively constant. Data compiled from cooperating dealers' records in Table 15 summarize the catch per dig by year and area since 1952. There is

Table 12. Commercial Harvest of Razor Clams from Clatsop Beaches in Numbers of Clams by Age Group, May-August 1956-58.

	Age							Total Catch
	0	1	2	3	4	5	6	
1956								
May	624	49,022	22,676	4,208	1,377	26	—	77,933
June	5,864	34,505	19,408	5,445	2,255	—	—	67,477
July	4,255	46,029	21,614	8,084	4,574	489	63	85,108
August	4,354	41,075	19,196	6,977	5,451	255	—	77,308
Total	15,097	170,631	82,894	24,714	13,657	770	63	307,826
1957								
May	—	35,265	18,516	8,252	1,996	164	—	64,193
June	—	35,237	15,302	5,345	450	38	—	56,372
July	393	24,391	9,230	2,249	692	45	—	37,000
August	872	11,610	4,625	1,103	53	—	—	18,263
Total	1,265	106,503	47,673	16,949	3,191	247	—	175,828
1958								
May	—	44,224	27,655	12,651	2,258	135	—	86,923
June	—	47,141	25,944	14,200	4,017	234	78	91,614
July	35	43,749	18,053	10,655	2,047	72	50	74,661
August	1,058	22,420	5,820	3,042	694	33	—	33,067
Total	1,093	157,534	77,472	40,548	9,016	474	128	286,265

Table 13. Total Commercial Harvest of Razor Clams From Clatsop Beaches, in Pounds and Numbers of Clams, 1956-58.

	Pounds	Numbers of Clams
1956		
May-August	66,994	307,826
Total	97,992	--
1957		
May-August	41,579	175,828
Total	67,118	--
1958		
May-August	62,296	286,265
Total	82,354	--

Table 14. Calculated Total Harvest of Razor Clams from Clatsop Beaches for Both Commercial and Personal Use, May-August for Selected Years.

Year	Numbers of Clams
1951	
Personal-use	988,623
Commercial	647,170
Total	1,635,793
1953	
Personal-use	758,239
Commercial	1,074,272
Total	1,832,511
1955	
Personal-use	1,130,447
Commercial	536,260
Total	1,666,707
1956	
Personal-use	990,382
Commercial	307,826
Total	1,298,208
1957	
Personal-use	1,532,320
Commercial	175,828
Total	1,708,148
1958	
Personal-use	1,620,664
Commercial	286,265
Total	1,906,929

Table 15. Commercial Poundages, Mantides Dug (Effort), and Catch per Mantide, by Sub-Area, 1953-58. (Unspecified Deliveries Not Included.)

Year	Area I			Area II			Area III			Area IV			Area V			Total		
	Lbs.	E	CUE	Lbs.	E	CUE	Lbs.	E	CUE	Lbs.	E	CUE	Lbs.	E	CUE	Lbs.	E	CUE
1953	48,113	1,463	32.9	22,135	824	26.9	28,333	1,171	24.2	5,261	207	25.4	54,064	2,697	20.0	157,991	6,360	24.8
1954	16,277	428	38.0	8,673	275	31.5	18,586	690	26.9	6,274	236	26.6	18,489	1,041	17.8	68,299	2,670	25.6
1955	12,508	436	28.7	10,345	307	33.7	23,888	769	31.1	6,314	239	26.4	12,958	580	22.3	66,013	2,331	28.3
1956	21,745	723	30.1	1,307	57	22.9	1,949	101	19.3	1,278	66	19.4	11,977	560	21.4	38,256	1,507	25.4
1957	4,561	164	27.8	2,493	91	27.4	644	29	22.2	966	23	42.0	6,305	257	24.5	14,968	564	26.5
1958	13,337	364	36.6	6,424	189	34.0	1,356	56	24.2	1,233	52	23.7	2,621	110	23.8	24,971	771	32.4

little change in the catch per effort for 1957 from previous years. The reduction in numbers of clams harvested by commercial diggers is apparently due largely to a reduction in the number of diggers rather than a drastic decline in the clam population. Factors which may have contributed to this reduction in diggers include: the increase in the commercial minimum size in 1954 eliminated diggers whose catches had been largely made up of small clams; all catches were reduced somewhat by this change; and an increase in competition by personal-use diggers.

Screening Activities

Screening to measure the magnitude of the fall razor clam set was continued during this period. Both Seaside Beach and the northern beaches were sampled at least once each during the low-tide series. Methods similar to those used and reported on in the past were employed. Screening results are shown in Table 16. The set, as measured in this manner, is consistently higher on Seaside Beach than in areas north of the Necanicum River.

HYDROGRAPHY

Hydrographic work during the period of this report was confined to cooperative studies with Oregon State University Department of Oceanography. This included final physical measurements of the Yaquina River and estuary which enabled Dr. Wayne Burt to complete and publish a paper on the results of this study. 1/ The remainder of the hydrographic work was confined to flushing studies in Oregon estuaries (techniques described in Progress Report Number 31, page 11). The bays and number of surveys are shown in Table 17.

In addition to the hydrographic surveys, surface records of temperature and salinity were continued off the dock at the Shellfish Laboratory (Table 18). It should be pointed out that these are surface records and

1/ Flushing of Polutants in the Yaquina River.

Table 16. Numbers of Young Razor Clams Taken by Screening on Clatsop Beaches, 1949-58.

Year	Dates	Areas 1/	Number of Stations	Clams Per Square Meter of Sand
1949	—	V	9	3.70
1950	—	V	10	2.50
1951	10/16-11/18	V	20	1.10
1952	10/21-12/17	V	71	2.10
1953	10/21-11/26	V	26	542.60
	10/21-11/28	I-IV	12	19.00
1954	10/12-12/10	V	44	91.40
	10/12-12/10	I-IV	15	22.40
1955	10/4-12/30	V	90	.48
	10/3-12/29	I-IV	89	.45
1956	10/4-12/17	V	77	14.76
	10/3-11/20	I-IV	71	1.28
1957	9/24-11/8	V	52	10.77
	9/26-11/23	I-IV	50	.06
1958	10/13-12/10	V	38	69.00
	9/15-12/9	I-IV	31	1.68

1/ Areas numbered from I through V north to south, Columbia River to Seaside.

Table 17. Estuarine Hydrographic Surveys in Conjunction with Oregon State University Oceanography Department.

Estuary Surveyed	Year and Number of Surveys Made		
	1956	1957	1958
Coos	1	1	2
Umpqua	1	1	2
Siuslaw	1	1	2
Alsea	—	1	2
Yaquina	1	1	2
Siletz	—	1	2
Netarts	—	—	1
Tillamook	—	1	2
Nehalem	—	1	2
Columbia	—	1	—

Table 18. The Maximum, Minimum, and Monthly Mean Water Temperatures from Surface Samples at Olson's Dock in Yaquina Bay, 1956-58.

Month	Temperature (°C.)			Salinity (0/00)		
	Mean	Min.	Max.		Min.	Max.
			1956			
January	8.4	7.2	9.4	16.0	4.1	27.1
February	7.0	6.0	9.0	23.6	10.5	31.1
March	8.0	5.5	9.1	18.8	5.1	29.0
April	9.3	8.3	10.1	24.5	12.8	32.7
May	11.3	9.5	13.9	31.1	26.4	33.2
June	12.8	10.2	14.5	31.4	29.5	33.3
July	12.3	9.5	15.7	33.5	31.6	34.5
August	11.5	9.0	14.2	33.8	33.1	34.9
September	11.9	10.0	13.0	33.2	32.7	33.9
October	11.3	9.6	12.9	32.4	30.7	33.5
November	9.3	8.0	11.0	30.7	25.6	32.5
December	8.6	8.0	9.0	24.5	9.8	31.9
Annual Ave.	10.1	8.4	11.8	27.8	21.0	32.3
			1957			
January	6.5	3.8	8.0	27.7	22.0	31.6
February	7.4	5.0	9.5	24.9	14.4	32.0
March	8.9	8.0	9.5	19.0	7.1	27.6
April	10.4	9.8	12.0	23.9	17.8	30.3
May	13.2	10.1	14.7	28.2	26.5	30.6
June	13.4	10.5	15.5	30.4	28.9	32.5
July	12.0	9.9	15.0	33.1	32.1	34.5
August	12.6	10.0	17.0	33.2	31.0	34.2
September	12.7	10.5	14.7	33.5	30.1	34.6
October	13.7	12.9	15.3	32.8	31.9	33.5
November	12.1	11.5	13.0	32.7	32.1	33.1
December	9.6	7.2	10.8	21.8	9.2	32.8
Annual Ave.	11.0	9.1	12.9	28.4	23.6	32.3
			1958			
January	9.9	8.8	11.0	25.8	14.8	31.1
February	10.2	8.8	11.0	17.5	8.5	28.4
March	9.9	8.7	11.1	25.9	16.1	30.4
April	11.1	10.2	12.3	23.8	12.9	30.8
May	10.9	8.8	13.0	30.8	25.4	33.6
June	13.8	12.6	15.4	31.7	31.1	32.7
July	11.5	9.8	14.1	33.4	32.1	34.2
August	10.7	9.3	13.1	33.5	33.2	34.0
September	12.5	10.0	14.5	33.0	32.1	33.5
October	10.6	9.0	11.8	33.1	32.5	33.8
November	11.0	9.0	12.2	26.5	19.7	32.4
December	10.3	9.2	11.0	27.0	19.0	32.5
Annual Ave.	11.0	9.5	12.5	28.5	23.1	32.3

have not been corrected for the stage of the tide at which they were taken. Their value is mainly in recording gross changes in temperature and salinity at the Newport Laboratory.

ECOLOGY

Ecological work during this period was confined to working on screening and sampling techniques within Yaquina Bay and on the open beach from Newport to Yaquina Head. Within the bay considerable difficulty was encountered in arriving at suitable sample sizes and screening procedures. Techniques used to date are time consuming and of questionable value. This phase of our work will be limited until such time that we can find a suitable method of obtaining quantitative samples and efficient methods of screening. Fortunately, we were more successful in our work on the beach. The most common animal found between Newport and Yaquina Head (excluding barnacles) was the Littorina snail. This small snail is one of the algae grazers and is world wide in distribution. After setting up permanent sampling stations, periodic counts were made of the numbers of Littorine snails on 25 fronds of 3 species of algae and one species of eel grass. It is hoped from this work that changes in numbers of animals in polluted and non-polluted areas can be made. Data on hand looks promising.

ABALONE AND ROCK SCALLOP

Although the presence of the red abalone (Haliotis rufescens) in the Brookings (southwest Oregon) area was known since 1953, very little work had been done on distribution and abundance. In 1958 two commercial abalone divers from California offered to do exploratory work for the OFC at no cost to the state and under our direct supervision. On August 4, 1958,

a formal agreement was entered into between these two fishermen and the OFC. Since that time several exploratory dives in the vicinity of Brookings have been made and some intertidal exploration done. We have verified the occurrence of this animal as far north as Coos Bay.

Although only limited numbers of abalone have been found to date, the divers did find what appears to be commercial quantities of rock scallop (Hinnites multirugosus). This animal will be actively studied in conjunction with the abalone.

The resultant publicity from this agreement brought numerous offers of help from skin and commercial divers. This interest necessitated the adoption of sport regulations and alteration of commercial scallop regulations to permit the harvest of rock scallops. These regulations, because of our limited knowledge, were patterned after the regulations in existence in California. The regulations on the personal-use harvest of abalone and scallop and the revised commercial regulations for rock scallop appear in General Order Number XIX, as revised December 16, 1958.

MISCELLANEOUS

During this period, as usual, a large number of miscellaneous items had to be investigated and a number of meetings attended. The most noteworthy items were as follows:

1. Fish kills: two fish kills on Big Creek were investigated and one each on Schooner Creek and Olallie Creek, Lincoln County.
2. At the request of the Water Resources Analyst, several beach sand removal requests were investigated from Gleneden Beach, Lincoln County, to Goldbeach, Curry County. Also, several dredging and log boom sites were checked.