THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, *PANDALUS JORDANI*, OFF OREGON

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INTRODUCTION

Maximum use of a resource depends on knowledge of distribution and abundance of the harvested species. Wise use and sound management depend on basic knowledge of distribution, abundance, and reliable data on the structure and biology of the harvested species. The relatively new shrimp fishery off Oregon brought with it the need for more information about this resource than was available at the time this study was proposed, especially distribution and abundance.

Exploratory fishing in 1951-52 by the Fish Commission of Oregon (Pruter and Harry, 1952) and by the National Marine Fisheries Service in 1958 and 1960 (Alverson, *et al.*, 1960; Ronholt and Magill, 1961) had located major fishable concentrations of shrimp between the Columbia River and Cape Blanco. Ronholt (1963) summarized findings of the various cruises and showed the survey areas and areas of high shrimp availability in his Figure 1. Magill and Erho (1963) summarized the development and status of the Washington and Oregon shrimp fisheries. They also showed the principal shrimp producing grounds off Washington, Oregon, and California in their Figure 1. Concentrations of shrimp were shown as occurring in more or less isolated pockets along the coasts of the three states.

Conclusions regarding interarea abundance were considered relative and perhaps more indicative of availability than abundance (Ronholt, 1963). The commercial fishery during 1957-66 was spotty, and reliable indices of interarea and within-area abundance and distribution were difficult to obtain with any degree of confidence.

1/ *Funds supplied in part through the Commercial Fisheries Research and Development Act (PL 88-309), Contract No. 14-17-0001-1908.*

Objectives of this study were to obtain estimates of the standing crop and define distribution of pink shrimp off Oregon. We hoped to obtain these estimates within a short enough time span to minimize possible biases from mortality and migration within and between shrimp concentrations. We also hoped to obtain a series of estimates, seasonally, to record changes in distribution/abundance with time.

Other objectives were estimates of age and sex composition geographically and seasonally, and fecundity and time of spawning.

Our last objective was to correlate distribution and abundance of shrimp with depth and the type of bottom sediment. Systematic studies of the type of sediment on which shrimp are found were lacking even though the literature is full of references associating shrimp with green mud and sand strata.

METHODS AND MATERIALS

Three survey cruises were made to obtain data on distribution, abundance, and biological parameters. Two vessels were chartered for the 1966 cruise (March 1-April 2); MV *Columbia*, a 69-foot schooner-type trawler, and MV *Faymar*, a 50-foot Pacific trawler. These vessels surveyed the north and south halves of the survey area, respectively, utilizing their own flat wooden otter doors on double warps. The MV *Sunrise* was chartered for subsequent cruises (September 30-November 9, 1966, and February 20-May 4, 1967). The *Sunrise* is a 59-foot Pacific trawler and used its own steel V-doors on double warps. We believe the difference in otter door types affected comparative fishing efficiency little, if any.

We furnished nylon shrimp trawls for all cruises. They were 41-foot headrope Gulf semiballoon trawls of 1-1/8-inch mesh web throughout except for the posterior 2/3 of the codends. The posterior 2/3 of the codends were

made of 1-1/2-inch mesh web. A 1/2-inch knotless liner inside the codend completed the net. Galvanized 1/4-inch diameter chain hung loop-style on the footrope and a 5/16-inch steel tickler chain attached to the otter boards completed the auxiliary gear. We made minor changes in the auxiliary gear after the first cruise to reduce excessive digging of the footrope and improve shipboard handling of the net. These included removing half (alternating "loops") of the chain loops, attaching the ends of the tickler chain to the bridles (instead of the otter doors), and connecting the chain to the footrope by 18-inch long "dropper" chains.

Tests of identical gear by National Marine Fisheries Service divers in Puget Sound during January 1970 measured the horizontal opening (between the wings) of the net under tow at 27 feet, 8 inches. The vertical opening was about 4 feet between the foot and headropes at the center of the net. Although the divers observed the footrope as being about 18 inches off bottom (and tickler chains about 16 inches off bottom) during the Puget Sound tests, we believe the nets used in 1966-67 in much deeper water probably were tending bottom closely due to the catches of benthic invertebrates and fish that were made. Also the chain loops were burnished during the cruises, indicating they were on the bottom.

We initially intended to obtain bottom samples for sediment type with a Dietes-LaFond bottom grab at each station occupied during our last cruise. However, we abandoned this effort in favor of an extensive collection of data on bottom sediment type made previously by Oregon State University personnel. Bottom sediment type for areas not covered by OSU information was obtained by using our bottom grab and also by examination of sediments and shale brought up in the net or adhering to the otter boards.

We collected data on length-frequency, sex composition, and average number of shrimp per pound (count/lb.) at sea by sampling the catch of each tow. A 1/2 to 1 pound random sample was drawn from each catch. These samples were then weighed to the nearest 10 grams on an Ohaus Model 8802 spring balance of 500-gram capacity. Sex was determined using the method of Tegelberg and Smith (1957). We measured the dorsal carapace length of shrimps with vernier calipers from the base of the eyestalk to the posterior mid dorsal carapace edge. Length was recorded to the nearest 0.2 mm by sex during cruises 1 and 2, and to the nearest lower 0.5 mm during the last cruise. Measurements were used to determine age composition of catches by dissection of the polymodal length-frequencies. Numbers of shrimp by sex and age were calculated by tow and summarized by cruise and survey area, based on sex ratio, length-frequency distribution, and mean shrimp per pound. Fecundity was determined by counting the eggs on females obtained in traps. Eggs were stripped from individual females and placed in a petri dish before being counted.

For this study, the offshore waters were divided into five areas: (1) N. Lat. 42°00' to Cape Blanco; (2) Cape Blanco to the Umpqua River; (3) Umpqua River to Cape Perpetua; (4) Cape Perpetua to Cape Kiwanda; (5) Cape Kiwanda to the Columbia River (N. Lat. 46°16'). Calculations of biomass are based on areas as modified (Figure 1):

Area 1-A N. Lat. 42°00' - Rogue River

1-B Rogue River-Cape Blanco

2-A Cape Blanco-Cape Arago

2-B Cape Arago-Umpqua River

3-A Umpqua River-N. Lat. 44°02'

3-B N. Lat. 44°02'-Cape Perpetua (Heceta and Stonewall Banks)

4 and 5 - as previously described

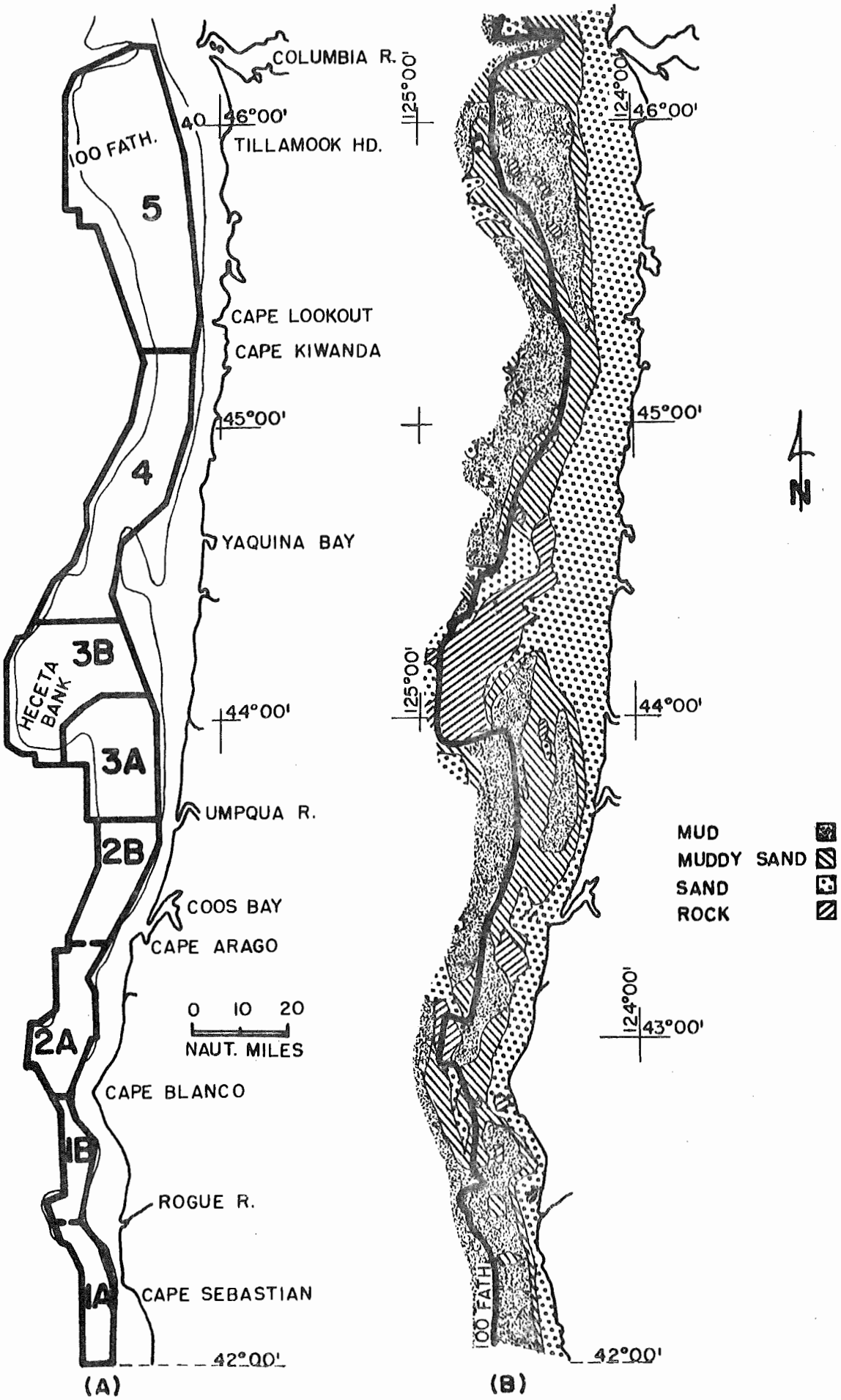

Figure 1. Charts showing (A) approximate survey and subarea boundaries and (B) bottom sediments off Oregon (from Byrne and Panshin, 1968)

Due to untrawlable bottom and small or no shrimp catches, Area 3-B was not used in the calculations and we discontinued surveying it after the first cruise. Figure 1 also shows survey area boundaries.

We collected all data on catch and biological parameters by sample tows of 0.2 to 1.5 miles (0.5 mile average) in length calculated by plotting tows on a C&GS chart. Tows were of 10-20 minutes (mean, 15 minutes) duration, at a speed averaging about 2.0 knots. A fathometer and Loran set was used for navigation and tow location. Station selection for the first cruise was by means of a random sampling scheme. This resulted in considerable clustering of stations, especially off northern Oregon which caused undersampling of large areas elsewhere. We therefore substituted a systematic sampling scheme for cruises 2 and 3.

During the first cruise, depth strata sampled were between the 50-70, 70-90, and 90-125 fathom isobaths. The survey area was between the Columbia River and California-Oregon boundary (N. Lat. 42°00'), and the 50 and 125 fathom isobaths. We had to restrict our sampling to this area because of time restrictions effected by trying to reduce possible distribution biases of migration or movement of shrimp. Prior research (Alverson, *et al.*, 1960) and commercial fishing (Milburn and Robinson, 1969) had shown these isobaths as being the approximate limits of shrimp distribution off Oregon. Subsequent commercial fishing data indicated this was probably true during cruise periods.

For the first cruise, 40 stations were selected at random from square-mile grids in each of the five areas, by the ratio 15:15:10 for the respective depth strata from shallowest to deepest. Our Biometrics section determined from analysis of existing catch data that this sampling intensity and ratio should yield reliable estimates of biomass, within a realistic

sampling period and capacity for survey completion. This resulted in a mean sampling intensity of one tow for approximately 13 square miles of the total survey area (2,606 square nautical miles). Mean square area of a sample tow was 0.0033 square miles for 198 completed tows (0.025% of the total survey area).

For the second and third cruises, a systematic sampling scheme was used, based on 4-mile square grids in Areas 5, 4, and 3; and 3.5 mile square grids in areas 1 and 2. Average width of the survey area in the latter areas was too narrow to place 4-mile square grids and maintain reasonable sampling intensity. Sampling intensity was about the same as in the first cruise. The second cruise (fall 1966) was not completed due to inclement weather; only 96 of 180 stations were occupied. During cruises 2 and 3, we discontinued depth stratification because depth isobaths were frequently straddled by shrimp concentrations.

Population estimates were calculated using a ratio estimate for expanding the sample data (catch per sampled area--assuming the width of sample area as 28 feet) to the entire study area (Cochrane, 1959). We assumed a fishing coefficient of 1.0 (all shrimp in the path of the trawl available to the trawl). Probably the fishing coefficient was less than 1.0 which means our estimates are biased toward being too low. Confidence limits on the population estimates were calculated using a confidence coefficient of 80% for the first cruise. No confidence limits were calculated for succeeding cruises which were made using a systematic, instead of a random, sampling scheme.

We calculated area of survey using a planimeter on pertinent Coast and Geodetic Survey marine charts. This also introduced a bias toward underestimating biomass. Although the ocean bottom is not flat, the short

sampling tows tended to cover areas which were relatively level when compared to the entire survey area, and this resulted in underestimates of area and, therefore, biomass.

Correlations between shrimp distribution-abundance and bottom sediments were based on OSU sediment data (Runge, 1965) and a shelf sediment chart (Byrne and Panshin, 1968). Our own data were used primarily to fill in the few gaps left by these workers, mainly localized areas of rock and shale.

RESULTS

General

We made 204, 96, and 173 tows, respectively, during three successive cruises, for a total of 473. Tow location, time, duration, date, catch, and catch/effort, and mean size of shrimp per tow are shown in Appendix Tables 1-3 for each cruise. Also shown is the bottom sediment type for each tow, coded for rock, sand, mud, and muddy sand. Results indicate shrimp were restricted generally to mud or muddy sand sediments. They were scarce or absent on sand substrates. On rock bottom, sampling intensity was statistically too light to assess comparative abundance, although tows over this substrate were nearly devoid of shrimp.

Shrimp were generally distributed in an uneven pattern south of Cape Blanco. Catches were made off Port Orford, few between there and Cape Sebastian, then they improved again south of Cape Sebastian to the California-Oregon boundary line (42°00' N. Lat.). Shrimp were generally caught throughout Areas 2 and 3 except for Heceta Bank. Stonewall Bank, just south of Yaquina Bay, also yielded few shrimp. During cruises 2 and 3 between Yaquina Bay and the Columbia River, catches again were made with a high degree of regularity. During cruise 1, catches in Areas 4 and 5 were

sporadic and highly variable, probably due to the random sampling scheme and resultant lumping of sampling stations.

Distribution of Shrimp by Bottom Sediment

Catches were strongly correlated with bottom type, a fact reported by other authors, but without the aid of the systematic continental shelf sediment chart by Byrne and Panshin (1968), Figure 1B in this report.

No significant catches of pink shrimp were made over rock areas, partly due to the untrawlable nature of this type of bottom. The only large expanse of rock bottom off Oregon occurs on the western half of Heceta Bank extending through Stonewall Bank off Yaquina Bay. Other significant patches of rock area occur on the western half of Coquille Bank. Most of the bottom off Oregon is composed of sand (roughly from shore to 40-50 fathoms of depth), mud and muddy sand sediment.

Catches over sand were significantly less than those on either mud or muddy sand and catches on mud bottom were significantly larger than those on muddy sand. Relative differences between mean catches on different bottom types compared to those found in mud or muddy sand were:

Standard	Mud	Muddy Sand	Sand
Mud	1.000	0.455	0.102
Muddy Sand	2.198	1.00	0.224

Catch rates varied considerably within areas and between bottom types from cruise to cruise; we observed only two exceptions to the generally greater abundance of shrimp over mud than muddy sand, one in Area 4 where the overall catch rate was greater over muddy sand than mud (Table 1) and another in Area 5 during the fall 1966 cruise where catches were slightly larger on muddy sand than mud.

Table 1. Average catch per mile towed, by period, area, and sediment type 1/

Area	Period	Sediment type			
		Rock	Sand	Muddy sand	Mud
1	Spring 1966	-	0.0 (1)	5.5 (8)	22.3 (36)
	Fall 1966	-	-	20.2 (4)	154.0 (25)
	Spring 1967	0.0 (1)	-	0.0 (3)	91.9 (23)
	Average	0.0 (1)	0.0 (1)	8.3(15)	80.6 (84)
2	Spring 1966	0.0 (5)	4.0 (1)	54.2(16)	232.9 (16)
	Spring 1967	10.0 (1)	84.8 (4)	122.7(19)	471.6 (10)
	Average	1.7 (6)	68.6 (5)	91.4(35)	324.7 (26)
3	Spring 1966	0.2(13)	0.0 (1)	0.8 (6)	10.5 (13)
	Spring 1967	0.0 (1)	-	4.3 (6)	176.9 (12)
	Average	0.2(14)	0.0 (1)	2.6(12)	90.4 (25)
4	Spring 1966	0.0 (4)	8.4(18)	25.1(16)	62.7 (6)
	Fall 1966	0.0 (2)	0.0 (3)	123.1 (8)	-
	Spring 1967	0.0 (2)	98.4(11)	147.1(22)	13.3 (3)
	Average	0.0 (8)	38.6(32)	100.5(46)	46.2 (9)
5	Spring 1966	-	0.0 (9)	16.4(16)	41.4 (18)
	Fall 1966	0.0 (1)	25.4 (7)	225.6(20)	210.7 (24)
	Spring 1967	0.0 (1)	0.0 (8)	231.7(22)	495.8 (24)
	Average	0.0 (2)	7.4(24)	170.2(58)	268.2 (66)

1/ *Figures in parentheses are number of tows.*

Distribution by Depth

Depth range of shrimp varied between cruises and areas (Figure 2). In Area 1 shrimp were found mostly in 50-69 fathoms and almost entirely so during September-October 1966 (66-12) and February-April 1967 (67-2). Relative abundance was reversed between cruises 66-12 and 67-2, however, with most shrimp caught in 50-59 fathoms during the fall of 1966 and in 60-69 fathoms during the spring of 1967. The March-April 1966 cruise (66-1) also produced the best catches at 60-69 fathoms.

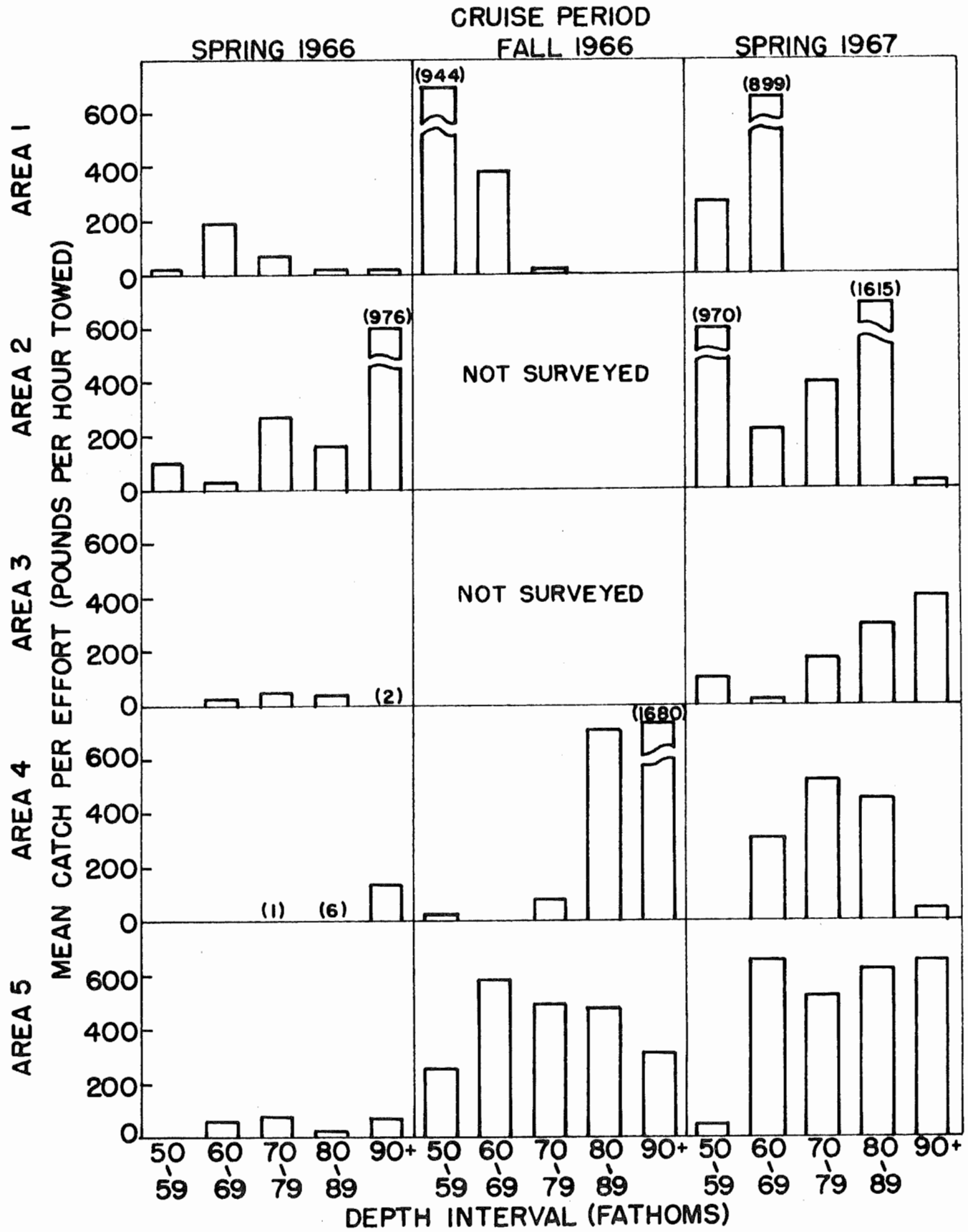

Figure 2. Relative depth distribution of shrimp, by area and cruise, in 10-fathom intervals

Area 2 distributions were over a much wider range of depth than in Area 1; and largest concentrations were found deeper in both cruises (66-1, 67-2). Highest catch rates were in the 80-125 fathom range; in the spring of 1967, however, a strong showing of shrimp appeared in 50-59 fathoms as well.

In Area 3, shrimp were most abundant during the spring of 1967 in waters deeper than 90 fathoms. A gradual increase in abundance was evident from 60 to 125 fathoms. Catches during the spring of 1966 were small but mostly in the 60 to 89 fathom range.

In Area 4, shrimp were found quite deep in cruises 66-1 and 66-12; highest mean catch rates of the study were obtained in 90 to 125 fathoms during cruise 66-12. By the spring of 1967, shrimp were more dispersed, centering in the depth interval of 70 to 89 fathoms. Few shrimp were captured shallower than 60 fathoms in Area 4 or Area 5 during the spring.

In Area 5, greatest catch rates of the study (overall) were obtained in the fall 1966 and spring 1967 cruises. Shrimp during these periods were scattered over a wide depth range--60 to 125 fathoms. A gradual drop in catch/effort was evident here during cruise 66-12 from 60 to 125 fathoms, almost the reverse of the case in Area 3 during cruise 67-2.

No overall consistent pattern, then, was found over the three cruises within or between areas, with the exception of Area 1 where depth distribution was consistently narrow, and in Areas 2-5 where distribution was over a fairly wide range.

Estimates of Abundance

We estimated the biomass of shrimp off Oregon during three cruises as being 23.1, 47.2, and 111.7 million pounds, respectively, in spring and autumn of 1966 and the spring of 1967.

Estimates by area and cruise are presented in Table 2, showing estimated numbers by year class and sex as well as weight for the populations. Of the three cruise periods, the 1967 spring estimate was by far the largest. The largest biomass estimate for this period was in Area 5--65.2 million pounds. The next largest 1967 spring estimate was in Area 2--22.0 million pounds. These two areas also contained the largest amount of bottom.

Even though the estimates given for Area 1 show a large variation in biomass (1.1 vs. 7.8 million pounds) between March and October 1966, we believe that they are fairly reliable. Estimates made by the California Department of Fish and Game during 1966 for populations south of Area 1 (between 42°00' N. Lat. and Cape Mendocino) showed a large reduction in estimated biomass between spring and fall (Dahlstrom, *et al.*, 1967) corresponding with the large increase in biomass in our Area 1. Most of the increase off Oregon occurred in Area 1-A adjacent to 42° N. Lat.

The 1964 year-class was dominant in catches during March 1966 and appeared strongly during the fall of 1966 north of Area 1. It was present in large numbers even in 1967 in Areas 4 and 5.

The 1966 year class (born in March-April 1966) was dominant in all areas by 1967 and was dominant by the fall of 1966 in Area 1. California surveys showed it was dominant also off northern California in autumn 1966 and during 1967.

Biological Parameters

Spawning. Magill and Erho (1963) described timing of spawning of shrimp off northern Oregon (Area 5) and Washington. For northern Oregon, approximately 50% of the females were gravid by mid-October and over 75% by the first week of November. Larval release in Area 5 was given as

Table 2. Standing crop (estimated) of shrimp, by area and period, off Oregon, March 1966-May 1967

Area	Period	Survey area naut. miles^2	Estimated population (pounds)	Percentage error 1/	Estimated population in millions of shrimp				
					Year class				
					1966	1965	1964	1963	Females
1	3/66	258	1,105,050	±83	0.0	21.2	115.0	3.1	61.0
	10/66	258	7,779,499		902.4	714.2	1,005.2	0.0	249.1
	3/67	258	6,219,606		997.0	107.6	50.7	1.6	62.5
2	3/66	499	14,535,371	±46	0.0	593.0	1,674.5	58.2	807.0
	2/67	499	22,008,395		3,819.3	842.2	244.9	1.5	245.4
3 2/	3/66	325	509,275	±19	0.0	56.5	38.9	2.3	27.4
	4/67	325	5,411,250		1,289.2	100.4	44.4	3/	57.6
4 4/	3/66	538	2,635,662	±58	0.0	7.9	343.0	10.1	104.7
	11/66	245	4,005,505		74.2	101.3	307.8	1.0	214.2
	4/67	538	12,889,404		863.6	243.5	613.2	6.9	513.0
5	3/66	986	4,278,354	±59	0.0	201.8	562.1	6.2	207.9
	10/66	986	35,449,658		98.7	1,081.5	2,915.5	16.4	2,261.7
	4/67	986	65,163,754		6,080.4	1,949.4	2,050.4	20.2	2,030.2
Total	Spring 1966	2,606	23,063,712	-	-	-	-	-	-
	Fall 1966	1,489	47,234,662	-	-	-	-	-	-
	Spring 1967	2,606	111,692,409	-	-	-	-	-	-

1/ *Eighty per cent confidence limits expressed as a percentage of the point estimate. Limits calculated for 3/66 estimates only.*

2/ *Estimate for subarea 3a only.*

3/ *Less than 0.1.*

4/ *Area 4 not completely surveyed in 11/66.*

generally ending before the first of April during the period 1957-60. Data collected since then have generally strengthened their conclusions. By mid-November most shrimp in Area 5 were gravid in all years for which data are available during the period 1957-71 (Table 3). Data from 1967 and 1968 show that almost all females were gravid throughout January and February. Larval release begins by mid-March and is usually complete by mid-April. In Area 2, data from the period 1963 to 1971 show a similar spawning period. Females begin to spawn by mid-October and we think that the process is probably complete by late November, though we have no data during that period or in December. Larval release begins by late February, is essentially complete by the end of March in most years, and rarely extends beyond mid-April. The peak of larval release in both areas occurs during March. During 1971, larval release was delayed unusually long in both areas. This unusually late retention of eggs coincided with colder water temperatures in March (anonymous, 1971).

Fecundity. Data collected during the winter of 1968 showed that fecundity was directly related to length (Figure 3). It ranged from 780 eggs at 16.5 mm carapace length to 2,425 eggs at 25.0 mm. The average for age group II females (average mode about 20.0 mm) was 1,400 to 1,500 eggs per female. Average age-group I (18.0 mm) and age group III (22.0 mm) fecundity was in the neighborhood of 1,000 and 2,000 eggs per female, respectively.

Table 3. Percentage of ovigerous females, by week and month, annually for Areas 2 and 4-5, October 1-April 30, 1957-71

Month	Week	Year '57	'58	'59	'60	'61	'62	'63	'64	'65	'66	'67	'68	'69	'70	'71	Mean %
								Area 2									
October	1							0	5	0							1.7
	2																-
	3							3		12		7					7.3
	4								20			24			20		21.3
November	1-4																-
December	1-4																-
January	1																-
	2							100									100.0
	3							98									98.0
	4							100									100.0
February	1																-
	2							90									90.0
	3											95					95.0
	4								83			75					79.0
March	1							87		96	90	75	86		81		85.8
	2									80	77	43	78	68			69.1
	3								41	75	66	8	51			73	52.3
	4								8	46	34	11		15		60	29.0
April	1							9		14	9	1	8		13	40	13.4
	2							0		0	0	0	0		4	26	4.3
	3							0	0	0	0	0	0	0	0	26	2.9
	4							0	0	0	0	0	0	0	0	3	0.3
								Areas 4 and 5 Combined									
October	1	4	2	3	1	0		12			0				10		4.0
	2	6			3						5		6	14			6.8
	3	6		20	2						10	8					9.2
	4	55	48	38							44	4			56		40.8
November	1	83		80	52						48	45					61.4
	2	83		80	52									85			75.0
	3		98			96						90					94.6
	4		98			96											97.0
December	1-4																-
January	1														100		100.0
	2																-
	3												100				100.0
	4												99				99.0
February	1												98				98.0
	2											100	100		97		99.0
	3												100				100.0
	4												79				79.0
March	1		62												72		67.0
	2		35	60								80	76	13	36		60.0
	3		8	8								34	32	3	5		15.0
	4		2	2	1	43			33		38			1	4	47	19.0
April	1		0	0	0		19	0			5	29			1	34	9.8
	2		0	0	0	2		0				2		0	0	15	2.1
	3		0	0	0	0	0	0	0		0	0	0	0	0		0.0
	4		0	0	0	0	0	0	0		0	0	0	0	0	3	0.2

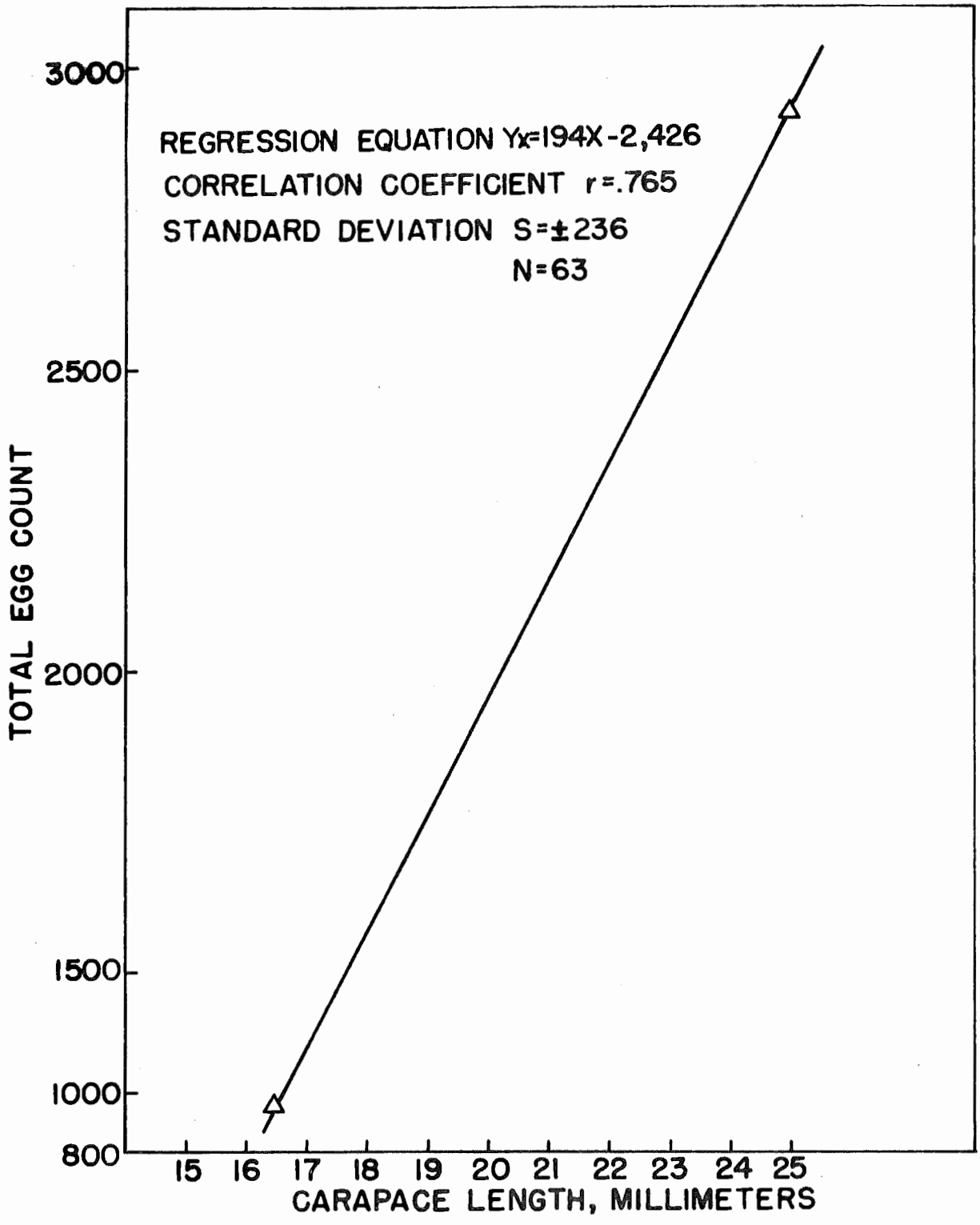

Figure 3. Egg count versus carapace length for *Pandalus jordani* collected in Area 5, October 26-November 1, 1967

DISCUSSION

Distribution

The occurrence of pink shrimp over green mud or muddy sand bottom has been reported by many authors (Pruter and Harry, 1952; Tegelberg and Smith, 1957; Dahlstrom, 1961; Ronholt and Magill, 1961; Ronholt, 1963). The green color is imparted by the mineral, glauconite, (Ronholt, 1961; Runge, 1965) which is mixed with the mud sediment. Analysis of the data in Runge's thesis showed that small amounts of glauconite were found in areas of mud or muddy sand off most of the Oregon coast. The association of green mud with the presence of shrimp has fostered the implication that shrimp are not found on gray or blue sediment. This, however, is unfounded. Sediments other than green probably do not commonly occur off Oregon, thus preventing the opportunity of shrimp associations with other colors from being established.

Results of this study verified the fact that pink shrimp are found mostly on green mud and muddy sand sediments. Few shrimp were found on the extensive expanses of sandy sediment off Oregon. The few tows over rocky areas were likewise unproductive. The type of sediment off Oregon appears to be correlated with current. Wherever sand occurs, it is likely that currents on the bottom are regular and fairly strong, while rocky areas have even stronger currents. On areas where muddy bottom occurs there generally is little or no current at the bottom, while muddy sand usually is associated with currents intermediate between those found with mud and sand (Byrne and Panshin, 1968). It is likely that the current velocity affects the type of sediment off Oregon, therefore, distribution of pink shrimp probably is related to current, and bottom type may be only an incidental factor; that is, pink shrimp find areas of little or moderate current favorable and these areas at least off Oregon are associated with green mud or muddy sand. Most

catches of shrimp on muddy sand occurred in areas nearly adjacent to mud and, therefore, probably on bottom that was associated with minimal current activity. That pink shrimp should find areas of minimal current favorable is not surprising since they are thin shelled and light bodied pandalids (Butler, 1964). Heavier bodied and thicker shelled pandalids like *Pandalus platyceros* are usually found in areas of rocky or irregular bottom where currents are generally much stronger. It would be much easier for *P. jordani* to hold position in an area of slight or no current than in strong currents. A similar species, *P. borealis*, in the Gulf of Maine, is found in greatest abundance over areas of soft mud, high in organic content (Haynes and Wigley, 1969). The incidence of organic carbon, fine-grained sediments (clay to tilloid), and shrimp in the Gulf of Maine is probably correlated with currents to some extent. Probably the shrimp in the Gulf find the organic carbon and associated organisms favorable for feeding as well as for maintaining position in slight currents. This may also hold for *P. jordani* off Oregon. Pearcy (1970) stated that shrimp caught on the bottom were feeding on benthic organisms and "detritus."

The shallowest depth at which pink shrimp have been caught off Oregon was off Port Orford in 1968. Commercial trawlers captured shrimp in 35 to 45 fathoms in late June to July 14, 1968, at catch rates exceeding 1,000 pounds per hour tow. This area also is mud bottom, the shallowest intrusion of such sediment off Oregon. A depth of about 50 fathoms is the approximate inshore limit of shrimp occurrence off Oregon elsewhere. That depth roughly corresponds to the inshore edge of mud and muddy sand sediments off most of Oregon.

In each area off Oregon, within-year variations in east-west and north-south concentrations of shrimp are thought to frequently occur; this movement of shrimp probably occurs, however, within the area of mud and muddy sand in

each area. It also does not appear to follow any regular seasonal trend from year to year (Milburn and Robinson, 1969). The movements are ill-defined and generally difficult to document because of variable fishing effort.

Evidence that shrimp populations may move fairly extensive distances was present, however, during 1966-67 in Area 1-A (between 42°00' N. Lat. and the Rogue River) when, during March 1966, few shrimp were found there (99,190 pounds) while that fall a population estimated at 3,074,850 pounds was present (Table 4). California Department of Fish and Game surveys in their Area A (Cape Mendocino to 42°00' N. Lat.) in 1966-67 indicated a general northward shift of the Area A population between March and September 1966. Their estimates off northern California in spring and fall 1966, respectively, were 5,086,000 and 2,210,000 pounds (Dahlstrom *et al.*, 1967), indicating a decrease in population there, while the Area 1-A (Oregon) population increased. In 1967, spring and fall surveys conducted by California Department of Fish and Game in Area A and in the Southern part of Area 1-A (border to Cape Sebastian, Oregon) resulted in estimates for the two areas as given below by Gotshall, *et al.*, (1967).

	Spring	Fall
Mad River - 42°00' N. Lat. Area A (California)	4,854,017	8,073,516
42°00' N. Lat. - Cape Sebastian Area 1-A (Oregon)	4,648,000	2,649,785
Total	9,502,017[1/]	10,723,301[2/]

1/ *Based on area of 188 nautical miles*^{2}.

2/ *Based on area of 215 nautical miles*^{2}.

Table 4. Population estimates by subarea off Oregon, 1966-67

Subarea	Geographic limits	Midpoint estimate in pounds 1/ Spring 1966	Fall 1966	Spring 1967
1a	42°00' N. Lat. to Rogue River	99,190	3,074,850	5,654,292
1b	Rogue River to Cape Blanco	1,465,536	4,397,283	878,508
2a	Cape Blanco to Cape Arago	4,038,320	-	16,094,529
2b	Cape Arago to Umpqua River	10,200,998	-	7,866,446
3a	Umpqua River to Heceta Bank	509,275	-	5,411,250
4a & 4b	Cape Perpetua to Cape Kiwanda	2,635,662 2/	4,005,505 3/	12,889,404
5a	Cape Kiwanda to Tillamook Bay	0 2/	6,387,039	8,980,464
5b	Tillamook Bay to Astoria Canyon	4,278,354 2/	29,303,470	57,273,106

1/ *Totals by subarea (1a + 1b, etc.) may vary from Table 2 due to the statistical analysis differences.*

2/ *Believed to be underestimates due to sample distribution.*

3/ *Estimates based on only part of Area 4 (245 naut. miles^2); both spring estimates based on total subarea of 538 naut. miles^2.*

It is apparent that the total population within the two areas was similar between spring and fall of 1967 but that a shift southward occurred during the summer; the population was split about 50-50 between the areas in the spring while about 80% was south of the border in the fall. In 1968, this southward trend continued and little or no catch was recorded in Area 1-A until late in the summer when some successful fishing was accomplished off Brookings in August. Probably the shrimp between Cape Sebastian and the

Mad River are part of one discrete population which may shift north and south with prevailing currents or countercurrents from season to season and year to year. The largest part is off California in most years, with remnant parts resident off Oregon. At times, however, a large segment may be found off Oregon, as in 1966 and 1967.

Whether shrimp in Area 1-B (Rogue River-Cape Blanco) are also part of the Area 1-A and California Area A population is uncertain. The much greater distance between concentrations in Areas 1-A and 1-B (about 30 nautical miles) would appear to render this relationship improbable. If a feasible mark for pink shrimp could be developed, the relationships between known shrimp populations could be made much clearer through a mark and recovery program. Such a program seems the only means at present likely to show such relationships or to demonstrate movements between and within areas.

There also is reason to suspect that shrimp movements may occur in northern Oregon and possibly between northern Oregon and southern Washington. Whether these movements consist of the entire population or only a segment (perhaps larvae or 0-age shrimp) is uncertain. The very large increases in the estimated populations in Areas 4 and 5-B (Table 4) between the fall of 1966 and the spring of 1967 cannot be explained only by the fact that a very strong 1966 year class contributed (through growth and recruitment) to the population increase. In Area 1, the 1966 year class (5 months old in September 1966) contributed a substantial number of shrimp (34%) to the catches in the fall of 1966. Yet this year class was only 2.5% of the estimated catch (by number) in Area 5 in October 1966. It was present in Area 5 by the spring of 1967, however, contributing about 60% (by number) of the very large estimated population. The 1966 year class certainly was not available on the bottom within the survey limits in 1966. Yet it was avail-

able to the gear since it was captured in large numbers in Area 1 a month earlier. It was either off bottom during the survey, or was not within the survey area.

The possibility of shrimp movements being due to currents or especially countercurrents off bottom has been suggested by Gotshall (personal communication, August 1966), Milburn and Robinson (unpublished manuscript), and Pearcy (1970). Pandalid larvae are thought to be pelagic and planktonic for some time after hatching (Berkeley, 1930; Modin and Cox, 1966; and Gotshall, personal communication, 1969) and, therefore, subject to the whims of oceanic currents. Diel vertical migrations of adult *P. jordani* (12 months and older) are known to occur off Oregon (Milburn and Robinson, unpublished manuscript; Pearcy, 1969). During their nightly stay in the water column they could be subject to drifting in whatever direction the current is moving. If two currents are present over a given area of bottom, counter to one another in direction, the upward and downward migration of shrimp through such countercurrents would tend to place them back on the bottom near where they started. However, the tendency is for shrimp to move rapidly up in the water column to some depth range off bottom where they remain until near dawn when an equally rapid descent probably occurs. With this behavior pattern, a considerable dislocation could occur. Rapid apparent dislocations of shrimp within a specific depth range (usually 4-10 fathoms) have been frequently reported by commercial fishermen from Coos Bay and Astoria. Strong currents usually associated with coastal upwelling and tides in summer are known to exist off Oregon (Runge, 1965) and have frequently been reported by commercial fishermen, especially in June and July when upwellings and extreme high and low tides are at a peak. During the midsummer months, catch/unit effort usually drops also, especially off Coos Bay and northern Oregon (Milburn and Robinson,

1969), but frequently picks up again in August to September. The drop in catch/effort is often associated with apparent dispersal of shrimp, which are frequently caught over a wider depth range at that time.

Recruitment

During surveys in the fall of 1966 (for Area 1) and spring of 1967 (all areas), it was evident that the 1966 year class (age I in 1967) was very strong. Generally this year-class dominated most survey and commercial catches from 1967 through 1968 (Figure 4) and was also very strong in 1969. Dominant, weak, and fair year-classes have generally been present in all areas off Oregon during the same years and, since 1964 at least, trends in year-class strength off northern California have been nearly identical to those off Oregon. The 1964 and 1966 year classes have contributed a large share of the landings in Oregon and California since 1965. A very strong 1968 year class was present in 1969 off California and Oregon. This stemmed from the strong parent stock composed of early maturing females of the 1966 year class and older females of the 1965 and 1964 year classes. An apparent direct correlation between parent stock size and subsequent offspring is indicated.

Yet, the 1967 year class was one of the weakest on record in providing commercial catches in spite of a very large parent population of mature females present in all areas in the spring of 1967. The 1967 year class should, therefore, have been at least of moderate strength. Some factor in the environment must have been unfavorable to recruitment that year.

The strong 1961 year class which contributed very much to the Area 2 fishery in 1963 and 1964 (Figure 4) stemmed from a population that, judging from the low catch/effort in Area 2 in 1960-62, may not have contained a very strong parent stock. The apparent buildup in populations off northern

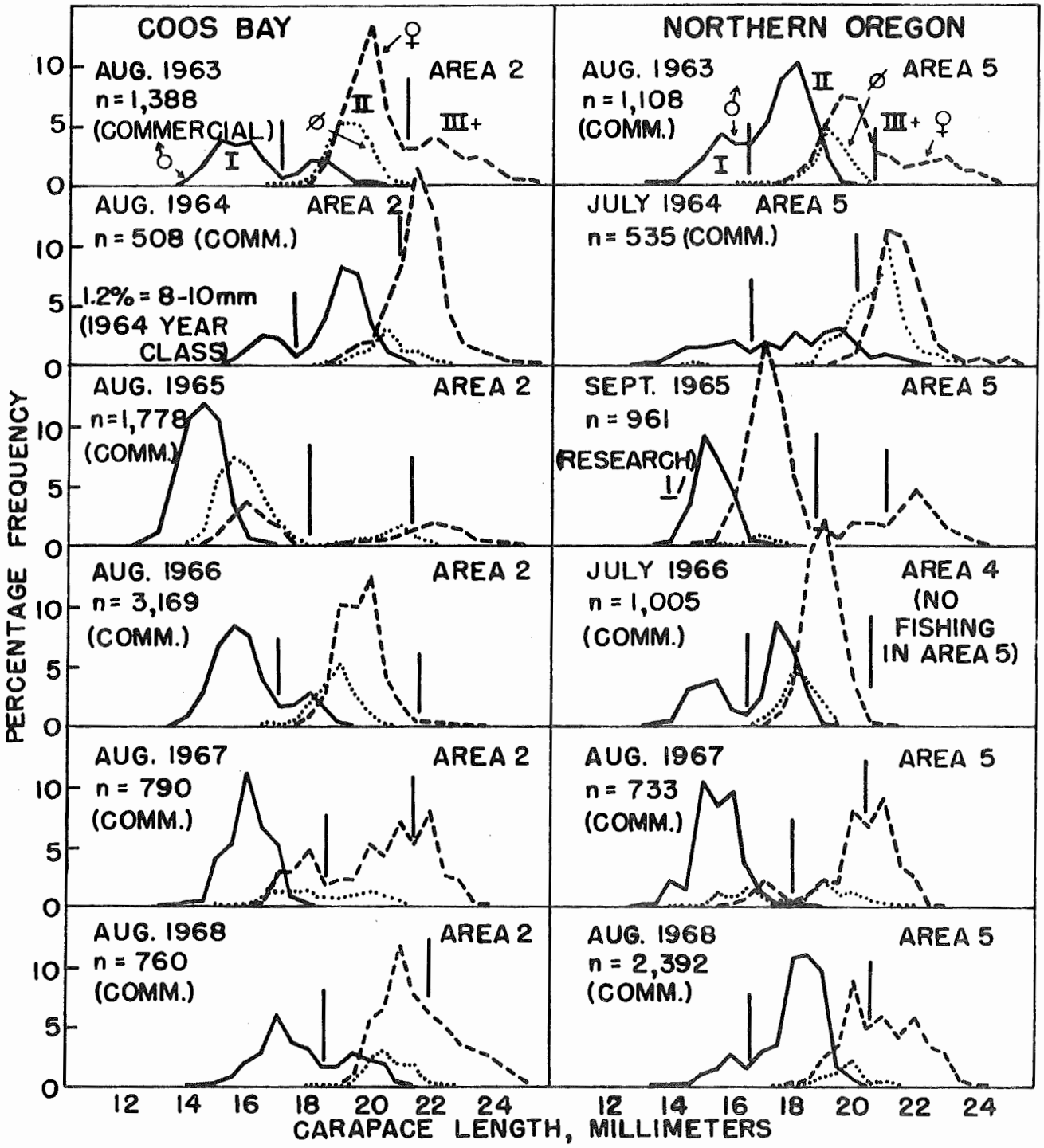

Figure 4. Length-frequency, by sex, for shrimp caught off northern Oregon and Coos Bay in summer, 1963-68

1/ *Captured by Canadian research vessel, G. B. Reed, but measured by Fish Commission. No commercial fishing after June in 1965.*

California and Area 1-A since 1964 (about 5 million pounds in 1965 to about 10 million pounds in 1967) also would indicate that favorable factors not related to parent stock size may yield recruitment success out of proportion to parent stock size. The largest portion of the apparent buildup in stock size off California and Oregon also coincided with a very large Soviet fishery on Pacific hake, *Merluccius productus*, off Oregon, Washington, and California, which began in 1966. Hake are known to be voracious predators of probably any forage animal available to them. This does not explain, however, the strength of the 1964 and 1966 year classes, which had hatched before or during the advent of the Soviet fishery. At present the effect of reduction of hake stocks on shrimp populations is not clear.

Estimates of Standing Crop

As given in Tables 2 and 4, estimates varied considerably from area to area off Oregon during each successive cruise period. They increased during each succeeding survey in Areas 1-A, 2, 3, 4, and 5, decreasing in Area 1-B between fall 1966 and spring 1967. A decrease also occurred in Area 2-B during the same period.

We believe we grossly underestimated populations in Areas 4 and 5 during the spring of 1966. In Area 5, for example, the spring 1966 estimate of 4,278,354 pounds (Table 4) was exceeded by commercial catches of 4.34 and 4.43 million pounds in 1967 and 1968, respectively, (Table 5). In Area 1-B the spring 1967 estimate of 878,508 pounds (Table 4) was nearly equalled by a catch from that area in 1967 of 733,595 pounds while it yielded 1,302,728 pounds at a record catch rate of 1,087 pounds per hour tow in 1968. In Area 1-B at least, this indicates that shrimp move into the area from outside.

Table 5. Oregon commercial shrimp catch and catch-per-unit effort, by year and area, 1957-70

Year	Data type[1]	Area of catch 1	2 and 3	4	5	Total[2]
1957	C	0	286,876	0	116,800	403,623
	C/E	-	No data	-	No data	No data
1958	C	0	0	0	1,441,055	1,522,155
	C/E	-	-	-	569	569
1959	C	16,100	53,400	0	2,129,962	2,764,127
	C/E	240	414	-	525	524
1960	C	136,680	82,345	0	588,651	1,132,506
	C/E	318	287	-	318	380
1961	C	74,860	431,126	0	400,085	1,455,912
	C/E	550	462	-	330	417
1962	C	157,820	905,400	0	292,500	2,750,440[3]
	C/E	470	340	-	345	434
1963	C	116,580	1,626,012	0	1,029,913	3,114,771
	C/E	288	584	-	550	548
1964	C	496,059	4,534,023	2,010	223,165	5,477,427
	C/E	771	640	183	587	644
1965	C	658,677	921,574	0	92,155	1,750,640
	C/E	350	320	0[4]	264	327
1966	C	1,213,077	2,766,626	473,178	250,699	4,751,300
	C/E	570	520	553	650	538
1967	C	1,478,225	2,706,349	1,656,496	4,342,155	10,373,956
	C/E	581	374	580	645	527
1968	C	1,609,913	4,301,676	325,856	4,432,430	10,976,258
	C/E	937	583	556	690	661
1969	C	17,100	3,826,300	215,100	5,072,100	10,504,800
	C/E	130	430	430	588	522
1970	C	1,692,300	4,889,900	2,207,600	3,517,100	13,733,800
	C/E	1,077	561	675	560	614

1/ *C = landed shrimp weight, heads on, raw; C/E = catch-per-unit effort in pounds per hour tow.*

2/ *Includes Oregon landings of shrimp captured off Washington and California.*

3/ *Includes 1.293,000 pounds caught off California at C/E of 574 pounds per hour.*

4/ *Only 6 hours effort in 1965.*

We feel that the estimates for the spring of 1967 are probably minimal in all areas and, therefore, give us some basis to say that Areas 4 and 5 probably are grossly underharvested at present levels of catch.

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APPENDIX

Appendix Table 1a. Tow log, MV *Faymar*, cruise 66-1, March 1966

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H3									
1	3-3	42°00.3'	42°01.0'	124°26.3'	124°26.1'	1621	1620	50	50	4	15	0820	0	-	-
2	"	42 04.3	42 05.0	124 26.0	124 26.2	1570	1560	50	50	4	15	0925	0	-	-
3	"	42 05.2	42 04.5	124 30.5	124 31.0	1553	1562	66	66	4	15	1045	33	132	167
4	"	42 03.9	42 03.2	124 35.3	124 35.0	1565	1573	100	100	4	15	1210	0	-	-
5	"	42 03.9	42 05.0	124 24.7	124 34.4	1565	1552	88	88	4	15	1300	0	-	-
6	"	42 06.2	42 07.0	124 32.8	124 32.8	1538	1528	78	78	4	15	1350	5	20	148
7	"	42 07.0	42 06.5	124 35.1	124 35.0	1527	1533	107	107	4	15	1450	0	-	-
8	"	42 08.4	42 07.9	124 35.0	124 35.0	1515	1509	98	98	4	15	1545	0	-	-
9	"	42 09.0	42 09.8	124 33.9	124 33.9	1502	1494	85	85	4	15	1640	0	-	-
10	3-4	42 11.2	42 12.2	124 28.7	124 28.8	1483	1470	59	59	4	20	0635	8	24	192
11	"	42 11.9	42 11.1	124 31.5	124 31.6	1470	1480	73	73	4	15	0750	T[2]	-	161
12	3-17	42 08.0	42 08.8	124 29.5	124 28.5	1520	1510	65	65	4	15	0815	T	-	-
13	"	42 12.0	42 12.8	124 35.5	124 35.4	1465	1455	100	100	4	15	0945	0	-	-
14	"	42 14.1	42 15.1	124 35.3	124 35.3	1440	1428	100	100	4	15	1035	0	-	-
15	"	42 15.2	42 14.3	124 32.9	124 32.7	1430	1440	79	79	4	15	1137	T	-	142
16	"	42 14.2	42 14.6	124 30.0	124 30.5	1445	1438	63	63	4	15	1250	T	-	119
17	"	42 15.0	42 15.8	124 28.4	124 29.2	1435	1425	55	55	4	15	1335	0	-	-
18	"	42 18.2	42 18.9	124 30.5	124 30.6	1395	1385	60	60	4	15	1435	3	12	130
19	3-22	42 04.1	42 02.9	124 31.9	124 32.0	1565	1580	68	69	4	20	0850	12	36	153
20	"	42 02.7	42 03.4	124 33.7	124 33.6	1580	1572	80	80	4	15	0955	T	-	-
21	"	42 04.0	42 03.1	124 29.0	124 29.2	1570	1580	58	58	4	15	1105	0	-	-
22	"	42 03.3	42 04.0	124 25.4	124 25.5	1582	1574	48	48	4	15	1200	0	-	-
23	"	42 04.1	42 03.6	124 20.5	124 20.4	1580	1587	20	20	2	15	1300	0	-	-
24	3-23	42 19.9	42 20.4	124 32.2	124 32.4	1372	1366	58	58	4	15	0725	T	-	260
25	"	42 19.0	42 17.7	124 35.0	124 35.2	1380	1396	82	82	3	15	0830	T	-	106
26	"	42 19.2	42 17.4	124 35.4	124 35.7	1390	1400	100	100	3	15	0925	0	-	-
27	"	42 19.8	42 20.3	124 36.0	124 36.5	1370	1365	80	80	4	15	1030	T	-	-
28	"	42 22.8	42 23.2	124 37.1	124 37.6	1332	1327	62	62	4	15	1150	0	-	-
29	"	42 22.1	42 22.6	124 40.1	124 40.4	1340	1334	86	86	4	15	1250	0	-	-
30	"	42 24.3	42 24.9	124 43.3	124 43.6	1313	1306	110	110	4	15	1405	2	8	87
31	"	42 27.8	42 28.8	124 44.8	124 44.6	1270	1260	85	85	4	15	1525	0	-	-

Appendix Table 1a. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H3									
32	3-23	42 26.2	42 26.8	124 37.3	124 37.5	1290	1284	48	48	3	15	0830	0	-	-
33	"	42 31.9	42 33.3	124 36.1	124 35.2	1222	1206	50	50	3	15	1005	0	-	-
34	"	42 33.7	42 34.2	124 41.0	124 41.0	1200	1195	77	77	4	15	1135	123	492	123
35	"	42 35.0	42 35.5	124 42.3	124 42.3	1185	1180	119	119	4	15	1235	0	-	-
36	"	42 35.3	42 35.8	124 39.9	124 39.5	1180	1175	72	72	4	15	1340	T	-	95
37	"	42 37.0	42 36.2	124 38.9	124 39.0	1160	1170	67	67	4	15	1440	340	1,360	116
38	"	42 36.1	42 35.6	124 36.3	124 36.9	1170	1177	57	57	4	15	1530	8	32	229
39	"	42 38.1	42 38.7	124 38.5	124 38.4	1145	1140	67	67	3	15	1645	T	-	-
40	"	42 40.2	42 40.8	124 41.5	124 41.5	1124	1118	88	88	3	15	1740	T	-	153
41	3-27	42 43.2	42 44.0	124 36.3	124 37.4	1085	1075	50	50	4	15	0635	0	-	-
42	"	42 42.4	42 42.0	124 39.4	124 39.4	1087	1100	75	75	4	15	0735	T	-	103
43	"	42 42.7	42 43.3	124 41.8	124 41.9	1095	1090	100	100	3	15	0835	24	96	151
44	"	42 43.6	42 44.5	124 40.0	124 41.2	1083	1075	75	75	4	15	0930	T	-	156
45	"	42 46.9	42 48.0	124 42.7	124 43.3	1057	1050	87	87	3	15	1035	5	20	124
						2H4									
46	"	42 55.8	42 56.4	124 41.2	124 40.9	1080	1085	62	62	3	15	1235	9	36	201
47	"	42 55.0	42 54.9	124 46.0	124 47.3	1090	1090	100	100	2	15	1350	5	20	128
48	"	42 55.8	42 55.9	124 49.6	124 50.6	1110	1110	94	94	1	15	1445	0	-	-
49	"	42 57.6	42 58.6	124 49.1	124 48.0	1125	1130	65	65	1	15	1535	0	-	-
50	"	42 59.1	42 59.6	124 51.5	124 51.3	1147	1151	120	120	1 HU[3]	10	1630	0	-	-
51	"	43 00.8	43 01.4	124 42.3	124 42.4	1140	1145	83	83	4	15	1810	7	28	145
52	3-28	42 57.4	42 58.0	124 39.5	124 39.0	1095	1100	59	60	3	15	0620	T	-	291
53	"	43 00.1	42 00.8	124 36.8	124 36.4	1122	1130	59	59	3	15	0720	97	388	175
54	"	42 59.7	43 00.4	124 41.3	124 40.9	1125	1130	75	75	3	15	0825	10	40	167
55	"	43 00.8	43 01.7	124 44.5	124 45.4	1145	1155	87	87	4	15	0925	148	592	187
56	"	43 04.1	43 04.7	124 44.0	124 42.3	1180	1186	100	100	4	15	1025	0	-	-
57	"	43 03.1	43 02.5	124 41.7	124 42.5	1165	1160	83	83	4	15	1125	25	100	160
58	"	43 01.9	43 02.6	124 39.8	124 39.3	1150	1155	73	73	4	15	1215	537	2,148	149
59	"	43 03.3	43 04.1	124 37.7	124 37.5	1162	1172	70	70	4	15	1305	26	104	160
60	"	43 08.2	43 08.6	124 36.9	124 37.2	1222	1226	65	65	4 HU	11	1415	0	-	-
61	"	43 12.0	43 12.3	124 37.6	124 37.7	1270	1272	68	68	4 HU	6	1515	0	-	-

Appendix Table 1a. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
62	3-28	43 12.9	43 13.3	124 35.4	124 35.4	1280	1283	50	50	1	10	1600	0	-	-
63	"	43 15.6	43 16.0	124 37.4	124 37.5	1315	1318	69	69	4	10	1705	0	-	-
64	"	43 16.0	43 16.3	124 39.7	124 39.5	1319	1322	86	86	4	13	1755	2	9	250
65	3-29	43 16.8	43 17.3	124 40.5	124 40.4	1330	1335	95	95	4	15	0635	69	276	239
66	"	43 18.3	43 18.8	124 39.1	124 39.0	1347	1354	87	87	4	15	0725	58	232	222
67	"	43 19.6	43 20.3	124 40.0	124 39.7	1365	1372	98	98	4	15	0820	610	2,440	148
68	"	43 19.4	43 18.7	124 36.3	124 36.8	1360	1352	73	73	3	15	0925	0	-	-
69	"	43 18.5	43 18.8	124 33.4	124 33.2	1370	1373	60	60	1 HU	10	1035	0	-	-
70	"	43 21.0	43 21.6	124 35.8	124 35.4	1380	1386	73	73	3	15	1135	21	84	214
71	"	43 23.5	43 24.3	124 36.6	124 35.9	1410	1420	86	86	3	15	1230	10	40	267
72	"	43 24.2	43 25.0	124 37.9	124 37.5	1420	1430	102	102	4 HU	15	1325	825	3,300	177
73	"	43 25.1	43 25.8	124 34.2	124 33.7	1432	1440	75	75	3	15	1500	0	-	-
74	3-30	43 26.8	43 27.3	124 31.5	124 31.4	1455	1460	65	65	3	15	0655	9	36	285
75	"	43 27.1	43 27.8	124 36.4	124 36.0	1458	1463	110	110	4	15	0830	552	2,208	128
76	"	43 29.1	43 29.6	124 22.2	124 21.8	1488	1495	53	53	3	15	1030	T	-	-
77	"	43 29.6	43 30.1	124 28.0	124 27.8	1490	1496	64	64	3	15	1145	0	-	-
78	"	43 30.6	43 31.1	124 30.2	124 29.9	1500	1506	73	73	3	15	1235	21	84	156
79	"	43 31.9	43 32.5	124 32.2	124 31.9	1516	1522	90	90	3	15	1330	378	1,516	164
80	"	43 33.2	43 33.9	124 33.7	124 33.3	1530	1540	115	115	4	15	1440	1	4	64
81	"	43 32.9	43 33.3	124 25.4	124 25.4	1532	1537	65	65	3	15	1610	40	160	137
82	"	43 34.1	43 34.5	124 18.4	124 18.0	1555	1560	51	51	3	15	1735	28	112	148
83	3-31	43 39.0	43 39.5	124 21.2	124 20.8	1612	1617	58	58	4	15	0645	24	96	158
84	"	43 39.2	43 39.6	124 28.4	124 28.8	1608	1613	75	75	3	15	0805	0	-	-
85	"	43 40.7	43 41.1	124 28.5	124 28.7	1625	1631	75	75	4 HU	15	0900	0	-	-
86	"	43 37.8	43 38.4	124 35.4	124 35.3	1588	1595	127	127	4	15	1035	T	-	-
87	"	43 42.0	43 42.6	124 34.0	124 33.8	1640	1647	110	110	4	15	1140	T	-	110
88	"	43 42.2	43 43.0	124 34.7	124 34.6	1642	1650	130	130	4	15	1240	T	-	98
89	"	43 42.8	43 43.4	124 35.3	124 35.3	1650	1657	138	138	4	15	1330	0	-	-
90	"	43 45.9	43 46.8	124 31.0	124 32.2	1690	1700	95	95	1	15	1440	0	-	-
91	"	43 47.1	43 47.6	124 32.8	124 32.6	1705	1710	98	98	1	15	1525	T	-	220
92	"	43 51.9	43 52.5	124 34.6	124 34.8	1765	1770	110	110	4	15	1645	2	8	133
93	"	43 53.0	43 53.7	124 26.5	124 26.0	1780	1790	66	66	3	15	1755	0	-	-

Appendix Table 1a. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
94	4-1	43 53.8	43 54.3	124 33.0	124 33.1	1788	1794	93	93	4	15	0605	0	-	-
95	"	43 56.4	43 57.1	124 29.9	124 29.4	1820	1830	72	72	3	15	0720	0	-	-
96	"	43 56.5	43 57.1	124 35.1	124 35.5	1820	1828	94	94	1	15	0845	2	8	116
97	"	43 58.3	43 59.0	124 37.5	124 37.5	1842	1850	88	84	4	15	0940	16	64	197
98	"	44 00.2	44 00.7	124 37.8	124 37.6	1865	1870	78	78	4	10	1030	43	258	230
99	"	44 02.4	44 02.9	124 39.1	124 38.3	1892	1897	70	70	4	10	1120	T	-	-
100	"	44 00.9	44 00.4	124 35.3	124 34.6	1874	1870	80	80	4	10	1215	2	12	141
101	"	44 01.1	44 01.4	124 34.2	124 33.2	1876	1880	77	77	4	15	1255	4	16	128
102	"	44 04.2	44 03.6	124 22.1	124 21.6	1920	1915	57	57	3	15	1430	0	-	-
103	"	43 59.1	43 58.6	124 22.2	124 21.9	1858	1853	62	62	3	15	1540	T	-	-
104	"	43 55.7	43 55.2	124 21.6	124 22.8	1818	1809	63	63	3	15	1630	0	-	-
105	"	43 54.1	43 53.2	124 22.9	124 22.0	1795	1785	62	62	3	15	1715	6	24	202
106	"	43 50.7	43 49.8	124 21.1	124 21.2	1755	1745	62	62	4	15	1800	3	120	195

1/ Bottom type: 1 = rock; 2 = sand; 3 = muddy sand; and 4 = mud.

2/ T = trace, less than 1 pound of shrimp taken.

3/ HU = hung up.

Appendix Table 1b. Tow log, MV *Columbia*, cruise 66-1, March 1966

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
1	3-3	43°56.5'	43°55.7'	124°47.9'	124°47.8'	1820	1810	62	72	1 TN[2]	15	0807	0	-	-
2	"	44 02.2	44 02.5	124 53.8	124 53.5	1890	-	73	73	1 TN	7	1120	0	-	-
3	"	44 06.9	44 07.5	124 55.3	124 55.5	1950	-	95	96	2	15	1331	T[3]	-	-
4	"	44 07.4	44 07.1	124 52.6	124 52.6	1954	-	62	62	1 HU[2]	4	1518	0	-	-
5	"	44 07.2	44 07.5	124 50.9	124 50.9	1952	-	58	58	1 HU	5	1553	0	-	-
6	3-4	44 14.9	44 15.6	124 43.0	124 43.5	2048	-	56	56	1	15	0820	0	-	-
7	3-11	44 20.1	44 20.2	124 34.9	124 34.4	2112	-	48	48	1 HU	4	0804	0	-	-
8	"	44 16.9	44 17.6	124 31.3	124 32.0	2075	-	48	48	1	15	0918	0	-	-
9	"	44 12.7	44 12.5	124 32.2	124 33.2	2022	-	54	54	3	16	1027	0	-	-
10	"	44 16.9	44 17.3	124 43.7	124 43.8	2071	-	55	55	1 HU	11	1211	0	-	-
11	"	44 18.7	44 19.4	124 47.9	124 47.5	2093	2100	82	82	1	15	1337	0	-	-
12	"	44 20.6	44 21.2	124 48.5	124 48.1	2115	2122	94	97	3	15	1423	T	-	-
13	"	44 20.8	44 20.3	124 46.9	124 46.8	2119	2112	79	80	3	15	1517	T	-	-
14	"	44 19.6	44 18.9	124 46.7	124 46.4	2103	2095	81	81	1	16	1557	T	-	-
15	"	44 23.5	44 24.2	124 47.4	124 47.2	2151	2160	127	128	4	16	1706	0	-	-
16	3-12	44 41.8	44 41.5	124 24.0	124 24.6	2383	2379	57	57	1	15	0701	0	-	-
17	"	44 40.8	44 40.4	124 25.0	124 25.8	2368	2365	53	53	1	15	0745	0	-	-
18	"	44 44.9	44 45.5	124 26.0	124 25.9	2420	2426	70	70	3	16	0845	0	-	-
19	"	44 45.9	44 45.7	124 25.0	124 25.8	2432	2431	71	73	3	15	0935	0	-	-
20	3-18	44 45.6	44 45.1	124 22.2	124 21.8	2418	2423	63	63	2	16	1048	0	-	-
21	3-22	44 26.9	44 26.5	124 30.4	124 30.6	2198	-	49	49	1 HU	3	1229	0	-	-
21b[4]	"	44 26.1	44 25.1	124 30.1	124 30.7	2188	2180	49	51	1	17	1253	0	-	-
22	"	44 29.6	44 30.2	124 32.5	124 32.3	2230	2236	59	59	2	15	1356	0	-	-
23	"	44 31.6	44 32.1	124 33.4	124 33.4	2254	2260	69	69	2	16	1434	0	-	-
24	"	44 31.5	44 30.9	124 34.3	124 35.2	2252	2245	81	83	2	17	1525	T	-	-
25	"	44 31.2	44 30.3	124 36.4	124 37.0	2248	2242	91	92	2	16	1623	T	-	-
26	"	44 29.6	44 29.0	124 36.0	124 37.0	2228	2221	81	81	2	15	1709	T	-	-
27	"	44 28.0	44 28.4	124 34.3	124 34.4	2210	2212	63	63	1	15	1805	0	-	-
28	3-23	44 31.9	44 32.3	124 29.8	124 29.8	2258	-	54	54	2 HU	2	0748	0	-	-
28b[4]	"	44 32.0	44 32.5	124 33.0	124 32.7	2259	2256	70	71	2	15	0830	T	-	-
29	"	44 32.3	44 32.6	124 33.1	124 32.9	2262	2266	71	71	2	15	0914	0	-	-

Appendix Table 1b. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
30	3-23	44 33.6	44 34.2	124 36.7	124 36.5	2278	2285	98	100	2	15	1007	T	-	-
31	"	44 35.9	44 36.5	124 34.0	124 33.2	2308	2313	81	82	2	15	1112	0	-	-
32	"	44 37.2	44 37.8	124 33.2	124 33.2	2323	2330	84	84	2	16	1204	0	-	-
33	"	44 38.5	44 39.1	124 34.1	124 33.6	2340	2346	90	91	2	15	1259	T	-	-
34	"	44 40.6	44 41.2	124 36.0	124 35.6	2364	2370	117	117	4	15	1359	175	700	139
35	"	44 41.0	44 41.6	124 36.7	124 36.4	2368	2376	122	124	4	22	1519	50	136	130
36	"	44 44.0	44 44.4	124 31.9	124 32.0	2408	2411	80	81	3	15	1642	0	-	-
37	"	44 45.9	44 46.7	124 16.7	124 16.3	2438	2445	55	55	2	16	1829	0	-	-
38	3-24	44 49.6	44 50.1	124 28.3	124 27.7	2478	2484	91	91	3	15	0613	15	60	144
39	"	44 50.4	44 50.9	124 27.0	124 26.7	2488	2494	88	88	3	16	0653	2	8	-
40	"	44 57.3	44 47.8	124 21.8	124 21.4	2575	2581	92	93	2	15	0840	90	360	155
41	"	44 58.2	44 58.5	124 20.5	124 20.1	2586	2588	95	95	3 HU	6	0920	T	-	-
42	"	44 59.4	44 58.9	124 14.0	124 14.8	2603	2597	74	76	3	15	1105	0	-	-
43	"	44 56.3	44 55.7	124 09.6	124 09.6	2568	2560	50	50	2	16	1215	0	-	-
44	"	44 55.5	44 55.8	124 11.0	124 11.1	2558	2562	54	56	2	15	1257	0	-	-
45	3-25	45 01.4	45 00.8	124 12.8	124 13.0	2629	6222	73	74	2	16	0637	1	4	-
46	"	45 04.3	45 04.8	124 14.1	124 14.0	2663	2669	82	82	3	15	0803	90	36	117
47	"	45 05.3	45 04.6	124 18.4	124 18.4	2673	2667	101	99	3	15	1027	150	600	138
48	"	45 04.9	45 04.5	124 19.4	124 20.6	2668	2667	124	125	4	15	1142	1	4	-
49	"	45 09.0	45 09.6	124 13.9	124 13.6	2722	2729	88	88	3	15	1509	5	20	110
50	"	45 09.4	45 08.8	124 11.4	124 11.6	2728	2721	74	74	3	15	1604	1	4	-
51	3-26	45 11.3	45 11.8	124 07.6	124 07.6	2754	2760	54	54	2	15	0728	0	-	-
52	"	45 15.9	45 15.4	124 12.3	124 12.3	2808	2801	82	82	3	15	0838	0	-	-
53	"	45 12.1	45 12.8	124 18.6	124 18.6	2760	2767	134	135	4	17	0959	0	-	-
54	"	45 16.7	45 17.1	124 18.1	124 18.3	2815	2820	100	100	3	15	1120	0	-	-
55	"	45 22.2	45 22.8	124 19.4	124 19.5	2883	2898	98	98	3	16	1314	0	-	-
56	"	45 22.8	45 22.1	124 16.0	124 16.0	2891	2884	92	92	4	15	1400	0	-	-
57	"	45 22.5	45 23.0	124 05.9	124 06.1	2891	2896	48	48	2	16	1517	0	-	-
58	"	45 26.1	45 26.6	124 10.2	124 10.6	2935	2941	68	67	2	15	1626	0	-	-
59	"	45 26.7	45 27.4	124 10.5	124 10.4	2935	2941	66	67	2	15	1701	0	-	-
60	"	45 31.1	45 31.7	124 11.5	124 12.2	2997	3004	66	67	3	16	1803	0	-	-

Appendix Table 1b. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
61	3-27	45 27.4	45 26.8	124 16.1	124 15.9	2948	2942	91	91	4	18	0719	0	-	-
62	"	45 28.9	45 29.5	124 18.3	124 19.0	2967	2973	94	94	4	25	0834	0	-	-
63	"	45 30.2	45 30.6	124 24.6	124 25.3	2980	2984	110	109	3	16	0938	0	-	-
64	"	45 34.2	45 34.7	124 16.0	124 16.2	3033	3039	76	76	4	15	1103	0	-	-
65	"	45 37.2	45 37.6	124 15.8	124 15.7	3070	3075	75	75	4	16	1201	0	-	-
66	"	45 37.9	45 38.5	124 15.0	124 15.0	3080	3085	68	68	4	15	1245	0	-	-
67	"	45 40.3	45 40.9	124 12.4	124 12.2	3110	3117	60	58	3	15	1341	0	-	-
68	"	45 40.9	45 41.4	124 09.2	124 09.4	3118	3124	56	56	2	15	1421	0	-	-
69	"	45 41.9	45 42.5	124 14.0	124 14.2	3130	3137	68	68	3	15	1513	0	-	-
70	"	45 46.4	45 46.9	124 14.3	124 14.6	3183	3189	68	70	3	15	1642	0	-	-
71	"	45 46.2	45 46.7	124 17.7	124 18.6	3180	3186	78	80	4	15	1735	0	-	-
72	"	45 43.2	45 43.1	124 18.8	124 19.9	3143	3142	78	80	4	17	1834	0	-	-
73	3-28	45 40.9	45 40.3	124 24.9	124 25.1	3112	3105	91	93	4	20	0750	15	45	314
74	"	45 43.3	45 43.9	124 24.6	124 24.7	3142	3149	84	83	4	15	0856	4	16	-
75	"	45 43.3	45 44.0	124 28.8	124 29.7	3140	3148	101	101	4	15	1015	250	1,000	166
76	"	45 49.2	45 49.9	124 25.9	124 26.1	3215	3223	83	83	4	20	1207	25	75	165
77	"	45 50.2	45 50.7	124 36.8	124 37.6	3221	3226	99	97	3	17	1348	0	-	-
78	"	45 57.3	45 57.7	124 35.7	124 37.4	3308	3312	93	91	4	15	1527	0	-	-
79	"	46 02.2	46 02.9	124 38.6	124 37.8	3367	3374	93	91	4	14	1648	0	-	-
80	"	46 03.0	46 03.5	124 37.0	124 37.2	3378	3383	87	87	4	15	1734	0	-	-
81	"	46 06.4	46 07.0	124 39.6	124 39.5	3418	3425	99	99	3	15	1838	0	-	-
82	3-29	46 09.6	46 10.4	124 39.4	124 38.8	3458	3463	108	136	2	15	0625	0	-	-
83	"	46 10.9	46 11.7	124 36.2	124 36.0	3478	3484	94	94	2	15	0712	0	-	-
84	"	46 10.8	46 10.4	124 31.1	124 31.0	3478	3472	74	75	2	15	0845	0	-	-
85	"	46 12.1	46 12.9	124 25.3	124 25.4	3497	3505	73	120	2 HU	15	0939	0	-	-
85b[4]	"	46 12.8	46 12.5	124 24.8	124 25.1	3504	3503	72	74	3	11	1042	0	-	-
86	"	46 15.3	46 15.8	124 23.8	124 23.3	3537	3544	100	110	4	15	1206	0	-	-
87	"	46 10.9	46 10.2	124 20.6	124 20.8	3483	3476	61	61	3	15	1345	4	18	146
88	"	46 08.5	46 08.1	124 24.5	124 25.1	3453	3448	68	68	3	15	1455	75	300	197
89	"	46 05.5	46 05.9	124 26.5	124 27.4	3420	3416	70	70	3	15	1553	120	480	189
90	"	46 03.1	46 02.8	124 24.2	124 24.5	3387	3383	70	70	4	15	1646	17	68	168
91	"	46 03.1	46 02.7	124 26.5	124 26.3	3385	3380	72	72	4	15	1741	60	240	157

Appendix Table 1b. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
92	3-30	45 54.0	45 53.5	124 13.1	124 12.5	3278	3271	59	59	3	15	0603	T	-	-
93	"	45 55.7	45 56.0	124 16.8	124 17.5	3298	3301	67	67	4	15	0703	60	240	196
94	"	45 57.4	45 58.0	124 14.5	124 15.1	3320	3327	61	61	3	15	0800	T	-	-
95	"	46 06.8	46 07.3	124 18.6	124 18.9	3435	3440	58	58	3	15	0949	T	-	-
96	"	46 08.8	46 09.5	124 17.4	124 17.3	3460	3467	56	56	2	15	1045	T	-	-
97	"	46 12.0	46 12.6	124 19.4	124 19.6	3498	3505	60	60	3	15	1138	T	-	-
98	"	46 13.9	46 14.5	124 19.5	124 19.3	3522	3530	61	62	3	15	1226	T	-	-

1/ Bottom type: 1 = rock; 2 = sand; 3 = muddy sand; and 4 = mud.

2/ TN - tore net and HU = hung up.

3/ T = trace, less than 1 pound of shrimp taken.

4/ Replicate tow.

Appendix Table 2. Tow log, MV *Sunrise*, cruise 66-12, September-November 1966

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H3									
1	9-30	42 40.1	42 39.5	124 35.3	124 35.4	1122	1128	52	53	4	15	0724	327	1,296	127
2	"	42 39.6	42 39.9	124 40.6	124 41.2	1130	1132	85	86	3	15	0928	0	-	-
3	"	42 43.0	42 42.4	124 40.3	124 40.2	1092	1097	83	83	4	15	1105	0	-	-
4	"	42 45.5	42 45.8	124 41.4	124 41.6	1068	1065	76	76	3 HU[2]	10	1301	2	12	-
5	"	42 43.2	42 43.3	124 36.3	124 36.8	1085	1085	52	55	4	10	1606	234	1,404	216
6	10-1	42 35.4	42 36.6	124 35.4	124 35.6	1180	1163	52	54	4	15	0739	429	1,680	257
7	"	42 34.9	42 34.5	124 40.6	124 40.2	1185	1190	76	74	4	15	0910	0	-	-
8	"	42 32.9	42 33.1	124 40.4	124 40.6	1210	1208	74	74	4 HU	6	1030	T[3]	-	51
9	"	42 32.1	42 31.6	124 35.9	124 36.3	1220	1226	50	50	4	15	1136	396	1,584	282
10	"	42 22.6	42 23.0	124 38.9	124 39.2	1334	1332	75	71	4	14	1419	T	-	-
11	"	42 21.6	42 21.1	124 34.3	124 34.2	1348	-	61	65	4	15	1600	5	20	505
12	"	42 18.3	42 18.9	124 34.2	124 34.6	1388	1382	77	77	3	16	1725	20	75	-
13	10-2	42 18.4	42 17.8	124 31.5	124 31.4	1392	1398	62	63	3	15	0715	35	140	700
14	"	42 14.6	42 14.9	124 29.8	124 30.2	1440	1436	62	62	4	15	0845	40	160	321
15	"	42 11.6	42 10.9	124 29.9	124 29.9	1478	1485	67	67	4	16	1021	275	1,030	485
16	"	42 07.2	42 06.5	124 29.4	124 29.5	1530	1538	64	64	4	16	1145	80	300	155
17	10-3	42 00.8	42 00.2	124 24.8	124 24.7	1615	1622	46	46	4	15	0710	T	-	-
18	"	42 01.5	42 02.3	124 30.2	124 29.8	1600	1590	62	62	4	16	0830	210	788	313
19	"	42 00.3	41 59.5	124 34.2	124 34.2	1610	1620	86	85	4	14	1005	T	-	-
20	"	42 03.5	42 02.8	124 35.0	124 34.8	1570	1578	89	89	4	15	1145	0	-	-
21	"	42 07.4	42 06.8	124 35.2	124 34.7	1522	1530	105	100	4	15	1320	T	-	-
22	"	42 03.9	42 03.4	124 29.9	124 30.5	1570	1576	63	62	4	15	1435	28	112	430
23	"	42 07.4	42 03.7	124 25.5	124 25.8	1570	1578	48	50	4	15	1545	80	320	745
24	"	42 06.7	42 06.0	124 26.6	124 26.7	1540	1548	50	51	4	15	1710	220	880	780
25	10-4	42 10.7	42 10.1	124 35.3	124 35.0	1482	1490	98	96	4	15	0738	T	-	-
26	"	42 14.3	42 13.7	124 35.2	124 35.2	1438	1446	93	95	4	15	0910	T	-	-
27	"	42 35.3	42 36.1	124 37.6	124 37.6	1180	1170	61	61	4	15	1250	192	768	217
28	"	42 38.6	42 39.2	124 37.3	124 37.2	1140	1132	58	58	4	15	1345	85	340	433
29	"	42 42.8	42 43.4	124 38.2	124 38.8	1090	1080	65	66	4	15	1455	34	136	376

Appendix Table 2. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H3									
30	10-7	46 11.0	46 10.5	124 18.8	124 18.5	3485	3480	59	60	3	15	1115	43	172	116
31	"	46 14.2	46 13.4	124 22.4	124 22.2	3525	3515	65	65	3	15	1240	0	-	-
32	"	46 12.5	46 11.7	124 17.1	124 17.3	3505	3495	51	50	2	15	1345	47	188	108
33	10-10	46 09.1	46 08.4	124 24.0	124 23.8	3460	3452	67	68	3	15	1040	31	124	112
34	"	46 09.6	46 10.2	124 33.7	124 33.8	3462	3468	77	79	3	15	1200	T	-	-
35	"	46 05.7	46 06.5	124 32.6	124 31.9	3415	3425	74	74	3	15	1315	8	32	-
36	"	46 06.8	46 06.6	124 23.1	124 27.7	3430	3428	68	68	3	15	1415	140	560	132
37	"	46 06.6	46 06.1	124 20.4	124 19.8	3432	3425	60	60	3	15	1514	384	1,536	137
38	"	46 02.3	46 02.9	124 13.9	124 14.2	3380	3388	52	52	3	15	1709	19	76	90
39	"	46 07.1	46 07.4	124 16.4	124 16.9	3438	3442	51	52	3	15	1810	165	660	106
40	10-14	46 03.2	46 02.8	124 18.9	124 18.8	3390	3385	61	61	3	15	1341	242	968	112
41	"	46 02.8	46 03.2	124 24.3	124 24.5	3382	3387	70	70	4	15	1450	76	296	104
42	"	46 02.7	46 02.1	124 27.1	124 26.9	3380	3372	73	73	4	15	1555	96	384	108
43	"	46 02.5	46 03.1	124 35.3	124 35.5	3373	3380	83	84	4	15	1728	20	80	-
44	10-15	45 58.9	45 59.7	124 13.3	124 14.2	3338	3348	57	57	3	24	0715	340	850	104
45	"	45 58.7	45 59.3	124 20.0	124 20.2	3335	3372	71	71	4	15	0855	52	208	136
46	"	45 59.3	45 59.7	124 24.9	124 25.1	3340	3345	75	76	4	15	0955	108	432	124
47	"	45 59.0	45 59.6	124 30.7	124 30.7	3333	3340	81	82	4	18	1104	43	143	116
48	"	45 55.6	45 56.1	124 31.2	124 31.3	3290	3295	83	83	4	10	1245	105	630	147
49	"	45 55.5	45 55.0	124 26.2	124 26.1	3292	3286	79	80	4	17	1350	200	706	123
50	"	45 55.4	45 55.9	124 17.4	124 19.2	3295	3300	73	73	4	17	1512	145	512	115
51	"	45 54.8	45 54.4	124 14.5	124 14.3	3288	3282	60	60	3	15	1623	330	1,320	105
52	"	45 53.5	45 52.7	124 11.3	124 11.0	3270	3262	49	50	2	15	1725	0	-	-
53	10-16	45 51.1	45 51.7	124 13.7	124 14.0	3242	3248	65	65	3	16	0727	420	1,575	115
54	"	45 49.4	45 50.2	124 19.1	124 19.4	3228	3219	77	77	4	15	0847	330	1,320	109
55	"	45 50.6	45 51.2	124 25.8	124 25.9	3232	3238	82	82	4	15	1020	225	900	126
56	"	45 51.3	45 51.0	124 29.8	124 28.7	3238	3235	83	83	4	11	1211	170	927	120
57	"	45 50.1	45 50.4	124 36.4	124 37.2	3219	3223	100	99	3	11	1344	0	-	-
58	"	45 47.0	45 47.4	124 31.0	124 31.0	3185	3190	95	95	4	10	1507	3	18	340
59	"	45 46.5	45 46.1	124 23.2	124 23.1	3182	3177	83	79	4	10	1635	150	900	122
60	"	45 47.0	45 47.3	124 19.9	124 19.4	3190	3193	76	76	4	10	1743	250	1,500	104

Appendix Table 2. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H3									
61	10-17	45 45.9	45 45.4	124 07.3	124 07.1	3180	3176	50	50	2	12	0722	0	-	-
62	"	45 46.2	45 46.7	124 13.8	124 13.3	3182	3186	69	70	3	14	0840	172	737	138
63	"	45 42.8	45 42.4	124 13.0	124 12.8	3140	3136	69	69	3	12	0947	67	335	-
64	"	45 42.4	45 42.3	124 20.1	124 18.5	3132	3131	71	76	4	11	1100	30	164	108
65	"	45 43.1	45 42.5	124 25.4	124 25.2	3138	3132	90	89	4	10	1232	0	-	-
66	"	45 43.3	45 42.9	124 36.5	124 35.4	3136	3132	112	115	4	10	1422	0	-	-
67	"	45 38.2	45 37.9	124 25.6	124 25.5	3079	3075	96	100	4	10	1604	228	1,368	115
68	"	45 39.1	45 39.0	124 20.7	124 21.7	3092	3090	83	81	1	10	1710	0	-	-
69	"	45 38.7	45 38.4	124 13.5	124 12.2	3090	3087	70	71	3	10	1828	105	630	120
70	10-18	45 37.9	45 37.4	124 09.7	124 09.0	3081	3076	51	51	2	11	0740	0	-	-
71	10-28	45 29.3	45 28.8	124 09.5	124 09.3	2975	2970	60	60	2	15	1421	80	320	94
72	"	45 29.5	45 29.0	124 14.4	124 14.3	2976	2970	82	82	4	15	1533	282	1,128	115
73	"	45 29.5	45 29.1	124 20.1	124 19.8	2974	2968	94	94	4	15	1648	330	1,320	107
74	"	45 28.5	45 28.4	124 23.6	124 23.2	2960	2958	110	-	3	11	1812	25	136	101
75	10-31	46 01.3	46 00.4	124 03.3	124 03.2	3370	3359	28	30	-	27	1222	0	-	-
76	"	45 53.6	45 52.4	124 05.4	124 03.9	3275	3260	40	38	-	24	1358	0	-	-
77	11-1	45 23.3	45 22.8	124 10.0	124 09.1	2900	2895	64	62	2	18	0633	T	-	-
78	"	45 26.3	45 26.9	124 09.3	124 09.5	2938	2945	63	63	2	15	0745	T	-	-
79	"	45 26.7	45 26.2	124 15.3	124 15.1	2940	2935	84	85	4	14	0859	40	171	105
80	"	45 26.4	45 26.8	124 20.9	124 20.5	2935	2940	95	96	3	14	1008	T	-	873
81	"	45 23.3	45 22.4	124 14.2	124 14.7	2898	2887	85	85	4	15	1145	10	40	-
82	"	45 18.4	45 18.1	124 19.7	124 20.8	2836	2830	124	122	4	15	1320	8	32	-
83	"	45 18.6	45 19.4	124 14.9	124 14.3	2840	2850	87	87	3	15	1435	45	180	89
84	11-4	44 43.6	44 43.9	124 19.5	124 20.0	2406	2410	55	58	2	11	0905	0	-	-
85	"	44 42.5	44 41.8	124 24.5	124 25.4	2391	2382	59	58	3	17	0955	20	71	621
86	"	44 46.3	44 47.2	124 25.1	124 25.3	2347	2448	72	74	3	16	1125	10	38	104
87	"	44 50.0	44 49.3	124 19.4	124 19.2	2485	2477	70	69	2	11	1306	T	-	-
88	"	44 49.9	44 50.9	124 13.9	124 14.2	2487	2499	70	-	2	19	1411	0	-	-
89	11-8	44 39.2	44 39.1	124 23.5	124 22.9	2350	2349	48	49	1 HU	7	0946	0	-	-
90	"	44 39.1	44 39.8	124 29.5	124 29.7	2347	2357	64	67	3	15	1059	0	-	-

Appendix Table 2. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H3									
91	11-8	44 42.6	44 43.4	124 29.9	124 29.2	2390	2399	72	71	1 TN[2]	15	1212	0	-	-
92	"	44 47.7	44 47.9	124 29.2	124 29.9	2453	2455	86	92	3	10	1351	160	960	113
93	"	44 50.3	44 51.1	124 29.2	124 28.7	2485	2495	97	98	3	10	1509	280	1,680	105
94	"	44 50.2	44 50.8	124 24.6	124 25.1	2486	2492	81	85	3	15	1624	180	720	114
95	11-9	44 53.1	44 53.6	124 18.5	124 19.7	2523	2530	74	77	3	10	0746	60	360	99
96	"	44 53.1	44 53.6	124 23.8	124 24.0	2522	2528	84	89	3	10	0856	78	468	100

1/ Bottom type: 1 = rock; 2 = sand; 3 = muddy sand; and 4 = mud.

2/ HU = hung up and TN = tore net.

3/ T = trace, less than 1 pound of shrimp taken.

Appendix Table 3. Tow log, MV *Sunrise*, cruise 67-2, February-May 1967

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
1	2-20	43 22.2	42 22.9	124 28.9	124 28.8	1398	1405	56	58	2	15	1145	129	516	293
2	"	43 22.2	42 21.0	124 33.4	124 33.7	1395	1380	66	65	3	15	1255	6	24	287
3	"	43 21.8	43 22.6	124 39.2	124 38.7	1390	1400	103	102	4	18	1417	26	87	116
4	2-21	43 25.4	43 24.6	124 24.9	124 25.3	1440	1430	51	50	2	15	0850	35	140	257
5	"	43 24.8	43 25.8	124 28.6	124 28.6	1430	1442	60	61	2	15	1020	85	340	282
6	"	43 25.9	43 26.6	124 33.7	124 34.0	1440	1450	75	80	3	15	1130	225	1,020	267
7	"	43 28.7	43 29.8	124 33.9	124 33.9	1475	1490	87	96	3	15	1315	5	18	-
8	"	43 29.6	43 30.1	124 28.3	124 28.3	1490	1495	65	71	3	15	1450	85	340	188
9	"	43 32.7	43 33.6	124 29.4	124 28.9	1527	1538	74	74	3	20	1600	126	378	193
10	"	43 32.8	43 33.3	124 33.8	124 33.8	1526	1532	110	114	4	16	1720	T[2]	-	-
11	2-22	43 28.2	43 33.6	124 28.0	124 27.3	1472	1482	60	60	3	17	0835	120	423	257
12	"	43 33.0	43 33.6	124 23.7	124 23.5	1535	1543	62	62	3	18	1025	112	373	241
13	"	43 32.4	43 31.9	124 20.1	124 21.6	1530	1522	54	57	3	10	1140	833	4,998	222
14	"	43 36.0	43 35.5	124 20.0	124 20.3	1575	1568	56	58	3	10	1320	32	216	211
15	"	43 40.7	43 41.3	124 17.3	124 17.8	1635	1641	53	55	4	12	1440	135	675	265
16	"	43 36.4	43 35.6	124 24.6	124 25.1	1575	1565	66	66	3	12	1605	22	110	-
17	"	43 35.5	43 35.8	124 27.5	124 28.2	1562	1565	72	77	3	15	1655	72	288	204
18	2-26	43 18.1	43 18.6	124 35.5	124 35.5	1345	1350	65	66	1 TN[3]	10	0825	4	25	-
19	"	43 17.2	43 16.8	124 41.2	124 41.5	1335	1330	102	105	4	11	1000	2	11	-
20	"	43 14.8	43 14.4	124 40.7	124 40.8	1305	1300	97	98	4	10	1108	16	96	152
21	"	43 10.6	43 10.1	124 41.0	124 41.3	1255	1249	84	92	3	15	1233	T	-	-
22	3-7	43 08.3	43 08.6	124 39.8	124 40.3	1225	1229	86	89	4	6	0850	125	1,260	238
23	"	43 08.1	43 09.1	124 45.1	124 44.7	1230	1240	132	132	3	15	0956	0	-	-
24	"	43 04.8	43 04.4	124 39.3	124 39.6	1182	1178	82	82	4	15	1225	1,100	8,400	219
25	"	43 04.2	43 04.6	124 34.3	124 34.0	1172	1178	56	54	3	10	1448	20	120	-
26	3-8	43 04.6	43 05.1	124 43.4	124 42.8	1185	1190	102	103	3	10	1453	1	6	-
27	3-9	43 00.7	43 01.9	124 34.6	124 34.3	1130	1138	50	51	3	10	0640	73	438	233
28	3-21	43 01.0	43 00.7	124 38.2	124 38.9	1135	1132	68	69	3	15	0950	48	192	122
29	"	43 01.3	43 01.7	124 42.0	124 41.9	1145	1159	83	82	4	15	1055	4	16	-
30	"	42 58.0	42 58.4	124 44.6	124 44.7	1115	1118	80	80	4	10	1245	0	-	-
31	"	42 57.6	42 51.9	124 42.1	124 42.2	1103	1106	73	74	4	10	1349	54	324	90

Appendix Table 3. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]		Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4										
32	3-26	42 56.7	42 56.2	124 40.0	124 40.3	1088	1083	59	59	3		15	1115	90	360	137
33	"	42 53.7	42 53.3	124 43.8	124 44.0	1070	1067	79	-	3		10	1250	0	-	-
34	"	42 54.6	42 54.2	124 47.1	124 47.8	1090	1090	110	106	2		10	1413	0	-	-
						2H3										
35	"	42 42.6	42 42.8	124 37.3	124 36.4	1090	1088	51	55	4		15	1705	0	-	-
36	3-27	42 42.4	42 42.8	124 38.6	124 38.6	1095	1091	67	69	4		16	0622	T	-	-
37	"	42 42.1	42 41.6	124 39.7	124 39.7	1100	1105	79	79	4		13	0727	T	-	-
38	"	42 39.4	42 39.0	124 40.3	124 39.9	1132	1136	89	86	3		10	0821	0	-	-
39	"	42 38.6	42 39.4	124 37.3	124 37.6	1140	1130	60	72	4		15	0917	0	-	-
40	"	42 39.5	42 39.1	124 34.8	124 34.4	1130	1135	51	51	1		15	1015	0	-	-
41	"	42 34.9	42 35.6	124 35.4	124 35.3	1185	1178	52	52	4		15	1115	2	8	-
42	"	42 35.3	42 35.8	124 38.1	124 38.0	1180	1175	60	62	4		13	1205	165	761	121
43	"	42 35.2	42 34.7	124 40.4	124 40.5	1182	1187	73	73	4		15	1255	T	-	-
44	"	42 33.3	42 33.7	124 36.0	124 36.0	1205	1200	52	53	4		15	1355	87	348	-
45	4-2	42 40.4	42 40.1	124 42.9	124 42.9	1125	1125	120	135	3		6	1235	0	-	-
46	4-3	42 21.7	42 21.7	124 40.4	124 40.4	1345	1351	93	97	4		15	0723	T	-	-
47	"	42 21.6	42 21.2	124 34.6	124 34.5	1349	1355	62	63	4	TN[3]	10	0843	T	-	-
48	"	42 17.5	42 17.0	124 34.4	124 34.4	1400	1405	79	85	3		11	0950	T	-	-
49	"	42 18.7	42 18.3	124 29.4	124 29.1	1390	1395	50	56	4		15	1105	T	-	-
50	"	42 14.6	42 14.1	124 29.0	124 29.1	1440	1445	59	60	4		10	1212	25	150	197
51	"	42 14.3	42 14.8	124 34.8	124 35.0	1438	1433	90	98	4		15	1316	0	-	-
52	"	42 10.8	42 10.4	124 36.2	124 36.2	1480	1485	130	138	4		10	1452	0	-	-
53	"	42 11.4	42 12.1	124 30.8	124 30.5	1478	1470	70	70	4		16	1656	0	-	-
54	"	42 08.4	42 07.9	124 26.4	124 26.3	1520	1524	48	47	4		12	1710	0	-	-
55	4-4	42 01.3	42 01.8	124 26.0	124 26.5	1608	1601	50	52	4		12	0718	380	1,900	227
56	"	42 01.3	42 02.2	124 30.2	124 29.6	1602	1592	62	60	4		10	0830	920	5,520	197
57	"	42 01.2	42 01.2	124 33.0	124 33.0	1600	1600	75	75	4	HU[3]	1	0935	0	-	-
58	"	42 02.7	42 03.2	124 34.0	124 33.9	1580	1576	84	81	4		10	1021	0	-	-
59	"	42 04.5	42 05.0	124 30.2	124 30.2	1562	1557	64	64	4		10	1110	T	-	-
60	"	42 04.9	42 05.0	124 26.3	124 26.0	1570	1562	51	49	4		10	1202	0	-	-
61	"	42 06.6	42 05.9	124 29.0	124 29.5	1538	1545	62	64	4		10	1325	T	-	-

Appendix Table 3. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
62	4-6	43 36.7	43 37.3	124 33.4	124 33.2	1575	1582	110	108	4	14	0808	0	-	-
63	"	43 43.4	43 43.6	124 32.5	124 32.9	1658	1660	120	126	4	10	0930	0	-	-
64	"	43 43.8	43 44.4	124 28.7	124 29.1	1665	1672	68	71	3	15	1044	18	72	250
65	"	43 43.0	43 42.7	124 23.8	124 23.6	1658	1655	58	60	3	15	1153	T	-	-
66	"	43 42.5	43 42.9	124 18.1	124 19.4	1657	1660	55	57	4	15	1325	T	-	-
67	"	43 47.0	43 46.5	124 18.2	124 18.3	1712	1705	55	54	4	15	1515	T	-	-
68	"	43 46.4	43 47.0	124 23.6	124 23.7	1700	1707	62	59	3	15	1625	0	-	-
69	"	43 47.4	43 47.8	124 27.2	124 27.4	1710	1714	67	67	3	15	1714	T	-	-
70	"	42 47.2	43 47.6	124 33.5	124 33.6	1705	1710	108	112	4	15	1820	T	-	-
71	4-7	43 49.8	43 50.4	124 33.8	124 33.9	1738	1745	105	106	4	15	0542	65	260	173
72	"	43 50.2	43 50.7	124 28.3	124 28.5	1745	1750	71	72	3	15	0700	0	-	-
73	"	43 50.8	43 50.4	124 19.5	124 19.7	1759	1765	57	57	4	10	0830	T	-	-
74	"	43 53.4	43 53.7	124 24.0	124 24.2	1786	1790	57	-	1	10	0933	0	-	-
75	"	43 53.1	43 52.9	124 30.1	124 30.6	1780	1778	65	68	4	10	1028	0	-	-
76	"	43 53.2	43 53.4	124 34.1	124 34.4	1779	1781	101	106	4	11	1141	295	1,609	310
77	"	43 56.2	43 55.7	124 37.2	124 37.1	1815	1810	98	98	4	13	1355	40	185	242
78	"	43 56.8	43 57.3	124 34.8	124 35.2	1825	1830	88	87	4	10	1520	50	300	-
79	4-8	43 56.4	43 56.8	124 29.5	124 29.6	1820	1825	73	74	3	10	1432	0	-	-
80	"	44 00.4	44 01.0	124 34.8	124 34.8	1868	1875	70	71	4	10	1551	83	498	191
81	"	44 38.8	44 38.0	124 33.3	124 33.1	2343	2332	84	85	2	12	0857	68	340	117
82	"	44 35.4	44 35.0	124 33.0	124 32.1	2301	2297	80	75	2	10	0955	T	-	-
83	"	44 32.1	44 31.4	124 34.3	124 34.6	2260	2251	75	75	2	16	1055	0	-	-
84	"	44 27.8	44 28.2	124 43.6	124 44.7	2205	2208	95	100	3	10	1307	T	-	-
85	"	44 24.2	44 23.8	124 44.1	124 43.4	2160	2158	82	84	4	12	1430	T	-	-
86	"	44 21.1	44 20.6	124 48.3	124 48.2	2122	2116	110	102	3	10	1542	0	-	-
87	"	44 21.6	44 21.9	124 44.5	124 45.1	2129	2130	67	69	3	10	1647	0	-	-
88	"	44 21.7	44 22.1	124 41.0	124 41.0	2130	-	55	56	-	8	1750	0	-	-
89	4-19	44 27.5	44 28.1	124 34.1	124 34.2	2222	2230	74	76	- HU	14	0834	0	-	-
90	"	44 42.5	44 42.9	124 25.0	124 25.2	2390	2395	61	65	3	15	1222	T	-	-
91	4-21	44 42.1	44 42.4	124 18.5	124 18.6	2388	2390	51	52	2	15	0725	0	-	-
92	"	44 46.1	44 47.0	124 22.2	124 21.7	2440	2448	65	65	3	15	0852	0	-	-

Appendix Table 3. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
93	4-21	44 47.3	44 47.7	124 24.3	124 24.0	2450	2455	70	70	3	15	0939	380	1,520	136
94	"	44 46.4	44 47.4	124 29.8	124 30.0	2438	2450	86	88	3	18	1050	T	-	-
95	"	44 46.8	44 47.5	124 33.7	124 33.9	2440	2448	123	125	4	16	1237	28	105	-
96	"	44 49.9	44 49.6	124 31.6	124 31.0	2479	2476	115	110	3	15	1415	20	80	122
97	"	44 49.4	44 48.9	124 28.0	124 27.9	2474	2468	96	94	3	20	1545	25	75	139
98	"	44 49.7	44 49.2	124 23.0	124 22.9	2480	2472	79	79	3	15	1735	232	928	191
99	4-22	44 49.4	44 48.7	124 18.7	124 18.7	2478	2470	69	69	2	16	0557	600	2,250	154
100	"	44 49.4	44 48.6	124 13.6	124 13.8	2480	2470	55	55	2	19	0755	0	-	-
101	"	44 53.2	44 53.7	124 14.7	124 14.8	2527	2534	62	66	2	15	0917	84	336	193
102	"	44 53.6	44 54.3	124 19.6	124 19.7	2530	2538	76	76	3	15	1020	11	44	-
103	"	44 53.6	44 52.9	124 23.8	124 23.7	2527	2519	86	85	3	16	1205	0	-	-
104	"	44 52.7	44 53.3	124 29.4	124 29.5	2515	2521	110	117	3	17	1320	25	88	88
105	"	44 56.3	44 55.7	124 23.3	124 23.2	2562	2555	96	91	3	15	1448	25	100	92
106	"	44 56.9	44 56.2	124 19.6	124 19.5	2570	2562	86	86	3	15	1548	42	168	88
107	"	44 58.1	44 58.6	124 14.8	124 14.9	2586	2592	69	70	2	15	1705	0	-	-
108	"	45 00.4	44 59.7	124 09.2	124 09.1	2618	2610	51	50	2	16	1816	0	-	-
109	4-23	44 59.9	45 00.8	124 14.1	124 14.3	2610	2620	74	75	3	16	0545	189	709	149
110	"	45 02.2	45 02.7	124 20.0	124 20.2	2637	2642	102	107	3	17	0700	45	159	85
111	"	45 03.6	45 03.1	124 13.6	124 13.5	2655	2650	81	81	3	18	0830	405	1,350	136
112	"	45 03.9	45 04.6	124 08.8	124 09.1	2662	2668	58	58	2	16	0940	0	-	-
113	"	45 07.1	45 07.8	124 09.2	124 09.4	2700	2709	61	61	2	20	1040	0	-	-
114	"	45 06.5	45 07.4	124 15.2	124 15.5	2690	2701	86	90	3	20	1227	455	1,365	90
115	"	45 07.4	45 08.3	124 18.5	124 18.7	2700	2712	107	104	3	18	1344	2	7	-
116	"	45 10.8	45 11.4	124 19.4	124 19.5	2742	2750	103	104	4	17	1505	T	-	-
117	"	45 11.2	45 11.7	124 14.5	124 13.8	2750	2755	88	88	3	15	1615	112	448	85
118	"	45 10.3	45 11.1	124 10.2	124 10.5	2740	2750	60	60	3	16	1755	0	-	-
119	4-24	45 18.6	45 19.0	124 08.4	124 08.6	2842	2847	58	60	2	17	0540	0	-	-
120	"	45 15.7	45 15.0	124 08.8	124 08.5	2806	2798	58	58	2	15	0650	0	-	-
121	"	45 15.5	45 15.9	124 15.0	124 15.1	2802	2806	89	89	3	17	0812	55	194	90
122	"	45 18.4	45 18.8	124 14.1	124 14.2	2838	2842	90	91	4	15	0920	45	180	95
123	"	45 19.5	45 19.9	124 19.6	124 20.1	2850	2854	120	115	3	18	1042	0	-	-

Appendix Table 3. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
124	4-24	45 22.7	45 23.1	124 19.4	124 19.4	2890	2895	98	97	3	16	1252	0	-	-
125	"	45 26.2	45 26.6	124 20.3	124 20.3	2933	2938	94	94	3	15	1359	0	-	-
126	"	45 26.7	45 26.1	124 15.3	124 15.1	2940	2933	85	85	4	16	1518	445	1,669	109
127	"	45 22.6	45 22.0	124 14.0	124 13.9	2890	2882	85	85	4	16	1644	75	281	120
128	"	45 22.4	45 22.1	124 07.9	124 07.8	2890	2886	62	62	2	12	1800	0	-	-
129	4-25	45 26.9	45 27.3	124 09.0	124 09.2	2945	2950	60	60	2	10	0610	0	-	-
130	"	45 28.9	45 28.5	124 09.3	124 09.1	2970	2965	60	60	2	12	0706	0	-	-
131	"	45 29.8	45 29.3	124 16.2	124 15.5	2978	2972	85	85	4	17	0833	580	2,047	125
132	"	45 29.5	45 29.1	124 21.4	124 21.3	2973	2968	95	96	3	16	1009	0	-	-
133	4-30	46 07.2	46 06.7	124 14.3	124 14.1	3440	3435	49	50	3	16	0743	45	169	175
134	"	46 03.1	46 02.7	124 13.7	124 13.6	3390	3385	52	52	2	16	0849	0	-	-
135	"	45 58.9	45 58.4	124 14.5	124 14.4	3338	3332	57	59	3	17	1012	25	88	200
136	"	45 54.8	45 54.3	124 13.5	124 13.4	3288	3282	62	62	3	16	1120	58	218	177
137	"	45 50.5	45 50.1	124 13.8	124 13.7	3235	3230	65	66	3	15	1325	0	-	-
138	"	45 47.4	45 46.9	124 09.3	124 09.1	3188	3182	51	52	2	15	1452	0	-	-
139	"	45 46.6	45 47.0	124 13.9	124 14.0	3187	3192	69	69	3	17	1606	675	2,382	185
140	"	45 42.9	45 42.4	124 13.9	124 13.6	3141	3136	69	69	3	16	1719	0	-	-
141	"	45 38.0	45 37.7	124 07.3	124 07.2	3082	3079	51	50	2	10	1842	0	-	-
142	5-1	45 38.5	45 38.8	124 15.6	124 15.6	3086	3090	74	73	4	11	0600	0	-	-
143	"	45 38.3	45 37.8	124 20.0	124 19.8	3082	3076	86	88	4	15	0719	125	500	108
144	"	45 37.9	45 37.5	124 25.5	124 25.5	3075	3070	100	106	4	11	0840	75	409	104
145	"	45 38.0	45 37.5	124 29.0	124 28.8	3075	3068	114	115	3	17	0943	2	7	-
146	"	45 43.5	45 42.8	124 36.0	124 36.0	3138	3130	120	123	3	17	1137	0	-	-
147	"	45 43.5	45 42.9	124 29.4	124 29.4	3142	3135	106	110	4	15	1330	215	860	96
148	"	45 43.2	45 42.8	124 25.4	124 25.3	3140	3136	92	95	4	16	1447	390	1,463	140
149	"	45 43.3	45 43.3	124 20.7	124 20.7	3143	3143	65	75	- HU	0	1604	0	-	-
150	"	45 46.8	45 46.1	124 18.9	124 18.7	3188	3180	81	82	4	16	1719	10	38	-
151	"	45 46.0	45 45.6	124 25.1	124 25.0	3175	3170	86	87	4	12	1835	0	-	-
152	5-2	45 47.4	45 47.1	124 31.1	124 31.0	3190	3186	97	99	4	12	0528	500	2,500	111
153	"	45 51.0	45 50.5	124 36.5	124 36.5	3230	3225	101	103	3	15	0710	0	-	-
154	"	45 50.8	45 51.3	124 29.6	124 29.8	3233	3238	91	91	4	16	0844	1,000	3,750	187

Appendix Table 3. (Continued)

Tow no.	Date (1966)	Latitude Start	Latitude End	Longitude Start	Longitude End	Loran Start	Loran End	Depth (fms) Start	Depth (fms) End	Bottom type[1]	Time net on bottom (min.)	Time gear set	Shrimp catch (lbs.)	Catch per hour	Shrimp per pound
						2H4									
155	5-2	45 51.1	45 50.3	124 25.0	124 24.8	3238	3229	86	86	4	17	1000	102	360	138
156	"	45 50.9	45 50.5	124 20.1	124 20.0	3238	3233	83	83	4	14	1120	145	621	133
157	"	45 54.5	45 54.0	124 18.7	124 18.5	3282	3277	78	80	4	15	1305	220	880	139
158	"	45 58.8	45 59.3	124 20.0	124 20.1	3336	3340	74	74	4	13	1429	132	609	166
159	"	46 03.3	46 03.8	124 19.8	124 20.0	3390	3398	64	66	3	16	1539	80	300	170
160	"	46 06.8	46 07.2	124 19.2	124 19.4	3435	3438	64	63	3	10	1645	305	1,830	186
161	"	46 14.1	46 13.8	124 17.6	124 17.3	3525	3522	55	55	3	16	1006	56	210	121
162	"	46 10.5	46 10.1	124 18.8	124 18.7	3480	3475	60	60	3	15	1113	120	480	128
163	"	46 10.5	46 10.1	124 25.3	124 25.2	3478	3472	71	72	3	15	1259	70	280	199
164	"	46 06.7	46 06.3	124 25.5	124 25.4	3430	3425	68	68	3	15	1402	540	2,160	170
165	"	46 02.0	46 01.6	124 24.1	124 24.0	3373	3368	72	73	4	16	1513	320	1,200	177
166	"	45 58.5	45 59.0	124 23.2	124 23.4	3330	3336	78	79	4	15	1623	105	420	167
167	"	45 54.5	45 54.2	124 25.0	124 24.5	3280	3277	80	81	4	16	1732	140	525	136
168	"	45 54.9	45 55.2	124 29.9	124 30.0	3282	3286	86	88	4	14	1850	110	471	117
169	5-4	45 59.4	46 00.0	124 30.9	124 31.0	3338	3344	89	90	4	20	0517	660	1,980	181
170	"	46 03.4	46 02.9	124 30.6	124 30.5	3386	3381	83	85	4	15	0701	14	56	-
171	"	46 02.8	46 02.4	124 36.6	124 36.2	3375	3370	95	96	4	16	0813	30	113	170
172	"	46 07.0	46 07.6	124 30.0	124 30.1	3432	3438	80	80	3	15	0951	35	140	193
173	"	46 11.5	46 11.0	124 30.9	124 30.8	3485	3480	78	78	3	15	1107	195	780	213

1/ Bottom type: 1 = rock; 2 = sand; 3 = muddy sand; and 4 = mud.

2/ T = trace, less than 1 pound of shrimp taken.

3/ HU = hung up; TN = tore net.