



STOCK ASSESSMENT TRAWL SURVEYS FOR PANDALID SHRIMPS IN THE  
KODIAK ISLAND AND CHIGNIK DISTRICTS OF ALASKA, 1985

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## ADF&G TECHNICAL DATA REPORTS

This series of reports is designed to facilitate prompt reporting of data from studies conducted by the Alaska Department of Fish and Game, especially studies which may be of direct and immediate interest to scientists of other agencies.

The primary purpose of these reports is presentation of data. Description of programs and data collection methods is included only to the extent required for interpretation of the data. Analysis is generally limited to that necessary for clarification of data collection methods and interpretation of the basic data. No attempt is made in these reports to present analysis of the data relative to its ultimate or intended use.

Data presented in these reports is intended to be final, however, some revisions may occasionally be necessary. Minor revision will be made via errata sheets. Major revisions will be made in the form of revised reports.

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## ABSTRACT

Four trawl surveys (two spring, two fall) to assess shrimp abundance were conducted among select bays in Kodiak and Chignik Districts of Alaska in 1985. Pink shrimp (*Pandalus borealis*) were the target species for the stratified-systematic surveys. Ancillary information on the biomass of fish and other decapods was obtained along with data on water temperatures. Detailed descriptions of the trawling gear, on-board procedures, and sampling and survey designs are given. Biomass indices for all major taxa caught in the trawls (with variances for shrimp) and abundance indices for pink shrimp by age and sex are given for each surveyed area.

KEY WORDS: pink shrimp, *Pandalus borealis*, trawl surveys, sampling and survey designs, abundance indices, Kodiak, Chignik.

## INTRODUCTION

Data obtained through annual trawl surveys is used to assess the abundance of pandalid shrimps for fisheries management in the Westward Region. This report contains the results from four surveys conducted in the Kodiak Island and Chignik Districts during 1985. For each fishing area these surveys provide a series of stock abundance indices and size composition data which is used to monitor recruitment, growth, and the effects of fishing on pandalid shrimp stocks. Information on both abundance and size are used to open and close fishing sections according to criteria in the management plan reported in Jackson et al. 1983 and adopted by the Alaska Board of Fisheries (ADF&G 1984).

## DESCRIPTION OF SURVEYED SECTIONS

The shrimp fishery in the Westward Region includes all Pacific Ocean waters south of Cape Douglas, west of Cape Fairfield, east of 172° E. seaward to the 300 fathom contour, and all Bering Sea waters east of 172° E. The area is referred to as Statistical Area J by the Board of Fisheries (ADF&G 1984) and is divided into five fishing districts: Kodiak, Chignik, South Peninsula, North Peninsula, and Aleutian. All districts except the North Peninsula contain several fishing sections within which the majority of commercial trawling occurs. All references to shrimp districts and sections throughout this report are in accordance with the geographical units shown in Figure 1.

## HISTORY OF SURVEY PROGRAM

Shrimp stock assessment surveys have been conducted in the Westward Region since April 1971 (Gaffney 1977; Jackson 1973, 1974, 1975, 1980, 1981). The first two years of surveys concentrated on obtaining information on the inshore life history and stock distribution of pandalid shrimp on the east side of Kodiak Island. Since 1973, the surveys have been used to obtain abundance indices of major pandalid shrimp stocks in the Westward Region. The National Marine Fisheries Service (NMFS) and the Alaska Department of Fish and Game (ADF&G) shared survey efforts during the 1970's through an informal cooperative agreement; ADF&G focused survey effort on the Kodiak District while NMFS concentrated on Chignik, South Peninsula, and Aleutian Districts. The two agencies divided surveying of the Chignik District from 1974 to 1978 with ADF&G surveying in the spring and NMFS in the fall. Since 1979, ADF&G has assumed responsibility for surveying all shrimp fishing sections in the Westward Region with the exception of Pavlof Bay, which NMFS continues to survey each fall.

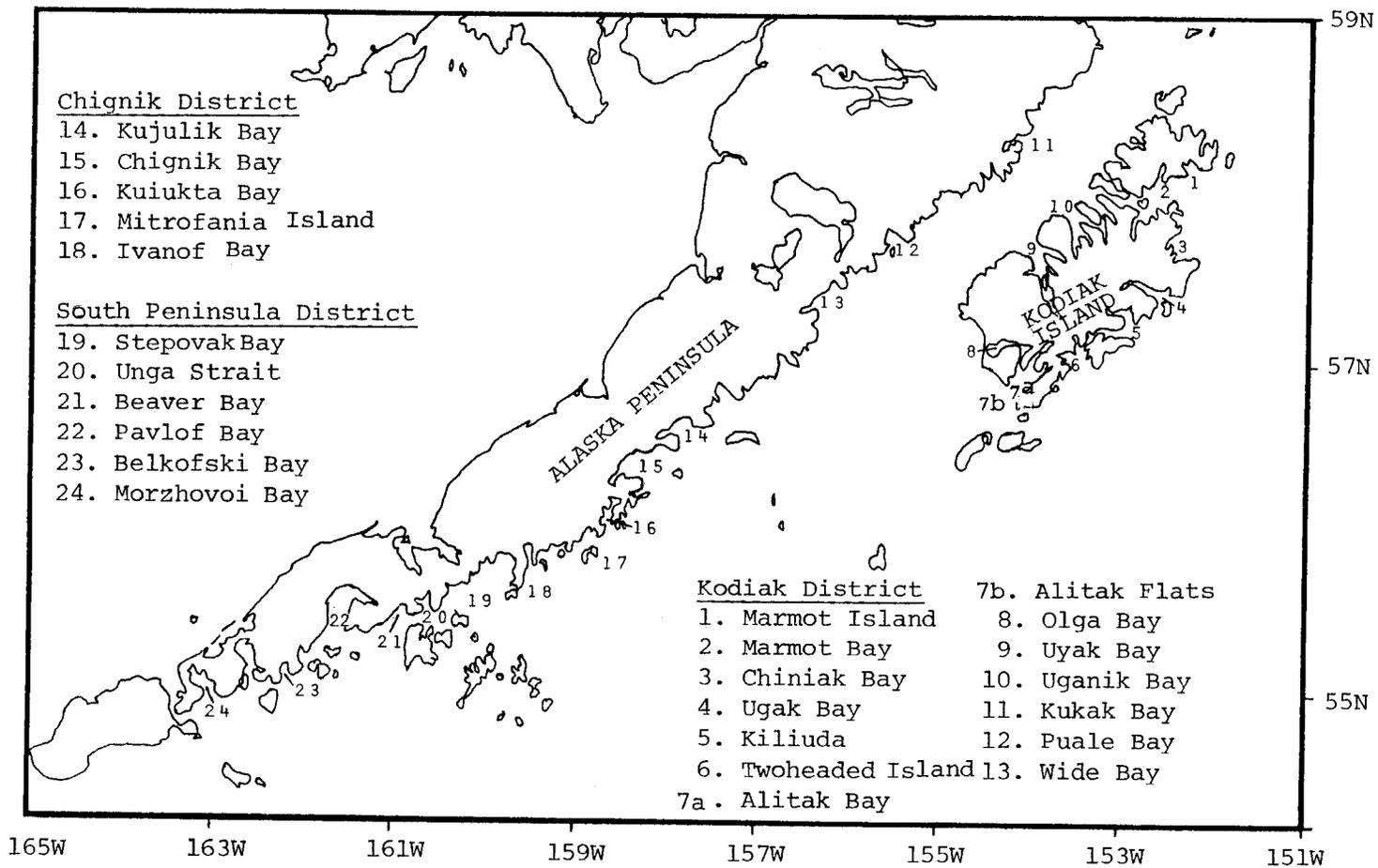


Figure 1. Shrimp fishing districts and sections of the Westward region (Statistical Area J) shrimp fishery.

## METHODS

### Trawling Procedure

For each tow, the net (see Appendix A for gear description) was kept on the bottom for about 30 minutes and was towed at a speed of 2 knots along a straight path into the tide and parallel to (but not on) a bottom edge. Warp lengths were set at a 3:1 ratio with depth. Tows were made during full daylight hours during periods of normal tides and weather when pink shrimp (*Pandalus borealis*), the target species, are expected near the bottom (Parsons and Sandeman 1981; Frechette et al. 1981). In the event a tow was unsuccessful (i.e., net snagged the bottom, twisted, or was improperly set), the net was retrieved and mended, chains were adjusted to standard lengths, and the set was repeated or dropped from the schedule. For each successful tow, the codend was brought aboard and weighed with a 10,000 pound capacity load cell before and after release of the catch into deck bins.

### Survey Design

Four surveys were conducted in 1985, two in the spring and two in the fall. A stratified-systematic survey design with random selection of towing stations was used in each area surveyed (see Cochran 1977). The primary objective of these surveys was to index the biomass of pink shrimp in each survey area. Each surveyed area was divided into strata based on information on distribution of biomass from previous surveys, past commercial catches, and size of the surveyed area (the surveys in small bays and inlets were not stratified). Within each stratum, one tow was made for every two to four square nautical miles. Previous surveys have shown that this density of tows would generally produce biomass indices of pink shrimp that were within  $\pm 25\%$  of the true values 80% of the time (Jackson et al. 1983). Tow stations were selected from grids drawn over nautical charts within each stratum.

Biomass indices were calculated as scaled estimates of pounds per stratum through an area-swept calculation. The weight of each taxon in all tows was adjusted for deviations from standard procedures:

$$1) \quad W(ijkx) = 30 \frac{S(ijx)W'(ijkx)}{(2) T(ijx)}$$

where  $W'(ijkx)$  is the unadjusted catch weight of taxon  $k$  caught in stratum  $j$  in area  $i$  during tow  $x$ , and  $W(ijkx)$  is the same weight after adjustment (units are pounds per nautical mile towed); 30 is the number of minutes in a standard tow, while  $T$  is the number of minutes in tow  $ijx$ ; 2 is the standard speed during towing (in knots), while  $S$  is the actual, average surface speed (knots) of the vessel during the  $ijx$  tow. The biomass index for each stratum is a scaled estimate of the biomass swept up by the trawl and expanded by the area of the stratum:

$$2) \quad \bar{I}(ijk) = \bar{W}(ijk.)A(ij) \left[ \frac{6076}{32} 10^{-7} \right]$$

where  $\bar{W}(ijk.)$  is the adjusted catch weights averaged over the replicate tows in area  $i$  stratum  $j$  for taxon  $k$ ;  $I$  is the index for area  $i$ , stratum  $j$ , and taxon  $k$ ; 6076 is the number of feet in a nautical mile; and 32 is the estimated number of feet swept by the net during an instant of time. The biomass index for each area  $i$  is a scaled estimate of the biomass swept and expanded by the total area:

$$3a) \quad I(ik) = \left[ \frac{6076}{32} 10^{-7} \right] \sum_j \bar{W}(ijk.)A(ij)$$

where  $I(ik)$  is the index for species  $k$  in area  $i$ . The mean catch weight in pounds trawled per nautical mile is the sum of the means for each stratum weighted by its area:

$$3b) \quad \bar{W}(ik) = \frac{\sum_j \bar{W}(ijk.)A(ij)}{A(i)}$$

where  $A(i)$  is the square nautical miles in area  $i$ . The variances of  $I(ijk)$ ,  $W(ik)$ , and  $I(ik)$  are calculated according to equations:

$$4) \quad V[I(ijk)] = \left[ \frac{6076}{32} 10^{-7} \right]^2 V[\bar{W}(ijk.)]A(ij)^2$$

$$5a) \quad V[\bar{W}(ik)] = \frac{\sum_j V[\bar{W}(ijk.)]A(ij)^2}{A(i)^2}$$

$$5b) \quad V[I(ik)] = \left[ \frac{6076}{32} 10^{-7} \right]^2 \sum_j V[\bar{W}(ijk.)]A(ij)^2$$

Indices were calculated for pink shrimp, humpy shrimp (*P. goniurus*), coonstripe shrimp (*P. hypsinotus*), sidestripe shrimp (*Pandalopsis dispar*), and several taxa of fish incidentally caught in the trawls. Calculations based on Equations 1-5 were made with a series of FORTRAN programs in the Library DGGAFFNEY on the Honeywell Computer at the University of Alaska Computer Network.

## Sampling Design

Each trawl catch was processed using the basic shipboard procedures described in Hughes (1976). First, all halibut (*Hippoglossus stenolepis*), skate (*Raja* sp.), red king crab (*Paralithodes camtschatica*), and Tanner crab (*Chionoecetes bairdi*), rockfish (*Sebastes* sp.), and blackcod (*Anoplopoma fimbria*) were counted and weighed by taxon. Next, a 50-100 pound sample of shrimp and fish were taken randomly from the remaining catch. All animals in the sample except shrimp were counted and weighed by taxon. The weight of a taxon in the tow was estimated as:

$$W'(ijkx) = \frac{(\text{Weight of taxon in the sample})(\text{Weight of tow})}{\text{Weight of sample}}$$

where  $W'(ijk)$  is the unadjusted catch weight described in Equation 1. Then, the first of several, systematically drawn five-pound subsamples of shrimp was sorted and weighed by species. On board, the carapace was measured on 200-300 shrimp of each species that comprised at least 30% by weight of the subsample. Each carapace was measured to the nearest .5 mm from the posterior margin of the eye socket to the posterior mid-point of the carapace. Additional systematically drawn five-pound subsamples, one for each 500 pounds of shrimp in the tow, were mixed with similar subsamples drawn from other replicate tows in the stratum to form a total subsample (hereafter called a composite subsample) from the entire stratum. When five-pound subsamples were not available due to insufficient shrimp catch, all remaining shrimp were put in the composite subsample.

After each tow was made in a stratum, five to ten pounds of shrimp were systematically selected from the composite subsamples and were preserved in isopropyl alcohol. After the survey, the preserved shrimp were counted, weighed, and measured (carapace length as on the vessel) by species and by sex. Sex was determined using the progression outlined in Allen (1959).

## Sex and Age Composition

Sex composition of each stratum was estimated with one or two procedures. If length-frequency information was available for each tow made in a stratum, the sex composition of each length category of the composite subsample was used to estimate abundance by sex (the combination method):

$$6) \quad N(ijkl_s) = \frac{m(ijkl_s)}{m(ijkl)_d} \sum_x \left[ \frac{W(ijkx)}{w(ijkx)} n(ijkl_x) \right]$$

where  $N(ijkl_s)$  is the estimated number of individuals in the taxon per nautical mile towed with length  $l$  and sex  $s$  in the stratum,  $m(ijkl_s)$  is the number with length  $l$  and sex  $s$  in the composite subsample from the stratum,  $m(ijkl)$  is the number with length  $l$  in the composite subsample,  $w(ijkx)$  is the weight of the taxon in the composite subsample from tow  $x$ ,  $W(ijkx)$  is the weight of the taxon in tow  $x$ ,  $n(ijkl_x)$  is the number of individuals in the

taxon of length  $l$  in tow  $x$  of those shrimp measured onboard, and  $d$  is the sum of the nautical miles towed in the stratum.

When tow-by-tow information was not available to use in the combination method (usually because of too few shrimp per tow to meet the sampling goal for onboard measurement of length-frequency), the length frequency of the composite subsample was used (the simple method):

$$7) \quad N(ijkl_s) = \frac{m(ijkl_s)}{d \cdot w(ijk) \cdot m(ijk)} \sum_j \sum_x W(ijk_x)$$

where  $W(ijk)$  is the weight of the composite subsample for taxon  $k$  from stratum  $j$  in area  $i$ ,  $m(ijk)$  is the number of shrimp in the composite subsample from the stratum. Because the combination method produced estimates with better precision than did the simple method, the combination method was used whenever possible (Watson and Bernard, 1986). An estimate of sex composition by length for each area is the sum of  $N(ijkl_s)$  over all strata within an area.

Basic calculations of  $N(ijkl_s)$  for each stratum were made with a series of FORTRAN programs named ESTIMATE on the Honeywell Computer at University of Alaska. The ESTIMATE program is part of a library of programs named DGGAFFNEY.

The abundance of pink shrimp by age in an area was estimated by separating modes in histograms of  $N(ijkl_s)$  over lengths by sex (Anderson 1981; Frechette and Parsons 1983; Tesch 1971) (Appendix B). Modes for male frequencies were assigned ages as I, II, or III relative to similar assignments made for histograms from past surveys (Jackson 1980; 1981) and for histograms of samples taken from commercial catches (McCrary and Petersen 1970; Petersen 1969; Petersen and McCrary 1969). Modes for transitional shrimp (an intermediate sex stage between male and female in protandrous hermaphrodites) were assigned ages as II, III, or IV according to their positions relative to modes for males. Because larger males in an age group are the first to become transitionals (Rasmussen 1953), the modes for transitionals are slightly larger than modes for males of the same age. However, modes at about the same lengths for females and for transitionals were assigned the same ages. Females were assigned ages as II, III, IV, V, or VI. Whenever adjacent modes within a sex could be separated by eye, the frequencies were summed over the separate ranges to obtain estimates of abundance by mode (age). Whenever adjacent modes within a sex could not be separated by eye, the computer routine NORMSEP developed by Tomlinson (1971) (based on the procedure outlined in Hasselblad 1966), was used to estimate the fraction of  $N(ijkl_s)$  for each length category in the overlapping zone between the modes. Each  $N(ijkl_s)$  was then prorated by the fractions and summed accordingly to estimate abundance for each age (mode). The program NORMSEP was used on an IBM PC-2 microcomputer.

## RESULTS

### Kodiak Stocks

#### Biomass Indices:

Fourteen fishing sections were surveyed in the Kodiak District during 1985 with 137 tows successfully completed. A spring survey was conducted in Chiniak Bay and fall surveys were conducted in Marmot Bay, Marmot Island, Ugak Bay, Kiliuda Bay, Twoheaded Island, Alitak Flats, Uyak Bay, Uganik Bay, Kukak Bay, Wide Bay and Puale Bay Sections. Both spring and fall surveys were conducted in Alitak Bay and Olga Bay. Biomass indices were generated for each shrimp species and for all fish as a group for each survey and for each area (Table 1). Detailed information on biomass indices of shrimp species as well on water temperatures, strata sizes, and towing history is in Appendix C. Relative to the variances of the indices, biomass of pink, humpy, and coonstripe shrimp generally did not change significantly from spring to fall in the Kodiak District (Table 1). Surveys in Alitak and Olga Bays showed no significant change in biomass for pink, humpy or coonstripe shrimp. Biomass indices from all 1985 surveys as compared to historic indices are at or near historic low levels. Relative to established criteria, all stocks with the exception of Olga Bay are currently classed as severely depressed; Olga Bay is classed as recovering (ADF&G 1982). Biomass indices were also generated for major fish and invertebrate taxa and are summarized in Appendix D.

#### Sex and Age Composition:

Sex and age composition data were collected from two sources: (1) catch samples from 79 stations that included pink shrimp (55 samples - 9,960 individuals), humpy shrimp (22 samples - 4,734 individuals), and coonstripe shrimp (2 samples - 364 individuals), and (2) composite subsamples that included pink shrimp (20 samples - 5,074 individuals) and humpy shrimp (5 samples - 990 individuals) (Appendix E). Two-year-old pink shrimp dominated survey catches followed by three- and four-year-old shrimp. Female pink shrimp were more abundant in Chiniak, Uyak, Wide, and Olga (spring) Bays than male pink shrimp which were more abundant in the other survey catches (Table 2). Detailed information on age and sex composition of pink and humpy shrimp along with length-frequency histograms and means and modes of shrimp length is in Appendix B.

#### Species Composition:

Pink shrimp dominated shrimp catches in most surveyed sections. However, humpy shrimp dominated catches in Wide and Olga Bays. Shrimp species composition data is summarized in Appendix C. For catches of all taxa in the Kodiak District, flatfish ranked first in abundance (257.21 pounds per trawl mile (lbs/TM) followed by pollock (234.98 lbs/TM) and shrimp (114.55 lbs/TM). Species composition data is summarized by area, cruise, and major taxa in Appendix D.

Table 1. Summary of biomass indices (in millions of pounds) and standard error (SE) for shrimp and fish by area and cruise for Kodiak District trawl surveys in 1985.

Fishing Section/ Survey Date	Pink		Humpty		Coonstripe		Sidestripe		Other		Total		Fish	
	Index	SE	Index	SE	Index	SE	Index	SE	Index	SE	Index	SE	Index	SE
Marmot Bay														
11 September, 1985	0.88	0.38	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.01	0.91	0.39	5.80	0.42
Marmot Island														
12 September, 1985	0.84	0.29	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.87	0.28	6.29	0.9
Chiniak Bay														
13 June, 1985	0.16	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.05	1.21	0.12
Ugak Bay														
2 October, 1985	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.03	2.20	0.20
Kiliuda Bay														
30 September, 1985	0.12	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.07	9.06	5.06
Twoheaded Island														
27 September, 1985	0.26	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.06	6.02	1.40
Alitak Bay														
8 June, 1985	1.54	0.53	0.01	0.01	0.00	0.00	0.03	0.02	0.02	0.01	1.60	0.55	3.32	0.77
Alitak Bay and Flats														
21 September, 1985	1.30	0.51	0.00	0.00	0.00	0.00	0.04	0.03	0.04	0.01	1.39	0.53	5.40	1.00
Uyak Bay														
8 September, 1985	0.12	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.04	3.35	0.46
Uganik Bay														
9 September, 1985	0.23	0.09	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.24	0.09	2.54	0.32
Kukak Bay														
10 September, 1985	0.32	0.14	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.35	0.14	1.47	0.18
Wide Bay														
6 September, 1985	0.02	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	1.74	0.01
Puale Bay														
5 September, 1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17	0.51
Olga Bay														
30 May, 1985	0.02	0.01	0.33	0.16	0.16	0.05	0.01	0.00	0.03	0.01	0.54	0.19	0.18	0.03
2 September, 1985	0.03	0.02	0.52	0.30	0.30	0.06	0.01	0.00	0.00	0.00	0.86	0.30	0.32	0.12

Table 2. Summary of estimated indices<sup>1</sup> of pink shrimp in numbers by age and sex per nautical miles towed for areas in the Kodiak District in the spring and autumn of 1985.

Fishing Section/ Survey Date	Ages						Male	Trans- itional	Female	Combined
	I	II	III	IV	V	VI				
Marmot Bay										
11 September, 1985		8,336	2,489	952 +			5,313	1,695	4,769	11,777
Marmot Island										
12 September, 1985	31	12,634	3,937 +				7,357	4,804	4,441	16,602
Chiniak Bay										
13 June, 1985		5,497	2,430	597 +			16	3,011	5,497	8,524
Ugak Bay										
2 October, 1985	6	869	294	27 +			556	139	501	1,196
Kiliuda Bay										
30 September, 1985		856	777	37 +			897	549	224	1,670
Twoheaded Island										
27 September, 1985		679	300	38 +			625	60	332	1,017
Alitak Bay										
8 June, 1985	1,919	ND	ND	1,694 +			6,408	5,511	4,609	16,528
Alitak Bay and Flats										
21 September, 1985	247	2,868	515	576 +			2,456	411	1,339	4,206
Uyak Bay										
8 September, 1985		808	305	18	39 +		480	148	542	1,170
Uganik Bay										
9 September, 1985		2,974	1,987	320	47 +		2,481	934	1,913	5,328
Kukak Bay										
10 September, 1985		11,350	3,277	1,218	374 +		11,044	607	4,568	16,219
Wide Bay										
6 September, 1985		ND	ND +				5,725	2,591	6,703	15,019
Olga Bay										
30 May, 1985		61	192	36 +			117	0	172	289
2 September, 1985	15	195	310	63 +			449	10	124	583

<sup>1</sup> Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table indicates that the number is for that age and all older. The term (ND) in place of a number indicates that no modes were present in the relevant portions of the length-frequency histograms.

## Chiniak Stocks

### Biomass Indices:

A single spring survey was conducted in Chignik Bay in 1985 with 11 tows successfully completed. Relative to historic biomass indices, the Chignik Bay stock is near historic low levels and is classed as severely depressed as defined by established criteria (ADF&G 1982). Biomass indices were generated for each shrimp species and for all fish as a group (Table 3). Detailed information on biomass indices of shrimp species as well on water temperatures, strata sizes, and towing history is in Appendix C. Biomass indices were also generated for major fish and invertebrate taxa (Appendix D).

### Sex and Age Composition:

Sex and age composition data were collected from two sources: (1) 11 station catch samples (pink shrimp only) comprised of 2,307 individuals, and (2) two composite subsamples comprised of 554 individuals (Appendix E). Unlike trends in the Kodiak District, two-year-old pink shrimp were not the most abundant age group in the Chignik District surveys (Table 4). Three-year-old pink shrimp ranked first in abundance followed by two- and four-year-old shrimp. Transitionals were the most abundant sex followed by males and females. Detailed information on age and sex composition of pink shrimp along with length-frequency histograms and means and modes of shrimp length is in Appendix B.

### Species Composition:

Pink shrimp dominated shrimp catches in the Chignik District. Shrimp species composition data is summarized in Appendix C. For catches of all taxa in the Chignik District, flatfish ranked first in abundance (318.92 lbs/TM) followed by shrimp (142.56 lbs/TM) and pollock (80.95 lbs/TM) (Appendix D).

## ACKNOWLEDGMENTS

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This report is dedicated in memory of L. Wayne Burkholder, captain and owner of the F/V BUCK-N-ANN. Prior to this death in a farming accident near Astoria, Oregon in October 1985, Wayne had conducted a shrimp survey for the Department in Olga Bay in September of the same year. Wayne's presence as both fisherman and friend will be missed.

Table 3. Summary of biomass indices (in millions of pounds) and standard error (SE) for shrimp and fish by area and cruise for Chignik District trawl surveys in 1985.

Fishing Section/ Survey Date	Pink Index	SE	Humpy Index	SE	Coonstripe Index	SE	Sidestripe Index	SE	Other Index	SE	Total Index	SE	Fish Index	SE
Chignik Bay 10 June, 1985	1.12	0.17	0.00	0.00	0.00	0.00	0.04	0.02	0.04	0.01	1.20	0.18	4.12	0.39

Table 4. Summary of estimated indices<sup>1</sup> of pink shrimp in numbers by age and sex per nautical miles towed for the areas in the Chignik District in the spring of 1985.

Fishing Section/ Survey Date	Ages						Male	Trans- itional	Female	Combined
	I	II	III	IV	V	VI				
Chignik Bay (Area 207) 10 June, 1985		4,362	9,030	1,110	683 +		3,712	6,674	4,799	15,185

<sup>1</sup> Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table indicates that the number is for that age and all older.

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APPENDIX A

Gear Description

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The trawl used in 1985 was developed in 1972-73 by the National Marine Fisheries Service (Wathne 1977) and has been used by the Alaska Department of Fish and Game in stock assessment surveys since 1973. The trawl is a box-style, high opening, net with a 61-foot footrope (Figure A1). The estimated fishing width is 32-34 feet; the estimated fishing height is 11.5-13.5 feet. The net is fished from paired 5-1/2 x 8-1/2 foot V-doors on 10-fathom triple dandylines (3/8" wire rope) which are attached to the headrope with a 24-inch extension chain, to the mid rib with an 18-inch extension chain and to the footrope directly. Twenty-nine 8-inch steel floats attached to the headrope provide flotation. A 55-foot tickler chain and a 61-foot height-regulating chain are attached to the footrope wing tips. The height-regulating chain is suspended under the footrope by six 12-inch dropper chains. The tickler chain may or may not be suspended from a single four-foot dropper chain at the midpoint of the footrope. The dropper chain keeps the tickler chain directly under the height chain for towing into the tide. Both tickler and height-regulating chains may be either of 3/8-inch or 5/16-inch steel (the lighter chain is more effective on muddy bottoms).

The wings, intermediate, and codends are all made of 1-1/4 inch stretch mesh nylon-cotton blend; the codend has an insert also made of the same material.



APPENDIX B

Estimated Indices of Shrimp Abundance by Sex and Age

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Appendix Table B1. Estimated indices of pink shrimp in numbers by sex and age per nautical mile towed for the areas in the Kodiak district in the spring and autumn of 1985. Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table below indicates that the number is for that age and all older. The term (ND) in place of a number indicates that no modes were present in the relevant portions of the length-frequency histogram.

---

Marmot Bay

11 September, 1985	I	II	III	IV	V	VI	All Ages
Males		5,163	150				5,313
Transitionals		1,562	133				1,695
Females		1,611	2,206	952 +			4,769
All Sexes		8,336	2,489	952			11,777

---

Marmot Island

12 September, 1985	I	II	III	IV	V	VI	All Ages
Males	31	7,326					7,357
Transitionals		4,499	305				4,804
Females		809	3,632 +				4,441
All Sexes	31	12,634	3,937				16,602

---

Chiniak Bay

13 June, 1985	I	II	III	IV	V	VI	All Ages
Males			16				16
Transitionals		1,973	1,038				3,011
Females		3,524	1,376	597 +			5,497
All Sexes		5,497	2,430	597			8,524

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-Continued-

Appendix Table B1. Estimated indices of pink shrimp in numbers by sex and age per nautical mile towed for the areas in the Kodiak district in the spring and autumn of 1985. Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table below indicates that the number is for that age and all older. The term (ND) in place of a number indicates that no modes were present in the relevant portions of the length-frequency histogram (continued).

Ugak Bay							
2 October, 1985	I	II	III	IV	V	VI	All Ages
Males	6	550					556
Transitionals		133	6				139
Females		186	288	27 +			501
All Sexes	6	869	294	27			1,196
Kiliuda Bay							
30 September, 1985	I	II	III	IV	V	VI	All Ages
Males		778	119				897
Transitionals		78	450	21			549
Females			208	16 +			224
All Sexes		856	777	37			1,670
Twoheaded Island							
27 September, 1985	I	II	III	IV	V	VI	All Ages
Males		625					625
Transitionals		44	16				60
Females		10	284	38 +			332
All Sexes		679	300	38			1,017
Alitak Bay							
8 June, 1985	I	II	III	IV	V	VI	All Ages
Males	1,919	4,489					6,408
Transitionals		ND	ND				5,511
Females		ND	ND	1,694 +			4,609
All Sexes	1,919	ND	ND				16,528

-Continued-

Appendix Table B1. Estimated indices of pink shrimp in numbers by sex and age per nautical mile towed for the areas in the Kodiak district in the spring and autumn of 1985. Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table below indicates that the number is for that age and all older. The term (ND) in place of a number indicates that no modes were present in the relevant portions of the length-frequency histogram (continued).

Alitak Bay and Flats

21 September, 1985	I	II	III	IV	V	VI	All Ages
Males	247	2,209					2,456
Transitionals		200	211				411
Females		459	304	576 +			1,339
All Sexes	247	2,868	515	576			4,206

Uyak Bay

8 September, 1985	I	II	III	IV	V	VI	All Ages
Males		480					480
Transitionals		136	12				148
Females		192	293	18	39 +		542
All Sexes		808	305	18	39		1,170

Uganik Bay

9 September, 1985	I	II	III	IV	V	VI	All Ages
Males		2,472	9				2,481
Transitionals		100	834				934
Females		402	1,144	320	47 +		1,913
All Sexes		2,974	1,987	320	47		5,328

Kukak Bay

10 September, 1985	I	II	III	IV	V	VI	All Ages
Males		11,044					11,044
Transitionals		306	301				607
Females			2,976	1,218	374 +		4,568
All Sexes		11,350	3,277	1,218	374		16,219

-Continued-

Appendix Table B1. Estimated indices of pink shrimp in numbers by sex and age per nautical mile towed for the areas in the Kodiak district in the spring and autumn of 1985. Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table below indicates that the number is for that age and all older. The term (ND) in place of a number indicates that no modes were present in the relevant portions of the length-frequency histogram (continued).

---

Wide Bay

6 September, 1985	I	II	III	IV	V	VI	All Ages
Males		ND	ND				5,725
Transitionals			2,591				2,591
Females			6,703 +				6,703
All Sexes	0	ND	ND	0	0	0	15,019

---

Olga Bay

30 May, 1985	I	II	III	IV	V	VI	All Ages
Males		61	56				117
Transitionals							0
Females			136	36 +			172
All Sexes		61	192	36			289

2 September, 1985	I	II	III	IV	V	VI	All Ages
Males	15	195	239				449
Transitionals			10				10
Females			61	63 +			124
All Sexes	15	195	310	63			583

---

Appendix Table B2. Estimated indices of pink shrimp in numbers by sex and age per nautical mile towed for the areas in the Chignik district in the spring of 1985. Numbers were estimated with Equations 6 and 7 as described in the text and are unadjusted for trawl width. The symbol (+) following the number by age of females in the table below indicates that the number is for that age and all older.

---

Chignik Bay

10 June, 1985	I	II	III	IV	V	VI	All Ages
Males		3,712					3,712
Transitionals		616	6,058				6,674
Females		34	2,972	1,110		683 +	4,799
All Sexes		4,362	9,030	1,110		683	15,185

---

Appendix Table B3. Estimated, modes, means, and standard deviations of carapace lengths for ages and sexes of pink shrimp from surveys in the Kodiak district in 1985. Modes were picked off length-frequency histograms (Figure B1) while means were estimated from length-frequencies using NORMSEP (Tomlinson 1971).

Marmot Bay					
11 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	16.0		97	5,163
	III	19.5		3	150
Transitionals	II	17.0		92	1,562
	III	21.0		8	133
Females	II	17.9	0.8	34	1,611
	III	21.4	0.8	46	2,206
	IV+	22.7	1.3	20	952

Marmot Island					
12 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	16.0		100	7,326
Transitionals	II	17.0		94	4,499
	III	22.0		6	305
Females	II	19.3	0.8	18	809
	III+	22.6	0.9	82	3,632

Chiniak Bay					
13 June, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	III	18.0		100	16
Transitionals	II	13.0		66	1,973
	III	19.0		34	1,038
Females	II	15.0		64	3,524
	III	19.9	0.6	25	1,376
	IV+	22.0	0.6	11	597

-Continued-

Appendix Table B3. Estimated, modes, means, and standard deviations of carapace lengths for ages and sexes of pink shrimp from surveys in the Kodiak district in 1985. Modes were picked off length-frequency histograms (Figure B1) while means were estimated from length-frequencies using NORMSEP (Tomlinson 1971)(continued).

Ugak Bay

2 October, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	I	9.5		1	6
	II	16.5		99	550
Transitionals	II	19.0		96	133
	III	22.0		4	6
Females	II	20.1	0.9	37	186
	III	22.6	0.7	57	288
	IV+	25.6	0.8	5	27

Kiliuda Bay

30 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	15.5		86	778
	III	20.0		14	119
Transitionals	II	18.1	0.6	14	78
	III	21.5	1.0	82	450
	IV	24.8	0.4	4	21
Females	III	21.7	0.8	93	208
	IV+	24.0	0.4	7	16

Twoheaded Island

27 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	15.5		100	625
Transitionals	II	17.5		73	44
	III	20.0		27	16
Females	II	18.0	0.3	3	10
	III	21.2	0.9	86	284
	IV+	24.2	0.4	11	38

-Continued-

Appendix Table B3. Estimated, modes, means, and standard deviations of carapace lengths for ages and sexes of pink shrimp from surveys in the Kodiak district in 1985. Modes were picked off length-frequency histograms (Figure B1) while means were estimated from length-frequencies using NORMSEP (Tomlinson 1971)(continued).

Alitak Bay					
8 June, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	I	14.3	1.4	30	1,919
	II	16.9	0.6	70	4,489
Transitionals II - III		19.0		100	5,511
Females II-	III			63	2,915
	IV+	23.6	1.5	37	1,694
Alitak Bay and Flats					
21 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	I	14.7	1.5	10	247
	II	17.7	0.9	90	2,209
Transitionals	II	20.2	0.6	49	200
	III	22.2	1.1	51	211
Females	II	21.4	0.9	34	459
	III	22.3	1.3	23	304
	IV+	24.5	1.0	43	576
Uyak Bay					
8 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	15.0		100	480
Transitionals	II	18.0		86	136
	III	20.5		14	12
Females	II	16.0		35	192
	III	20.8	0.8	54	293
	IV	22.8	0.1	3	18
	V+	24.3	1.2	7	39

-Continued-

Appendix Table B3. Estimated, modes, means, and standard deviations of carapace lengths for ages and sexes of pink shrimp from surveys in the Kodiak district in 1985. Modes were picked off length-frequency histograms (Figure B1) while means were estimated from length-frequencies using NORMSEP (Tomlinson 1971)(continued).

Uganik Bay					
9 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	14.0		99	2,472
	III	18.0		1	9
Transitionals	II	16.5		11	100
	III	19.5		89	834
Females	II	17.0		21	402
	III	20.6	0.8	60	1,144
	IV	22.8	0.8	17	320
	V+	24.8	0.1	2	47
Kukak Bay					
10 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	15.0		100	11,044
Transitionals	II	18.4	0.7	50	306
	III	21.6	0.8	50	301
Females	III	21.8	0.9	65	2,976
	IV	24.0	0.6	27	1,218
	V+	25.3	0.7	8	374
Wide Bay					
6 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II-III	15.5		100	5,725
Transitionals	III	18.5		100	2,591
Females	III	19.5	0.7	100	6,703

-Continued-

Appendix Table B3. Estimated, modes, means, and standard deviations of carapace lengths for ages and sexes of pink shrimp from surveys in the Kodiak district in 1985. Modes were picked off length-frequency histograms (Figure B1) while means were estimated from length-frequencies using NORMSEP (Tomlinson 1971)(continued).

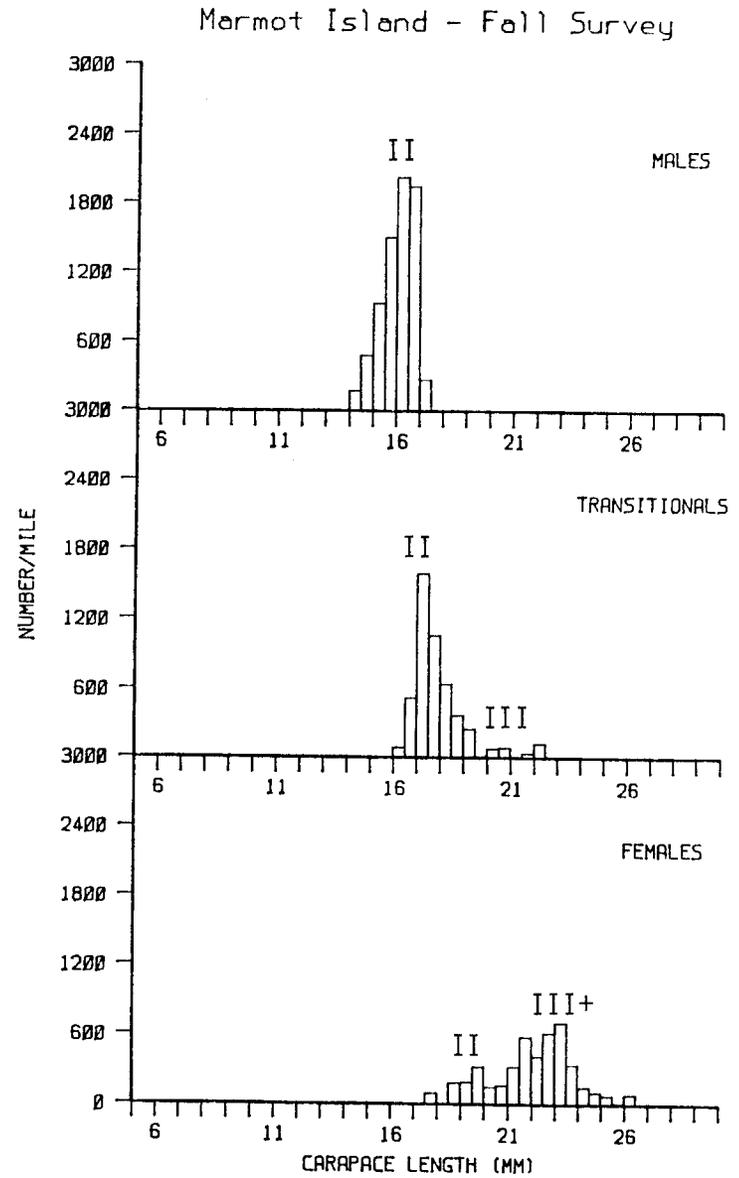
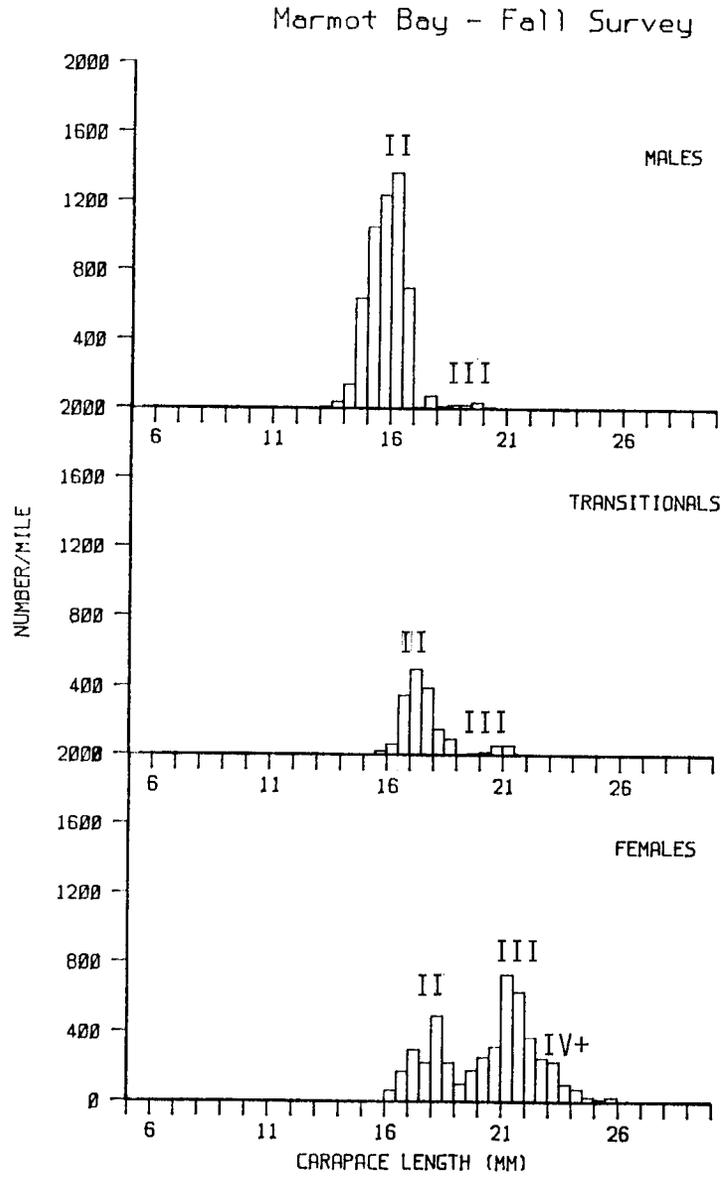
Olga Bay					
30 May, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	16.7	1.0	53	61
	III	20.3	0.5	47	56
Females	III	21.8	0.7	79	136
	IV+	23.5	1.1	21	36
2 September, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	I	13.8	0.8	3	15
	II	17.2	0.4	43	195
	III	20.4	1.2	53	239
Transitionals	III	21.5		100	10
Females	III	22.0	0.3	49	61
	IV+	23.0	0.6	51	63

Appendix Table B4. Estimated, modes, means, and standard deviations of carapace lengths for ages and sexes of pink shrimp from surveys in the Chignik district in 1985. Modes were picked off length-frequency histograms (Figure B2) while means were estimated from length-frequencies using NORMSEP (Tomlinson 1971).

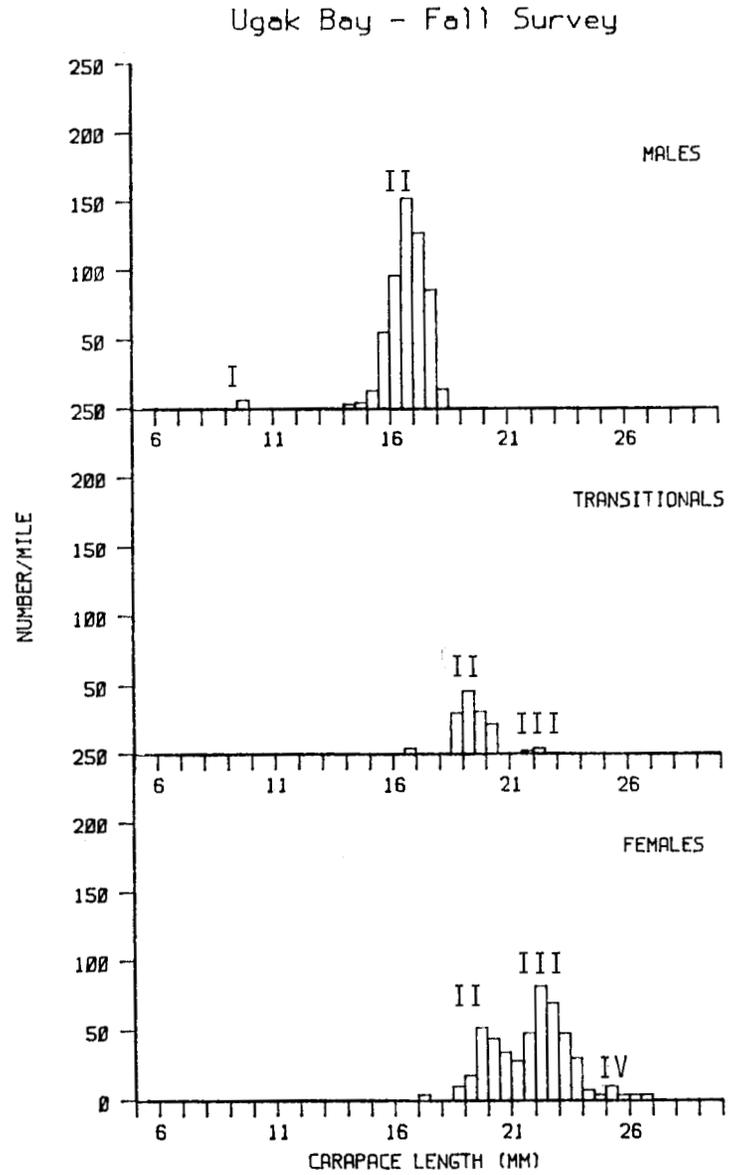
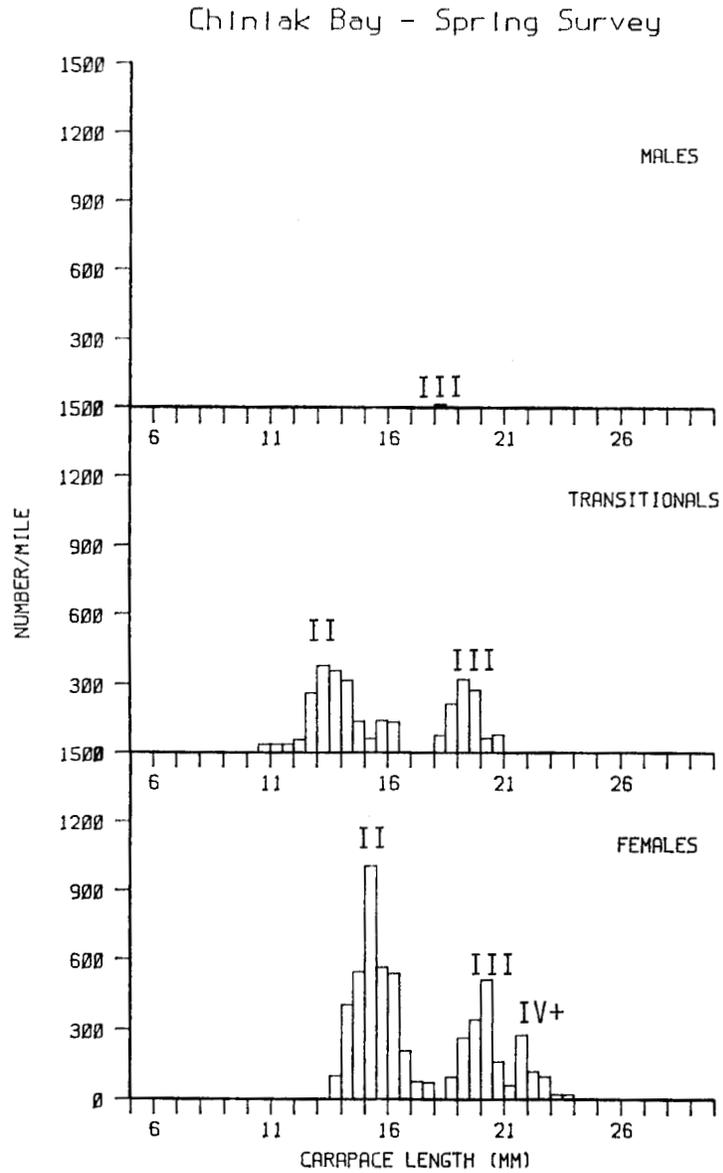
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Chignik Bay					
10 June, 1985	Age	Mode Mean	Std. Dev.	%	N
Males	II	12.5		100	3,712
Transitionals	II	14.6	0.8	9	616
	III	18.5	0.8	91	6,058
Females	II	14.5		1	34
	III	19.1	0.8	62	2,972
	IV	21.5	0.9	23	1,110
	V+	22.9	1.2	14	683

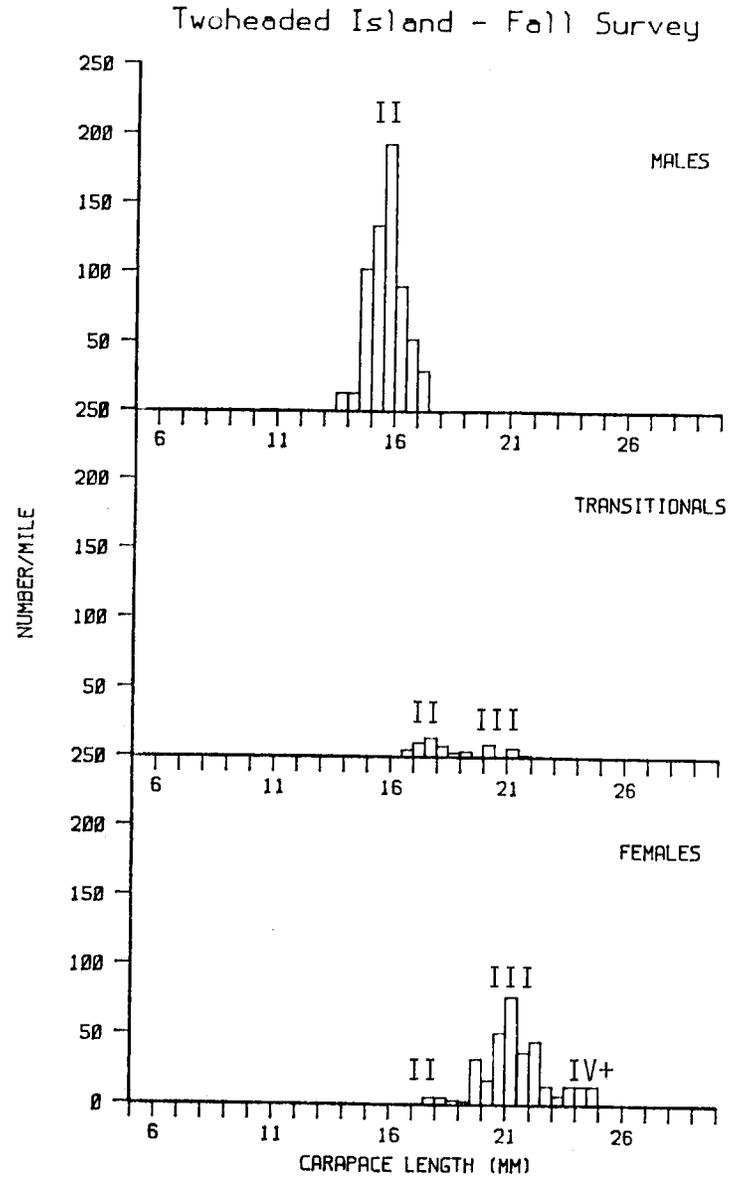
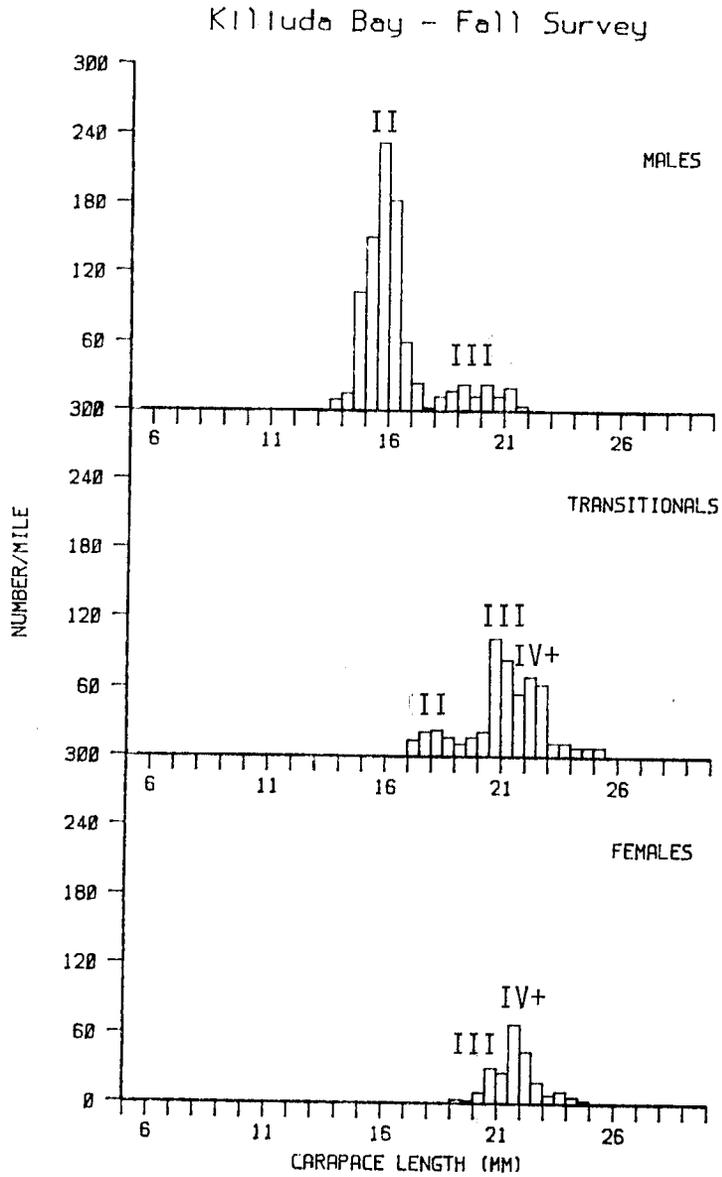
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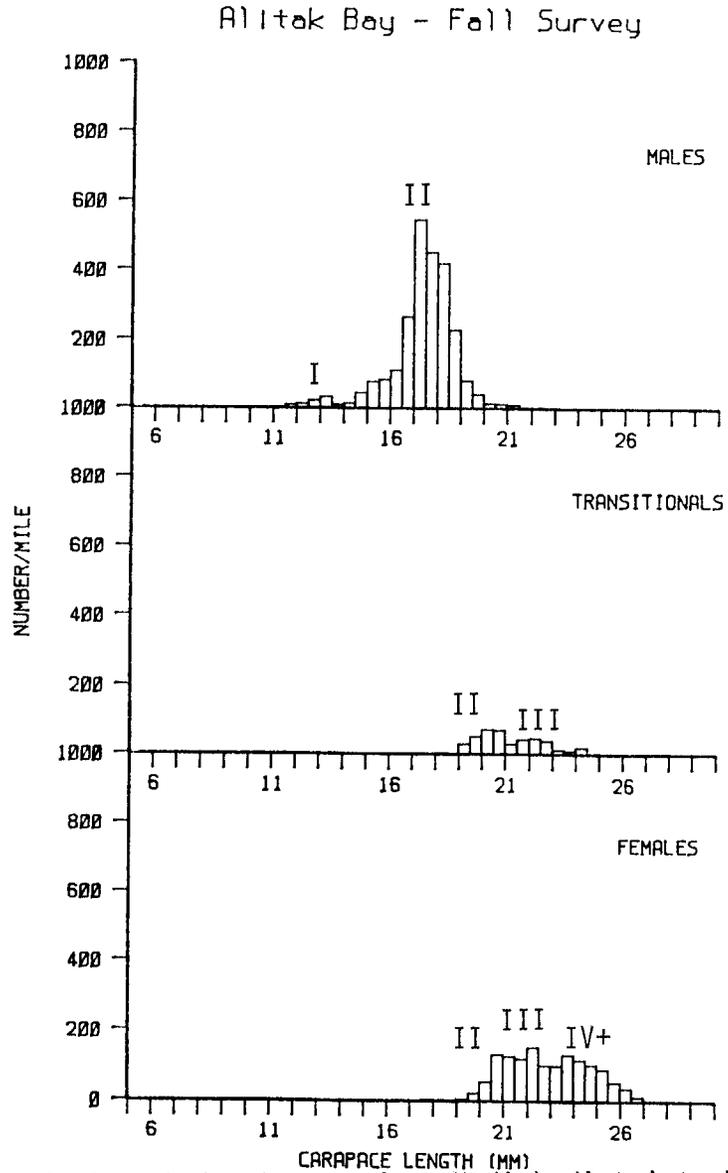
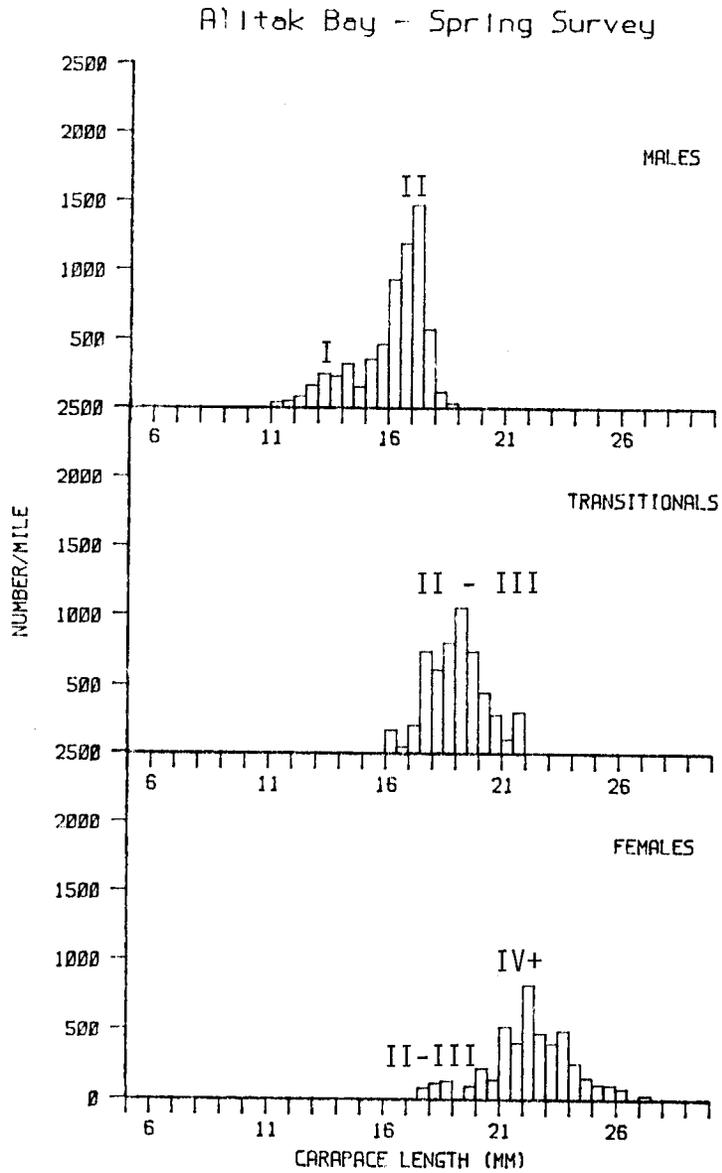
Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages (continued).



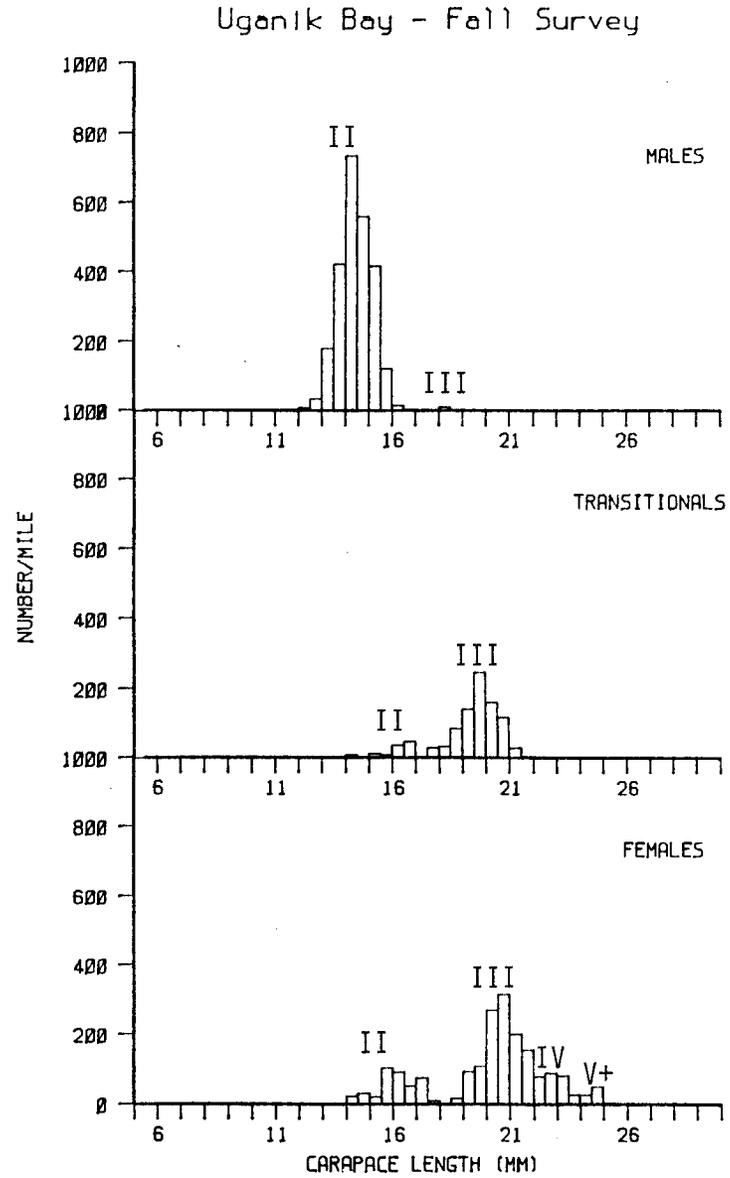
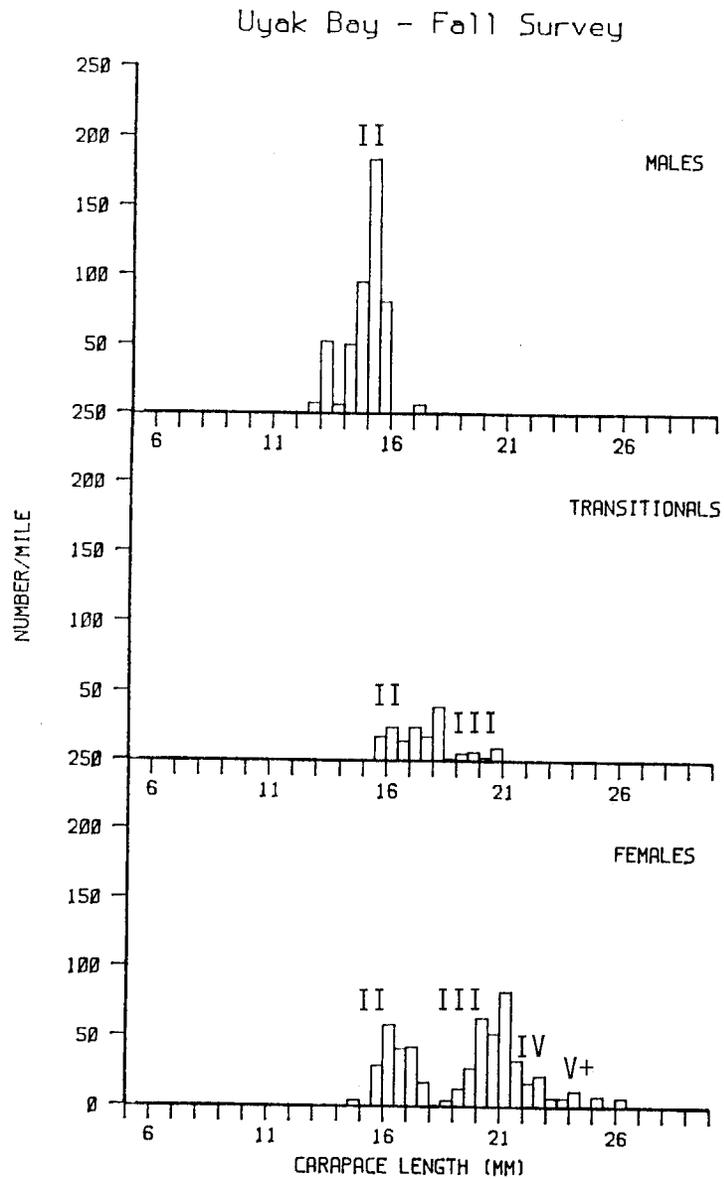
Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages (continued).



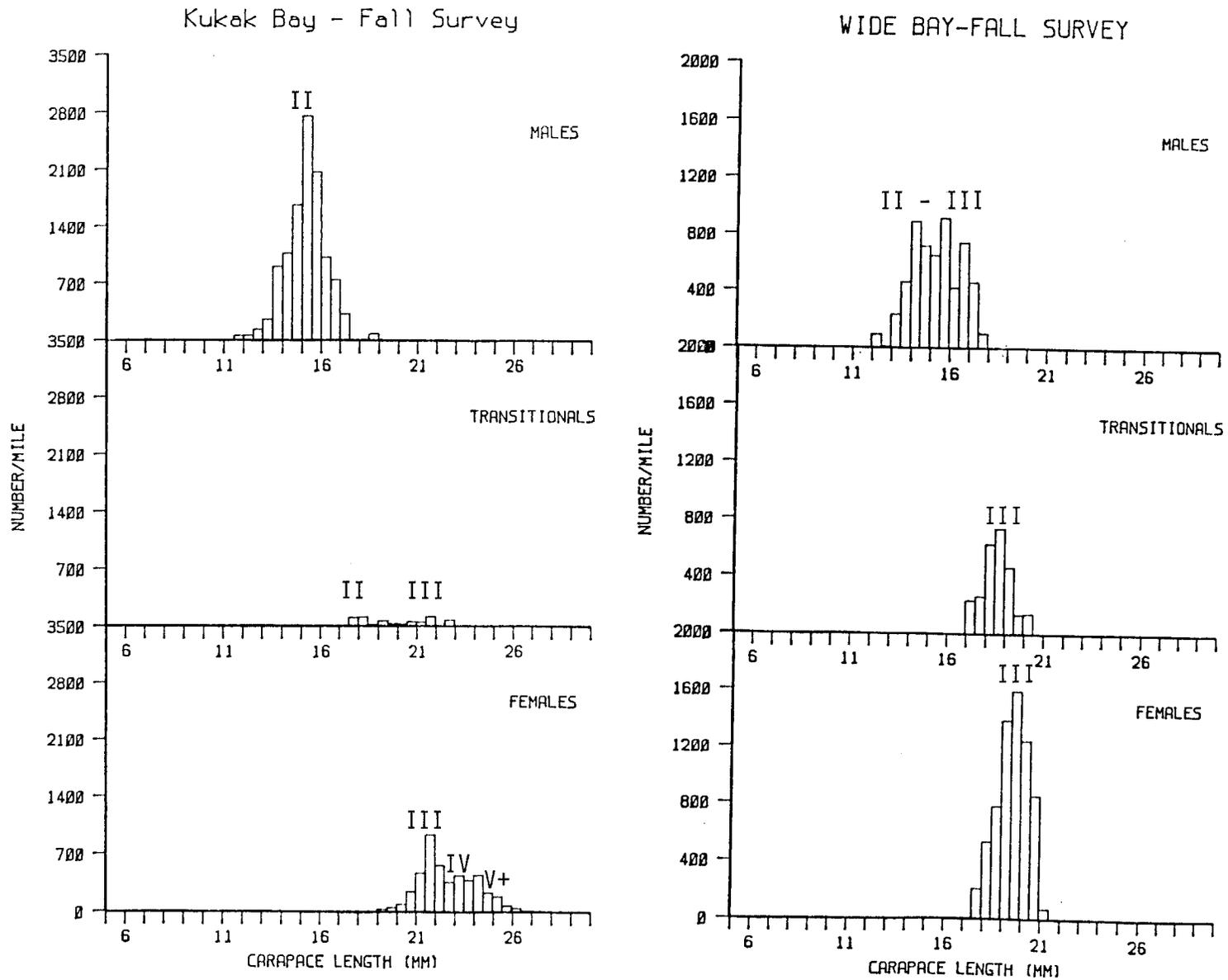
Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages (continued).



Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages (continued).

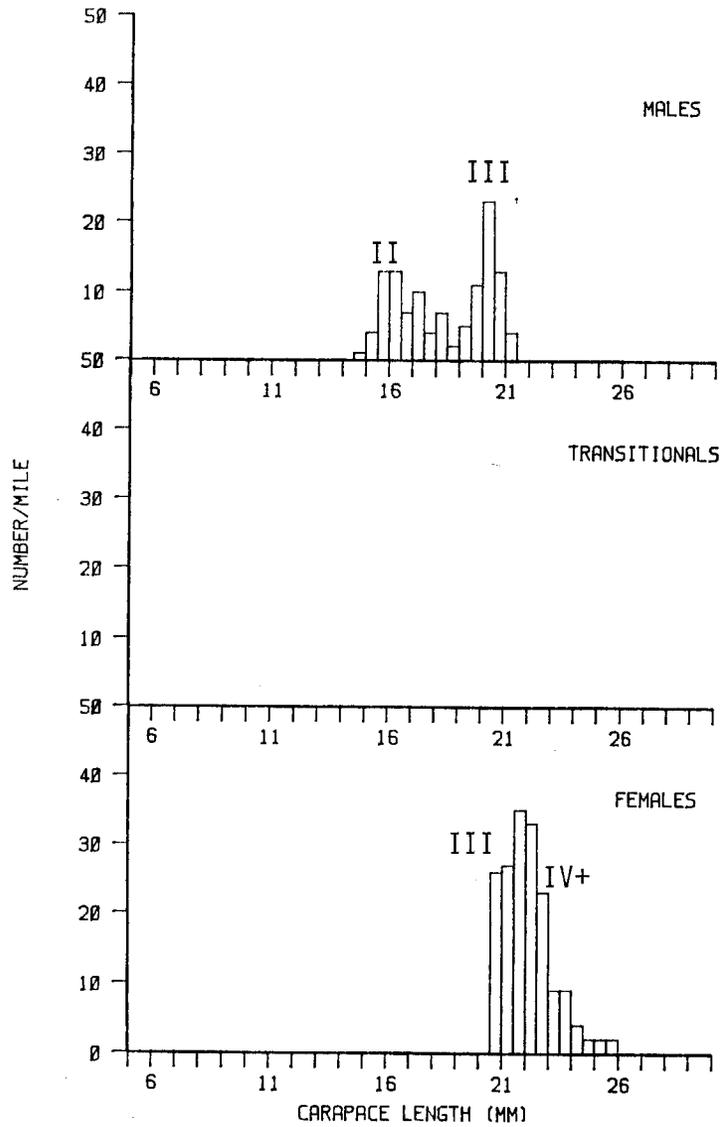


Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages (continued).

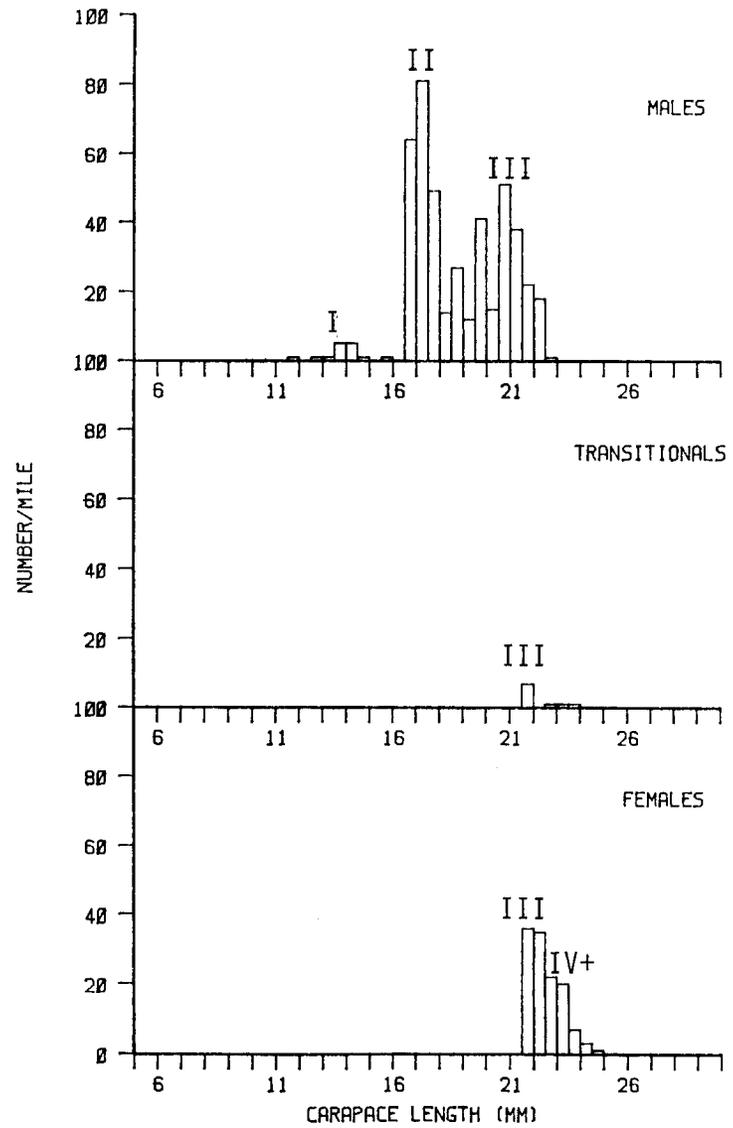


Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages (continued).

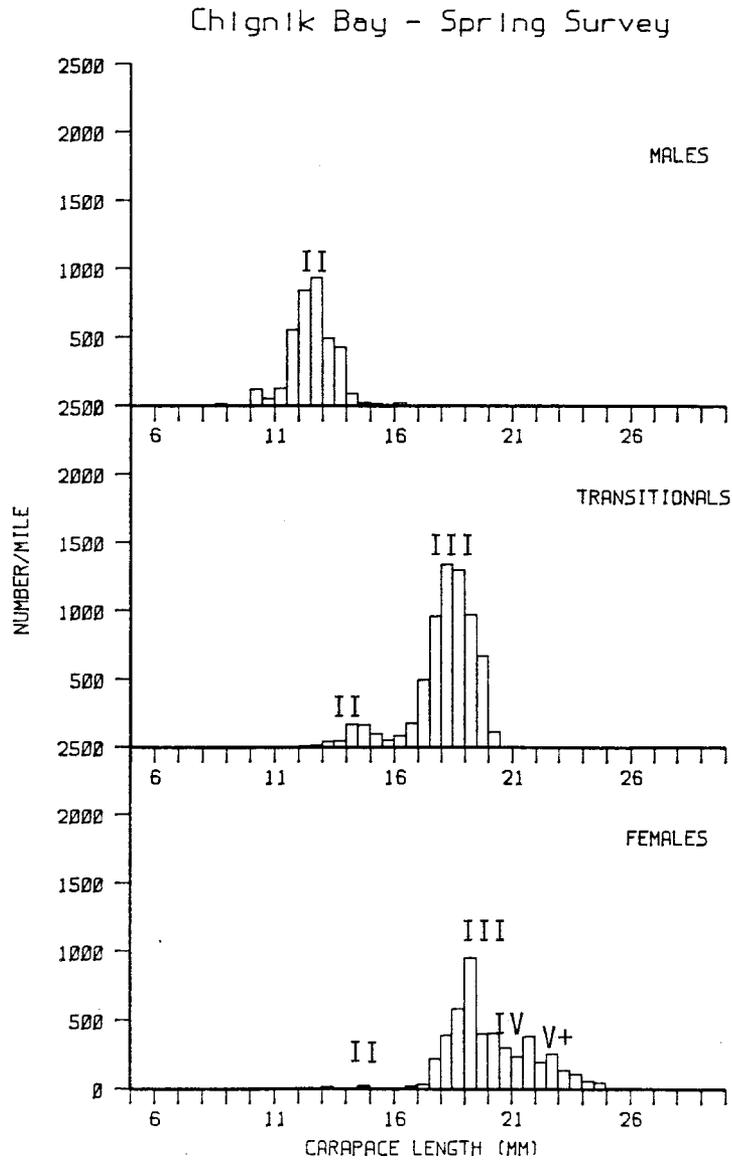
Olga Bay - Spring Survey



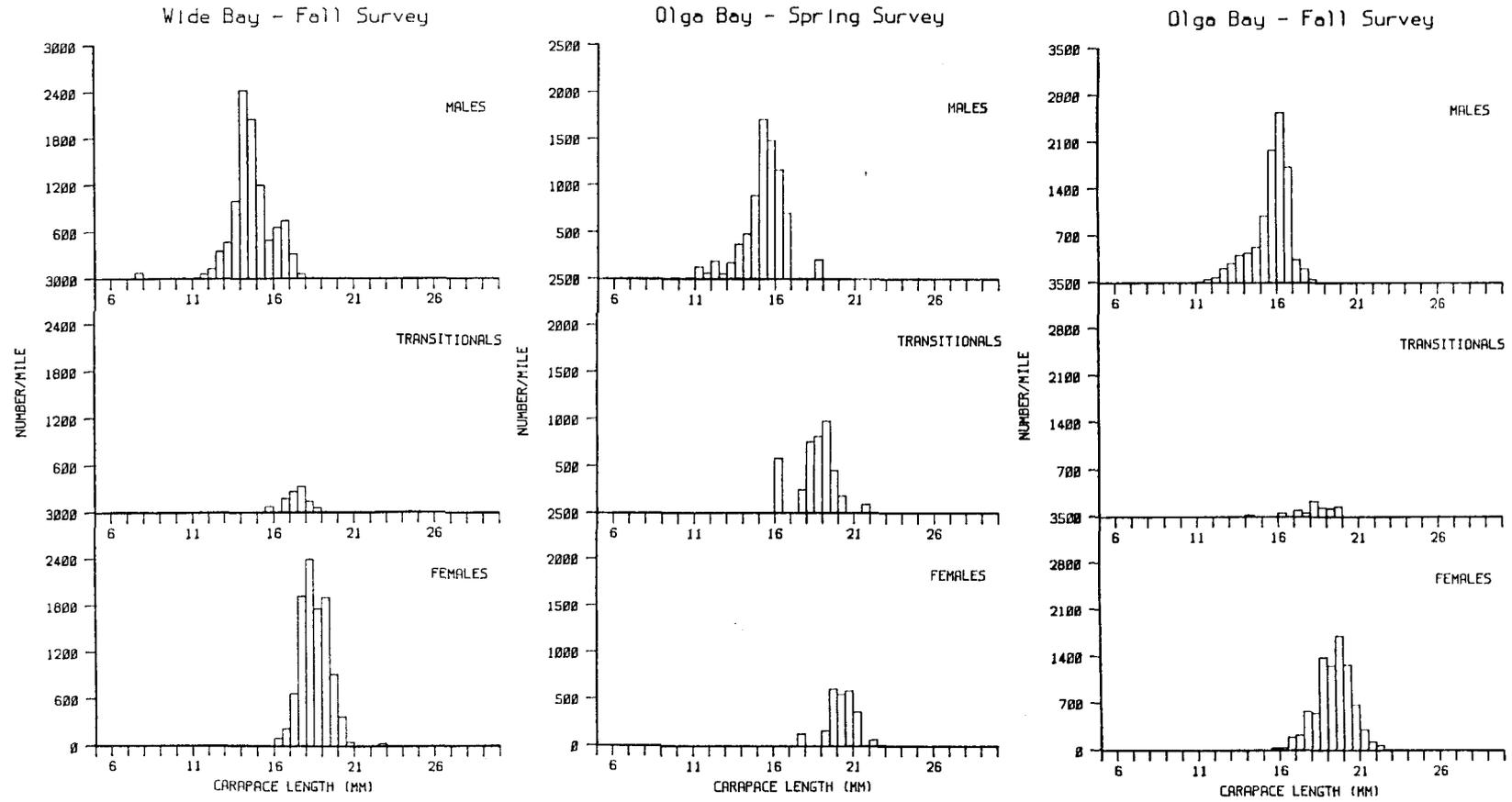
Olga Bay - Fall Survey



Appendix Figure B1. Histograms of carapace lengths of pink shrimp by sex from Kodiak district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages.



Appendix Figure B2. Histograms of carapace lengths of pink shrimp by sex from Chignik district shrimp surveys in 1985. Roman numerals approximately flag lengths that correspond to ages.



Appendix Figure B3. Histograms of carapace lengths of humpy shrimp from Kodiak district shrimp surveys in 1985.

APPENDIX C

Biomass Indices for Shrimp and Fish by Area, Cruise, and Stratum

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Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985.

Marmot Bay Cruise 8503 11 September, 1985							
	Stratum Number	Stratum Area (nm)	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	30.96	6	85.33	16.46		
	3	1.48	2	62.00	4.00		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/NM Towed	141	0	0	3	3	147	957
SE	64	0	0	2	1	66	71
Biomass Index	0.83	0.00	0.00	0.02	0.02	0.86	5.62
SE	0.38	0.00	0.00	0.01	0.01	0.39	0.42
CV	0.45	0	0	0.76	0.53	0.45	0.07
Stratum 3:							
Mean Lbs/NM Towed	175	0	0	4	3	182	633
SE	34	0	0	3	2	34	119
Biomass Index	0.05	0.00	0.00	.00	.00	0.05	0.18
SE	0.01	0.00	0.00	.00	.00	0.01	0.03
CV	0.19	0	0	0.89	0.58	0.19	0.19
All Strata:							
Mean Lbs/NM Towed	143	0	0	3	3	148	942
SE	61	0	0	2	1	63	68
Biomass Index	0.88	0.00	0.00	0.02	0.02	0.91	5.80
SE	0.38	0.00	0.00	0.01	0.01	0.39	0.42
CV	0.43	0	0	0.72	0.50	0.42	0.07

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Marmot Island  
Cruise 8503  
12 September, 1985

Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
			Mean	SD	Surface	Bottom
2	23.7	6	91.67	9.34		

Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
------	-------	-------------	-------------	-------	-------	------

All Strata:							
Mean Lbs/MM Towed	187	0	0	5	2	194	1398
SE	63	0	0	3	1	62	200
Biomass Index	0.84	0.00	0.00	0.02	0.01	0.87	6.29
SE	0.29	0.00	0.00	0.01	.00	0.28	0.90
CV	0.34	0	0	0.66	0.42	0.32	0.14

Chiniak Bay  
Cruise 8501  
13 June, 1985

Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
			Mean	SD	Surface	Bottom
2	3.05	2	50.00	2.00		
3	5.98	3	79.00	2.45	6.8	5.6
4	2.05	1	39.00	0.00		

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Chiniak Bay Cruise 8501 13 June, 1985	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
<hr/>							
Stratum 2:							
Mean Lbs/NM Towed	34	0	1	0	1	36	697
SE	25	0	1	0	1	26	200
Biomass Index	0.02	0.00	.00	0.00	.00	0.02	0.40
SE	0.01	0.00	.00	0.00	.00	0.01	0.12
CV	0.73	0	1.73	0.00	1.41	0.72	0.29
<hr/>							
Stratum 3:							
Mean Lbs/NM Towed	123	0	0	0	3	126	559
SE	38	0	0	0	2	38	37
Biomass Index	0.14	0.00	0.00	0.00	.00	0.14	0.63
SE	0.04	0.00	0.00	0.00	.00	0.04	0.04
CV	0.31	0	0	0	0.58	0.30	0.07
<hr/>							
Stratum 4:							
Mean Lbs/NM Towed	0	0	0	0	0	0	444
SE	0	0	0	0	0	0	0
Biomass Index	0.00	0.00	0.00	0.00	0.00	0.00	0.17
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CV	0	0	0	0	0	0	0
<hr/>							
All Strata:							
Mean Lbs/NM Towed	76	0	0	0	2	78	576
SE	22	0	0	0	1	22	58
Biomass Index	0.16	0.00	.00	0.00	.00	0.16	1.21
SE	0.05	0.00	.00	0.00	.00	0.05	0.12
CV	0.29	0	1.73	0	0.54	0.28	0.10

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Ugak Bay  
Cruise 8503  
2 October, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	12.04	6	50.67	2.83	9.5	8.3
	3	15.81	3	54.00	0.00		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/NM Towed	40	0	0	1	2	43	753
SE	14	0	0	0	1	14	84
Biomass Index	0.09	0.00	0.00	.00	.00	0.10	1.72
SE	0.03	0.00	0.00	.00	.00	0.03	0.19
CV	0.35	0	0	0.74	0.45	0.33	0.11
Stratum 3:							
Mean Lbs/NM Towed	1	0	0	0	0	1	160
SE	1	0	0	0	0	0	23
Biomass Index	.00	0.00	0.00	0.00	0.00	.00	0.48
SE	.00	0.00	0.00	0.00	0.00	.00	0.07
CV	1.00	0	0	0	0	0.50	0.14
All Strata:							
Mean Lbs/NM Towed	18	0	0	0	1	19	416
SE	6	0	0	0	0	6	38
Biomass Index	0.09	0.00	0.00	.00	.00	0.10	2.20
SE	0.03	0.00	0.00	.00	.00	0.03	0.20
CV	0.34	0	0	0.74	0.45	0.32	0.09

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Kiliuda Bay  
Cruise 8503  
30 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	3.99	2	49.00	2.00	9.5	6.3
	3	21.25	5	64.40	3.41		
	4	22.01	2	76.00	0.00	9.4	5.8
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/NM Towed	31	0	0	0	0	31	916
SE	29	0	0	0	0	29	175
Biomass Index	0.02	0.00	0.00	0.00	0.00	0.02	0.69
SE	0.02	0.00	0.00	0.00	0.00	0.02	0.13
CV	0.95	0	0	0	0	0.93	0.19
Stratum 3:							
Mean Lbs/NM Towed	7	0	0	0	0	7	874
SE	2	0	0	0	0	1	124
Biomass Index	0.01	0.00	0.00	0.00	0.00	0.01	0.66
SE	.00	0.00	0.00	0.00	0.00	.00	0.09
CV	0.27	0	0	0	0	0.20	0.14
Stratum 4:							
Mean Lbs/NM Towed	22	0	0	0	0	22	1845
SE	16	0	0	0	0	15	1210
Biomass Index	0.09	0.00	0.00	0.00	0.00	0.09	7.71
SE	0.07	0.00	0.00	0.00	0.00	0.06	5.06
CV	0.71	0	0	0	0	0.68	0.66

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Kiliuda Bay  
Cruise 8503  
30 September, 1985

	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
<b>All Strata:</b>							
Mean Lbs/MM Towed	21	0	0	0	0	21	1592
SE	12	0	0	0	0	12	888
Biomass Index	0.12	0.00	0.00	0.00	0.00	0.12	9.06
SE	0.07	0.00	0.00	0.00	0.00	0.07	5.06
CV	0.58	0	0	0	0	0.55	0.56

Twoheaded Island  
Cruise 8503  
27 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	1	38.28	10	66.30	5.07	9.5	7.6
<b>All Strata:</b>							
Mean Lbs/MM Towed	36	0	0	0	0	36	828
SE	9	0	0	0	0	9	192
Biomass Index	0.26	0.00	0.00	0.00	.00	0.27	6.02
SE	0.06	0.00	0.00	0.00	.00	0.06	1.40
CV	0.24	0	0	0	1.25	0.24	0.23

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Alitak Bay  
Cruise 8501  
8 June, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	45.27	12	41.83	24.08	6.0	5.9
						6.0	4.6
						5.8	3.0
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
All Strata:							
Mean Lbs/NM Towed	179	1	0	3	2	186	386
SE	62	1	0	3	1	64	89
Biomass Index	1.54	0.01	.00	0.03	0.02	1.60	3.32
SE	0.53	0.01	.00	0.02	0.01	0.55	0.77
CV	0.35	0.63	1.13	0.88	0.43	0.34	0.23

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Alitak Bay and Flats  
Cruise 8503  
21 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	45.27	16	47.75	25.51	10.5	3.2
	3	78.30	6	32.17	3.76	10.0	4.9
						10.0	9.2
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/MM Towed	126	0	0	4	4	134	419
SE	58	0	0	3	2	60	114
Biomass Index	1.08	.00	.00	0.04	0.03	1.15	3.60
SE	0.50	.00	.00	0.03	0.01	0.52	0.98
CV	0.46	1.44	1.24	0.69	0.44	0.45	0.27
Stratum 3:							
Mean Lbs/MM Towed	15	0	0	0	1	16	121
SE	8	0	0	0	0	8	12
Biomass Index	0.22	.00	0.00	.00	0.01	0.24	1.79
SE	0.11	.00	0.00	.00	0.01	0.11	0.17
CV	0.50	1.48	0	1.48	0.78	0.48	0.10
All Strata:							
Mean Lbs/MM Towed	56	0	0	2	2	59	230
SE	22	0	0	1	1	23	42
Biomass Index	1.30	.00	.00	0.04	0.04	1.39	5.40
SE	0.51	.00	.00	0.03	0.01	0.53	1.00
CV	0.39	1.25	1.24	0.66	0.38	0.38	0.19

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Uyak Bay  
Cruise 8503  
8 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	7.02	2	65.50	9.00	11.7	6.6
	3	16.95	6	68.17	15.79		
	4	1.94	1	35.00	0.00	11.9	7.1
	5	0.82	1	42.00	0.00		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/MM Towed	12	0	0	0	0	12	800
SE	8	0	0	0	0	7	139
Biomass Index	0.02	0.00	0.00	0.00	0.00	0.02	1.07
SE	0.01	0.00	0.00	0.00	0.00	0.01	0.18
CV	0.65	0	0	0	0	0.58	0.17
Stratum 3:							
Mean Lbs/MM Towed	29	0	0	0	0	30	643
SE	14	0	0	0	0	14	130
Biomass Index	0.09	0.00	0.00	.00	.00	0.09	2.07
SE	0.04	0.00	0.00	.00	.00	0.04	0.42
CV	0.47	0	0	1.48	1.48	0.46	0.20
Stratum 4:							
Mean Lbs/MM Towed	16	0	0	0	0	16	432
SE	0	0	0	0	0	0	0
Biomass Index	0.01	0.00	0.00	0.00	0.00	0.01	0.16
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CV	0	0	0	0	0	0	0

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Uyak Bay  
Cruise 8503  
8 September, 1985

	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 5:							
Mean Lbs/MM Towed	1	0	0	0	0	1	346
SE	0	0	0	0	0	0	0
Biomass Index	.00	0.00	0.00	0.00	0.00	.00	0.05
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CV	0	0	0	0	0	0	0

All Strata:							
Mean Lbs/MM Towed	23	0	0	0	0	23	660
SE	9	0	0	0	0	9	90
Biomass Index	0.12	0.00	0.00	.00	.00	0.12	3.35
SE	0.04	0.00	0.00	.00	.00	0.04	0.46
CV	0.39	0	0	1.48	1.48	0.38	0.14

Uganik Bay  
Cruise 8503  
9 September, 1985

Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
			Mean	SD	Surface	Bottom
2	0.68	1	37.00	0.00		
3	12.62	3	91.00	20.05	11.6	5.6
4	1.52	1	68.00	0.00		
5	5.67	2	76.50	17.00		

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Uganik Bay Cruise 8503 9 September, 1985							
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
<b>Stratum 2:</b>							
Mean Lbs/NM Towed	0	0	0	0	0	0	691
SE	0	0	0	0	0	0	0
Biomass Index	0.00	0.00	0.00	0.00	0.00	0.00	0.09
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CV	0	0	0	0	0	0	0
<b>Stratum 3:</b>							
Mean Lbs/NM Towed	69	0	0	1	2	72	658
SE	35	0	0	1	2	36	94
Biomass Index	0.16	0.00	0.00	.00	0.01	0.17	1.58
SE	0.08	0.00	0.00	.00	.00	0.09	0.23
CV	0.52	0	0	1.32	0.69	0.50	0.14
<b>Stratum 4:</b>							
Mean Lbs/NM Towed	6	0	0	0	0	6	986
SE	0	0	0	0	0	0	0
Biomass Index	.00	0.00	0.00	0.00	0.00	.00	0.28
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CV	0	0	0	0	0	0	0
<b>Stratum 5:</b>							
Mean Lbs/NM Towed	57	0	1	4	1	62	548
SE	30	0	1	2	1	29	209
Biomass Index	0.06	0.00	.00	.00	.00	0.07	0.59
SE	0.03	0.00	.00	.00	.00	0.03	0.22
CV	0.53	0	1.73	0.55	1.00	0.47	0.38
<b>All Strata:</b>							
Mean Lbs/NM Towed	59	0	0	1	2	62	653
SE	23	0	0	1	1	24	82
Biomass Index	0.23	0.00	.00	0.01	0.01	0.24	2.54
SE	0.09	0.00	.00	.00	.00	0.09	0.32
CV	0.40	0	1.73	0.55	0.60	0.38	0.13

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Kukak Bay  
Cruise 8503  
10 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	6.42	5	49.00	14.60		
	3	6.19	3	44.00	4.90		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/NM Towed	251	0	0	22	3	276	557
SE	117	0	0	18	2	116	95
Biomass Index	0.31	.00	0.00	0.03	.00	0.34	0.68
SE	0.14	.00	0.00	0.02	.00	0.14	0.12
CV	0.47	1.00	0	0.80	0.55	0.42	0.17
Stratum 3:							
Mean Lbs/NM Towed	11	0	0	0	0	11	676
SE	4	0	0	0	0	4	120
Biomass Index	0.01	0.00	0.00	0.00	0.00	0.01	0.79
SE	0.01	0.00	0.00	0.00	0.00	.00	0.14
CV	0.38	0	0	0	0	0.31	0.18
All Strata:							
Mean Lbs/NM Towed	133	0	0	11	2	146	615
SE	60	0	0	9	1	59	76
Biomass Index	0.32	.00	0.00	0.03	.00	0.35	1.47
SE	0.14	.00	0.00	0.02	.00	0.14	0.18
CV	0.45	1.00	0	0.80	0.55	0.41	0.12

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Wide Bay  
Cruise 8503  
6 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	0.92	6	26.83	4.18	11.5	9.3
	3	7.33	1	33.00	0.00		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/MM Towed	139	168	15	2	2	325	189
SE	88	66	5	1	1	147	42
Biomass Index	0.02	0.03	.00	.00	.00	0.06	0.03
SE	0.02	0.01	.00	.00	.00	0.03	0.01
CV	0.63	0.39	0.35	0.95	0.56	0.45	0.22
Stratum 3:							
Mean Lbs/MM Towed	0	0	0	0	0	0	1223
SE	0	0	0	0	0	0	0
Biomass Index	0.00	0.00	0.00	0.00	0.00	0.00	1.70
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CV	0	0	0	0	0	0	0
All Strata:							
Mean Lbs/MM Towed	15	19	2	0	0	36	1108
SE	10	7	1	0	0	16	5
Biomass Index	0.02	0.03	.00	.00	.00	0.06	1.74
SE	0.02	0.01	.00	.00	.00	0.03	0.01
CV	0.63	0.39	0.35	0.95	0.56	0.45	.00

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Puale Bay  
Cruise 8503  
5 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	1	9.4	3	46.00	6.82	11.0	9.2
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
All Strata:							
Mean Lbs/NM Towed	2	0	0	0	0	2	658
SE	2	0	0	0	0	1	287
Biomass Index	.00	0.00	0.00	0.00	0.00	.00	1.17
SE	.00	0.00	0.00	0.00	0.00	.00	0.51
CV	0.76	0	0	0	0	0.58	0.44

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Olga Bay  
Cruise 8502  
30 May, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	10.62	4	50.75	13.77		
	3	6.85	4	59.25	14.71		
	4	1.57	2	46.50	11.00		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/NM Towed	0	113	37	1	6	157	56
SE	0	73	10	1	3	75	7
Biomass Index	0.00	0.23	0.08	.00	0.01	0.32	0.11
SE	0.00	0.15	0.02	.00	0.01	0.15	0.01
CV	0	0.65	0.27	0.92	0.43	0.48	0.12
Stratum 3:							
Mean Lbs/NM Towed	10	76	56	3	10	155	47
SE	6	48	36	1	7	84	23
Biomass Index	0.01	0.10	0.07	.00	0.01	0.20	0.06
SE	0.01	0.06	0.05	.00	0.01	0.11	0.03
CV	0.57	0.64	0.65	0.41	0.73	0.54	0.48
Stratum 4:							
Mean Lbs/NM Towed	13	6	43	3	1	65	40
SE	9	3	7	2	1	11	6
Biomass Index	.00	.00	0.01	.00	.00	0.02	0.01
SE	.00	.00	.00	.00	.00	.00	.00
CV	0.74	0.44	0.16	0.87	1.73	0.16	0.14
All Strata:							
Mean Lbs/NM Towed	5	91	44	2	7	149	51
SE	2	45	14	1	3	52	9
Biomass Index	0.02	0.33	0.16	0.01	0.03	0.54	0.18
SE	0.01	0.16	0.05	.00	0.01	0.19	0.03
CV	0.48	0.49	0.32	0.36	0.42	0.35	0.17

-Continued-

Appendix Table C1. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Kodiak district in 1985 (continued).

Olga Bay  
Cruise 8504  
2 September, 1985

	Stratum Number	Stratum Area	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	10.62	4	45.25	10.34		
	3	6.85	4	49.75	4.93		
	4	1.57	2	47.50	9.00		
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
<b>Stratum 2:</b>							
Mean Lbs/NM Towed	0.50	55.00	61.25	0.50	1.75	119.00	66.00
SE	0.65	46.17	23.64	0.65	1.91	61.68	22.96
Biomass Index	.00	0.11	0.12	.00	.00	0.24	0.13
SE	.00	0.09	0.05	.00	.00	0.12	0.05
CV	1.29	0.84	0.39	1.29	1.09	0.52	0.35
<b>Stratum 3:</b>							
Mean Lbs/NM Towed	16.69	311.46	125.55	3.00	0.00	456.70	136.19
SE	12.44	221.62	26.73	3.16	0.00	212.46	86.51
Biomass Index	0.02	0.41	0.16	.00	0.00	0.59	0.18
SE	0.02	0.29	0.03	.00	0.00	0.28	0.11
CV	0.75	0.71	0.21	1.05	0.00	0.47	0.64
<b>Stratum 4:</b>							
Mean Lbs/NM Towed	10.50	6.00	53.50	2.50	0.50	73.00	47.00
SE	8.17	2.65	18.97	2.96	0.87	11.00	11.00
Biomass Index	.00	.00	0.02	.00	.00	0.02	0.01
SE	.00	.00	0.01	.00	.00	.00	.00
CV	0.78	0.44	0.36	1.18	1.73	0.15	0.23
<b>All Strata:</b>							
Mean Lbs/NM Towed	7.15	143.22	83.74	1.56	1.02	236.70	89.68
SE	4.54	83.79	16.40	1.22	1.07	83.83	33.67
Biomass Index	0.03	0.52	0.30	0.01	.00	0.86	0.32
SE	0.02	0.30	0.06	.00	.00	0.30	0.12
CV	0.64	0.59	0.20	0.78	1.05	0.35	0.38

Appendix Table C2. Biomass indices (in millions of pounds) for shrimp and fish by area, cruise, and stratum for surveys in the Chignik district in 1985.

Chignik Bay  
Cruise 8501  
10 June, 1985

	Stratum Number	Stratum Area (nm)	Tows Made	Depth of Tows (fathoms)		Water Temps (Celsius)	
				Mean	SD	Surface	Bottom
	2	33.7	8	86.25	17.34	5.5	4.3
	3	10.5	3	50.67	12.98	5.3	3.4
	Pink	Humpy	Coon stripe	Side stripe	Other	Total	Fish
Stratum 2:							
Mean Lbs/NM Towed	148	0	0	6	5	159	461
SE	20	0	0	3	1	22	51
Biomass Index	0.95	0.00	0.00	0.04	0.03	1.02	2.95
SE	0.13	0.00	0.00	0.02	0.01	0.14	0.32
CV	0.14	0	0	0.56	0.25	0.14	0.11
Stratum 3:							
Mean Lbs/NM Towed	86	0	0	0	3	89	583
SE	54	1	0	0	2	56	109
Biomass Index	0.17	.00	0.00	0.00	0.01	0.18	1.16
SE	0.11	.00	0.00	0.00	.00	0.11	0.22
CV	0.63	1.58	0	0	0.93	0.63	0.19
All Strata:							
Mean Lbs/NM Towed	133	0	0	5	4	143	490
SE	20	0	0	3	1	22	47
Biomass Index	1.12	.00	0.00	0.04	0.04	1.20	4.12
SE	0.17	.00	0.00	0.02	0.01	0.18	0.39
CV	0.15	1.58	0	0.56	0.25	0.15	0.10

APPENDIX D

Biomass Indices of Major Taxa

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Appendix Table D1. Biomass indices in pounds per trawl mile (TM) of major taxa by fishing section and cruise for surveys in the Kodiak district in 1985.

Fishing Section	Cruise	Date	Shrimp Pounds/TM	Pac cod Pounds/TM	Pollock Pounds/TM	Roundfish Pounds/TM	Halibut Pounds/TM	Flatfish Pounds/TM	King Crab Pounds/TM	Tanner Pounds/TM	Misc. Invt Pounds/TM	Total Pounds/TM
Marmot Bay	8503	9/85	148.26	87.24	182.88	29.83	25.02	587.39	0.00	2.02	27.36	1090.00
Marmot Island	8503	9/85	194.05	136.60	124.17	36.07	20.18	1058.88	0.00	6.24	14.76	1591.57
Chiniak Bay	8501	9/85	77.96	30.81	58.60	9.41	3.12	458.72	0.00	3.26	11.65	653.53
Ugak Bay	8503	6/85	18.82	78.01	51.96	18.71	12.80	187.14	0.00	0.19	67.68	435.30
Kiliuda Bay	8503	10/85	15.97	80.44	797.35	19.49	4.60	408.46	0.00	0.36	18.92	1345.60
Twoheaded Island	8503	9/85	36.47	44.57	250.67	24.37	7.10	463.73	0.00	0.10	37.40	864.40
Alitak Bay	8501	5/85	185.92	50.92	138.00	60.17	28.83	100.25	0.00	2.17	1.58	567.83
Alitak Bay and Flats	8503	9/85	134.00	87.19	194.56	15.00	4.63	72.44	0.00	2.19	43.19	553.25
Uyak Bay	8503	9/85	23.05	32.19	405.73	36.78	0.00	92.91	0.00	0.00	92.06	682.73
Uganik Bay	8503	9/85	61.74	23.49	338.16	16.93	2.54	236.60	0.00	0.82	34.24	714.52
Kukak Bay	8503	9/85	145.98	84.93	346.07	36.68	3.51	116.52	0.00	9.17	18.27	761.13
Wide Bay	8503	9/85	288.76	0.15	201.55	79.90	2.37	6.63	0.00	0.00	13.42	592.77
Puale Bay	8503	9/85	2.00	39.67	434.33	78.67	0.00	60.67	0.00	0.00	44.67	660.00
Olga Bay	8502	5/85	148.60	0.00	0.36	46.87	0.00	3.49	0.45	0.00	0.00	199.77
	8504	9/85	236.70	0.00	0.27	85.12	0.00	4.29	0.00	0.00	0.00	326.38
Average lbs/TM			114.55	51.75	234.98	39.60	7.65	257.21	0.03	1.77	28.35	735.92
Rank			3	4	2	5	7	1	9	8	6	

Appendix Table D2. Biomass indices in pounds per trawl mile (TM) of major taxa by fishing section and cruise for surveys in the Chignik district in 1985.

Fishing Section	Cruise	Date	Shrimp Pounds/TM	Pac cod Pounds/TM	Pollock Pounds/TM	Roundfish Pounds/TM	Halibut Pounds/TM	Flatfish Pounds/TM	King Crab Pounds/TM	Tanner Pounds/TM	Misc. Invt Pounds/TM	Total Pounds/TM
Chignik Bay	8501	6/85	142.56	52.71	80.95	20.47	13.38	318.92	0.00	3.65	0.27	632.91
Average lbs/TM			142.56	52.71	80.95	20.47	13.38	318.92	0.00	3.65	0.27	632.91
Rank			2	4	3	5	6	1	9	7	8	

APPENDIX E

Station and Composite Length Frequency Sample Sizes

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Appendix Table E1. Station and composite length-frequency subsample sizes by fishing section for surveys in the Kodiak district in 1985 (P = pink shrimp; H = humpy shrimp; C = coonstripe shrimp).

Fishing Section	Station Catch							Composite							
	Number of Subsamples Taken			Subsample Size				Number of Subsamples Taken			Subsample Size				
	P	H	C	P	H	C	P	H	C	P	H	C			
Marmot Bay	5			1,075						2			552		
Marmot Island	5			930						1			238		
Chiniak Bay	3			566						1			307		
Ugak Bay	4			609						1			308		
Kiliuda Bay	1			188						3			713		
Twoheaded Island	1			157						1			304		
Alitak Bay and Alitak Flats	17			3,386						3			814		
Uyak Bay	1			201						1			320		
Uganik Bay	4			769						2			659		
Kukak Bay	5			981						2			491		
Wide Bay	3	5		566	896					1	1		182	330	
Puale Bay	ND			ND						ND			ND		
Olga Bay	6	17	2	532	3,838	364				2	4	ND	186	660	ND
Total	55	22	2	0	9,960	4,734	364	0		20	5	0	0	5,982	1,409

Appendix Table E2. Station and composite length-frequency subsample sizes by fishing section for surveys in the Chignik district in 1985 (P = pink shrimp; H = humpy shrimp; C = coonstripe shrimp).

Fishing Section	Station Catch						Composite					
	Number of Subsamples Taken			Subsample Size			Number of Subsamples Taken			Subsample Size		
	P	H	C	P	H	C	P	H	C	P	H	C
Chignik Bay	11			2,307			3			874		
Total	11	0	0	2,307	0	0	3	0	0	874	0	0

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