

TRAWL SHRIMP INDEX FISHING IN THE
SOUTHERN DISTRICT OF THE COOK INLET AREA

FALL 1990

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SOUTHERN DISTRICT OF THE COOK INLET AREA

SEPTEMBER 24 - OCTOBER 10, 1990

Lower Cook Inlet Data Report Number 90-06

by

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INTRODUCTION

The commercial trawl shrimp fishery in the Cook Inlet Management Area (H) began with intermittent harvests in the 1950's and early 1960's, but the small catches did not accurately reflect the size of the stocks in the area. In the late 1960's trawl catches reached the five million pound level annually and remained near that level through the early 1980's (Table 1). More recently, the commercial fishery has been closed since the fall of 1986 due to low abundance levels. Pink shrimp (*Pandalus borealis*) historically made up the bulk of the commercial catch, with sidestripes (*Pandalopsis dispar*) seasonally making up a lower but still significant portion of the catch. Humpy shrimp (*Pandalus goniurus*) at times comprised up to 50 percent of the annual commercial harvest, but this species appears to undergo the most erratic population fluctuations and their contribution to the most recent fisheries were minor. Finally, coonstripes (*P. hypsinotus*) consistently made up approximately five percent or less of the harvest. Effort has varied from a low of one vessel during 1968 to a high of 23 in 1981.

Trawl shrimp population abundance index surveys have been conducted by the Department in the Southern District once each year (May) from 1971 through 1975 and twice annually (May and October) since then. Results of the surveys have been used to monitor stock status and establish harvest guidelines for each of the three regulatory sub-seasons (summer, fall, and winter) during the fishing year. Eight new sampling stations were added to the survey during the spring of 1988 east of the Homer Spit because this area had become the major area of shrimp occurrence. Expanding the number of stations in this area also increased the statistical accuracy of the survey estimate of abundance.

METHODS

The fall 1990 trawl index survey was conducted aboard the state research vessel **PANDALUS** during the period September 24 through September 28, October 1 through October 3, and October 9 and 10. The reason for the time lag between October 3 and 10 was a building series of tides during that time period, making trawling more difficult and the results unreliable. The survey utilizes a 61-foot National Marine Fisheries Service (NMFS) designed high opening shrimp net. This particular style of net, used in the surveys since 1975, replaced a 66-foot Nordby trawl net utilized for the surveys between 1971 through 1974. Based on comparative tows, the older Nordby net was assumed to be 50 percent as efficient as the newer NMFS net (Davis, 1982).

Individual one nautical mile tows were made in systematically selected one-square mile stations throughout Kachemak Bay, Tutka Bay, and Sadie Cove. In recent years, to reduce the potential of net damage, one-half mile tows were utilized in stations west of

Homer Spit which have had a recent history of no shrimp catch. If tows in the one-half mile stations indicated presence of shrimp, the tow was repeated with a length increase to the standard distance of one mile.

Upon completion of each tow, the total catch was weighed to the nearest two pounds using a digital electronic hanging scale and subsequently dumped on the rear deck. All very large non-shrimp objects (rocks, stumps, pots, large fish, etc.) were removed from the catch, weighed directly, and returned over the side of the vessel. Additionally, all Pacific halibut (*Hippoglossus stenolepis*), blackcod (*Anoplopoma fimbria*), and Pacific cod (*Gadus macrocephalus*) were sorted out of the catch prior to sampling. These three species were then counted and weighed.

For those catches containing shrimp, two random samples of approximately 10,000 grams each (3 gallon bucket) were collected from individual tows of five hundred pounds or more; for catches of less than five hundred pounds, one such sample was collected. Each 10,000 gram bucket sample was then separated by fish and other non-shrimp material (which included finfish, flatfish, shellfish other than shrimp, and any miscellaneous debris), and shrimp. Each of these groups was weighed on an electronic platform scale to obtain percentages of the total catch.

A 2,500 gram subsample was next randomly selected from the shrimp in the original 10,000 gram sample. The shrimp were further separated by species. Each species was weighed separately for species composition. In addition, small quantities of shrimp from the subsample were labelled and retained for later length frequency analysis in the laboratory. In the case of pink shrimp, which generally comprise the highest percentage of each shrimp subsample, a quantity of approximately 350 to 400 grams was retained from each station. For the other species, normally all individuals were retained since they usually amount to a relatively small number of shrimp per station subsample.

For those tows which contained no shrimp, one or two basket samples of approximately 15,000 to 25,000 grams each were collected from the catch. Fish and other non-shrimp material were subsequently separated by species, counted, and weighed in order to obtain a more accurate estimate of fish species composition in areas of little or no shrimp occurrence.

RESULTS

A total of 34 successful tows from those stations utilized in the survey design prior to the spring of 1988 ("traditional stations") yielded an overall average catch of 80.3 pounds of Pandalid shrimp per one nautical mile towed (Table 2). When the data from the eight stations added to the surveys in 1988 ("non-traditional" stations) east of Homer Spit were included in the

survey results, the average catch of shrimp increased to 104.6 pounds per nautical mile towed. These figures do not include any catch data from the Tutka Bay/Sadie Cove areas since those areas are closed to commercial trawling.

The average catches of Pandalid shrimp per nautical mile by respective area were 306.7 pounds per tow east of the Homer Spit (traditional stations only), 256.3 pounds per tow east of the Homer Spit (all stations combined), 1.4 pounds per tow west of the Spit, and 36.0 pounds per tow in Tutka Bay/Sadie Cove (Table 3). The abundance index estimate for the Southern District based on the results of the fall 1990 survey for the traditional stations only ranged from 0.6 to 2.1 million pounds with a midpoint of 1.3 million pounds. Calculating in the non-traditional stations, the abundance index midpoint estimate was 1.7 million pounds, with a range of 1.0 to 2.6 million pounds. Formulas and explanations used to calculate the midpoint estimate and range are shown in Appendix Table 1.

As expected, pinks dominated the catches at 91.8 percent, the highest percentage ever recorded in the fall surveys. Humpies comprised only 2.1 percent of the catches, the lowest percentage of this species in the fall surveys since 1985. Sidestripes contributed 1.8 percent of the total, the lowest percentage of this species in the history of both the spring or fall surveys, while coonstripes also contributed 1.8 percent to the catches, the lowest percentage for this species in the fall surveys since 1981 (Table 4). Incidence of "other" shrimp, such as *Crangon* sp. and *Eualis* sp. was approximately 2.5 percent. Preliminary average counts per pound for pink shrimp in the traditional stations east of the Homer Spit were 154 for the closed commercial waters north and northeast of Glacier Spit and 129 for the open commercial waters south and west of Glacier Spit. West of Homer Spit, the average pink shrimp count per pound was 78 for eleven stations in which shrimp were caught (Table 5).

The largest single catch of Pandalid shrimp, totalling 977 pounds, occurred in station U27, a non-traditional station located approximately 1.0 mile due west of Bear Cove (Figure 1). The catch from station U27 was dominated by pink shrimp at 90 percent. Station R25, approximately two miles due west of Mallard Bay, had the next highest catch of Pandalid shrimp at 800 pounds. The catch was comprised almost exclusively of pinks at 93 percent. Twelve stations had a zero catch of shrimp, eleven west of Homer Spit and one east of the Spit. The catch from the single tow in Tutka Bay totalled only 39 pounds of shrimp, of which 75 percent was pinks and 13 percent coonstripes (Table 6).

Percentages of fish and other non-shrimp species by weight in the catches of the traditional stations were 78.5 and 99.8 percent for the areas east and west of the Homer Spit, respectively (Table 7). The former figure is the highest ever recorded for

the fall survey. For the waters east of the Homer Spit, the largest single station catch of fish and non-shrimp species occurred at station O22, located approximately two miles southwest of Glacier Spit. The catch, totalling 2,650 pounds, was dominated equally by walleye pollock (*Theragra chalcogramma*), at nearly 33 percent of the non-shrimp total, and Tanner crab (*Chionocetes bairdi*), also at nearly 33 percent of the non-shrimp total. One other station east of the Spit had a non-shrimp catch in excess of 2,000 pounds, while six additional stations had non-shrimp catches in excess of 1,000 pounds.

West of the Homer Spit, station I14 had a fish and non-shrimp catch of 3,400 pounds. This station is located approximately one mile due west of Yukon Island. The catch was composed almost exclusively of pollock at 85 percent. The adjacent tow to the south, station H14, totalled over 2,500 pounds of fish and non-shrimp, once again dominated by pollock at 66 percent, followed by flathead sole (*Hippoglossoides elassodon*) at 13 percent. In Tutka Bay and Sadie Cove, the two tows averaged approximately 1,100 pounds of fish each. The Tutka tow was dominated by pollock (32 percent) and a variety of jellyfish species (24 percent), while the Sadie catch was dominated by flathead sole (28 percent) and pollock (21 percent).

The most commonly occurring non-shrimp species throughout the survey were pollock, flathead sole, and arrowtooth flounder (*Atheresthes stomias*). In terms of total weight, pollock represented the largest portion of the non-shrimp catches west of the Homer Spit (Table 8), followed by flathead sole and arrowtooth flounder. East of the spit, seven tows were sampled for non-shrimp species, with pollock dominating the non-shrimp catches overall, followed by Dungeness crab (*Cancer magister*) and flathead sole.

DISCUSSION

The average catch of shrimp from all traditional stations decreased over the spring survey of 1990, but was similar to the average of the fall survey of 1989. The resulting abundance midpoint estimate of 1.3 million pounds was a new all-time low for the survey (Table 2). When the non-traditional stations were considered, the calculated overall abundance midpoint of 1.7 million pounds was a decline from previous surveys which included the non-traditional stations. The average catch of shrimp from the Tutka/Sadie area was a new low for those bays.

The highest catches of shrimp occurred in the commercially closed area north and northeast of Glacier Spit (Figure 1). The six stations in this area averaged 573 pounds of shrimp per tow, which compared to approximately 1,300 pounds per tow for this area during the spring of 1990, 500 pounds per tow in the fall of 1989, and 729 pounds per tow in the spring of 1989. Overall for

the ten stations west and southwest of Glacier Spit (open commercial area), the fall 1990 shrimp catches averaged 84 pounds per tow, compared with 104 pounds per tow for this area in the spring of 1990, 197 pounds per tow during the fall 1989 survey, and only 22 pounds per tow in the spring 1989 survey. West of the Spit, the areas of shrimp occurrence remained approximately the same as recent surveys but the abundance decreased slightly.

Catches of fish and non-shrimp species, including crabs, in the closed commercial area east of the Spit averaged 563 pounds per tow, while those in the open area averaged 1,308 pounds. The former figure was high, but was similar to averages for that area in recent surveys. The latter figure was by far the highest for that area in recent surveys. West of the Spit, fish and non-shrimp species catches averaged 986 pounds per tow, over twice the average catch from the spring survey of 1990, but less than the average from the fall survey in 1989.

Count per pound information collected in the field suggested that the pink shrimp found in the closed commercial area east of the Homer Spit were a mixture of females, males, and juveniles. In the open commercial area, the lower number counts per pound indicated that shrimp in this area were larger, consisting of mostly males and females, but fewer juveniles. West of the Spit the very low number counts implied mostly females. All count per pound figures from the area east of the Homer Spit were marginally lower than those from the spring survey of 1990, but they were considerably lower than those from the fall of 1989.

Shrimp survival appears to have been poor over the past year compared to the previous year. Counts per pound indicated fewer young, small shrimp in all areas, suggesting either poor reproductive success or poor survival and subsequent growth of these younger shrimp. The majority of shrimp continued to be found in the northeast portion of Kachemak Bay. Incidence and abundance of fish species increased over the spring of 1990 and all of 1989 in the open commercial area east of the Spit, but decreased in the area west of the Spit compared to recent years' fall surveys. Fish abundances throughout Kachemak Bay continued to be high by historical standards.

Current environmental factors seem to be the primary element influencing the pink shrimp stocks in Kachemak Bay. Based on the results of the fall 1990 survey, the pink shrimp stocks would appear to be remaining somewhat stable or slightly weaker due to either poor survival or reproductive success. Stocks of fish, which potentially prey upon shrimp within Kachemak Bay, may be increasing and further encroaching into the areas of major shrimp abundance east of the Homer Spit. The shrimp stocks do not appear to be rebounding and have not yet begun to return to levels seen in the 1970's, remaining very low by historical standards.

The staff is presently preparing an analysis of pink shrimp size frequencies from the Kachemak Bay trawl shrimp surveys. In addition to providing a compilation of historical information, this paper should help to determine annual growth for pink shrimp in Kachemak Bay.

LITERATURE CITED

Davis, Allen S. 1982. The commercial otter trawl shrimp fishery of Cook Inlet. ADF&G Informational Leaflet No. 205: 91 pp.

Table 1. Historical trawl shrimp catches by guideline harvest level for the Kachemak Bay trawl shrimp fishery in the Cook Inlet Management Area (H).

SEASON	NUMBER OF VESSELS	CATCH (lbs)			TOTAL
		JUN 1-OCT 31	NOV 1-MAR 31	APR 1-MAY 31	
1969-70a	7	1,289,656	1,692,854	889,330	3,871,840
1970-71a	3	3,211,924	2,076,228	617,836	5,905,988
1971-72a	7	2,618,630	1,761,569	140,707	4,520,906
1972-73a	10	2,772,422	2,109,660		4,882,082
1973-74b	13	2,502,154	2,323,780		4,825,934
1974-75	4	2,512,764	2,519,148		5,031,912
1975-76	4	1,997,563	2,421,456		4,419,019
1976-77	5	2,545,885	2,453,101		4,998,986
1977-78	7	2,490,969	2,546,977		5,037,946
1978-79	6	2,952,733	3,060,066		6,012,799
		JUL 1-SEP 30	OCT 1-DEC 31	JAN 1-MAR 31	
1979-80	7	2,013,298	2,052,646	1,731,483	5,797,427
1980-81	15	1,780,298	2,691,746	1,704,706	6,177,129
1981-82	23	1,614,868	1,686,781	1,693,850	4,995,499
1982-83	15	998,522	1,012,388	1,009,857	3,020,767
1983-84	10	CLOSED	CLOSED	525,508	525,508
1984-85	10	519,651	528,506	518,529	1,566,686
1985-86	5	488,606	257,782	503,340	1,249,728
1986-87	3	504,206	CLOSED	CLOSED	504,206
1987-88	0	CLOSED	CLOSED	CLOSED	0
1988-89	0	CLOSED	CLOSED	CLOSED	0
1989-90	0	CLOSED	CLOSED	CLOSED	0
1990-91	0	CLOSED	CLOSED	CLOSED	0

a Catches listed for comparative purposes by seasons established in 1973.

b June 1 - October 31 and November 1 - March 31 seasons with respective guidelines established.

Table 2. Abundance index estimates of commercial species of Pandalid shrimp (millions of pounds) in the Southern District (Kachemak Bay), by sampling period and year, based on pounds of shrimp caught per one nautical mile tow (traditional stations only).

MONTH	YEAR	MEAN CATCH (lbs/tow)	NUMBER OF STATIONS	% ERROR	ABUNDANCE INDEX (Mill. of lbs.)	(Mill. of lbs.)	
<u>SPRING</u>							
May	1971	130.2a	56	20.0	3.7	3.0	to 4.5
May	1972	271.1a	66	35.5	7.7	5.0	to 10.5
May	1973	592.8a	59	27.8	16.9	12.2	to 21.6
Jun	1974	476.6a	30	22.8	13.6	10.5	to 15.7
May	1975	1,136.9b	37	27.9	16.2	11.7	to 20.7
May	1976	541.3	36	28.3	7.7	5.5	to 9.9
Jun	1977	407.9	40	17.1	5.8	4.8	to 6.8
May	1978	810.9	36	25.2	11.5	8.6	to 14.5
May	1979	743.7	41	20.9	10.6	8.4	to 12.8
May	1980	513.7	39	19.5	7.3	5.9	to 8.7
May	1981	486.1	37	18.4	6.9	5.6	to 8.2
May	1982	306.8	38	21.8	4.4	3.4	to 5.3
May	1983	204.0	37	24.8	2.9	2.2	to 3.6
May	1984	282.3	34	34.2	4.1	3.0	to 5.2
May	1985	197.5	34	39.7	3.2	1.9	to 4.5
May	1986	157.2	34	50.9	2.6	1.3	to 4.0
May	1987	178.8	34	45.2	3.0	1.6	to 4.3
May	1988	247.5	33	45.0	4.1	2.3	to 6.0
May	1989	90.5	31	65.9	1.5	0.5	to 2.5
May	1990	106.5	33	87.1	1.7	0.2	to 3.2
<u>FALL</u>							
Oct	1976	719.8	33	21.6	10.3	8.0	to 12.5
Nov	1977	738.1	36	28.9	10.5	7.5	to 13.5
Oct	1978	1,160.3	32	25.5	16.5	12.3	to 20.7
Oct	1979	1,133.3	32	23.3	16.1	12.4	to 19.9
Oct	1980	1,689.4	37	19.3	24.1	19.4	to 28.7
Oct	1981	604.8	35	26.9	7.9	5.8	to 10.0
Oct	1982	519.2	36	26.3	7.4	5.4	to 9.3
Oct	1983	481.3	36	36.6	6.9	4.9	to 8.8
Oct	1984	531.9	35	26.3	7.6	6.1	to 9.1
Oct	1985	284.9	34	32.0	4.1	2.8	to 5.4
Sep	1986	154.0	34	37.9	2.6	1.6	to 3.6
Sep/Oct	1987	227.0	34	66.1	3.8	1.3	to 6.3
Nov	1988	152.3	28	64.8	2.5	0.9	to 4.2
Sep	1989	84.8	32	49.0	1.4	0.7	to 2.1
Sep/Oct	1990	80.3	34	54.5	1.3	0.6	to 2.1

a66' Nordby net, 50% assumed net efficiency.

bFrom this survey to present, a 61' NMFS net with 100% assumed net efficiency has been used.

Table 3. Mean catch of Pandalid shrimp in pounds per one nautical mile tow, by area (traditional stations only), by period, and by year, captured during trawl shrimp index surveys in the Southern District (Kachemak Bay) of the Cook Inlet Management Area (H).

Month	Year	MEAN CATCH OF PANDALID SHRIMP (lbs/tow)		
		West of Spit	East of Spita ^a	Tutka/Sadie ^b
<u>SPRING</u>				
May	1971 ^c	126.5	69.3	
May	1972 ^c	366.9	75.7	
May	1973 ^c	759.2	156.1	
Jun	1974 ^c	492.1	211.2	
May	1975 ^d	1,250.0	660.0	
May	1976	479.6	802.0	
Jun	1977	317.6	678.7	
May	1978	749.5	1,175.7	
May	1979	786.0	633.9	
May	1980	488.1	539.2	
May	1981	454.5	584.7	1,492.3
May	1982	268.6	413.3	452.0
May	1983	97.2	536.2	1,830.8
May	1984	56.0	910.0	1,179.8
May	1985	2.6 ^e	830.4	2,027.0
May	1986	2.0 ^e	588.4	1,102.9
May	1987	24.0 ^e	609.0	714.3 ^f
May	1988	39.1 ^e	898.9	2,006.0 ^g
May	1989	2.7	342.8	508.0 ^h
May	1990	6.0	374.0	303.5 ^h

^aTraditional stations only.

^bThe Tutka/Sadie area was not surveyed prior to 1981.

^cNordby trawl net (66' ground rope, 53' head rope, 60' tickler chain) with 50% assumed net efficiency.

^dFrom this survey to present, a 61' NMFS net with 100% assumed net efficiency has been used.

^eExtremely small shrimp catches (less than 10% of total) were not processed for actual weight and are referred to as "trace shrimp", and are considered zero for calculations.

^fOnly 2 of the 3 tows in Sadie Cove included.

^gOnly one tow in Sadie Cove made and its weight was estimated due to a malfunctioning electronic scale.

^hOnly one tow made in Sadie Cove.

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Month	Year	MEAN CATCH OF PANDALID SHRIMP (lbs/tow)		
		West of Spit	East of Spita ^a	Tutka/Sadie ^b
<u>FALL</u>				
Oct	1976	574.7	1,127.0	
Nov	1977	695.6	456.6	
Oct	1978	1,310.2	626.0	
Oct	1979	1,263.7	805.6	
Oct	1980	1,764.4	1,456.2	
Oct	1981	626.6	541.9	734.0
Oct	1982	303.4	1,274.4	1,309.5
Oct	1983	48.1	1,607.6	3,492.3
Oct	1984	305.7	1,185.5	2,741.0
Oct	1985	88.8	829.8	876.9
Sep	1986	18.0 ^c	518.9	1,188.9
Sep/Oct	1987	2.0 ^c	852.0	667.7
Nov	1988	1.3 ^c	471.0	597.5 ^d
Sep	1989	3.5	292.6	461.5 ^d
Sep/Oct	1990	1.4	306.7	33.0 ^d

^aTraditional stations only.

^bThe Tutka/Sadie area was not surveyed prior to 1981.

^cExtremely small shrimp catches (less than 10% of total) were not processed for actual weight and are referred to as "trace shrimp", and are considered zero for calculations.

^dOnly 1 tow made in Sadie Cove.

Table 4. Catch composition (percent) of Pandalid shrimp species in the Southern District (Kachemak Bay) trawl abundance index surveys by sampling period and year (traditional stations only). "Other" shrimp (*Crangon* sp. and *Eualis* sp.) are additional to those years where figures do not add up to 100 percent.

YEAR	MONTH	PINK	HUMPY	COON	SIDE	ABUNDANCE INDEX (Million lbs.)
SPRING						
1971	May	83.8	9.9	1.9	4.4	3.7
1972	May	62.0	33.2	1.3	3.5	7.7
1973	May	67.5	27.3	1.8	3.4	16.9
1974	Jun	81.6	7.9	2.2	8.3	13.6
1975	May	74.8	16.6	2.7	5.9	16.2
1976	May	82.6	5.3	3.6	8.5	7.7
1977	Jun	83.4	3.3	6.1	7.2	5.8
1978	May	67.9	24.8	1.3	6.1	11.5
1979	May	78.3	14.3	2.3	5.1	10.6
1980	May	63.4	23.6	1.9	11.1	7.3
1981	May	72.7	13.8	4.2	9.3	6.9
1982	May	73.2	12.6	3.4	10.8	4.4
1983	May	71.3	1.4	1.4	25.9	2.9
1984	May	85.4	1.8	0.9	11.8	4.1
1985	May	89.0	1.6	1.0	8.4	3.2
1986	May	70.6	7.4	1.3	20.1	2.6
1987	May	78.3	10.1	2.1	9.6	3.0
1988	May	67.5	17.9	2.2	10.5	4.1
1989	May	94.3	1.4	1.4	2.0	1.5
1990	May	74.4	17.9	4.0	2.6	1.7
FALL						
1976	Oct-Dec	69.0	20.8	3.0	7.2	10.3
1977	Nov	58.1	29.2	2.0	10.7	10.5
1978	Oct	47.4	45.9	1.7	5.0	16.5
1979	Oct	45.2	50.4	0.7	3.7	16.1
1980	Oct	57.8	34.5	1.5	6.2	24.1
1981	Oct	57.8	30.4	1.6	10.2	7.9
1982	Oct	71.2	16.0	2.5	10.3	7.4
1983	Oct	72.1	15.4	2.6	9.8	6.9
1984	Oct	68.4	19.8	2.9	8.9	7.6
1985	Oct	71.7	1.1	2.9	19.2	4.1
1986	Sep	75.5	2.3	3.9	12.1	2.6
1987	Sep/Oct	63.6	8.5	3.0	19.4	3.8
1988	Nov	78.1	10.3	3.2	4.9	2.5
1989	Sep	86.7	3.1	2.9	2.0	1.4
1990	Sep/Oct	91.8	2.1	1.8	1.8	1.3

Table 5. Historical average numbers of pink shrimp (*Pandalus borealis*) per pound by area from samples taken during ADF&G trawl index surveys in the Southern District (Kachemak Bay) of the Cook Inlet Management Area (H).

Year	East of Homer Spit			West of Homer Spit Pinks/lb.	Combined Avg. All Areas Pinks/lb. ^a
	Open Commercial Area Pink Count/lb.	Closed Commercial Area Pink Count/lb.	Combined Avg. Pink Count/lb.		
<u>Spring Survey</u>					
1971	230.3	213.4	220.0	159.6	180.4
1972	185.3	203.1	196.7	137.3	151.9
1973	230.4	167.2	182.5	152.0	158.5
1974	133.8	125.6	129.5	126.0	126.8
1975	154.6	143.5	150.0	135.9	138.1
1976	169.6	157.8	165.9	107.5	126.7
1977	144.7	142.7	143.5	109.0	120.5
1978	155.0	163.6	158.6	123.7	130.2
1979	170.7	203.3	185.1	126.6	147.1
1980	173.6	190.1	181.7	112.0	127.5
1981	193.1	190.9	192.2	111.7	134.9
1982	180.8	177.2	178.7	112.8	129.2
1983[May/Jun]	151.3	176.2	164.0	102.6	128.3
1983[Jul]	169.3	194.4	177.0	106.7	161.0
1984	177.5	224.2	206.7	98.5	142.6
1985	193.8	244.3	220.9	199.0	218.2
1986	155.5	229.4	200.5	NO SAMPLES	200.5
1987	134.8	271.4	212.6	108.5	204.7
1988	107.5	247.3	209.8	95.0	175.5
1989	121.3	197.7	184.4	85.0	176.3
1990	133.9	163.8	157.1	93.7	144.7

Table 5, page 2 of 2.

Year	East of Homer Spit			West of Homer Spit Pinks/lb.	Combined Avg. All Areas Pinks/lb. ^a
	Open Commercial Area Pink Count/lb.	Closed Commercial Area Pink Count/lb.	Combined Avg. Pink Count/lb.		
<u>Fall Survey</u>					
1976	NO SAMPLES	144.1	144.1	112.5	123.0
1977	NO SAMPLES	164.0	164.0	144.1	152.7
1978	148.1	159.6	155.0	133.4	140.3
1979	149.8	NO SAMPLES	149.8	135.0	138.4
1980	150.8	183.0	173.3	135.4	144.2
1981	112.9	182.0	154.2	127.2	139.5
1982	202.0	181.9	191.1	106.8	149.5
1983[Oct]	198.9	232.7	217.8	146.2	200.9
1983[Dec]	118.3	218.4	170.2	NO SAMPLES	170.2
1984	183.8	205.8	196.3	142.6	168.9
1985	190.0	246.7	234.7	247.5	239.1
1986	215.3	230.7	223.2	131.4	207.7
1987	115.0	184.0	152.0	NO SAMPLES	152.0
1988	109.5	146.5	138.8	83.1	138.6
1989	145.3	188.8	178.0	92.0	174.7
1990	129.1	153.9	149.3	77.7	147.7

^aDoes not include any samples from the Tutka Bay/Sadie Cove area.

Table 6. Catches by station in pounds per one nautical mile tow in the Southern District (Kachemak Bay) during the fall trawl shrimp index survey, September 24 - October 10, 1990 (61-foot high opening NMFS net).

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP					Total ^a Lbs.	%	FISH	
			Pink	Humpy	Coon	Side	Other			Total Lbs.	%
<u>West of Homer Spit</u>											
18	64-66	L17	T	0	T	T	T	1	0.1	801	99.9
21	51-49	H14	2	0	0	0	1 ^b	2	0.1	2,520	99.9
22	57-63	L16	1	0	0	T	T	2	0.1	1,672	99.9
23	89-88	K16	1	0	0	T	1	2	0.3	564	99.7
24	25-29	J15	0	0	0	0	0	0	0.0	49	100.0
25	42-50	I14	3	0	0	0	0	3	0.1	3,401	99.9
26	66-56	J13	3	0	0	T	0	3	0.5	691	99.5
27	48-52	L13	1	0	0	0	0	1	0.1	1,365	99.9
28	57-50	L15	4	0	0	2	0	6	0.3	1,992	99.7
29	89-75	K15	2	0	0	1	1 ^b	3	0.3	872	99.7
30	71-54	K14	5	0	0	3	0	8	0.7	1,098	99.3
31 ^c	47	L10	0	0	0	0	0	0	0.0	816	100.0
32 ^c	47-42	L09	0	0	0	0	0	0	0.0	816	100.0
33 ^c	46-45	K09	0	0	0	0	0	0	0.0	588	100.0
34 ^c	43-42	K11	0	0	0	0	0	0	0.0	314	100.0
35 ^c	45	J11	0	0	0	0	0	0	0.0	342	100.0
36 ^c	35-36	J07	0	0	0	0	0	0	0.0	308	100.0
37 ^c	35-39	H05	0	0	0	0	0	0	0.0	130	100.0
38 ^c	46-44	H07	0	0	0	0	T ^b	0	0.0	454	100.0
39 ^c	44	H08	0	0	0	0	T ^b	0	0.0	454	100.0
40 ^c	55-58	I09	0	0	0	0	0	0	0.0	370	100.0
41 ^c	61	I12	5	0	T	0	1	5	0.3	1,887	99.7
42 ^c	41-52	H10	T	0	0	T	2 ^b	2	0.1	1,260	99.9
43 ^c	52-49	H11	T	0	0	T	2 ^b	2	0.1	1,260	99.9
44 ^c	45-52	H12	0	0	0	0	0	0	0.0	620	100.0
<u>Subarea</u>											
Total			26	0	0	7	6	40	0.2	24,644	99.8
Percent			66.1	0.0	0.8	18.1	15.1				
Mean per tow			1.1	0.0	0.0	0.3	0.3	1.7	0.2	985.8	99.8

^a Includes species such as *Crangon sp.* and *Eualis sp.*

^b "Other" shrimp include a small amount of *P. platyceros*.

^c One-half nautical mile tow doubled to represent standard one nautical mile tow.

Table 6, page 2 of 3.

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP					Total ^a Lbs.	%	FISH	
			Pink	Humpy	Coon	Side	Other			Total Lbs.	%
<u>East of Homer Spit (Traditional)</u>											
1	24-26	R24	143	11	4	4	3 ^b	164	33.3	330	66.7
2	20-26	S25	342	5	4	6	3	361	46.8	410	53.2
7	24-28	T26	520	12	13	4	3	553	57.3	413	42.7
8	29	R25	760	16	7	16	20	820	56.4	634	43.6
9	31-24	Q24	564	8	13	6	28	619	46.4	715	53.6
12	28-35	O24	193	7	7	0	7	214	10.7	1,786	89.3
14	47-42	N22	4	1	0	1	0	6	0.5	1,156	99.5
15	39-40	O22	18	0	0	5	0	23	0.9	2,653	99.1
16	46-49	N21	T	0	0	0	0	0	0.0	1,996	100.0
<u>Subarea</u>											
	Total		2,545	60	49	43	64	2,760	21.5	10,093	78.5
	Percent		92.2	2.2	1.8	1.6	2.3				
	Mean per tow		282.8	6.6	5.4	4.8	7.1	306.7	21.5	1,121.4	78.5
<u>Kachemak Bay Total</u>											
	Total		2,572	60	49	50	70	2,800	7.5	34,737	92.5
	Percent		91.8	2.1	1.8	1.8	2.5				
	Mean per tow		77.9	1.8	1.5	1.5	2.1	84.9	7.7	1,021.7	92.3
<u>Tutka Bay/Sadie Cove</u>											
19	40-48	C/D20	30	T	5	4	0	39	4.9	755	95.1
20	44-42	H18	29	1	3	0	T	33	2.3	1,443	97.7
	Total		59	1	8	4	0	72	3.2	2,198	96.8
	Percent		80.8	1.7	10.9	6.1	0.6				
	Mean per tow		29.3	0.6	3.9	2.2	0.2	36.2	3.2	1,099	96.8

^a Includes species such as *Crangon* sp. and *Eualis* sp.

^b "Other" shrimp include a small amount of *P. danae*.

Table 6, page 3 of 3.

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP					Total ^a Lbs.	%	FISH	
			Pink	Humpy	Coon	Side	Other			Total Lbs.	%
<u>East of Homer Spit (Non-traditional)</u>											
3	28-25	U27	893	14	56	14	18	995	53.3	873	46.7
4	28	O20	22	0	5	0	1 ^b	29	2.3	1,207	97.7
5	20-29	P21	114	T	1	0	1	117	9.4	1,125	90.6
6	31-30	P22	174	4	2	1	1	183	21.4	670	78.6
10	34-36	O21	72	0	0	2	0	73	5.1	1,367	94.9
11	33-34	P23	197	3	3	3	6	211	12.7	1,448	87.3
13	36-41	O23	69	4	1	2	2	79	13.0	525	87.0
17	38	N20	5	0	0	0	0	5	0.2	2,237	99.8
<u>Subarea</u>											
	Total		1,547	25	68	22	29	1,690	15.2	9,452	84.8
	Percent		91.5	1.5	4.0	1.3	1.7				
	Mean per tow		193.3	3.2	8.5	2.7	3.6	211.3	15.2	1,181.5	84.8

^a Includes species such as *Crangon sp.* and *Eualis sp.*

^b "Other" shrimp include a small amount of *P. platyceros*.

Table 7. Percent composition of fish during trawl shrimp index surveys in the Southern District (Kachemak Bay) based on catches of fish and shrimp per one nautical mile tow, by sampling period and year (traditional stations only).

YEAR	EAST OF SPIT (241-13, 14, 15)		WEST OF SPIT (241-11 and 241-12)	
	MAY	OCT	MAY	OCT
1972	36.2		5.5	
1973	22.2		7.9	
1974	6.9		3.9	
1975	10.6		9.0	
1976	9.0	11.9	16.1	13.8
1977	8.6	20.3	30.4	18.7
1978	29.4	14.8	19.6	16.7
1979	18.6	16.7	12.8	17.5
1980	10.7	17.7	13.7	16.1
1981	5.1	38.2	35.2	40.8
1982	19.1	35.4	32.1	64.5
1983	30.4	42.0	59.5	87.9
1984	18.0 ^a	35.3	75.0 ^a	57.0
1985	7.4	22.0	99.3	92.9
1986	10.8	18.1	99.3	94.3
1987	23.2	42.1	90.4	99.8
1988	40.4	60.6 ^b	94.4	99.9 ^b
1989	38.9	75.1	99.6	99.7
1990	67.7	78.5	98.5	99.8

^aDoes not include large cod and halibut.

^bSurvey actually occurred Nov. 13-19 aboard R/V RESOLUTION.

Table 8. Breakdown of fish catches by species in the Southern District (Kachemak Bay) trawl shrimp index of abundance survey, September 24 - October 10, 1990.

Fish Species	EAST OF SPIT (7 Tows)			WEST OF SPIT (25 Tows)		
	Occurrence # of Tows	Total Lbs.	% of Total	Occurrence # of Tows	Total Lbs.	% of Total
Halibut	4	52	0.4	14	330	1.3
Pacific cod	5	64	0.5	19	1,595	6.5
Pollock	7	5,012	40.4	24	11,176	45.3
Flathead sole	7	1,780	14.4	24	3,791	15.4
Arrowtooth flounder	7	280	2.3	24	1,656	6.7
Rex sole	1	9	0.1	20	483	2.0
Dover sole	1	4	T	15	681	2.8
Rock sole	2	39	0.3	2	153	0.6
Butter sole	0	0	0	8	153	0.6
Yellowfin sole	4	130	1.0	6	95	0.4
English sole	0	0	0	5	24	0.1
Blackcod	0	0	0	7	14	0.1
Tomcod	3	112	0.9	17	1,176	4.8
Smelt	6	33	0.3	3	6	T
Sculpins/ Irish Lords	7	802	6.5	12	187	0.8
Poachers	1	2	T	8	15	0.1
Tanner crab	6	1,321	10.7	19	529	2.1
Dungeness crab	7	2,112	17.0	6	111	0.5
King crab	0	0	0	0	0	0
Starry flounder	2	123	1.0	1	88	0.4
Pricklebacks	2	15	0.1	2	6	T
Skates	2	163	1.3	4	134	0.5
Herring	1	15	0.1	6	16	0.1
Searchers	0	0	0	5	8	T
Rockfish	0	0	0	14	424	1.7
Eelpouts	7	22	0.2	6	32	0.1
Pink scallop	0	0	0	5	35	0.1
Weathervane scallop	0	0	0	5	11	T
Urchins	0	0	0	7	270	1.1
Octopus/Squid	0	0	0	1	36	0.1
Starfish	1	8	0.1	5	8	T
Sandfish	2	6	T	6	5	T
Snailfish	1	1	T	3	7	T
Clams/snails	0	0	0	7	41	0.2
Alaska plaice	0	0	0	1	4	T
Sea Anemones	0	0	0	4	166	0.7
"Other" crab	1	6	T	5	7	T
<i>Parastichopus</i>	0	0	0	3	26	0.1
<i>Pentamera</i>	1	24	0.2	0	0	0
<i>Cucumaria</i>	0	0	0	0	0	0
Wrymouth	0	0	0	0	0	0
Kelp/rocks/ shells/debris	7	211	1.7	12	439	1.8
TOTALS	7	12,401	100.0	25	24,645	100.0

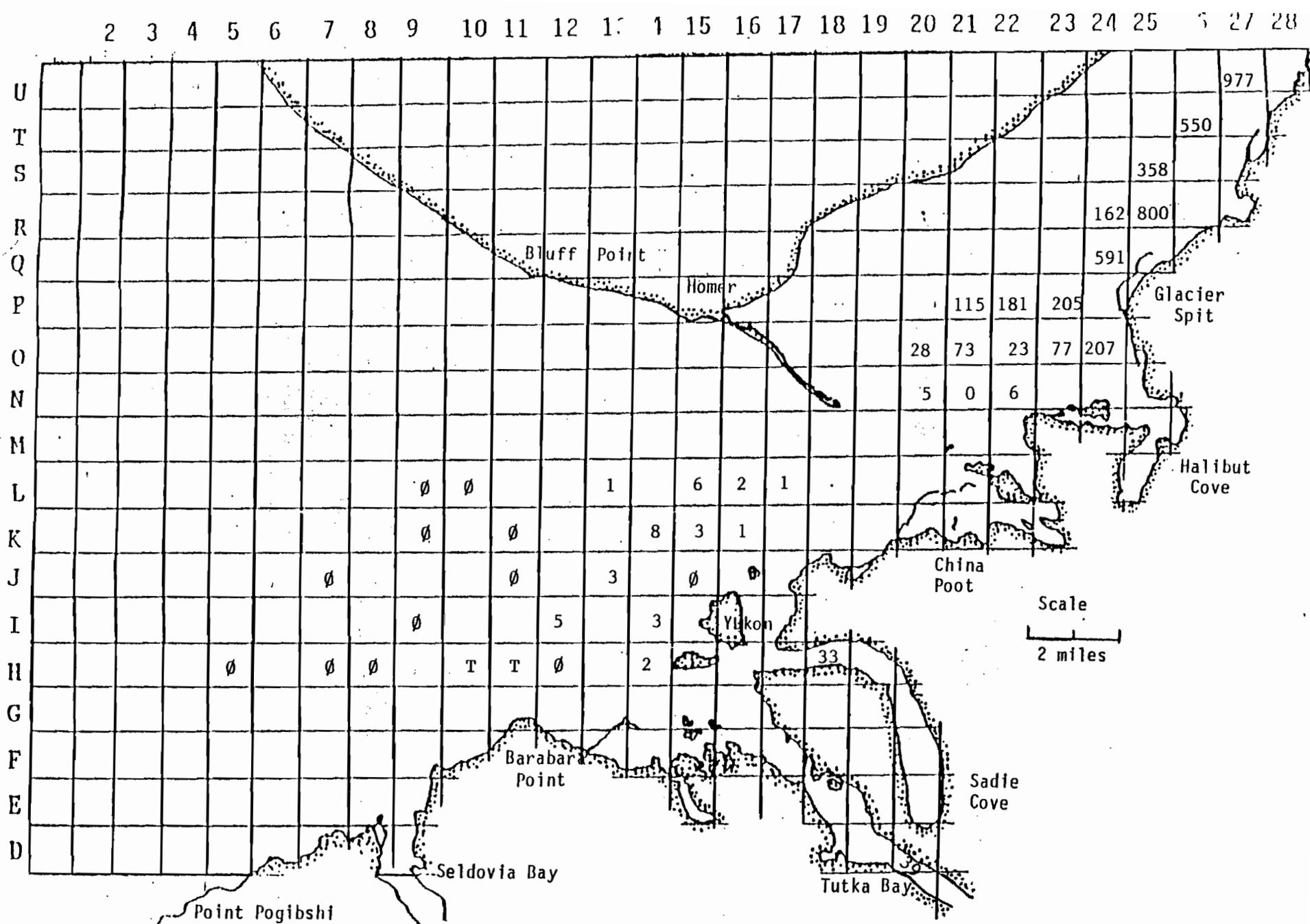


Figure 1. Kachemak Bay shrimp trawl survey catches in pounds of commercial Pandalid shrimp per one nautical mile tow (61' high opening NMFS net, R/V PANDALUS) during September 24 - October 10, 1990.

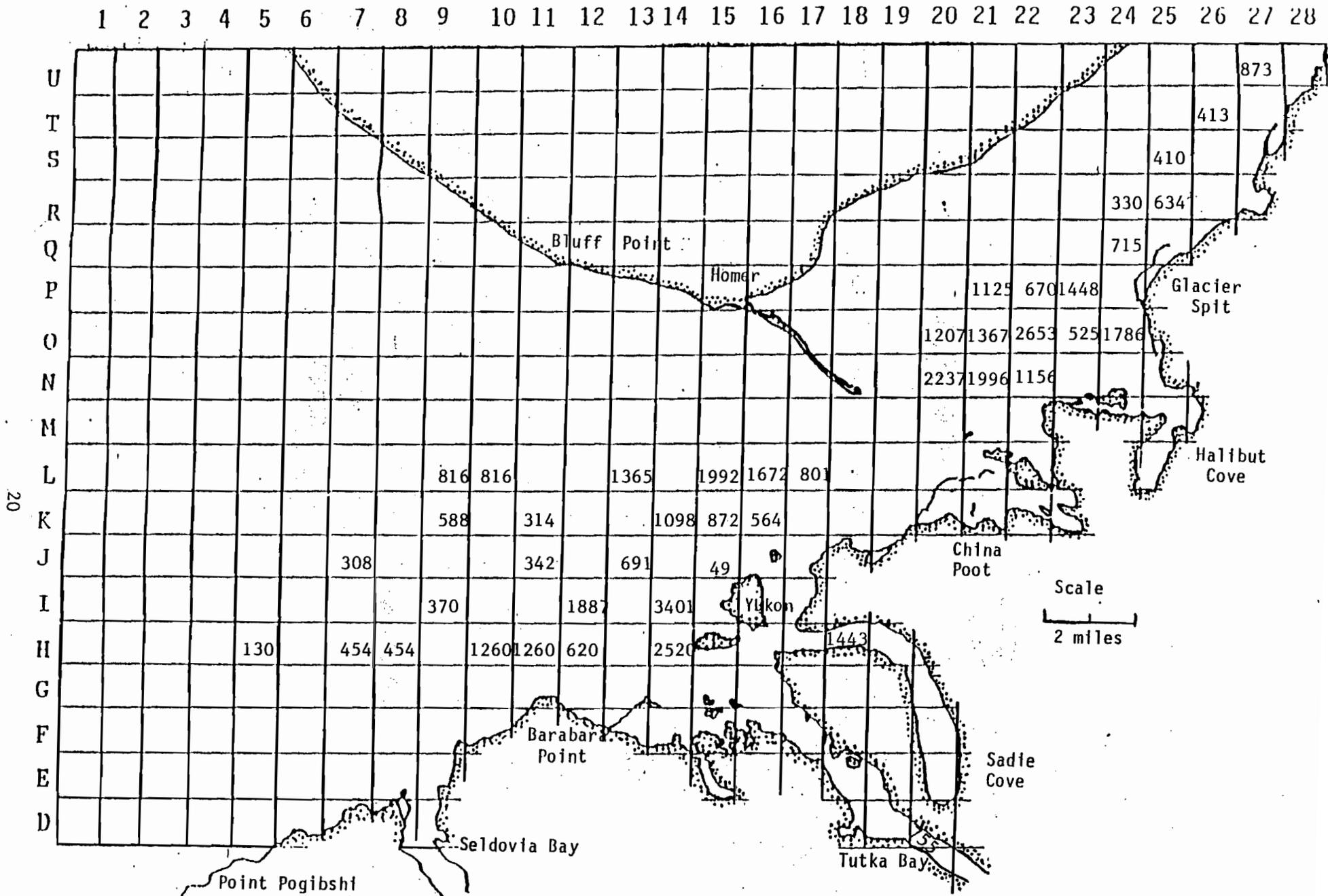


Figure 2. Kachemak Bay trawl shrimp trawl survey catches in pounds of FISH and NON-SHRIMP matter per one nautical mile tow (61' high opening NMFS net, R/V PANDALUS) during September 24 - October 10, 1990.

Appendix Table 1. Formulas and explanations for calculations of abundance estimate and range for Pandalid shrimp in the Southern District of the Cook Inlet Management Area (H).

$$\text{Mean shrimp catch} = \frac{\sum_{i=1}^N x_i}{N} = \bar{x}$$

Area - total (Nm²) considered = A

Total number of tows = N

$$\text{Sample variance (SV)} = \frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2$$

where x_1, x_2, \dots, x_N are the standardized (1 Nm) catches of shrimp from each tow.

$$\text{Standard deviation (SD)} = \sqrt{SV}$$

$$\text{Standard error of the mean (SE)} = \frac{SD}{\sqrt{N}}$$

$$\text{Population estimate (p)} = \left(\frac{6076}{32} \times A \right) \bar{x}$$

Standard deviation of the population estimate (Sp) =

$$\left(\frac{6076}{32} \times A \right) SE$$

$$\text{Percent error} = \frac{1.3 \times SE}{\bar{x}} \times 100$$

Notes: 6,076 is the number of feet in a nautical mile; 32 is the effective width of the net; 88 is the area of the stratum (A) in square nautical miles; and \bar{x} is the mean catch.

Percent error: 1.3 is the value from the normal distribution statistical table giving an approximate 80% confidence interval.

Source: Watson, Leslie. 1981. Shrimp trawl survey manual. May 1, 1981. ADF&G, Kodiak, AK. 44 pp.

Kachemak Bay Trawl Shrimp

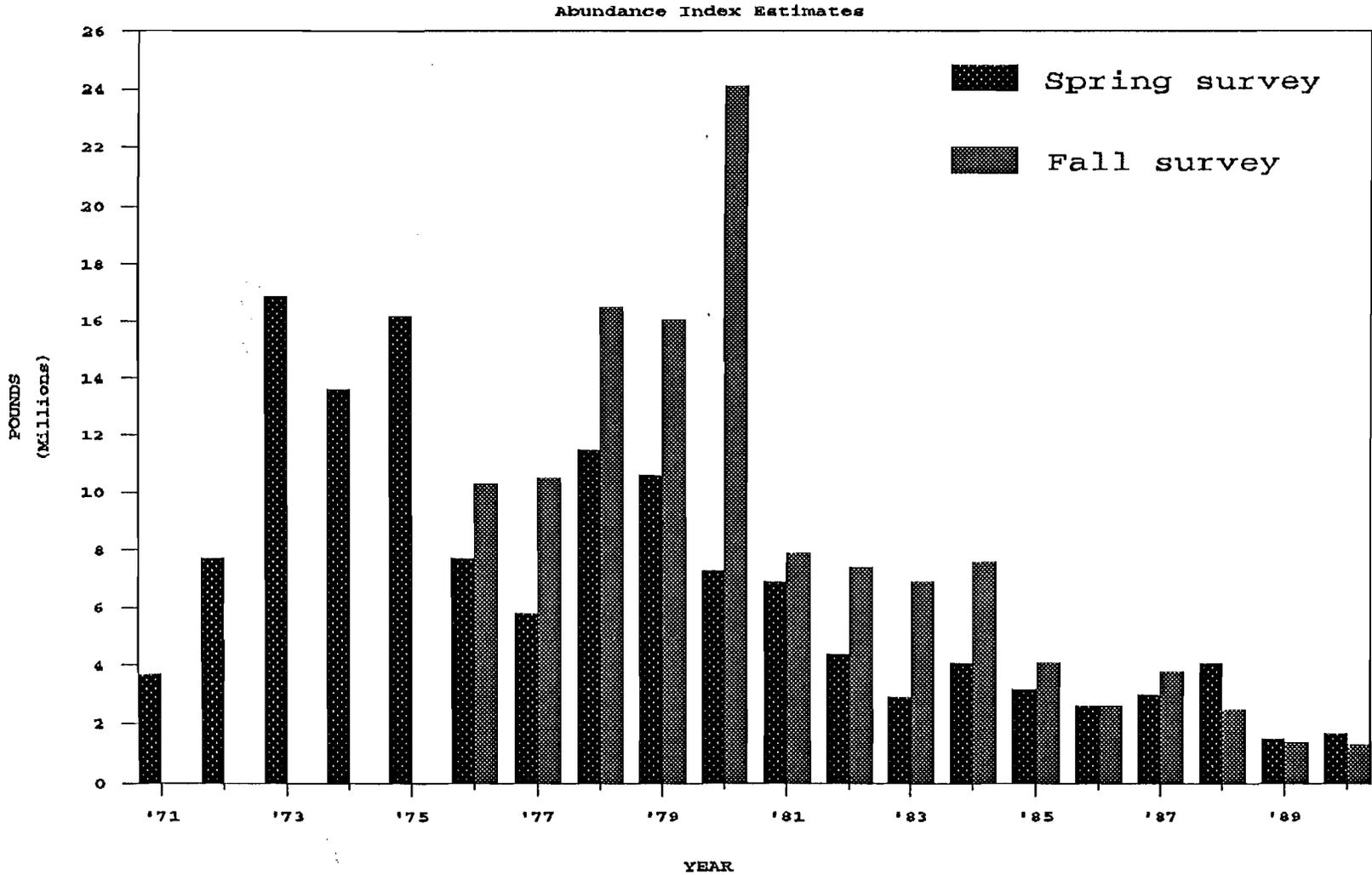


Figure 3. Historical trawl shrimp estimates of abundance for commercial species of Pandalid shrimp derived from bi-annual surveys in Kachemak Bay, Alaska.

Kachemak Bay Trawl Shrimp Index

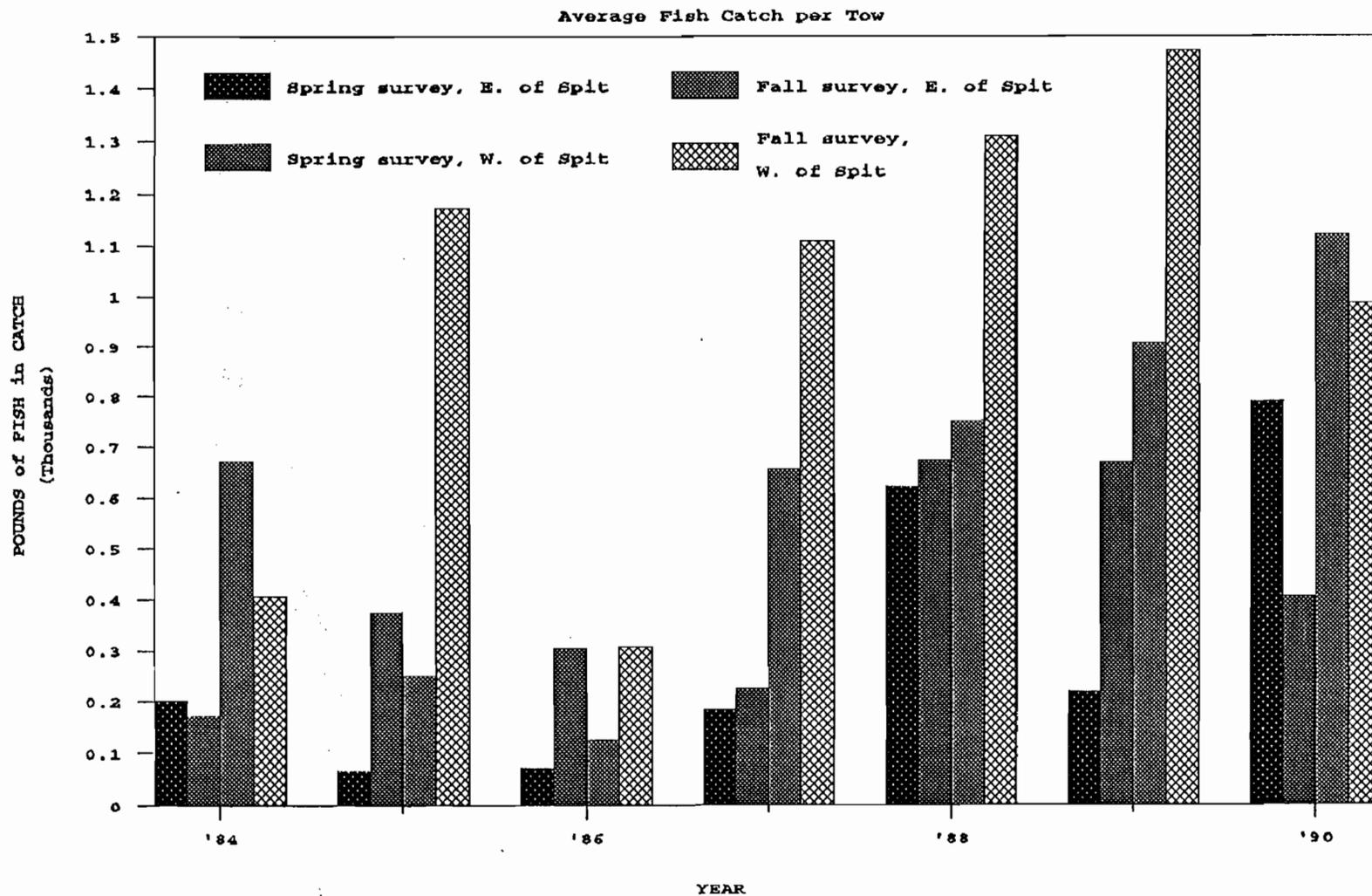


Figure 4. Historical average catch of fish and non-shrimp material per nautical mile in the bi-annual trawl shrimp index of abundance surveys in Kachemak Bay, Alaska.

Kachemak Bay Trawl Shrimp Index

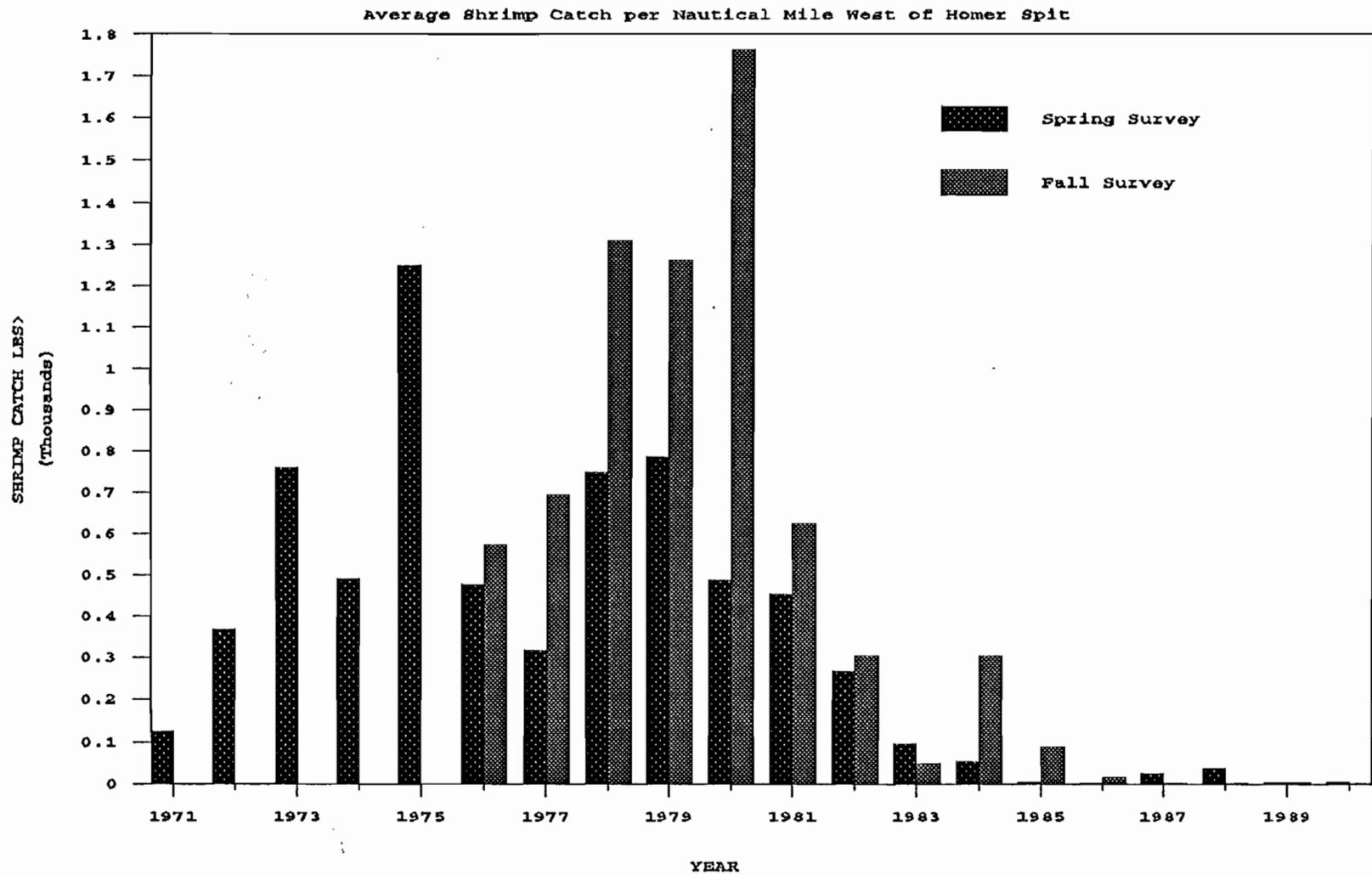


Figure 5. Historical average catch of shrimp per nautical mile west of the Homer Spit in the trawl shrimp index of abundance surveys in Kachemak Bay, Alaska.

Kachemak Bay Trawl Shrimp Index

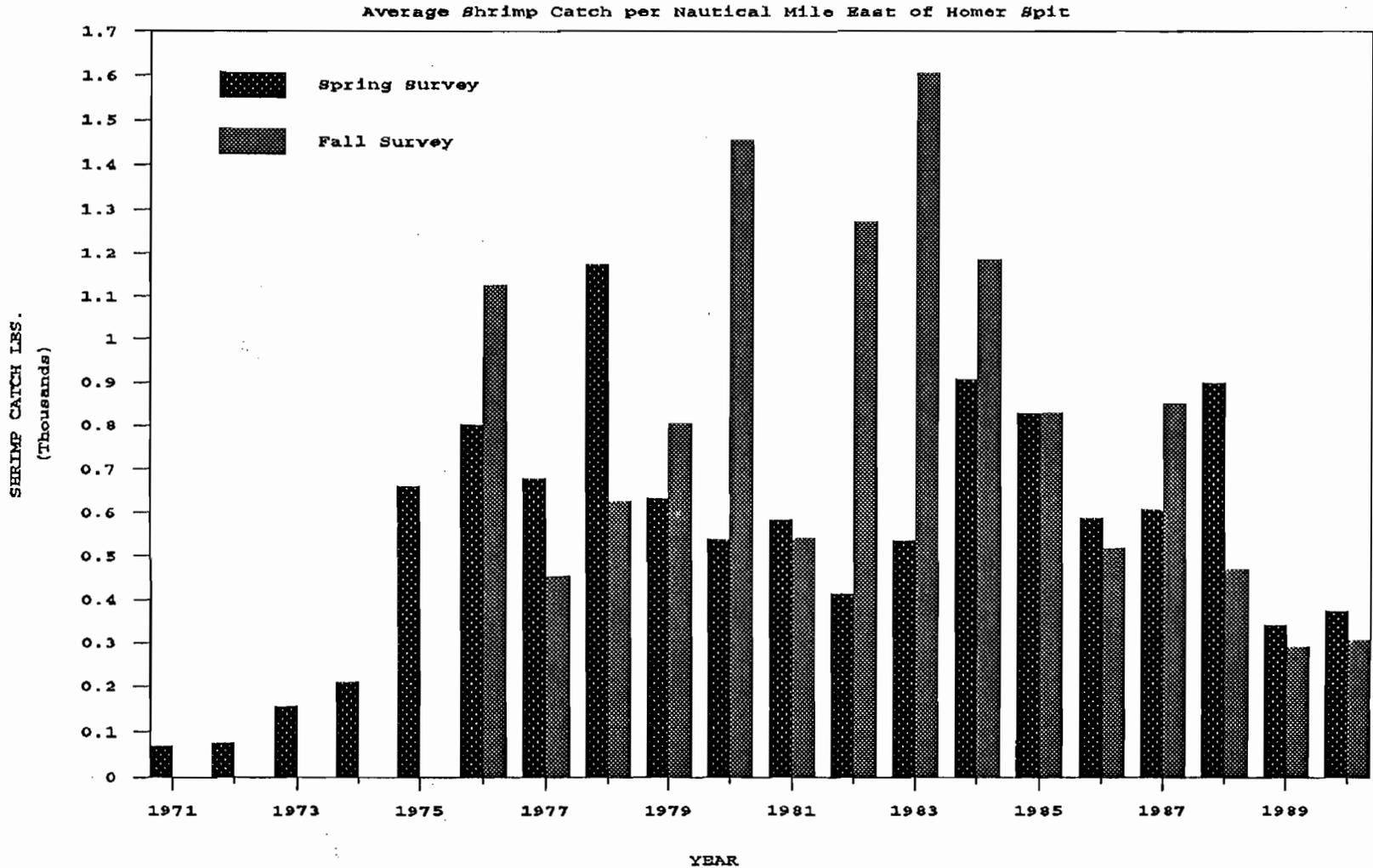


Figure 6. Historical average catch of shrimp per nautical mile east of Homer Spit in the trawl shrimp index of abundance surveys in Kachemak Bay, Alaska.

Kachemak Bay Trawl Shrimp Index

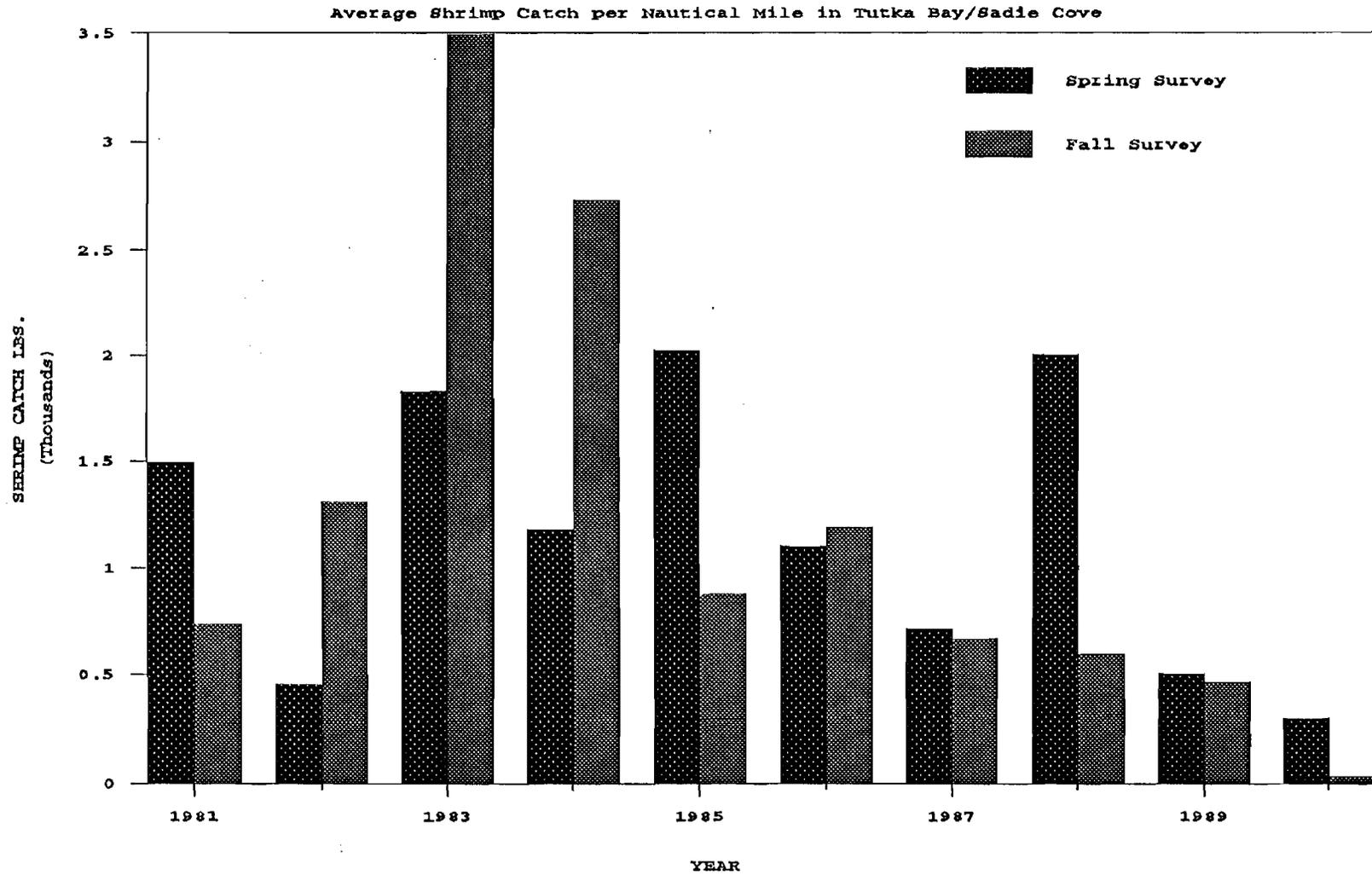


Figure 7. Average catch of shrimp per nautical mile in the Tutka Bay/Sadie Cove area in the trawl shrimp index of abundance surveys in Kachemak Bay, Alaska.