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

SPRING 1988

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Regional Information Report[1] No. 2H88-22

Alaska Department of Fish and Game
Division of Commercial Fisheries, Central Region
333 Raspberry Road
Anchorage, Alaska 99518

June 1988

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

MAY 19 - 20, MAY 23 - 27,
and
MAY 30 - JUNE 1, 1988

Lower Cook Inlet Data Report Number 88-03

by

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June 1988

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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 seasonally 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) have 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) have 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 have been minor. Finally, coonstripes (P. hypsinotus) have consistently made up approximately five percent 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.

METHODS

Initial surveys conducted between 1971 through 1974 utilized a 66-foot Nordby trawl net with assumed 50 percent net efficiency. Beginning in 1975 a 61-foot NMFS-designed net with assumed 100 percent net efficiency has been used. 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 indicate presence of shrimp, the tow is repeated with a length increase to the standard distance of one mile.

The spring 1988 trawl index survey was conducted aboard the state research vessel "Pandalus" from May 19 through 20, May 23 through 27, and May 30 through June 1. Upon completion of each tow, the total catch was weighed using a digital electronic hanging scale and subsequently dumped on the rear deck. Two random subsamples of approximately 10,000 grams each were collected from individual tows of five hundred pounds or more; for catches of less than five hundred pounds, one such subsample was collected. Each subsample was then separated by fish (which include finfish,

shellfish, and any miscellaneous debris) and shrimp, and each of these groups was weighed to obtain percentages of the total catch. A 2,500 gram subsample was randomly selected from the shrimp in the original 10,000 gram subsample and separated by species, with each species 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 is retained from each station. For the other species, normally all individuals are retained since they usually amount to a relatively small number of shrimp per station subsample.

RESULTS

A total of 33 successful tows yielded an overall average catch of 247.5 pounds of Pandalid shrimp per one nautical mile tow (Table 2). This figure does not include any catch data from the Tutka Bay/Sadie Cove areas since those areas are closed to commercial trawling. One traditional station at the mouth of Halibut Cove was towed twice but the net mudded down both times, and no further attempts were made here for fear of net damage (this station was not utilized for calculations). On the last day of the survey, with only the Sadie Cove stations remaining, the digital hanging scale ceased functioning, so only one tow was made in Sadie Cove and the catch there was estimated. The average catches by respective area were 898.9 pounds per tow east of the Homer Spit, 39.1 pounds per tow west of the Spit, and 2,006 pounds per tow in Tutka Bay/Sadie Cove (Table 3). The abundance index estimate for the Southern District based on the results of the spring 1988 survey ranged from 2.3 to 6.0 million pounds with a midpoint of 4.1 million pounds. Formulas and explanations used to calculate the midpoint estimate and range are shown in Appendix Table 1.

Shrimp species composition is presented in Table 4. As expected pinks dominated the catches at 67.5 percent. Humpies comprised 17.9 percent of the catches, the highest percentage during the spring surveys since 1980. Sidestripes and coonstripes contributed 10.5 and 2.2 percent to the catches, respectively. Incidence of "other" shrimp, such as Crangon sp. and Eualis sp. was approximately 1.9 percent.

Preliminary average counts per pound for pink shrimp east of the Homer Spit were 247 and 108, respectively, for the closed commercial waters north and northeast of Glacier Spit and the open commercial waters south and west of Glacier Spit (Table 5). West of Homer Spit, the average pink shrimp count per pound was 95 for the seven stations from which samples were obtained.

The largest catches of Pandalid shrimp in the survey once again occurred in the most northeasterly stations (Figure 1), with the largest being 1,903 pounds approximately 2.5 miles due north of Glacier Spit (Table 6). Although dominated by pinks (64 percent), this particular station contained the highest percentage of humpy shrimp, at 33 percent, of any of the stations surveyed. Eleven stations had a zero catch of shrimp, all west of Homer Spit. The catch from the single tow in Tutka Bay totalled 3,194 pounds, 82 percent of which was pinks and 11 percent coonstripes.

Percentages of fish in the catches were 40.4 percent for the area east of the Homer Spit and 94.4 percent west of the spit (Table 7). The former figure is a record high for the spring survey while the latter is the second highest on record. The largest single station catch of fish (1,130 pounds) occurred east of Homer Spit about two miles north of Peterson Bay. One other station east of the Spit had a fish catch in excess of 1,000 pounds, while four stations west of the Spit had catches of fish greater than 1,000 pounds each. The most commonly occurring fish species throughout the survey were pollock (Theragra chalcogramma), Pacific cod (Gadus macrocephalus) , and various flatfish, including but not limited to yellowfin sole (Limanda aspera), rex sole (Glyptocephalus zachirus), flathead sole (Hippoglossoides elassodon), Dover sole (Microstomus pacificus), starry flounder (Platichtys stellatus), arrowtooth flounder (Atheresthes stomias), and Alaska plaice (Pleuronectes quadrituberculatus). Also common in the catches were shortfin eelpouts (Lycodes brevipes).

DISCUSSION

The average catches of shrimp during the spring survey of 1988 from all areas of Kachemak Bay are slight increases from the previous fall survey, with a resulting slight increase in the midpoint of the abundance estimate from 3.8 to 4.1 million pounds. Examination of Figure 1 shows that the majority of the shrimp caught in the survey were from the five stations located in the closed commercial area north and east of Glacier Spit, with an average of 1,330 pounds of Pandalid shrimp caught per station. The average of the three successful tows made west and south of Glacier Spit, the open commercial area, was only 173 pounds.

Although average catches of shrimp west of Homer Spit were only slight increases from recent surveys, and fish percentages were still very high, the areas of shrimp occurrences, including "trace" quantities, were expanded from previous surveys. For example, during 1985, 1986, and 1987, the spring surveys contained between seventeen and nineteen stations which had zero catches of shrimp west of the Spit, but in the spring of 1988 the total number of zero stations was eleven.

Count per pound data collected in the field suggests that the pink shrimp found in the closed commercial area are predominantly juveniles and males, supporting the "nursery" or rearing area theory used to justify this closed area. The open commercial area counts per pound suggest that shrimp in this area are primarily transitionals and females, but catches in this area were relatively small and contained high percentages of fish. West of the Spit the small counts indicate mostly transitionals and females.

Several positive signs concerning the pink shrimp stocks in Kachemak Bay were indicated by the spring 1988 trawl shrimp survey. Foremost is the slight increase in the abundance estimate. Secondly, some reproductive success is apparently occurring as evidenced by the presence of significant numbers of small shrimp near the head of the bay. And although abundance of pink shrimp west of Homer Spit is minuscule by historic standards, areas of shrimp occurrences have expanded. The percentage of humpy shrimp in the catches has increased steadily in both annual surveys since 1985. However, numbers of pink females still appear to be relatively low, and the pink shrimp have not expanded significantly into the open commercial area east of Homer Spit, a traditional area of formerly high commercial harvest. Incidence of fish species, despite being lower than the fall 1987 survey, also remains extremely high, with the total poundage in the spring of 1988 triple that of a year earlier.

Current environmental factors seem to be the primary element influencing the pink shrimp stocks in Kachemak Bay. The Department has no control over these factors but can control the additional factor of fishing mortality. Enhancing shrimp reproductive success and survival could be accomplished by continuing to eliminate fishing mortality and reducing predation levels.

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) JUN 1-OCT 31	NOV 1-MAR 31	APR 1-MAY 31	TOTAL
1969-70[a]	7	1,289,656	1,692,854	889,330	3,871,840
1970-71[a]	3	3,211,924	2,076,228	617,836	5,905,988
1971-72[a]	7	2,618,630	1,761,569	140,707	4,520,906
1972-73[a]	10	2,772,422	2,109,660		4,882,082
1973-74[b]	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	-------

[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.

MONTH	YEAR	MEAN CATCH (lbs/tow)	NUMBER OF STATIONS	% ERROR	ABUNDANCE INDEX (Mill. of lbs.)	(Mill. of lbs.)
SPRING						
May	1971	130.2[a]	56	20.0	3.7	3.0 to 4.5
May	1972	271.1[a]	66	35.5	7.7	5.0 to 10.5
May	1973	592.8[a]	59	27.8	16.9	12.2 to 21.6
Jun	1974	476.6[a]	30	22.8	13.6	10.5 to 15.7
May	1975	1,136.9[b]	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
FALL						
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

[a] 66' Nordby net, 50% assumed net efficiency.
[b] From 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, by period, and by year, captured during trawl shrimp index surveys in the Southern District (Kachemak Bay) of the Cook Inlet Management Area (H).

		MEAN CATCH OF PANDALID SHRIMP (lbs/tow)		
Month	Year	West of Spit	East of Spit	Tutka/Sadie[a]
SPRING				
May	1971[b]	126.5	69.3	
May	1972[b]	366.9	75.7	
May	1973[b]	759.2	156.1	
Jun	1974[b]	492.1	211.2	
May	1975[c]	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[d]	830.4	2,027.0
May	1986	2.0[d]	588.4	1,102.9
May	1987	24.0[d]	609.0	714.3[e]
May	1988	39.1[d]	898.9	2,006.0[f]

[a] The Tutka/Sadie area was not surveyed prior to 1981.
[b] Nordby trawl net (66' ground rope, 53' head rope, 60' tickler chain) with 50% assumed net efficiency.
[c] From this survey to present, a 61' NMFS net with 100% assumed net efficiency has been used.
[d] Extremely 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.
[e] Only 2 of the 3 tows in Sadie Cove included.
[f] Only one tow in Sadie Cove made and its weight was estimated due to a malfunctioning electronic scale.

Month	Year	MEAN CATCH OF PANDALID SHRIMP (lbs/tow) West of Spit	East of Spit	Tutka/Sadie[a]
FALL				
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[b]	518.9	1,188.9
Sep/Oct	1987	2.0[b]	852.0	667.7

[a] The Tutka/Sadie area was not surveyed prior to 1981.
[b] Extremely small shrimp catches (less than 10% of total) were not procesed for actual weight and are referred to as "trace shrimp", and are considered zero for calculations.

Table 4. Catch composition (percent) of Pandalid shrimp species in the Southern District (Kachemak Bay) trawl abundance index surveys by sampling period and year. "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
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

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

Year	East of Homer Spit: Open Commercial Area Pink Count/lb.	East of Homer Spit: Closed Commercial Area Pink Count/lb.	East of Homer Spit: Combined Avg. Pink Count/lb.	West of Homer Spit Pinks/lb.	Combined Avg. All Areas Pinks/lb.[a]
Spring Survey					
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

-Continued-

[a] Does not include any samples from the Tutka Bay/Sadie Cove area.

Table 5, page 2 of 2.

Year	East of Homer Spit: Open Commercial Area Pink Count/lb.	East of Homer Spit: Closed Commercial Area Pink Count/lb.	East of Homer Spit: Combined Avg. Pink Count/lb.	West of Homer Spit Pinks/lb.	Combined Avg. All Areas Pinks/lb.[a]
Fall Survey					
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

[a] Does 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 spring trawl shrimp index survey, May 19-20, May 23-27, and May 31-June 1, 1988 (61-foot high opening NMFS net).

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP Pink	Humpy	Coon	Side	Other[a]	Total Lbs.	%	FISH Total Lbs.	%
West of Spit											
1[b]	39-45	L09	---	---	---	---	---	0	----	500	100.0
2[b]	45-46	L10	---	---	---	---	---	0	----	500	100.0
3[b]	45-48	K09	---	---	---	---	---	0	----	640	100.0
4[b]	44	H08	---	---	---	---	---	0	----	370	100.0
5[b]	44-46	H07	---	---	---	---	---	0	----	370	100.0
6[b]	37-35	H05	---	---	---	---	---	0	----	540	100.0
7[b]	35-37	J07	---	---	---	---	---	0	----	1,120	100.0
8[b]	42-44	K11	T	---	---	---	---	T	----	1,040	95.0+
9[b]	46-44	J11	T	---	---	---	---	T	----	620	95.0+
10[b]	52	I09	T	---	---	---	---	T	----	460	95.0+
11[b]	49-51	H11	---	---	---	---	---	0	----	600	100.0
12[b]	51-47	H10	---	---	---	---	---	0	----	600	100.0
13[b]	57-48	H12	T	---	---	---	---	T	----	520	95.0+
14[b]	60	I12	T	---	---	---	---	T	----	760	95.0+
15[b]	57-63	J13	47	0	0	1	2	50	6.7	690	93.3
16[b]	46-47	L13	T	---	---	---	---	T	----	660	95.0+
17	58-75	K14	174	0	0	72	3	249	30.0	581	70.0
18	88-76	K15	69	0	0	173	4	246	18.1	1,114	81.9
28	64-65	L17	11	1	0	74	5	91	16.2	469	83.8
29	56-63	L16	72	0	0	101	6	179	15.8	951	84.2
30	56-45	L15	95	0	T	6	5	106	12.0	774	88.0
31	88-69	K16	20	0	0	61	5	86	11.6	654	88.4
33	43-46	H14	T	---	---	---	---	T	----	1,050	95.0+
34	45-51	I14	---	---	---	---	---	0	----	660	100.0
35	28-32	J15	---	---	---	---	---	0	----	580	100.0
Subarea											
Total			488+	1	T	488	30	1,007+	5.6	16,823	94.4
Percent			48.5	0.1	---	48.5	3.0				
Mean per tow			19.5+	---	---	19.5	1.2	40.2	5.6	672.9	94.4

[a] Includes other shrimp such as Crangon sp. and Eualis sp.
[b] One-half mile tow doubled to represent standard one mile tow.

Table 6, page 2 of 2.

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP Pink	Humpy	Coon	Side	Other[a]	Total Lbs.	%	FISH Total Lbs.	%
East of Spit											
19	31-30	R24	1,223	629	16	35	8	1,911	89.3	229	10.7
20	26-28	S25	1,039	230	54	57	34	1,414	79.0	376	21.0
21	29-35	T26	1,005	131	65	137	56	1,394	56.0	1,096	44.0
22	31-30	R25	800	201	32	60	17	1,110	65.3	590	34.7
23	27-36	O24[b]	MUDDED	DOWN		TWICE,	NO	WEIGHTS	OR	SAMPLES	TAKEN
24	40-41	O22	349	0	1	37	2	389	48.6	411	51.4
25	54-44	N22	T	---	---	T	---	T	----	1,130	95.0+
26	48-43	N21	74	0	0	58	7	139	16.6	701	83.4
27	27-36	Q24	643	296	15	4	8	966	69.0	434	31.0
Subarea											
	Total		5,133	1,487	183	388	132	7,323	59.6	4,967	40.4
	Percent		70.1	20.3	2.5	5.3	1.8				
	Mean per tow		641.6	185.9	22.9	48.5	16.5	915.4	59.6	620.9	40.4
Kachemak Bay											
	Total		5,621	1,488	183	876	162	8,330	27.7	21,790	72.3
	Percent		67.5	17.9	2.2	10.5	1.9				
	Mean per tow		170.3	45.1	5.5	26.5	4.9	252.4	27.7	660.3	72.3
Tutka Bay/Sadie Cove[c]											
32	38-46	C/D20	2,630	208	350	6	13	3,207	81.2	743	18.8
36	40-38	H18	772[d]	9[d]	2[d]	36[d]	3[d]	821[d]	34.2[d]	1,579[d]	65.8[d]
	Total		3,402	217	352	42	16	4,028	63.4	2,322	36.6
	Percent		84.5	5.4	8.7	1.0	0.4				
	Mean per tow		1,701.0	108.5	176.0	21.0	8.0	2,014	63.4	1,161	36.6

[a] Includes other shrimp such as Crangon sp. and Eualis sp.
[b] This unsuccessful tow was not utilized in the abundance index calculations.
[c] Tutka/Sadie tows are not included in the Kachemak Bay index, but serve as an indication of localized productivity.
[d] The electronic scale was not functioning for this tow, therefore the total weight of the tow was estimated and subsequent species weights are also only estimates.

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.

YEAR	EAST OF SPIT (241-13, 14, 15) MAY	OCT	WEST OF SPIT (241-11 and 241-12) 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		94.4	

[a] Does not include large cod and halibut.

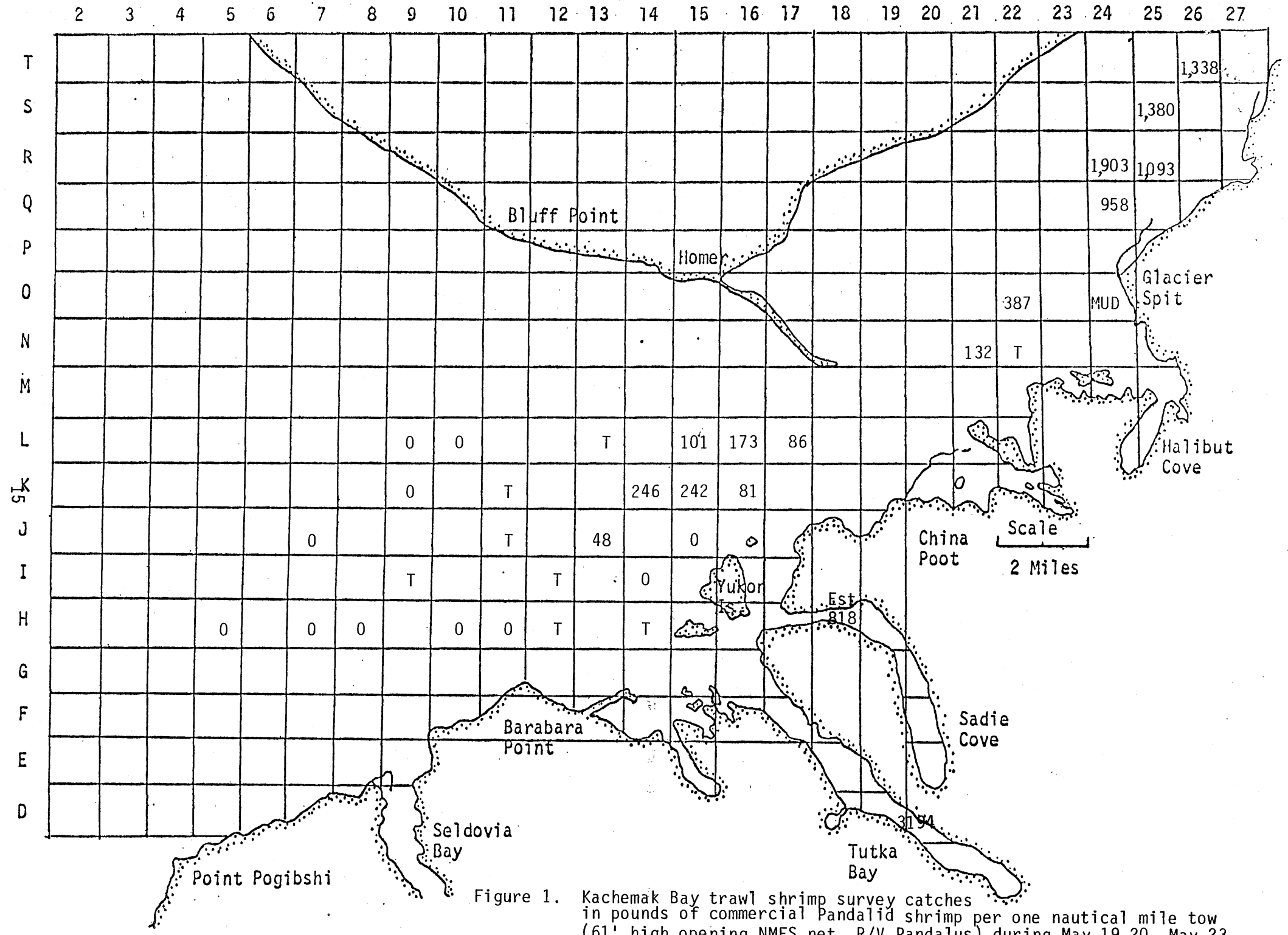

Figure 1. Kachemak Bay trawl shrimp survey catches in pounds of commercial Pandalid shrimp per one nautical mile tow (61' high opening NMFS net, R/V Pandalus) during May 19-20, May 23-27, and May 30-June 1, 1988.

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 area (Nm^2) 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 $x_1, x_2, \ldots\ldots, x_N$ are the standardized (1 nm) catches of shrimp from each tow.

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

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

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

$$\text{Standard deviation of the population estimate (Sp)} = \left(\frac{6076}{32} \times A\right) SE$$

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

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 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. 44pp.