

**FINAL REPORT
FISH RESEARCH PROJECT
OREGON**

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INTRODUCTION

Ocean pink shrimp (*Pandalus jordani*) are distributed from San Diego, CA, to Unalaska, AK, (Butler 1964), with the commercial harvest centered off the Oregon coast (Zirges and Robinson, 1980). The shrimp fleet is quite mobile and vessels routinely fish and land shrimp in different states. In recognition of the regional nature of this fishery, the Pacific Fishery Management Council developed a draft Fishery Management Plan for pink shrimp in the late 1970's. The affected states are currently using this plan as the basis for shrimp resource management through mutually consistent state regulations. The Shrimp Resource Assessment project was initiated to supplement the Oregon Department of Fish and Wildlife's fishery monitoring activities and to specifically address the need for an interjurisdictional management approach for pink shrimp.

This final report for project (#1-IJ-4) incorporates by reference activities covered in our 1988 and 1989 annual progress reports (Hannah et al 1989, Hannah and Jones 1990). Research results submitted for publication in peer reviewed journals are not reported upon in detail in this report. Reprints of the resultant journal articles will be forwarded as attachments as soon as they are available.

Project Objectives

The primary objective of the Shrimp Resource Assessment project is to provide scientific information and alternative resource use strategies for the management of the pink shrimp fishery resource. To accomplish this objective, we developed five specific annual tasks:

1. Collect and code shrimp fishery logbook data, match logbook information to official landing records, and summarize in a form readily useable in mathematical models,
2. Collect shrimp market samples dockside and compile age, sex, maturity, length, and weight data,
3. Analyze fishery catch data and biological market samples,
4. Provide fishery managers in neighboring states with reports describing location of catch, total catch and effort, catch per unit effort (lb/trip, lb/h, lb/vessel), and biological parameters of the shrimp caught in the fishery, and
5. Communicate fishery and research problems and strategies to other state and federal agencies and provide management recommendations for the entire harvest area.

FY 90 Accomplishments

We completed all of the planned annual tasks in 1990. Summarization and analysis of the 1990 trawl logbook data is complete. In 1990 we collected and analyzed shrimp market samples for the months April through October for all state statistical areas receiving

substantial fishing effort. An improved logbook sub-sampling procedure was developed in 1989 and successfully implemented in 1990. Briefly, the method adjusts subsampling rates in season to result in comparable sampling rates for each port, month and gear type.

We maintained and improved communication with resource managers from California and Washington in 1990. Monthly shrimp landing reports, including summaries of market sample data, were provided to the states of California and Washington. Numerous contacts were made with resource managers from California and Washington to discuss the severely depressed 1990 age one year class and its impact on the trawl fishery. Contacts were also made to compare October age composition samples and discuss prospects for 1991 recruitment.

FISHERY CATCH AND EFFORT

The 1990 pink shrimp season resulted in a total catch of 31.9 million pounds, 17.2 million pounds less than the 1989 total (Table 1). The 1990 total exceeded the ten year average of about 26.8 million pounds. Early season catches were well above the ten year average monthly catches, while late season catches were well below these levels (Figure 1). This abnormal catch pattern was caused by the combination of a strong age 2 year class of shrimp with an extremely weak incoming age 1 class. In recent years, age 2 shrimp have dominated the early months of the season, being replaced by age one shrimp in the months of July through October. The weakness of the incoming age one year class is evident in catch trends and in CPUE, which declined from 18,500 lb per trip in April to only 13,300 lb per trip in October (Table 1). This decline in CPUE was much steeper than observed in 1989 when the age one year class was much larger.

Table 1. Catch and effort statistics (preliminary) for the Oregon pink shrimp fishery for 1989 and 1990.

	April	May	June	July	Aug.	Sept.	Oct.	Total
Catch (x 1000 lb)								
1990	6,079	7,593	7,504	4,013	3,464	2,360	881	31,894
1989	8,254	9,372	7,013	3,543	8,274	7,354	5,343	49,151
Effort (trips)								
1990	329	481	449	359	351	286	148	2,403
1989	442	520	392	154	489	449	395	2,841
Catch/Trip (x 1000 lb)								
1990	18.5	15.8	16.7	11.2	9.9	8.3	6.0	13.3
1989	18.7	18.0	17.9	23.0	16.9	16.3	13.5	17.3

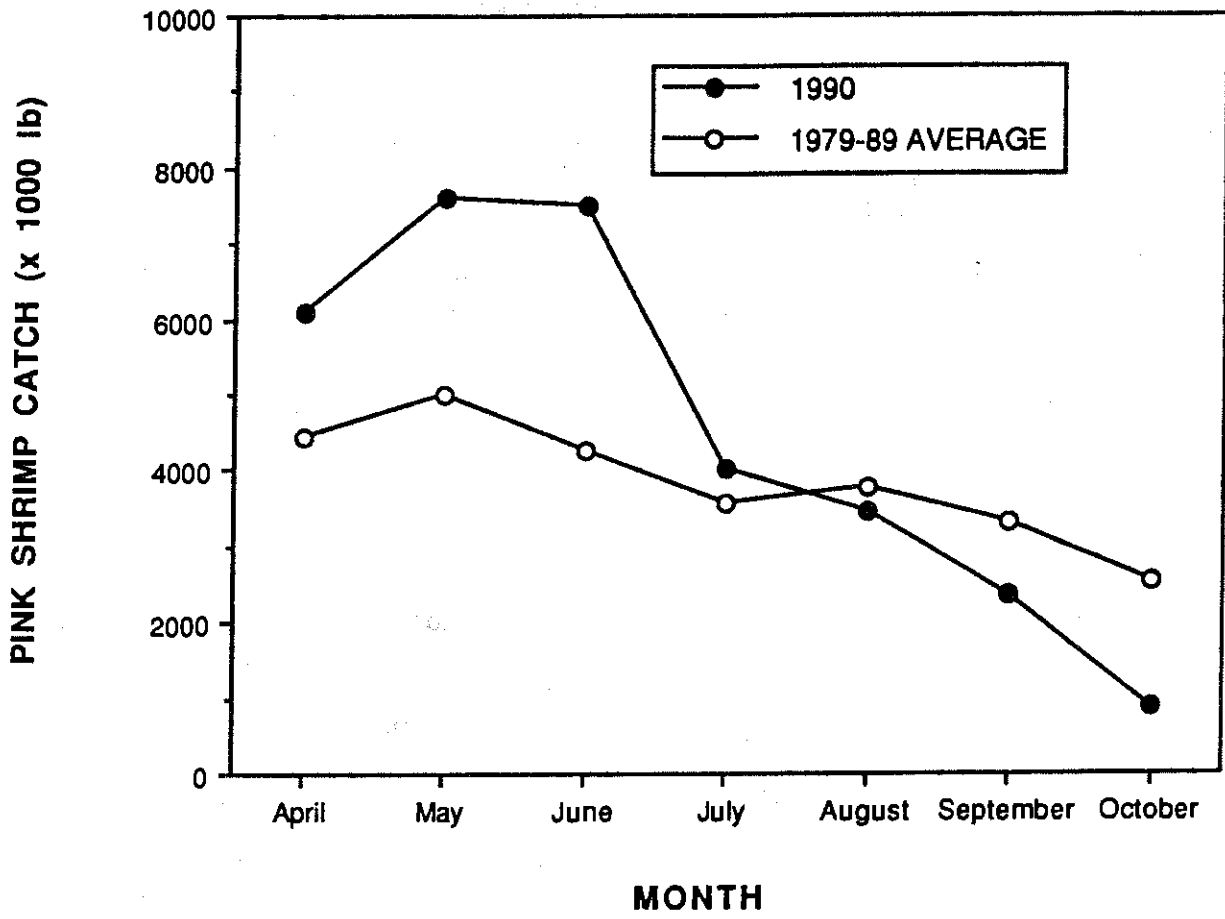


Figure 1. Comparison of the monthly shrimp catch (lb) in 1990 with the 1979-89 average.

Fishing effort declined from 2,841 trips in 1989 to 2,403 trips in 1990. Total hours fished declined somewhat less than total trips because vessels fished 5 and 6 day trips in 1990 compared to 4 day trips in 1989 to offset declining daily catches.

Shrimp fishing in 1990 began slowly due to price disputes between fishermen and processors, unlike 1989 when fishing began quickly. Many vessels did not begin fishing until mid-April. The opening ex-vessel price was 45¢/lb for legal grade shrimp (< 160 shrimp/lb) as compared to 40¢/lb for 140 count and larger shrimp and 25¢/lb for smaller legal shrimp in 1989. In mid-June 1990 the ex-vessel price of shrimp increased to 50¢/lb for legal grade shrimp and then to 55¢/lb in August. In late August the price jumped again to 60¢/lb which remained in effect for the balance of the season. In contrast, 1989 prices dropped from an opening price of 40¢/lb to 35¢/lb near season's end. The rising prices of shrimp in 1990 probably resulted from the steady steep decline in landings throughout the season coupled with strong market demand.

Count per pound violations were non-existent in 1990. It was nearly impossible for fishermen to catch a load of shrimp with a count greater than 160 per pound due to the low population numbers of age one shrimp.

BIOLOGICAL DATA COLLECTION

Sampling Methods

We attempted to collect 4-6 samples of approximately 100 shrimp from each of Oregon state statistical areas 19-32 during each month of the fishing season (Figure 2). Statistical areas 19-32 encompass the area from the Oregon-California border to the U.S.-Canada border. Shrimp samples were obtained at the docks prior to processing. We measured carapace lengths and determined average weight expressed as the number of whole shrimp per pound. Each shrimp was classified as male, female or transitional based upon close examination of the inner ramus of the first pleopod after Tegelberg and Smith (1957).

Individual samples within a month and statistical area were combined for analysis of age and sex composition. When sample size deviated substantially from 100 shrimp, the raw length and sex frequency data were rescaled proportionally to a sample size of 100 before combining with other samples. As a result, samples were given equal weight in determining age and sex composition.

Age composition for each month and statistical area was then determined by identifying modes in the combined length frequency histogram. We assigned ages using nadirs in the histograms to set a range of carapace lengths corresponding to each age group. After the age and sex of each shrimp were assigned, age and sex composition and mean length at age were compiled for each month and statistical area.

Results And Discussion

We collected market samples for most statistical areas and months (Tables 2 and 3). The notable exceptions were areas 29 and 18 which received a low level of effort by Oregon

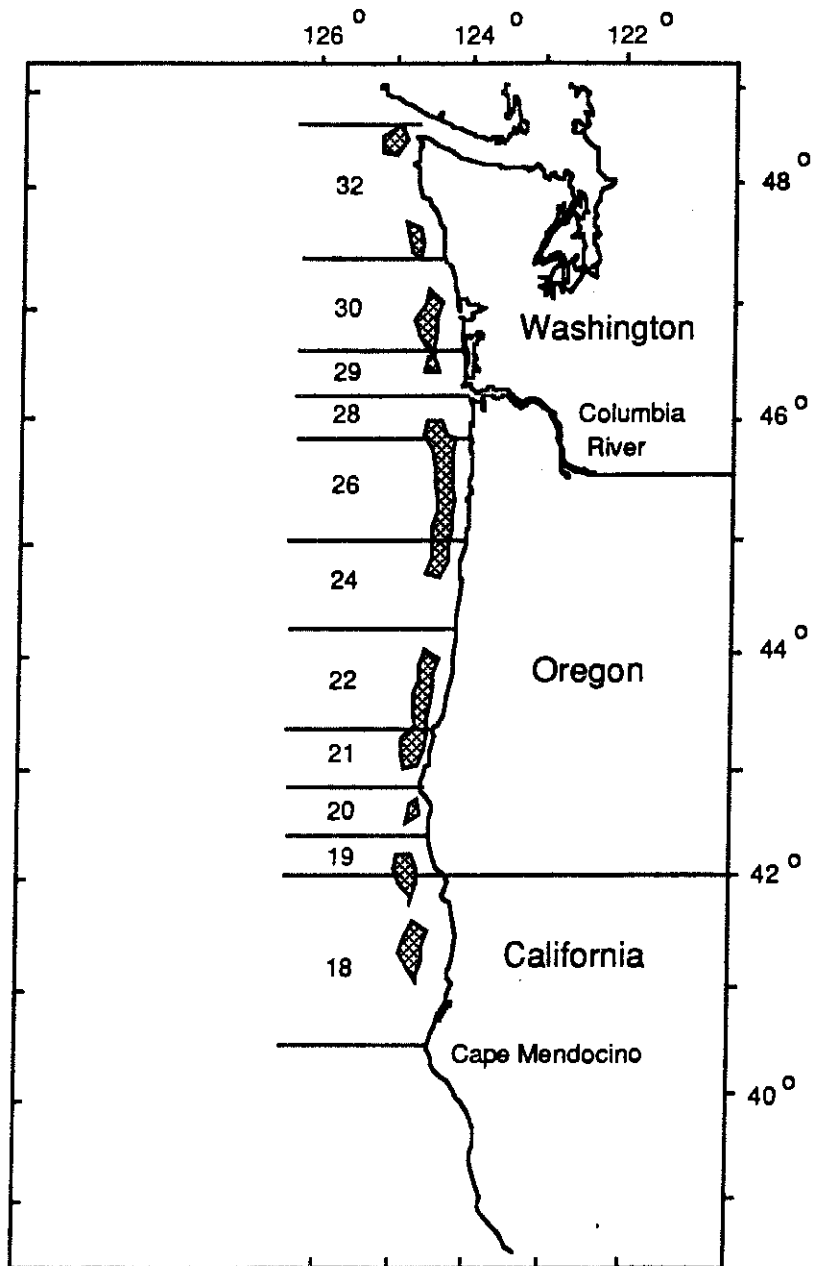


Figure 2. Oregon state statistical areas 18-32 and commercially fished pink shrimp beds along the Washington, Oregon and northern California coasts.

Table 2 . Monthly pink shrimp age composition (percent) , count per pound (Ct), and number Sampled (N) by Oregon state statistical area, 1990.

State Area	Age	Apr	May	Jun	Jul	Aug	Sep	Oct
32	0	0.0	0.0	0.5	0.0	0.0	0.0	0.7
	1	3.7	24.1	45.5	29.0	31.5	42.7	43.8
	2	70.7	60.2	46.5	66.7	66.5	57.0	55.4
	3+	25.7	15.7	7.5	4.3	2.0	0.3	0.2
	Ct	115.1	124.5	131.6	108.5	99.4	101.9	102.9
	N	300	402	200	396	400	391	300
30	0	0.0	0.0	0.0	0.2	0.0	0.8	2.1
	1	1.3	6.2	23.6	28.5	30.9	48.4	40.2
	2	76.7	83.3	68.1	65.0	68.9	50.6	57.3
	3+	22.0	10.4	8.3	6.3	0.2	0.3	0.4
	Ct	121.3	118.9	108.3	104.8	102.8	101.9	93.8
	N	601	402	301	494	408	399	513
29	0	--	--	0.0	--	--	0.3	1.0
	1	--	--	2.5	--	--	18.2	34.4
	2	--	--	81.3	--	--	80.1	64.6
	3+	--	--	16.3	--	--	1.4	0.0
	Ct	--	--	87.4	--	--	67.8	71.9
	N	0	0	80	0	0	296	209
28	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1	11.6	33.4	29.6	35.9	58.8	40.0	36.4
	2	59.8	51.0	68.7	60.8	40.2	60.0	63.6
	3+	28.6	15.6	1.8	3.3	1.0	0.0	0.0
	Ct	96.4	103.9	105.4	86.5	92.5	75.7	74.5
	N	199	302	399	393	403	100	200
26	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1	4.6	6.0	36.7	35.0	33.5	43.6	19.6
	2	86.4	86.6	60.1	62.2	63.1	56.4	79.4
	3+	9.0	7.4	3.1	2.8	3.4	0.0	1.0
	Ct	87.8	80.2	92.6	80.5	75.2	78.6	69.2
	N	501	501	700	500	401	101	301
24	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1	2.6	8.9	4.7	4.3	17.8	8.7	19.8
	2	85.8	85.5	92.0	85.9	76.6	90.7	80.0
	3+	11.6	5.6	3.3	9.8	5.6	0.7	0.2
	Ct	94.0	84.6	79.6	77.1	76.3	71.2	74.3
	N	500	799	700	603	602	600	904

Table 2. Continued.

State Area	Age	Apr	May	Jun	Jul	Aug	Sep	Oct
22	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1	1.5	3.3	12.7	8.3	16.5	18.6	16.1
	2	85.9	79.1	77.4	81.9	79.3	78.0	82.1
	3+	12.6	17.6	9.9	9.8	4.2	3.5	1.8
	Ct	87.6	77.7	78.5	70.6	69.4	71.8	61.8
	N	601	301	700	408	789	404	397
21	0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
	1	6.8	15.6	8.0	14.9	13.0	12.2	27.9
	2	77.6	67.9	79.0	76.8	82.4	86.8	71.1
	3+	15.6	16.6	13.0	8.3	4.7	1.0	0.3
	Ct	101.1	96.2	81.7	82.8	70.7	67.5	72.7
	N	603	302	300	396	400	401	681
20	0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
	1	5.5	26.9	23.3	29.7	23.7	38.6	18.1
	2	76.7	61.1	69.2	67.6	76.0	61.4	80.1
	3+	17.8	12.0	7.5	2.7	0.3	0.0	0.6
	Ct	94.7	95.5	90.9	91.3	74.8	84.0	75.8
	N	601	401	305	201	300	200	501
19	0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
	1	7.8	32.6	18.0	7.0	13.3	22.9	34.1
	2	81.5	55.0	79.1	84.6	80.7	74.8	63.1
	3+	10.7	12.4	2.9	8.4	6.0	2.3	1.6
	Ct	97.7	106.9	87.2	72.1	69.5	72.4	72.0
	N	599	298	412	416	399	312	496
18	0	--	--	--	--	--	--	1.0
	1	--	--	--	--	--	--	16.8
	2	--	--	--	--	--	--	80.2
	3+	--	--	--	--	--	--	2.0
	Ct	--	--	--	--	--	--	68.1
	N	0	0	0	0	0	0	101

Table 3 . Mean pink shrimp carapace lengths (mm) at age, by month and Oregon statistical area during 1990.

Area	Age	Apr	May	Jun	Jul	Aug	Sep	Oct
18	0	--	--	--	--	--	--	10.5
	1	--	--	--	--	--	--	17.4
	2	--	--	--	--	--	--	21.7
	3+	--	--	--	--	--	--	25.8
19	0	--	--	--	--	--	--	10.3
	1	14.2	14.4	16.1	16.3	16.8	17.3	17.8
	2	19.2	20.1	20.6	21.3	21.4	21.5	22.0
	3+	22.9	23.9	24.5	24.7	25.4	25.5	25.8
20	0	--	--	--	--	--	--	10.2
	1	14.5	14.9	16.1	16.4	17.0	17.5	17.5
	2	19.0	19.8	20.2	20.5	21.4	21.1	21.4
	3+	22.4	22.7	23.6	24.4	25.5	--	25.8
21	0	--	--	--	--	--	--	10.2
	1	14.5	14.7	15.3	16.2	16.6	17.1	17.5
	2	19.0	19.6	20.0	20.6	21.2	21.7	21.7
	3+	22.4	22.7	23.2	24.0	25.0	25.8	26.5
22	0	--	--	--	--	--	--	--
	1	13.6	14.3	15.7	16.5	16.9	16.9	17.5
	2	18.6	20.2	20.7	21.2	21.4	21.5	22.1
	3+	22.2	23.1	24.1	24.5	25.1	25.5	26.1
24	0	--	--	--	--	--	--	--
	1	13.9	14.4	15.5	16.1	16.9	16.9	17.4
	2	19.1	20.2	20.3	20.5	20.9	21.3	21.4
	3+	22.2	23.3	23.6	23.2	24.4	25.6	25.8
26	0	--	--	--	--	--	--	--
	1	13.8	14.7	15.5	16.4	17.2	17.1	17.4
	2	19.9	20.3	20.7	21.3	21.6	21.8	21.8
	3+	22.9	23.4	24.0	24.4	24.8	--	25.7
28	0	--	--	--	--	--	--	--
	1	13.9	14.7	15.2	16.3	17.0	17.4	17.1
	2	18.7	19.2	19.7	21.0	21.3	21.8	22.1
	3+	21.5	22.2	22.6	23.7	24.6	--	--

Table 3. Continued

Area	Age	Apr	May	Jun	Jul	Aug	Sep	Oct
29	0	--	--	--	--	--	6.0	8.8
	1	--	--	14.5	--	--	17.1	17.3
	2	--	--	19.6	--	--	21.7	21.9
	3+	--	--	22.5	--	--	25.0	--
30	0	--	--	--	9.5	--	8.0	8.7
	1	13.3	13.4	14.7	15.3	16.1	16.5	16.5
	2	17.2	17.8	18.9	19.5	19.7	20.4	20.6
	3+	20.7	21.1	22.0	22.9	24.0	24.5	24.8
32	0	--	--	5.5	--	--	--	8.5
	1	12.4	13.5	14.1	14.9	15.6	16.0	16.1
	2	17.7	18.1	18.9	19.4	19.9	20.4	20.1
	3+	20.5	21.0	21.6	22.2	23.4	24.0	25.0

boats in 1990.

The age composition of the pink shrimp catch in 1990 (Table 2) showed a much lower percentage of age one shrimp than in 1989 (Figure 3). Age one shrimp comprised nearly 70% of the catch in 1989, and exceeded 70% in 1987 and 1988. By contrast, age one shrimp in 1990 exceeded 50% of the catch only once, during August in area 28. Generally, the largest percentages of age one shrimp observed ranged from 40-45% of the catch. The consistently low count per pound (Table 2) reflected the dominance of age 2 and older shrimp. Counts were well below 100 shrimp per pound in most areas and months, and somewhat above this level early in the season in areas 30 and 32. Overall, the grade of shrimp landed in 1990 was uniformly excellent.

The mean carapace lengths for age one and two shrimp sampled in 1990 (Table 3) were mostly smaller than those observed over the last few years. Hannah and Jones (in press) showed that average shrimp carapace length at age increased after 1978 as compared to 1966-77. Mean carapace lengths observed in 1990 were generally at the lower end of the range observed since 1978. Catch per unit effort values were lower in 1990 than in 1989 indicating lower densities of shrimp. The drop in growth in 1990 is therefore most likely a result of environmental variation such as cold sea bottom temperatures, rather than a density-dependent effect.

Zero age shrimp were observed in seven of the eleven state statistical areas in October of 1990. In 1989, age zero shrimp were encountered in only one of ten areas sampled in October. The lack of age zero shrimp in 1989 appears to have correctly indicated low age one recruitment in 1990. The higher levels of age zero shrimp in October of 1990 may indicate a rebound in recruitment of age one shrimp in 1991. Zero age shrimp collected in fall 1990 appeared to be somewhat smaller in size than zero age shrimp in recent years.

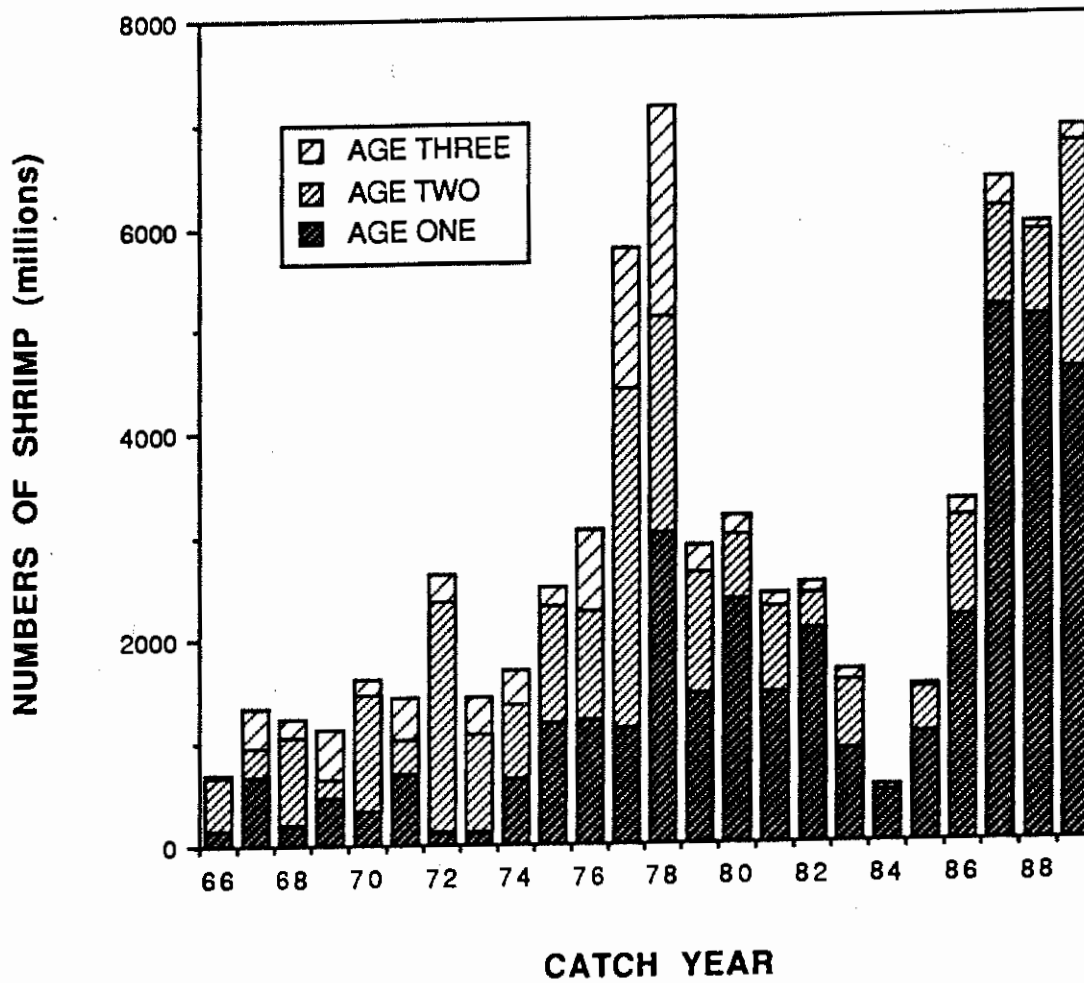


Figure 3. Age composition of the pink shrimp catch by number, 1966-89.

When age zero shrimp are small and when overall catch rates are low, as in 1990, age zero shrimp are caught less efficiently by standard shrimp trawl gear. Even when age zero shrimp are large they are incompletely recruited to trawl gear, consequently the catch of age zero shrimp in the fall is only a very crude indicator of age one recruitment the following spring.

The sex composition of pink shrimp in the fall of 1990 was characterized by very low levels of primary females (Table 4) especially when compared to recent years (Figure 4). Pink shrimp are protandric hermaphrodites and seem to be capable of either accelerating or delaying sex change in response to the ratio of older breeders to first time breeders (Charnov et al. 1978, Hannah and Jones in press). This ratio is strongly influenced by fluctuations in recruitment. The low level of age one shrimp in 1990 resulted in a relative excess of age 2 and older shrimp which are usually female. As a result, most age one shrimp and even some age 2 shrimp failed to transition into females in 1990, resulting in a sexually balanced breeding stock despite an unusual age structure in the population.

RESEARCH ACTIVITIES

During 1990 we finalized our work describing fishery-induced changes in the population structure of pink shrimp (Hannah and Jones, in press). Reprints of our Fishery Bulletin paper will be forwarded as soon as they become available.

Our 1990 research focused on evaluating population and environmental influences on age one shrimp recruitment. We have identified some of the environmental factors which may be important in determining recruitment success in shrimp and have run some preliminary multivariate models. Only the preliminary stages of this work were completed in 1990.

FY-91 ACTIVITIES

We plan to continue to collect, summarize and analyze data from the pink shrimp fishery in 1991. We plan to continue our evaluation of the importance of parent stock and environmental factors in determining shrimp recruitment using multivariate techniques. This project should provide a framework for assessing the current management approach and potential alternatives.

ACKNOWLEDGEMENTS

Many people made significant contributions to collecting and analyzing the information in this report. Neil Richmond, Terry Link, Aaron Currier and Rodney Marsh collected and analyzed data. We also thank Jim Golden for his careful editing of this report and also the Marine Region office staff for helping to produce the report in a timely fashion.

Table 4. Sex composition of the pink shrimp catch during April, September and October, 1990.

Month	Area	Males (%)	trans. (%)	females (%)	Prim Fem** (%)	Primary Females*	N
April	18	--	--	--	--	--	--
	19	58.1	5.0	36.9	0.0	0	599
	20	68.1	4.0	28.0	0.0	0	601
	21	70.6	1.8	27.6	0.0	0	503
	22	56.7	13.0	30.3	0.0	0	601
	24	56.2	17.4	26.4	0.0	0	500
	26	48.9	30.3	20.8	0.0	0	501
	28	43.2	20.1	36.7	0.0	0	199
	29	--	--	--	--	--	--
	30	39.6	20.6	39.8	0.0	0	601
	32	39.3	23.0	37.7	0.0	0	300
September	18	--	--	--	--	--	--
	19	50.8	1.8	47.3	0.0	0	312
	20	62.8	4.6	32.6	0.9	1	200
	21	44.1	2.7	53.1	0.0	0	401
	22	46.8	4.0	49.3	0.0	0	404
	24	50.7	4.3	45.0	0.0	0	600
	26	66.3	1.0	32.7	0.0	0	101
	28	38.0	1.0	61.0	17.5	7	100
	29	32.4	0.3	67.2	0.0	0	296
	30	62.4	0.0	37.6	0.0	0	399
	32	51.9	1.3	46.8	0.6	1	391
October	18	54.5	0.0	45.5	0.0	0	101
	19	53.8	0.2	46.0	0.6	1	496
	20	51.5	0.4	48.1	1.6	1	501
	21	54.5	0.3	45.2	0.0	0	681
	22	53.7	0.8	45.6	0.0	0	397
	24	54.8	1.0	44.2	1.9	2	904
	26	59.1	2.0	38.9	0.0	0	301
	28	47.0	0.0	53.0	0.7	1	200
	29	41.1	0.0	58.9	1.4	1	209
	30	55.2	0.2	44.6	0.0	0	513
	32	56.0	0.3	43.6	0.0	0	300

* The number of age one females.

** $(\text{The number of age one females} / \text{The total number of age one shrimp}) \times 100$

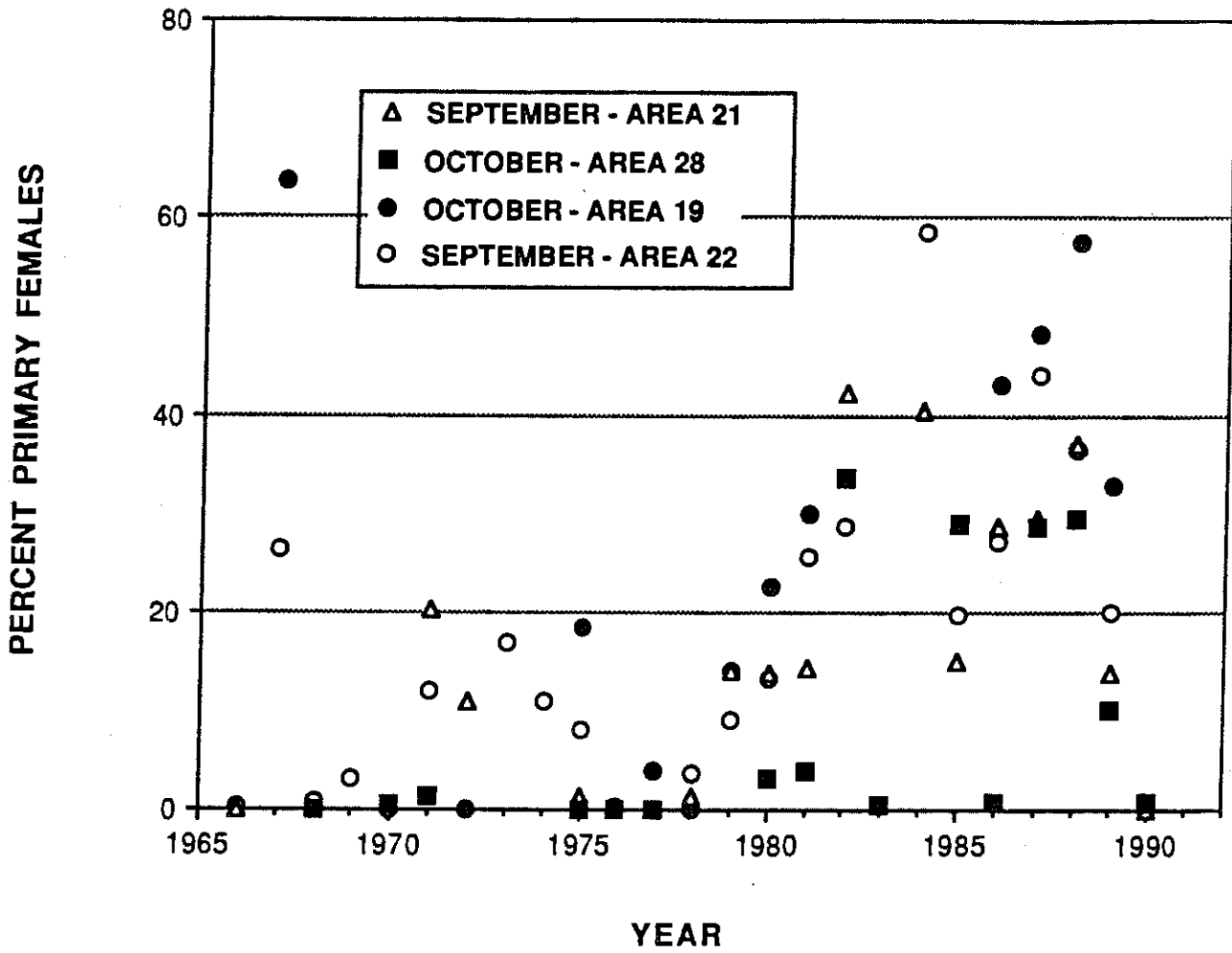


Figure 4. The percentage of primary females in the trawl catch for selected areas and months, 1966-89.

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