http://dx.doi.org/10.7773/cm.v2i2.288

SHRIMP POPULATION DYNAMICS AND FISHERY IMPACT IN THE NORTHERN GULF OF CALIFORNIA. 1967-1968.

ELAINE SNYDER-CONN* and RICHARD C. BRUSCA**

(Recived September 11, 1975)

*The University of Arizona, Tucson.
**New Address Assistant Professor and Curator of Crustacea. The University of Southern California, Allan Hancock Foundation, University Park, Los Angeles, Calif. 9007.

ABSTRACT

In this paper we present data of monthly shrimp catches by species composition and size from Puerto Peñasco, Sonora, Mexico, for the 1967-1968 season. We also analyse fishing effort and its effect. The total catch and numbers of individuals captured of Penaeus stylirostris climaxed in September and October; the total catch and numbers of individuals captured of P. californiensis were greates from November to December. Maximum growth of P. stylirostris ocurred from May to November and cesased during the winter and early spring months. Maximum growth of P. californiensis was from May throgh December, slowing greatly from January to March. The average growth from September through April was 1.82 g/month for P. stylirostris and 1.07 g/month for P. californiensis. Also, the former species greatly exceeded the latter species in model size due to its enhanced summer growth rate. Both species exhibited a single prominent breeding season in the spring and a lesser breeding period in the fall. Patterns of size distribution indicate that most individuals of both species live year or less, under the conditions of sustained fishing presure. Overfishing is evidente for both species.

RESUMEN

En el presente escrito se presentan los datos de captura en Puerto Peñasco, Sonora, México, por mes, composición de especies de camarón y talla, durante el período de la estación de pesca 1967-1968. También se analizan esfuerzo de pesca y su efecto. La captura total y el número total de individuos de Penaeus stylirostris estuvo a su punto mayor en septiembre y octubre; la captura total y el número total de individuos de P.

californiensis alcanzó mayor intensidad en noviembre y diciembre. El crecimiento máximo de P. stylirostris ocurrio desde mayo hasta noviembre; el crecimiento cesa en invierno y en los primeros meses de la primavera. El crecimiento máximo de P. californiensis ocurrió desde mayo hasta diciembre, decelerando marcadamente desde enero hasta marzo. El crecimiento medio desde septiembre hasta abril fue 1.82 g/mes para P. stylirostris y 1.07 g/mes para P. californiensis. También P. stylirostris excedió mucho a P. californiensis en talla modal debido a su más rápida tasa de crecimiento en verano. Ambas especies exhiben una sola estación mayor de crianza en la primavera y un periodo menor de crianza en el otoño. Los modelos de ambas especies viven un año o menos, bajo condiciones de pesca sostenida. Exceso de pesca es evidente en ambas especies.

INTRODUCTION

The commercial shrimp fishery of the Gulf of California is based primarily on three penaeid species; Penaeus californiensis, the brown shrimp , P. stylirostris, the blue shrimp , and P. vannamei, the white shrimp . In the northern Gulf of California shrimp catches consist mainly of P. californiensis and P. stylirostris while in the southern Gulf catches of P. stylirostris and P. vannamei predominate. The industry has been an active and salient economic influence in Mexico since al least 1935 (Chapa et al., 1968). Shrimp fishing was apparently intensive as early as 1940-1945, when a toal of 17 million kg of headless shrimp were exported to the United States by Mexico (Cardenas, 1951). In addition, the Japanese were engaged in concentrated shrimp fishing in the Gulf furing these years (Steinbeck and Ricketts, 1941). In 1974 over 850 shrimp trawlers operated out of Mazatlan, Yavaros, Topolobampo, Guaymas, Santa Cruz, San Felipe, and Puerto Peñasco - key fishing centers of the Gulf shrimp catch from 46 million kg in 1962 to 31 million kg in 1970 (Lluch, 1974) evinces a clear need for improved management of this vital natural resource.

Olguín (1968) has analysed the reproductive biology of P. californiensis at Guaymas by examining the female gonads monthly. He found evidence for two periods of egg development: February through April and September through November. However, maturation of the eggs was only noted for May through August. His study agreed with the observations of Cárdenas (1951) wich showed that P. californiensis achieved sexual maturity between March and June. However, Chapa et al. (1968) found tath while young of P. stylirostris predominated in September catches of shrimp, young P. californiensis were abundant throughout the year. This finding suggest that some P. californiensis may be reproductively active year-round. At Mazatlan, this seems to be the case, although there is a September peak in recruitment (Lluch, 1974). Both of the other species, however, demonstrated a clear seasonality of reproduction, with recruitment in the fall months at Mazatlán (Lluch, 1974).

Recent interest in the shrimp of the Gulf of California stems from the annual declines in catch per unit effort at most fishing ports and total catch others (Chapa et al. 1968, Chávez and Lluch 1971, Lluch 1974). Lluch (1974) summarizes changes in the shrimp yield and concludes that there are three primary causes of the decrease in shrimp production: (1) overexploitation due to the increasing size of the commercial fleet, (2) overexploitation due to the retention of smaller shrimp by the finer mesh nets, and (3) environmental fluctuations in freshwater runoff and accompanying nutrient supply. Overexploitation is also well document by Lluch. The work of Mathews (1974) gives additional support to the idea of overexploitation. The influence of fresh water supply, however, requires more evidence. The data presented by Lluch (1974) show only a poor correlation between catch and pluvial precipitation (r=.28, n=13) (Snyder and Brusca, unpublished).

METHODS AND MATERIALS

Our results are derived from data gathered by Filiberto Vega and Ramon Durazo during the 1967-1968 shrimping season at Puerto Peñasco, Sonora, Mexico. Señores Vega and Durazo were at this time employed in Puerto Peñasco at the Laboratorio de Biología Marina operated jointly by the University of Arizona and the Universidad de Sonora. Information was obtained principally from two sources. Shrimp records of fishing cooperatives provided total catch data per fishing boat (in the form of kg headless, or "tails", shrimp) and fishing effort was calculated from records of the arrivals and departures of boats delivering shrimp to the cooperatives, kept by the Port Captain of Puerto Peñasco.

Original catch data was in the form of kg (per species) in different weiht categories of headless shrimp. To determine the numbers of individuals in each weight category, we used the following standard conversion factors, presented by Lluch (1974) for headless shrimp:

g/shrimp (headless)	class ("tails"/lb)
6	71-80
7	61-70
8	51-60
10	41-50
13	31-40
16	26-30
20	21-25
25	16-20
32	13-15
41	11-12
50	< 11

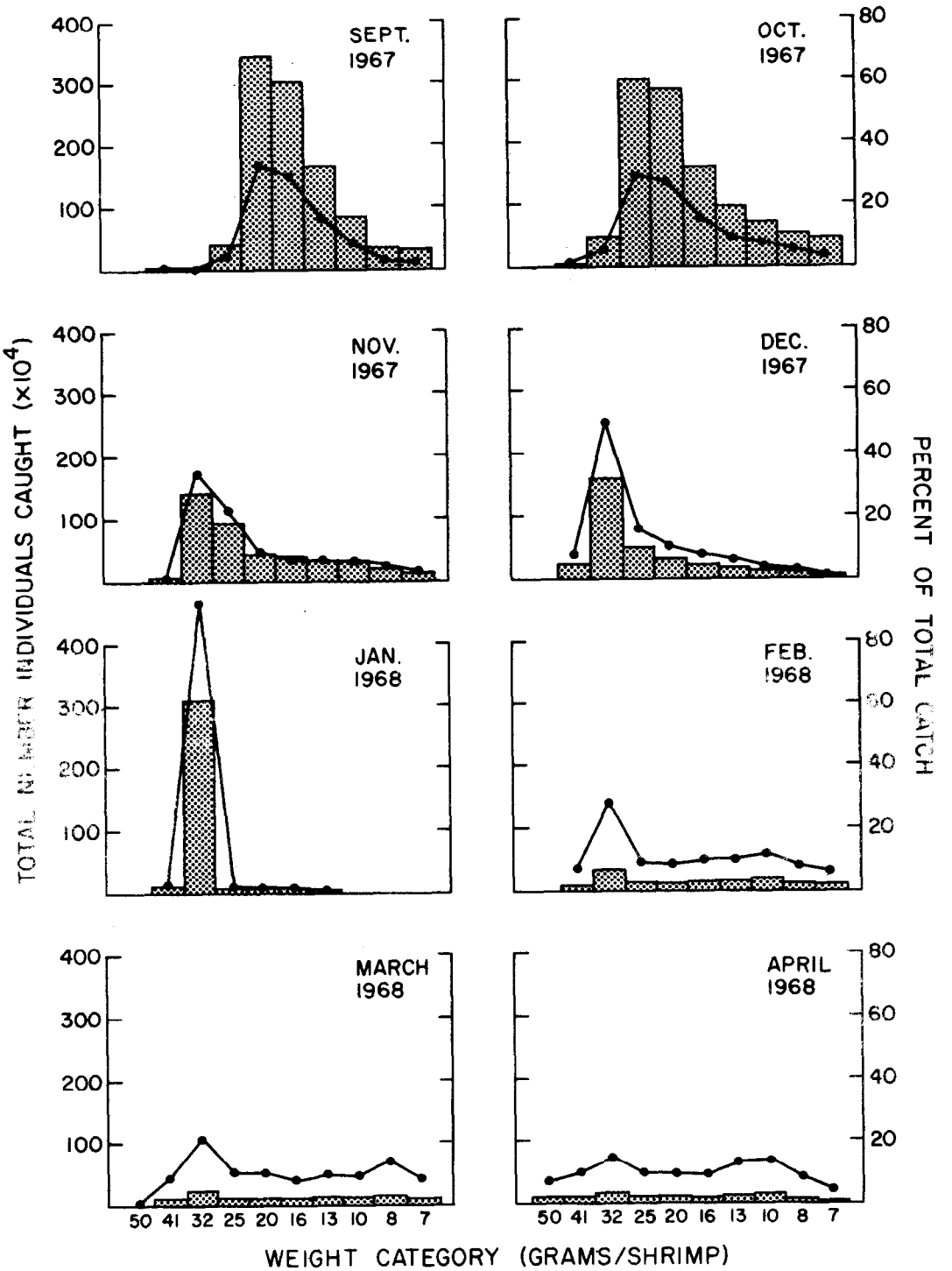

Figure 1. Monthly Size Distribution of Penaeus stylirostris Catch at Puerto Peñasco, Sonora, México, 1967-1968. The histograms indicate the total numbers of individuals in each weight category, while the solid lines show percentage composition. Note the reversal of the abscissa.

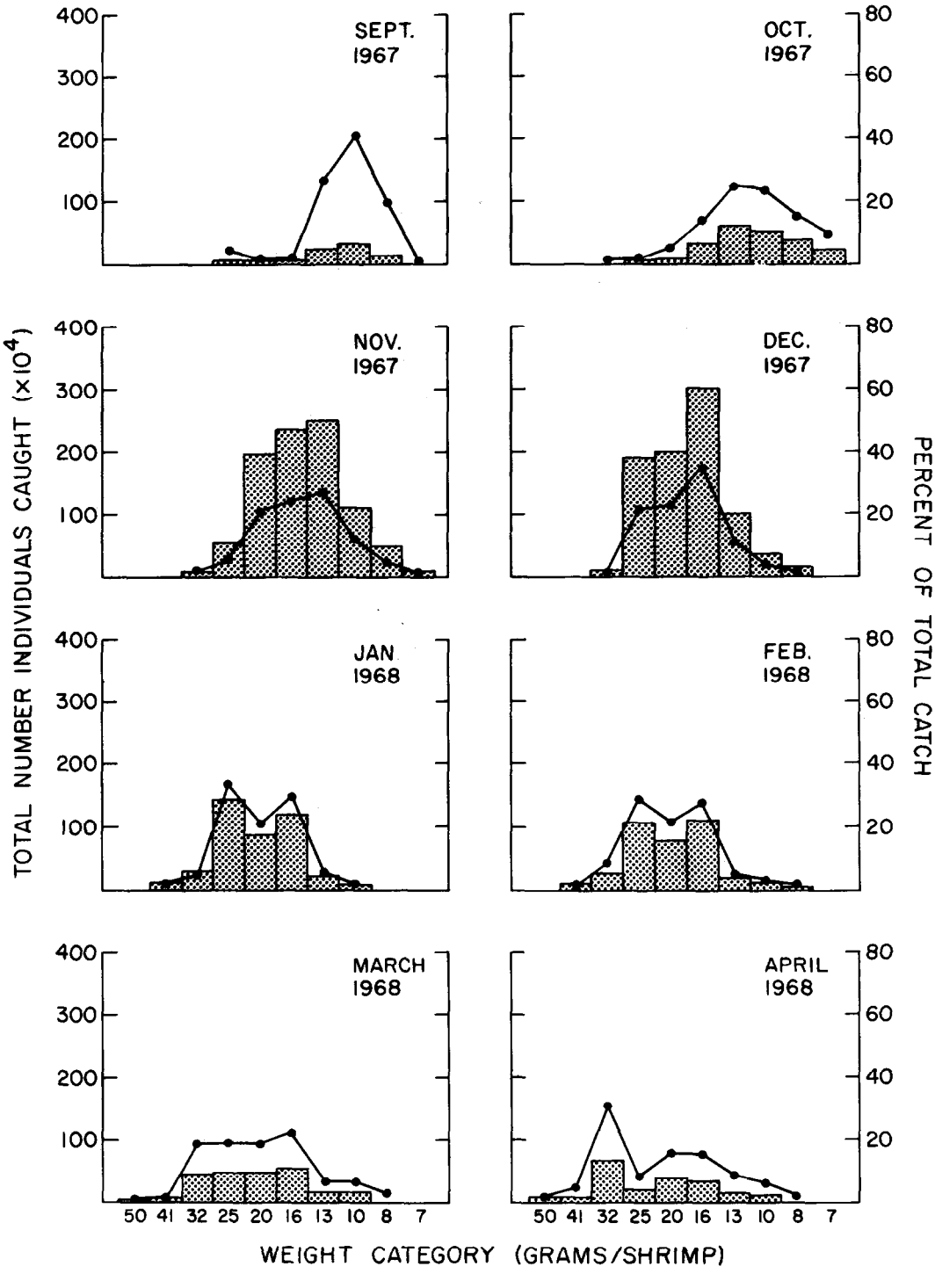

Figure 2. Monthly Size Distribution of Penaeus californiensis Catch at Puerto Peñasco, Sonora, México, 1967-1968. The histograms indicate total numbers of individuals in each weight category, while the solid lines show percentage composition. Note the reversal of the abscissa.

We have used these size classes in Figures 1 and 2 so as to facilitate comparisons with similar data from Mexican sources. However, for detailed population analyses, weight intervals of equivalent size were needed so as not to bias the data. For example, if 100 individuals were reported in class would weigh about 7 g. but if 100 individuals were reported in class 61-70, all the individuals could weigh 23, 24, 25, 26, or 27 g. Therefore, this system creates a bias in the graphed data the smaller classes, composed of larger-size shrimp would seem to contain more individuals than the larger classes, wich consist of smaller shrimp. We have therefore adjusted the data, assuming randomness in the distribution of catch sizes and use the following categories of weight: 8.5 g, 12.5 g, 16.5 g, 20.5 g, etc. Classes 1, 2, 3, 4, etc. Were then assigned to each weight, respectively. Data using these adjusted catoegories of weight appear in Tables 1 and 2. All catch data presented in the results are for headless shrimp.

Growth rates for P. californiensis and P. stylirostris were estimated indirectly by examining the modal size class each month. To improve our accuracy, we identified both the largest size class and the largest class inmediately adjacent to this class, defining the two as the "modal couplet". An important assumption, however, was that degrowth does not occur in shrimp. Therefore, while the model couplet was able to remain the same from one month to another, showing no growth, it was not permitted to shrink in size. In Tables 1 and 2 the modal couplets for the two species are indicated in boxes for each month. The weighted mean of the two values within each couplet was calculated in order to estimate average growth per month. Capture data were unavailable for the period from May to mid-July.

RESULTS AND DISCUSSION

Penaeus stylirostris.- Table 1 and Figure 1 illustrate the monthly size composition of the population by weight category, within the size range captured by shrimp trawlers. These data are necessarily biased in that the smallest individuals are not captured by trawl nets. Nevertheless, the adjusted data (Table 1) fit a broad unimodal curve, consistent with a concentration of breeding and successful larval development within a single breeding "season". A longevity of one year or less is suggested for most individuals under the conditions of heavy, sustained fishing pressure. Since shrimp of the youngest weight class, averaging 8.5 g (abdominal weight) per individual diminish greatly in numbers after the period of September and October, it may be assumed that the major peak of spawning and larval development occurs during the early spring and summer months. This assumption roughly corresponds to predictions based on experimental data. The rearing of larval P. stylirostris from spawn to 8.5 g (abdominal weight) takes place in 6 1/2 months in the mariculture laboratory under constant, presumably optimal

Table 1. Monthly Size Composition of *Penaeus stylirostris* at Puerto Peñasco, Sonora, Mexico, 1967-1968

Total Kilograms Captured (Headless Shrimp)

Class	mean gm	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
1	8.5	10,732	12,252	4,154	1,621	26	2,411	3,479	1,654
2	12.5	24,766	14,656	5,576	2,330	172	2,311	1,792	1,982
3	16.5	61,636	36,682	7,315	4,776	822	2,596	1,880	1,762
4	20.5	54,671	45,782	6,334	5,124	706	1,802	1,742	1,397
5	24.5	8,134	59,811	18,106	9,792	1,029	3,504	2,242	1,850
6	28.5	2,232	20,258	19,509	19,166	3,497	4,484	2,933	1,933
7	32.5	268	7,154	20,204	22,544	4,369	5,202	3,200	1,983
8	36.5	237	3,706	10,518	13,184	3,001	3,375	2,355	1,821
9	40.5	212	342	1,070	4,123	1,702	1,624	1,564	1,701
10	44.5	157	273	806	3,082	1,267	1,207	1,267	1,982
11	48.5	0	78	49	98	20	13	426	2,883

Number Individuals in Adjusted Size Classes

Class	mean gm	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
1	8.5	1,263	1,441	489	191	3	284	292	195
2	12.5	1,981	1,172	446	186	14	185	143	159
3	16.5	3,736	2,223	443	289	50	157	114	107
4	20.5	2,667	2,233	309	250	34	88	85	68
5	24.5	332	2,441	739	400	42	102	92	76
6	28.5	78	711	685	672	123	157	103	68
7	32.5	8	220	622	694	134	160	98	61
8	36.5	7	102	288	361	82	92	65	50
9	40.5	5	8	26	102	42	40	39	49
10	44.5	3.5	6	18	69	28	27	28	45
11	48.5	0	2	1	2	.4	.3	9	59

Table 2. Monthly Size Composition of *Penaeus californiensis* at Puerto Peñasco, Sonora, Mexico, 1967-1968

Total Kilograms Captured (Headless Shrimp)

Class	mean gm	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
1	8.5	3,715	8,585	11,519	3,937	616	1,527	1,876	1,278
2	12.5	4,140	9,433	35,786	14,506	2,863	2,886	2,765	2,659
3	16.5	565	6,253	45,375	55,890	27,376	19,255	10,860	6,723
4	20.5	192	2,234	31,131	30,735	13,641	12,191	7,740	5,837
5	24.5	771	733	11,294	37,623	27,418	20,461	9,724	3,874
6	28.5	203	296	3,661	11,097	10,011	8,589	7,506	7,682
7	32.5	4	150	1,119	2,260	4,219	4,643	6,782	8,971
8	36.5	4	96	823	1,322	2,409	2,470	3,626	5,329
9	40.5	4	42	531	389	610	309	486	1,695
10	44.5	5	32	404	309	539	336	592	1,604
11	48.5	8	0	27	70	330	418	913	1,342

Number Individuals in Adjusted Size Classes

Class	mean gm	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
1	8.5	437	1,010	1,355	463	72	180	221	150
2	12.5	331	755	2,863	1,160	229	231	221	213
3	16.5	34	379	2,750	3,387	1,659	1,167	658	407
4	20.5	9	109	1,519	1,499	665	595	378	285
5	24.5	31	30	461	1,536	1,119	835	397	158
6	28.5	7	10	128	389	351	301	263	270
7	32.5	.1	5	34	70	130	143	209	276
8	36.5	.1	3	23	36	66	68	99	146
9	40.5	.1	1	13	10	15	8	12	42
10	44.5	.1	.7	9	7	12	6	13	36
11	48.5	.2	0	.6	1	7	9	19	28

temperature conditions at the University of Arizona's Environmental Research Laboratory at Puerto Peñasco (D. Lightner, pers. comm.).

The peak in the number of individuals in each monthly sample of Table 1 is relatively broad, suggesting that the main effective spawning season occurs over three or four months in the

northern Gulf of California. Lesser peaks may also be seen in the numbers of young shrimp (Class 1) from February through April. These peaks suggest the possibility of a second breeding period in the fall. Since these young would not mature until early summer, it is difficult, given the possible bias in samples of the commercial fishery, to estimate the actual importance of this generation.

As shoen by the modal classes (boxed in Table 1) and the growth curve (Figure 3), individual growth in P. stylirostris is greatest in the summer and fall and appears to discontinue during the winter months (December to April). This is in contrast to the growth pattern of P. californiensis; P. californiensis is a more temperate species, ranging as far north as San Francisco, California, while P. stylirostris is a somewhat more tropical species, ranging north only as far as the Gulf of California (Brusca, 1973). This difference may partially account for the rapid growth of the brown shrimp continuing as late as December, and for the continued very slow growth throughout the winter in the upper Gulf. In P. stylirostris growth is discontinued in the upper Gulf from December through April apparently.

Changes in the modal weight categories are not substantially different from those of numbers captured per size category (Table 1). The greatest catches occurred in September and October and were concentrated in medium-size individuals 15-22 g each (headless).

Penaeus californiensis.- Table 2 and Figure 2 illustrate the monthly size composition of the population by weight category, within the size range captured by shrimp trawlers. These data also fit a unimodal curve, indicative of a "seasonal" breeding pattern (Table 2). In contrast, Lluch (1974) concluded that P. californiensis was a nonseasonal breeder in the southern Gulf.

At present little documentation exists on the life history, ecology or migration pattern of any penaeid shrimp and the stability of the resident populations of these shrimp in the Gulf of California, at current levels of fishing effort, is questionable. The results of this analysis underscore the urgent need to understand the shrimp biology in the northern Gulf of California.

Commercial Shrimping in the Northern Gulf of California.- Shrimping in the northern Gulf of California was, until recently, limited to the September 15- July 15 season. These dates were apparently based largely on political pressure from the shrimping industry rather than on fisheries research (Chapa et al., 1968; Lluch 1974). In 1975, however, the Instituto Nacional de Pesca imposed a closed season on the whole Mexican Pacific shrimp fishery from June 30 to September 30, when their shrimp inventories revealed stock shrotages (Anonymous, 1975). As in most regions of the world, Mexican shrimp trawlers employ vaieties of otter trawls for night fishing. Prior to 1954 single otter trawls with a 2-2.5 inch (5.1-6.4 cm) mesh size were used. From 1954-1962 shrimpers began using two trawls simultameously. In 1963 the mesh size reduced to 1.5 inches (3.8 cm), resulting in the capture

of smaller, inmature shrimp (Lluch, 1974). Mathews (1974) discusses recent changes by some shrimpers to a four trawl system. He estimated that this system would increase the effective catch in an area from 50% to 65%.

The pattern of fishing in the Gulf varies with the species fished and the season. Examination of data provided by Puerto Peñasco shrimpers from 1966 to 1969 reveals that trawling depths range from 12-64 m ($\bar{x}$ = 35 m, n = 48) in the northern Gulf (Brusca and Snyder-Conn, unpublished), but the depths fished may be deeper in the south. With the exception of the rocky coastlines along southern Baja California, nearly all areas of the Gulf are fished. Mathews (1974) calculated that Mexican shrimping areas are currently trawled about 6.4 times each year. Fishing is prohibited by law in the delta region of the Colorado River, based on the premise that these shallow waters serve as nursery areas for commercial shrimp as well as the endangered totoaba (Cynoscion macdonaldi). However, this regulation is not enforced and commercial fishing occurs seasonally in this region (Chapa et al., 1968; C. Flanagan, pers. comm.).

Previous Research.- Some research efforts have been made in recent years concerning the commercial shrimp industry of western Mexico (Chapa 1956; Chapa et al. 1968; Núñez and Chapa 1950, 1951a,b; Secretaría de Industria and Comercio 1969). These studies deal with the species and size compositions of shrimp catches primarily. Very little is knowm of the ecology of the different peneid species in the Gulf of California. However, Chávez and Arvizu (1969) have studied the fish fauna which accompanies the shrimp.

Knowledge of the distribution and movements of shrimp is particularly scant. There is some evidence for migratory behavior in all the shrimp species of the Gulf. Cárdenas (1951) states that from May to June large shrimp (Penaeus californiensis and P. vannamei) become uncommon in the shallow waters of the Guaymas area. Further, he found that P. stylirostris adults were rarely ever present in these areas. Further south, López (1968) found that postmysid P. vannamei undergo summer migrations into bays near Mazatlán, but occur throughout the year in bays south of Mazatlán. The estuaries, sheltered coastal areas and esteros serve as nurseries to many marine species including shrimp (Findley, 1974). Young of all three peneid species occur in these habitats and may arrive partly by means of current transport. Small to medium size P. californiensis appear to remain near shore in May to July, while young of the other two species migrate offshore earlier (Cárdenas, 1951). In general, larger shrimp of all three species occur in deeper, offshore waters, depending on their latitudinal distribution, as is true of shrimp species worldwide (Allen, 1966). However, spawning migrations of P. stylirostris males and females may be found in water less than two meters in depth during May (Bill Salser, pers. comm.).

The biology of the different species of shrimp is perhaps the most poorly understood subject, in part because of the likelihood of complex migrational patterns (Allen, 1966). Chapa et al. (1968) found that in the central Gulf, at Guaymas, there was an abundance of young throughout the year, but a peak in abudance from June through December. Olguín (1968), also studying at Guaymas, noted two periods of growth of eggs in female gonads: February through April and September through November. However, he noted only one period in which eggs were mature, in May through August. Dependence of the breeding period on local temperature regimes would accomodate a shift from seasonal to nonseasonal breeding patterns over this range of latitudes. This may explain the more pronounced seasonality of breeding in the upper Gulf.

A longevity of one year or less for most individuals is also indicated in the graphical distributions. Shrimp of the youngest captured weight class (8.5 g) are especially evident in October and November (Table 2), forming 44% of the total numbers captured in October. Hence, spawning and larval development seem to occur in the spring and summer for the brown shrimp also. The slightly later fall appearance of young in P. californiensis is likely due to a slower summer growth rate of the larvae rather than a later breeding period. It may also be accounted for by a different migratory pattern. In Table 2, the abundance in several adjacent size classes suggests a broad, but pronounced period of spawning in the northern Gulf, of approximately three to four months in duration. A second but slight increase in young again occurs in the spring. Resolution of whether these young are a consequence of all spawning or migration will depend on the collection of summer data and also obtaining unbiased samples over a wide area for a period of several years.

As exhibited by the modal boxes in Table 2, and the growth curve (Figure 3), individual growth in P. californiensis was highest during the summer and fall months. The distribution of catch sizes was similar, but not identical, to the distribution of the numbers of individuals according to weight category. This difference results from the increased weight of individuals in the higher weight categories. The greatest catch for this species occurred in December, when individuals averaged 18.5 g (headless).

Growth Rates.- Figure 3 depicts the growth curves for each species under consideration. Note that the overall growth rates of the two species differed greatly from September to Arpil. During this period, P. stylirostris averaged 1.82 g/month; P. californiensis averaged 1.07 g/month. This results is attributable to the higher rate of fall growth of P. stylirostris. Penaeus californiensis continued very slow growth in the winter and early spring, while growth of P. stylirostris ceased at this time. In addition to faster net growth from September to April, P. stylirostris grew much faster in the summer as is indicated by its much larger, initial modal size class in September.

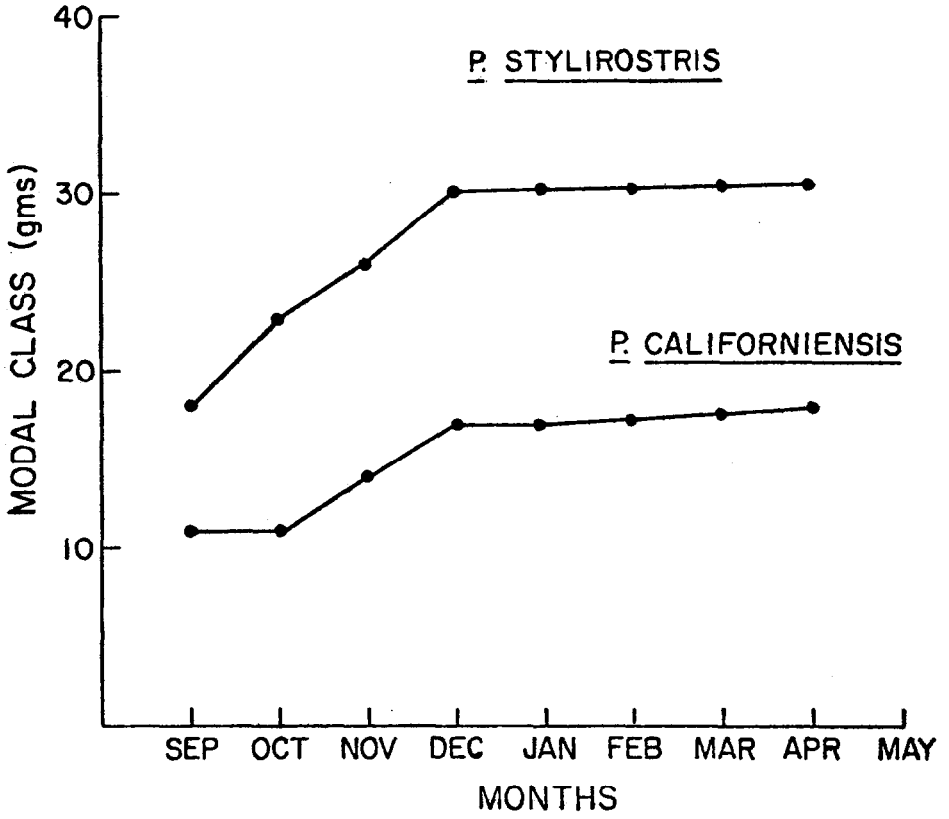

Figure 3. Growth Curves of Penaeus stylirostris and P. californiensis at Puerto Peñasco, Sonora, México, 1967-1968. The modal class weight was calculated from the weighted average of the modal size couplet each month.

Effects of Fishing.- Figure 4 depicts the relation between fishing effort in total fishing days per month and changes in catch. Table 3 contains a breakdown of fishing effort throughout the season. From September to April, 76 shrimp boats operated out of Puerto Peñasco, capturing a total of 1,427,733 kg of healess shrimp. Penaeus californiensis represented 45% and P. stylirostris 55% of the total catch. Although fishing pressure was maintained at a constant rate from October through April, catch per unit effort declined dramatically. The total yield for April was about 10% of that for September (at the beginning of the season) even though only the second half of September fell within the shrimping season. The impact of the fishery is especially noticeable for P. stylirostris which showed a rapid decline from October to April. This decline is described by a hyperbolic function, the predictable form for a steadily overexploited population of a given density. The curve appears to be similar to that given by Lluch (1974) in his overexploitation model. A similar, but slower, decline is exhibited by P. californiensis, beginning in November. Penaeus stylirostris is iniatially larger and commands a higher market price (B. Salser, pers. comm.), so that fishing effort may be concentrated on this species at the beginning of the season.

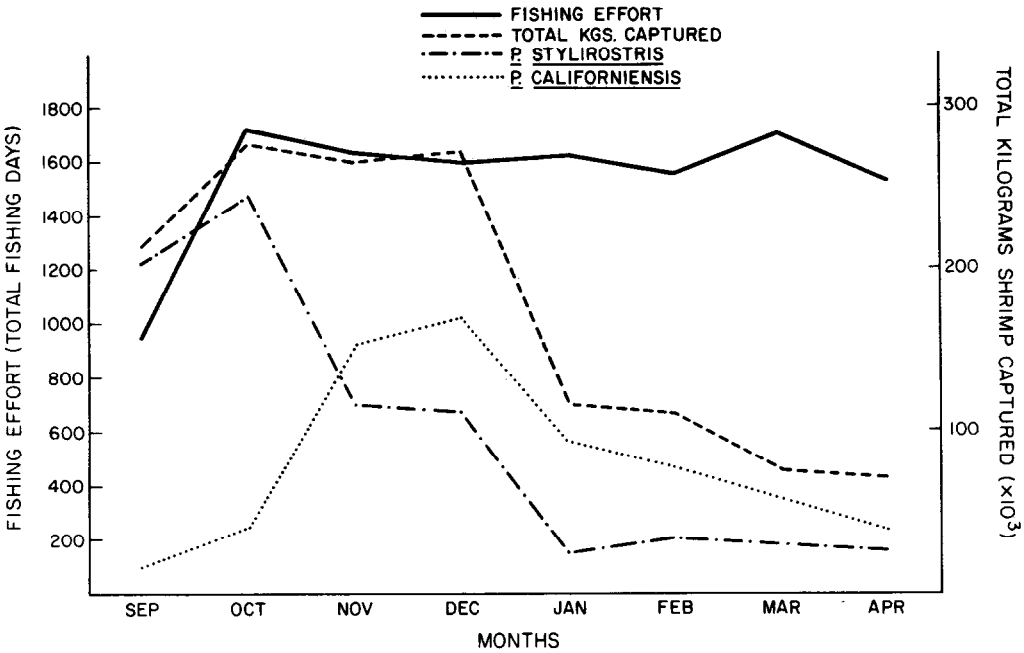

Figure 4. Shrimp Catch versus Fishing Effort at Puerto Peñasco, Sonora, México, 1967-1968.

Table 3. Analysis of Fishing Effort during the 1967-1968 Season at Puerto Peñasco, Sonora, Mexico

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Total "fishing days"	943	1707	1623	1595	1613	1534	1690	1521	1577
Mean - no. days per boat for month	13.10	23.07	21.93	21.55	21.80	21.01	22.84	20.84	21.90
Mean - no. trips/boat	1.75	1.99	1.76	1.69	1.54	1.37	1.35	1.55	1.68
Approx. total no. trips made	128	147	130	125	114	100	100	113	121
Mean - no. days per trip	7.36	11.59	12.48	12.76	14.15	15.34	16.90	13.46	13.03
Catch per unit effort (Kg catch/trip)	1349	1557	1812	1954	936	1007	758	601	-

ASKNOWLEDGEMENTS

We thank Christine Flanagan and Donald Thomson of the University of Arizona, Bill Salser of Puerto Peñasco Unidad Experimental, the University of Arizona-Universidad de Sonora, and Oscar Villavicencio of the Universidad de Sonora for review of the manuscript. Graphics work was graciously funded by the University of Arizona Alumni Association. This paper is a contribution from the Marine Sciences Program, Department of Ecology and Evolutionary Biology, The University of Arizona.

BIBLIOGRAPHY

Allen, J. A. 1966. The rhythmes and population dynamics of decapod decapod Crustacea. Oceanogr. Mar. Biol. Ann. Rev. 4:247-265.

Anonymous. 1975. Tecnica Pesquera No. 90:3.

Brusca, R. C. 1973. A handbook to the common intertidal invertebrates of the Gulf of California. University of Arizona Press, Tucson, 218 pp.

Cardenas, M. 1951. Los camarones del noroeste de Mexico. Soc. Mexicana de Geografia y Estadistica. Mexico, D.F. 89 pp.

Chapa, H. 1956. La distribucion geografica de los camarones del nororeste de Mexico y el problema de las artes fijas de pesca. Dir. Gral. de Pesca e Ind. Conexas. Mexico, D.F. 87 pp.

Chapa, H., C. Guilbot, and H. Romero. 1968. Ensayo de interpretacion de las tallas comerciales de camaron en los litorales de Sonora, Mexico. FAO Fish. Rep. No. 57:357-372.

Chavez, E. and D. Lluch. 1971. Estado actual de la pesca de camaron en el noroeste de Mexico. Rev. Soc. Mex. Hist. Nat. 32: 141-156.

Chavez, H. and J. Arvizu. 1969. Estudio de los recursos pesqueros demersales del Golfo de California 1968/ 1969. III. Fauna de acompañamiento del camaron (peces finos y "basura"). Mem. IV Congreso Nat. Oceanografia Mexico. Nov. 17-19 de 1969.

Findley, L.T. 1974. Aspectos ecologicos de los esteros con manglares en Sonora: Antropologia del Desierto, B. Braniff and R. S. Felger (eds), Instituto Nacional de Antropologia e Historia, Mexico, D.F.

Lluch, D. 1974. La pesqueria del camaron de Altamar en el Noroeste. Instituto Nacional de Pesca, Serie Informativa INP/SI 116. Programa del Pacifico, Mexico.

Lopez, L. 1968. Estudio preliminar sobre las migraciones de postmisis de Penaeus vannamei Boone. FAO Fish. Rep. No. 57:405-413.

Mathews, C.P. 1974. ¿Cuanto resistira el camaron? Ciencias Marinas 1(2):86-91.

Nuñez, R. and H. Chapa. 1950. La pesca del camaron por medio de artes fijas en los estados de Sinaloa y Nayarit. I. Principales especies y sus movimientos de salida al mar abierto. Cont. Tec. Inst. Pesca del Pacif. 1:1-24.

_____.1951. a. La pesca del camaron por medio de artes fijas en los estados de Sinaloa y Nayarit. 2. Descripcion de un tapo, localizacion relativa de las artes fijas en la zona, metodo de pesca, proceso de apastillado y consideraciones generales. Cont. Tec. Inst. Pesca del Pacif. 2: 1-29.

_____.1951 b. La pesca del camaron por medio de artes fijas en los estados de Sinaloa y Nayarit. 3. Datos sobre la produccion, estudio comparativo de especies y tamaños de camaron que integran la produccion de aguas interiores y oceanicas. Cont. Tec. Inst. Pesca del Pacif. 3:1-30.

Olguin, M. 1968. Estudio de la byologia del camron cafe Penaeus californiensis Holmes. FAO Fish. Rep. No. 57:331-356.

Secretaria de Industria y Comercio. 1969. Programa camaron Golfo de California. Inst. Nac. de Invest. Biologico-Pesqueras, Documentos de Programacion 3:1-28. Mexico, D.F.