Review of Ecuadorian Offshore Shrimp Fisheries and Suggestions for Management and Research

Revisión de la Pesquería Ecuatoriana del Camarón Costero y Sugerencias para su Manejo e Investigación.

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Resumen

En la pesca de arrastre del camarón blanco entre 1965 y 1979, las capturas de *Penaeus occidentalis* comprendieron entre el 50 y el 60% de los desembarques totales de camarón blanco, siendo la especie más importante en la pesca con buques de arrastre. En segundo lugar se ubicó la especie *P. stylirostris* (25 - 45%) y finalmente *P. vannamei* (6%). A este respecto debe anotarse que se observó amplias variaciones anuales en la composición por especies de las capturas.


Se ha supuesto que el Golfo de Guayaquil es el principal lugar de cría para *P. vannamei* y tal vez para otras especies de camarón blanco. Igualmente, se piensa que el tamaño y la persistencia del área de cría puede estar determinada por la influencia de las corrientes de aguas frías y cálidas. Somers demostró una relación estrecha entre la cantidad de lluvias y la CPUE: conforme aumentan las lluvias también lo hacen las CPUE. Sin embargo, esta relación encontrada está dominada por la presencia de El Niño de 1983, que mostró gran cantidad de lluvias y muy alta CPUE.

El autor analiza a continuación aspectos referidos a la información científica para manejo, las necesidades de datos estadísticos y el manejo actual de las pesquerías, incluyendo la implantación de vedas. Finalmente presenta varias recomendaciones, tales como: Ampliar el programa de recolección de datos estadísticos (capturas, esfuerzo de pesca, composición por especies y por tallas de las capturas comerciales, caza artesanal de postlarvas), efectuar estudios independientes para evaluar las acciones de manejo y determinar el reclutamiento y distribución de postlarvas y juveniles del camarón, así como estudios de marcación-recaptura para determinar los límites de los "stocks".
Introduction

The Ecuadorian offshore trawl fishery commenced in 1952, according to Cobin and Looch (1966). Between 1954 and 1975 the fishery fluctuated from a high of 8,700 m.t. in 1969 to a low of around 5,000 m.t. in 1964, with production generally not exceeding 6,000 metric tons. Since 1976, with the inception of the census study, the information on total catch, and the information on total vessel effort, was available for the offshore trawl fisheries. However, the number of vessels has gradually increased to approximately 250-300 in 1985.

Predominant Species

Cain and Marin (1982) estimated that Penaeus argus (Linnaeus) comprised between 90 percent and 100 percent of the shrimp catch from 1965 to 1979, and is the most important species to the trawl fishery. The second most important species is Penaeus stylirostris which constituted between 25 percent and 45 percent of the catch during the 1965 through 1974 period; P. wessulensis was of only minor importance in the Gulf of Guayasqul and other areas, constituting, on the average, approximately 5 percent of the catch. It should be noted, however, that there appears to be considerable annual variation in the species caught by the offshore fishery. In some years, such as 1973 and 1977, P. wessulensis comprised 13 percent of the total catch, and in 1979, 21 percent of the commercial catch was made of this species. McPadden (personal communication) shows that in 1985, P. wessulensis made up at least 30 percent of the shrimp catch in the Gulf of Guayasqul (Table 1).

Two other species, P. californiensis and P. brevistatus, do not appear to be a major part of the offshore catch, possibly because these species are found further offshore, and the fishery does not operate in offshore waters as readily as in the nearshore waters. These appear to be two principal fishing grounds: one north of the port of Manta with both white and brown shrimp as main components, and the other south of Manta, composed mostly of white shrimp. The interchange of shrimp and shrimp designation between the areas is unknown.

CPUE

Detailed information on monthly catch-per-unit effort (CPUE) by commercial double-trawl fishery available from 1973 to the present, and annual CPUE estimates from 1956 to 1972 are available. The data from June 1973 to the present are based on interviews with vessel captains in the Gulf of Guayasqul. Charles McPadden (personal communication) has used this data to clearly demonstrate the marked annual variation in the fishery. In addition, monthly mean size and length frequency distribution by species is available in raw form, but has not been analyzed in any depth. This information is available in raw form but not in a computer format, so it cannot be analyzed to determine periods of peak production.

McPadden (personal communication), U.N. Food and Agriculture Organization (FAO) consultant from Australia, evaluated the impact of the posteleral and offshore shrimp fisheries on the long-term production (including harvestable population) of major commercial species of shrimp. The results of both Somers and this author (1986) show that there is a marked annual variation in the fishery. The variations in the data are significant for the decline in CPUE other than overfishing may be due to the mangle in the mangle area that is used as nursery areas by larval and juvenile shrimp (Zimmerman and Minello, this volume). Alvarez (this volume) indicates a 10 to 15 percent of the mangle area has been lost in the last ten years in Ecuador.

Since May 1985, McPadden has collected information on CPUE for white and brown shrimp. This data reveals that the monthly CPUE for white shrimp increased to a level below 40 lb/day, whereas brown shrimp monthly CPUE peaked in September 1985 at over 110 lb/day.

Managing Recruitment

The Ecuadorian governments initiated a closed season from December 1985 to January 1986. Since the season opened, the CPUE was at least two times higher than before the closed season. However, it is difficult to determine whether the CPUE before the closure period declined to extremely low levels. If these data represent what is actually happening in the fishery, it is likely that the abundance and availability of white shrimp, regulations to reduce fishing mortality should be considered.

Somers (1985) indicated that there was insufficient evidence to demonstrate that any significant declines in recruitment to the offshore fishery. However, the current CPUE levels (less than 40 lb/day) are extremely low compared to other world wholesalers for the type of vessel that are presently being utilized off Ecuador, and has declined precipitously from the initial CPUEs after the fishery had stabilized between 1956 and 1964.

If the percents of species composition are correct, as identified by McPadden, there has been a significant increase in P. wessulensis as captured in the increased CPUE for this species in the last few years; however, the decline in the other species should cause concern. A significant cause for the decline in CPUE other than overfishing may be due to the mangle in the mangle area that are used as nursery areas by larval and juvenile shrimp (Zimmerman and Minello, this volume). Alvarez (this volume) indicates a 10 to 15 percent of the mangle area has been lost in the last ten years in Ecuador.

McPadden has also estimated the number of postelar shrimp delivered to mangle area by the artisanal fishery, but there is considerable uncertainty concerning these values. Magee (personal communication) indicates that up to 50 percent of the caught larvae die before they reach the pond, therefore the estimates are probably low by at least half. There appears to be a peak of postelar production at around 4 billion individuals (i.e., perhaps 8 billion) in 1984, declining somewhat after that. McPadden (1985) indicates that the catch estimates of postlarvae in 1985 were slightly lower than the corresponding estimates for 1984. He has also pointed out that the postlarval fishery involves at least 90,000 participants, and he has clearly identified a need for accurate monitoring of this fishery to determine recruitment levels both in the postlarval and offshore stocks.

in fishing trips each month from the ports of Puebla, Guayaquil and Manabi, and every other month from Esmeraldas. Information is collected on the catch-per-tow, hours fished, areas fished and species composition. Second, in February 1986, a logbook system was initiated throughout the country. Information will be obtained on catch-per-tow by area and time fished. The data from the shrimp fishery will be available for analysis in the information obtained from interviews on catch and fishing effort. Reliable information is not available on total catch or total fishing effort.
Biological Influences on Fisheries

Water Temperature

It is hypothesized that the Gulf of Guaymall is a prime nursery area for P. maximus and perhaps other white shrimp species. McPadden (1985) indicated that juvenile white shrimp are found predominantly in the Gulf of Guaymall, whereas mature animals have not generally been observed in this area. The size and persistence of the nursery area may be dictated by the influence of the warm or cool currents. The movement of warm water (26°C) from the north into the Gulf of Guaymall during September, October and November probably enhances spawning for white shrimp as well as transporting larvae into the Gulf. If the warm water area is large enough and lasts long enough, spawning and recruitment will probably be very good. However, if the cooler southern currents with temperatures of 23°C to 25°C confine the warm water areas during this period, spawning and survival of larvae and juveniles are negatively affected. Further, if the cold southern water penetrates the Gulf, the juveniles may migrate north toward the Esmeraldas area during the April-May period.

Rainfall

Sources has demonstrated a close relationship between rainfall and CPUE (Figure 2). Low rainfall results in low CPUEs, as rainfall increases, so does CPUE. However, this relationship is dominated by the El Nino phenomenon of 1983 and its corresponding high rainfall and high CPUE. The correlation is extremely good at the lower and mid level of the scale and implies a linear relationship with relatively low levels of rainfall (up to 2,000 mm per year). This relationship indicates that recruitment from 1973 to 1984 was influenced more by environmental conditions than by other factors. Overfishing does not appear to be a major factor in the success of year-class strength.

Fishery Management and Scientific Information

Governments have prime responsibility for conserving marine resources and ensuring that marine stocks are available to future generations in the same quantities as to the present generation, U.S. President Theodore Roosevelt said. "The nation behaves well if it preserves the natural resources as assets which it must turn over to the next generation increased and not impaired in value." Resource managers share this responsibility. They must, of course, prevent recruitment overfishing and certainly minimize growth overfishing (i.e., harvesting animals before the maximum population of that year-class is achieved). Difficulty arises most often in allocation of the resources between competing user groups. Managers must utilize the best scientific information available, as well as input from the industry and consumer groups. Obviously, there is a need for information exchange among scientists, managers, the harvesters and enforcement (Figure 5).

The acceptability of management decisions depends on the flow of information, therefore it is important that significant input be provided by the users of the resources. Various methods may be used to provide industry input. For example, special panels may be established as advisory groups to government officials making management decisions. In the United States, having citizen advisory groups is a legal requirement during development of management plans for federal sectors (Leary, 1985).

At the opposite end of the continuum is a system located by an industry user who controls all management decisions with little or no user input. Regardless of which management system is eventually used, it is important that good scientific information be available for the decision makers. Therefore, it is recommended that Ecuador consider expanding the program initiated by McPadden to collect statistical information on the shrimp industry from logbooks and interviews of vessel captains regarding catch, effort, CPUE and species composition. Also, a comprehensive program to collect other fishery-dependent data as well as fishery-independent data should be implemented.

Fishery-Dependent Data

The following fishery-dependent data is critically needed for management decisions:

- total catch
- fishing effort
- size composition and species composition of the commercial catch

While it might be impossible to take a regular census of the offshore fishery, some type of sampling program is required to provide accurate total catch and fishery effort information. A special study should be conducted to determine the appropriate experimental design, methodology and approach for a country-wide sampling program to collect the necessary fishery statistics. The key to implementing a sampling program is to estimate total catch and effort is to make recording the number of vessel trips mandatory. Of course, cooperation of the industry is critical; without assurance from the government that the confidentiality of the data will be maintained, it will be impossible to obtain this cooperation. It is also necessary to establish field stations at major landing ports, such as Esmeraldas, Manabi, Bolivar and Guaymall. These field stations could be manned by a small team of data collectors and research scientists who would obtain fishery catch statistics.

Equal important is the collection of accurate information on the artisanal postlarvae fishery, including the quantity of each species of postlarvae caught monthly, areas fished and the number of individuals involved. Sampling the inshore postlarvae fishery on a regular basis could also be conducted from the field stations.

Fishery-Independent Surveys

A major question concerning the stocks of shrimp off Ecuador is the interchange between the Esmeraldas and the Gulf of Guaymall. A well-planned study could be conducted by tagging shrimp in either or both areas and obtaining recoveries from the fleet. This information would need to be supplemented with the amount of fishing effort deployed in both areas, as well as the effort expended in areas between the Gulf of Guaymall and Esmeraldas. Finally, the collection of tag recoveries would be enhanced by the establishment of field stations.

Fishery-independent surveys to monitor the shrimp populations in the fishery grounds are expensive but do provide long-term information on biomass and trends of the major species. For example, such surveys conducted once or twice a year could be used for evaluation of shrimp closures (Matthews, 1982). The current program to monitor the distribution and abundance of postlarvae and juvenile shrimp in the Guaymall area should be continued, and expanded to other areas of the coast.

Management of Ecuadorian Fisheries

The two shrimp closures recently imposed by Ecuador appear to have been successful, but without a system of statistics on total catch, fishing effort, CPUE, as well as size composition and species composition of the commercial catch, it is important to accurately assess the effects of these closures (Nichols, 1982; Klime et al., 1982; Poffenberger, 1982; and Matthews, 1982). Without such evidence, it will be unlikely that continued industry support for periodic closures will be available, though sometimes, even with good information, the political whims of various user groups may be swayed because of selfish interests.

Establishing a permanent, long-term program to collect fisheries statistics from the offshore fishery and the postlarval fishery will form a data base for evaluating both. Without that type of data base, it will be difficult to determine if recruitment overfishing is occurring. The fishery-dependent data can also be used to analyze trends of both the postlarval and offshore fisheries and determine the impact of the major shrimp stocks of Ecuador.

Although recruitment overfishing does not appear to be a serious problem, the fishery's low CPUEs in 1984 and 1985, and the switch in species composition from P. occidentalis to P. stylirostris to
P. vannamei are of some concern. The Ecuadorian government should consider a method of imposing a limited entry system since there seem to be enough vessels to capture the amount of shrimp currently being harvested. Any increase in fishing effort or number of vessels will only decrease CPUE and the per boat ration. The long-term benefits of the limited entry system would be the probable recovery of the shrimp species and an increase in the fishery for shrimp. Long-term planning is essential to the well-being of the shrimp industry of Ecuador. The author recommends that a management and research plan be jointly developed by the government and shrimp industry to identify goals and objectives and to describe possible management actions that will ensure the shrimp fishery.

Summary

It is the responsibility of the Ecuadorian government to develop a long-term plan for the management of their shrimp fisheries. Included in this plan should be implementable goals, objectives and a financial support plan for management and enforcement, but for research as well. To these ends, the British Mission is working to develop such a plan.

The closed season and area restrictions imposed in 1985 by the government appear to have adequately reduced CPUE and to have allowed an increase in biomass through population growth. However, because of some increase, it is expected that fishing effort will be reduced as population growth increases. Nevertheless, the closed season and area closures should probably continue, if only because it reduces fishing effort. The available data collection system should be developed not only to evaluate closures, but also to evaluate populations of the stocks to provide advice for future management actions. The collection of fishery statistics should, however, be interpreted with caution. Shrimp-independent surveys may also be needed to evaluate well as conducting mark-recapture studies to determine stock boundaries. Joint planning and development implementation of these programs between industry and the Instituto Nacional de Pesca (INP) will accelerate support.

Finally, consideration should be given to limiting future expansion of the offshore shrimp fishery by developing some form of limited entry system.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>P. stylirostris</th>
<th>P. vannamei</th>
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(Source: McPadden, personal communication)

Table 2

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<th>Area</th>
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<th>Total Weight, millions of pounds</th>
<th>Fishing Effort, thousands of days fished</th>
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(Cobo and Laosh, 1966)
Figure 1. Total estimated shrimp production and number of shrimp vessels for Ecuador.

Figure 2. Monthly catch per unit effort (lbs head-off) for all shrimp species and P. Vannamei in the Gulf of Guayaquil from 1973 to 1985.

Figure 3. Relationship between rainfall (mm) and CPUE (kg/day, heads-off) in the Gulf of Guayaquil (CPUE = 22.2 + 0.034 rainfall; r² = 88).
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