

Mexico Baja California Sur blue and brown shrimp
– bottom trawl/cast net]

Fishery Improvement Project (FIP)

Data Collection Protocol

Elaborated by:

Instituto Nacional de Pesca y Acuicultura



Translated by:



DATA COLLECTION PROTOCOL CRIAP LA PAZ SHRIMP PROGRAM, INAPESCA

Juan Antonio García Borbón and Carlos Hiram Rábago Quiroz

INAPESCA's Pacific Shrimp Program, CRIAP La Paz

INTRODUCTION

Shrimp from the Mexican Pacific Ocean is one of the most important fishery resources, not only because of its high commercial value but also because of the impact it has on society with the generation of employment since it is a fishery that is exploited in different phases of its life cycle and offers other moments for its exploitation. In Mexico, shrimp is ranked second in terms of volume in fishery production; however, in terms of value, it is in the first place. In exports, it is first among fishery species, with the United States of America, Japan, and France as its main destinations. Regarding the value of production, it was valued at 7,696.8 million pesos. Therefore, it can be considered the primary fishery in the country. In Baja California Sur and by the magnitude of production, this resource is positioned in fourth place, after fisheries such as sardine, squid, and clams. In the artisanal shrimp fishery of the lagoon system of Bahía Magdalena - Almejas, around 900 fishermen with 450 boats participate directly and indirectly at least another thousand jobs are generated in the process of beheading the product.

This work period lasts approximately half a year (September to February), so that, together with the clam fisheries, it constitutes one of the leading fishing activities in the communities surrounding the lagoon system of Bahía Magdalena - Almejas, which is the most important in the State. Variably but unequivocally, when environmental variations and stock conditions allow it, the distribution and abundance of the resource extend, although on a smaller scale, to at least two other lagoon systems on the west coast of the State, the San Ignacio lagoon and the Guerrero Negro - Ojo de Liebre lagoon system, as well as to the marine zone of the west coast of the Baja California peninsula. In general, in the area of management and administration of the fishing activity, one of its main goals is to maintain a stable pattern of catches over time and, if possible, to obtain increases in the same when the environmental conditions and the health of their populations allow it.

On the other hand, shrimp trawl fisheries are distinguished by catching a significant amount of non-target or incidental species, called "shrimp accompanying fauna" (SAF). Internationally, one of the essential concerns in the management and conservation of exploited marine ecosystems today is the mortality of bycatch species (Pope et al., 2000; Davis, 2002). The shrimp fishery in tropical areas is one of the most significant contributors to this problem, generating about 1.86 million tons, representing 27.3% of the total bycatch of the world's commercial fisheries (Kelleher, 2005). In the lagoon system of Bahía Magdalena-Almejas, B.C.S., a modified trawl net (Magdalena I) was made mandatory to reduce the magnitude of the SAF and eliminate the capture of sea turtles by including an excluder device (DOF, 2001).

A basic description of the fauna affected by shrimp trawling and an evaluation of the changes caused by fishing are essential to understanding the effects of shrimp trawling on the ecosystem and the administrative measures related to fishery management (FAO, 2006). Currently, fisheries management should be carried out with an ecosystem approach to conserve stocks, reduce bycatch, conserve ecosystem structure and function, and develop sustainable fisheries that fishers can live from (FAO, 2006; Gillett, 2010). Complementarily, an ecosystem approach is perhaps particularly appropriate for shrimp management because shrimp play an important role as prey in most ecosystems; they are susceptible to climatological factors that determine their life cycle and recruitment; they are sensitive to the quality of coastal habitats; their fisheries impact other fisheries through bycatch; and trawling has potential impacts on the seabed and the fauna living there (Gillett, 2010; Cowan et al., 2012).

In the context of the relevance of the present research proposal, it is intended to continue responding to specific research demands with the following particular lines of research: (a) research oriented to update population parameters and the status of the resource; (b) continue with the analysis of the accompanying fauna; (c) incorporate new analysis tools for fishery modeling under the perspective of integrated analysis based on length; and eventually it will be possible to continue with the update of the corresponding file of the National Fishing Chart, the chapter of the "red" book on "Sustainability and Responsible Fishing in Mexico: Evaluation and Management" and the Fishery Management Plan.

OBJECTIVES

To update the knowledge of the structure and population dynamics of the species that compose the shrimp resource and accompanying fauna of the fisheries in protected waters (Magdalena-Almejas Bay) during 2022.

Particular objectives

- Characterizing species composition and establishing population aspects such as sex ratio, size structure, reproductive cycle development, and spatial and bathymetric abundance distribution.
- Estimating the parameters that define the processes of mortality, growth, reproduction, and selection.
- Characterization of the size at first maturity, relative recruitment, exploitation rate, and population size.
- Characterization of the shrimp's accompanying fauna (SAF) during the 2022 closure and the 2022-2023 fishing season in the lagoon complex Bahía Magdalena-Almejas, B.C.S.
- Determining the essential species in the SAF according to the ecological indexes (biological value index BVI, relative abundance index RAI and relative importance index RII).
- Comparison of species present in the shrimp's accompanying ichthyofauna from 2014 to 2022 with those reported in works before 2014 carried out in the lagoon system Bahía Magdalena-Almejas.
- Determine the species of commercial value found within the SAF in the lagoon complex Bahía Magdalena-Almejas, B.C.S.

MATERIAL AND METHODS

Shrimp

For the Bahía Magdalena-Almejas lagoon complex, monthly shrimp biological fishing sampling campaigns will be carried out during the closed and fishing seasons. Shrimp collections during the closed season (data independent of fishing) are carried out in a series of stations that include estuaries and bays, in which areas of importance in the environmental dynamics are selected for their location, such as the mouths of the bays, in the most important estuaries, on the possible migratory routes of shrimp and in front of the tributaries of the streams generated seasonally during the rainy season. The sampling stations are located in potential entrainment areas because not all are susceptible to entrainment, so different polygons were established for each zone. In Magdalena Bay (Fig. 1) 11 polygons were defined, while in Almejas Bay 5 polygons were shown (Fig. 2). The date, geographic location with a portable satellite positioner (GPS), time of day, and

depth with an optical depth meter were recorded at each station. For the surface and bottom water layers, temperature, salinity, dissolved oxygen, and pH are recorded using a Van Dorn bottle and a YSI multiparameter meter. Finally, the characteristics of the fishing gear used are noted.



Fig. 1. Polygons comprising the shrimp and accompanying fauna sampling stations in the deep zone of Magdalena Bay, B.C.S.

For sampling in the estuaries, those days are considered when the tidal effect is at its maximum, so sampling is carried out during the new moon or full moon, and during the low tide stage at the entrance and terminal ends, as well as in the intermediate zone of the estuaries. Ten sets are made with a standard 1.5 " (38.1 mm) line to obtain an average estimate of abundance per set; these collections are complemented with groups of "louse" lines (< 1.25 inches) to broaden the size spectrum. In the deep areas of the bays and channels, sets are made at the end or beginning of neap tide periods or during neap tide periods. Collections are made using a small boat with an outboard motor (55-105 HP), and a trawl net ("Magdalena I") of 8-9 fathoms headrope length and 1 3/8" (34.92 mm) mesh size; the set has a standard duration of 60 minutes. In the intermediate zone between estuaries and bays and considering that it is the traditional fishing gear in these areas, the suripera net will be used to evaluate the comparative efficiency with the other nets.

The sampling points correspond to the estuaries called 1) San Carlos, 2) San Buto, and 3) La Herradura, eventually also registering in the area called 4) Banderitas. For the estuaries in the Bahía Almejas region, the estuaries defined are 1) Salinas, 2) El Cayuco, and possibly 3) Puerto Chale.



Fig. 2. Polygons comprising the shrimp and accompanying fauna sampling stations in the deep zone of Bahía Almejas, B.C.S.

From the catch obtained at each station, the shrimp species composition (Pérez-Farfante 1988, Pérez-Farfante and Kensley 1997) and their proportion in weight and the corresponding number for each one of them is determined. From the shrimp captured, the specimens are separated and counted by species. For shrimp, depending on the number of specimens in each haul, if it is less than 100, the total is considered for analysis; otherwise, a subsample of 100 individuals is separated as the minimum sample size. The relative abundance of the season is determined in terms of abundance per unit of time (Kg/hr), surface area (kg/m²) using the swept area method (Sparre and Venema, 1997), and fishing gear (Kg/set). Sex ratio, size structure (total length) by

length intervals of 5 mm full length, and degree of gonadal maturity were recorded by morphochromatic evaluation. In shrimp, for males of both species, two degrees of maturity are considered, I - Immature (separate petasma) and II - Mature (united petasma); in females, also of both species, 4 stages are recognized: I - Immature, II - Developing, III - Mature, IV - Spawned, varying for each species the colors and shades. Morphometric relationships between length (total and abdominal) and weight (total and abdominal) are also established for each species.

During the fishing season, the sampling unit for Magdalena Bay-Clams is the fishing boat. The number of boats subject to sampling is a minimum of 6 per day, during five working days in each month, a value defined by the work capacity of 2 people at the time of arrival of the boats. For each vessel, the magnitude of the catch is recorded by workday or "tide," by setting, and by time unit. The areas of operation, total effort in number, and duration of fishing sets are recorded. From the total catch, a random sample of 5 kg of shrimp is selected, and the species composition by weight and number is determined. Then, 60 specimens per species were randomly selected, and their sex, total length, and degree of gonadal maturity were recorded. The type and characteristics of the fishing gear and maneuvers, brand and power of the engine, and the amount of fuel used are also recorded for each vessel.

For the 2022 cycle, we intend to conduct at least ten monthly sampling campaigns, during the 2021-2022 season (January and March), during the 2022 closed season (May to August), and for the 2022-2023 season (September to December). For both periods of the fishery, random samples of 120 individuals per shrimp species will be obtained for the determination of lengths (± 1 mm) and weights (± 0.1 gram) total and abdominal for each sex to estimate the parameters of the relationships between length and weight.

Ichthyofauna of Shrimp Accompanying Ichthyofauna

The activities for the study of the SAF will be carried out during the March-August period (closed season) and in some campaigns during the 2022-2023 fishing season (October-December). It should be noted that there are problems in obtaining SAF samples during the fishing season since it depends on the "willingness" of the fishermen to bring such samples.

During the closed season and in the historical stations where samples are taken month by month in the lagoon complex Bahía Magdalena-Almejas, B.C.S., in addition to shrimp, samples of SAF are taken, both samples proportional to the total catch obtained per set. The logs record the date,

the name of the capture zone, depth of the trawl, trawl time, shrimp catch, and the catch of SAF. A SAF sample is taken on board the vessel (when the total yield is greater than 10 kg and the total catch is less than 10 kg) and is appropriately labeled and refrigerated for processing. Once at the CRIAP facilities, the samples are frozen for further analysis.

Table 1. The activities for the SAF study are subject to the shrimp sampling campaigns, which consider the following calendar.

2022												
Activities/Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Field Sampling (Fishing Season)												
Sample processing (Identification -biological)												
Data analysis												
Field Sampling (Closed Season)												
Sample processing (Identification-biological)												
Data analysis												

REFERENCES

- Castro-Aguirre, J. L. & H. Espinosa-Pérez. 1996. Listados faunísticos de México. VII. Catálogo sistemático de las rayas y especies afines de México (Chondrichthyes: Elasmobranchii: Rajiformes: Batoideomorpha). Instituto de Biología, UNAM. México, D.F., México.
- Eschmeyer, W. N., E. S. Herald & H. Hammann. 1983. A field guide to the Pacific coast fishes of North America. Houghton Mifflin, Boston, USA.
- Espinosa-Pérez, H., J. L. Castro-Aguirre. & L. Huidobro-Campos. 2004. Listados faunísticos de México. IX. Catálogo sistemático de tiburones (Elasmobranchii: Selachimorpha). Instituto de Biología, UNAM. México, D.F., México.
- Fischer, W., Krupp, F., Schneider, W., Sommer, C., Carpenter, K.E. & Niem V.H. (Eds.) 1995. Guia FAO para la identificación de especies para los fines de pesca. Pacifico Centro-Oriental. (Vol- II-III) FAO. Rome, Italy.

- Ginsburg, I. 1958. Flounders of the genus *Paralichthys* and related genera in American waters. U.S. Fish. And Wildl. Serv, Fish. Bull. 52:267-351.
- Hendrickx, M. E., 1996. Los camarones penaeoidea bentónicos (Crustacea: Decapoda: Dendrobranchiata) del Pacífico mexicano. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Instituto de Ciencias del Mar y Limnología, U.N.A.M. México. 147 p.
- Jordan, D.S. & B.W. Evermann. 1896-1900. The fishes of North and Middle America. Bulletin of the United States Natural History Museum. 47: 1-3313.
- Love, M.S., M. Yoklavich. & L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. University of California, Berkeley, California, USA.
- McPhail, J. D. 1958. Key to the croakers (Sciaenidae) of the eastern Pacific. Univ. Brit. Columbia, Inst. Fish., Mus. Contrib. 2:1-20.
- Meek, S.E. & S.F. Hildebrand. 1923-1928. The marine fishes of Panama. Publ. Field. Mus. Nat. Hist., Zool. Ser. 15 (1-4): 1-1045.
- Miller, D. J. & R.N. Lea. 1976. Guide to the coastal marine fishes of California. California Dept. Fish and Game, Fish. Bull. 157:1-249.
- Olguín-Palacios, M. 1968. Contribución al estudio de la biología del camarón café *Penaeus californiensis* Holmes. FAO Fish. Rep. 57:331–356.
- Orr, J. W., M. A. Brown. & D. C. Baker. 2000. Guide to rockfishes (Scorpaenidae) of the genera *Sebastes*, *Sebastolobus*, and *Adelosebastes* of the Northeast Pacific Ocean, Second Edition. NOAA Tech. Mem. NMFS-AFSC-117, 47 p.
- Pérez-Farfante, I., 1988. Illustrated key to penaeoid shrimps of commerce in the Americas. U.S. Dept. Comm. NOAA Tech Rep. NMFS. 64: 1 - 32.
- Pérez-Farfante, I., y B. Kensley, 1997. Penaeoid and sergestoid shrimps and prawns of the world. Keys and diagnoses for the families and genera. Memories du Muséum National D'Histoire Naturelle. Tome 175. Zoologie. París.
- Robertson & Allen, 2006. Shorefishes of the tropical Eastern Pacific: an Information system. Version 2.0. Smithsonian Tropical Research Institute, Balboa, Panamá.
- Rosenblatt, R.H. & G.D. Johnson. 1974. Two new species of sea basses of the genus *Diplectrum*, with a key to the Pacific species. Cal. Fish and Game 60:178-191.

Sparre, P. y S.C. Venema, 1995. Introducción a la Evaluación de Recursos Pesqueros Tropicales. Parte 1. Manual. FAO Documento Técnico de Pesca No. 306/1. Rev.1., 440 p.

Walter, H.J. & R.H. Rosenblatt. 1988. Pacific toadfishes of the genus *Porichthys* (Batrachoididae) with description of three new species. *Copeia* 4:887-904.