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

Fishery Improvement Project (FIP)

Fishery impacts data collection and analysis.

One year progress report

October 2023

Fishery impacts data collection and analysis report.

CONTENT

INSTITUTO NACIONAL DE PESCA Y ACUACULTURA

CENTRO REGIONAL DE INVESTIGACIÓN ACUÍCOLA Y PESQUERA

LA PAZ BAJA CALIFORNIA SUR

INFORME TÉCNICO

"FAUNA DE ACOMPAÑAMIENTO DEL CAMARÓN DEL 2014 AL 2022 EN EL COMPLEJO LAGUNAR BAHÍA MAGDALENA – ALMEJAS, BAJA CALIFORNIA SUR"

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LA PAZ, BAJA CALIFORNIA SUR, SEPTIEMBRE DE 2023

Introduction

Shrimp trawl fisheries are distinguished by catching a significant amount of non-target or incidental species, which together are called "shrimp accompanying fauna" (FAC for its acronym in spanish). Internationally, nowadays one of the most significant concerns in the management and conservation of exploited marine ecosystems is the mortality of bycatch species (Pope et al., 2000; Davis, 2002, Willer et al, 2022, Hilborn et al. 2023). The shrimp fishery in tropical areas is one of the major contributors to this problem, generating about 1.86 million tons, which represents 27.3% of the total bycatch of the world's commercial fisheries (Kelleher, 2005). In the lagoon system of Bahía Magdalena-Almejas, Baja California Sur (B.C.S.), it is one of the few lagoon systems in Mexico where the use of trawl nets is allowed for shrimp capture, and where the use of a modified trawl net (Magdalena I) was made mandatory, which reduces the magnitude of the FAC and eliminates the capture of sea turtles by including an excluder device (DOF, 2001).

The basic description of the fauna affected by shrimp trawling and the evaluation of their changes as a result of fishing is essential to contribute to the understanding of the effects of shrimp trawling on the ecosystem and the administrative measures related to the management of the fishery (FAO, 2009). 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 fishermen can live from (FAO, 2009; Gillett, 2010, Hilborn et al. 2023). Complementarily, an ecosystem approach is perhaps particularly appropriate for shrimp management in this specific lagoon system, because shrimp play an important role as prey in most ecosystems; they are susceptible to climatological factors that determine their life cycle and recruitment; It is sensitive to the quality of coastal habitats; its fishing has repercussions on other fisheries through bycatch; and trawling has potential repercussions on the seabed and the fauna living there (Gillett, 2010; Cowan et al., 2012, Hilborn et al. 2023).

With the objective of having a characterization of the shrimp accompanying fauna (FAC) during the closed season and the fishing season, in the lagoon complex Bahía Magdalena-Almejas, B.C.S., we determined the shrimp:FAC ratio, the composition by large groups and the most important species according to the index of biological value (IVB) and index of relative abundance IAR, in addition a comparison of fish species present in the FAC from 2014 to 2022 was made.

Study area and field sample collection

The Bahía Magdalena-Almejas lagoon system is located on the southwestern coast of the Baja California peninsula (24º16' N - 25º45' N and 111º20' W - 112º18' W). This system has three geomorphologically distinct zones (Fig. 1): Canales Zone (137 km^2) located to the northwest; Magdalena Bay (883 km^2) located in the central part of the complex; and Almejas Bay (370 km^2) located to the southeast (Funes-Rodríguez et al. 2007). The lagoon system is covered by at least 30% mangrove areas.

Zoogeographically, the lagoon complex is considered a transition zone, since it is located between the temperate conditions of the California Current and the subtropical area, which favors a great richness and abundance of flora and fauna. Sea surface temperature presents a pronounced contrast between the coldest month (May, 17.8 °C) and the warmest month of the year (August, 29 °C) (Hernández-Rivas et al. 1993, Lluch-Belda et al. 2000).

The activities for the study of the FAC were carried out during the shrimp closed season (March-August) and in some campaigns during the fishing season (September-February). These surveys are part of the activities of the project "Evaluation and management of the shrimp resource in Baja California Sur, developed at the Centro Regional de Investigación Acuícola y Pesquera La Paz, belonging to the Instituto Nacional de Pesca y Acuacultura (INAPESCA).

During the closed season and in the historical stations where they are conducted on a monthly basis in the lagoon complex Bahía Magdalena-Almejas, B.C.S. (Fig. 1), in addition to shrimp, samples were taken from the FAC, both samples proportional to the total catch obtained per haul. The fishing hauls were carried out in small boats, with bottom trawls (16-17 m long, mesh opening of 3.5-4.0 cm in the body and codend), the duration of each fishing haul was from 30 to 60 minutes. The logs recorded the date, catch zone name, trawl depth, trawl time, geographic position, shrimp catch, and FAC. On board the vessel, once the catch was placed on top of the vessel and the shrimp were separated from the rest of the organisms caught, FAC samples were obtained (when the total catch was greater than 10 kg and the total catch, if it was less than 10 kg) and were duly labeled and refrigerated for processing. Once at the facilities of the Centro Regional de Investigación Acuícola y Pesquera de La Paz, B.C.S., the samples were frozen for later analysis.

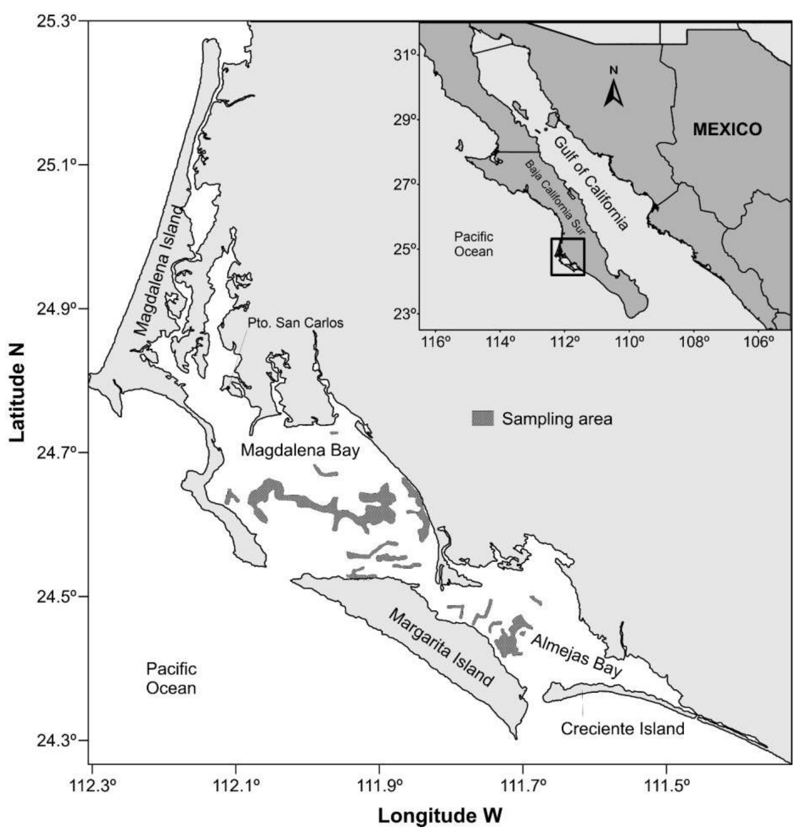

Figure 1. Sampling areas during the closed season and fishing in the lagoon complex Bahía Magdalena-Almejas, Baja California Sur.

During the fishing season, FAC samples were obtained directly from commercial vessels. It should be noted that there were some difficulties in obtaining samples during the fishing season, since it depended on the "willingness" of the fishermen to submit the samples. Generally, the samples obtained during the fishing season were from the last fishing haul of the day, so that the fish and the rest of the organisms would arrive at the landing site in good condition and so that they would come from different fishing sites. The fishing day in this lagoon system normally lasts from the evening (6-7 pm) until dawn the following day (6-7 am).

Processing of FAC samples in the Laboratory

In the laboratory, the samples were thawed and the organisms were separated by groups and families. Taxonomic identification of fish species was done using keys and descriptions by Jordan and Evermann (1896-1900), Meek and Hildebrand (1923-1928), Miller and Lea (1976), Eschmeyer et al. (1983), Fischer et al. (1995), and Robertson and Allen (2006). Specialized bibliography for some groups: Castro-Aguirre and Espinosa-Pérez (1996) for rays, Espinosa-Pérez et al. (2004) for sharks, McPhail (1958) for the family Sciaenidae, Ginsburg (1958); for Pleuronectiformes, Rosenblatt and Johnson (1974); for Diplectrum, Walter and Rosenblatt (1988), for Porichthys, Orr et al. (2000); and Love et al. (2002) for the genus Sebastes. Reference specimens were frozen and some were fixed with 10% formaldehyde and subsequently preserved in 70% ethyl alcohol. Some of the fish species whose identification was not 100% certain, were taken to CICIMAR-IPN Ichthyologists for corroboration. After the identification of the fish species, the corresponding biometrics were performed, which consisted of recording total length, standard length, total weight, sex and sexual maturity.

Information analysis

Because fish were the most abundant group within the FAC, subsequent analyses were performed only for this group of organisms.

In order to obtain the most common and abundant species in the FAC, several indices were used for data analysis. Since there are several indexes that allow assigning hierarchical ranks and each one provides different information (although all of them are based on presence and/or abundance), two indexes frequently used in the scientific literature were applied: the index of relative abundance (IAR) and the index of biological value (IVB), which together allowed determining the abundance and importance in the community in time and space of the various species.

The RAI made it possible to determine the relative amount in number contributed by the species and those that represented the most important part of the community, by means of the following expression:

$$IAR = \left(\frac{N}{NT}\right) \times 100$$

where: N, is the relative abundance in number; N, is the number of individuals of each species captured; and NT, is the total number of individuals of all species.

Species were grouped into four categories according to this index: abundant species (A): those with a relative abundance greater than 1%; frequent species (F): species with a relative abundance between 0.1 and 0.99%; common species (C): with a relative abundance between 0.01 and 0.099%; rare species (R): those with a relative abundance less than 0.01% (Rodríguez-Romero et al. 2008).

The BVI, proposed by Sanders (1960), made it possible to determine the dominant species per sample. It is an index based on scores to rank the importance of species according to their abundance in each sampling and has the advantage of combining relative abundance with the spatiotemporal constancy of the species, both by stations and by sampling (Loya-Salinas and Escofet 1990). Therefore, it provides a value that is a function of the number of stations and sampling. Ranges from 1 to 10 were given in order of abundance of the species within each sample (Rank 1 = 10 points). This index is expressed as follows:

$$IVB_i = \sum_{i=1}^{j} Pvij$$

where: i, are the species; j, is the season; and Pvij, is the score (level) of each species i in the sample.

For the comparison of fish species within the FAC, the presence or absence of the species within the period from 2014 to 2022 in this lagoon system was determined.

Results

From 2014 to 2022, 161 samples of FAC were taken, 145 during the closed season and 16 during the fishing season (Table 1). During this period, more than 800 kilograms of FAC were analyzed, corresponding to the 161 samples. It should also be noted that during 2020 and 2021 it was not possible to sample the accompanying fauna during either the fishing season or the closed season, due to the difficulties caused by the COVID-19 pandemic.

In general, for both the closed season and the fishing season of the years analyzed, a shrimp:FAC ratio of 1:5 was obtained, that is, for each kilogram of shrimp caught, 5 kilograms of FAC were obtained. From 2014 to 2022 the FAC was composed of three large groups: fish 85%, crustaceans 5%, mollusks 5% and echinoderms 2%. Because fish were the most abundant group (greater than 80% each year) within the FAC, the results shown below were obtained only for this group of organisms.

Table 1. Number of FAC samples by month and year during the 2014 to 2022 closed and fishing season, Bahía Magdalena-Almejas lagoon complex, Baja California Sur, México.

Month/No. Sample	2014	2015	2016	2017	2018	2019	2022	Total
Jan								
Feb						1		1
Mar	5		1		6	1		13
Apr	4	5	7	4	5	6		31
May		1	4		3	5	3	16
Jun	5	4	5	2	8	4	2	30
Jul	5	8	5	8	8	1	3	38
Agu	4	4	3	4			4	19
Sep				1				1
Oct			1	1				2
Nov			1	2	4			7
Dec		1	1	1				3
	*Closure	145						
	*Fishing	16						

From 2014 to 2022, more than 14,500 organisms of the fish group (the most abundant group in the FAC) were analyzed, of which 126 species were identified (Table 2), 17 belonging to the class Chondrichthyes (sharks and rays) and 109 to the class Actinopterygii (oceanic fishes). The families with the greatest representation in terms of number of species were: Sciaenidae (12) and Paralichthyidae (10).

Table 2. List of FAC species during the 2014 to 2022 closed and fished season, in the lagoon complex Bahía Magdalena-Almejas, Baja California Sur. Abu= abundance (number of organisms), IVB= index of biological value, IAR= index of relative abundance. A= abundant, F= frequent, C= common, R= rare.

No.	Genero	especie	IVB	% IVB	Abu	% Abu	IAR	No.	Genero	especie	IVB	% IVB	Abu	% Abu	IAR
1	Paralabrax	maculatofasciatus	348	13.18	1788	12.067	A	64	Symphurus	williamsi	0	0.00	34	0.229	F
2	Etropus	crossotus	293	11.10	1602	10.812	A	65	Heterodontus	francisci	0	0.00	26	0.175	F
3	Eucinostomus	dowii	288	10.91	2244	15.145	A	66	Cynoscion	parvipinnis	0	0.00	25	0.169	F
4	Etropus	peruvianus	265	10.04	1200	8.099	A	67	Paralichthys	woolmani	0	0.00	17	0.115	F
5	Diplectrum	pacificum	253	9.58	1192	8.045	A	68	Ariosoma	gilberti	0	0.00	15	0.101	F
6	Eucinostomus	gracilis	227	8.60	1866	12.594	A	69	Mustelus	lunulatus	0	0.00	14	0.094	C
7	Haemulopsis	axillaris	116	4.39	713	4.812	A	70	Pleuronichthys	ocellatus	0	0.00	12	0.081	C
8	Achirus	mazatlanus	114	4.32	282	1.903	A	71	Urotrygon	aspidura	0	0.00	12	0.081	C
9	Orthopristis	reddingi	80	3.03	323	2.180	A	72	Prionotus	birostratus	0	0.00	11	0.074	C
10	Pleuronichthys	ritteri	69	2.61	243	1.640	A	73	Sphoeroides	sechurae	0	0.00	11	0.074	C
11	Haemulopsis	nitidus	63	2.39	364	2.457	A	74	Chaetodon	humeralis	0	0.00	9	0.061	C
12	Occidentarius	platypogon	49	1.86	526	3.550	A	75	Symphurus	atramentatus	0	0.00	9	0.061	C
13	Urobatis	halleri	46	1.74	204	1.377	A	76	Alectis	ciliaris	0	0.00	8	0.054	C
14	Porichthys	analis	37	1.40	192	1.296	A	77	Pseudobatos	leucorhynchus	0	0.00	8	0.054	C
15	Balistes	polylepis	35	1.33	151	1.019	A	78	Scomber	japonicus	0	0.00	7	0.047	C
16	Orthopristis	chalceus	26	0.98	145	0.979	F	79	Mustelus	californicus	0	0.00	6	0.040	C
17	Sphoeroides	lobatus	23	0.87	97	0.655	F	80	Xenichthys	xanti	0	0.00	6	0.040	C
18	Pseudupeneus	grandisquamis	22	0.83	90	0.607	F	81	Caulolatilus	affinis	0	0.00	5	0.034	C
19	Synodus	scituliceps	21	0.80	81	0.547	F	82	Deckertichthys	aureolus	0	0.00	5	0.034	C
20	Haemulopsis	elongatus	19	0.72	106	0.715	F	83	Eucinostomus	entomelas	0	0.00	5	0.034	C
21	Syacium	ovale	17	0.64	66	0.445	F	84	Halichoeres	semicinctus	0	0.00	5	0.034	C
22	Synodus	lucioceps	15	0.57	52	0.351	F	85	Heterodontus	mexicanus	0	0.00	5	0.034	C
23	Anchoa	nasus	15	0.57	21	0.142	F	86	Pristigenys	serrula	0	0.00	5	0.034	C
24	Prionotus	stephanophrys	14	0.53	89	0.601	F	87	Selene	peruviana	0	0.00	5	0.034	C
25	Paralichthys	californicus	13	0.49	73	0.493	F	88	Hypanus	dipterurus	0	0.00	4	0.027	C
26	Calamus	brachysomus	13	0.49	54	0.364	F	89	Menticirrhus	undulatus	0	0.00	4	0.027	C
27	Chaetodipterus	zonatus	10	0.38	32	0.216	F	90	Sardinops	sagax	0	0.00	4	0.027	C
28	Prionotus	ruscarius	9	0.34	68	0.459	F	91	Syacium	latifrons	0	0.00	4	0.027	C
29	Diplobatis	ommata	9	0.34	64	0.432	F	92	Brachygenys	californiensis	0	0.00	3	0.020	C
30	Pleuronichthys	guttulatus	8	0.30	37	0.250	F	93	Cheilotrema	saturnum	0	0.00	3	0.020	C
31	Sphoeroides	lispus	8	0.30	12	0.081	C	94	Diplectrum	eumelum	0	0.00	3	0.020	C
32	Porichthys	margaritatus	8	0.30	4	0.027	C	95	Diplectrum	euryplectrum	0	0.00	3	0.020	C
33	Urotrygon	rogersi	7	0.27	23	0.155	F	96	Rhinoptera	steindachneri	0	0.00	3	0.020	C
34	Sphoeroides	annulatus	6	0.23	48	0.324	F	97	Hippoglossina	tetrophthalma	0	0.00	2	0.013	C
35	Orthopristis	cantharinus	6	0.23	32	0.216	F	98	Narcine	entemedor	0	0.00	2	0.013	C
36	Symphurus	fasciolaris	6	0.23	32	0.216	F	99	Opisthonema	libertate	0	0.00	2	0.013	C
37	Citharichthys	xanthostigma	6	0.23	25	0.169	F	100	Opistognathus	punctatus	0	0.00	2	0.013	C
38	Bagre	panamensis	6	0.23	20	0.135	F	101	Pareques	viola	0	0.00	2	0.013	C
39	Ophidion	galeoides	5	0.19	54	0.364	F	102	Prionotus	horrens	0	0.00	2	0.013	C
40	Xystreurys	liolepis	5	0.19	24	0.162	F	103	Sphyraena	ensis	0	0.00	2	0.013	C
41	Scorpaena	sonorae	5	0.19	18	0.121	F	104	Apogon	pacificus	0	0.00	1	0.007	R
42	Pleuronichthys	verticalis	5	0.19	15	0.101	F	105	Bairdiella	armata	0	0.00	1	0.007	R
43	Lutjanus	guttatus	5	0.19	3	0.020	C	106	Bairdiella	icistia	0	0.00	1	0.007	R
44	Zapteryx	exasperata	4	0.15	17	0.115	F	107	Bellator	gymnostethus	0	0.00	1	0.007	R
45	Mustelus	henlei	3	0.11	19	0.128	F	108	Chloroscombrus	orqueta	0	0.00	1	0.007	R
46	Bothus	leopardinus	3	0.11	6	0.040	C	109	Cynoscion	reticulatus	0	0.00	1	0.007	R
47	Trachinotus	paitensis	3	0.11	2	0.013	C	110	Diplectrum	macropoma	0	0.00	1	0.007	R
48	Carangoides	otrynter	3	0.11	1	0.007	C	111	Fistularia	corneta	0	0.00	1	0.007	R
49	Diapterus	brevirostris	3	0.11	1	0.007	C	112	Haemulon	maculicauda	0	0.00	1	0.007	R
50	Oligoplites	saurus	3	0.11	1	0.007	C	113	Haemulon	steindachneri	0	0.00	1	0.007	R
51	Paralabrax	nebulifer	3	0.11	1	0.007	C	114	Hyporthodus	niphobles	0	0.00	1	0.007	R
52	Scorpaena	guttata	3	0.11	1	0.007	C	115	Larimus	pacificus	0	0.00	1	0.007	R
53	Hippoglossina	bollmani	2	0.08	30	0.202	F	116	Lophiodes	caulinaris	0	0.00	1	0.007	R
54	Anchoa	ischana	2	0.08	18	0.121	F	117	Menticirrhus	elongatus	0	0.00	1	0.007	R
55	Gymnura	marmorata	2	0.08	13	0.088	C	118	Opisthonema	medirastre	0	0.00	1	0.007	R
56	Hippocampus	ingens	2	0.08	13	0.088	C	119	Peprilus	simillimus	0	0.00	1	0.007	R
57	Eucinostomus	currani	2	0.08	8	0.054	C	120	Prionotus	albirostris	0	0.00	1	0.007	R
58	Symphurus	atricauda	2	0.08	5	0.034	C	121	Scorpaena	mystes	0	0.00	1	0.007	R
59	Elattarchus	archidium	1	0.04	20	0.135	F	122	Sphoeroides	sp. 1	0	0.00	1	0.007	R
60	Urobatis	maculatus	1	0.04	20	0.135	F	123	Synodus	lacertinus	0	0.00	1	0.007	R
61	Diodon	holocanthus	1	0.04	17	0.115	F	124	Umbrina	analis	0	0.00	1	0.007	R
62	Myliobatis	californica	1	0.04	14	0.094	C	125	Umbrina	roncador	0	0.00	1	0.007	R
63	Myrophis	vafer	1	0.04	2	0.013	C	126	Umbrina	wintersteeni	0	0.00	1	0.007	R

The relative abundance index (RAI) determined that 15 species were the ones that contributed the highest abundance (87%) of the total sampled. Thirty-seven species were classified as frequent, 51 as common and 23 as rare (Table 2). And with the index of biological value (IBV) we obtained that 15 species were those that contributed more than 86% of the value of this index (Table 3). Comparing the 15 most important species according to the IVB and the IAR, we found that they are the same, only their order of importance changes (Table 3).

Table 3. Most important species according to their abundance (IAR) and frequency of occurrence (IVB), in the FAC during the closed and fishing season from 2014 to 2022, in the lagoon complex Bahía Magdalena-Almejas, Baja California Sur. Abu= abundance (number of organisms), IVB = biological value index (total value according to the index).

Genero	especie	Abu	% Abu	IAR	Genero	especie	IVB	% IVB
Eucinostomus	dowii	2244	15.14	A	Paralabrax	maculatofasciatus	348	13.2
Eucinostomus	gracilis	1866	12.59	A	Etropus	crossotus	293	11.1
Paralabrax	maculatofasciatus	1788	12.07	A	Eucinostomus	dowii	288	10.9
Etropus	crossotus	1602	10.81	A	Etropus	peruvianus	265	10.0
Etropus	peruvianus	1200	8.10	A	Diplectrum	pacificum	253	9.6
Diplectrum	pacificum	1192	8.04	A	Eucinostomus	gracilis	227	8.6
Haemulopsis	axillaris	713	4.81	A	Haemulopsis	axillaris	116	4.4
Occidentarius	platypogon	526	3.55	A	Achirus	mazatlanus	114	4.3
Haemulopsis	nitidus	364	2.46	A	Orthopristis	reddingi	80	3.0
Orthopristis	reddingi	323	2.18	A	Pleuronichthys	ritteri	69	2.6
Achirus	mazatlanus	282	1.90	A	Haemulopsis	nitidus	63	2.4
Pleuronichthys	ritteri	243	1.64	A	Occidentarius	platypogon	49	1.9
Urobatis	halleri	204	1.38	A	Urobatis	halleri	46	1.7
Porichthys	analis	192	1.30	A	Porichthys	analis	37	1.4
Balistes	polylepis	151	1.02	A	Balistes	polylepis	35	1.3

Regarding the comparison of fish species present in the FAC from 2014 to 2022, 2018 was the year with the highest number of species recorded (73) and 2019 the year with the lowest number of species (52). In the 7 years sampled, 126 fish species were identified (Table 4), which represents 58% of the species obtained in 2018, the year where the highest number of species was obtained, and 41% of the species extracted in the year where the lowest number of species was obtained (2019).

Comparison of fish species present in the FAC from 2014 to 2022, in the lagoon complex Bahía Magdalena-Almejas, Baja California Sur. X = presence.

Genero	especie	2014	2015	2016	2017	2018	2019	2022
Heterodontus	francisci	X	X	X	X	X	X	X
Heterodontus	mexicanus	X						
Mustelus	californicus	X						
Mustelus	henlei		X	X	X	X	X	X
Mustelus	lunulatus	X			X	X		
Diplobatis	ommata	X	X	X	X	X	X	X
Narcine	entemedor	X					X	
Pseudobatos	leucorhynchus			X	X	X	X	X
Zapteryx	exasperata	X	X	X	X	X		
Urobatis	halleri	X	X	X	X	X	X	X
Urobatis	maculatus	X	X				X	
Urotrygon	aspidura					X	X	X
Urotrygon	rogersi	X	X	X	X	X		X
Hypanus	dipterurus	X				X	X	
Gymnura	marmorata	X	X	X				X
Myliobatis	californica	X	X	X		X	X	X
Rhinoptera	steindachneri	X	X					
Myrophis	vafer			X				
Ariosoma	gilberti	X			X	X		X
Anchoa	ischana			X	X	X		
Anchoa	nasus	X	X				X	
Opisthonema	libertate	X	X					
Opisthonema	medirastre					X		
Sardinops	sagax			X	X		X	
Bagre	panamensis			X	X		X	
Occidentarius	platypogon	X	X	X	X	X	X	X
Synodus	lacertinus				X			
Synodus	lucioceps	X	X	X	X	X	X	
Synodus	scituliceps			X	X	X	X	X
Ophidion	galeoides		X	X	X	X	X	
Porichthys	analis	X	X	X	X	X	X	X
Porichthys	margaritatus			X				
Lophiodes	caulinaris			X				
Hippocampus	ingens	X		X	X	X		
Fistularia	corneta	X						
Scorpaena	guttata		X					
Scorpaena	mystes	X						
Scorpaena	sonorae	X	X	X	X	X	X	X
Bellator	gymnostethus			X				
Prionotus	albirostris							X
Prionotus	birostratus			X	X	X	X	X
Prionotus	horrens						X	
Prionotus	ruscarius	X	X		X	X	X	X
Prionotus	stephanophrys	X		X	X	X	X	X
Hyporthodus	niphobles			X				
Diplectrum	eumelum	X						
Diplectrum	euryplectrum				X			
Diplectrum	macropoma					X		
Diplectrum	pacificum	X	X	X	X	X	X	X
Paralabrax	maculatofasciatu:	X	X	X	X	X	X	X
Paralabrax	nebulifer		X					
Opistognathus	punctatus			X		X		
Pristigenys	serrula				X	X	X	
Apogon	pacificus			X				
Caulolatilus	affinis				X			
Alectis	ciliaris	X				X		
Carangoides	otrynter		X					
Chloroscombrus	orqueta					X		
Oligoplites	saurus		X					
Selene	peruviana	X		X				X
Trachinotus	paitensis		X					X
Lutjanus	guttatus		X			X		
Deckertichthys	aureolus	X						

Genero	especie	2014	2015	2016	2017	2018	2019	2022
Diapterus	brevirostris		X					
Eucinostomus	currani	X	X		X			X
Eucinostomus	dowii	X	X	X	X	X	X	X
Eucinostomus	entomelas	X		X				
Eucinostomus	gracilis	X	X	X	X	X	X	X
Brachygenys	californiensis					X		X
Haemulon	maculicauda				X			
Haemulon	steindachneri					X		
Haemulopsis	axillaris	X	X	X	X	X	X	X
Haemulopsis	elongatus	X	X	X	X	X	X	X
Haemulopsis	nitidus	X	X	X	X	X	X	X
Orthopristis	cantharinus	X						
Orthopristis	chalceus	X	X		X			
Orthopristis	reddingi	X	X	X	X	X	X	X
Xenichthys	xanti		X			X		
Calamus	brachysomus	X	X	X	X	X	X	X
Bairdiella	armata			X				
Bairdiella	icistia					X		
Cheilotrema	saturnum		X			X		
Cynoscion	parvipinnis	X	X	X	X	X	X	
Cynoscion	reticulatus			X				
Elattarchus	archidium	X						X
Larimus	pacificus					X		
Menticirrhus	elongatus		X					
Menticirrhus	undulatus							X
Pareques	viola		X			X		
Umbrina	analis							X
Umbrina	roncador					X		
Umbrina	wintersteeni							X
Pseudupeneus	grandisquamis	X	X	X	X	X		X
Chaetodon	humeralis				X	X	X	
Halichoeres	semicinctus				X	X	X	X
Chaetodipterus	zonatus		X	X	X	X	X	X
Sphyraena	ensis			X				
Scomber	japonicus		X	X	X	X		
Peprilus	simillimus			X				
Citharichthys	xanthostigma	X			X			X
Etropus	crossotus	X	X	X	X	X	X	X
Etropus	peruvianus	X	X	X	X	X	X	X
Hippoglossina	bollmani	X						
Hippoglossina	tetrophthalma			X				
Paralichthys	californicus	X	X	X	X	X	X	X
Paralichthys	woolmani	X				X	X	X
Syacium	latifrons					X	X	
Syacium	ovale	X		X	X	X	X	X
Xystreurys	liolepis	X		X	X	X	X	X
Pleuronichthys	guttulatus	X	X	X	X	X		X
Pleuronichthys	ocellatus			X		X		
Pleuronichthys	ritteri	X		X	X	X	X	X
Pleuronichthys	verticalis	X	X			X		X
Achirus	mazatlanus	X	X	X	X	X	X	X
Bothus	leopardinus	X	X	X	X			
Symphurus	atramentatus		X	X	X	X	X	
Symphurus	atricauda			X				
Symphurus	fasciolaris	X	X		X	X	X	
Symphurus	williamsi	X		X	X	X		X
Balistes	polylepis	X	X	X	X	X	X	X
Sphoeroides	annulatus	X	X	X	X	X	X	X
Sphoeroides	lispus		X		X	X		X
Sphoeroides	lobatus	X	X	X	X	X	X	X
Sphoeroides	sechurae	X						
Sphoeroides	sp. 1	X						
Diodon	holocanthus	X	X	X	X	X	X	X

Conclusions

From 2014 to 2022 a ratio of 1:5 kilograms of shrimp to kilograms of FAC caught was estimated in the lagoon complex Bahía Magdalena-Almejas, B.C.S. It should be noted, from our own experience observed during sampling during the closure period, that most of the fish and other groups of organisms, when the catch is dumped on the boat (panga) and the shrimp are separated, are returned to their habitat alive (80-90%). The rest are used as food by seabirds (pelicans, gulls, frigate birds, earwigs, etc.) or go directly to the seafloor where they are food for scavengers (crabs, crabs, etc.).

Of the more than 800 kilograms of FAC analyzed from 2014 to 2022 in the lagoon complex Bahía Magdalena-Almejas, B.C.S., fish were the most abundant group, with more than 85% of the total abundance. For this reason, emphasis was placed on characterizing and analyzing this group of organisms within the FAC.

According to the index of biological value (IVB) and index of relative abundance (IVB), 15 species of fish contributed more than 85% in terms of abundance and frequency of occurrence. Therefore, future studies should be carried out to learn more about the population dynamics of these 15 species. The role that these 15 species play in the ecosystem should be elucidated, and improvements in fish excluder devices focused on the most abundant and frequent species should be proposed and investigated.

It is necessary to increase the effort in the collection and analysis of samples from the FAC during the fishing season, in order to have a better characterization during this period.

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