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New records of ray-finned fishes (Actinopterygii) from Puerto Morelos Reef National Park (Mexican Caribbean)

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Abstract

We documented the nearshore ray-finned fishes in Puerto Morelos Reef National Park (PMRNP) by sampling 57 localities, including rocky intertidal pools, sandy bottoms, *Thalassia* beds, coral reefs, artificial reefs, karstic-slab bottoms, demersal-pelagic areas, and sessile-*Sargassum* patches. We recorded seven species new to Caribbean Mexican waters and one hundred and six species new to the PMRNP, most of which are small cryptobenthic reef fish. The resultant checklist includes 349 species, and specimens of 285 of which (81.7%) have been deposited in an ichthyological museum collection. These include both voucher organisms and with tissue samples for genetic analysis. A comparison with inventories at other localities of the Greater Caribbean indicates that more targeted sampling for cryptobenthic and deep-reef fishes is needed to provide a complete inventory. We also comment on the local use of some species as fishery resources.

Keywords

cryptobenthic, marine fish, Mexican Caribbean, new records

Introduction

The Mexican Caribbean is part of the central province of the Greater Caribbean biogeographic region (Robertson and Cramer 2014), a large area that includes all of the Caribbean Sea, except the northern coast of South America. This area is a semi-closed sea with a long and complex geological history (Pindell and Kennan 2009) that produced an arc of islands, the Antilles, along its eastern boundary. It is an area of low productivity, with abundant

coral reefs and large areas of ancillary habitats, including seagrass beds and mangroves closely associated with the reefs. The Greater Caribbean also has many endemic shore fishes, up to 700 species (Robertson et al. 2015). The Mexican Caribbean is part of Yucatan's karstic limestone rock peninsula extending northeast from Central America into the Gulf of Mexico. The Caribbean coast of Mexico, in the State of Quintana Roo, extends 400 km from Cabo Catoche in the north to Xcalak in the south (Schmitter-Soto et al. 2000; de la Lanza-Espino et al. 2013). It has a narrow continental shelf, no upwelling areas, low productivity, substantial amounts of freshwater entering the coastal fringe from subterranean aquifers, low input of suspended solids, and surface water temperatures consistently above 25°C (Robertson et al. 2015; Rioja-Nieto and Álvarez-Filip 2019). These conditions have facilitated the formation of the second largest coral reef barrier in the world, the Mesoamerican Barrier Reef System, which also includes substantial amounts of ancillary habitats used by reef fishes: mangroves, "karstic-slab" bottoms (sheets of limestone rock-forming low profile, low complexity rocky bottoms, loose coral rubble, and rockeries), seagrasses, macroalgal beds, and soft bottoms (gravel, sand, and mud). This habitat diversity along the Mexican Caribbean has promoted the development of a rich shore-fish fauna, with more than 577 species (Schmitter-Soto et al. 2000).

The fishes and reefs in the area support large amounts of tourist activity, primarily through sport diving, and the artisanal and sport fishing industry (Cinner and Pollnac 2004). Despite this high diversity and economic importance of the Mexican Caribbean reefs, community-level research on coastal fishes of that area is relatively scarce, and no in-depth studies have been carried out on reef fishes. Previous studies have covered mainly on the southern portion of that area focusing on fishes on coral patches (Caballero-Vázquez and Schmitter-Soto 2001), fishes in coastal lagoons (Avilés-Torres et al. 2001; Caballero-Vázquez et al. 2005), fish assemblages (Vásquez-Yeomans and González-Vera 1992; Lara and González 1998; Loreto et al. 2003; Núnez-Lara et al. 2005; Cobián-Rojas et al. 2018; Schmitter-Soto et al. 2018), fish diets (Valdez-Moreno et al. 2012), and on fishes in seagrass habitats (Álvarez-Guillén et al. 1986; Yeager and Arias-González 2008; Zarco-Perelló and Enríquez 2019). Schmitter-Soto et al. (2000) presented a general checklist of Mexican Caribbean marine fishes. In the northern Mexican Caribbean, Reséndez-Medina (1975) provided a list for the Nichupté Lagoon, Fenner (1991) analyzed the impact of hurricanes on the fishes of Cozumel Island and Loreto and Lazcano (2017) explored Arrowsmith Bank. However, the northern portion is the most populated area, experiencing rapid coastal development and increased tourism infrastructure. This includes Mexico's most important area for tourism, the Tulum–Cancun touristic corridor, which exerts high pressure on marine natural resources, including reef communities (COESPO 2017; Rioja-Nieto and Álvarez-Filip 2019).

Several natural protected areas have been established to reduce the impact of human activities in the Mexican Caribbean, including Puerto Morelos Reef National Park (PMRNP), established in 1988 (SEMARNAP 2000). The PMRNP Management Plan recorded 226 fish species (SEMARNAP 2000). However, very few research articles have been published listing the fish species found in the park (Álvarez-Guillén et al. 1986; Álvarez-Cadena et al. 2007; Zarco-Perelló and Enríquez 2019), and the recent new record of a reef blenny (*Hypsoblennius exstochilus* Böhlke, 1959) in the Mexican Caribbean, which was found in PMRNP (Sánchez-Jiménez et al. 2017), indicates that taxonomic inventories of the Mexican Caribbean are yet to be completed.

The main goal of presently reported study was to provide an updated checklist, including new records for the Mexican Caribbean and the PMRNP, of the ray-finned fish fauna from this park while incorporating information on local use by fishermen. We also compare the relative abundance of different shallow and deep reef-associated fishes in the Greater Caribbean Region (GCR) and at six sites. Because there have been few fish studies conducted in the northern Mexican Caribbean, and since all of them were focused on conspicuous reef fishes and relied on visual censuses, we expected a substantial increase of the known fish richness, mainly in cryptobenthic and non-coral reef species. This knowledge will increase understanding of regional fish diversity and could be useful for this protected area's conservation and management strategies.

Materials and methods

Puerto Morelos Reef National Park (PMRNP) covers 9066 ha, in a narrow strip along ~20 km of the coastline (Fig. 1). The center of the park is defined by a barrier reef that runs parallel to the coast, with its outer margin exposed to wave action throughout the year. Inshore from the barrier reef is a shallow, sheltered lagoon that varies between 60 and 3000 m in width and its maximum depth approximates 8 m. PMRNP is within an area of low tidal amplitude (Merino and Otero 1991); the dominant current flows to the north and is stronger than in more southern localities of the coast (Muhling et al. 2013). This park also encompasses other habitats used by fishes, including mangrove forests along the shoreline, *Thalassia* seagrass beds within the lagoon, sand bottoms, artificial reefs, gorgonian fields, rocky intertidal pools, karstic-slab bottoms (sheets of horizontal, low relief karstic limestone rock, sometimes with gorgonians, small, scattered coral growths, loose coral rubble, and rockeries), patch reefs, freshwater springs, and deep areas (>40 m) (SEMARNAP 2000). The park boundary extends only 1–3 km beyond the outer edge of the barrier reef into the northern approaches to the channel that separates Cozumel Island from the mainland. Almost all park area outside the barrier reef is shallower than 30–50 m. There is only one section of the park where water depths extends 50 m (see nautical chart SM922.3; SEMAR 2023). That section of the park, in its southeast corner, represents < 0.5% of the area of the PMRNP.

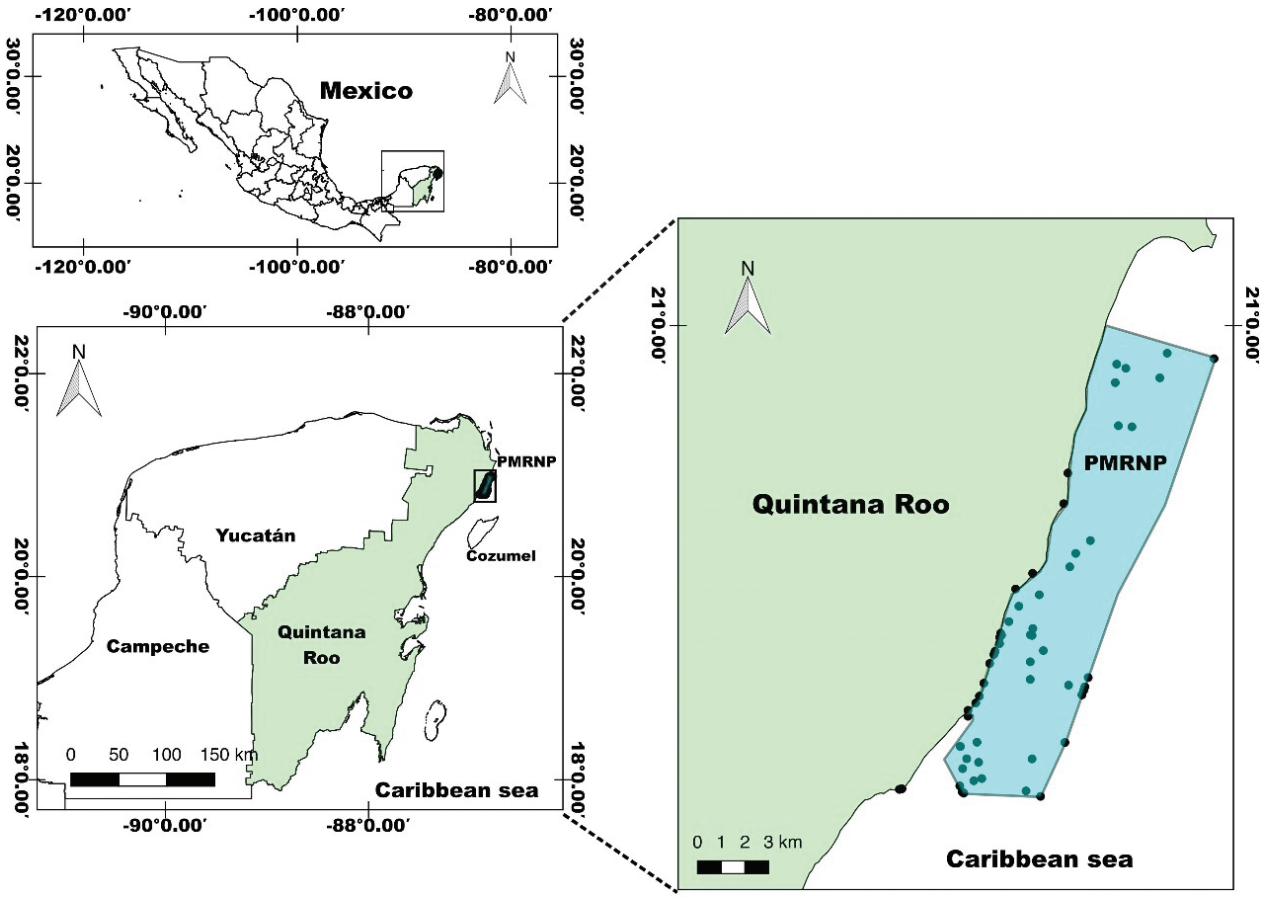

Figure 1. Sample locations in Puerto Morelos Reef National Park in Quintana Roo State, Mexico. Shadow blue represents the polygon of the National Park. Black points within the park indicate collecting sites.

Collection methods. This study covers the results from fish collections at 57 localities scattered throughout most of PMRNP (Table 1 and Fig. 1). We conducted field samplings from May 2014 to May 2015. Habitats sampled included karstic rock intertidal pools, sandy bottoms, *Thalassia* beds, coral reefs, artificial reefs, submerged karstic-slab bottoms, and patches of benthic *Sargassum* macroalgae attached to the sand and pelagic areas (mid- to surface waters in areas offshore from the barrier reef). Methods varied according to the habitat to be sampled. Collections at depths of 4 to 40 m were carried out by SCUBA diving. Non-cryptic fishes were speared using multi-pronged pole spears. Cryptobenthic fishes are species that live closely associated with or within benthic habitats, are visually cryptic in form and behavior, and often are small (Viesca-Lobatón et al. 2008; Brandl et al. 2018). Such species were collected using clove oil (eugenol) anesthetic at a ratio of 1:5 (eugenol:ethanol) for coral reefs, artificial reefs, and submerged karstic-slab bottoms, and 1:40 for collections at tide pools (see Table 1). We captured sedated fish with a slurp gun or hand net. For some sand-bottom sites, we use a seine net, 10 m long × 2 m high with a 1 cm open mesh. We cooperated with local artisanal fishermen to collect incidental and commercial species at the limits of the National Park. We caught those fishes with hook-an-line and gillnets of 7–12 cm mesh size at a maximum depth of 80 m. We also obtained information about the use of those species from those fishers. The habitat type from which each species was collected is also included in the checklist.

We took photographs of most freshly collected specimens soon after collection when we took tissue samples from the pectoral fin, which were placed at 96% analytical grade ethanol and stored at –80°C in the Tissue Collection of the Ichthyological Collection at Universidad Michoacana (CPUM, registration key: MICH.-PEC-227-07-09). Whole-fish specimens were then fixed in 5% or 10% formalin neutralized with sodium borate and subsequently preserved in 70% ethanol. Voucher specimens were deposited in the fish collection (CPUM). We identified fishes using the keys and descriptions from Humann and Deloach (2002), Carpenter (2002), and Robertson et al. (2015). Twenty species that were difficult to identify morphologically had their identity corroborated using mitochondrial DNA barcodes. For 16 species, we used the gene cytochrome c oxidase subunit (*cox1*); for the *Bathygobius* species, we used mitochondrial cytochrome b (*cytb*). We amplified the *cox1* gene with the primers Fish1F and Fish1R, following Ward et al. (2005), and for *cytb* we used the primers Glud-G and H16460 following Perdices et al. (2002). The sequences of the 16 species with *cox1* were deposited in Genbank under ascension numbers MZ720809–MZ720822 and MZ868935, and MZ870594. We corroborated the identity of species with the Boldsystem or Genbank sequences (Blast) to verify identification.

Table 1. Georeferenced and habitat type of the sampling sites in Puerto Morelos Reef National Park in Quintana Roo State, México.

Sampling site	Latitude, Longitude	Habitat type	Depth [m]
Ojo Norte	20.8863, –86.8572	S, R	5–9
Ojo de Agua	20.8499, –86.8732	S, R	3–7
Muelle Fiscal	20.8418, –86.8778	AR	5–10
La Bocana	20.8748, –86.8525	R, SB, S	2–10
Limones	20.9888, –86.7971	R	3–8
Boya Zona Norte	20.9788, –86.8001	S	15–20
Barco hundido	20.8544, –86.8371	AR	25–40
Jardín frontal	20.8313, –86.8741	R	6–10
La Pared	20.8246, –86.8783	R, SB	6–12
Pared frontal	20.8231, –86.8735	R, SB	4–10
Cueva de tiburón	20.8684, –86.8473	R, SB	15–20
Rordman	20.8745, –86.8518	TF	5–9
Fish market	20.8136, –86.8811	R, SB	10–18
Hoyanquita	20.8206, –86.8799	TF, R, S, SB	10–15
Cuevones	20.9129, –86.8282	TF, R, SB, S	6–12
Punta Caracol	20.8910, –86.8489	TF, SB, R, S	3–7
El volador	20.8111, –86.8801	S, R, SB	10–15
El Oasis	20.8107, –86.8795	S, TF, R, SB	8–15
Picudas	20.8773, –86.8515	R, SB	5–9
Bocana sur	20.8754, –86.8646	S, TF	1–3
Muelle UNAM	20.8681, –86.8668	AR	1–3
Punta Norte	20.9769, –86.8182	R	9–12
Mantarraya	20.8157, –86.8754	S, TF, SB	11–15
Los Abanicos	20.9078, –86.8342	S, TF, SB	8–11
Bonanza sur	20.9594, –86.8169	R, SB	3–9
Canal Limones	20.9827, –86.8139	S, R	4–9
El Rapidin	20.8115, –86.8543	S, SB	35–40
Frente al CID	20.8296, –86.8809	TF, S, SB	1–5
Manatí	20.9844, –86.8176	R	11–15
Muelle Desire	20.8631, –86.8690	AR	1–3
Red ball	20.8245, –86.8518	AR	8–12
Cazones	20.9023, –86.8366	R, SB	10–14
Límite del Parque Norte	20.9866, –86.7782	P	40
Mar Casa de Playa	20.8997, –86.8516	S, TF	1–4
Ojo Pargo	20.8801, –86.8612	S, R	7
La Herradura	20.8166, –86.8722	S, SB	8–14
Punta Brava	20.8124, –86.9045	RI	< 1
Muelle Puerto	20.8472, –86.8746	AR	1–3
Pelicanos	20.8442, –86.8778	S, TF, SB	1–3
Nichupte	20.8296, –86.8809	S	1–3
Punta Sur del Parque	20.8094, –86.8484	P	80
Muelle Los Gemelos	20.8737, –86.8650	AR	1–3
Lado Sur Punta Brava	20.8122, –86.9056	S	1–3
Royalton	20.9403, –86.8373	S, SP	1–3
Frente Muelle General	20.8312, –86.8386	S, TF	1–3
Restaurante Único	20.8552, –86.8714	S	1–3
Matón Viejo	20.9590, –86.8114	SP	2–5
Petempich	20.9279, –86.8390	S, TF	1–3
Silversam	20.8933, –86.8585	RI	< 1
Frente a la CONANP	20.8669, –86.8673	S	1–3
Hotel Excellent	20.8746, –86.8642	TF	1–3
Hotel Dreams	20.8712, –86.8650	S, TF	1–3
Pescadores Sitio 2	20.8567, –86.8526	P	50
Pescadores Sitio 3	20.8505, –86.8317	P	60
Pescadores Sitio 4	20.8537, –86.8304	P	30
Pescadores Sitio 5	20.8575, –86.8291	P	80
Pescadores Sitio 6	20.8522, –86.8310	P	50

Collection habitat: R = coral reef, TF = *Thalassia* bed, S = sandy bottom, P = pelagic, AR = artificial reef, SB = karstic-slab bottom, RI = intertidal pool, SP = *Sargassum* patch. **Bold** type denotes sites at which clove oil was used to collect cryptobenthic fish.

The species recorded in the management plan of PMRNP (SEMARNAP 2000) that were not collected in this study were also included in the list, except for a few species whose identification we considered uncertain. We also included records from FishNet, GBIF, and IDigBio of fish found in the PMRNP. Families, genera, and species in the resultant checklist (Table 2) are arranged alphabetically. The determination of fish names and their taxonomic validity was aided based on the online version of Eschmeyer's Catalog of Fishes (Fricke et al. 2023). It should be emphasized that this updated monthly Catalog is not a nomenclatural act.

We classified different types of shallow and deep reef fishes collected in PMRNP according to categories used in the most recent version of the list of "Reef-associated bony fishes of the Greater Caribbean" published by Robertson and Tornabene (2020). That database classified fishes as pelagic, demersal (use the bottom and water column), and benthic (restricted to the bottom, with cryptobenthic a subcategory of that group). It also divides species into shallow and deep forms, with the former including species found above 40 m, while deep forms are entirely or primarily restricted to depths below 40 m. Using this categorization, we compared variation in the taxonomic structure of shallow and deep components of the fauna of PMRNP to that of six well-studied sites scattered from Bermuda to the southern Caribbean (see Robertson et al. 2020, 2022).

Table 2. Checklist of shallow water ray-finned fishes known from Puerto Morelos Reefs National Park, México. [Abbreviations explained in the table's footnote.]

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
FAMILY ACANTHURIDAE					
Acanthurus chirurgus (Bloch, 1787)		R, TF, S, AR, SB	3, 5, CPUM		
Acanthurus coeruleus Bloch et Schneider, 1801		R, TF, S, AR, SB	3, CPUM		
Acanthurus tractus Poey, 1860		R, TF, S, AR	1, 3, 5, CPUM		
FAMILY ALBULIDAE					
Albula goreensis Valenciennes, 1847	G	TF	CPUM		
Albula vulpes (Linnaeus, 1758)		S, TF	3, 5, CPUM		
FAMILY ANTENNARIIDAE					
Histrio histrio (Linnaeus, 1758)		TF, SP	3, 5, CPUM		+
FAMILY APOGONIDAE					
Apogon aurolineatus (Mowbray, 1927)		"RA	5		+
Apogon binotatus (Poe, 1867)		"RA	5		+
***Apogon maculatus* (Poey, 1860)**	NP, GBIF	R	3, CPUM		+
Apogon planifrons Longley et Hildebrand, 1940		R	5, CPUM		+
Apogon quadrisquamatus Longley, 1934		"RA	3, 5		+
***Apogon robbyi* Gilbert et Tyler, 1997**	NM, GBIF	R	3, CPUM		+
***Apogon townsendi* (Breder, 1927)**	NP, GBIF	R	3, CPUM		+
Astrapogon puncticulatus (Poey, 1867)		R, S	3, 5, CPUM		+
***Phaeoptyx conklini* (Silvester, 1915)**	NP	R	CPUM		+
***Phaeoptyx pigmentaria* (Poey, 1860)**	NP, GBIF	R	3, CPUM		+
FAMILY ATHERINIDAE					
Atherina harringtonensis Goode, *1*877		P	5, CPUM		
Atherinomorus stipes (Muller et Troschel, 1848)		P	3, 5, CPUM		
FAMILY AULOSTOMIDAE					
Aulostomus maculatus Valenciennes, 1841		R, TF, AR	1, 3, 5, CPUM		
FAMILY BALISTIDAE					
Balistes capriscus Gmelin, 1789		R, TF, S, AR	3, 5, CPUM	SF	
Balistes vetula Linnaeus, 1758		R, AR, P	1, 3, 5, CPUM	SF	
Canthidermis sufflamen (Mitchill, 1815)		R, TF, S, AR, SB, P	1, 3, 5, CPUM		
Melichthys niger (Bloch, 1786)		"RA	5		
Xanthichthys ringens (Linnaeus, 1758)		R	3, CPUM		
FAMILY BATRACHOIDIDAE					
***Sanopus astrifer* (Robins et Starck, 1965)**	NP, GBIF	R	3, CPUM		+
FAMILY BELONIDAE					
Platybelone argalus (Lesueur, 1821)		P	3, 5, CPUM		
***Strongylura marina* (Walbaum, 1792)**	NP, GBIF	P	3, CPUM		
***Strongylura notata* (Poey, 1860)**	NP, GBIF	P	3, CPUM		
***Strongylura timucu* (Walbaum, 1792)**	NP, GBIF	P	3, CPUM		
***Tylosurus acus* (Lacepéde, 1803)**	GBIF	P	3, CPUM		
Tylosurus crocodilus (Péron et Lesueur, 1821)		P	3, 5, CPUM		
FAMILY BLENNIIDAE					
Entomacrodus nigricans Gill, 1859		RI	5, CPUM		+
Hypsoblennius exstochilus Böhlke, 1959		SB	CPUM		+
Ophioblennius macclurei (Silvester, 1915)		R	3, 5, CPUM		+
Scartella cristata (Linnaeus, 1758)		RI	3, 5, CPUM		+

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
FAMILY BOTHIDAE					
Bothus lunatus (Linnaeus, 1758)		R, S	3, 5, CPUM		+
***Bothus maculiferus* (Poey, 1860)**	NP, GBIF	S	3, CPUM		+
Bothus ocellatus (Agassiz, 1831)		S	3, 5, CPUM		+
FAMILY CALLIONYMIDAE					
***Callionymus bairdi* (Jordan, 1888)**	NP, GBIF	R	3, CPUM		+
FAMILY CARANGIDAE					
Alectis ciliaris (Bloc, 1787)		"BP	5		
Caranx bartholomaei (Cuvier, 1833)		TF, S	1, 3, 5, CPUM		
Caranx crysos (Mitchill, 1815)		TF, S	1, 3, 5, CPUM		
Caranx hippos (Linnaeus, 1766)		"BP	5		
Caranx latus Agassiz, 1831		P	3, 5, CPUM	LC	
Caranx ruber (Bloch, 1793)		R, TF, S, AR, SB, P	1, 3, 5, CPUM	LC	
***Chloroscombrus chrysurus* (Linnaeus, 1766)**	NP, GBIF	P	3, CPUM		
Decapterus macarellus (Cuvier, 1833)		S, TF, RI, AR	3, 5, CPUM	B	
***Decapterus punctatus* (Cuvier, 1829)**	NP, GBIF	P	3, CPUM		
Selar crumenophthalmus (Bloch, 1793)		S, TF	3, CPUM		
***Selene brownii* (Cuvier, 1816)**	NP, GBIF, G	R	3, CPUM		
***Selene setapinnis* (Mitchill, 1815)**	NP, GBIF	R	3, CPUM		
Selene vomer (Linnaeus, 1758)		R, TF, S	3, 5, CPUM		
***Seriola dumerili* (Risso, 1810)**	NP	TF	PR	CF	
Seriola rivoliana Valenciennes, 1833		TF	3, 5, CPUM	CF	
Trachinotus falcatus (Linnaeus, 1758)		TF	1, 3, 5, CPUM	LC	
Trachinotus goodei Jordan et Evermann, 1896		TF	3, 5, CPUM	LC	
FAMILY CARAPIDAE					
Carapus bermudensis (Jones, 1874)		"RA	5		+
FAMILY CENTROPOMIDAE					
Centropomus undecimalis (Bloch, 1792)		P	3, 5, CPUM	LC	
FAMILY CHAENOPSIDAE					
***Acanthemblemaria aspera* (Longley, 1927)**	NP, GBIF	R, SB, AR	3, CPUM		+
Acanthemblemaria greenfieldi Smith-Vaniz et Palacio, 1974		R, SB	3, 5, CPUM		+
***Acanthemblemaria maria* Böhlke, 1961**	NP, GBIF, G	R	3, CPUM		+
***Acanthemblemaria spinosa* Metzelaar, 1919**	NP, GBIF	R, SB	3, CPUM		+
***Chaenopsis* cf *limbaughi* Robins et Randall, 1965**	NM, G	TF, S	CPUM		+
Chaenopsis ocellata Poey, 1865		TF	3, 5, CPUM		+
***Chaenopsis roseola* Hastings et Shipp, 1981**	NM, GBIF	S	3, CPUM		+
***Stathmonotus tekla* Nichols, 1910**	NP, GBIF	SB, RI	3, CPUM		+
FAMILY CHAETODONTIDAE					
Chaetodon capistratus Linnaeus, 1758		R, TF, S, AR	1, 3, 5, CPUM		
Chaetodon ocellatus Bloch, 1787		R, TF, S	3, 5, CPUM		
Chaetodon sedentarius Poey, 1860		"RA	5		
Chaetodon striatus Linnaeus, 1758		R, TF, S, AR, SB	1, 3, 5, CPUM		
***Prognathodes aculeatus* (Poey, 1860)**	NP	R	CPUM		
FAMILY CIRRHITIDAE					
***Amblycirrhitus pinos* (Mowbray, 1927)**	NP, GBIF	R	3, CPUM		+
FAMILY CLUPEIDAE					
***Harengula clupeola* (Cuvier, 1829)**	NP, GBIF	TF	CPUM	B	
Harengula humeralis (Cuvier, 1829)	G	S, TF	3, 5, CPUM	B	
Harengula jaguana Poey, 1865		P	3, 5, CPUM	B	
Jenkinsia lamprotaenia (Gosse, 1851)		"P	3	B	
Jenkinsia stolifera (Jordan et Gilbert, 1884)		"P	5	B	
Opisthonema oglinum (Lesueur, 1818)		"P	3, 5	B	
FAMILY CONGRIDAE					
***Heteroconger longissimus* Günther, 1870**	NP, GBIF	S	3, CPUM		
FAMILY CORYPHAENIDAE					
Coryphaena equiselis Linnaeus, 1758		"P	3		
Coryphaena hippurus Linnaeus, 1758		P	3, 5, PR	SF	
FAMILY DACTYLOPTERIDAE					
***Dactylopterus volitans* (Linnaeus, 1758)**	NP, GBIF	S	3, CPUM		+
FAMILY DACTYLOSCOPIDAE					
***Gillellus uranidea* Böhlke, 1968**	NP, GBIF	R, RI, SB	3, CPUM		+
FAMILY DIODONTIDAE					
Chilomycterus antillarum Jordan et Rutter, 1897		"RA	5		
Chilomycterus schoepfii (Walbaum, 1792)		"RA	5		

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
Diodon holocanthus Linnaeus, 1758		R, TF, S	1, 3, 5, CPUM		
Diodon hystrix Linnaeus, 1758		R	3, 5, CPUM		
FAMILY ECHENEIDAE					
***Echeneis naucrates* Linnaeus, 1758**	NP	P	CPUM		
Echeneis neucratoides Zuiew, 1786		“P	3		
***Remora osteochir* (Cuvier, 1829)**	NP, GBIF	P	3, CPUM		
Remora remora (Linnaeus, 1758)		“P	1		
FAMILY ELOPIDAE					
Elops saurus Linnaeus, 1766		P	3, 5, CPUM		
***Elops smithi* McBride, Rocha, Ruiz-Carus** et **Bowen 2010**	NP, GBIF	TF	3, CPUM		
FAMILY ENGRAULIDAE					
Anchoa cayorum (Fowler, 1906)		P	3, 5, CPUM		
Anchoa colonensis (Hildebrand, 1943)		P	5, CPUM		
Anchoa lamprotaenia Hildebrand, 1943	G	P	5, CPUM		
Anchoa parva (Meek et Hildebrand, 1923)		“P	5		
FAMILY EPHIPPIDAE					
***Chaetodipterus faber* (Broussonet, 1782)**	NP, GBIF	TF	3, CPUM		
FAMILY EXOCOETIDAE					
***Hirundichthys speculiger* (Valenciennes, 1847)**	NP, GBIF	P	3, CPUM		
FAMILY FISTULARIIDAE					
***Fistularia tabacaria* Linnaeus, 1758**	NP, GBIF	S, TF	3, CPUM		
FAMILY GEMPYLIDAE					
Diplospinus multistriatus Maul, 1948		“P, “B	3		
Gempylus serpens Cuvier, 1829		“P, “B	3		
Nesiarchus nasutus Johnson, 1862		“BP	3		
FAMILY GERREIDAE					
Eucinostomus argenteus Baird et Girard, 1855		R, TF, S, AR	3, 5, CPUM	LC	
Eucinostomus gula (Quoy et Gaimard, 1824)		TF, S, RI	3, 5, CPUM	B	
Eucinostomus jonesii (Günther, 1879)		TF	3, 5, CPUM	B	
***Eucinostomus lefroyi* (Goode, 1874)**	NP	TF, S, RI	CPUM	B	
Eucinostomus melanopterus (Bleeker, 1863)		TF	3, 5, CPUM	B	
Gerres cinereus (Walbaum, 1792)		TF	1, 2, 3, 5, CPUM	B	
FAMILY GOBIESOCIDAE					
Acyrtops beryllinus (Hildebrand et Ginsburg, 1927)		“D	5		+
Gobiesox punctulatus (Poey, 1876)		“RA	5		+
***Tomicodon cryptus* Williams et Tyler 2003**	NM, G	R, RI	CPUM		+
***Tomicodon lavettsmithi* Williams et Tyler 2003**	NM, G	R, RI	CPUM		+
FAMILY GOBIIDAE					
***Barbulifer antennatus* Böhlke et Robins, 1968**	NP, GBIF	SB	3, CPUM		+
***Barbulifer ceuthoecus* (Jordan et Gilbert, 1884)**	NP	RI	CPUM		+
***Bathygobius antilliensis* Tornabene, Baldwin et Pezold 2010**	NP, G*	RI	CPUM		+
Bathygobius curacao (Metzelaar, 1919)	G*	RI	5, CPUM		+
***Bathygobius lacertus* (Poey, 1860)**	NP, G*	RI	CPUM		+
Bathygobius soporator (Valenciennes, 1837)	G*	TF	5, CPUM		+
***Coryphopterus dicrus* Böhlke et Robins, 1960**	NP, GBIF	R, SB, AR	3, CPUM		+
***Coryphopterus eidolon* Böhlke et Robins, 1960**	NP, GBIF	R	3, CPUM		+
***Coryphopterus glaucofraenum* Gill, 1863**	NP, GBIF	R	3, CPUM		+
***Coryphopterus hyalinus* Böhlke et Robins, 1962**	NP	R	CPUM		
***Coryphopterus personatus* (Jordan et Thompson, 1905)**	NP, GBIF	R	3, CPUM		
***Coryphopterus tortugae* (Jordan, 1904)**	NP, GBIF, G	R	3, CPUM		+
***Ctenogobius saepepallens* (Gilbert et Randall, 1968)**	NP, GBIF	S	3, CPUM		+
***Elacatinus colini* Randall et Lobel 2009**	NM, G	R	CPUM		+
***Elacatinus prochilos* (Böhlke et Robins, 1968)**	NP	R, SB	CPUM		+
***Gnatholepis thompsoni* Jordan, 1904**	NP, GBIF	R, S, SB, AR	3, CPUM		+
***Lythrypnus nesiotes* Böhlke et Robins, 1960**	NP, GBIF	R	3, CPUM		+
***Lythrypnus okapia* Robins et Böhlke, 1964**	NM, GBIF	R	3, CPUM		+
***Microgobius carri* Fowler, 1945**	NP, GBIF	S	3, CPUM		+
***Priolepis hipoliti* (Metzelaar, 1922)**	NP, GBIF	R	3, CPUM		+
***Ptereleotris helenae* (Randall, 1968)**	NP, GBIF	S	3, CPUM		
***Risor ruber* (Rosen, 1911)**	NP, GBIF	R	3, CPUM		+
FAMILY GRAMMATIDAE					
Gramma loreto Poey, 1868		R	3, 5, CPUM		

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
FAMILY HAEMULIDAE					
Anisotremus surinamensis (Bloch, 1791)		TF	3, 5, CPUM		
Anisotremus virginicus (Linnaeus, 1758)		R, AR	3, 5, CPUM	LC	
Brachygenys chrysargyreum (Günther, 1859)		R	3, 5, CPUM		
***Emmelichthyops atlanticus* Schultz, 1945**	NP, GBIF	R	3, CPUM		
Haemulon album Cuvier, 1830		R, P	5, CPUM	CF	
Haemulon atlanticus Carvalho, Marceniuk, Oliveira et Wosiacki, 2020		"RA	5		
Haemulon aurolineatum Cuvier, 1830		R, TF, S, AR, RI	1, 3, 5, CPUM		
***Haemulon bonariense* Cuvier, 1830**	NP, GBIF	TF	3, CPUM		
Haemulon carbonarium Poey, 1860		R, S, RI	3, 5, CPUM		
Haemulon flavolineatum (Desmarest, 1823)		R, TF, S, AR	1, 3, 5, CPUM	LC	
Haemulon macrostomum Günther, 1859		R, TF	3, 5, CPUM		
Haemulon melanurum (Linnaeus, 1758)		R, S, P	1, 3, 5, CPUM	LC	
Haemulon parra (Desmarest, 1823)		R, TF, SB, AR, RI,	1, 3, 5, CPUM		
Haemulon plumierii (Lacepede, 1801)		R, TF, S, AR	1, 3, 5, CPUM	CF	
Haemulon sciurus (Shaw, 1803)		S	3, 5, CPUM	CF	
Haemulon striatum (Linnaeus, 1758)		R, TF, S, AR, SB, P	3, 5, CPUM		
***Haemulon vittatum* (Poey, 1860)**	NP, GBIF	AR	3, CPUM		
FAMILY HEMIRAMPHIDAE					
Hemiramphus brasiliensis (Linnaeus, 1758)		P	3, 5, CPUM		
Hyporhamphus unifasciatus (Ranzani, 1841)		P	3, 5, CPUM		
FAMILY HOLOCENTRIDAE					
Holocentrus adscensionis (Osbeck, 1765)		R, P	3, 5, CPUM		
Holocentrus rufus (Walbaum, 1792)		R, P, AR	3, 5, CPUM		
Myripristis jacobus (Cuvier, 1829)		R	3, 5, CPUM		
***Neoniphon coruscum* (Poey, 1860)**	NP, GBIF	R, S	3, CPUM		
***Neoniphon marianus* (Cuvier, 1829)**	NP, GBIF	R	3, CPUM		
***Neoniphon vexillarium* (Poey, 1860)**	NP, GBIF	R, S, TF	3, CPUM		
FAMILY ISTIOPHORIDAE					
***Makaira nigricans* (Lacepede, 1802)**	NP	P	PR	SF	
FAMILY KYPHOSIDAE					
Kyphosus sectatrix (Linnaeus, 1766)		R, TF, S, AR, RI	3, 5, CPUM		
Kyphosus vaigiensis (Quoy et Gaimard, 1825)		TF	3, 5, CPUM		
FAMILY LABRIDAE					
Subfamily Labrinae					
Bodianus rufus (Linnaeus, 1758)		R, AR	3, 5, CPUM		
***Clepticus parrae* (Bloch et Schneider, 1801)**	NP, GBIF	R, S	3, CPUM		
Doratonotus megalepis (Günther, 1862)		"RA	5		+
Halichoeres bivittatus (Bloch, 1791)		R, TF, S, AR, RI	1, 3, 5, CPUM		
Halichoeres garnoti (Valenciennes, 1839)		R, TF, S, AR	3, 5, CPUM		
Halichoeres maculipinna (Muller et Troschel, 1848)		R, TF, SB	1, 3, 5, CPUM		
Halichoeres pictus (Poey, 1860)		R, RI, SB	1, CPUM		
Halichoeres poeyi (Steindachner, 1867)		R, TF, SB	1, 3, 5, CPUM		
Halichoeres radiatus (Linnaeus, 1758)		R, AR	3, 5, CPUM	LC	
Lachnolaimus maximus (Walbaum, 1792)		R, TF	3, 5, CPUM	CF	
Thalassoma bifasciatum (Bloch, 1791)		TF, S, RI, SB, AR	1, 3, 4, 5, CPUM		
***Xyrichtys martinicensis* (Valenciennes, 1840)**	NP, GBIF	S	3, CPUM		
Xyrichtys novacula (Linnaeus, 1758)		S	1, 3, CPUM		
Xyrichtys splendens Castelnau, 1855	G	TF, S	1, 3, 5, CPUM		
Subfamily Scarinae					
Cryptotomus roseus (Cope, 1871)		SB	1, 3, 5, CPUM		
Nicholsina usta (Valenciennes, 1840)		R, TF, SB	3, 5, CPUM		
*Scarus coelestinus (*Valenciennes, 1840)		"RA	5		
Scarus coeruleus (Edwards, 1771)		"RA	5		
Scarus guacamaia (Cuvier, 1829)		"RA	5		
Scarus iseri (Bloch, 1789)		R, TF	1, 3, 5, CPUM		
Scarus taeniopterus (Lesson, 1829)		R, TF	3, 5, CPUM		
Scarus vetula (Bloch et Schneider, 1801)		"RA	3, 5		
Sparisoma atomarium (Poey, 1861)		R, TF, S, AR, SB	1, 3, 5, CPUM		
Sparisoma aurofrenatum (Valenciennes, 1840)		R, S	3, 5, CPUM		
Sparisoma chrysopterum (Bloch et Schneider, 1801)		R, TF, S	1, 3, 5, CPUM		
Sparisoma radians (Valenciennes, 1840)		R, TF, RI	1, 3, 5, CPUM		
Sparisoma rubripinne (Valenciennes, 1840)		R, TF	1, 3, 5, CPUM		
Sparisoma viride (Bonnaterre, 1788)		TF, S	1, 3, 5, CPUM		

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
FAMILY LABRISOMIDAE					
Gobioclinus bucciferus (Poey, 1868)		R, RI	3, 5, CPUM		+
***Gobioclinus gobio* (Valenciennes, 1836)**	NP	R, SB	CPUM		+
***Gobioclinus kalisherae* (Jordan, 1904)**	NP, GBIF	R, RI, SB	3, CPUM		+
Labrisomus nuchipinnis (Quoy et Gaimard, 1824)		R, TF, AR	3, 5, CPUM		+
***Malacoctenus boehlkei* (Springer, 1959)**	NP, GBIF	R	3, CPUM		+
***Malacoctenus erdmani* (Smith, 1957)**	NP, GBIF	R, SB	3, CPUM		+
Malacoctenus gilli (Steindachner, 1867)		R, RI	2, 3, 5, CPUM		+
Malacoctenus macropus (Poey, 1868)		R, TF, SB	3, 5, CPUM		+
Malacoctenus triangulatus (Springer, 1959)		R, SB	3, 5, CPUM		+
Malacoctenus versicolor (Poey, 1876)		RI	CPUM		+
Paraclinus cingulatus (Evermann et Marsh, 1899)		“RA	5		+
Paraclinus fasciatus (Steindachner, 1876)		R, RI, SB	3, 5, CPUM		+
***Paraclinus nigripinnis* (Steindachner, 1867)**	NP, GBIF	R, RI, SB	3, CPUM		+
***Starksia occidentalis* (Greenfield, 1979)**	NP, G	R, SB	CPUM		+
Starksia weigti (Baldwin et Castillo, 2011)		R	CPUM		+
FAMILY LOBOTIDAE					
***Lobotes surinamensis* (Bloch, 1790)**	NP, GBIF	TF, RI	3, CPUM		
FAMILY LUTJANIDAE					
Lutjanus analis (Cuvier, 1828)		R, TF, S	1, 3, 5, CPUM	CF	
Lutjanus apodus (Walbaum, 1792)		R, TF, S, RI	3, 5, CPUM	CF	
***Lutjanus buccanella* (Cuvier, 1828)**	NP	P	CPUM	CF	
Lutjanus campechanus (Poey, 1860)		“RA	5	CF	
Lutjanus griseus (Linnaeus, 1758)		R, TF, S, AR	3, 5, CPUM	CF	
Lutjanus jocu (Bloch et Schneider, 1801)		R, TF, S, SB	3, 5, CPUM	CF	
Lutjanus mahogoni (Cuvier, 1828)		R, TF, S, AR, RI	3, 5, CPUM		
Lutjanus synagris (Linnaeus, 1758)		R	3, 5, CPUM	CF	
***Lutjanus vivanus* (Cuvier, 1828)**	NP	P	CPUM	CF	
Ocyurus chrysurus (Bloch, 1791)		R, TF, S, AR	1, 3, 5, CPUM	CF	
***Rhomboplites aurorubens* (Cuvier, 1829)**	NP, GBIF	R, P, AR	3, CPUM	CF	
FAMILY MALACANTHIDAE					
Malacanthus plumieri (Bloch, 1786)		S	3, 5, CPUM	CF	
FAMILY MONACANTHIDAE					
Aluterus monoceros (Linnaeus, 1758)		“RA	1		
Aluterus scriptus (Osbeck, 1765)		R, TF, AR	3, 5, CPUM		
Cantherhines pullus (Ranzani, 1842)		R	3, 5, CPUM		
Monacanthus ciliatus (Mitchill, 1818)		TF	1, 3, 5, CPUM		
Monacanthus tuckeri (Bean, 1906)		R	1, 3, 5, CPUM		
Stephanolepis hispidus (Linnaeus, 1766)		TF, S	1, 3, 5, CPUM		
Stephanolepis setifer (Bennett, 1831)		TF, S, RI	3, 5, CPUM		
FAMILY MUGILIDAE					
Mugil cephalus (Linnaeus, 1758)		TF	5, CPUM		
Mugil curema (Valenciennes, 1836)		TF	3, CPUM		
***Mugil liza* (Valenciennes, 1836)**	NP, GBIF	TF	3, CPUM		
FAMILY MULLIDAE					
Mulloidichthys martinicus (Cuvier, 1829)		R, TF, S, SB	5, CPUM		
Pseudupeneus maculatus (Bloch, 1793)		TF, S	1, 3, 5, CPUM		
FAMILY MURAENIDAE					
***Echidna catenata* (Bloch, 1795)**	NP	RI	CPUM		+
Gymnothorax funebris (Ranzani, 1839)		R	3, 5, PR		+
***Gymnothorax miliaris* (Kaup, 1856)**	NP, GBIF	R, TF	3, CPUM		+
Gymnothorax moringa (Cuvier, 1829)		R, TF, SB, AR	3, 5, CPUM		+
Gymnothorax vicinus (Castelnau, 1855)		R, TF	3, 5, CPUM		+
FAMILY OGCOCEPHALIDAE					
Ogcocephalus corniger (Bradbury, 1980)		“D	3		
Ogcocephalus nasutus (Cuvier, 1829)	G	S	5, CPUM		
FAMILY OPHICHTHIDAE					
Myrichthys breviceps (Richardson, 1848)		“RA	3, 5		+
Myrichthys ocellatus (Lesueur, 1825)		S	5, CPUM		+
***Myrophis punctatus* (Lütken, 1852)**	NP	TF	CPUM		
Phaenomonas longissima (Cadenet et Marchal, 1963)		“D	3		
FAMILY OPISTOGNATHIDAE					
***Opistognathus macrognathus* (Poey, 1860)**	NP, GBIF	S	3, CPUM		+
***Opistognathus nothus* (Smith-Vaniz, 1997)**	NP, GBIF	S	3, CPUM		+
***Opistognathus whitehursti* (Longley, 1927)**	NP, GBIF, G	S	3, CPUM		+

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
FAMILY OSTRACIIDAE					
Acanthostracion polygonius (Poey, 1876)		TF	1, 3, 5, CPUM		
Acanthostracion quadricornis (Linnaeus, 1758)		R	1, 3, 5, CPUM		
Lactophrys bicaudalis (Linnaeus, 1758)		R, TF, AR, SB	1, 3, 5, CPUM		
Lactophrys trigonus (Linnaeus, 1758)		R, TF, AR	1, 3, 5, CPUM		
Lactophrys triqueter (Linnaeus, 1758)		TF	1, 3, 5, CPUM		
FAMILY PEMPHERIDAE					
Pempheris schomburgkii (Müller et Troschel, 1848)		R, TF, AR	3, 5, CPUM		+
FAMILY POLYNEMIDAE					
***Polydactylus oligodon* (Günther, 1860)**	NP	TF, S	3, 5, CPUM		
Polydactylus virginicus (Linnaeus, 1758)		TF, S	3, 5, CPUM		
FAMILY POMACANTHIDAE					
Centropyge argi (Woods et Kanazawa, 1951)		"RA	3		
***Holacanthus bermudensis* (Goode, 1876)**	NP, GBIF	S	3, CPUM		
Holacanthus ciliaris (Linnaeus, 1758)		R, TF, AR, SB	3, 5, CPUM		
Holacanthus tricolor (Bloch, 1795)		R, TF, S, AR, SB	3, 5, CPUM		
Pomacanthus arcuatus (Linnaeus, 1758)		R, S	3, 5, CPUM		
Pomacanthus paru (Bloch, 1787)		R, TF	1, 3, 5, CPUM		
FAMILY POMACENTRIDAE					
Abudefduf saxatilis (Linnaeus, 1758)		R, S	3, 5, CPUM		
Abudefduf taurus (Muller et Troschel, 1848)		R	5, CPUM		
Chromis cyanea (Poey, 1860)		R, S	3, 5, CPUM		
Chromis insolata (Cuvier, 1830)		R, TF, S	3, 5, CPUM		
Chromis multilineata (Guichenot, 1853)		RI	3, 5, CPUM		
Microspathodon chrysurus (Cuvier, 1830)		R	3, 5, CPUM		
***Stegastes adustus* (Troschel, 1865)**	NP	R, TF, AR, RI	^3, CPUM		
Stegastes diencaeus (Jordan et Rutter, 1897)		R, RI, SB, AR	3, 5, CPUM		
Stegastes leucostictus (Muller et Troschel, 1848)		R, TF, RI, SB	1, 3, 5, CPUM		
Stegastes partitus (Poey, 1868)		R, TF, AR, SB	3, 5, CPUM		
Stegastes planifrons (Cuvier, 1830)		R, RI, SB, AR	3, 5, CPUM		
Stegastes xanthurus (Poey, 1860)		R, RI, AR	3, 5, CPUM		
FAMILY PRIACANTHIDAE					
Heteropriacanthus cruentatus (Lacepède, 1801)		R, P	3, 5, CPUM	CF	
FAMILY SCIAENIDAE					
Equetus punctatus (Bloch et Schneider, 1801)		"RA	5		
Odontoscion dentex (Cuvier, 1830)		R, TF	3, 5, CPUM		+
Pareques acuminatus (Bloch et Schneider, 1801)		R, TF, S, SB, AR	1, 3, 5, CPUM		
Pareques umbrosus (Jordan et Eigenmann, 1889)		"RA	5		
Umbrina coroides Cuvier, 1830		TF, S	3, 5, CPUM		
FAMILY SCOMBRIDAE					
Acanthocybium solandri (Cuvier, 1832)		P	3, 5, CPUM	SF	
Auxis rochei (Risso, 1810)		"P	3	SF	
***Euthynnus alletteratus* (Rafinesque, 1810)**	NP	P	PR	SF	
Katsuwonus pelamis (Linnaeus, 1758)		P	3, PR	SF	
Scomberomorus brasiliensis Collette, Russo et Zavala-Camin, 1978		"P	3		
Scomberomorus cavalla (Cuvier, 1829)		P	5, PR	SF	
Scomberomorus regalis (Bloch, 1793)	G	TF, P	1, 3, 5, CPUM	SF	
***Thunnus atlanticus* (Lesson, 1831)**	NP	P	PR	SF	
FAMILY SCORPAENIDAE					
Pterois volitans (Linnaeus, 1758)		R, TF, AR	3, 4, CPUM	CF	+
***Scorpaena bergii* Evermann et Marsh, 1900**	NP, GBIF	R, SB	3, CPUM		+
Scorpaena calcarata (Goode et Bean, 1882)		R	CPUM		+
Scorpaena grandicornis (Cuvier, 1829)		"RA	5		+
***Scorpaena inermis* (Cuvier, 1829)**	NP, GBIF	R	3, CPUM		+
Scorpaena plumieri (Bloch, 1789)		R, TF, AR, SB	3, 5, CPUM		+
***Scorpaenodes caribbaeus* (Meek et Hildebrand, 1928)**	NP	R	CPUM		+
FAMILY SERRANIDAE					
***Alphestes afer* (Bloch, 1793)**	NP, GBIF	R	3, CPUM		+
Cephalopholis cruentata (Lacepede, 1802)		R	3, 5, CPUM	CF	
Cephalopholis fulva (Linnaeus, 1758)		R	3, 5, CPUM	CF	
Epinephelus adscensionis (Osbeck, 1765)		"RA	5	CF	
Epinephelus guttatus (Linnaeus, 1758)		R	3, 5, CPUM	CF	
Epinephelus itajara (Lichtenstein, 1822)		R, S	5, PR	CF	
Epinephelus morio (Valenciennes, 1828)		R	5, CPUM	CF	

FAMILY and species	New records	Habitat	References and vouchers	USG	CRS
Epinephelus striatus (Bloch, 1792)		R, S	5, CPUM	CF	
***Hypoplectrus guttavarius* (Poey, 1852)**	NP, GBIF	R, S	3, CPUM		
***Hypoplectrus indigo* (Poey, 1851)**	NP, GBIF	R	3, CPUM		
***Hypoplectrus nigricans* (Poey, 1852)**	NP, GBIF	R	3, CPUM		
Hypoplectrus puella (Cuvier, 1828)		R, P	3, 5, CPUM		
***Hypoplectrus unicolor* (Walbaum, 1792)**	NP, GBIF	R	3, CPUM		
***Hyporthodus nigritus* (Holbrook, 1855)**	NP	R, TF, P	PR	CF	
Mycteroperca bonaci (Poey, 1860)		P	3, 5, CPUM	CF	
Mycteroperca interstitialis (Poey, 1860)		R, TF	3, 5, CPUM		
Mycteroperca phenax (Jordan et Swain, 1884)		"RA	5	CF	
Mycteroperca tigris (Valenciennes, 1833)		"RA	5	CF	
Mycteroperca venenosa (Linnaeus, 1758)		TF	3, 5, CPUM	CF	
Rypticus saponaceus (Bloch et Schneider, 1801)		R	3, 5, CPUM		+
***Rypticus subbifrenatus* (Gill, 1861)**	NP	R, RI, SB	CPUM		+
Serranus baldwini (Evermann et Marsh, 1899)		R, TF	5, CPUM		+
Serranus tabacarius (Cuvier, 1829)		"RA	5		
Serranus tigrinus (Bloch, 1790)		P	3, 5, CPUM		
Serranus tortugarum (Longley, 1935)		"RA	5		
FAMILY SPARIDAE					
***Archosargus rhomboidalis* (Linnaeus, 1758)**	NP, GBIF	P	3, CPUM		
Calamus bajonado (Bloch et Schneider, 1801)		P	1, 3, 5, PR	CF	
Calamus calamus (Valenciennes, 1830)		TF, S, P	3, 5, CPUM	CF	
***Calamus leucosteus* (Jordan et Gilbert, 1885)**	NP, GBIF	P	3, CPUM	CF	
Calamus penna (Valenciennes, 1830)		P	5, PR	CF	
***Calamus proridens* (Jordan et Gilbert, 1884)**	NP, GBIF	P	3, CPUM	CF	
Lagodon rhomboides (Linnaeus, 1766)		P	3, 5, CPUM		
FAMILY SPHYRAENIDAE					
Sphyraena barracuda (Edwards, 1771)		R, TF	1, 3, 5, CPUM	CF, SF	
Sphyraena borealis (DeKay, 1842)		"P	1		
FAMILY SYNGNATHIDAE					
Anarchopterus tectus (Dawson, 1978)		"D	3		+
Bryx dunckeri (Metzelaar, 1919)		"D	3		+
***Cosmocampus brachycephalus* (Poey, 1868)**	NP, GBIF	S	3, CPUM		+
Cosmocampus elucens (Poey, 1868)		"BP	3, 5		+
***Hippocampus erectus* (Perry, 1810)**	NP, GBIF	TF	3, CPUM		+
***Hippocampus reidi* (Ginsburg, 1933)**	NP, GBIF	TF	3, CPUM		+
***Hippocampus zosterae* (Jordan et Gilbert, 1882)**	NP, GBIF	TF	3, CPUM		
Syngnathus caribbaeus (Dawson, 1979)		TF	5, CPUM		+
***Syngnathus floridae* (Jordan et Gilbert, 1882)**	NP, GBIF	TF	3, CPUM		
***Syngnathus pelagicus* (Linnaeus, 1758)**	NP, G	TF, SP	CPUM		
FAMILY SYNODONTIDAE					
***Synodus intermedius* (Agassiz, 1829)**	NP, GBIF	AR	3, CPUM		+
Synodus saurus (Linnaeus, 1758)		"D	3, 5		+
Trachinocephalus myops (Forster, 1801)		"D	5		+
FAMILY TETRAODONTIDAE					
Canthigaster jamestyleri (Moura et Castro, 2002)		"RA	1		
Canthigaster rostrata (Bloch, 1786)		R	1, 3, 5, CPUM		
***Lagocephalus laevigatus* (Linnaeus, 1766)**	NP, GBIF	R	3, CPUM		
***Sphoeroides pachygaster* (Muller et Troschel, 1848)**	NP, GBIF	R, TF	3, CPUM		
Sphoeroides spengleri (Bloch, 1785)		TF	1, 3, 5, CPUM		
Sphoeroides testudineus (Linnaeus, 1758)		R, TF, S, AR, SB, P	1, 3, 5, CPUM		
FAMILY TRIPTERYGIIDAE					
***Enneanectes altivelis* (Rosenblatt, 1960)**	NP	AR	CPUM		+
***Enneanectes boehlkei* (Rosenblatt, 1960)**	NP	R	CPUM		+
***Enneanectes jordani* (Evermann et Marsh, 1899)**	NP	R	CPUM		+

USG = usage; CRS = cryptic species; **New records:** NP = new for the PNAPM, NM = new for Mexico, GBIF = new records from this study hosted by GBIF (**all new records are in bold**), G = genetic corroboration with *cox1* gene, G* = genetic corroboration with *cytb* gene. **Habitats of collected specimens:** R = coral reefs, TF = *Thalassia* beds, S = sandy bottoms, P = pelagic, AR = artificial reefs, SB = karstic-slab bottoms, RI = rocky intertidal pools, SP = Sargasso patches. FishBase habitats of species other than those collected during this study: "D = demersal, "RA = reef associated, "P = pelagic, "BP = benthopelagic. **Sources of information:** 1) Zarco-Perelló and Enríquez (2019); 2 = FishNet2, 3 = GBIF, 4 = iDigBi, 5 = SEMARNAP (2000) park management plan; CPUM = specimens deposited in the Fish Collection of Universidad Michoacana de San Nicolás de Hidalgo, PR = photographic or observed records. **Usage:** B = bait, CF = commercial fishing, LC = local consumption, SF = sport fishing. **Cryptobenthic species:** Robertson and Tornabene (2020).

Results

We sampled 2987 individuals from 57 localities. Some localities were represented by more than one habitat type, with the number of habitat sites sampled as follows: two rocky tide pools, 27 sandy bottoms, 15 *Thalassia* beds, 21 coral reefs, seven artificial reefs, 19 karstic-slab bottoms, six pelagic areas, and two benthic *Sargassum* patches (Table 1).

The checklist of "bony fishes" (=ray-finned fishes) of PMRNP compiled from the different sources comprises 349 species belonging to 17 orders, 67 families, and 169 genera (Table 2). The families representing the greatest number of species were Labridae (28), Serranidae (25), Gobidae (22), Haemulidae (17), and Carangidae (17). The genera with the highest number of species were *Haemulon* Cuvier, 1829 (13), *Lutjanus* Bloch, 1790 (9), and *Apogon* Lacepède, 1801 (7) (Table 1).

Of the 349 species in the checklist, 82% (285) were collected and deposited at the CPUM. In addition, 12 species (3%) were observed or photographed but not caught (Table 2). Records of 15% (52 species) were obtained from literature or public repositories. Of the 297 species recorded during the fieldwork, 106 were new records for the PMRNP, and seven were new records for Mexico: *Apogon robbyi* Gilbert et Tyler, 1997; *Chaenopsis roseola* Hastings et Shipp, 1981; *Chaenopsis* cf *limbaughi* Robins et Randall, 1965; *Tomicodon cryptus* Williams et Tyler, 2003; *Tomicodon lavettsmithi* Williams et Tyler, 2003; *Elacatinus colini* Randall et Lobel, 2009; and *Lythrypnus okapia* Robins et Böhlke, 1964. The identification of 12 newly reported species and eight previously reported species were corroborated genetically (Table 2). All species showed > 99% statistically significant matches in comparing the target sequences with a sequence in public repositories, except *Chaenopsis* cf *limbaughi*, which showed a similarity of 94%.

Of the 297 collected and photographed species, 159 were recorded from a single habitat type, with 56 (19%) found only on coral reefs, 39 (13%) in the pelagic zone, 30 (10%) in *Thalassia* beds, 19 (6%) in sandy bottoms, 9 (3%) in rocky intertidal pools, three (1%) in karstic-slab bottoms and three (1%) in artificial reefs. In addition, 138 (47%) species were collected in more than one habitat type (Table 1 and Fig. 2).

The 349 species found in PMRNP correspond to 35% of all the reef-associated ichthyofauna reported for the Great Caribbean (992 species; see Robertson and Tornabene 2020). Of this, 15.7% represent pelagic species. Of the 84.3% non-pelagic species, 58.5% are demersal species, 39.1% are benthic, 38.4 cryptobenthic, and 26.8% are core reef species. Only one—*Lutjanus vivanus* (Cuvier, 1828)—is considered a deep-reef species (Tables 3, 4)

The fishery catches included 70 species, of which 12 are used as bait, 39 are captured for commercial sale, ten are used for local consumption, and ten species from sport fishers. Serranidae (12), Lutjanidae (10), and Scombridae (7) were the families with the highest number of species used in fisheries (Fig. 3 and Table 2).

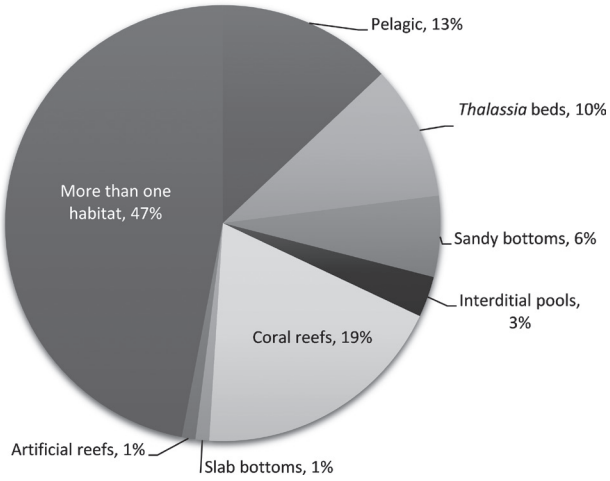

Figure 2. Percentage of habitat type from which the fish species were captured at Puerto Morelos Reef National Park in Quintana Roo State, Mexico.

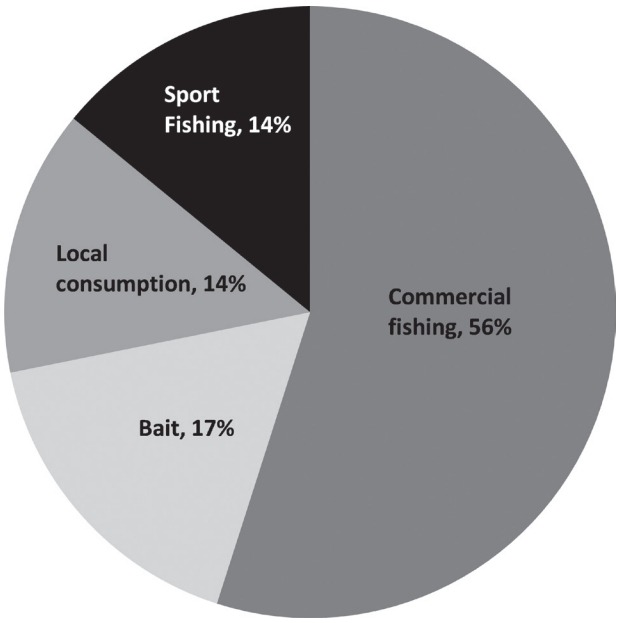

Figure 3. Percentage of human usage of the 70 species of fish caught in Puerto Morelos National Park in Quintana Roo State, Mexico, according to the Cooperative Society of Fisheries Production of Puerto Morelos.

Discussion

The present checklist represents the first comprehensive systematic list of fishes recorded from Puerto Morelos Reef National Park, with 349 species included, 285 of which are represented by voucher organisms that have been included in a registered ichthyological collection and from which tissue samples for genetic analyses also are in that collection (e.g., CPUM). Of the 297 captured or photographed species, 114 (39%) represent new records for PMRNP or for Mexico. Although 82 of those 114 new records can be found in the database of the aggregator GBIF, those records are for specimens collected as a part of presently reported study and deposited in the CPUM.

Table 3. Relative abundance of different types of shallow and deep reef-associated fishes in the Great Caribbean region (GCR), at Puerto Morelos Reef National Park (PMRNP), and at six sites scattered throughout the GCR.

Parameter	GCR	PMRNP	Alligator	Bermuda	St. Croix	Roatan	Statia	Curacao
Species (*n*)	992	349	482	353	493	481	341	529
Pelagics (*n*)	78	55	53	44	51	42	34	50
Pelagic species [% of fauna]	8.0	**15.7**	11.0	12.5	10.3	8.7	10.0	9.5
Non-pelagic species [% of fauna]	92.0	84.3	89.0	87.5	89.7	91.3	90.0	90.5
Demersal species [%]	34.6	**58.5**	49.2	54.7	45.0	44.0	56.4	44.7
Benthic [%]	65.4	39.1[PL]	50.8	45.3	55.0	56.0	43.6	55.3
Cryptobenthic species [%]	64.6	38.4[PL]	49.9	43.7	54.3	55.6	43.0	54.7
Core CRF species [%]	45.9	26.8[PL]	27.7	19.1	35.7	39.0	30.0	35.7
Shallow non-pelagics (*n*)	772	293	407	284	424	393	266	401
Percent of fauna	84.6	99.6	94.9	91.9	95.9	89.6	86.7	83.7
Demersal species [%]	34.9	**58.7**	48.2	53.9	43.9	44.5	56.8	45.6
Benthic species [%]	65.1	39.2[PL]	51.8	46.1	55.9	55.5	43.2	54.4
Cryptobenthic species [%]	64.0	38.5[PL]	50.9	44.7	55.2	54.7	42.4	53.6
Core CRF species [%]	46.0	26.9	29.2	20.4	37.3	29.2	20.4	37.3
Deep non-pelagics (*n*)	141	1.0[PL]	22	25	18	46	41	78
Deep non-pelagics [% of fauna]	14.2	0.3	4.6	7.1	3.7	9.6	12.0	14.7

n = number; **bold** numbers indicate percentage values substantially higher than the corresponding values for the region. [PL] indicate percentage values substantially lower than the corresponding values for the region.

Table 4. Comparison between pelagic and non-pelagic species in six well-studied GC and PMRNP sites.

Site	Shallow non-pelagics	Deep non-pelagics	Pelagics
PMRNP	293	1	55
Bermuda	284	25	44
Alligator	407	22	53
Roatan	393	46	42
St Croix	424	18	51
Statia	266	41	34
Curacao	401	78	50

The high proportion of new records is likely related to the lack of systematic inventory surveys made in this and other marine protected areas of the Mexican Caribbean (Álvarez-Cadena et al. 2007; Zarco-Perelló and Enríquez 2019). Also, the checklist presented in the management plan of PMRNP is based in one bibliographic record from all the Mexican ichthyofauna (Espinosa-Pérez et al. 1993), and one prospective study made in *Thalassia* beds (Álvarez-Guillén et al. 1986).

The seven new records for Mexico obtained are: *Apogon robbyi*, known from the western Caribbean and Florida; *Chaenopsis roseola*, known from the west Florida shelf; *Chaenopsis* cf *limbaughi*, reported from the Caribbean and Bahamas; *Tomicodon cryptus*, reported from some Antilles islands; *T. lavettsmithi*, previously known only from Belize; *Elacatinus colini*, reported from Belize and Honduras; and *Lythrypnus okapia*, reported from the northern Caribbean and Bahamas. Of these new records, the identifications of *Chaenopsis* cf *limbaughi*, *Tomicodon cryptus*, *T. lavettsmithi*, and *Elacatinus colini* were corroborated by comparison of their mtDNA sequences with those in GenBank using BLAST (http://www.ncbi.nlm.nih.gov/genbank) and by Boldsystems (http://www.boldsystems.org).

The most common habitat types in the national park are coral reefs, *Thalassia* beds, and soft bottoms (Fig. 4). While 169 of the 297 collected or photographed species were found in coral reefs (57%), *Thalassia* fields (119) and sandy bottoms (87) accounted for 40% and 29%, respectively. The seven new records for Mexico and 51 of the 106 (48%) new records to PMRNP are cryptobenthic species. The above mentioned 106 species represent 20.8% of the cryptobenthic reef fishes (588) known from the Great Caribbean (Robertson and Tornabene 2020). This is a relatively low percentage, considering that 59.2% of fishes in the Great Caribbean Region, between 43% and 54.3% in Dutch Caribbean islands, 55.6% in Roatan, and 49.9% in Alligator Reef, Florida, are cryptobenthic forms (Robertson et al. 2020, 2022). We also found that the percentage of benthic, cryptobenthic, and deep-reef species are underrepresented in PMRNP compared to other locations in the Great Caribbean (Tables 3, 4). This indicates that most of the existing inventory efforts in PMRNP have been aimed at conspicuous shallow, demersal coral reef fishes. In our comparison, we also found that the percentage of demersal and pelagic species in PMRNP is higher than in other sites. Including local fishery species in PMRNP inventory could contribute to that pattern. PMRNP has the highest absolute abundance of such species of any sites listed in Table 3.

Our results highlight the need for future inventory efforts to focus more intensely on the cryptic component. The increase in the diversity of cryptic species in PMRNP recorded during the presently reported study is strongly

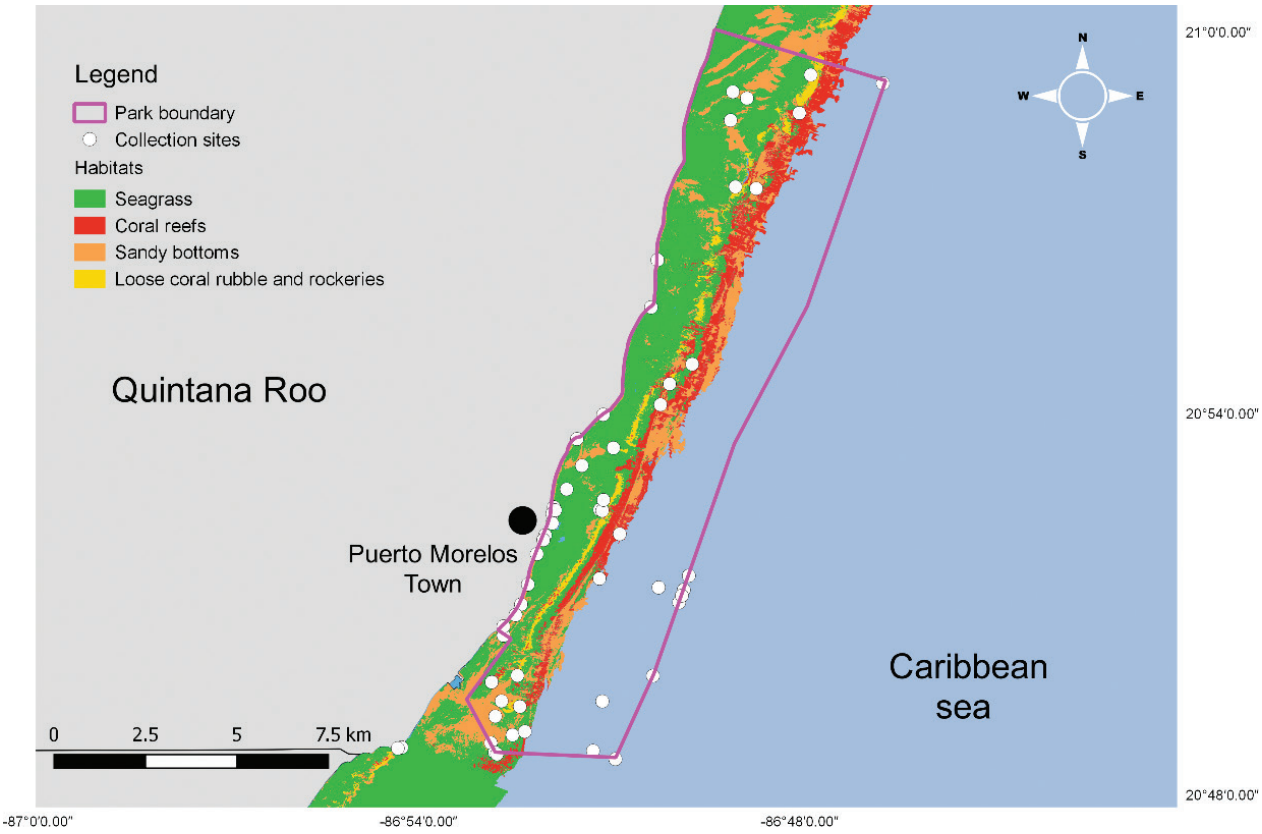

Figure 4. Distribution of four major habitat types within Puerto Morelos Reef National Park in Quintana Roo State, Mexico. White dots indicate the collection sites.

related to using anesthetic collections, often lacking in inventory studies (e.g., Robertson et al. 2020). Previous studies conducted in PMRNP were based on visual censuses, photo identification, and video transects (Arias-González et al. 2008; Zarco-Perelló and Enríquez 2019). However, collections are needed to provide reference organisms for taxonomic corroboration, biological or ecological studies. In addition, obtaining tissue samples for molecular work of voucher specimens can be used for future evolutionary or integrative systematic and taxonomic studies. Also, many small, nocturnal, or visually cryptic species are unlikely to be counted in a visual census, particularly in regions with large areas with highly complex habitat structures, as is the case with coral reefs in PMRNP (SEMARNAP 2000).

Currently, only one deep-reef species is known from the PMRNP, a meager number compared to other localities. However, although deep areas with benthic habitats occupy only a tiny percentage of the park, no sampling has been specifically directed at assessing what demersal and benthic fish species occur there. Even the few of hectares of deep habitat in the park's southeast corner could contain a substantial number of deep-reef species depending on what habitat types are present.

In artisanal fishing, the species local fishermen consider to have the highest economic value is the invasive red lionfish, *Pterois volitans* (Linnaeus, 1758), followed by the groupers and snappers (Serranidae and Lutjanidae), all top predators. In addition, large numbers of individuals of the family Clupeidae are caught to be used as bait (Table 2) in an unregulated fishery. Since those species are also an important food source to fish predators, the effects of this activity on the park ecosystem need to be examined. Finally, tourism is the most important commercial activity involving the PMRNP fish, including sport fishing and diving.

Our work reported 106 new species records for Puerto Morelos Reef National Park (PMRNP) and seven new species records for Mexico, this being a complete ray-finned fish fauna checklist previously available for the area by 48% (SEMARNAP 2000), highlighting the need for future inventory efforts in marine ichthyofauna in Mexican Caribbean, mainly focused in cryptobenthic and deep-reef species. Our results also should provide important input for decisions about the conservation and management of the coastal area of northern Quintana Roo, such as the conservation of less charismatic species and areas, such as cryptobenthic species or sites such as *Thalassia* seagrass fields or rocky intertidal areas.

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