Estuarine Fish Feeding Changes as Indicator to Mangrove Restoration Success in Seasonal Karstic Wetlands

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The loss of mangrove areas due to anthropogenic activities has triggered efforts to recover or restore these ecosystems, their functions, and associated diversity. Such functions include nursery areas and energy flow through trophic relationships for a large variety of inhabitant species (e.g., fish). The food webs and trophic dynamics of estuarine fish provide important information on the food resources in mangrove ecosystems and their response to restoration processes. Nonetheless, few studies focus on using fish feeding characteristics as an approximation to assess the conservation or recovery status of these aquatic ecosystems. Thus, the aim of the present study was to compare the trophic dynamics of an ichthyic community in a mangrove ecosystem related to karstic wetlands in the Mexican–Caribbean using freshwater, estuarine, and marine fish species as bioindicators of the restoration process in mangroves. Stomach contents were analyzed for eight species of fish inhabiting specific mangrove zones (1—conserved zone, and 2—restored zone; a zone exposed to ecological restoration processes due to impacts of anthropic activities) related to karstic wetlands in the Mexican–Caribbean. Four feeding characteristics were considered: trophic guild, trophic level, feeding strategy, and prey abundance. Results showed differences and changes in the use of food sources at the trophic level mainly for *Floridichthys polyommus*, changing from a secondary consumer in the conserved zones to a primary consumer in the restored zones. This suggests that the feeding characteristics of the inhabiting fish are related to the mangrove's conservation/restoration status and the trophic dynamics in the community. The results of this study are relevant as a tool for mangrove restoration plans regarding the analysis of fish and their food prey, in order to perform an easy and rapid assessment to determine the conservation/restoration status of these aquatic ecosystems from a functional perspective.

Keywords: trophic ecology, mangrove restoration, estuarine fish, feeding strategy, trophic guilds, zoobenthivores

INTRODUCTION

Worldwide, mangroves are coastal ecosystems that are distributed in tropical and subtropical zones; they provide many ecosystem services such as water filtration, carbon storage, and coastline maintenance as a buffer to the impact of hurricanes and tides (Nagelkerken et al., 2008; Twilley and Day, 2013). Also, a high primary productivity and complex arrangement of submerged and aerial roots (neumatophores) form a refuge and feeding habitat for many species of fish at different life cycle stages (Blaber, 2000; Laegdsgaar and Johnson, 2001). Even when the ecological relevance of mangrove areas is acknowledged, these ecosystems are the most threatened by anthropic activities (Twilley and Day, 2013; Hamilton and Casey, 2016).

The accelerated reduction in mangrove areas has led to the implementation of different conservation and restoration efforts, with the objective of maintaining ecosystem functions at the local, regional, and global scale (FAO, 2007). Mainly, mangrove restoration activities are based on recovering hydrologic processes and substrate retention through reforestation. Therefore, the ecosystem restoration indicators have focused on hydrology and vegetation structure (McAlpine et al., 2016). However, the biotic interactions that include vertebrates (e.g., fish and birds), invertebrates (e.g., crustaceans and insects), primary producers (e.g., algae and plants), and food webs reflect the restoration progress of ecosystem functions in less time (Bosire et al., 2008).

Fishes serve as bioindicators of the mangrove restoration process, as its narrow relationship with the roots in this habitat (used as refuge, feeding, and reproduction areas) and high recovery rate of species after the restoration process (Laegdsgaar and Johnson, 2001; Nagelkerken et al., 2008; Vaslet et al., 2015). It is estimated that the mangrove fish community in restored mangroves is similar to that of conservation zones in nearly 5 years (Bosire et al., 2008). In addition, mangrove ecosystems are an important source of structure food webs due to the connections with adjacent aquatic systems, such as coral reefs (Nagelkerken et al., 2000; Mumby, 2006) and terrestrial ecosystems, which increase the availability of prey for larger vertebrates such as birds and reptiles (Trexler and Goss, 2009; De Dios Arcos et al., 2019).

Different aspects of the ichthyic community have been assessed in relation to restoration processes, primarily those considering the structure and composition of species (e.g., Trexler and Goss, 2009; Arceo-Carranza et al., 2016; Enchelmaier et al., 2020; Soria-Barreto et al., 2021). Nonetheless, these results only reflect the importance of mangrove ecosystems as refuge (Kovalenko et al., 2019; Le Guen et al., 2019). Recently, the importance in including the trophic interactions among fish and its preys has been proposed as an indirect tool useful to assess the conservation and restoration status of mangrove ecosystems, because of its high connectivity to terrestrial and marine environments and process related to the maintenance of biodiversity and functions at different scales (Palmer et al., 1997; Vander Zanden et al., 2016; Hale et al., 2019; Loch et al., 2020).

Classifying species by functional groups or guilds provides a more detailed perspective of the biotic and abiotic responses related to species ecological relationship, organism–environment responses, incorporating characteristics driving interactions and exploitation of available resources in the ecosystem, and how these influence processes and functions (Elliott et al., 2007; Violle et al., 2007). Also, it can reveal other mechanisms that promote diversity such as the response of communities to environmental changes (i.e., predator–prey relationships), prey preferences, and prey abundance (Kovalenko et al., 2019).

Habitat modification promotes changes in the trophic structure of aquatic ecosystem and modifies the prey diversity availability for the ichthyofauna (Bernardino et al., 2018). Therefore, the feeding habits are modified in order to exploit the available resources in the environment (Elliott et al., 2007; Vander Zanden et al., 2016). In relation to the seasonal dynamics, the ecotone that represents the mangrove ecosystems harbors high functional diversity such as opportunistic species related to a large trophic plasticity, others related to changes in environmental conditions, and in most cases high richness of species with specialized diets, which in most cases migrate to higher, richer, prey-conserved zones. Regarding the aforementioned, the study and comparison of changes in fish diets between recovering zones through restoration processes are relevant in order to assess the status and success of restoration plans and techniques. Therefore, the aim of the present study was to compare the trophic dynamics of eight fish species that inhabit a mangrove ecosystem related to karstic wetlands in the Mexican–Caribbean using freshwater, estuarine, and marine fish species as bioindicators of the restoration process in aquatic environments.
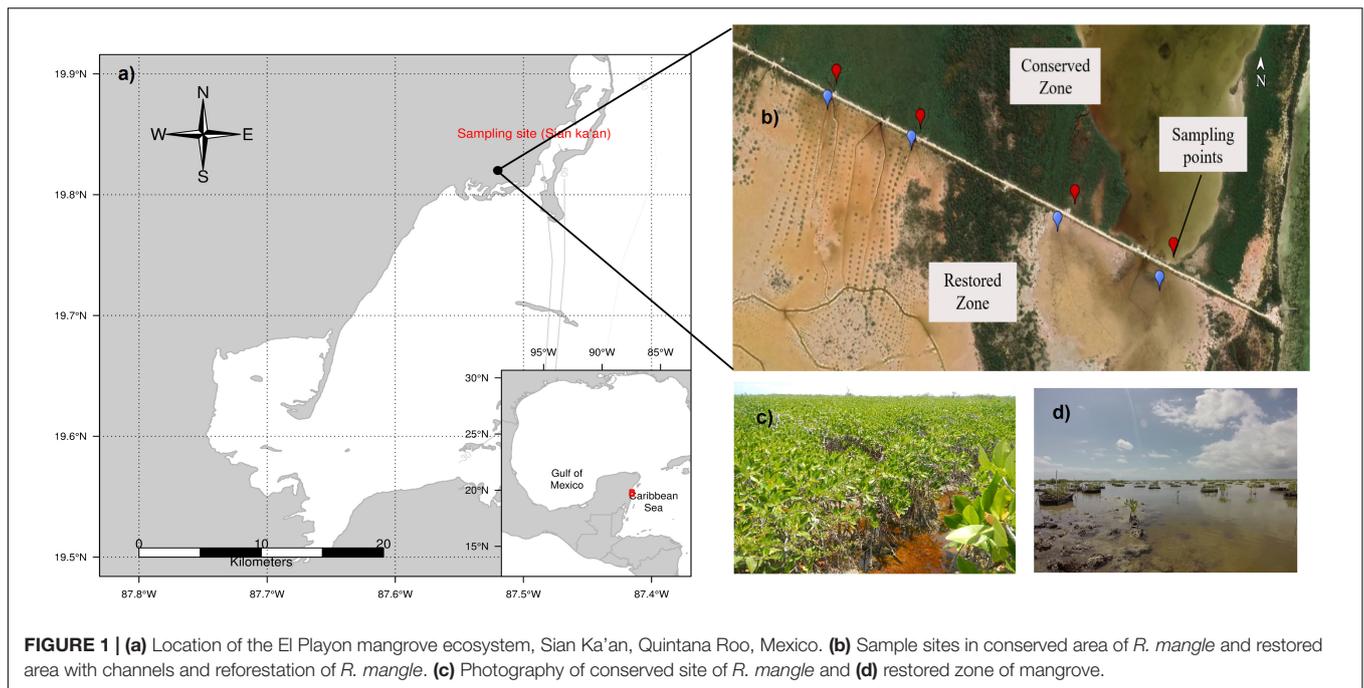
MATERIALS AND METHODS

Study Area

The Sian Ka'an Biosphere Reserve is located in the State of Quintana Roo, Mexico, at the western region of the Caribbean Sea. Even when this area is decreed as Natural Reserve, it has been significantly modified by anthropic activities (e.g., mangrove deforestation, cattle establishment, water flow modification, etc.). The zone known as "El Playón" in the eastern zone of the reserve (19°49′12.16″ N, 87°29′29.22″ W) remains with a vegetation composed mainly of red mangrove (*Rhizophora mangle*); the zone presents fragmentation due to a road construction, which altered the vegetation cover, hydrologic flow, and connectivity, particularly for the southern portion of this zone.

Since 2009, the southern zone has been under restoration process (now referred as "restored" zone) in its hydrology and forestry through the construction of culverts, desilting channels, and reforestation of *R. mangle*. In contrast, the northern zone presents a high density of *R. mangle* trees, and its hydrology does not present any alteration related to its structure (Herrera-Silveira et al., 2014). This zone was considered as a reference zone (now referred as "conserved" zone) (**Figure 1**).

This area presents three climatic seasons influenced by regional precipitation: rainy, dry, and cold fronts, regionally known as "nortes"; a saline gradient also is reported in relation to the influence of the freshwater entry due to

FIGURE 1 | (a) Location of the El Playon mangrove ecosystem, Sian Ka'an, Quintana Roo, Mexico. **(b)** Sample sites in conserved area of *R. mangle* and restored area with channels and reforestation of *R. mangle*. **(c)** Photography of conserved site of *R. mangle* and **(d)** restored zone of mangrove.

groundwater upwellings (Herrera-Silveira et al., 2015); the salinity of superficial water presents a variation of 7 to 37 ppm in the southern zone and 3 to 33 ppm in the northern zone; both areas presented a gradient having lower salinity values in the intern zone; the water level varies from 0.30 m in the dry season to 0.75 m in the rainy season in both areas. The temperature of water oscillate was from 24 to 34°C in conserved zone and from 24 to 36°C in restored zone. The higher temperatures are recording in dry season, whereas the lower temperature is related to "nortes" season. Turbidity is higher in the restored area, with many dissolved solids; on the contrary, the conserved area presents crystal clear waters with total transparency (Hernández-Mendoza, 2020).

Fish Sampling

Considering an annual cycle, six bimonthly collections were done from August 2017 to May 2018 at four sampling points near the culverts (2–5 m from the shore) within each zone (conserved and restored; **Figure 1**). Fish were collected in each sampling point using a cast net (two throws; 0.70-m radius and a mesh size of 1 cm). The collected fish were placed in thermal boxes at 4°C and further fixed using formaldehyde at 4%.

Laboratory and Statistical Analysis

To ecologically characterize the species of fish that feed in the mangrove, fish were identified to species level and classified according to their salinity tolerance (marine, freshwater, and estuarine fish) and ontogenic phases such as juveniles and adults, depending on its length at first sexual maturity (**Table 1**) regarding the specialized literature (Schmitter-Soto, 1998; Castro-Aguirre et al., 1999; FAO, 2002; Miller, 2009; Froese and Pauly, 2019). Based on the presence of fish in the

conserved and restored mangrove zones, a diet analysis was done through stomach content analysis (**Table 2**) for marine (*Atherinomorus stipes*, *Eucinostomus gula*, *Gerres cinereus*, *Lutjanus griseus*, and *Sphoeroides testudineus*), estuarine (*Gambusia yucatana* and *Floridichthys polyommus*), and freshwater species (*Mayaheros urophthalmus*).

A total of 274 stomachs of the fishes collected in the mangrove zone were dissected using a stereo-microscope zoom 20 × (Nikon C-LEDS SMZ445). The entire digestive tract from the esophagus to the anus for each individual was examined. The prey species were separated and identified up to the lowest possible taxa. All identified prey items were counted and weighed (in grams). Prey items were grouped in 11 prey categories: macrocrustaceans, macrophytes (remains of terrestrial vegetation) macroalgae, insects, detritus, polychaetes, fish, mollusks, zooplankton (zoeae, decapods, and copepods), and others (foraminifera). In order to obtain the main preys included in the diet, the percentage of the prey-specific index of relative importance (PSIRI%) was used (Brown et al., 2012).

$$\%\text{PSIRI}i = \frac{\%\text{FO}i \times (\%\text{PN}i + \%\text{PW}i)}{2}$$

where % FO is frequency of occurrence *i*; % PN, numeric proportion *i*; % PW, weight proportion *i*.

To identify differences between fish species diet, an analysis of similarities (ANOSIM) was performed using "site" as a factor. In addition, an analysis of similarity percentage (SIMPER) was used to identify the preys that mostly contributed to differences in the diet. Analyses were done using the statistical software PRIMER 7.0 for Windows (PRIMER Ltd., Plymouth, United Kingdom).

Three ecological aspects related to fish feeding were evaluated: (1) trophic guild, (2) feeding strategy (specialist or generalist),

TABLE 1 | Abundance, size range (min–max), and juvenile use of mangrove site (first maturity size) of fish species in mangrove areas.

Species	Abundance		Size range (cm)		Estuarine use	First maturity size (cm)	Life stage	
	C	**R**	**C**	**R**			**C**	**R**
Atherinomorus stipes	255	20	1.9/4.32	2.18/3.95	M	6.4	J	J
Eucinostomus gula	34	27	2.44/6.13	2.7/7.46	M	11	J	J
Floridichthys polyommus	18	258	1.61/5.48	3.1/9.4	Est	4.22	J-A	J-A
Gambusia yucatana	207	397	1.17/11.61	1.05/3.46	Est	NI	NI	NI
Gerres cinereus	32	113	1.8/11.6	2.15/12.5	M	16.5	J	J
Lutjanus griseus	7	7	2.53/10.3	6.89/10.16	M	18	J	J
Mayaheros urophthalmus	6	21	5.7/8.57	3.22/12.3	F	12	J	J, A
Sphoeroides testudineus	7	28	1.0/11.6	9.1/14.02	M	10.8	J-A	J-A

C, conserved; R, restored; M, marine; estuarine (E); F, freshwater; J, juveniles; A, adults; NI, no information.

and (3) trophic level. Following Elliott et al. (2007), the guilds were classified in detritivores, omnivores, zooplanktivorous, and zoobenthivores and analyzed through a cluster analysis using the average linkage method by similarity matrices based on Bray–Curtis distances. Based on the %PSIRI values obtained from the analyses of feeding groups. Similarity profile analysis was performed to identify true groups with an α level of 0.05. The feeding strategy was determined through the graphic method by Costello (1990) modified by Amundsen et al. (1996). The trophic level was calculated starting from the percentage weight of the prey for each species using the software TrophLab (Pauly et al., 2000).

RESULTS

Diet Composition

The diet regarding the marine species in its juvenile stage, *A. stipes* fed primarily on decapod larvae and copepods, with no significant differences in its diet between zones (ANOSIM $R = 0.119$, $p = 0.08$). The feeding of the mojarras *E. gula* was based on microcrustaceans and insects in both zones (ANOSIM $R = 0.13$, $p = 0.06$), whereas *G. cinereus* fed on microcrustaceans and mollusks (ANOSIM $R = -0.05$, $p = 0.82$); none of the two species presented differences between the conserved and restored zones. Snappers (*L. griseus*) preferred and consumed microcrustaceans and fish in both sites with no significant differences (ANOSIM $R = -0.132$, $p = 0.97$). *S. testudineus* showed differences in its diet between the conserved and restored zone ($R = 0.335$, $p = 0.001$). However, the main prey consumed in both zones was mollusks. The SIMPER analysis showed a dissimilarity of 66.53%, highlighting that microcrustaceans and mollusks contributed with more of the 50% in the total diet.

The estuarine species present in the restored zone and the conserved zones were as follows: *G. yucatana*, which fed mostly on insects and microphytas (ANOSIM $R = -0.018$, $p = 0.62$); *F. polyommus*, showed changes in its diet between zones (**Figure 2**), since it predominantly consumed detritus and macrophytes in the restored zone. By the other hand, in the conserved zone this species fed mainly on microcrustaceans (ANOSIM $R = 0.65$, $p = 0.001$) in comparison to the restored zone. The SIMPER analysis showed a dissimilarity of 88.14% in

the diet between zones, detritus, and macrophytes contributed with 66.87% of the total diet. Finally, the only freshwater species recorded was *M. urophthalmus* and showed no statistical differences in the diet in both zones (ANOSIM $R = -0.014$, $p = 0.5$), which was dominated by smaller fish, macrophytes, and mollusks in both zones.

Guilds and Trophic Levels

In accordance with the diet analysis, four trophic guilds were identified: planktivores (PV), detritivores (Dv), omnivores (Ov), and zoobenthivores (Zb) (**Figure 3** and **Table 2**). The trophic level values for the fish species in the restored zone ranged from 2.02 for *F. polyommus* to 3.58 for *L. griseus*, whereas for the conserved zone, the minimum value obtained was 2.77 in *G. yucatana*, and the maximum was 3.54 for *L. griseus*. The species with the higher trophic level were characterized according to their consumption of fish and macrocrustaceans (**Figure 4**). No changes were registered either in the guilds or trophic levels in the majority of the species recorded between the conserved and restored mangrove zones. Only *F. polyommus* showed a difference in guild and trophic level, changing from detritivore and a level of 2.02 in the restored zone to a zoobenthivore and level 3.24 in the conserved zone (**Table 2** and **Figure 4**). According to the feeding strategies, only two species were characterized as specialists, as a result of the low variation in the preys consumed. *Atherinomorus stipes* consumed from only three different food groups in both zones, and *F. polyommus* in the restored zone only consumed detritus and macrophytes (**Table 2**).

DISCUSSION

Changes in fish diet are highly related to the richness and abundance of the prey species at a spatial and temporal scale (Hinojosa-Garro et al., 2013). This is also related to environmental seasonal changes and by anthropic activities, where a majority of fish present opportunistic behavior in order to take advantage of peaks in prey abundance (Demopoulos and Smith, 2010). Mangrove deforestation may be due to changes in hydrologic patterns that affect the ecosystem, altering the diversity, biotic interactions, and trophic webs (Shinnaka et al., 2007). Trophic webs connect the resources of the ecosystem with

TABLE 2 | Relative importance of the preys, trophic guild, trophic level, feeding strategy, and number of stomach analyzed of the fish species in restored and conserved mangroves.

| Prey	A. stipes		E. gula		F. polyommus		G. yucatana		G. cinereus		L. griseus		M. urophthalmus		S. testudineus	
	C	R	C	R	C	R	C	R	C	R	C	R	C	R	C	R
Detritus	0	0	0	0	22.50	54.19	0	0	0	0	0	0	0	0	0	0
Insect	0	1.39	35.49	12.63	26.24	<0.01	48.67	56.65	6.22	1.02	0.37	0	1.90	8.78	0	0
Macro-crustaceans	13.79	26.0	0.30	0.193	0	45.60	31.62	0	0.05	0.01	30.23	10.53	21.52	12.76	22.70	23.69
Macrophytes	0	0	1.80	1.61	1.11	0.104	1.523	22.54	1.334	1.196	4.415	0.666	23.50	21.90	6.03	18.79
Micro-crustaceans	17.37	3.88	62.32	82.80	48.23	0.037	5.927	5.143	76.65	82.29	31.35	66.77	3.309	12.18	46.52	50.109
Mollusk	0	0	0	0	1.12	0.005	0.517	0	12.93	6.084	0.324	3.328	24.360	11.159	20.126	0.213
Others	0	0	0.077	0.311	0.78	0.005	8.854	0.391	0.050	0.053	0	3.414	0	0	1.255	0.04
Fish	0	0	0	0	0	0	0	6.109	0	0	33.29	15.28	24.65	30.94	0	6.52
Zooplankton	68.82	68.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	0	0	0	2.43	0	0	2.88	9.16	2.73	9.34	0	0	0.73	2.26	3.35	0.62
Trophic guild	Pv	Pv	Zb	Zb	Zb*	Dv*	Ov	Ov	Zb	Zb	Zb	Zb	Ov	Ov	Zb	Zb
Trophic level	3.13	3.11	3.28	3.27	3.05*	2.02*	2.77	2.89	3.28	3.25	3.54	3.58	3.4	3.44	3.24	3.18
Feeding strategy	S	S	G	G	G	S	G	G	G	G	G	G	G	G	G	G
Stomach analyzed (n)	20	20	20	20	18	20	20	20	20	20	7	7	6	21	7	28

*Significantly different. C, conserved zone; R, restored zone; Pv, planktivore; Zb, zoobenthivore; Dv, detritivore; Ov, omnivore; S, specialist; G, generalist.

the inhabiting organisms, and through its study, which provide a holistic vision on the state of the ecosystem as compared with information that results only from species richness and abundance (Villéger et al., 2010; Thompson et al., 2012; Ellis and Bell, 2013; Vander Zanden et al., 2016). In the species analyzed in this study, there were interspecific differences identified in the diets, and most of these species fed on zoobenthic organisms, a trophic guild largely reported in marine and estuarine fish within mangrove ecosystems and favored because of high secondary productivity (Elliott et al., 2007; Arceo-Carranza et al., 2013; Dolbeth et al., 2013; Palacios-Sánchez et al., 2019).

Most of the fish inhabiting these estuarine environments are characterized as having generalist-type diets that are flexible in taking advantage of temporal peaks in prey abundance, such that the diet in these estuarine species reflects the variety and type of available resources in its environment (Livingston, 1984; Elliott et al., 2007). This was found in the fish diets from the Sian Ka'an zone, primarily in *F. polyommus*, a species registering a shift in its diet and taking advantage of the abundance of microcrustaceans such as amphipods and tanaidaceans. This shift in diet suggests an altered state in the environment caused by anthropic activities, in this case, the road interrupting the hydrologic flow and decreasing the vegetation cover related to mangroves, and microhabitats for fish prey existing in the restored zone.

Many of estuarine and marine species using the estuaries in early phases of development are considered generalist. This is found to be related with the ontogenetic development and change in the morphoanatomical characteristics of fish, which allows them to shift from one food source to another, functioning like opportunistic species that exploit the available resources found in the surroundings, making them capable of responding to biotic and abiotic changes, either in a disturbed zone with less diversity in prey, or in a conserved zone that present higher numbers in potential prey (Wooton, 1990; Bellwood et al., 2006). This trophic flexibility is common in estuarine fish, with species temporally exploiting the peaks in prey abundance that exist, however, when there are disturbances that alter the trophic webs and lower the trophic levels; some fish respond by consuming prey at lower trophic levels, such as *F. polyommus* that is secondary consumer (Poot Salazar et al., 2005) in the conserved zone (feeding zoobenthos), and primary consumer in the restored zone feeding on detritus and phytobenthos. Contrarily, for a marine fish such as *L. griseus*, a species associated with mangroves in their juvenile phase, feed on microcrustaceans, and upon migrating to the reef zones, the food source is based on macrocrustaceans and fish, additionally increasing its trophic level (Faunce and Serafy, 2008). Similarly, *S. testudineus* can change its diet according to the available resources, between microcrustaceans and mollusks (Palacios-Sánchez and Vega-Cendejas, 2010; Chi-Espinola and Vega-Cendejas, 2013), but they remain at the same trophic level and zoobentophagous guild.

Nonetheless, there are species that have one food guild, and one type of prey, better adapted to a specialist strategy, such as the juveniles of *A. stipes*, with a diet based on the consumption of zoeas larvae, of decapods and copepods (Vaslet et al., 2015).
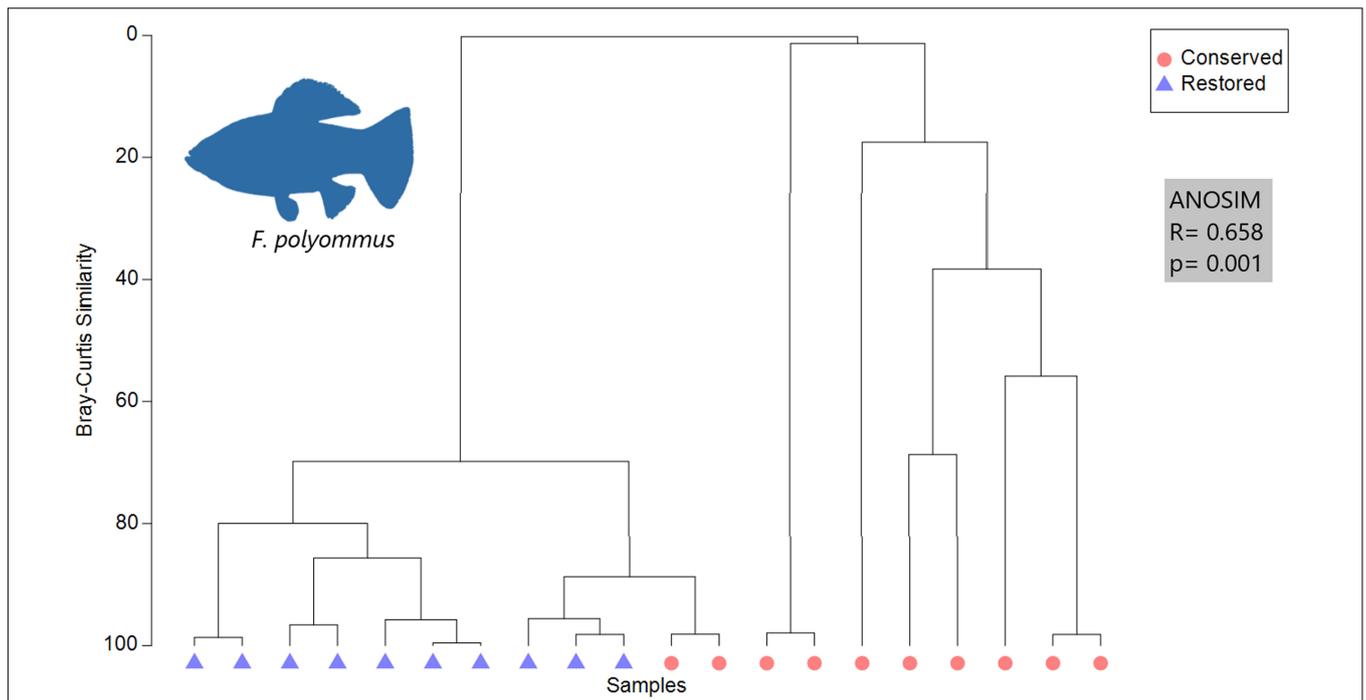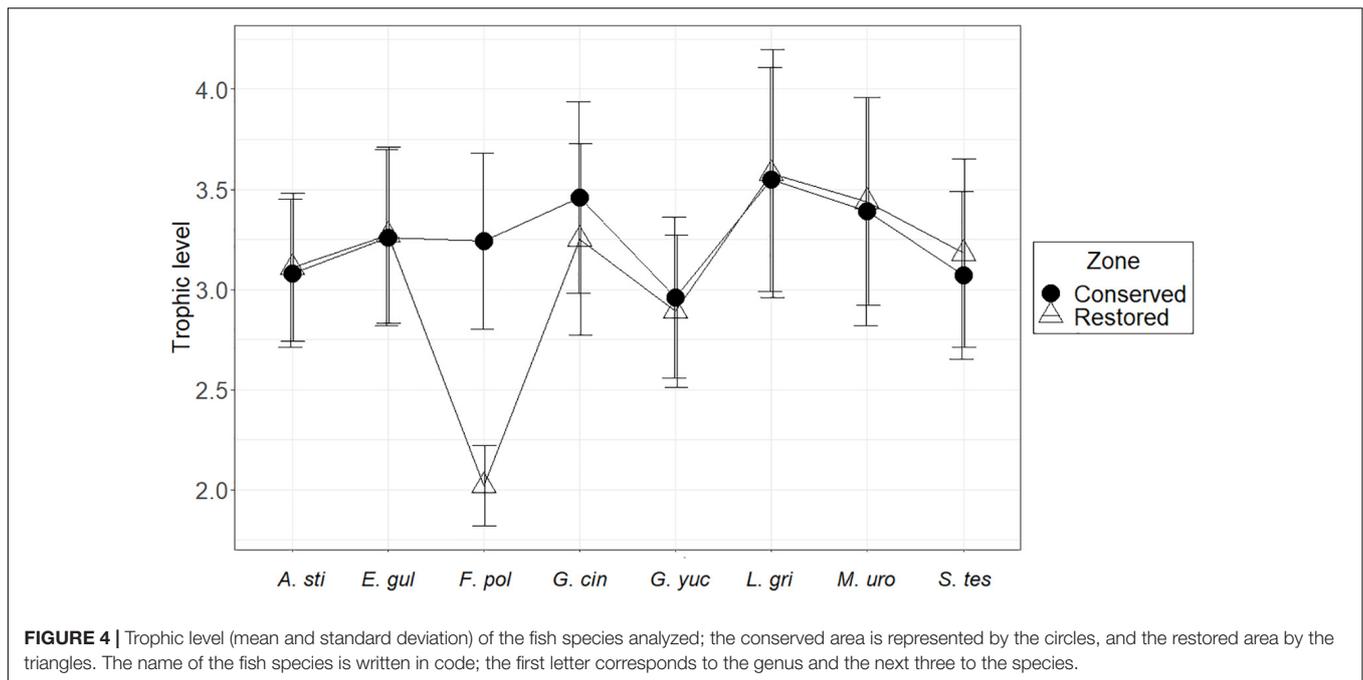
FIGURE 2 | Cluster analysis of *F. polyommus* showing the similarity of the preys in conserved and restored mangrove zones, and the results of the ANOSIM analysis.
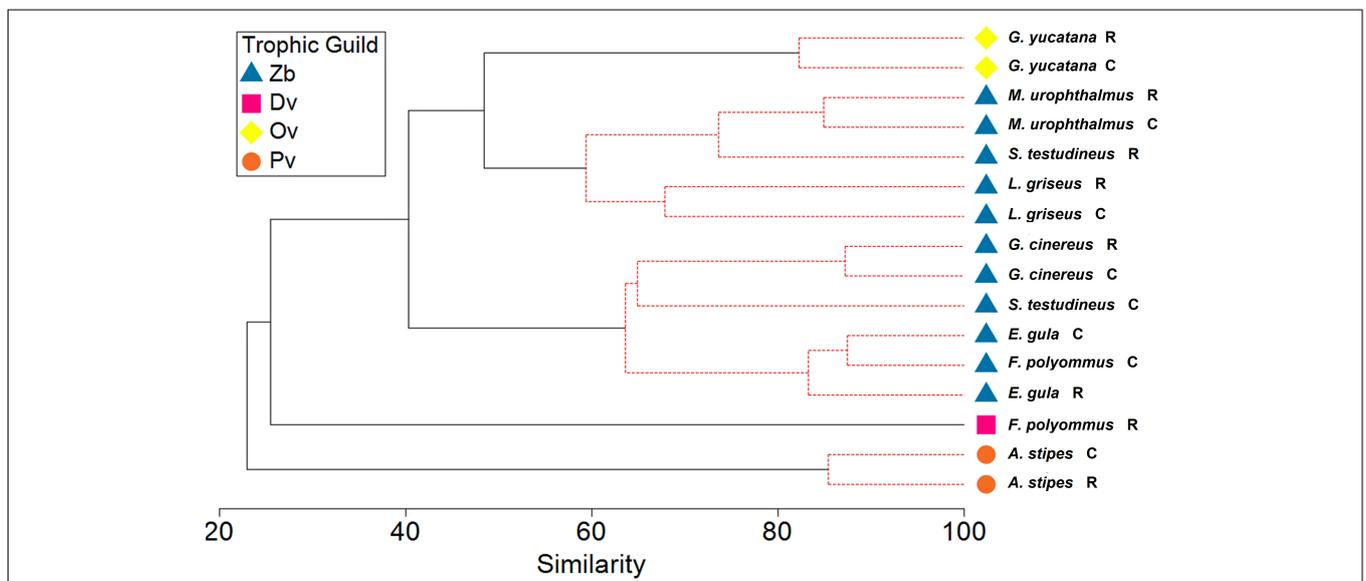
FIGURE 3 | Cluster analysis showing the groups by trophic guilds of the fish species. Pv, planktivores; Dv, detritivores; Ov, omnivores; Zb, zoobenthivores; C, conserved; R, restored.

Atherinomorus stipes is related with mangrove areas in the Mexican–Caribbean; notwithstanding, its presence is limited by ecosystem alterations, more so, if there is an increase in turbidity of the water, limiting foraging and hindering its encounter with preferred prey (Nash et al., 2017). This high turbidity in water observed for the restored zone probably explains the low abundance of this specie.

The sharing of food resources reduces competition between fish; however, in estuarine environments, many species share from a pool of prey, more so, in the juvenile phases; thus, in theory, the amount of food available for each individual is affected by the consumption of individuals co-occurring in nursery zones. Saulnier et al. (2020) and Day et al. (2020) reported that marcrobenthos

FIGURE 4 | Trophic level (mean and standard deviation) of the fish species analyzed; the conserved area is represented by the circles, and the restored area by the triangles. The name of the fish species is written in code; the first letter corresponds to the genus and the next three to the species.

produced in these zones directly affect the density of juvenile organisms, which relates to zones that are better conserved and have mangrove habitats, and submerged grasses that provide feeding zones. Fish, therefore, are important elements that serve in quantifying diversity, abundance, and composition of prey found in conserved and impacted environments, and in this case, those that are found in the process of restoration.

An alteration in hydrology, because of anthropogenic actions in estuarine ecosystems, drives a change in the fish assemblages, whether in its taxonomic composition or in functional aspects such as the food guilds and trophic levels (Baptista et al., 2015; Arceo-Carranza et al., 2016; Soria-Barreto et al., 2021). This was reflected in differences in the diets presented by resident species from the mangrove; for example, in *F. polyommus*, the altered hydrology affected the vegetation and microhabitats for available prey; thus, it presented a diet based on detritus and macrophytes in the restored zone, resources that are characteristic for ecosystems in secondary succession (Harrington and Harrington, 1982).

This study provides evidence on the impact that is generated in the trophic webs (species richness and prey abundance in diets) due to anthropic activities (Bosire et al., 2008). The interruption of water flow caused by road construction in this area of the Mexican–Caribbean affects not only the mangrove cover, but also the faunal diversity (benthonic and nektonic), including the predator–prey interactions of the fish communities present (Bosire et al., 2008; Chen and Ye, 2011). Shifting to alternative prey provokes changes in the vertical structure of the food web decreasing the number of trophic levels, modifying the structure and function of the biological communities in

these coastal wetlands. According to some studies on mangrove restoration, there is a gradual shift to more heterogeneous food sources after several years of the restoration process (Loch et al., 2020).

Finally, the results of this work show that trophic ecology of fish are a useful tool, especially in prey abundance, trophic levels, and trophic guilds, key points to know the ecological functions of the community and thus determining and monitoring restoration processes. This garners relevance when there is an attempt to find ecological indicators that show the advances in restoration projects, and in so doing, establish the functional success of the restoration of coastal wetlands. In this case, *F. polyommus*, being an opportunistic organism, is ideal to know the food resources in the conserved and restored mangroves.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

LH-M and DA-C contributed in the idea and design of the study. LH-M performed the analysis and writing of the manuscript. DA-C and LE-V contributed in the writing and criticism of the intellectual content. All authors contributed to the discussion, review, and approval of the final manuscript.

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