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Currents of connection: Habitat connectivity of common reef fishes (Siganids and Lutjanids) in the coastal waters of Misamis Occidental

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Abstract

The study was conducted to establish habitat connectivity of Siganids and Lutjanids along mangrove, seagrass and coral reef ecosystems in the coastal waters of Misamis Occidental. A total of 449 individuals belonging to six species of Siganids and five of Lutjanids were identified from the three different study sites. Three species of Siganids and one species of Lutjanids were found common in all ecosystems. Coral reef ecosystem had higher abundance of siganids and lutjanids compared to mangrove and seagrass ecosystems. *Siganus spinus* and *Siganus guttatus* exhibited behavior of being ontogenetic shifters. The juvenile individuals prefer to inhabit mangrove and seagrass ecosystem and migrate to coral reef ecosystem as they become adult. *Siganus fuscescens* are a generalist species, moving across three ecosystems from early life stage to adult. *Lutjanus ehrenbergii* is an ontogenetic shifter species: the juveniles prefer to stay in mangrove and seagrass ecosystems and adults migrate to coral reef ecosystem. The distribution of common Siganids and Lutjanids among the three major coastal ecosystems based on their different life stages suggests that these ecosystems are interconnected. Results on gut-content analysis reveal that the major food items of Siganids were seagrasses and seaweeds indicating a general trend of being herbivores while the major food items of Lutjanids were crustaceans, small fishes and cephalopods indicating that they are mainly carnivores. The study provides evidence of connectivity of major coastal ecosystems. Thus, removing one ecosystem will affect the other important ecosystems.

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Introduction

Most if not all aquatic organisms undertake ontogenetic migrations from one ecosystem or habitat to another ecosystem throughout their lifetime. Studies have reported several inter-habitat migration patterns for both vertebrate and invertebrate fauna. Most coral reef organisms, for instance, pass through an offshore pelagic larvae stage, after which individuals move to reef and settle to various habitats where they enter the benthic juvenile stage (Randall *et al.*, 2024; Leis and McCormick, 2002). Seagrass beds and mangroves often cover extensive areas surrounding coral reefs, and habitats in these areas have been considered important nursery habitats for coral reef fishes. While these coastal habitats are ecologically connected to each other (Beck *et al.,* 2001), the quantification of relationships and importance of adjacent habitats for coral reef associated fish species has been elucidated only recently (Nagelkerken *et al.,* 2000; Adams and Ebersole, 2002; Cocheret de la Morinière *et al.,* 2002; Dorenbosch *et al.*, 2004; Mumby *et al.,* 2004; Chittaro *et al.,* in press). However, despite the growing demand for ecological research on the habitat connectivity, very little was it known for such endeavor in the Philippine archipelago. If there are, most studies are focused on two (2) different habitats only (e.g. connectivity between mangrove and coral reef or between coral reef and adjacent reef), leaving the continuum functions of the three ecosystems.

The study areas on the contiguous ecosystems are specifically located in the coastal waters of Barangays Danlugan, Lopez Jaena, Punta, Panaon, and Basirang, Tudela Misamis Occidental. The areas are suited for the study since the three (3) major ecosystems are present. Reef fish species are identified as well in the different study sites. This study aims to determine the habitat connectivity for Siganids and Lutjanids among the three major ecosystems (mangrove, seagrass, and coral reef) in the coastal waters of Misamis Occidental.

Materials and methods

Locale of the study

This study was conducted in the coastal waters of Misamis Occidental, particularly in the major coastal ecosystems of the three municipalities, namely Lopez Jaena, Panaon, and Tudela, Misamis Occidental (Fig. 1).

Fig. 1. Geographical locations of the study areas. Map of the Philippines emphasizing the Province of Misamis Occidental (left) and Map of Misamis Occidental highligting the municipality of Lopez Jaena, Panaon and Tudela (right).

The three coastal municipalities are known to be rich in marine life that sustains the livelihood and subsistence of its populace for decades. The presence of mangrove, seagrass, and coral reef contiguous ecosystems in these municipalities makes it more productive in terms of marine life. These three municipalities are credited for their excellent track record in coastal protection, fisheries law enforcement and rehabilitation during the 1990's. Lopez Jaena has a total coral reef area estimated about 324.2 ha. Dense seagrass meadows comprise 321.4 ha while another 204.8 ha of seagrass area with patchy distribution and mangrove forests and patchy stands in nine barangays together covering of 143.0 ha (de Guzman *et al.*, 2009).

The coastal waters of Panaon and Tudela are also noted with wide areas of mangrove, seagrass and coral reef ecosystems, hence considered good sites for connectivity study. The study sites are known sources of shellfisheries and fishes in the province. Most of the coastal dwellers are dependent on their coastal resources. Artisanal fishing is common in the area (personal interview with local fishermen).

Taxonomic identification of reef fish species

Reef fish species were identified up to the lowest taxonomic unit genus and species. An underwater camera was used to take pictures of the collected fish species. Identification was confirmed from the book Reef Fish Identification: Tropical Pacific (Allen *et al.*, 2023), journal references, and fishbase database.

Fish visual census (abundance and distribution)

To know the species of reef fishes inhabiting mangrove, seagrass, and coral reef ecosystems, fish visual census (FVC) was used. Sampling was conducted in the three (3) ecosystems (mangrove, seagrass, and coral reef) in every site in the coastal waters of Lopez Jaena, Panaon and Tudela. There were three (3) sampling periods in the whole duration of study and these were done at day time during spring tide.

Fish abundance (number of individual) in each ecosystem was assessed using an underwater visual belt transect survey method. This non-destructive method allows quantitative comparison between multiple habitats, the recording of fish behavior, and reasonable estimation of the density of bottom-dwellers and fast swimmers (Horinouchi *et al.*, 2005). For each census, 20 meter transect with a width of 0.5 meter both sides, a total area of 20 meter square per transect, separated from each other by at least 10 meters, was established at random within each ecosystem using a scaled rope, adapted after (Nakamura *et al.*, 2009).

There were ten transects laid randomly within every ecosystem per sampling. A total of 30 transects were census per site per sampling period. The 1x20 meter transect line was laid in all sampling stations, each transect was approached slowly by the researcher/observer using SCUBA gears in all stations. Two (2) census swims were done in each transect. Reef fishes (target fish species) were counted and recorded during the first census. Second census swim was to record for other resident fish species found within the belt transect. Each census was conducted at day time during spring tide.

Fish size variability

The total length (TL) of each fish was estimated to size classes per species in centimeters, with individuals being recorded as adult, sub-adult or juvenile on the basis of body size and coloration, breeding behavior, and other available information.

Collection of samples

Collection of fish samples will be done once and it will be done in three (3) ecosystems (mangrove, seagrass and coral reef) in every site after the second sampling. With the assistance of local fishermen, fishes were collected using seine (mesh size 5mm) for juveniles and gill nets (mesh size 20 and 35mm for adults. At least ten (10) fish individuals per species were collected for gut-content analysis per site. The guts of each collected species were removed and were fixed immediately with 5% buffered formalin for laboratory analyses. These preserved samples were classified according to its sizes.

Gut-content analysis

Prior to the analysis, the following measurements were done; body length (SLs in cm), body weight (in gram) and body width (in cm). Then, the guts (stomach) of the fish samples were removed for food analysis. The gut contents were classified according to undigested foods and digested foods. The undigested foods were classified according to its type (e.g. seagrass leaf, algae, polychaetes larvae of cephalopods gastropods, crustaceans and etc.).

The percentage volume of each food item in the diet was visually estimated under a binocular microscope and magnifying glass (10x). Food resource use was expressed as the mean percentage composition of each item by volume, calculated by dividing the sum total of the individual volumetric percentages for the item by the number of specimens examined. Specimens with empty stomach were excluded from the analysis.

The analysis of fish stomach content followed a new method adopted by Lima-Junior and Goitein, 2001. The first step was to obtain the total wet weight of each stomach contents in the sample. Then one may calculate (1) frequency occurrence of food items,(2) the Volumetric Analysis Index, and (3) the Food Item Important Index.

Results and discussion

Abundance of siganids and lutjanids species in the three coastal ecosystems

A total of 449 individuals belonging to six species of siganids namely; *Siganus fuscescens, S. Spinus, S. guttatus, S. virgatus, S. unimaculatus and S. vulpinus* and five of lutjanids namely; *Lutjanus decussates, Lutjanus ehrenbergii, Lutjanus madras, Lutjanus biguttatus and Lutjanus boutton* were identified from the three different study sites in the coastal waters of Misamis Occidental (Table 1). The most abundant species were the *Siganus canaliculatus* a total of 113 individuals of family Siganidae and *Lutjanus ehrenbergii* with a total of 106 individuals of family Lutjanidae.

Three species of siganids were found common in all ecosystems namely; *Siganus fuscescens, Siganus spinus* and *Siganus guttatus* and one species of lutjanids, the *Lutjanus ehrenbergii* (Table 1).

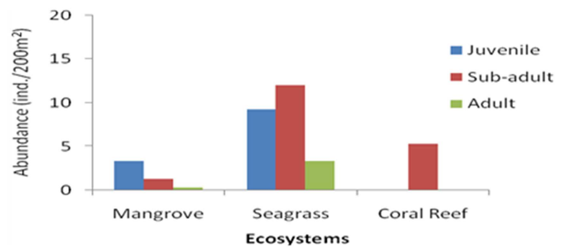
Table 1. Abundance of siganids and lutjanids species present in the three major ecosystems in the coastal waters of Lopez Jaena, Panaon and Tudela, Misamis Occidental

Sites	Species	Ecosystems			Total	Relative abundance (%)
		Mangrove	Seagrass	Coral reef		
Lopez Jaena	Siganids:					
	Siganus fuscescens	5	25	5	35	20.5
	Siganus spinus	6	7	12	25	14.6
	Siganus guttatus	12	5	13	30	17.5
	Siganus virgatus	0	0	28	28	16.4
	Siganus unimaculatus	0	0	3	3	1.8
	Siganus vulpinus	0	0	2	2	1.2
	Lutjanids:					
	Lutjanus biguttatus	0	0	0	0	0
	Lutjanus boutton	0	0	0	0	0
	Lutjanus decussatus	0	1	8	9	5.3
	Lutjanus ehrenbergii	12	14	12	38	22.2
	Lutjanus madras	0	0	1	1	0.6
Total No. of individuals		35	52	84	171	
Relative abundance (%)		20.47	30.41	49.12	100	
Panaon	Siganids:					
	Siganus fuscescens	4	45	6	55	32.4
	Siganus spinus	2	13	3	18	10.6
	Siganus guttatus	16	2	3	21	12.4
	Siganus virgatus	0	0	9	9	5.3
	Siganus unimaculatus	0	0	0	0	0
	Siganus vulfinus	0	0	0	0	0
	Lutjanids:					
	Lutjanus biguttatus	0	0	5	5	2.9
	Lutjanus boutton	0	0	3	3	1.8
	Lutjanus decussatus	0	0	7	7	4.1
	Lutjanus ehrenbergii	14	10	26	50	29.4
	Lutjanus madras	0	0	2	2	1.2
Total No. of individuals		36	70	34	170	
Relative abundance (%)		21.18	41.18	37.64	100	
Tudela	Siganids:					
	Siganus fuscescens	2	16	5	23	21.3
	Siganus spinus	1	5	6	12	11.1
	Siganus guttatus	12	1	7	20	18.5
	Siganus virgatus	0	0	16	16	14.8
	Siganus unimaculatus	0	0	0	0	0
	Siganus vulfinus	0	0	1	1	0.9
	Lutjanids:					
	Lutjanus biguttatus	0	0	2	2	1.9
	Lutjanus boutton	0	0	1	1	0.9
	Lutjanus decussatus	0	0	12	12	11.1
	Lutjanus ehrenbergii	8	1	7	16	14.8
	Lutjanus madras	0	0	5	5	4.6
Total No. of individuals		23	23	62	108	100.0
Relative abundance (%)		21.30	21.30	57.40	100	

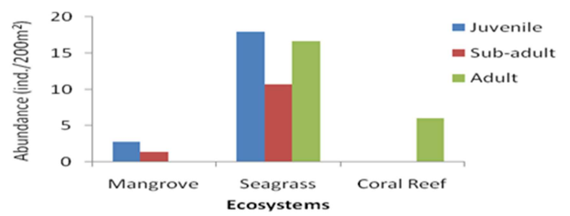
The presence of these species in all three major ecosystems indicates that these ecosystems are utilized by these fish species either for space, feeding, and breeding grounds, for reproduction and as a refuge (Sponaugle and Cowen 1997). *Lutjanus dicussatus,* on the other hand, is found in the two ecosystems (seagrass and coral reef) while *Siganus virgatus, Siganus unimaculatus, and Siganus vulfinus* of family Siganidae and *Lutjanus madras, Lutjanus biguttatus and Lutjanus boutton* of family Lutjanidae were only found in coral reef.

Spatial variation in the abundance of the connected siganids and lutjanids species

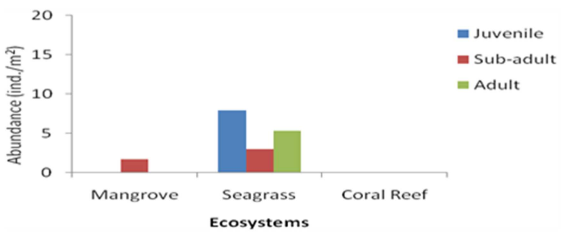
Fig. 2 shows the average abundance of *Siganus fuscescens* in the three ecosystems of Lopez Jaena, Panaon and Tudela coastal waters. In Lopez Jaena coastal waters, juveniles, sub-adult, and adult *S. fuscescens* were found in both mangrove and seagrass ecosystems but most abundant in seagrass, while in the coral reef ecosystem, only sub-adults were found.



a) Lopez Jaena



b) Panaon



c) Tudela

Fig. 2. Average abundance of *Siganus fuscescens* in the three ecosystems according to its size (cm) category at 200m² belt transect in the coastal waters of Misamis Occidental

In Panaon coastal waters, the *S. fuscescens* were observed to be abundant in the seagrass ecosystem from the juvenile stage to the adult. A few juveniles and sub-adults were also observed in mangrove ecosystems, and only adult *S. fuscescens* were found in the coral reef ecosystem. On the other hand, *S. fuscescens* in Tudela coastal waters were observed abundant in the seagrass ecosystems, few sub-adults in the mangrove ecosystem and no individuals were found in the coral reef ecosystem.

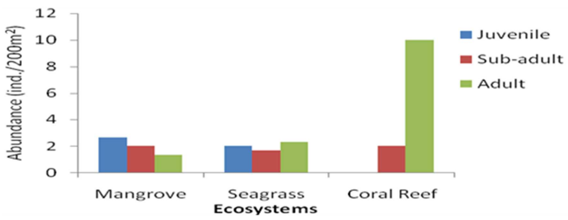
Generally, *S. fuscescens* is found in abundance from the early life stage to adult in seagrass beds in all sites. The result suggests that the habitat preference of *S. fuscescens* was the seagrass beds, and the movement of juvenile *S. fuscescens* was from seagrass to mangrove, while the adult *S. fuscescens* was generally from seagrass to coral reef.

In the Lopez Jaena mangrove ecosystem, the juvenile *S. spinus* were found more abundant, while juveniles and adult *S. spinus* were similarly abundant in the seagrass ecosystem, but in the coral reef ecosystem, adult *S. spinus* were found more abundant (Fig. 3).

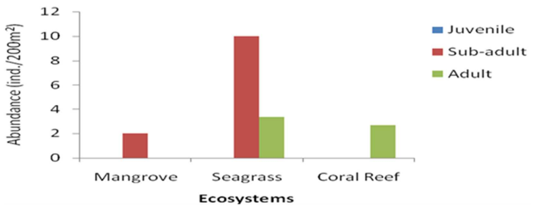
In Panaon coastal waters, the *S. spinus* were found in all three ecosystems but only in adult and sub-adult stages. Most of the sub-adult *S. spinus* were found in the seagrass ecosystem while adults were found in both seagrass and coral reef ecosystem.

In Tudela coastal waters, the *S. spinus* were found in the three ecosystems at different stages. Juveniles were found in the mangrove ecosystem, while sub-adults were found in the seagrass ecosystem and adults were found in the coral reef ecosystem.

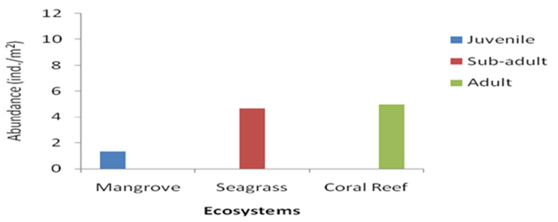
Generally, adult *S. spinus* were found in coral and seagrass beds and all sites except in Lopez Jaena where adult *S. spinus* were also observed in mangrove ecosystem. While sub-adult *S. spinus* were generally found in seagrass beds. And the juvenile *S. spinus* were found and mangrove except in Lopez Jaena where juvenile *S. spinus* were also found in seagrass beds. Results suggest the mangrove and seagrass systems functions as nursery ground while coral reef serves as post settlement area for *S. spinus*.



a) Lopez Jaena



b) Panaon

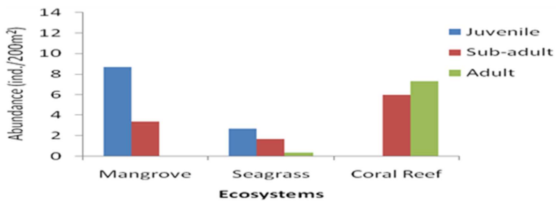


c) Tudela

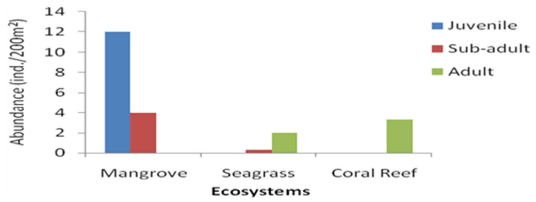
Fig. 3. Average abundance of *Siganus spinus* in the three ecosystems according to its size (cm) category at 200m² belt transect in the coastal waters of Misamis Occidental

In Lopez Jaena Coastal Waters, *S. guttatus* were found in all three ecosystems. In Mangrove ecosystem, only juveniles and sub-adults were found but juveniles were more abundant. In seagrass ecosystem, *S. guttatus* were found in all stages but they are observed less abundant. In coral reef ecosystem, juveniles were not observed but adults and sub-adults were found abundant (Fig. 4).

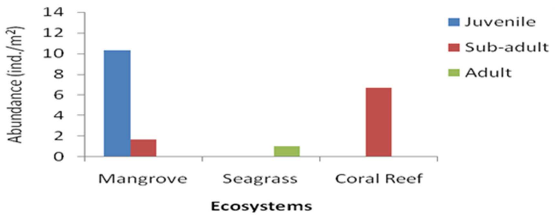
In Panaon Coastal Waters, *S. guttatus* were found in all three ecosystems. In Mangrove ecosystem, only juveniles and sub-adults were found but juveniles were more abundant. In seagrass ecosystem, only adults and sub-adults were found but less abundant. In coral reef ecosystem, only adults were observed.



a) Lopez Jaena



b) Panaon

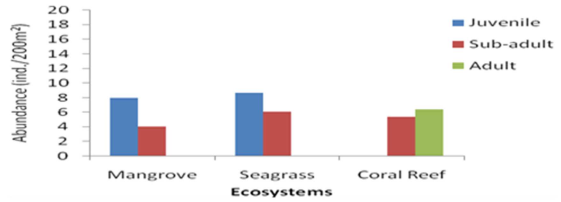


c) Tudela

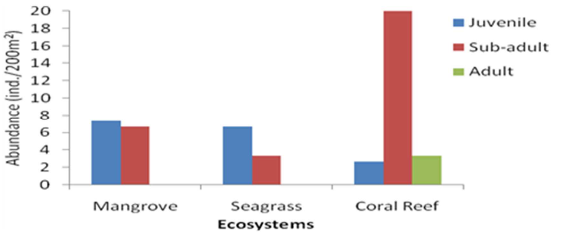
Fig. 4. Average abundance of *Siganus guttatus* in the three ecosystems according to its size (cm) category at 200m² belt transect in the coastal waters of Misamis Occidental

In Tudela coastal waters, *S guttatus* were found in all three ecosystems. In mangrove ecosystem, juveniles and sub-adults were found but juveniles were more abundant. In seagrass ecosystem, only adults were found but less abundant while in the coral ecosystem, only sub-adults were observed and were found abundant.

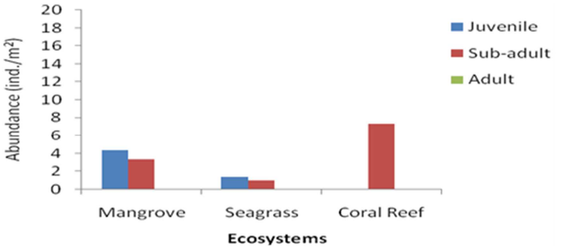
The juvenile *S. guttatus* were generally found in mangrove ecosystem in all sites while large sizes were generally found in coral reef ecosystem. And in seagrass beds *S. guttatus* were found least abundance in all sites. Result shows that seagrass ecosystem function as a nursery ground while coral reef ecosystem serve as post settlement area for *S. guttatus*.



a) Lopez Jaena



b) Panaon



c) Tudela

Fig. 5. Average abundance of *Lutjanus ehrenbergii* in the three ecosystems according to its size (cm) category at 200m² belt transect in the coastal waters of Misamis Occidental

In Lopez Jaena, the *L. ehrenbergii* were found in the three ecosystems at different life stages (sizes). In mangrove and seagrass ecosystems, only juveniles and sub-adults were found and the juveniles were recorded to be more abundant. In the coral reef ecosystem, sub-adult and adult stages were found and both were found abundant (Fig. 5).

The *L. ehrenbergii* in Panaon coastal waters, were also common in the three ecosystems. They were found in mangrove and seagrass ecosystems at juvenile and sub-adult stages while in coral reef ecosystems they were observed as juvenile, sub-adult and adult stages but they were most abundant at sub-adult stage.

In Tudela coastal waters, the *L. ehrenbergii* were also observed common in three ecosystems. They were found as juvenile and sub-adult stages in mangrove ecosystems while only sub-adult in coral reef ecosystem. The sub-adults were found mostly abundant in coral reef ecosystem while juveniles were abundant in mangrove ecosystem.

Generally, younger *L. ehrenbergii* were found in mangrove and seagrass ecosystems while adult individuals were found in coral reef. This indicates that mangrove and seagrass function as nursery ground while coral reef was a post settlement area for *L. ehrenbergii*.

Trophic connectivity of lutjanids and siganids species from mangrove, seagrass, and coral reef ecosystems in coastal waters of Lopez Jaena, Panaon and Tudela, Misamis occidental

The trophic ecology of *S. fuscescens* collected in Lopez Jaena reef area indicates five (5) prey items in the gut (Table 2). The frequency, percentage volume and importance index were reflected in each of the prey items. Seagrasses were the most preferred food item based on frequency and percentage volume. The rarest prey item based on percentage volume and frequency was *Dictyota*. The prey items with least frequency were *Gracilaria*, and *Sargassum*. The amorphous constituted about 7.14% of the gut content volume.

Table 2. Occurrence frequency, volume (%), and importance index for each food item in the sample (*Siganus fuscescens*) from Lopez Jaena, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	100	42.86	4285.71
Algae:			
Sargassum	40	10.71	428.57
Dictyota	10	5.36	53.57
Gracilaria	70	33.93	2375.00
Amorphous	30	7.14	214.29
Total		100.00	

The frequency of the prey items in the gut of *S. fuscescens* indicates that seagrasses were the most important prey item (100%) followed by *Gracilaria* (70%), *Sargassum* (40%), amorphous (30%) and *Dictyota* (10%).

The percentage volume of gut contents in *S. fuscescens* collected from Lopez Jaena reef area shows that seagrasses (42.86%), *Gracilaria* (33.93%), and *Sargassum* (40%) were the major food items that contributed to the biomass of *S. fuscescens* gut content.

Table 3. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus fuscescens*) from Panaon coastal waters

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	90	39.39	3545.45
Algae:			
Sargassum	80	30.30	2424.24
Gracilaria	70	22.73	1590.91
Enteromorpha	10	1.52	15.15
Sponges	10	1.52	15.15
Sand particles	30	4.55	136.36
Total		100.00	

The *Siganus fuscescens* sample from Panaon, Misamis Occidental show about five (5) prey items in the gut (Table 3). Based on frequency of prey items results shows that seagrasses (90%), *Sargassum* (80%) *Gracilaria* (70%), sand particles (30%) *Enteromorpha* and Sponges (10%). The percentage volume of prey items in the gut of *S. fuscescens* from Panaon shows the ranking of preferred food seagrasses has 39.39%, *Sargassum* with 30.30%, *Gracilaria* (22.73%), sand particles (4.55%) and *Enteromorpha* and sponges (1.52%). The results revealed that Seagrass, *Sargassum* and *Gracilaria* were the main food items for *S. fuscescens* in the coastal waters of Panaon.

Table 4. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus fuscescens*) from Tudela, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	100	43.18	4318.18
Algae:			
Sargassum	20	4.55	90.91
Dictyota	100	21.59	2159.09
Sand particles	80	30.68	2454.4
Total		100.00	

The *Siganus fuscescens* samples that were collected in Tudela, Misamis Occidental revealed four (4) prey items (Table 4) in the gut. Based on frequency occurrence it shows that seagrasses and *Dictyota* (100%), sand particles (80%) and *Sargassum* (20%). Ranking by percentage volume of the prey items shows that seagrasses (43%), sand particles (30.68%), *Dictyota* (21.59%) and *Sargassum* (4.55%) and the results revealed that seagrasses were the main food item of *S. fuscescens* from Tudela, Misamis Occidental.

Table 5. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus spinus*) from Lopez Jaena, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	20	3.57	71.43
Algae:			
Sargassum	70	19.05	1333.33
Dictyota	70	13.10	916.67
Gracilaria	100	59.52	5952.38
Enteromorpha	20	2.38	47.62
Amorphous	20	2.38	47.62
Total		100.00	

The *Siganus spinus* samples from Lopez Jaena shows about six (6) prey items in the gut (Table 5). The diet of *S. spinus* from Lopez Jaena based on frequency occurrence shows that *Gracilaria* (100%), *Sargassum* and *Dictyota* (70%), Seagrasses, *Enteromorpha* and amorphous (20%). The percentage volume of prey items in the gut of S. spinus shows the ranking of preferred food items *Gracilaria* (59.52%), *Sargassum* (19.05%), *Dictyota* (13.10%), Seagrasses (3.57%), *Enteromorpha* and Amorphous (2.38%). The results revealed that *Gracilaria* food item was the most preferred food for *S. spinus* in Lopez Jaena, Misamis Occidental.

The trophic ecology of *S. spinus* collected in Panaon reef area indicates seven (7) prey items in the gut (Table 6). The frequency, percentage volume and importance index were reflected in each of the prey items. *Sargassum* was the most preferred food item based on frequency and percentage volume. The rarest prey item based on percentage volume and frequency was *Dictyoota*, and *Enteromorpha*. The prey items with least frequency were *Gracilaria*, Seagrasses, and sponges. The amorphous constituted about 1.92% of the gut content volume.

Table 6. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus spinus*) from Panaon coastal waters

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	60	13.46	807.69
Algae:			
Sargassum	100	36.54	3653.85
Dictyota	10	1.92	19.23
Gracilaria	80	34.62	2769.23
Enteromorpha	10	1.92	19.23
Sponges	10	9.62	96.15
Amorphous	50	1.92	96.15
Total		100.00	

The frequency of the prey items in the gut of *S. spinus* indicates that *Sargassum* was the most important prey item (100%) followed by *Gracilaria* (80%), Seagrasses (60%), amorphous (50%), *Dictyota*a, *Enteromorpha* and sponges (10%).

The percentage volume of gut contents in *S. spinus* collected from Panaon reef area shows that *Sargassum* (36.54%), *Gracilaria* (34.62%), and Seagrasses (13.46%) were the major food items in gut of *S. spinus*.

Table 7. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus spinus*) from Tudela, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Algae:			
Sargassum	100	52.33	5232.56
Dictyota	40	9.30	372.09
Gracilaria	100	31.40	3139.53
Enteromorpha	10	1.16	11.63
Amorphous	20	5.81	116.28
Total		100.00	

The *S. spinus* samples that were collected in Tudela, Misamis Occidental revealed about five (5) prey items (Table 7) in the gut. The frequency occurrence shows that *Sargassum* and *Gracilaria* (100%), *Dictyota* (40%), Amorphous (20%) and *Enteromorpha* (10%) were main food items. Ranking by percentage volume of the prey items show that *Sargassum* (52.33%), *Gracilaria* (31.40%), *Dictyota* (9.30%), Amorphous (5.81%) and *Enteromorpha* (1.16%) were the important food items found in the gut of *S. spinus*. Generally, *Sargassum* and *Gracilaria* were the preferred food for *S. spinus* from Tudela, Misamis Occidental.

The trophic ecology of *Siganus guttatus samples* collected in Lopez Jaena reef area indicates five (5) prey items (Table 8) in the gut. The frequency, percentage volume and importance index were reflected in each of the prey items. *Gracilaria* was the most preferred food item based on frequency and percentage volume. The prey items with least frequency were Seagrasses, and *Gracilaria*. The rarest prey item based on percentage volume and frequency was *Dictyoota*. The amorphous constituted about 5.00% of the gut content volume.

Table 8. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus guttatus*) from Lopez Jaena, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	50	15.00	750.00
Algae:			
Sargassum	50	17.50	875.00
Dictyota	10	5.00	50.00
Gracilaria	80	57.50	4600.00
Amorphous	10	5.00	50.00
Total		100.00	

The frequency of the prey items in the gut of *S. guttatus* indicates that *Gracilaria* was the most important prey item (80%) followed by Seagrasses *and Sargassum* (50%), amorphous and *Dictyota* (10%).

The gut contents of *S. guttatus* collected from Lopez Jaena reef area based on percentage volume shows that *Gracilaria* (57.50%), *Sargassum* (17.50%), Seagrasses (15.00%) were the major food items in gut of *S. guttatus*.

The *Siganus guttatus* samples that were collected in Panaon, Misamis Occidental show about five (5) prey items (Table 9) in the gut. The frequency occurrence shows that Seagrasses (100%), *Gracilaria* (80%), *Sargassum* (50%), Dictyota and sponges (20%). Ranking by percentage volume of the prey items show that *Sargassum* (52.33%), *Gracilaria* (31.40%), *Dictyota* (9.30%), Amorphous (5.81%) and *Enteromorpha* (1.16%) were the important food items found in the gut of *S. spinus*. Generally, *Sargassum* and *Gracilaria* were the preferred food for *S. spinus* from Tudela, Misamis Occidental.

Table 9. Occurrence frequency, volume (%), and importance index for each food item in the sample (*Siganus guttatus*) from Panaon coastal waters

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	100	70.24	7023.81
Algae:			
Sargassum	50	15.48	773.81
Dictyota	20	2.38	47.62
Gracilaria	80	9.52	761.90
Sponges	20	2.38	47.62
Total		100.00	

The *Siganus guttatus* samples from Tudela, Misamis occidental revealed five (5) prey items in the gut (Table 10). The frequency of prey items in the gut of *S. guttatus* shows the ranking of preferred food, *Sargassum* (90%), Seagrasses and *Gracilaria* (80%), sand particles and amorphous (10%). The diet of *S. guttatus* in Tudela based on percentage volume shows that *Sargassum* (34.62%), *Gracilaria* (32.69%), Seagrasses (26.92%), sand particles (3.85%) and amorphous (1.92%) were the main food items.

Table 10. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Siganus guttatus*) from Tudela, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Seagrasses	80	26.92	2153.85
Algae:			
Sargassum	90	34.62	3115.38
Gracilaria	80	32.69	2615.38
Sand particles	10	3.85	38.46
Amorphous	10	1.92	19.23
Total		100.00	

The trophic ecology of *Lutjanus ehrenbergii* collected in Lopez Jaena reef area indicates four (4) prey items in the gut (Table 11). The frequency, percentage volume and importance index were reflected in each of the prey items. Crustaceans was the most preferred food item based on frequency while small fishes prey item based on percentage volume. The prey item with least frequency was Cephalopods. The amorphous constituted about 7.14% of the gut content volume.

Table 11. Occurrence frequency, volume (%) and importance index for each food item in the sample (*Lutjanus ehrenbergii*) from Lopez Jaena, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Small fishes	50	51.79	2589.29
Crustaceans	60	37.50	2250.00
Cephalopods	20	3.57	71.43
Amorphous	20	7.14	142.86
Total		100.00	

The frequency of the prey items in the gut of *L. ehrenbergii* indicates that Crustaceans was the most important prey item (60%) followed by *small fishes* (50%), cephalopods and amorphous (20%).

The percentage volume of gut contents in *L. ehrenbergii* collected from Lopez Jaena reef area shows that small fishes (51.79%), crustaceans (37.50%), amophous (7.14%) and cephalopods (3.57%) were the major food items in gut of *L. ehrenbergii* from Lopez Jaena Misamis Occidental.

Table 12. Occurrence Frequency, Volume (%) and Importance Index for each food item in the sample (*Lutjanus ehrenbergii*) from Panaon coastal waters

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Small fishes	40	21.69	867.47
Crustaceans	100	39.76	3975.90
Cephalopods	10	14.46	144.58
Gastropods	40	7.23	289.16
Amorphous	80	16.87	1349.40
Total		100.00	

The *Lutjanus ehrenbergii* samples for gut content analysis collected from Panaon, Misamis occidental revealed five (5) prey items (Table 12). The frequency of the gut contents of *L. ehrenbergii* shows that crustacean (100%), amorphous (80%), small fishes and gastropods (40%) and the cephalopods (10%). The diet of *L. ehrenbergii* based on percentage volume shows that crustaceans (39.76%), small fishes (21.69%), amorphous (16.87%), cephalopods (14.46%) and gastropods (7.23%) were the main food items.

Table 13. Occurrence frequency, volume (%) and importance index for each food item in the sample (Lutjanus ehrenbergii) from Tudela, Misamis Occidental

Food item	Occurrence frequency (%)	Volume (%)	Importance index
Small fishes	40	42.86	1714.29
Crustaceans	60	41.07	2464.29
Cephalopods	10	3.57	35.71
Gastropods	10	3.57	35.71
Amorphous	30	8.93	267.86
Total		100.00	

The collected samples of *Lutjanus ehrenbergii* for gut content analysis from Tudela revealed five (5) prey items (Table 13). Ranking by frequency occurrence crustaceans (60%), small fishes (40%), amorphous (30%), cephalopods and gastropods (10%). While based on percentage volume of the gut content, small fishes (42.86%), crustaceans (41.07%), amorphous (8.93%), cephalopods and gastropods (3.57%). Generally, the most preferred food items of *L. ehrenbergii* in Lopez Jaena were the small fishes and crustaceans.

Conclusion

Results of the study suggest that: (a) some species of siganids and lutjanids are presents in all three major coastal ecosystems that make them connected; (b) there is an evidence that siganids and lutjanids are utilizing coastal ecosystems as their nursery, feeding, and post settlement grounds indicating that each ecosystem has specific function for the ontogenetic development of siganids and lutjanids, thus, removing one ecosystem will affect the fish productivity of other important ecosystems; and (d) the siganids are mainly herbivores while lutjanids are carnivores. These results confirm the claims that coastal ecosystems are really connected.

Recommendations

For marine resource management to be effective, policies must align with the socio-cultural and political realities of the locality, while also considering the natural biological rhythms of the marine environment. Local government units (LGUs), in close collaboration with institutions of higher learning in coastal areas, should intensify their information campaigns about the importance of major coastal ecosystems—mangroves, seagrass, and coral reefs—with emphasis on their nursery, feeding, and post-settlement functions. Additionally, the Department of Environment and Natural Resources (DENR) – Environmental Management Bureau must support scientific research on habitat conservation, habitat restoration, ecosystem management, and the monitoring of restoration efforts by comparing the functions of restored and natural sites. The knowledge of habitat connectivity between Siganids and Lutjanids, introduced in this study, can be utilized by Protected Area Management personnel and LGUs to design coastal resource management programs, particularly in the establishment of Marine Protected Areas that take into account the three major ecosystems.

Further studies on habitat connectivity should be conducted using a broader range of fish species and invertebrates to expand our understanding of ecosystem dynamics. Additionally, ongoing research on the connectivity of Siganids and Lutjanids should explore other parameters, such as isotopes, to provide more comprehensive insights into these species' ecological relationships.

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