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FISH-TRANSECT SURVEYS IN POHNPEI LAGOON (EASTERN CAROLINE ISLANDS) TO DETERMINE THE INFLUENCE OF NEIGHBOURING HABITATS ON FISH COMMUNITY STRUCTURE

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Fish-transect surveys in Pohnpei lagoon (Eastern Caroline Islands) to determine the influence of neighboring habitats on fish community structure

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ABSTRACT - Fish communities were surveyed by visual counts along 50-m transect lines on isolated coral reefs, on coral reefs bordered by seagrass beds, on coral reefs bordered by mangroves, on coral reefs bordered by both seagrass beds and mangroves, and also in seagrass beds and mangroves, each of the latter two in four situations of bordering habitats analogous to the four situations of coral reefs surveyed. In all cases, patterns from replicate transects were heterogeneous for any family of fishes for any combination of habitats, i.e., no pattern of abundance was consistent for any set of replicates. Nevertheless, significant differences were found in fish communities under different combinations of habitats which implied that neighboring habitats were influential in determining the structure of fish communities. Each family of fishes showed a different pattern of influence by neighboring habitats. In order to effectively manage tropical coastal marine fisheries, we need to know more about the mechanisms of influence of habitat combinations on fish community structure.

Introduction

To learn how to rationally manage our tropical coastal ecosystems is of concern to Pacific islanders because coastal resources are a major source of protein for subsistence and for commerce. At the same time, as island populations increase rapidly, most settle on coastal areas for logistic, aesthetic, commercial, and traditional reasons. As human populations increase on tropical islands, coastal resources become needed in greater quantity and at the same time their production is becoming endangered by alteration of the environment by urban development. Therefore, as populations increase, we must have a better understanding of how to manage coastal resources.

The management of tropical fisheries resources might differ from the temperate fisheries upon which fisheries management models are based. Fisheries models for nearshore tropical marine habitats may need to be multispecific rather than monospecific because tropical coastal fish communities are more diverse than temperate fish communities and species interactions may play a greater role in the determination of fisheries population dynamics in the tropics.

The greater prevalence of interactions in the tropics might extend to habitats. It has been conjectured that seagrass beds or mangroves serve as nurseries for fishes recruiting to neighboring coral reefs. It has also been observed that certain coral reef inhabitants foraged out onto seagrass beds for food. If these interactions are significant, then they are certainly important for coastal resource management. If a coral reef community next to a mangrove has different attributes than an isolated coral reef community, then questions concerning altering the mangrove (e.g., clear-cutting for use of wood, land-fill for coastal housing, draining and filling for agriculture, etc.) must take this matter into account.

The literature on ecological interactions among tropical coastal ecosystems has been reviewed by Birkeland and Grosenbaugh (1985). Randall (1963) and Ogden and Zieman (1977) observed that coral reefs near seagrass beds supported a larger biomass of reef fishes than did isolated coral reefs. In fact, when Randall (1963) constructed on artificial reef out of construction blocks, the artificial reef which was placed in a seagrass bed maintained a resident population of fishes with eleven times the biomass of fish per unit area than that of comparable areas of fringing reefs. However, these areas are not strictly comparable, because a patch of any bordering area between habitats might be expected to have a greater abundance, biomass or diversity of animals than an average patch of either habitat simply because of individuals of species from two habitats being present in the border area, not because of any enhancement of productivity, recruitment, food supply, etc. Furthermore, small structures such as artificial reefs have a greater ratio of border length to surface area or greater "edge effect."

Even direct observations of ecological processes are of unknown significance. For example, juvenile mullids, siganids, acanthurids, chaetodontids, diodontids, and juveniles of other coral reef species have been seen in abundance in seagrass beds. But it has never been shown that these recruits are of any significance to neighboring coral reef communities. These species are found in apparently normal abundances on coral reefs isolated from seagrass beds. It may be that recruits that are initially found in seagrass beds are an excess supply of recruits that, for the most part, do not add to the coral reef populations.

To our knowledge there has been no systematic comparative survey of combinations of tropical coastal marine habitats in a tropical region for the purpose of determining whether the fish communities in certain coastal habitats differ under the influence of neighboring habitats. The purpose of this study was to complete such a survey.

Methods

The lagoon of Pohnpei (Eastern Caroline Islands) provides a rich variety of coastal marine habitats and combination of habitats. In order to objectively survey the influence of neighboring habitats on fish community structure, we chose to survey fish communities on coral reefs in four situations (in isolation, bordered by seagrass beds, bordered by mangroves, and bordered by both seagrass beds and mangroves), in seagrass beds in four analogous situations (in isolation, bordered by coral reefs, bordered by mangroves, and bordered by both coral reefs and mangroves), and in mangroves in four analogous situations. Numerous potential study sites with these habitats or combinations of habitats are available in Pohnpei lagoon.

In order to control for peculiarities of specific sites, we selected three replicate study sites for each of the twelve habitat combinations. In order to ensure objectivity, the sites were selected from a USGS (1983) map on the basis of juxtaposition of habitats on the map, prior to actual observation of the study sites.

At each replicate site and each habitat, the fish community was surveyed by visual counts along a 50-m transect line. A 50-m transect line was laid within the habitat being surveyed, then the observer would swim along the transect line, counting and recording all the fish seen within one meter of either side of the transect line. A distinction was made between juveniles and adults, and they were recorded separately in the field notes. When the data were later analyzed, however, it was clear that the criteria for distinctions between juveniles and adults must have changed between sites or dates or observers and so the data for juveniles and adults had to be lumped together for statistical analyses.

Results

The mean abundances of fishes representing each family in 50-m transects in each of three replicate areas for each of twelve habitat combinations in northern Pohnpei lagoon are given in Table 1. The mean frequencies in replicates were analyzed across habitat combinations, the null hypothesis being that if abundances in a given habitat are not influenced by neighboring habitats, then an isolated coral reef should have the same abundances of fishes per m^2 as a coral reef near a seagrass bed, a coral reef near a mangrove, or a coral reef near both a seagrass bed and a mangrove. The comparable null hypotheses were made for seagrass beds and mangroves under different combinations of neighboring habitats.

The frequencies were analyzed and the above null hypotheses were tested with replicate goodness-of-fit G-tests for those families which were abundant enough to have an expected frequency of at least 5 individuals per transect. Results of these analyses are summarized in Table 2. In Table 2, a blank space indicates that the family was represented by too few individuals for statistical analysis. "0" indicates that the abundance of the family of fishes in the habitat in question more-or-less fits the null hypothesis; "+" indicates that the family is represented by significantly more individuals than would have been predicted assuming that neighboring habitats do not influence the number of individuals present; "-" indicates that the family is represented by fewer individuals than would be expected if neighboring habitats had no influence on the number of individuals present.

In all cases the replicate areas were heterogeneous, e.g., transects taken in three separate coral reefs, each bordered by a seagrass bed, never showed a consistent pattern of relative abundance for any family of fishes. For example, scarids may be more abundant on isolated coral reefs than coral reefs bordered by seagrass beds in two of the replicates, but may be far more abundant on a coral reef bordered by a seagrass bed than on an isolated coral reef in a third replicate. This heterogeneity of results was the case for each family of fishes in each habitat combination.

Even though all patterns across habitat combinations were heterogeneous, the analyses of pooled replicates often showed patterns. For example, chaetodontids (butterfly fishes) were only found in numbers adequate for statistical analysis on coral reef transects. Chaetodontids were of equivalent abundance on isolated coral reefs, on coral reefs bordered by seagrass beds, on coral reefs bordered by mangroves, and on coral reefs bordered by both seagrass beds and mangroves. For a chaetodontid, it appears that a coral reef is a coral reef whether it is isolated or borders on another habitat. Likewise, lethrinids (emperors) are found in seagrass beds in equivalent numbers, whether the seagrass beds are isolated or border on other habitats (Table 2).

Piscivorous fishes were generally characteristic of coral reefs. For lutjanids (snappers) and lethrinids, an isolated coral reef appeared to be an equivalent habitat with a coral reef bordering on either a seagrass bed or a mangrove. However, for both of these families, a significantly greater number of individuals are found on coral reefs that border on both seagrass beds and mangroves (Table 2). Serranids, on the other hand, were found to be relatively scarce on isolated coral reefs and more abundant on coral reefs bordering on other habitats. However, the results from bordering habitats were equivalent whether seagrass beds, mangroves, or both (Table 2).

The results of analyses of transect data for all families with enough representatives for analysis are summarized in Table 2.

Discussion

The heterogeneity of relative abundance patterns indicates that factors other than the nature of bordering habitats are of major importance in the determination of species abundances in any particular habitat. Nevertheless, bordering habitats do appear to have a significant influence. Juvenile mullids (goatfishes) are often seen in seagrass beds and the results indicate that mullids are more abundant on those coral reefs that border seagrass beds. Therefore, seagrass beds may facilitate recruitment of mullids to coral reefs. However, the gobies show this same pattern to even a greater degree, and it is not known why this might be. Lutjanids and lethrinids show significantly greater abundance on coral reefs which border on both seagrass beds and mangroves while baitfish, gobies, pomacentrids (damselfishes), siganids and scarids are significantly less abundant under these conditions. It might be speculated that all these fishes recruit in equivalent or even greater numbers to coral reefs bordering on both seagrass beds and mangroves, but increased predator-pressure from piscivores reduces the standing stock of prey species.

The main conclusion of this study is that the fish communities in tropical coastal habitats are not entirely independent of fish communities in neighboring habitats. A tropical coastal habitat can be significantly influenced by the presence of neighboring habitats. The nature of these influences varies among fish families and the mechanisms of these influences are not known. To be able to manage tropical coastal resources, we must acquire a greater understanding of these influences of one habitat upon another.

This study should be developed further in three regards. First, the same survey program should be repeated at a different regional location to determine which patterns are consistent and which will be relegated to regional heterogeneity. Second, extra care should be taken to distinguish juveniles and adults in future date collection. If juveniles and adults were analyzed separately, new patterns might emerge and the results summarized in Table 2 then might be clearer and easier to explain. Third, once the above steps have been accomplished, the patterns should be examined in search for the responsible mechanisms in order to improve our knowledge of how to manage our coastal resources.

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Literature Cited

Birkeland, C., and D. Grosenbaugh. 1985. Ecological interactions between tropical coastal ecosystems. UNEP Regional Seas Reports and Studies No. 73. 71 p.

Ogden, J. C., and J. C. Zieman. 1977. Ecological aspects of coral reef-seagrass bed contacts in the Caribbean. Pages 377-382. In D.L. Taylor (ed.), Proceedings: Third International Coral Reef Symposium, Miami, Florida. 1. Biology. 656 p.

Randall, J. E. 1963. An analysis of the fish populations of artificial and natural reefs in the Virgin Islands. Caribb. J. Sci. 3:31-47.

USGS. 1983. Topographic map of the island of Ponape (northern half) Federated States of Micronesia. United States Department of the Interior Geological Survey.

Table 1. Mean abundances of representatives of various families of fishes in 50-m transects in each of three replicate locations for each of twelve habitat types.

Habitat types

Habitat	Code
Coral alone	1
Coral near seagrass	4
Coral near mangrove	5
Coral near seagrass and mangrove	7
Seagrass alone	2
Seagrass near coral	4
Seagrass near mangrove	6
Seagrass near coral and mangrove	7
Mangrove	3
Mangrove near coral	5
Mangrove near seagrass	6
Mangrove near coral and seagrass	7

Relicates are indicated with the letters A, B, C.

		Habitat			
Family	Transect	1	4	5	7
Pomacentridae	A	28	82	64	15
	B	37	155	86	86
	C	13	225	64	36
Labridae	A	30	10	22	77
	B	33	48	33	26
	C	12	45	6	14
Scaridae	A	78	50	27	17
	B	89	59	82	16
	C	53	203	26	10
Acanthuridae	A	72	29	64	93
	B	118	102	78	94

	C	33	37	42	22
Lethrinidae	A	4	3		
	B		2	1	1
	C	13	6	11	30
Siganidae	A	4	2		
	B	4	10		6
	C	34	8	4	5
Chaetodontidae	A	15	10	2	4
	B	10	12	13	12
	C	6	16	16	10
Ballistidae	A		2		2
	B	3		1	
	C	2	1		
Mullidae	A	2	12	1	2
	B	3	6	1	2
	C	2	5	20	3
Lutjanidae	A	3		1	1
	B	1			2
	C		2	2	18
Gobiidae	A	8	1		
	B		14	3	
	C		16		1
Blenniidae	A	6	2		1

	B	6	7	3	
	C	10			12
Apogonidae	A			1	2
	B			2	7
	C		2	90	24
Zanclidae	A	1			3
	B	26			
	C		3		2
Pomacanthidae	A		5		
	B	2	2	1	
	C		3		
Holocentridae	A		2		3
	B	3			8
	C	3			
Fistularidae	B	1			
Baitfish	C	700	300		
	B		20	70	13
	A			100	
Haemulidae	A		2		
	B		9		
Serranidae	A		4	4	3
	B		2	3	3
	C		2		2
Nemipteridae	A		2		
	C		2		
Carangiidae	C		1	4	

Sygnathidae	A			4	
Other			5		

		Habitat : Seagrass			
Family	Transect	2	4	6	7
Pomacentridae	A	4	56		14
	B	78	7		
	C		18	5	4
Labridae	A	29	29		24
	B	31	22	15	2
	C	3	20	3	8
Scaridae	A		6		
	B	15	8	2	
	C		29		
Acanthuridae	A	22	7		
	B	4	5	5	
Lethrinidae	A	3	4		1
	B	4		8	2
	C			2	4
Siganidae	A	223	295		39
	B	297	14	40	27
	C	3		22	14
Chaetodontidae	A	2	1		

Table 2. Summary of results of statistical (replicated goodness-of-fit G-test) analyses of the mean abundances presented in Table 1 of representatives of families of fishes in each replicate from each of twelve combinations of neighboring habitats. "+" indicates significantly greater abundance than expected by chance, "-" indicates significantly more scarce than expected by chance, and "o" indicates an abundance that is more-or-less expected regardless of habitat situation. One "+" or "-" indicates α (probability of falsely rejecting a true null hypothesis) $<.05$, "++" or "--" indicates $\alpha<.01$ and "+++" or "---" indicates $\alpha<.001$. For the key to habitat types 1-7, see the caption for Table 1.

	Transects in coral habitats				Transects in seagrass habitats				Transects in Mangrove habitats			
	1	4	5	7	2	4	6	7	3	5	6	7
Herbivores												
Acanthuridae	+++	---	---	++	++	0	-					
Scaridae	+++	+++	---	---	0	+++	---					
Siganidae	+++	0	--	-	+++	+++	---	---				
Piscivores												
Lethrinidae	0	0	0	++	0	0	0	0				
Lutjanidae	0	0	0	++					-	+	0	0
Serranidae		0	0	0								
Mixed diets												
Pomacentridae	---	+++	-	---	+++	+++	---	--				
Labridae	--	++	--	++	+++	+++	---	--				
Chaetodontidae	0	0	0	0								
Mullidae	0	+	0	0								
Gobiidae	0	+++	0	-	+++	---	-	---	++	-	0	0
Blenniidae	+	0	-	0					0	0	-	[illegible]
Apogonidae										---	+++	+
Baitfish	+++	+++	---	---								