Top predators on coral reefs

The impacts of bleaching-related structural loss on grouper communities in the Lakshadweep Archipelago, India

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Status report

ABSTRACT

Global climate-change induced coral bleaching, followed by coral death and degradation represents a major and increasingly prevalent disturbance on coral reefs ecosystems all over the world (Garpe et al. 2006). Mass bleaching events can bring about dramatic changes in the benthos, which can have concomitant ecosystem-wide consequences. A general trend of bleaching, degradation and homogenization of coral reefs has been observed (since the 98-bleaching event) across the Indo-pacific reefs. Given the anticipated increase in the frequency and severity of these bleaching events, it becomes paramount to study the direct and indirect impacts of mass-bleaching events on ecologically and economically important functional taxa in coral reefs. Our study focuses on the impacts of bleaching-related structural loss on a particular guild of benthic top predator, groupers (Family: Serranidae) in the Lakshadweep archipelago, India.

The orientation of the Lakshadweep islands with respect to the southwestern monsoon winds and the timing of the mass bleaching events (pre monsoon) creates a gradient of structure in the archipelago. In the aftermath of mass bleaching events (1998, 2005, 2010), the western aspect of atolls suffered dramatic structural losses, while the eastern aspect of atolls remained relatively stable. Total grouper biomass (gms/transect) after the 2010 bleaching event was found to be three times higher on the structurally stable eastern reefs as compared to the structurally dynamic western reefs. Size-structure grouper data shows that bigger size classes and bigger bodied species abound on the eastern as compared to the western reefs. Grouper biomass is strongly correlated to structure on the east and does not show a relationship with structure on the west. A nestedness analysis of grouper communities shows that grouper assemblages are nested subsets along a gradient of reef structure.

As groupers are heavily reliant on reef structure for their predation strategies (ambush), this study hints that habitat availability could be the primary limiting factor which structures populations of groupers on coral reefs.

Introduction

Structure can be defined as the 'architectural complexity' or the 'topographic complexity' of a site or the three-dimensional matrix, which provides shelter and refuges to its inhabitants. There is a general consensus in the literature that increasing structural complexity of a habitat, increases local species abundance and diversity, a pattern that is consistently seen across ecosystems and taxa (*fishes* (Luckhurst 1978, Beukers 1998, Ferreira et al. 2001, McClanahan 2005, Feary et al. 2007a), *birds* (MacArthur 1961), *mammals* (Dueser & Brown, 1980; Williams et al., 2002), *insects* (Haslett, 1997; Davidowitz & Rosenzweig, 1998), *aquatic invertebrates*

(Heck & Wetstone, 1977; Gilinsky, 1984)(Gratwicke 2005). The physical structure of a habitat profoundly influences its associated biodiversity and ecosystem functioning (MacArthur 1961). More complex habitats facilitate species coexistence through niche partitioning and the provision of refuges from predators and environmental stressors (Alvarez-Filip et al. 2009).

On coral reefs, habitat structure is shaped by the spatial arrangement of sessile organisms (hard corals). Structure being biogenic in nature, is therefore highly vulnerable to environmental perturbations (Bozec and Doledec 2005, Madin and Connolly 2006). Fluctuations in a range of physical variables, mediated by changes in global climate are predicted to affect directly the abundance, diversity, composition and demographic structure of the dominant habitat-forming corals which will have indirect repercussions for associated fishes as a result of change in habitat availability and quality (Pandolfi 2003, Feary et al. 2010). As fishes are considered among the most important fauna in tropical marine systems in terms of both economic and societal value (MacRae and Jackson 2001) understanding implications of climate change in fish communities is of paramount importance (Feary et al. 2010).

Spatial patterns of coral reef fishes are influenced by a number of biological processes such as recruitment, competition and predation (Hixon 1993, Almany 2004, Gratwicke 2005). The balance between these interacting processes is mediated by the reef habitat structure, which provides refuges and resources to fishes. On coral reefs, numerous studies have documented concomitant changes in the abundance, diversity or composition of fishes due to loss of reef structure (Sano and Shimizu 1987, Syms and Jones 2000, Booth 2002, Feary et al. 2007b, Munday et al. 2007, Pratchett et al. 2008, Graham et al. 2009, Bonin et al. 2009). These studies concur that communities of coral-reef fishes are strongly influenced by changes in habitat structure caused by climate-induced coral bleaching, but there is little consensus on the processes involved or the key aspects of habitat structure that shape communities of coral-reef fishes.

It has been often hypothesized that structure dampens the effect of predation by piscivores by providing refuges to prey species (Crowder 1982, Savino 1989, Johnson 2006). One guild of apex predators on coral reefs- groupers (Family -Serranidae) is well adapted to using high structured reef environments by their cleverly modified hunting strategies (sit and wait, sit and pursue). Groupers are top resident reef predators. They are competitively and numerically dominant predators on reefs and have a strong influence on community structure (Eklöv 1994). We therefore use this guild of top predators as a model guild to understand the effects of changing benthic structure on reef fishes.

In the Lakshadweep archipelago, the atolls have a general north-south orientation. The western aspect of atolls is subject to six months of turbulent monsoon currents and storms, while the eastern aspect of atolls remains relatively stable throughout the year. These local hydrodynamic processes play an important role in determining post-bleaching recovery of reefs in the Lakshadweep archipelago (Arthur et al. 2006). Previous studies have indicated a dramatic loss of coral structure on the western reefs (as compared to eastern reefs) in response to bleaching events as a result of this monsoonal forcing (Arthur 2000, Arthur and Done 2005, Arthur et al. 2006). We believe that the structural environment on the western reefs may be dynamic and therefore could play an important role in shaping fish communities.

Groupers are ambush predators (with a generalized diet) and are highly dependent on structure for predation. We hypothesize that structure might be a primary limiting factor in shaping grouper communities in the islands. This study has important ramifications for all structure-dependent reef fauna. Fish are believed to have high potential to resist and adapt to environmental changes. It is in our interest to understand the specific processes by which these top predatory fish adapt to change: whether they alter predation strategies, show prey switching behavior, alter phenology (Auster 2005), etc.

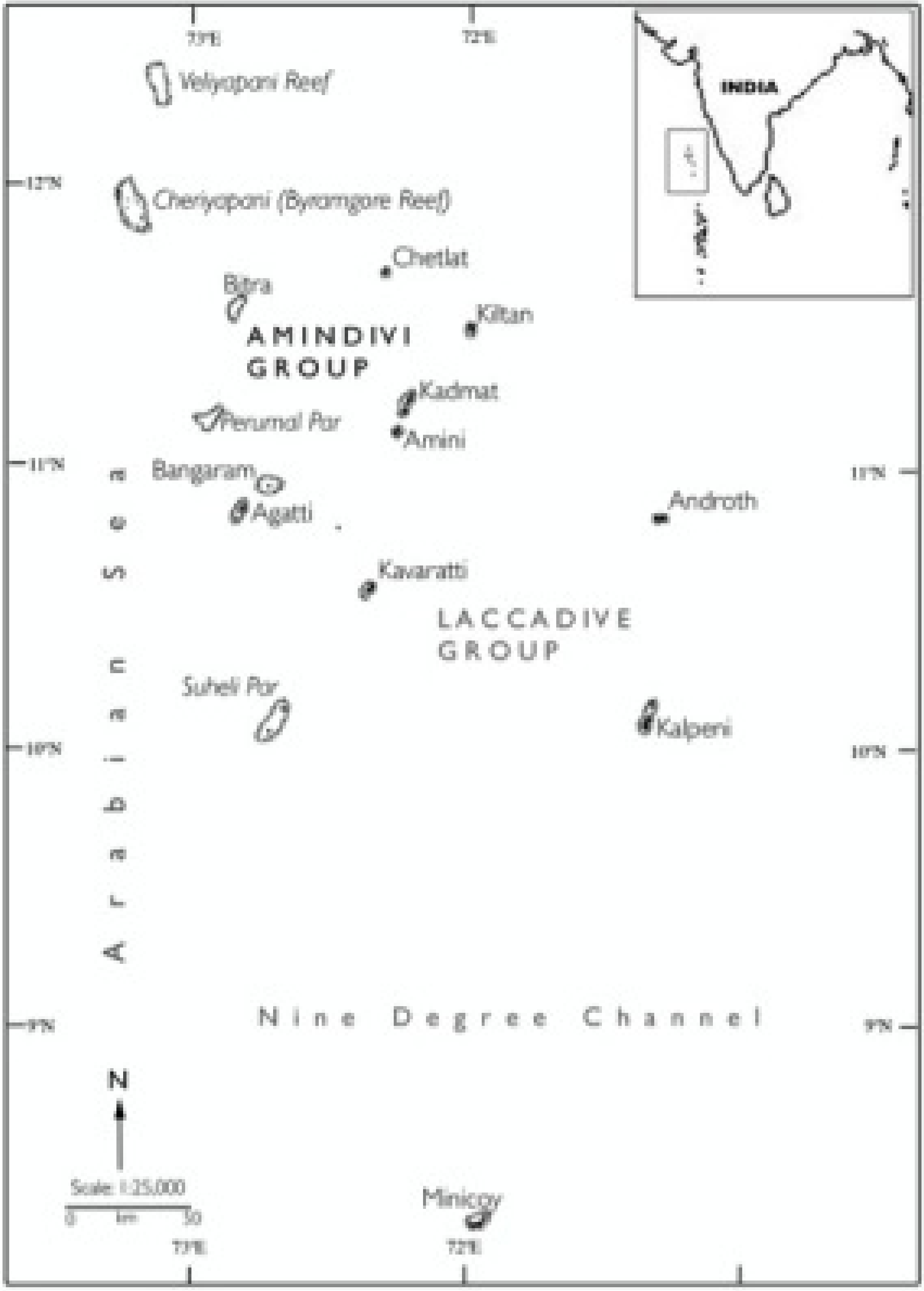
In the initial, descriptive stage of this project, we studied the distribution of the grouper community in the Lakshadweep Archipelago. We focused on understanding whether the groupers are strongly associated to reef structure. If this relationship were to hold true, we would expect the communities to look fairly different across a gradient of structure, due to species level attributes like body size, habitat and prey requirements etc.
In this report, we present very preliminary results from our data, which broadly address the following questions:

1. Is there a gradient of structure in the Lakshadweep islands? What is the effect of the 2010-bleaching event on the structural environments of these reefs?
2. How is the grouper community distributed across the islands?
3. How important is structure in shaping grouper communities in the Lakshadweep?

Methods

From November 2010 to April 2011, our team visited atolls across the Lakshadweep Archipelago and intensively sampled a total of 34 reef locations across 12 coral atolls (Map1, Table 5 Appendix). With the exception of Androth (a lagoonless island with fringing reefs) and Suheli (an uninhabited atoll), we surveyed every location in the archipelago including two submerged banks (Perumal Par and Cheriyapani). We surveyed reefs on the eastern and western aspect of each atoll. The number of reefs in each atoll varied with its size.

Map 1. Map of Lakshadweep showing different islands.



Benthic composition: At each location we sampled reefs at two depths (where possible), between 10-18 m (deep) and between 5-10 m (shallow). Benthic condition was assessed using 1 m^2 photographic quadrats established every 10 m along a 50 m free swim transect (5 quadrats per transect).

Structural complexity: We conducted a standardization experiment before the survey to measure 'structure' and determine the most informative and least time-consuming index of structure. Structure was measured at two different scales (1msq & 5msq) with indices such as rugosity (standard rugosity chain-link method), number and size of holes, estimating total standing structure from benthic photographs and estimating rugosity from scaled vertical reef photographs. We found that estimating total standing structure from photographs was the most informative and efficient index of measuring structural complexity. 'Total standing coral structure' was defined as percent hard coral (sum of dead, bleached and live coral) structure which was estimated by placing a percentage grid on a 1msq area of the benthic photograph.

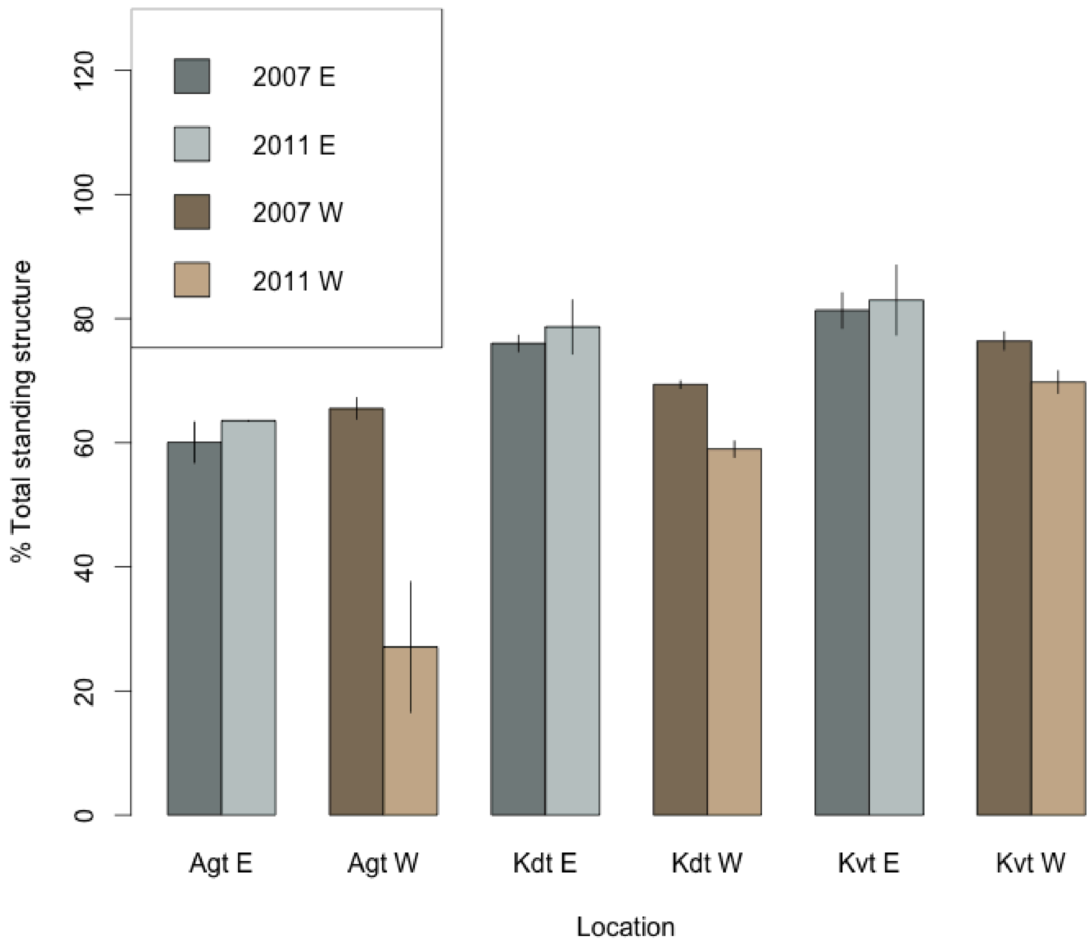
Fish composition: Data on fish species was collected along the benthic transect using a visual belt transect (50m x 5m x 5m). Data was collected on fish species, abundance and size classes (5-10cm, 10-30cm, 30-50cm, 50+cm).

Preliminary Results

Structural loss as a result of the bleaching event (2010): A gradient of structure in Lakshadweep

We assessed the present benthic status of the reefs across the archipelago after the 2010 bleaching event, our results show a mixed picture of impact across the archipelago, with few clear geographical patterns in live coral cover, percentage bleaching and hard coral cover after the bleaching event. Bleaching impacts on live coral cover were highly site specific and depended upon various factors like pre-bleaching reef condition and local hydrodynamic processes (Arthur et al 2011, Interim Rufford Report). What is evident, however, is that there was a marked difference in the amount of structural loss after the bleaching event on the eastern and western aspect of atolls, in response to the annual summer monsoons (Fig 1).We compared pre-bleaching (2007) and post-bleaching (2011) data from six reef sites at three atolls (Kadmat, Kavaratti and Agatti). Western reefs show a dramatic decline in structure after the 2010-bleaching event while the eastern reefs remain relatively stable (Fig 1). A previous study by Rohan Arthur shows similar patterns in structural declines after the 1998 bleaching event (Arthur 2000).

Figure 1: Bar graph indicating a change in 'total standing structure' at reefs on the eastern and western aspect of three atolls: Agatti (Agt), Kadmat (Kdt) and Kavaratti (Kvt), between years 2007 and 2011.



Patterns in distribution of groupers in the archipelago

We recorded 29 species of groupers in the islands in the genus *Cephalopholis, Epinephelus and Plectropomus* (See appendix, Table 4). We looked for broad patterns in the distribution of groupers across the archipelago with respect to various variables such as abundance, species richness, density and biomass, with few clear geographic patterns.

Table 1: One-way analysis of variance showing difference in mean of attributes with respect to aspect (E-W). Attribute mean (+/-SE), F-statistic and the associated p-value.

Attribute	**E (mean +/-SE)**	**W (mean +/-SE)**	**F**	**p**
Species richness	6.25 (0.56)	5.58 (0.58)	0.68	0.41
Biomass*	6400.3 (1006.6)	1938.4 (1040.8)	9.4	0.003*
Density	0.0299(0.004)	0.0198 (0.004)	2.29	0.13
Small Biomass	255.7 (32)	239 (33)	0.131	0.71
Medium Biomass*	1324.7 (98.7)	329 (102)	49.14	0.0001*
Large Biomass*	483 (100)	330 (104)	1.1	0.029*

a. Patterns in total biomass:

Mean total biomass (gms/transect) of groupers is three times higher on the eastern reefs as compared to the western reefs (Fig 1, Table 1).

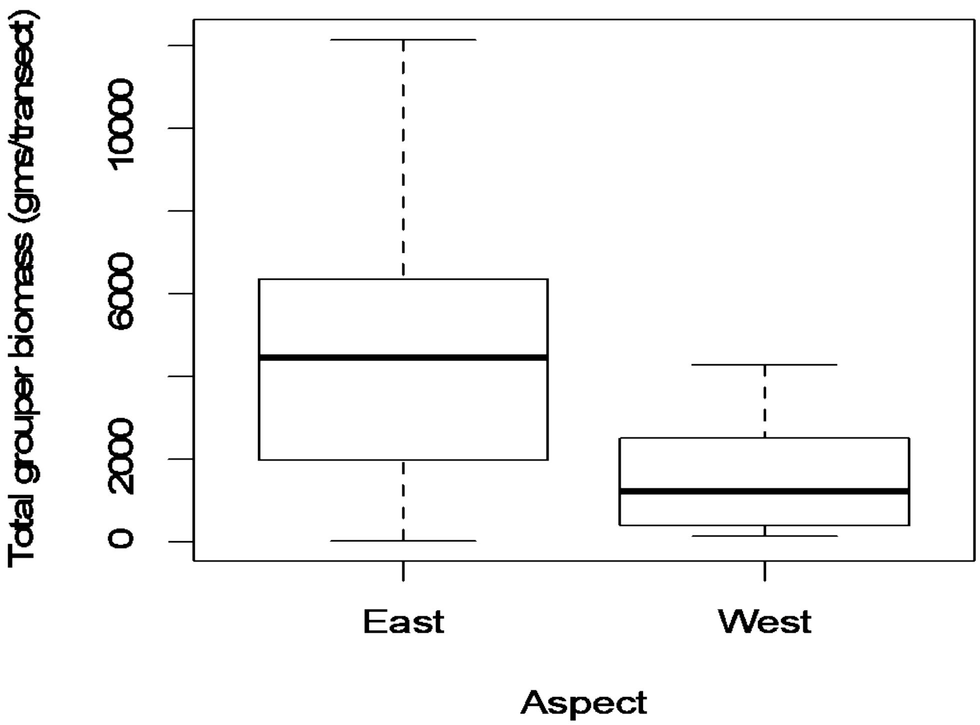


Fig 1: Mean total grouper biomass (gms/transect) on Eastern and Western

reefs.

b. Size class distribution:

Eastern reefs abound in medium (30-50cm) and large (50cm+) size class individuals (Fig 2, Table 1).

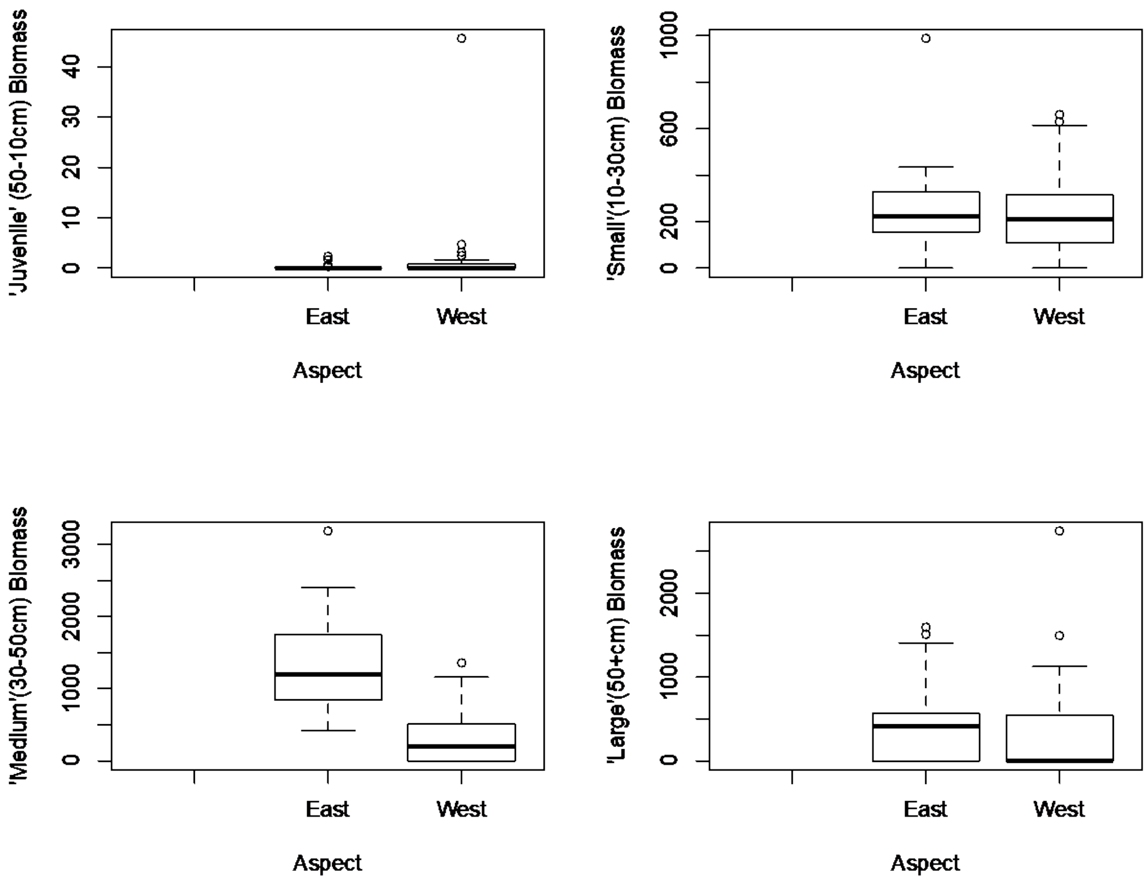


Fig 2: Size class distributions in Eastern and Western reefs. Eastern reefs show higher grouper biomass (gms/transect) of medium and large size-classes.

c. Species composition:

We conducted an Analysis of Similarity (ANOSIM) to look for dissimilarities between grouper community composition between eastern and western reefs. We found that communities on the east and west are more or less similar with respect to species composition, but the major dissimilarities lie in the biomass of inhabiting species. (ANOSIM R-statistic= 0.18, p=<0.05*)

The species that showed the most striking difference in biomass between east and west were determined by the Similarity Percentage procedure (SIMPER). Large-bodied species (max body size >30cm) abound in the east while smaller bodied species (max body size< 30cm) abound in the west (Table 2).

Table 2: **Average biomass per reef location of 12 grouper species giving the most significant contribution to the community difference between East and West. Contribution to the dissimilarity was given by the SIMPER procedure comparing grouper communities between Aspect (E & W), based on Bray-Curtis similarities.**

Species	**Avg Biomass E**	**Avg Biomass W**	**Contribution to total Dissimilarity**	**Max body size**
Cephalopholis argus	14873.48	4391.19	25.98	M
Plectropomus laevis	9445.6	2640.09	15.47	L
Plectropomus punctatus	12103.79	1168.25	14.07	L
Variola louti	3842.1	3751.83	10.95	L
Aethaloperca rogaa	4173.52	961.62	7.1	M
Cephalopholis urodeta	**764.61**	**1593.96**	**3.35**	**S**
Epinephelus polyphekadion	1196.93	701.42	2.65	L
Cephalopholis leopardus	**281.85**	**1177.25**	**2.64**	**S**
Epinephelus malabaricus	898.26	606.32	2.58	L
Gracila albimarginata	1527.69	240.9	2.54	M
Epinephelus fuscoguttatus	678.38	560.5	2.31	M
Variola albimarginata	413.25	380.65	1.88	M

*** max-body size= S=10-35cm, M=35-55cm, L=55+cm**

Importance of structure in shaping grouper communities

a. Nestedness analysis

Nestedness is a pattern reported for species occurrence in metacommunities (Ulrich et al. 2009). It is a pattern that is observed when sites with lower species richness tend to harbor species that are a subset of species in higher richness sites. Nestedness may arise when there are differences in habitat features: isolation, size, quality, or species attributes: abundance, area requirements, environmental tolerance, etc.

Various metrics have been used to determine degrees of nestedness. Nestedness analysis uses maximally packed presence-absence matrices in which sites are arranged in decreasing order of richness and species are arranged in decreasing order of occurrence. A nestedness metric is computed and compared to the distribution of 1000 values obtained from randomized, maximally packed matrices.

The NODF metric (Neto et al. 2008) has the ability to distinguish between a nested pattern arising out of habitat features (NODF $_{(sites)}$) and species attributes (NODF $_{(species)}$). Additionally, NODF allows us to arrange the sites according to a known gradient, to determine if the assemblages are nested along that gradient. In our analysis, we arranged the sites in decreasing order of structural complexity. We found that the 34 reef sites were nested along a gradient of structure (Nodf $_{(sites)}$ = 35.5, p=<0.005*), such that the grouper assemblage at low structured sites are a nested subset of the same at high structured sites.

Six reefs showed deviation from pattern of nestedness:
Four sites (**'Ultimate Climax', 'Cape Cod', 'Latif's revenge**' and **'Wet Nurse', see table 5 in appendix) were** found to be more nested than expected, i.e they had high structure but lower species richness than expected. However, we observed spawning aggregations of three grouper species *(P. punctatus, P. laevis and P.areolatus)* and the assemblage was dominated by these 3 species only.

Two sites (**Enough!** And **Strumpet's Trumpets)** were found to be less nested than expected (having higher species richness than expected). These sites had low structure but comprised an unusually high richness of species. These sites were located at the two most isolated atolls Kalpeni and Minicoy.These atolls in general harbor the highest fish biomass and diversity in the archipelago (data to be analysed). They have occurrences of rare species *(A. leucogrammicus, C.sonneratti, E.lanceolatus)*. If we were to exclude these six sites from the analysis, the degree of nestedness becomes stronger (NODF $_{(sites)}$=51.2, p<0.005*).

b. Relationship with structure

Grouper biomass shows a strong exponential relationship with structure on the east (Fig 3) and no relationship with structure on the west (Fig 4).

Fig 3: Grouper biomass (gms/transect) shows an exponential relationship (r^2=66.8) with structure on the eastern reefs

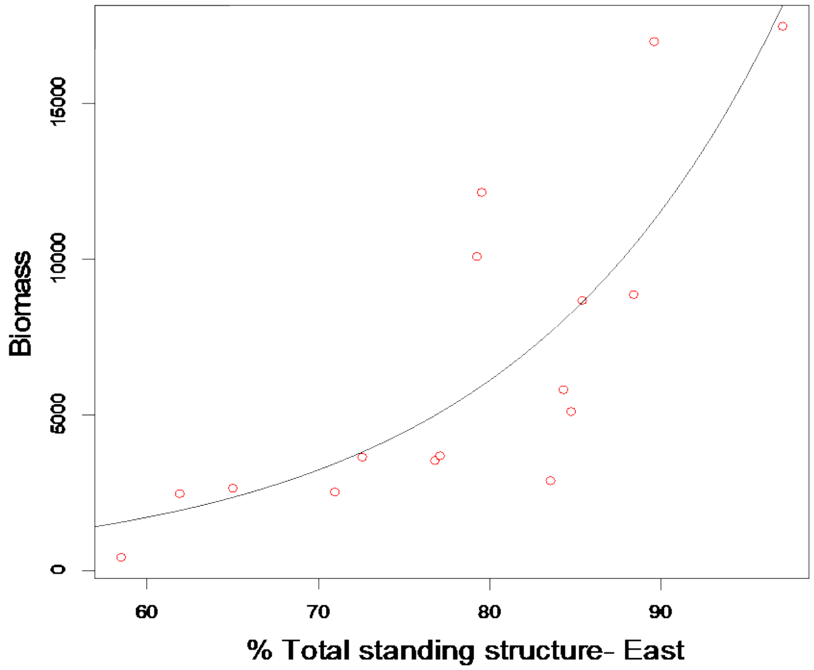
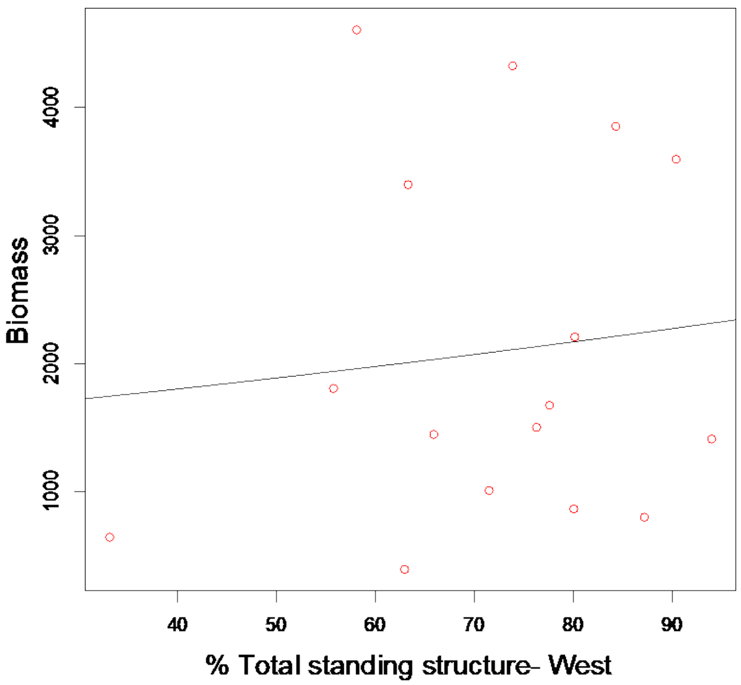


Fig 4: Grouper biomass (gms/transect) shows no relationship with structure on the western reefs



Discussion

Structural loss as a result of the bleaching event (2010): A gradient of structure in the Lakshadweep:

The structural environment on the eastern aspect of atolls seems to be temporally more stable as compared to reefs on the western aspect of atolls. The two primary reasons for this difference are, firstly, the difference in hydrological processes on the eastern and western aspect of atolls; the western aspect is subject to six months of monsoonal turbulence while the eastern aspect remains relatively sheltered during this period. Secondly, the timing of the bleaching events; bleaching takes place during the summer season (March-May), which is immediately followed by the monsoons (May-October). As bleached coral is highly susceptible to physical erosion, it is very likely to rapidly breakdown in the unsheltered reefs (western aspect), due to turbulent conditions and may remain intact in the sheltered reefs (eastern aspect).

In addition to differences in bleaching and monsoonal impacts on the eastern and western aspect of atoll, reefs in the Lakshadweep show different recovery patterns. Benthic and structural recovery after the 1998 bleaching events was found to be highly site specific in the atolls (Arthur and Done 2005). Arthur 2005, found that although reefs on the western aspect of three atolls (Agatti, Kavaratti, Kadmat) showed a dramatic loss of coral structure, they were also the quickest to recover from the bleaching event, primarily because the benthic community comprised dominantly of fast growing, branching species of acropora, pocillopora, montipora etc.

This sets up a gradient of structure in the Lakshadweep atolls, which allows us to distinguish between structurally dynamic reefs (mostly on the western aspect of atolls) and structurally stable reefs (on the eastern aspect of atolls). Further analysis of our current data, and previous datasets is needed to lend more support to our hypothesis of this structural gradient. Similarly, our future studies will look at inter- and intra annual variability in structure at 'structurally stable' and 'structurally dynamic reefs' in more detail. We hypothesize that this benthic-structural dynamism in the reef system plays an important role in structuring communities of structure dependent predators.

Patterns of distribution of groupers in the archipelago

Grouper biomass and demography seems to be driven by structural dynamism of reefs (Table 1, Fig 2). Structurally stable, eastern reefs tend to support a much higher overall biomass of groupers. This difference in biomass arises because the structurally stable eastern reefs abound in larger sized individuals of species (Fig 2, Table 1). Species composition does not vary much between the eastern and western reefs (Table 2), however we found that certain large bodied species are more

abundant on the structurally stable eastern reefs.
Habitat availability might be the primary reason that determines the size of individuals that can inhabit the reefs (Hixon 1993). Since groupers are ambush predators, the size of the ambush site (or hole) could be important in determining whether the predator can use the ambush site. Since structure in the east is temporally stable, it may be possible that the reef matrix harbors larger sized ambush sites and could therefore support larger bodied ambush predators as well. Alternately in the dynamic western reefs, it is possible that there are smaller ambush sites and therefore smaller bodied ambush predators. Here, prey availability could also be an important limiting factor. Our data does suggest that prey availability does not differ between reefs, however this needs to be formally tested and studied in more detail. Thus, we propose that structural dynamism of reefs could affect the demography and biomass distribution of benthic predators.

Importance of structure in shaping grouper communities:

a. Nestedness analysis

Community composition of groupers seems to be influenced by the amount of structural complexity of reefs. The nestedness analysis indicates that as the structural complexity of the reefs goes on reducing, the grouper community tends to relax as some species tend to drop off from the community *(P. areolatus, P. punctatus, E. malabaricus, E. multinotatus).* It is possible that these species have certain habitat requirements that cannot be met in structurally poor reef sites. It is also possible that these species are diet specialists and cannot survive in degraded habitats that do not support their preferred prey species. Another possibility could be that these species have less flexible predation strategies (primarily ambush strategy) that makes them less efficient predators in degraded habitats. We will be studying these traits in more detail in further work.

Isolation seems to be another important factor that seems to affect community composition, with isolated islands showing higher species diversity, biomass and richness (data to be analysed) - a concept that has been presented previously in the literature (Stevenson et al. 2007) and we will be looking into in more detail in further data analysis.

b. Relationship with structure

Groupers are primarily benthic ambush predators; however many species show flexible predation strategies. Our data indicate that groupers show a strong exponential relationship with structural complexity on the eastern reefs (Fig 3) and no relationship with structure on the western reefs (Fig 4). It is possible that groupers efficiently use their ambush predation strategy on the east because of the temporally stable habitat and have adapted to the dynamic structural environment on the west by adopting less structure-dependent predation strategies. At this stage we do not have the data to test the hypothesis of switching of predation strategies in response to changing habitat. Our next season's work will also focus on this theme.

Implications and future directions

Substantial seasonal changes occur in coral cover and structure in the Lakshadweep in response to bleaching events. Such variations in structure may result in fish assemblages becoming more and more adapted to non-coral dominated communities, where both habitat availability and feeding resources are more associated with seasonal changes in available benthic resources than with a stable coral reef platform (Feary et al. 2010). Reefs will lose out on specialist species (which may be functionally important and un-substitutable) assemblages being comprised eventually of generalist species.

What is evident from our initial surveys is that as the structural complexity of reefs reduces, reefs tend to harbor smaller bodied species and that some species of groupers drop off from communities. Further analysis of our data is needed to understand how structure affects individual species of groupers, which species are most sensitive to decreasing structure and what are the species attributes and requirements for which structure is a limiting factor.

The spatial extent of habitat devastation is ever increasing due to climate-change events and anthropogenic pressures. If this trend cannot be reversed by management actions, species with restricted dispersal or small geographic ranges will be threatened by extinction (Jones et al. 2004). Marine reserves are considered to be an effective management strategy for protecting marine biodiversity (Halpern 2002, Wilson et al. 2010) but there is a growing recognition that such areas cannot protect reefs from large-scale pollution or global warming (Jones et al. 2004).

In order to set this study in a predictive framework it becomes necessary to address the mechanisms underlying these relationships. These are some questions we would like to address in our next season:

1. Is there migration between habitats with increasing body size?

2. Are the differences in size class distributions between aspect a more complex interaction between both environment and demographic factors? (Fonseca 2007, Feary et al. 2010). I.e.is it possible that individuals tend to reach smaller maximum body sizes and have a shorter lifespan in stressful environments (Figueira et al. 2009)?

3. Is there a physiological cost to switching to less efficient predation strategies? Do groupers on the west show suppressed growth rates to adapt to the dynamic structure?

Acknowledgements

I would like to thank the Rufford Small Grant Foundation and Idea Wild for funding this project. The Lakshadweep Administration, Department of Science and Technology, Department of Fisheries and the Department of Environment and Forests for granting us permits to carry out the fieldwork. The Lacadives crew: Siddarth, Marieke, Torben, Umeed, Naintara and Soham for their support, advice and help with the dives and their lovely company. A special thank you to Ommini (Ibrahim), Shahjahan, Shamshu, Bunni, Kacchi, Mallik who were our friends in Kadmat, Ali kaka and the dive-crew in Minicoy, Baljeet and Rashid from Kalpeni – we owe it to these people for the smooth execution of our survey and a comfortable stay in the islands. I would also like to thank our friends, Jafer Hisham and Idris Babu for their valuable inputs to our work, their knowledge and understanding of the reefs and people of Lakshadweep. Aaron Lobo who helped us collect the fish data, and Dr Teresa Alcoverro who helped us with the structure and analysis, have been an indispensible part of this project and team. A big thank you to Anne, Naveen, Meera and Bharati who have seen me through every step of this project. A final thank you to Ashwin, my parents and Megha who have been silent, albeit my biggest support system during this project.

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Table 4: A Checklist of grouper species recorded during the study

	SCIENTIFIC NAME	COMMON NAME	MAX.BODY LENGTH	SIZE AND FOOD GUILD
1	Aethaloperca rogaa	Redmouth grouper	60	Medium Piscivore
2	Anyperodonleuco grammicus	Slender grouper	65	Medium Piscivore
3	Cephalopholis argus	Peacock hind	40	Medium Piscivore
4	Cephalopholis boenak	Chocolate hind	30	Medium Piscivore
5	Cephalopholis hemistiktos	Half-spotted hind	35	Medium Piscivore
6	Cephalopholis leopardus	Leopard hind	24	Small Piscivore
7	Cephalopholis miniata	Coral hind	41	Medium Piscivore
8	Cephalopholis sexmaculata	Sixspot hind	47	Medium Piscivore
9	Cephalopholis sonnerati	Tomato grouper	57	Medium Piscivore
10	Cephalopholis urodeta	Darkfin hind	27	Small Piscivore
11	Epinephelus caeruleopunctatus	Whitespotted grouper	76	Large Macroinvertevore
12	Epinephelus fasciatus	Blacktip grouper	40	Medium Macroinvertevore
13	Epinephelus fuscoguttatus	Brown-marbled grouper	90	Large Piscivore
14	Epinephelus hexagonatus	Hexagon grouper	26	Small Macroinvertevore
15	Epinephelus macrospilos	Snubnose grouper	50	Medium Macroinvertevore
16	Epinephelus malabaricus	Malabar grouper	140	Large Macroinvertevore
17	Epinephelus melanostigma	Blackspot grouper	35	Medium Macroinvertevore
18	Epinephelus merra	Honeycomb grouper	31	Medium Macroinvertevore
19	Epinephelus miliaris	Netfin grouper	53	Medium Omnivore

20	Epinephelus multinotatus	White-blotched grouper	100	Large Piscivore
21	Epinephelus polyphekadion	Marbled grouper	75	Large Omnivore
22	Epinephelus spilotoceps	Foursaddled grouper	30	Medium Omnivore
23	Gracila albomarginata	Slenderspine grouper	40	Medium Omnivore
24	Plectropomus areolatus	Squaretail grouper	100	Large Piscivore
25	Plectropomus laevis	Blacksaddled grouper	110	Large Omnivore
26	Plectropomus pessuliferus	Roving coralgrouper	90	Large Piscivore
27	Plectropomus punctatus	Marbled coralgrouper	96	Large Piscivore
28	Variola albimarginata	WhitemarginLyretail grouper	60	Large Piscivore
29	Variola louti	Lyretail grouper	80	Large Piscivore

Table 5: Reef sites sampled at the different atolls in Lakshadweep

Atoll	Reef	Aspect
Agatti	The Groove	W
	Airport View	W
	Japanese garden	E
Amini	3 Buoys	E
	Entrance point	W
Bangaram	Tinnakara Lighthouse	E
	Manta point	W
Bitra	The Hakka	W
	The Spurs	W
	Three Rays	E
	Ultimate Climax	E
Cheriyapani	Latif's Revenge	E
	Foundation stone	E
Chetlat	Red Fort	W
	SIK's manion	E
Kiltan	Pangolim point	W
	Lobosphyllia	E
Kadmat	The Cave	W
	North Cave	W
	Potato Patch	E
Kalpeni	The Green Mile	W
	Enough	W
	The Hole	E
	The Metropolis	E
Kavaratti	Lighthouse point	E
	Wall of Wonder	W
	Black Tangues	W
Peremul Par	Cape Cod	E
	Wet Nurse	E
Minicoy	Strumpet's Trumpets	E
	Wreck of the Old Navodaya	E
	NauEriMagu	W
	Engolikolo	W
	Regum Reef	W