Bonaire Expedition 2014

Relationships between coral reef complexity and fish communities

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Abstract

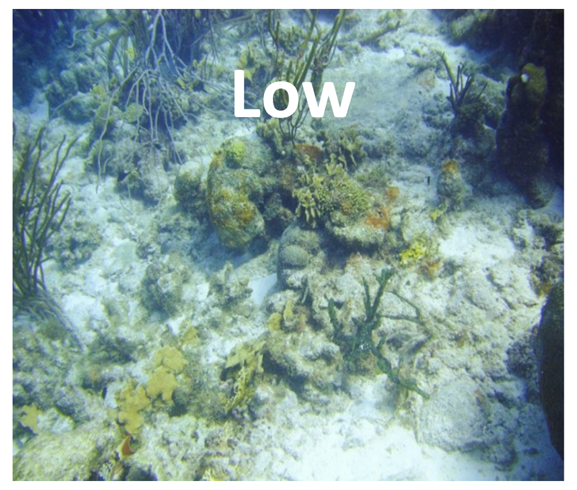
Coral reefs in the Caribbean are declining in structural complexity contributing to dramatic changes in fish community structure. However an understanding of nocturnal fish relationships with complexity and the effects of complexity on mesopredators is lacking. The expedition was the first to find an overall positive relationship between fish abundance, biomass, species richness and complexity, although at a family level these relationships were highly variable with some negative relationships evident at night Also graysby, a common mesopredator, selected specific features such as overhangs and towers emphasising the need to conserve high complexity reefs.

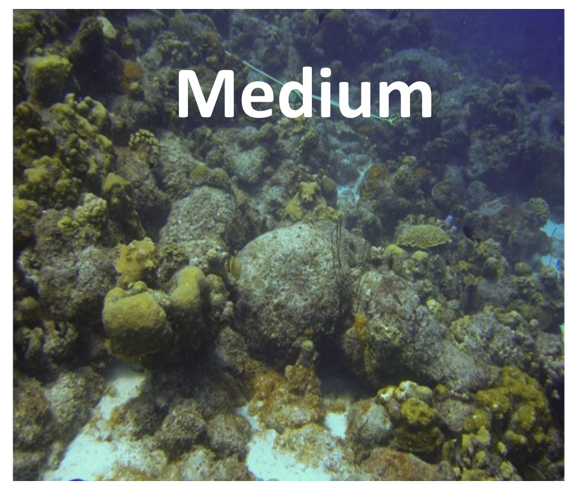
Introduction

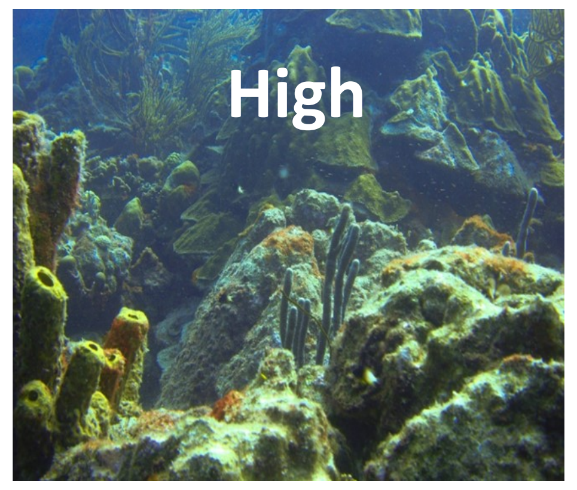
Habitat complexity is the physical structure in space which supports plant and animal communities by providing resources and microhabitats[1]. These resources include space for foraging, breeding, nesting and refuging. Of particular concern has been the decline in coral reef complexity in the Caribbean[2] causing a loss of diversity and abundance of coral-associated fish species[3]. Additionally the overexploitation of large predatory fish has affected mesopredators population and behaviour, such as graysby (*Cephalopholis cruentata*). The expeditions primary aim was to further understanding of relationships between complexity and fish communities by identifying relationships between fish communities and complexity at night (study 1) and identifying which specific reef features graysby selected (study 2).

Methods

Bonaire National Marine Park (Fig. 1) was selected as the expeditions study site because it provided a good range of reef complexities and the reefs were accessible from the shore. Plots of 5 m x 5 m were haphazardly located at least 10 m apart at a mean depth of 11.3m. Reef complexity was assessed by a visual assessment on a three point scale[4] (see pictures below) and further by enumerating and sizing reef features, such as holes and structurally complex corals such as *Orbicella* spp. structures. Underwater visual census of the whole fish community was conducted by a SCUBA diver, day and night (Study 1). Night surveys were conducted an hour after sunset with the use of red light to reduce the escape reaction of fish. On a more specific level graysby within the plot were observed and the features they were associating with recorded[5] (Study 2).







Results

Study 1 — This was the first study to find positive relationships between total fish biomass and complexity were found during the day and at night. However, differences in species composition were clear between the diurnal and nocturnal fish community composition (PERMANOVA, *pseudo-F* = 44.414, *p* = 0.001) and differences found between species composition across complexity levels were found (PERMANOVA, *pseudo-F* = 8.846, *p* = 0.001). Relationships between fish families and complexity were further explored and revealed differences between day and night (Fig. 2). Of particular interest was some families showed no day/night difference (graysby), a decrease in biomass (gobies), an increase in biomass (cardinalfish) or had a positive relationship during the day but at night had a negative relationship with complexity (grunts).

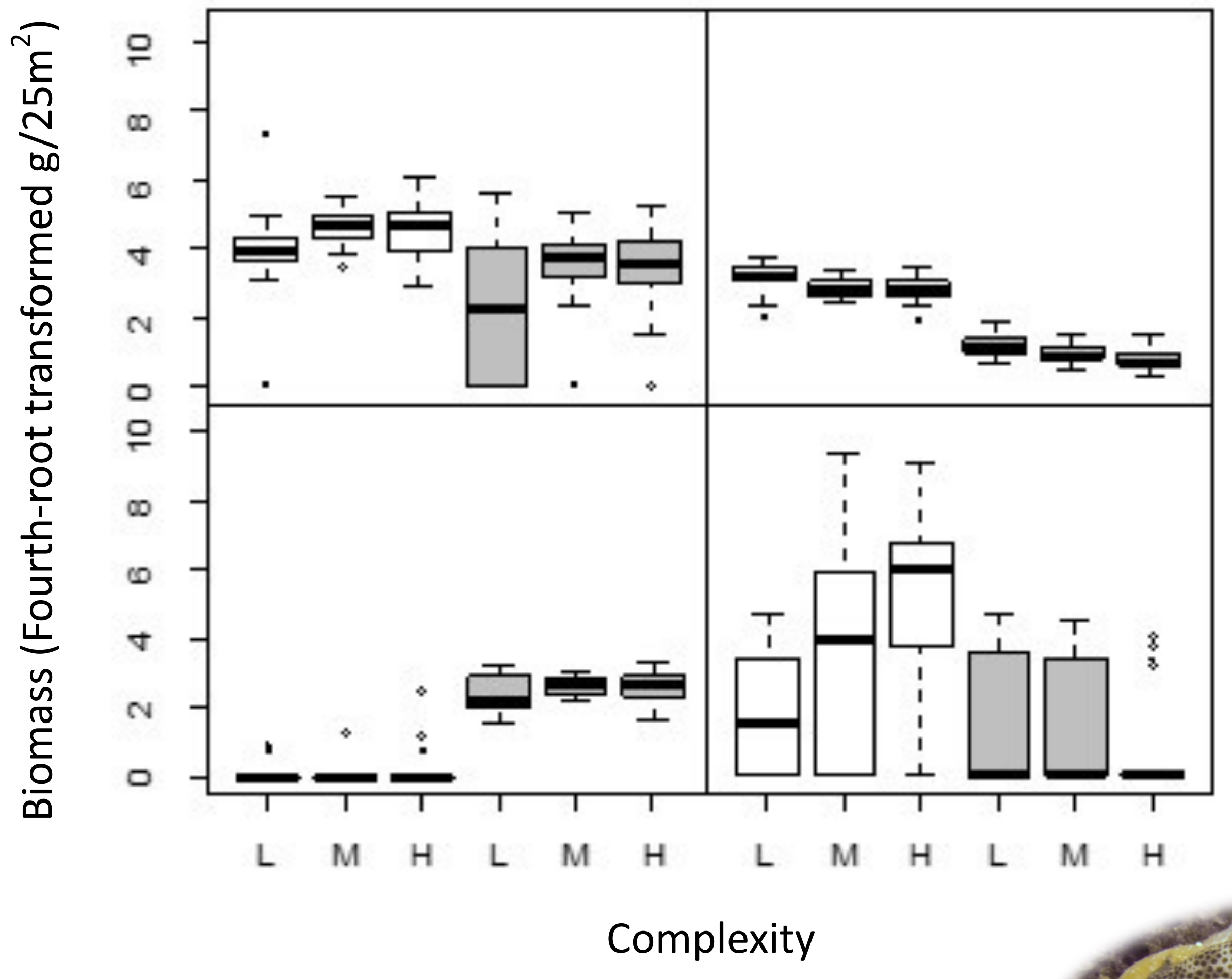
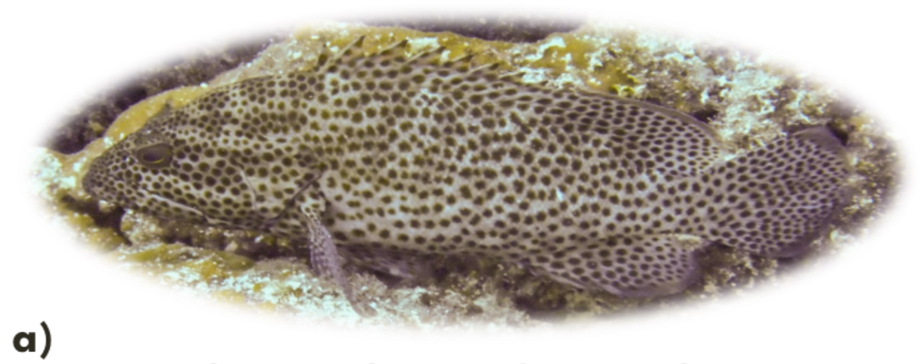


Figure 2. Total fourth-root transformed biomass of grayby (top left), gobies (top right), cardinalfish (bottom left) and grunts (bottom right) during the day (white) and at night (grey) across low (L), medium (M) and high (H) complexity reefs.

Study 2 — Graysby showed significant selectivity of features at low (Chi squared with log logistic regression, χ^2 = 80.862, df = 12, p < 0.001) and medium complexities (Chi squared with log logistic regression, χ^2 = 20.982, df = 13, p < 0.001) but not at high complexities (Chi squared with log logistic regression, χ^2 = 21.803, df = 13, p > 0.05). Further exploration showed that specific features such as overhangs, tall structures and coral colonies such as *Orbicella* structures were used disproportionately in relation to their abundance on the reef, also termed as selective use of these reef features.



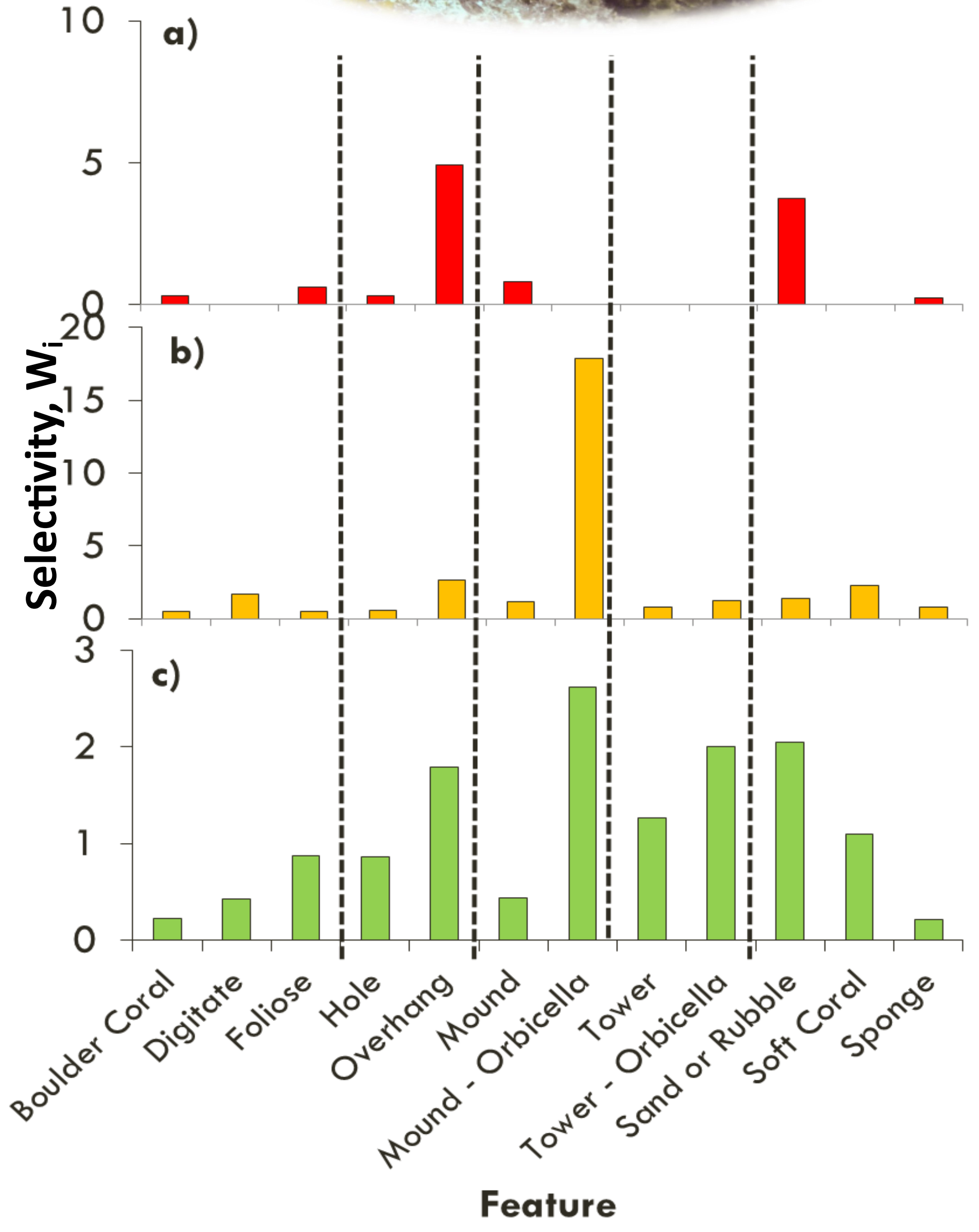


Figure 3. Selectivity of features across a) low, b) medium and c) high complexity reefs using Manlys Selectivity[6], W_i. Specific selectivity of features is represented by larger numbers, W_i closer to 0 represents non selective use.

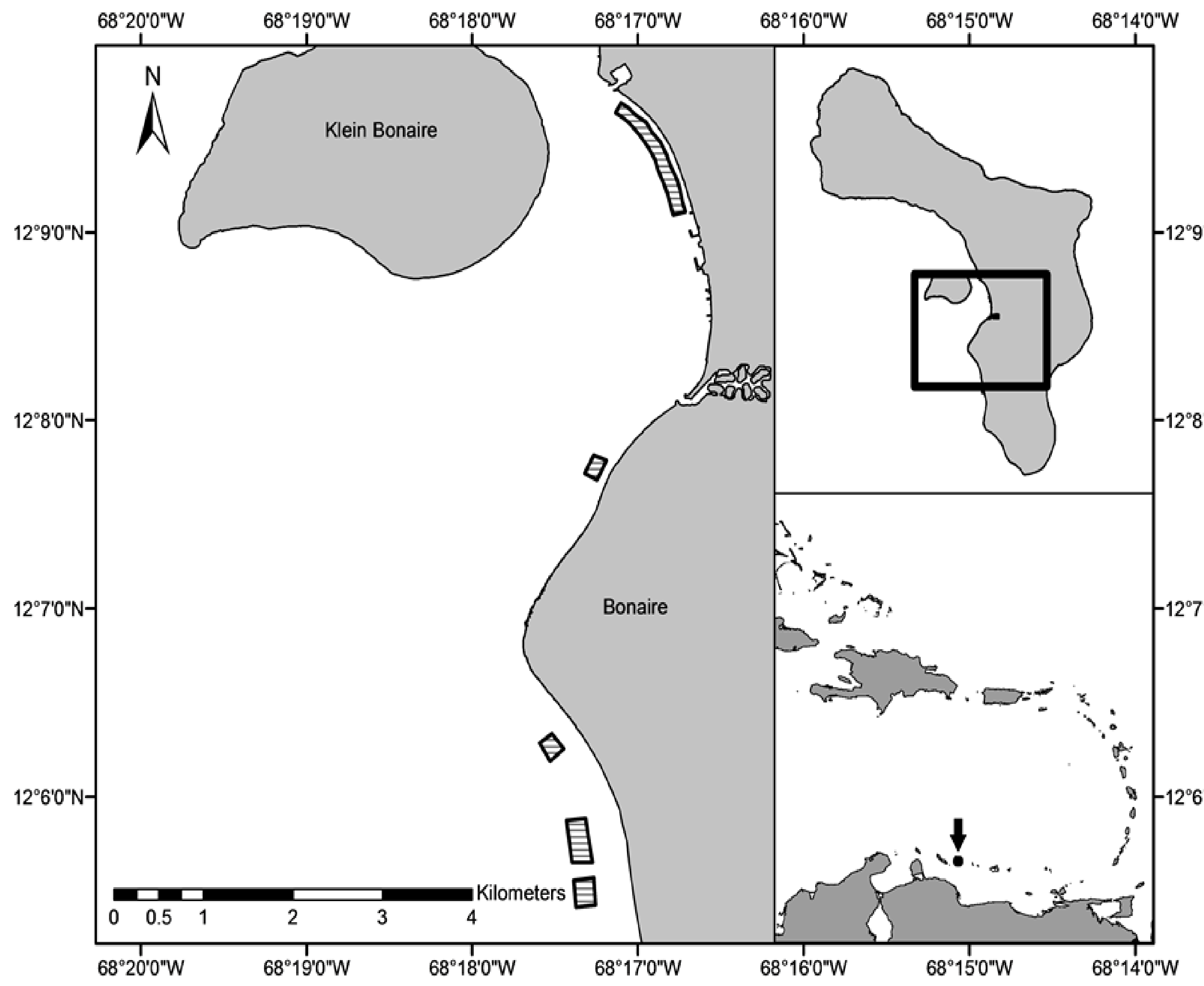


Figure 1. Map of Bonaire, southern Caribbean with dive sites located on leeward forereefs as shown in the highlighted boxes

Conclusions

This expedition revealed fish communities continue to associate with high complexity reefs at night, although some nocturnal fish families utilise low complexity reefs to forage. Although graysby abundance was not correlated to complexity they preferentially selected features such as towers and overhangs that gave them good vantage points to spot predators and seek prey. All of the results of this expedition are novel and furthers our understanding of complexity interactions, critical to foreseeing the effects of diminishing complexity on fish assemblages in the Caribbean. In addition the results emphasises the need to maintain high complexity reefs to conserve an abundant, productive and diverse fish community, for a healthy coral reef ecosystem, to sustain fisheries and ecosystem services.

References

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