Coral Community Structure Change of Brewers Bay, St. Thomas USVI After a 30-Year Period

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Introduction

- Coral reefs cover < 0.1% of the ocean surface area, but harbor up to 25% of all marine fish species. This eco-system provides humans services valued at approximately $US375 billion worldwide (Costanza et al., 1997).
- Global warming, ocean acidification, over fishing, eutrophication, and coastal development threaten the health and prosperity of coral reefs. Synergism of these coral hazards has resulted in a significant decline in live coral cover on many shallow Caribbean reefs in the last three decades.
- From 1978-1982 Rogers (1982) conducted an assessment of coral diversity at 3 sites in Brewers Bay, St. Thomas, USVI prior to and after an extension of the St. Thomas runway. Since then, the area has been subjected to hurricanes, mass bleaching, disease outbreaks, and nutrient input from a densely populated watershed.
- In 2012, we replicated Rogers's (1982) methods at these sites to illustrate community changes over a 30-year period.

STUDY HYPOTHESIS: Live coral cover has changed in response to environmental conditions in Brewers Bay over a 30-year time period.

Methods

- Three sites were surveyed within Brewers Bay: Brewers West (BWC), Brewers Middle (BMC), and Brewers East (BEC) (Fig 1).
- Each site was surveyed with 4 linear 10-m transects (Fig 2: D) and 4 9-m chain transects (Fig 3).
- Linear transects were surveyed for coral species, size (max diameter, width, and height), lesion presence, and mortality. Chain transects were surveyed for rugosity and benthic cover.
- Lesions documented included predation (damselfish), yellow band, and bleaching (Fig 2: A-D).
- Live coral cover and rugosity between time periods (study) and among sites were compared using a 2 way-Analysis of Variance (ANOVA).
- Diversity and species evenness were compared temporally using one-sample T-tests assuming unequal variances.
- To assess the 2005 mass bleaching event effect on live coral cover, we compared the Territorial Coral Reef Monitoring Program (TCRMP) data from Brewers Bay using a repeated measures ANOVA (RM-ANOVA).

Brewers Bay, St. Thomas, USVI

Fig 1: Coral survey sites at Brewers Bay, St. Thomas USVI.

Lesions

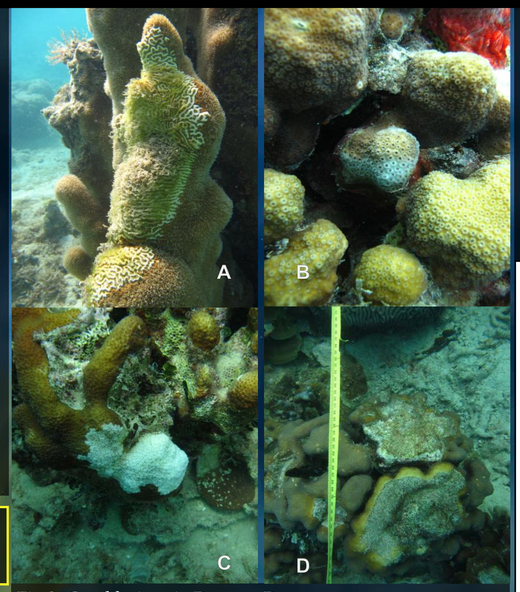

Fig 2: Coral lesions in Brewers Bay.
A: Damsel fish garden B: Bleaching
C: Predation D: Yellow band

Results: Community Structure

- 258 coral colonies of 17 species were surveyed from January-September, 2012.
- Sizes ranged from .25 cm^3 - 879750 cm^3 with a median of 336 cm^3.
- Five species dominated the coral community (Fig 4).
- Dead coral with turf algae was the most dominant benthic cover type (Fig 5).

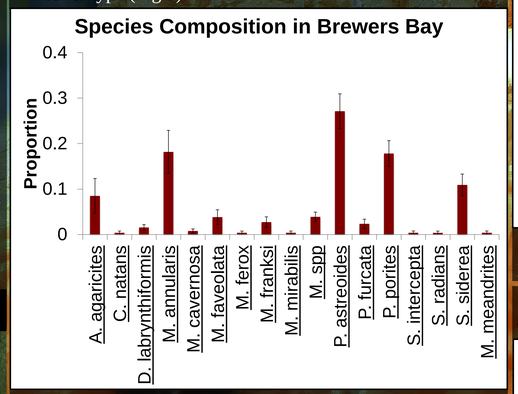

Fig 4. Average coral species proportions (± SEM) of Brewers Bay.

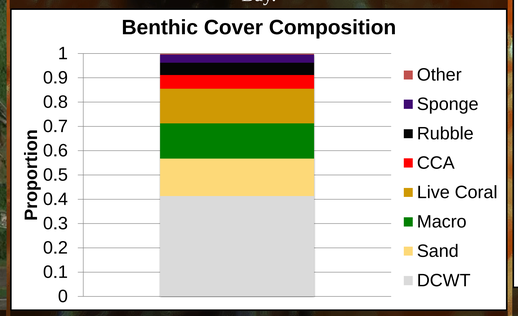

Fig 5: Average benthic cover composition of Brewers Bay.

Results: Temporal Comparisons

Live Coral Cover: 2-Way ANOVA Results

- Live coral cover exhibited significant effects of study and site, but no interaction between study and site (Fig 6, Table 1).
- Live coral cover by study indicated a significant decrease between 1982 and 2012 (Fig 6: Capital letters indicate significant groups).
- Live coral cover by site indicated that BEC had significantly less coral than BMC and BWC (Fig 6: Small letters indicate significant groups).

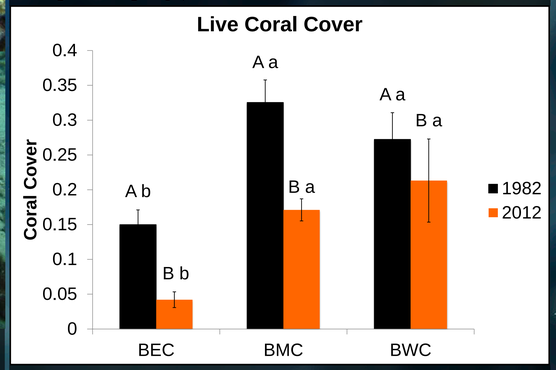

Fig 6: Average live coral cover (± SEM) at three sites, compared by study year. Letters indicate post-hoc test results, where $p < 0.05$.

Rugosity 2-Way ANOVA Results

- Rugosity exhibited significant effects of study and site, but no interaction between study and site (Fig 7, Table 1).
- Rugosity by study indicated a significant decrease between 1982 and 2012 (Fig 7: Capital letters indicate significant groups).
- Rugosity by site indicated that BEC was significantly less rugose than BMC and BWC (Fig 7: Small letters indicate significant groups).

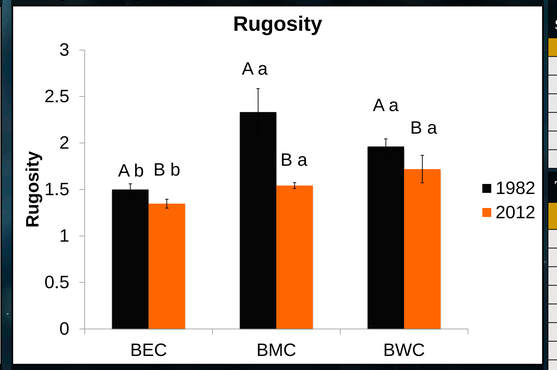

Fig 7: Average rugosity (± SEM) at three sites, compared by study year. Letters indicate post-hoc test results, where $p < 0.05$.

Species Diversity (H'): One-Sample T-test

- Results of statistical analysis indicated significant decrease in species diversity at BEC and for sites combined (Fig 8, Table 2).

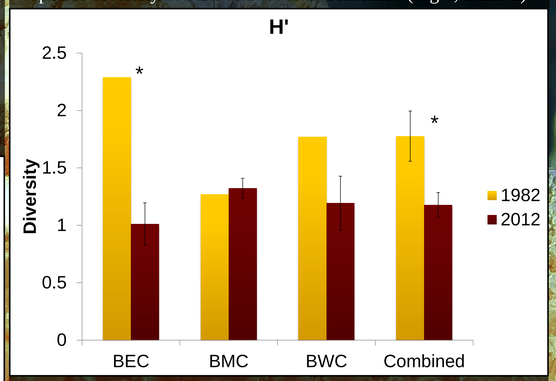

Fig 8: Species diversity (± SEM) at three sites, compared by study year. * indicates significant difference.

Species Evenness (H'/H'max): One-Sample T-test

- Results of statistical analysis indicated significant increase in species evenness at site BMC (Fig 9, Table 2).

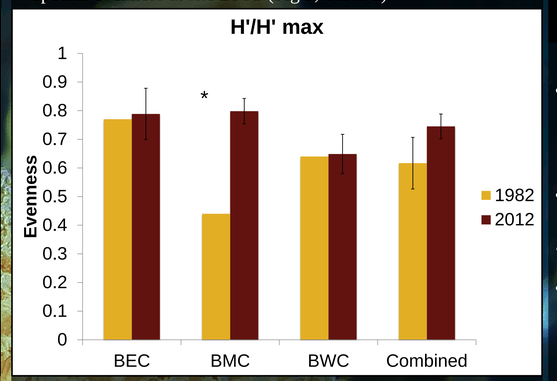

Fig 9: Species evenness (± SEM) at three sites, compared by study year. * indicates significant difference.

TCRMP Live Coral Cover Data: RM-ANOVA

- RM-ANOVA indicates no significant effect of year on live coral cover (Fig 10, Table 3).

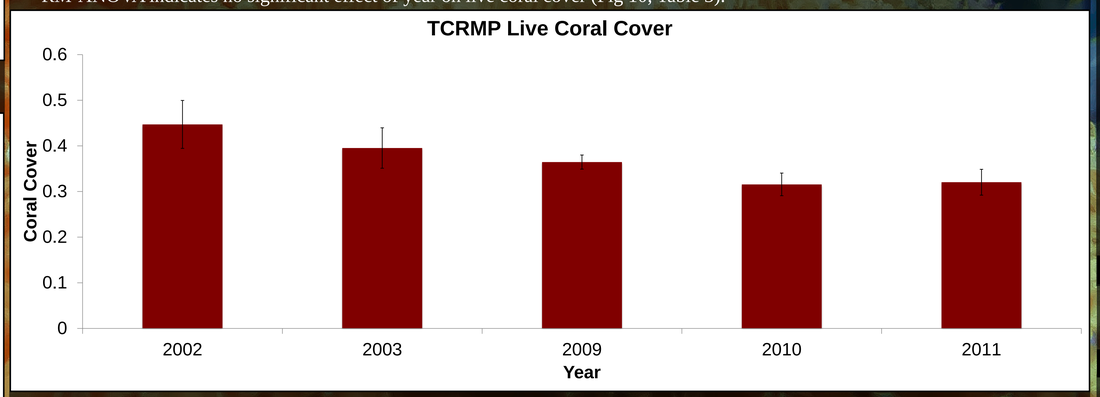

Fig 10: Average TCRMP live coral cover (± SEM) by year from 2002-2003 and 2009-2011. A mass bleaching event occurred in 2005, but no significant impact was detected on live coral cover according to the RM-ANOVA.

Statistical Summary

Fig 3: Chain Transect

Table 1: Results of 2-way ANOVA testing for the effect of study and site on live coral cover and rugosity.

Variable	ANOVA Source	F Ratio	p Value
Live Coral Cover	Study	**12.89**	**0.001**
Live Coral Cover	Site	**11.35**	**0.0002**
Live Coral Cover	Site * Study	0.8316	0.4443
Rugosity	Study	**9.25**	**0.005**
Rugosity	Site	**6.99**	**0.003**
Rugosity	Site * Study	1.58	0.22

Table 2: One-sample T-test results

Variable	Site	1982 Mean	2012 Up. 95%	2012 Low. 95%
H'	BEC	**2.29**	**1.6**	**0.42**
H'	BMC	1.27	1.6	1.05
H'	BWC	1.77	1.94	0.45
H'	Combined	1.78	1.41	0.94
H'/H' max	BEC	0.77	1.07	0.50
H'/H' max	BMC	**0.44**	**0.94**	**0.66**
H'/H' max	BWC	0.64	0.87	0.43
H'/H' max	Combined	**0.62**	**0.84**	**0.65**

Table 3: TCRMP live coral cover RM-ANOVA results.

Variable	Test	Value	Exact F	NumDF	DenDF	Prob>F
TCRMP Live Coral Cover	RM-ANOVA	6.62	3.31	4	2	0.2453

Conclusion

Coral Community Structure

- Sites show coral dominance by *Montastraea annularis*, *Porites astreoides*, *Porites porites*, *Siderastrea siderea*, and *Agaricia agaricites*. These species were also dominant during the Rogers (1982) study.
- Dead coral with turf algae comprised the greatest benthic proportion, followed by living coral and macro algae.

Temporal Comparisons

- Over the 30-year time span, significant decreases were observed in live coral cover, rugosity, and species diversity, accompanied by an increase in species evenness.

TCRMP

- Live coral cover did not differ significantly from 2002-2011 within the TCRMP data.

Overall Conclusion

- Live coral cover has declined in comparison to the Rogers (1982) study conducted from 1978-1982.
- This may be due to multiple factors, including worsening environmental conditions of Brewers Bay.
- However, TCRMP data from Brewers Bay suggests that the 2005 bleaching event did not significantly impact live coral cover.

References

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Acknowledgements

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