



KAUA'I *MONTIPORA* CORAL DISEASE PREVALENCE AND ENVIRONMENTAL DRIVERS

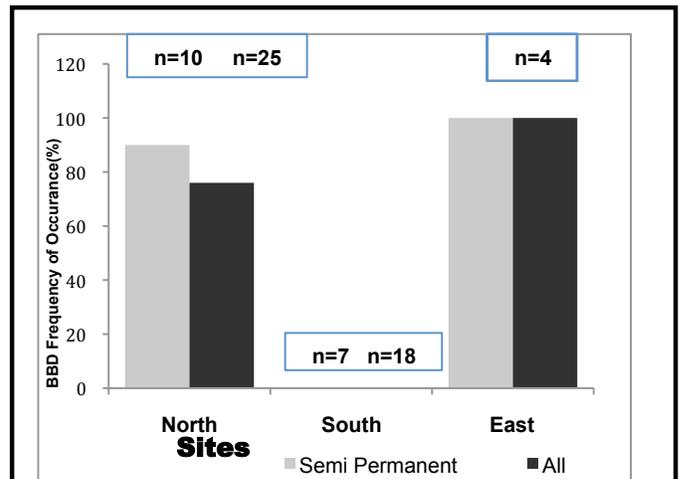


The Study

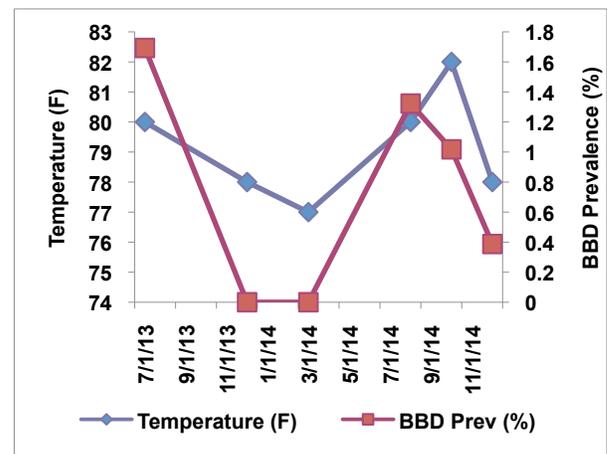
The Aeby and Callahan labs from University of Hawaii at Mānoa have been following the first recorded outbreak of black band disease in the Hawaiian Archipelago on the reefs of Kaua'i. The initial outbreak was reported through an EOR volunteer. The overall goal of this project is to spatially describe the prevalence and distribution of the *Montipora* coral disease outbreak on the north and south shores of Kaua'i and identify any correlations with environmental stressors. This will give managers the information needed to prioritize management actions and develop new strategies focused on the environmental drivers causing the outbreak. A total of 47 sites were surveyed with the establishment of 21 semi-permanent sites to monitor over time.

Major Findings

- BBD was found at 23 of the 47 sites surveyed around Kaua'i, with fourteen of the 21 semi-permanent having BBD affected *Montipora*.
- BBD was predominately found on the north (n=9 out of 10 semi-permanent sites) and east (n=4 out of 4 semi-permanent sites) facing shores. BBD was not observed at semi-permanent sites along the south shore (n=7).
- BBD abundance from all sites around Kaua'i ranged from zero to 5.1 BBD colonies per m² *Montipora* cover (n=25 sites).
- BBD prevalence along the 21 semi-permanent sites ranged from 0.23% to 5.2% with hotspots near Makua Beach and Anini Beach. Prevalence was calculated as the number of cases per the number of *Montipora* colonies within 450m².
- No relationship was established between BBD prevalence or abundance and abiotic site variables such as, visibility (proxy for total suspended particles), organic or terrestrial proportions of substrate sediment, and local sea surface temperatures (NOAA monthly data base). No relationship was found between montiporid abundance and BBD prevalence or BBD abundance.
- At one site followed through time (Anini 5) a weak positive relationship was observed between montiporid abundance and BBD prevalence and between temperature and BBD abundance.



BBD abundance at survey sites on north, south, and east facing shores from all survey sites (black bar) and semi-permanent sites (gray bar).

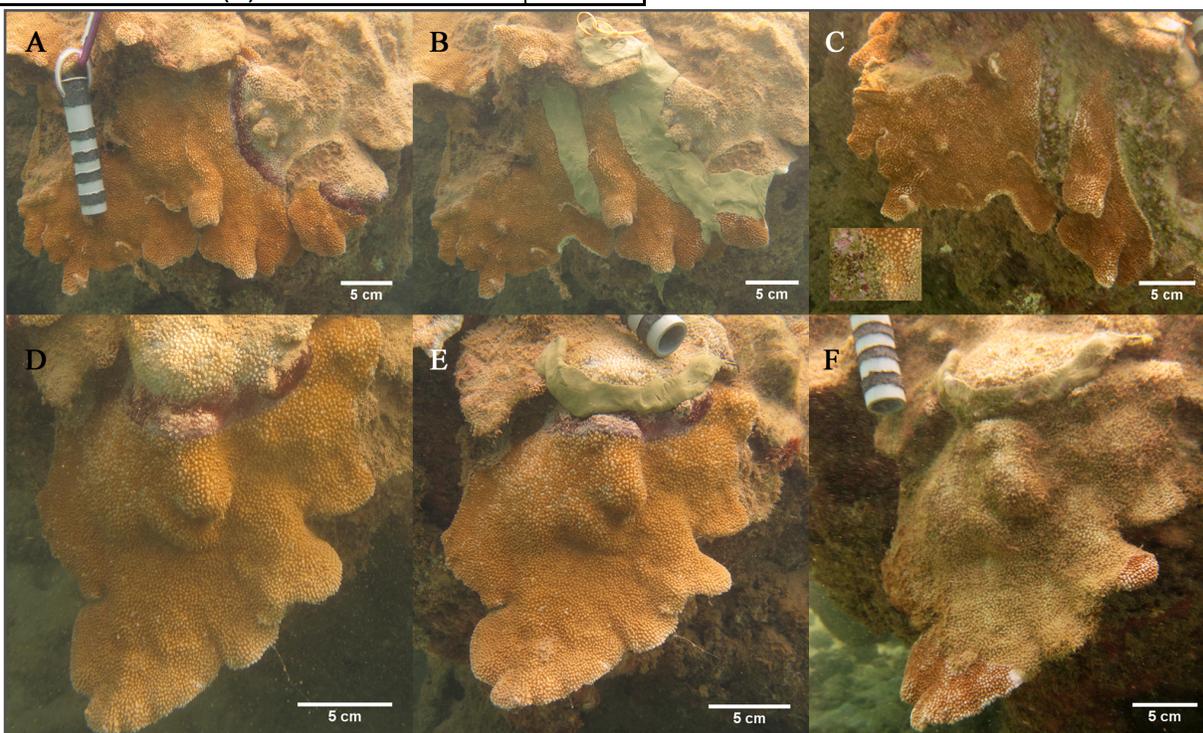


Temperature and BBD prevalence through time (7/13-12/14) at Anini 5.

- Lesion occlusion treatment of *M. capitata* at Anini Beach Park was successful in reducing the amount of tissue loss to affected colonies as compared to control colonies.

Non-treatment control colonies exhibited a 43% mortality rate (3 out of 7 colonies) with average disease prevalence through time of 75%. Colonies undergoing lesion occlusion exhibited a 14% mortality rate (1 out of 7 colonies) with average disease prevalence through time of 25%.

Colony #	Initial state	Oct-12	Nov-12	Jun-13	Jul-13	Dec-13	Colony Mortality (%)
3	Control	a	a	na	na	a	-75.4
5	Control	a	a	na	na	a	-62.1
7	Control	a	a	na	na	na	-5.7
9	Control	a	a	na	na	na	-82.7
13	Control	a	a	na	d	d	-100
14	Control	a	a	na	d	d	-100
16	Control	a	a	a	d	d	-100
Disease Prevalence (%)		100	100	14.3	0	50	avg. -75.1269
2	Treatment	a	a	na	na	na	1
4	Treatment	a	na	a	na	na	-69.2
6	Treatment	a	na	a	na	na	6.5
8	Treatment	a	na	na	na	na	6.5
10	Treatment	a	na	na	na	na	-12.3
12	Treatment	a	a	a	d	d	-100
15	Treatment	a	na	na	na	na	-6
Disease Prevalence (%)		100	28.6	42.9	0	0	avg. -24.90789

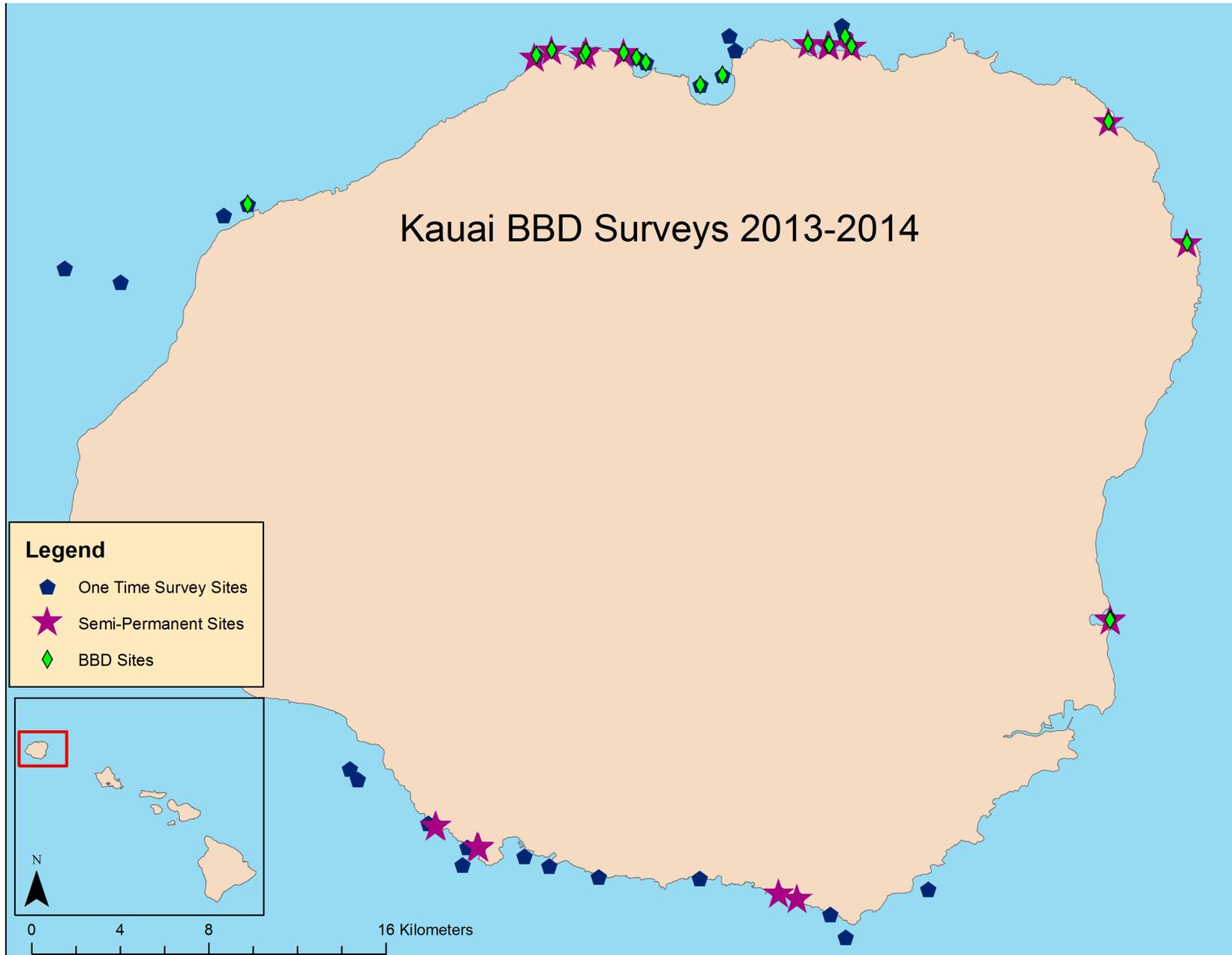


The lesion occlusion method of disease treatment. A) Infected *M. capitata* before treatment. B) Colony with marine epoxy over lesion and with a band of epoxy placed as a “firebreak” approximately 5 cm away. C) Same colony two months post-treatment. Note that the marine epoxy is overgrown with algae and the edge of the lesion is starting to grow over the epoxy. D) Control infected *M. capitata* before marking with marine epoxy. E) Colony with marine epoxy approximately 5 cm behind lesion. F) Control colony after two months. Scale bar 5 cm.

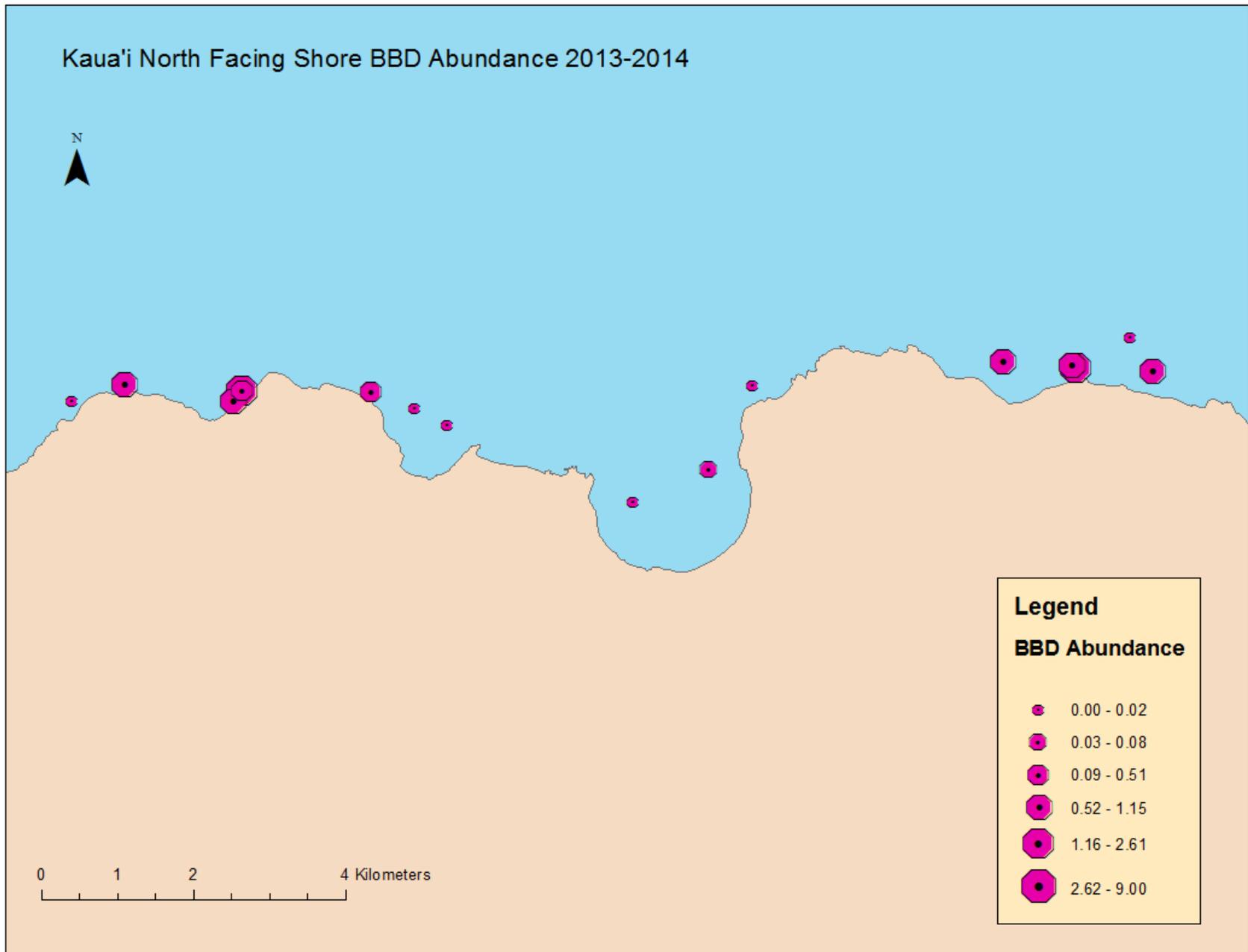
Recommendations

- ***Continuation of EOR Community Reporting Program Training*** - The Eyes of the Reef Program is an invaluable tool in the first tier of Rapid Response Contingency Plan of The State of Hawai'i. Training of primary and secondary responders enhances the state's ability to monitor against the five major threats to Hawai'i's coral reef ecosystems. Community and stakeholder as well as manager and scientist training and involvement with EOR acts as an early warning and detection system for future disease outbreaks.
- ***Increased Monitoring of Reefs at Risk during Elevated SST's*** – A weak correlation was found between SST and the prevalence of BBD. Temperature increases have been correlated to BBD prevalence in the Caribbean and the GBR. With global climate change models predicting an increase of global SST, it is important for managers to have the tools that would aid in efforts in monitoring and mitigating coral disease events.
- ***Secondary Response Team Assessment of Montiporid Reefs on East and West Facing Shores of Kaua'i*** - Surveys to date have focused on the north and south facing shores leaving large gaps in regions not assessed. With recent findings of BBD at four sites on the east facing shore, a need to fill in these survey gaps can establish a better picture of the distribution around the island of Kaua'i.
- ***Use of Lesion Occlusion*** – Lesion occlusion was successful in the treatment of BBD affected colonies. While this treatment was found to effective it is not feasible to administer to every infected colony on the reef. It is a good preventative management protocol for reefs that have very low BBD prevalence or abundance especially recent outbreak areas that could be contained.
- ***Collaborations Between Multiple Agencies*** - The initial responders to the BBD outbreak on Kaua'i were from HIMB, UHM, USGS and NOAA. The collaboration between DLNR, through DAR, and these agencies allowed for a rapid assessment of the disease event: the distribution, prevalence, and pathogens involved. Future collaborations between these and other agencies provide needed interdisciplinary insight into drivers of coral disease events, needed management efforts and action strategies to mitigate current and future reef ecosystem disease events.
- ***Continuation of Evaluating Environmental Variables Associated with Land Use*** - We found no statistical significance between environmental variables collected and the abundance of BBD, However, we only examined a few variables at a very course level. Poor water quality is known to negatively effect coral reef health and resilience. It is hypothesized that poor water quality from poor land use practices, is contributing to the disease outbreaks. An in-depth environmental study looking at sedimentation rates, freshwater input, nutrient levels and sources may render a clearer view of anthropogenic and natural drivers of BBD.

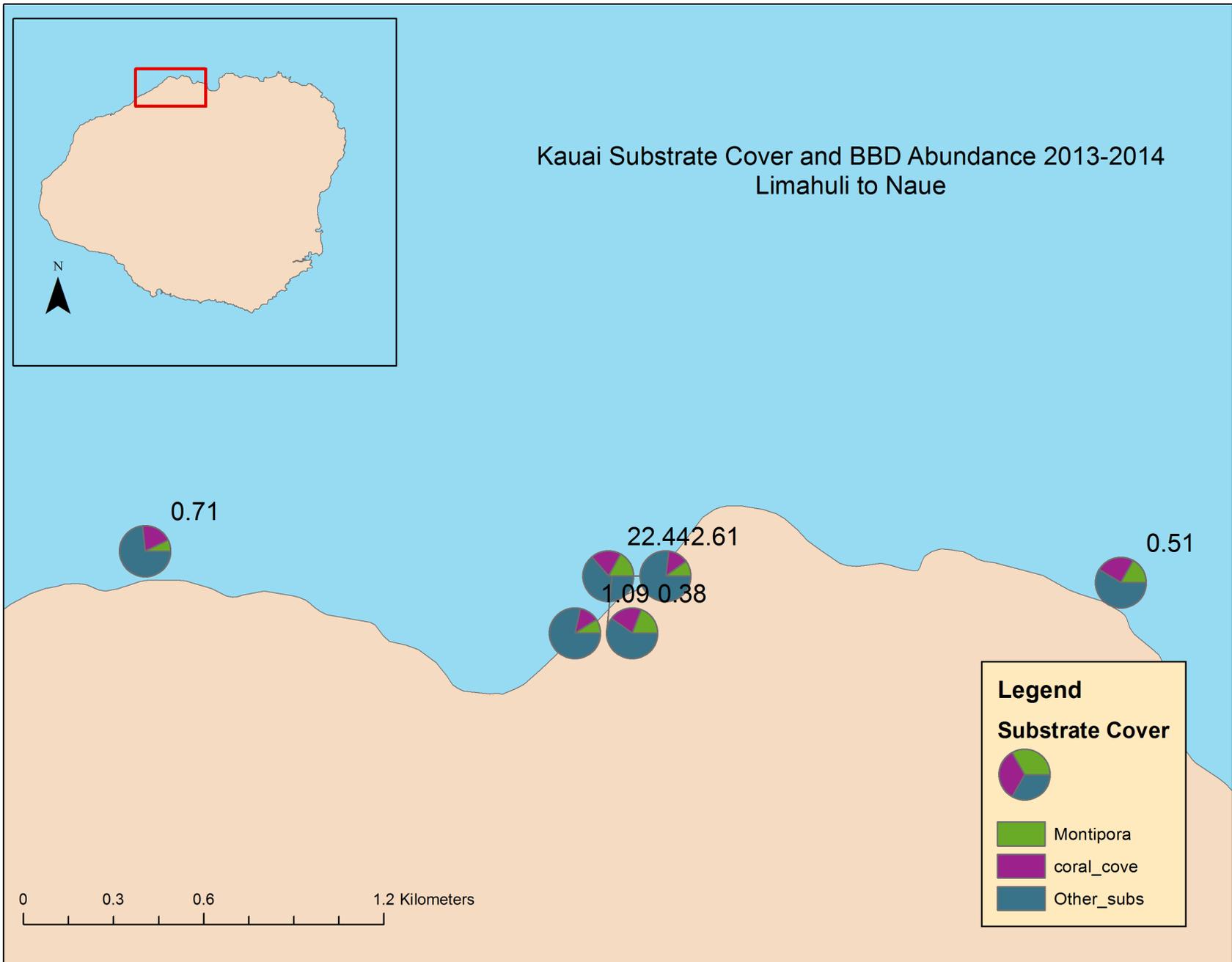
Maps



Map of all sites surveyed around Kaua'i. Purple stars indicate semi-permanent sites, blue pentagons represent one time survey sites and green diamonds indicate reefs with BBD.

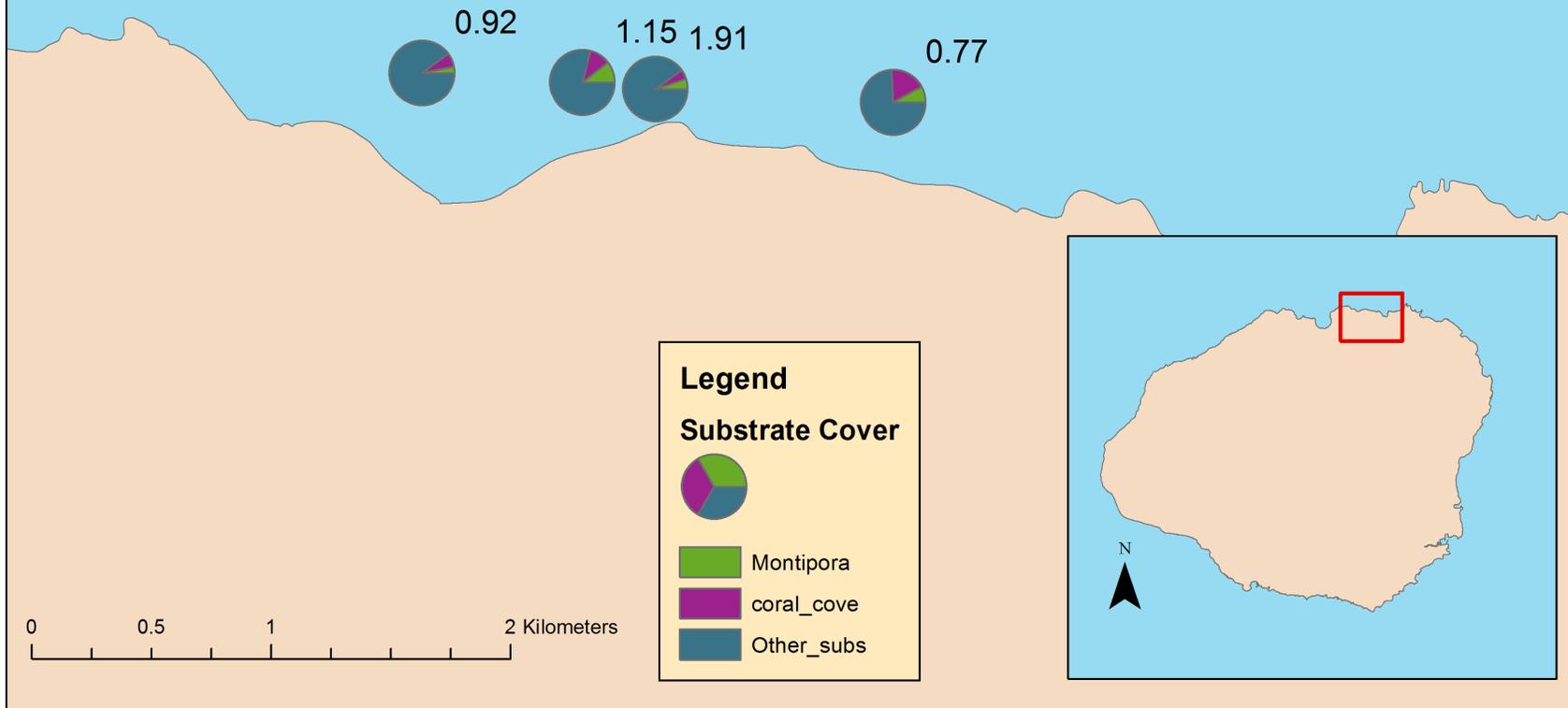


Black band disease abundance (# cases of BBD/m² *Montipora* cover) on the north shore of Kaua'i. The larger the bubble the higher the BBD abundance.

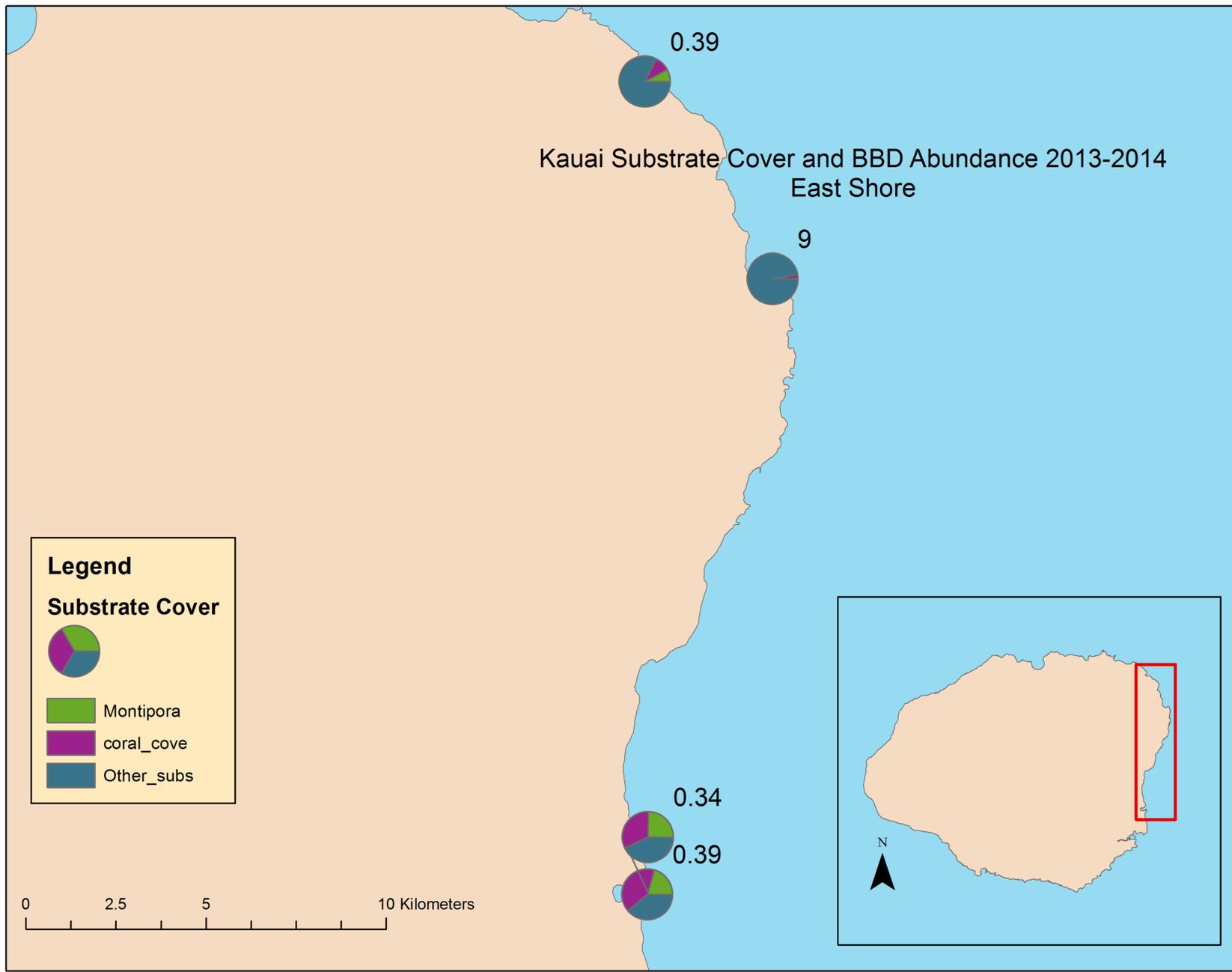


Black band disease abundance (BBD colonies per m² *Montipora* percent cover) from Limahuli to Naue on the north shore. Hot spot in the center is Makua beach where abundance ranged from 0.38 BBD to 22.44 colonies per m² montiporid percent cover.

Kauai Substrate Cover and BBD Abundance 2013-2014 Anini Beach

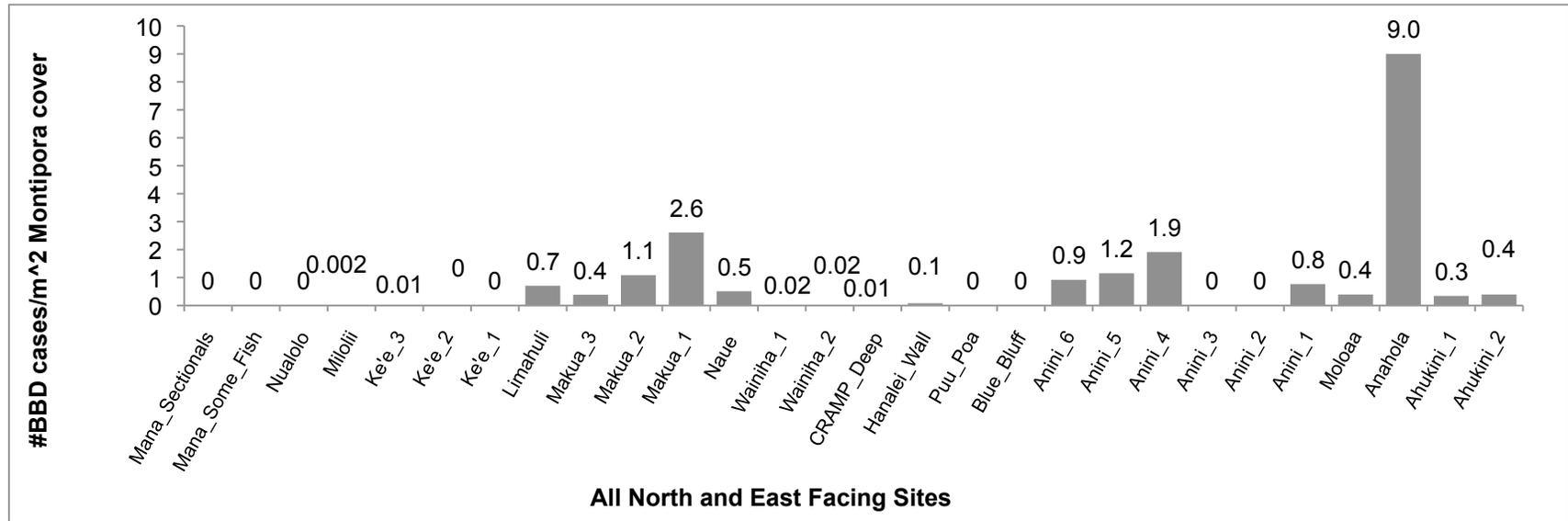


Black band disease abundance (BBD colonies per m² *Montipora* percent cover) at Anini Beach on the north shore.

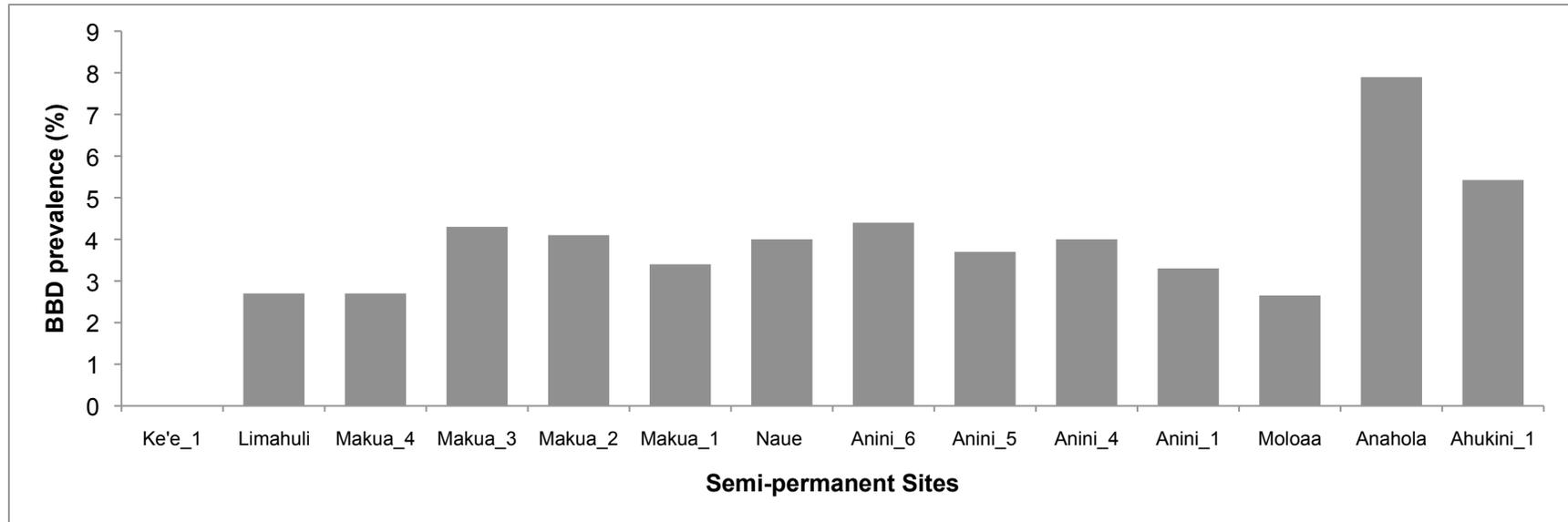


Black band disease abundance for east facing shore of Kauai. Numbers represent disease abundance (BBD colonies per m² *Montipora* percent cover) for each site: Moloaa, = 0.39, Anahola = 9, Ahukini 1 = 0.34, and Ahukini 2 = 0.39.

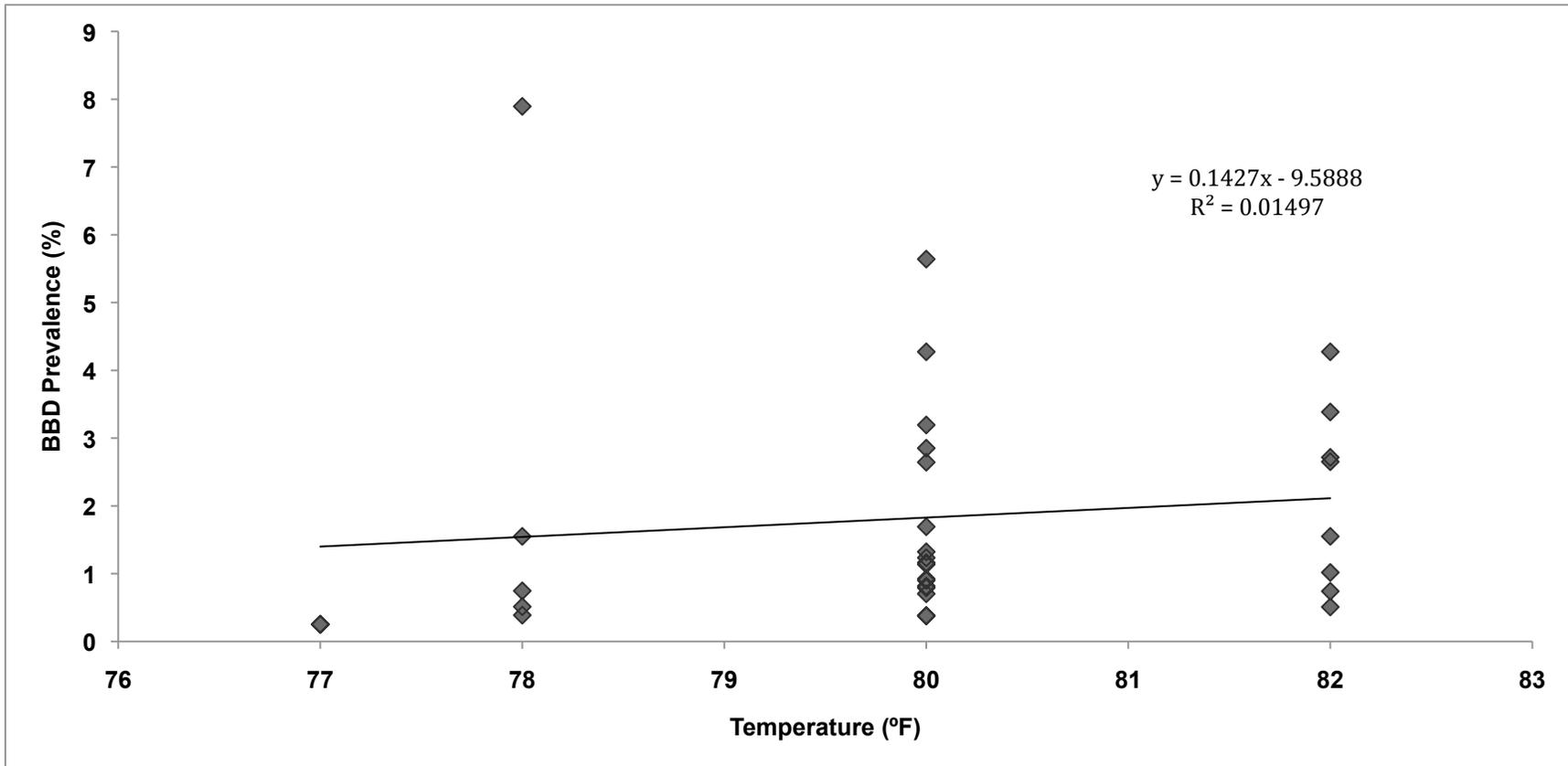
Additional Findings and Figures



Black band disease abundance across north and east facing shores. Abundance ranged from 0.002 to 9 BBD colonies per m² *Montipora* percent cover.



Semi-permanent sites across the north and east shore and BBD prevalence. Prevalence was calculated as a percentage for the number of colonies exhibiting BBD over the number of *Montipora* colonies surveyed per site. Prevalence ranged from 0 to 7.9%.



Relationship between BBD prevalence and sea surface temperature at sites (n= 27) visited between July and Dec 2013.

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