

Florida Reef Tract Coral Disease Outbreak

Coordination Meeting #11

April 26, 2018

1:00pm – 3:00 pm

Meeting Summary

Attendees:

Vanessa McDonough, Anna Toulone, Joanne Delaney, Lew Gramer, Ian Enochs, Derick Manzello, Cheryl Woodley, Tom Moore, Lena Weiss, Steve Blackburn, Jennifer Derby, Mel Parsons, Shelly Martin, Terri Johnson, Valerie Paul, Kristi Kerrigan, Karen Bohnsack, Mark Knowles, Janice Duquesnel, Ivana Kenny Carmola, Stephanie Schopmeyer, Nick Alcaez, Erin McDevitt, Jeff Beal, Jan Landsberg, Lisa Gregg, Dave Gilliam, Karen Neely, Roy Yanong, Julie Meyer, Brill Precht, Caitlin Lusic, Amelia Moura, Michelle Pico, Francisco Pagan, Jack Stamates, Wade Lehman, Chris Sinigalliano, Mary Beth Gidley, Lindsay Hubner, Tracy Zeigler, Brett Howell

Welcome, Roll Call

- Maurizio Martinelli (FDEP) welcomed attendees and introduced himself as the new facilitator of the Coordination Calls.
- The agenda included updates on the disease status along the Florida Reef Tract (FRT), coral resource tracking projects, research and intervention experimentation, and management issues. The attachments include:
 - The Agenda for this meeting
 - Supporting photos for the update on disease in Palm Beach and Martin Counties
 - Slides on FWC's sentinel site project
 - Supporting data for the update on Big Coral monitoring and intervention in SE FL
 - Slides for the update on our *Dendrogyra cylindrus* (pillar coral) populations
 - Slides for the update on histological analysis of *Montastrea cavernosa* samples
 - Slides supporting the presentation on intervention experimentation
- Martinelli introduced the Disease Advisory Committee (DAC), a group of experts who have agreed to meet more frequently to provide rapid feedback on research and management issues. The DAC holds calls every two weeks, but is in email and phone communication more frequently.

Disease Status Updates

Palm Beach & Martin Counties – Maurizio Martinelli (FDEP) on behalf of Dr. Josh Voss & Ian Combs (FAU HBOI)

- There were two additional sampling events following the conclusion of the post-Irma and disease impact surveys. First, on March 19, the HBOI team and Jeff Beal (FWC) conducted 4 sampling dives at St. Lucie State Park. Colonies of *Montastraea cavernosa* (MCAV) and *Pseudodiploria clivosa* (PCLI) that have been monitored over the past 7-8 years at St. Lucie were revisited, photographed, and small tissue biopsies were taken for gene expression analysis. Additionally, broader disease surveying occurred. The individuals displaying physical signs of

disease were sampled at two locations on the colony, adjacent to the disease line (< 1cm) and on visibly healthy tissue away from the disease line (> 5cm).

- 11 diseased colonies were found across 3 of the 4 sites. 16 tissue samples were collected from the 11 colonies – 10 PCLI and 1 *Solenastrea bournoni* (SBOU). The reason for only 16 tissue samples was that not all colonies had enough visibly healthy tissue for a distal sample. All samples were stored in ethanol, placed on ice, and transferred to a -80 °C freezer to await molecular analyses. While there was no disease found at the fourth site, >10 MCAV were found bleached.
- The second sampling effort was conducted on April 19 at Breakers Reef, off West Palm Beach, two dive teams conducted four 25 minute roving diver surveys recording observed colonies and the presence or absence of disease and to tag, sample, and track any infected colonies. A total of 306 colonies across two sites were recorded. Of those, only two were observed as bleached (both MCAV), and no visibly diseased colonies were observed.

Biscayne National Park – Dr. Vanessa McDonough (BNP)

- While there have been no 'formal' transects conducted in the past few weeks, observations by the team in the park suggest that the majority of the living colonies are looking healthy! There is some evidence of dark spots on *Siderastrea*, possible white band on *Orbicella*, a little bit of paling on *Porites porites* (PPOR) and *Porites astreoides* (PAST). But, for the most part, species looked to be doing well – MCAV, *Agaricia* spp., *Pseudodiploria* spp., and *Mycetophyllia* spp. were identified as looking especially healthy.

Looe Key – Stephanie Schopmeyer (FWC)

- Initial reports of diseased *Meandrina meandrites* (MMEA) colonies on the western side of Looe during the first week of April. From April 18-20, a group went out to conduct surveys to determine extent of disease.
- On the western side, the shallow reefs had about 20-40% (30+ colonies) of the MMEA diseased with an additional 5-6 colonies recently dead. Other species affected too: PSTR and *Diploria labyrinthiformis* (DLAB) with regions, and blotchy *Siderastrea sidera* (SSID). Surveys on deeper reefs only had 1 diseased MMEA. Thus far, no disease found on the eastern end.
- Due to how established the disease seemed, no intervention (i.e., removal of diseased colonies) was conducted. Instead, samples were taken for histology and microbiome analysis, and 3 healthy and 5 disease colonies were taken for research and sent to Dr. Valerie Paul (SI), Dr. Cheryl Woodley, and Dr. Erinn Muller for various transmission and pathogen isolation experiments.

Key West – Maurizio Martinelli (FDEP) on behalf of Cory Walters (Mote)

- Recent dives were conducted off Key West (Eastern Dry Rocks, Marker 32, Bahia Honda, and Big Pine Shoals), and thus far there is no disease.

Dry Tortugas National Park – Maurizio Martinelli (FDEP) on behalf of Meaghan Johnson (DTNP)

- There have only been reports of 'no disease' from the staff and partners working at various reef sites throughout the park. Over the next couple months, CREMP and NCRMP surveys will be

taking place and should provide a better picture of what is happening within the park and the surrounding region.

Coral Resource Fate Tracking

FWC colony tracking, sentinel sites, and tissue collection updates – *Maurizio Martinelli (FDEP) on behalf of Kerry Maxwell (FWC)*

- The team at FWC has three main branches to this project: 1) tracking tagged colonies (three sites with five species tagged, photographed every two weeks) to estimate the percent of new dead tissue and colonies due to this disease; 2) establish four sentinel monitoring sites to help map the larger-scale spatial progression of the disease through a reef system (and potentially use as sites for experimental disease intervention); and 3) sites at both disease-impacted and non-impacted sites for tissue samples to help with disease or pathogen identification.
- Photo-documentation of disease progression from tagged colonies across three different species was shown: rapid progression on MMEA (full mortality in one month), slightly slower progression of *Dichocoenia stokesii* (DSTO) (loss of most tissue in one month), and DLAB (only 25% tissue loss in three months).
- The sentinel sites all started with no disease in early February, but three of the sites began to show the first signs of disease within the first month. By the beginning of April, the disease was established at three of the sites, and by mid-April, all four sites had the disease.
- Tissue sampling had been conducted from three of five disease-impacted sites, but due to the recent reports of disease at Looe Key, the team is considering moving their non-disease impacted sites down to Key West.

Southeast Florida large colony tracking and intervention – *Maurizio Martinelli (FDEP) on behalf of Dr. Brian Walker (NSU)*

- Dr. Walker's team conducted their initial assessment of the large coral colonies of Southeast Florida reefs back in 2015. Dr. Walker's team returned to these colonies to reassess their condition and disease status. Of the colonies identified in 2015, 9 have died and 16 living corals have active disease. The mortality experienced by those corals was relatively high between 2016 and 2018: mean mortality of tissue on these colonies increased by about 16.5% and a maximum loss of 99% of tissue. 25 colonies entered a higher mortality class (>75% tissue loss). However, the colonies that were 'very healthy' (i.e. <10% mortality) in 2015 remained 'very healthy'.
- Dr. Walker's team is conducting experimental intervention on the diseased large coral colonies. Over the past week, the team has been creating firebreaks in the tissue in advance of the disease margin and applying experimental treatments like applications of chlorine and peroxide, which have shown success in stopping other diseases.

***Dendrogyra cylindrus* (Pillar Coral) reassessment and rescue** – *Dr. Karen Neely (NSU)*

- Dr. Neely and collaborators revisited all known colonies of *Dendrogyra cylindrus* (DCYL) north of Marker 32. Almost all colonies from Crocker northwards are dead and those from Sombrero Reef to Crocker are actively diseased. There are currently 63 genotypes and 176 colonies remaining in wild; this will likely be <50 genotypes and <100 colonies in a few months without active intervention. This represents a 58% loss of genotypes and 75% loss of colonies since 2014.

- In addition to surveys, the team took tissue samples of DCYL for gene banking purposes. Currently there are 61 genotypes currently in gene banks, 23 of which are extinct in the wild. Dr. Neely recommends regularly monitoring the remaining non-banked colonies for signs of disease.
- Finally, the team conducted roving diver surveys at 55 sites from Marker 32 to Carysfort. These surveys found very low live coral in North and heavy disease throughout the Middle Keys. There are the early stages of disease at Sombrero Reef and Bahia Honda (some healthy coral, some diseased coral), low disease prevalence at Looe Key, and, as of yet, no disease signs south of Looe Key.

Broward County fate tracking – Dr. Valerie Paul (SI)

- Dr. Paul has been monitoring diseased colonies off Broward County since July 2017 – monthly photos are taken of 22 colonies of MCAV and 2 colonies of *Orbicella faveolata* (OFAV). To date, four MCAV colonies have died. The living colonies show slow but steady disease progression, although the patterns of progression differ between colonies. In most cases, the disease lesion is along the edge of the colony. In some cases, the disease seems to stop in certain areas but then flare up in others. It seems that progression during these winter months was slower – perhaps negative impact on pathogen(s), or positive impact on the coral.
 - The corals lost an average of 1.8% of their healthy tissue per month
 - Like other tissue loss diseases, the rate of progression changes through time - sometimes more active - sometimes less active and varied among colonies from entire colony lost to the disease halting.

Research and Intervention Updates

Histology on *Montastrea cavernosa* – Dr. Jan Landsberg (FWC)

- Tissue samples were collected in November 2017, primarily for histological analysis but also for electron microscopy. From the histological analysis, it seems that the lesions start in deeper tissues and move towards the surface – there are cases where there are deep tissue lesions without any surface lesions, suggesting that the surface lesions may be a more advanced stage of the disease. The staining did not identify any obvious pathogens.
- ‘Crystalline inclusion bodies’ (CIBs) have been identified in the gastrodermis – these are inclusions that may be organic or inorganic, appearing as a crystalline matrix that looks like a viral array. It should be noted that these CIBs were found in supposedly ‘unaffected’ areas of disease colonies, suggesting that healthy-appearing tissue may, in fact, be compromised.
 - The CIBs and necrotic/evacuated zooxanthellae often co-occur in samples, suggesting that the disease (or CIBs) may be impacting the symbionts.
- Dr. Landsberg states that the disease pathology is different from known white plague, seeming more similar to yellow band disease that has been observed on MCAVs before.
- Dr. Val Paul (SI) inquired about the ease of removing the CIBs for further study, perhaps to facilitate genomic sequencing. Dr. Roy Yanong (UF) suggested that laser capture microdissection could be utilized. Dr. Julie Meyer (UF) stated that isolation of the CIBs would make subsequent sequencing more effective. Cheryl Woodley (NOAA) added that the slides used for histology might be used for laser capture microdissection purposes (depending on the material used to fix them) and suggested that Esther Peters (GMU) would be a good resource for these discussions.

- Dr. Karen Neely (NSU) inquired as to other species that might be used for this type of work, for example a species that does not express a bleaching margin like MCAV.
- Dr. Paul asked why Dr. Landsberg concluded that the disease does not look like white plague. Dr. Landsberg responded that the initial pathology is different. Dr. Landsberg and colleagues are working to develop 'case definitions' in order to provide more specific information on the gross and histological pathology for different species.
- Dr. Neely inquired about the bacteria that Dr. Landsberg had identified and shared on a previous call/meeting. Dr. Landsberg clarified that those bacteria were found on coral surface tissue, but the CIBs shown were from deeper tissue samples. There may or may not be a relationship – Dr. Landsberg found the bacteria via electron microscopy on one sample.

Antibiotic and antiseptic treatment trials – Dr. Karen Neely (NSU)

- Dr. Karen Neely (NSU) offered an update on the intervention/treatment trials that have been underway at Keys Marine Lab (KML) in collaboration with Dr. Cindy Lewis (KML). This work has focused primarily on things that would be easily applicable in the field, beginning with barriers. The treatments being tested were primarily chlorine (an antiseptic that worked against black band disease in the Pacific, and is currently permitted for use in disease intervention) and antibiotics (which have been effective in the treatment of DCYL and other corals in laboratory settings). Additionally, there is the potential to use a barrier with a high concentration of salt.
 - Chlorine has, this far, been ineffective (except, perhaps, in a gelatin-infused strip applied to PSTR – only tested and successful on one colony). Chlorine has been delivered via epoxy, cornstarch, modelling clay, and various other media.
 - Antibiotics have been more successful in ex-situ experiments and treatments. Some treatments only worked in some cases (e.g., ZSPAR successful on DSTO only). The final solution may involve trenching, in order for the antibiotics to reach deeper tissue layers.
- There was a report from Jamaica of a similar disease impacting DCYL. Experimental use of copper wire as a treatment was unsuccessful.
- Dr. Jan Landsberg (FWC) inquired as to the antibiotics utilized. Dr. Neely clarified that amoxicillin alone and a mix of amoxicillin and kanamycin have been tested; the mix was no more or less effective than amoxicillin alone.

Florida Aquarium and CoreRx trials – Keri O'Neil (FLAQ)

- Keri O'Neil and colleagues at the Florida Aquarium are working with the pharmaceutical manufacturer CoreRx to develop an antibiotic delivery medium. A dental paste utilized by Dr. Cheryl Woodley (NOAA) was effective in antibiotic treatment of diseased DCYL in the lab, but could not withstand any water movement (i.e., would not be applicable in the field). The team approached CoreRx with the challenge of developing a medium that adheres to coral while still delivering antibiotics. They trialed a few different media, currently the most promising option is 'Base 2' – a Vaseline-like gel that creates small channels to allow water to penetrate and the antibiotics to leach out slowly.
 - CoreRx process begins by identifying an active ingredient and formulating a delivery mechanism around that. They do not wish to work with chlorine.
 - CoreRx is working on this project pro bono.

FDEP Outbuilding Experimentation – Maurizio Martinelli (FDEP)

- FDEP has been experimenting with various delivery mechanisms for antiseptic agents like chlorine and hydrogen peroxide, applying the materials to submerged limestone rocks to see if anything sticks to the rock and whether it leaches materials. FDEP has tested the numerous inorganic compounds, including Portland Cement, silicone, spackle, various glues (including super, wood, and Elmer's glues), and mixes of different quantities of these substances.
- FDEP has also tested more organic materials, including a mixture of cornstarch and water, which when heated, forms a thick, dense gel. This worked for application on a small scale, but larger scale mixing turned very exothermic and unusable.
- FDEP is currently testing hydrogen peroxide pastes or gels, as well as peroxide and baking soda toothpastes. Preliminary experimentation shows that toothpaste straight from the tube adheres quite well to limestone rock but seems to have more difficulties in in-situ application.
- FDEP welcomes any suggestions on materials to test.

Regulatory and Management Updates

Update on permitting discussions – Karen Bohnsack (FDEP)

- In situ direct application of chlorine has received the necessary approvals to be implemented in the field. However, there are difficulties finding an appropriate delivery medium.
- Members of the team associated with the DCYL reassessment and rescue submitted a request to FDA Minor Use/Minor Species (MUMS) for permission to directly apply amoxicillin to diseased colonies of DCYL in site. FDA MUMS responded quickly in support – it is exempt from their regulation, but requires permits from the appropriate local regulatory agencies.

Communications and marketing strategies – Karen Bohnsack (FDEP)

- With the report of disease at Looe Key, press has picked up and has gotten leadership attention at DEP and other agencies. Folks associated with this disease response effort may be contacted by the media to provide information. If contacted, FDEP stresses the need to include a message of hope. While the situation is difficult, and there are serious implications to the tourism industry, we need to make sure that the positive and hopeful messages are also shared.
- FDEP is drafting language to share with partners and encourages anyone to reach out if they need a resource.

Wrap-up and Adjourn

- The next call will likely be towards the end of summer. As the June 30 marks the end of our fiscal year, we will likely have a number of report-outs to cover for the next coordination call. Anyone with updates should feel free to reach out to Maurizio Martinelli (FDEP).
- Two standing reminders:
 - 1) Please submit coral disease observations and reports:
 - In the SE region to: The Southeast Florida Action Network (or, SEAFAN), at SEAFAN.net
 - And in the Keys to: The FKNMS Community-based Observations of Coastal Ecosystems and Assessment Network (or, C-OCEAN), at mote.org/COCEAN

- 2) Please keep communication to the list associated with these coordination calls to a minimum. The intention was not to create a list-serve with the emails.