

## Florida Reef Tract Coral Disease Outbreak

### Coordination Meeting #10

January 11, 2018

1:00pm – 3:00 pm

### Meeting Summary

#### **Attendees:**

Mike Feely, Elsa Alvear, Anna Toline, Tracy Ziegler, Lauri MacLaughlin, Lonny Anderson, Sarah Fangman, Joanne Delaney, Billy Causey, Bill Goodwin, Derek Manzello, Lew Gramar, Mary Beth Gidley, Christopher Sinigalliano, Xaymara Serrano, Cheryl Woodley, Allison Moulding, Dana Wusinich-Mendez, Dana Williams, Jennifer Derby, Terri Johnson, Steve Blackburn, Mel Parsons, Valerie Paul, Maggie Johnson, Francisco Pagan, Alycia Shatters, Maurizio Martinelli, Mollie Sinnott, Kristi Kerrigan, Claire Burgett, Laura Eldredge, Joanna Walczak, Vladimir Kosmynin, Nick Alcaraz, Amber Whittle, Lisa Gregg, John Hunt, Jan Landsberg, Rob Ruzicka, Lindsey Huebner, Stephanie Schopmeyer, Yasu Kiryu, Kathy Fitzpatrick, Dave Gilliam, Brian Walker, Shelby Eagan, Alysha Brunelle, Cindy Lewis, Roy Yanong, Ilze Berkins, Julie Meyer, Esther Peters, Pamela Fletcher, Karen Neely, Erinn Muller, Bill Precht, Paul Fitzgerald

#### **Welcome, Roll Call, Meeting Purpose**

- Karen Bohnsack (DEP) welcomed attendees to the call.
- At the prior Coordination Meeting (#9, held July 27, 2017), it was agreed that meeting frequency would be every 3-4 months to allow the various projects relating to the disease outbreak to get underway. Following delays due to Hurricane Irma, it is the hope of the body that meeting frequency return to once per 3-4 months.
- The agenda includes a Skype presentation by Dr. Rob Ruzicka (FWC) on the evolution of the current state of knowledge about disease outbreak, new noteworthy disease observations, updates on response efforts, and strategies moving forward.
- Attachments include:
  1. Agenda
  2. Final Summary from Coordination Call #9
  3. PDF of Dr. Rob Ruzicka's Presentation
  4. Summary from the Coral Disease Workshop
  5. Cheeca Rocks Photomosaic Images
  6. PDF of Dr. Karen Neely's boundary survey update
  7. PDF of Long Key Bridge Rubble *Dendrogyra* experiment update

#### **Overview and Current Status of the Coral Disease Outbreak – Dr. Rob Ruzicka (FWC)**

- Dr. Rob Ruzicka's intended focus was not on the history of the outbreak but rather on recent observations from the Florida Keys and preliminary results from the Coral Reef Evaluation and Monitoring Program (CREMP) and Southeast Coral Reef Evaluation and Monitoring Program (SECREMP) surveys. Together these should offer a synopsis of the losses being experienced in Southeast Florida and the Florida Keys. Dr. Ruzicka's presentation was included as attachment #3.
- Slide 1: Title slide: Brief Overview and Preliminary Synopsis of Coral Loss Due to the Coral Disease Outbreak in SE FL and Florida Keys.

- Slide 2: Photographs of five coral colonies (*Diploria labyrinthiformis* (DLAB), *Psuedodiploria strigosa* (PSTI), *Dichoceenia stokesii* (DSTO), *Meandrina meandrites* (MMEA), *Eusmilia fastigiata* (EFAS)) with diseased tissue were pictured.
  - o The first warning sign of disease (i.e. corals exhibiting lesions) occurred late summer 2014 in the Miami-Dade region. A variety of coral were exhibiting lesions including brain coral, flower coral, and small massive corals. There was initially some confusion as the region was undergoing a severe thermal bleaching event, and thus the lesions were misidentified as thermal bleaching. However repeated visits clarified that the lesions were caused by disease agents.
- Slide 3: Time-series photographs of disease progression across a colony of *Dendrogyra cylindrus* (DCYL, aka pillar coral) and a colony of *Colpophyllia natans* (CNAT, aka brain coral).
  - o Over four weeks, a colony of CNAT experienced >50% tissue loss, and in just over one year, a colony of DCYL experienced nearly 100% tissue loss. These examples illustrate how rapidly the pathogen/disease can move across a colony. The rate of progression suggests that it would be easy to miss colony mortality, especially for small colonies.
- Slide 4: A map of the Florida Reef Tract displaying the severity of coral disease reports throughout 2017.
  - o The rough timeline of the disease spread is as follows: 2014 - first observed in Miami-Dade County, spread south to Biscayne National Park and north to Broward County; 2015 – disease spread northward to West Palm Beach; 2016 – first reports of disease in Carysfort Reef in the upper Keys; 2017 – the disease was entrenched throughout the southeast Florida region of the Florida Reef Tract; and there were reports of disease as far north as Martin County and as far south as the Middle Keys.
- Slide 5: A more detailed map of the disease distribution in the Florida Keys. A dotted red line indicates the estimated current disease boundary.
  - o At the end of 2016, disease was observed at two offshore sites: Carysfort Reef and Grecian Rocks. In mid-2017, during CREMP surveys, the disease was observed at inshore patch reefs adjacent to these offshore sites. This example illustrates a recurring pattern: the disease seems to progress first through the offshore portion of the reef tract, and several months (sometimes up to a year) later the inshore patch reefs are impacted.
  - o A dotted red line indicates the estimated current disease boundary, as based on data collected by Dr. Karen Neely (FKCC) and collaborators. The line is ‘slanted’ to reflect the inshore time lag.
  - o Dr. Ruzicka noted an additional document sent by John Hunt prior to the call, that shows additional reef sites where disease has been observed in some form. As the disease threatens places like Sombrero Reef and other patch reefs further south, we are at an important juncture with this disease outbreak. Further, we do not know the impact of Hurricane Irma (for example, whether the storm spread the disease further and accelerated its progress).
- Slide 6: CREMP data on coral disease prevalence from 2011-2017 in the Upper Keys.
  - o Dr. Ruzicka highlighted the dramatic increases in disease prevalence among five of eight coral species in 2017. Dr. Ruzicka stresses that these data represent only a ‘snapshot’ from July 2017 of the percent of living colonies that were infected, and thus do not account for the colonies that had already perished from the disease.
- Slide 7: CREMP data on coral species-specific and total coral abundance from 2011-2017.
  - o Dr. Ruzicka highlighted four species with reduced abundance in 2016 and 2017: loss of roughly half of CNAT colonies, roughly two thirds *Dichosenia stokesi* (DSTO) colonies, roughly half *Montastrea cavernosa* (MCAV), and all MMEA colonies due to the disease.

- Slide 8: Box plots from Dr. Dave Gillian's (NSU) SECREMP data on MMEA abundance in Southeast Florida.
  - o MMEA is an example of a coral species where the disease progresses very rapidly. These data show a small population of MMEA that was nearly wiped out by 2016. Similar stories of the loss of MMEA have been anecdotally reported elsewhere.
- Slide 9: Box plots from Dr. Dave Gillian's (NSU) SECREMP data on MCAV abundance in Southeast Florida.
  - o MCAV is an example of a coral species that can persist with lesions for a long period of time (in some cases, over a year). These data show a decline in abundance of MCAV by 2016, but it should be noted that many of the colonies reported in this study were actively diseased and had already experience partial mortality.
- Slide 10: Photos of infected colonies and percentages of whole colony mortality rates by species at Grecian Rocks.
  - o Most infected corals were experiencing whole colony mortality, more-so than has occurred during disease events in the past. This suggests that in- and/or ex-situ intervention is necessary.
  - o The combination of rates of infection, number of species impacted, speed that the disease can kill a colony, probability of whole colony mortality and disease persistence is alarming.
- Slide 11: Disease Response Partners.
  - o If participants would like to see what the disease progression looks like, there is a video online on the FWC website of the disease progression through an outcropping at Hens & Chickens. Karen Bohnsack (DEP) will share the link.
- Questions/Comments
  - o Lisa Greg (FWC) asked if there are coral species that should be prioritized for conservation purposes.
    - Dr. Rob Ruzicka is hesitant to prioritize one species over another. However, from an ecological perspective, one might endorse prioritization of the massive, framework building coral (e.g. CNAT., *Orbicella annularis* (OANN), MCAV) that provide a great deal of reef substrate and habitat. However, there is no single good answer as the disease is so prevalent and damaging to so many species.
    - Karen Bohnsack (DEP) acknowledged that tough management decisions (including prioritization) will likely need to be made, but these conversations are better suited for a more targeted discussion.

#### **Update on Florida Reef Tract Disease Observations/Post Hurricane-Irma Surveys and Status**

- Southeast Florida
  - o Palm Beach & Martin Counties – *Karen Bohnsack (DEP) on behalf of Dr. Joshua Voss (FAU HBOI)*
    - The HBOI team has revisited St. Lucie Reef twice and confirmed that *Porites astreoides* (PAST) colonies in this location have not been affected by disease. However, >50% of the MCAV and PSTI in the region have perished, including some of the long-term monitored colonies and transplants. Both disease and toppled colonies from Hurricane Irma contributed to mortality in the region.
    - The Jupiter area has relatively low disease prevalence, with <10 corals exhibiting active lesions observed on three survey dives. Those infected were

predominantly MCAV and a few *Siderastrea siderea* (SSID). This seems consistent with the patterns in Palm Beach County generally.

- On a positive note, in southern Palm Beach County, a very large *Madracis auretenra* (MAUR) patch (>50m in diameter) was unaffected by disease as of January 10!
- Broward & Miami-Dade Counties – *Dr. Brian Walker (NSU)*
  - Data has been collected at 60 sites, but not analyzed yet. Qualitatively, however, there were drastic changes on the reefs. Sites that had previously been recorded as having high species richness, density, or coral cover now have few living coral colonies reported. The impression is that the disease has ‘knocked off’ most of the previously living coral in the region; the main species still showing active infection are MCAV and SSID. The species that have persisted include *Porites sp.*, *Agaricia sp.* and *Siderastrea sp.*
  - Only a few sites showed strong impacts of Hurricane Irma, but mostly the widespread coral death seems to be from disease. Moving forward, Dr. Walker will be analyzing the data and will have a summary report available in a few weeks.
    - Karen Bohnsack (DEP) will share the summary report once it becomes available.
- Florida Keys National Marine Sanctuary – *Lauri MacLaughlin (NOAA ONMS)*
  - Late October through early November, extensive triage was undertaken in response to Hurricane Irma; these were not disease surveys. However, Lauri MacLaughlin did observe some disease at Dustin Rocks, and potentially at Sombrero Reef and Looe Key.
- Biscayne National Park – *Karen Bohnsack (DEP) on behalf of NPS staff*
  - Observations were made on three mid-channel patch reefs in Biscayne National Park from November to December 2017. There is some active yellow-band disease on OFAV. In addition, there are some active white plague-like disease lesions on SSID, which have generally experienced extensive tissue loss from disease in 2017.
  - In addition, there are post-Hurricane Irma impacts including sedimentation and physical impacts from debris.
- Dry Tortugas National Park – *Dr. Mike Feely (NPS), and Karen Bohnsack (DEP) on behalf of Meaghan Johnson (NPS)*
  - Dr. Mike Feely reported elevated yellow band disease at Loggerhead Reef. In general, the reefs in the area saw a decline from ~26% coral cover in 2012 to 21% in 2016, some of which is associated with white plague disease. The disease seems to have mostly subsided. A report will be compiled with some of these results.
    - Karen Bohnsack will circulate the report once it becomes available.
  - Karen Bohnsack reports that NPS staff did not observe any white plague disease on their Florida Reef Resilience Program (FRRP) surveys that covered >30 sites in October 2017.
- Disease Observations on Artificial Reefs – *Joanna Walczak (DEP)*
  - As a general reminder, Joanna Walczak requests that any disease observations are reported to the Southeast Florida Action Network (SEAFAN) near the mainland and to the FKNMS Community-Based Observations of Coastal Ecosystems and Assessment Network (C-OCEAN) in the Keys.
    - SEAFAN reporting: [www.SEAFAN.net](http://www.SEAFAN.net)
    - Team OCEAN reporting: [www.mote.org/COCEAN](http://www.mote.org/COCEAN)

- In addition, Walczak inquired about coral disease in underreported habitats, such as artificial substrates and deep reefs.
  - There have been reports of disease on the Long Key Bridge rubble, but are there any observations from shipwrecks or on other artificial substrates?
  - While there has been a lot of monitoring on shallower reefs, there is less information for deeper reefs.

#### **National Science Foundation Project Updates – Dr. Valerie Paul (SI)**

- To note: other Sampling, Analysis, and Experimentation updates are in a subsequent section.
- The goals as set forth last July are to (1) study disease transmission within a single species and between multiple species, (2) use antibiotic treatments for therapeutic diagnosis, and (3) to isolate causative bacteria and probiotics or other protective compounds.
  - Transmission experiments were conducted in the laboratory using sterile sea water in closed-system aquaria.
    - MCAV readily transmitted the disease to other MCAV both via physical contact and through water. Waterborne transmission did not occur 100% of the time, but it should be noted that this was in sterile laboratory conditions where there are is no particulate matter or other vectors to assist transmission.
    - MCAV transmitted to OFAV.
    - DSTO. transmitted to MCAV both through physical contact and through the water.
    - There was no transmission from MCAV to *Porites sp.* through either physical contact or through the water. This suggests that *Porites* may be somewhat resilient. Dr. Paul noted that they will also try experiments with *Stephanocoenia intersepta* (SINT), which may also be resistant based on some field observations.
    - Overall, this seems to confirm the hypothesis that the disease is moving through the water and not just through physical contact between corals.
  - Antibiotic trials proved highly variable. A treatment of antibiotics (a combination of kanamycin and amoxicillin) was added to the water, and in some cases the disease was arrested but in others it continued to progress. Further replication is necessary, but this does suggest that antibiotics are somewhat effective.
  - There has been a lot of isolation work done, headed by Dr. Blake Ushijima (OSU). A few suspect bacteria have been isolated, but it is too soon to report on them.
- In collaboration with Dr. Ken Banks (Broward County), coral colonies were tagged and have been tracked from July to December to study disease progression rates. Overall, rates of progression are highly variable between species.
  - MCAV exhibits slower disease progression as compared to other species. Dr. Paul reported 8-30% colony loss per month.
- Questions/Comments
  - Karen Bohnsack (DEP) commented that the transmission experiments with PAST was a glimmer of good news. Dr. Paul confirmed that *Porites* seem to be faring well. In general, these laboratory experiments are confirming what is observed in the field.
  - No experiments on *Acropora spp.* have been conducted, but field observations suggest that these species are not being affected.

#### **Update on Current Response Efforts**

- Coral Disease Workshop – Joanna Walczak (DEP), Karen Bohnsack (DEP)

- In November, DEP and FWC hosted a coral disease workshop to strategize the next phase of coral disease response efforts. The workshop was split into two separate parts: a 1-day intervention methodologies component and a 1.5-day priority sampling plan component. In total, there were ~40 participants. A summary of the workshop was included as attachment #4.
- The first component involved discussion of in- and ex-situ intervention strategies, in particular the specific techniques and constraints of such efforts. Some intervention strategies would involve regulatory hurdles, and one goal of the first session was to identify relevant regulations and begin to work towards addressing the regulatory needs.
  - Some techniques discussed were mechanical (e.g. trenching, physical barriers), delivery vehicles for antibiotics (such as chlorine or amoxicillin), and other treatments or treatment application methods.
  - All treatment options were up for discussion, and out-of-the-box thinking was encouraged; examples included ultraviolet lasers, photoactivated compounds, and use of welding torches.
  - Intervention at the habitat level was also discussed – whole colony removal and culling were considered. It was agreed that maintaining the reef structure was important.
  - Finally, the group discussed what further information was needed to move forward, and how to build the scientific knowledge in a constructive manner along the way.
  - Follow-up action items included moving forward with techniques that did not require especially arduous regulatory approval (e.g. isolated application of chlorine).
    - Jennifer Derby (EPA) commented that from the perspective of the EPA, the amount of chlorine that would potentially be used is far below the threshold for EPA permitting. Thus, permitting would have to be addressed at the state level.
      - Karen Bohnsack (DEP) will circulate information regarding the EPA threshold when it becomes available.
    - Dr. Vladimir Kosmynin (DEP) commented that, from his discussions, there should not be regulatory obstacles at the state level.
    - Karen Bohnsack (DEP) will follow up with Jennifer Moore (NOAA) regarding regulation of use of antibiotics in similar circumstances.
  - Questions/Comments
    - Dr. Ilze Berkins (UF) inquired as to whether immunologists or virologists were involved in these efforts. The answer for both: no. Dr. Berkins agreed to help identify immunologists who might be interested in this work.
      - Dr. Valerie Paul (SI) commented that the genomic data can be used to identify viruses that may be involved with the disease.
- The second component of the workshop was 1.5 days and aimed to 1) create a Florida Reef Tract-wide coral disease priority sampling plan, to include both a single event sample collection and fixed station assessment, and 2) develop a plan for how existing and future samples should be analyzed across all disciplines, and identify labs/personnel with the expertise to complete those analyses.

- The first day had presentations on the status of the disease outbreak, FWCs sampling and lab analysis efforts to date, and the latest updates from the work of Drs. Greta Aeby (UH) and Valerie Paul (SI) on coral disease treatment. Participants reviewed a suite of sampling methods (e.g., mucus collection, DNA swabs). Breakout groups developed a sampling plan designs, which the larger group synthesized into a single comprehensive plan that included guidelines for site selection, target species, samples to collect, and the types of lab analyses to be conducted.
    - The second day included additional presentations on disease boundary identification, fixed site data collection tools, and fate tracking for individual colonies. In addition, there was discussion on the types of data that could be collected at fixed sites (e.g. individual colony fate tracking, demographic information), how frequently these efforts should take place, and other opportunities at these sites (e.g. implementing and monitoring experimental intervention methods).
- Coral Disease Boundary Surveys – *Dr. Karen Neely (FKCC)*
  - A disease margin had been established based on previously collected CREMP data: Tennessee Reef. The Post-Hurricane Irma Rapid Assessment helped to refine the boundary. Efforts were targeted between Grassy Key, the north half of Marathon, and Long Key. Dr. Karen Neely reported that reefs south of Long Key looked clear of disease; Long Key had signs of disease, and Long Key Bridge rubble was especially ‘hot.’
  - Dr. Neely notes that these findings do not match the pattern described by Dr. Rob Ruzicka (FWC) (above) – here the disease is more prevalent and observed further south at inshore patch reefs as compared to offshore reefs. Dr. Neely notes that this could be due to sampling effort (as deep sites are not as heavily sampled), or perhaps unique local oceanographic conditions.
  - Despite the location of the disease margin seeming to be in the Long Key area, Coffins Patch (~10km southwest of Long Key) showed signs of disease. As of one month ago, the area between Long Key and Coffins Patch does not seem to be impacted. This suggests that the disease can ‘jump’ reefs rather than follow a linear path through the Florida Reef Tract. Further, this lends support to the idea of setting up ‘sentinel’ monitoring sites further south in order to catch any potential jumps.
  - Other observations: MMEA seems to be the first species impacted, and can serve as an early indicator species. DSTO and brain corals are impacted next, followed eventually by OANN, and finally MCAV.
  - Dr. Neely provided slides, included as attachment #6.
    - Slide 1: Map identifying the survey area within the Florida Reef Tract.
    - Slide 2: Map identifying the extent of disease observed at sites within the survey area.
    - Slide 3: Map of presence/absence of disease in MMEA at sites within the survey area.
    - Slide 4: Data from three sites on the status of coral (recently dead, symptomatic, exhibiting dark spot, and asymptomatic) by species.
      - Dr. Neely notes the very high percentage of recently dead or symptomatic coral (MMEA and brain corals) at Long Key Bridge rubble.
    - Slide 5: Data from three sites along Coffins Patch on the status of coral (recently dead, diseased, pale spots, asymptomatic) by species. The three sites represent

a gradient of overall coral infected (<1% to 20-50%), as determined by the Post-Hurricane Irma Rapid Assessment.

- Dr. Neely points out that these data present a good visual representation of the pattern of disease progression southward through the Florida Reef Tract. In addition, this helps visualize how quickly the disease is moving – knowing where the disease boundary was in mid-December does not mean that is where it currently is. Further, Dr. John Hunt had shared an updated map of where disease has been observed, and it included sites further south than the designated disease boundary.
- Mosaic Imaging at Cheeca Rocks – *Dr. Derek Manzello (NOAA AOML)*
  - Background: Dr. Derek Manzello began monitoring Cheeca rocks in 2012 using 100m<sup>2</sup> photomosaic images. Data were initially collected on an annual basis, but the frequency was increased to several times per year during 2014-2015 due to the thermal bleaching event. In July 2017, Dr. Manzello received reports of coral disease at the site. Dr. Manzello confirmed this report, noting that the disease was impacting CNAT.
  - Dr. Manzello provided a side-by-side comparison of photomosaics from a single site in May 2017 and November 2017. This image was included as attachment #5. Colonies with disease signs are circled and labelled (M – mottled; D – diseased).
    - The outlook at this site is generally positive. There was an increase in the number of colonies identified as ‘mottled’ and one colony that was diseased. However, as of this past December, across all five sites at Cheeca Rocks, three ‘mottled’ colonies and one diseased colony had fully recovered. However, two colonies that were pale in November are now showing signs of disease. But overall, there is limited tissue loss (even on diseased colonies).
  - Karen Bohnsack (DEP) noted that there are very few MMEA or DSTO at this site, and hypothesized that the lack of these species might help to preserve the area, or alternatively, that disease may already be impacting that site but is potentially not visible yet as there are very few of these “early indicator” species.
- Large Coral Assessment – *Dr. Brian Walker (NSU)*
  - Dr. Brian Walker’s project aims to document how previously-identified corals larger than 2m in diameter have been faring during the disease outbreak. Data collection officially begin in December, although a few spot checks were performed in October. Thus far, 21 large corals have been assessed: two were dead, one was diseased, six were bleached or partially bleached, and eight had experienced 75% mortality. Dr. Walker notes that the news is not all bad: some of these large corals are living and healthy with seemingly no effects from the disease, and some that had experienced considerable tissue mortality had successfully arrested disease progression and were currently asymptomatic.
    - One large SSID colony was dead, but covered in ‘a ton’ of SSID recruits.
  - Dr. Walker revisited LIDAR bathymetric data, and has identified over 100 new targets that have a high potential for being large coral colonies. This effort is self-funded, so confirmation will occur whenever possible.
  - Karen Bohnsack (DEP) noted the concern over these large corals that have survived through hundreds of years of impacts during Florida development; that fact that some of these historically resilient colonies are persisting through this disease event is encouraging.
- Data Management Plan – *Nick Alcaraz (FWC)*

- Nick Alcaraz is working on a central database to house the many disparate coral disease datasets being produced and utilized. The data aggregation portion is nearly complete, having identified the most relevant disease and environmental covariate datasets to include. Moving forward, Mr. Alcaraz will be working on the design of the database (ensuring it can be queried, applicable to modelling efforts, updateable, etc.). The goal is for the database to be a central clearinghouse for both managers and researchers to find relevant datasets.
- Related to this data management plan, FWC will be hosting FRRP data – presumably these data can be incorporated as well. In addition, Alcaraz encouraged those with ‘opportunistic’ data or other disease-related data to reach out and see whether it can be included. He is all ears!
  - In particular, Alcaraz noted that he is looking for datasets concerning physical oceanographic data (tidal flows, eddies, in-situ hydrodynamic data, etc.). Lauri MacLaughlin (NOAA) notes that there is historical data for tidal flows from HBOI that can be included.
- Karen Bohnsack (DEP) noted that collaboration is underway with Dr. Erinn Muller (Mote) and Rob van Woesik (FIT) to create spatial epidemiological maps that will be incorporated as well. These maps may help to inform how the disease progressed through the reef tract and what environmental factors may have contributed to its progression.

#### **Update on Sampling, Analysis, and Experimentation Efforts**

- Dr. Valerie Paul (SI) provided an update earlier (above).
- Sample Analysis: Microbiome Analysis – *Dr. Julie Meyer (UF)*
  - Background: In Spring 2017, Dr. Julie Meyer presented preliminary results of microbiome samples collected at Grecian rocks; the results were inconclusive, perhaps due to the large size of the samples collected.
  - In July 2017, Dr. Meyer collected smaller samples of MCAV near Fort Lauderdale. Samples were taken from presumably healthy colonies, and from diseased colonies. Samples were taken of healthy tissue far from the disease lesion, healthy tissue abutting the disease lesion, bleached and partially bleached tissue, and polyps that were ‘flaking off in pieces.’ Microbiome analyses were conducted on the surface-level mucous.
    - The analyses suggest that the infection is localized. Most of the colony appears to have a normal microbiome but samples very close to the disease lesion exhibit very different microbiomes (but it is hard to know whether this is the cause or the effect of the disease). There is no consistent community shift, but there is a differential abundance of a few taxa, some of which are related to potential pathogens that Dr. Valerie Paul (SI) and Blake Ushijima (OSU) have isolated. Some of the taxa identified include pathogens commonly found on diseased coral (something similar to *Vibrio coralliilyticus*, as well as rotobacteraceae). Dr. Meyer recently obtained additional samples and will continue to look for these potentially infectious pathogens.
  - Dr. Meyer also conducted microbiome analysis during some transmission experiments, but the results did not provide a consistent pattern.
    - When considered along with the effect of antibiotics on disease progression, Dr. Meyer argues that the pathogen is likely bacterial, and there is a chance to identify it.
- Intervention Experiments – *Dr. Cindy Lewis (KML), Dr. Karen Neely (FKCC)*

- Dr. Cindy Lewis removed a diseased colony of pillar coral (DCYL) from the Long Key Bridge Rubble and brought it into the lab. Dr. Lewis trimmed the colony and applied two doses of antibiotics in dental paste, which successfully arrested the disease progression. The coral is likely a unique genotype (a designation offered due to its distance from other pillar coral colonies, not laboratory analysis). Annotated images of this experiment were included as attachment #7.
- Dr. Karen Neely has previously utilized antibiotics delivered via dental paste on colonies of DCYL to great success in the lab, and uses this as somewhat of a control for subsequent trials. Dr. Neely has tested antibiotics mixed in dental paste, antibiotics mixed in marine epoxy, and chlorine powder mixed in marine epoxy, and is currently testing chlorine mixed in modelling clay and antibiotics mixed in modelling clay. Species included in these trials are DSTO, MMEA, CNAT and *Pseudodiploria strigosa* (PSTR).
  - Some of these approaches have worked some of the time – as of yet, there is no ‘magic bullet’ solution. Dr. Neely will continue to test different mitigation substances with different delivery vehicles, and is open to suggestions for things to test.
  - Lauri MacLaughlin (NOAA ONMS) asked whether hypersaline compounds had been tested. Dr. Neely answered that they had not, but welcomed any protocols for such an application. Dr. Vladimir Kosmynin (DEP) echoed that salt has antiseptic effects, but that it might be difficult to achieve sufficiently high concentrations and there will be difficulties with dissipation.
    - Karen Bohnsack (DEP) will follow up with a Coral Disease Workshop participant who had initially suggested hypersaline treatments.
  - Karen Neely (FKCC) inquired as to whether anyone had connections to material scientists who might assist in suggesting or eliminating certain substances.
    - Cheryl Woodley (NOAA) noted some efforts in this area: Keri O’Neil (Florida Aquarium) has contacts at a company that develops delivery vehicles, and Roy Yanong (UF) is searching within the UF pharmacology group for similar expertise.
  - Lauri MacLaughlin (NOAA ONMS) A participant suggested testing a mix of concrete with tile mud which is more flexible to work with.
  - Dr. Neely noted that there is a plethora of materials to test, and encouraged any other researchers with capacity to assist with these tests.

### Next Steps in Response Efforts

- Overview of the Potential Next-Phase Response Strategy – *Joanna Walczak (DEP)*
  - Joanna Walczak noted that from the management perspective, the work is largely going to pivot towards intervention strategies in the field. There is growing concern that, unless the disease can be slowed or arrested, it will grow from just a Florida issue into a wider Caribbean problem.
  - DEP has identified this disease outbreak as an Agency priority. The hope is that Legislative funding for these efforts will be recurring. There is still a multi-year award from EPA for these efforts that should last another year or so.
- FWC Sample Collection and Sentinel Sites – *John Hunt (FWC)*
  - John Hunt provided information on a proactive management project that aims to establish multiple ‘sentinel sites’ south of the current disease margin. These sites will be useful for monitoring disease progression and transmission rates, as well as implementing intervention strategies.

- Coral Disease Communications and Information Sharing – *Karen Bohnsack (DEP)*
  - o Karen Bohnsack drew participants’ attention to the new DEP website devoted to disease response. Interested parties can access meeting summaries, project reports, presentations, and more. Bohnsack will share the link.
    - It was noted that audio recordings of presentations are not available on the DEP website, but a separate site can be established for those who would like access to them.
  - o Bohnsack wanted to remind participants that there are community engagement groups such as SEFAN, C-OCEAN, and Bleach Watch. However, there is ongoing discussion on ‘crowdsourcing’ data or observations, as well as other means to engage local communities (especially in the Florida Keys).

#### **Wrap-up and Adjourn**

- Karen Bohnsack (DEP) offered a standing reminder: if you are contributing to this effort and have any milestones, project updates, or new information that would be useful to the group, please let Bohnsack know so that it can be included in future agendas.
- The next call will likely be sometime in April or early May – please keep an eye out for the next meeting and call for agenda items.
- Maurizio Martinelli (DEP) will be coordinating the subsequent call along with Karen Bohnsack (DEP), and then assume the role of facilitator full time.