Florida Reef Tract Coral Disease Outbreak

Coordination Meeting #8
June 9, 2017
1:00 PM – 3:00 PM

Meeting Summary

Attendees: Tracy Ziegler, Mary Beth Gidley, Derek Manzello, Jack Stamates, Lauri Maclaughlin, George Sedberry, Margaret Miller, Jennifer Moore, Alison Moulding, Valerie Paul, Pamela Fletcher, , Dana Williams, LeAnn White, Meghan Balling, Kristi Kerrigan, Kelly Montenero, Melissa Sathe, Daron Willison, Aubree Zenone, Karen Bohnsack, Joanna Walczak, Vladimir Kosmynin, Janice Duquesnel, Paul Rice, Lindsay Huebner, Yasu Kiryu, Jan Landsberg, Kate Lunz, Erin McDevitt, Kathy Fitzpatrick, Ken Banks, Cindy Lewis, Danielle Dodge, Esther Peters, Julie Meyer, Erinn Mueller, Dan Clark, Stephanie Clark, Ed Tichenor, Jennifer Stein, Angela Smith.

Welcome, Roll Call, Meeting Purpose

- Karen Bohnsack welcomed attendees to the call and reviewed the agenda and attachments sent prior to the meeting.
- The agenda includes sharing new or noteworthy disease observations, updates on ongoing response efforts (including pillar coral rescue, disease outbreak investigations, FRRP, and coordination with the USGS National Wildlife Health Center), and working group updates.
- Attachments include: Meeting agenda, a report from recent Pennekamp disease surveys, photos from Mote staff, and an updated DCYL disease map (with all known colonies), courtesy of Karen Neely.

Update on Florida Reef Tract Disease Observations

- Karen Bohnsack asked attendees to focus disease observation updates on new or noteworthy updates such as: the identification of disease-free sites, new information on the disease boundary or newly diseased sites, or other new observations or data
- Southeast Florida – *Kristi Kerrigan (DEP CRCP*)
    - Kristi Kerrigan noted that CRCP staff visited a few deep sites (~80') in Broward. It appeared that the disease has largely passed through as it is not as active as previously observed. There is still relatively recent mortality, but there are also surviving colonies.
    - In early June, NSU divers saw white plague-like disease on several (~12) *Pseudodiploria clivosa* (PCLI) colonies and 1 *Montastraea cavernosa* (MCAV) colony near one of their SECREMP sites in Martin County, located just south of the St. Lucie inlet. This is near where reference samples were obtained in April, at which point no disease was observed.
        - In response to an inquiry, Kristi clarified that this site was nearshore, probably around 20' deep, located the St. Lucie Inlet Preserve State Park boundary.
    - As of May, diseased MCAVs were still being observed in Broward County.
- Biscayne National Park – *Karen Bohnsack (DEP) on behalf of Vanessa McDonough/Amanda Bourque (BNP)*

    - BNP staff have reported that while there is still active disease, they have not seen any new emergence of disease; much of what is out there is already dead.
    - Colonies of Mycetophyllia still appear to be much healthier than all other species.
    - Kelly Montenero added that one disease report from BNP was submitted to SEAFAN. This included white band on *Acropora cervicornis* (ACER), white disease on *Siderastrea siderea* (SSID), and recently dead colonies of *Pseudodiploria strigosa* (PSTR) and PCLI.
- Florida Keys –
    - John Pennekamp Coral Reef State Park – *Janice Duquesnel (DEP FPS)/Karen Bohnsack (DEP) on behalf of Trudy Ferraro (DEP FPS)*
        - Janice noted that in mid-May her team completed surveys at long-term monitoring sites, which have been monitored since the early 1990s. These had not been visited since May 2016 so there was concern about what the condition would be.
        - Mostly *Dichocoenia stokesii* (DSTO) was observed affected by white disease, although seven other species were also observed with minimal amounts of disease.
        - Overall, these sites also did not have much recent mortality, and Basin Hill Shoal looked good. Janice clarified that at these sites, the entire reef is surveyed, not just a subset via transects.
        - At Mosquito Banks, mostly SSID, DSTO, *Colpophyllia natans* (CNAT), and MCAV were observed with white disease. During these 2017 surveys, in addition to disease, all living stony coral species were also recorded to better understand the diversity at these sites.
            - Janice noted an interesting observation: During the 2010 cold water bleaching event, a lot of coral coverage and species diversity was lost at Mosquito Banks. However, small colonies of some of those species that had been absent at these sites since 2010 were once again observed during the 2017 surveys, including *Porites astreoides* (PAST) and MCAV.
        - During ACER surveys at Turtle Rocks, again only minimal white disease was observed, primarily on PSTR, SSID, and PCLI. Not much recent mortality was observed and overall the corals appeared to be in relatively good condition. These were towed-diver surveys so a large section of the reef was covered and surveyed for the different types of diseases and their distribution. A fair amount of dark spots disease was observed, but this is consistent with previous observations over the last few years.
        - Karen Bohnsack also shared that Pennekamp staff went out for a second set of disease surveys in mid-late May (as a follow-up to surveys in February). The primary diseases identified at the sites were dark spot and un-identified white disease. Overall it appears that the disease outbreak is slowing down on the north end of the park, but this could be due to the mortality of much of the coral that had previously been affected. The southern area of the park still has an active and progressing disease outbreak.
            - The next survey event is planned for September/October 2017.
    - Florida Keys National Marine Sanctuary – C*ory Walter (MML)/FKNMS Staff*

- Mote staff have reported seeing lots of the white spot/dark spot on the SSID's throughout the Lower Keys (see photos) which may be the early stages of disease. They have not been back to visit the original site when this was first reported during the March call (#6), so are unsure if there has been any progression of the potentially early-stage disease at that site.
- Lauri Maclaughlin noted that during recent visits to sites inside of South Carysfort, Tom's Wreck and Molasses deep reef, active disease prevalence has dropped off compared to what was observed this past summer, fall, and winter. While it is still out there, it may be receding. Recent mortality from disease is apparent, but not active disease. Many other corals are already dead so are no longer actively diseased. A combination of predation and white disease was observed at the deep Molasses site (60'-90'), primarily on MCAV. Lauri reinforced Janice's report from Mosquito Banks that they did observe disease on *Diploria labyrinthiformis* (DLAB) and DSO, but also saw healthy *Eusmilia fastigiata* (EFAS) and new recruitment which may indicate some signs of recovery.
- Derek Manzello provided an update on his team's recent surveys around the upper Keys. In mid-May, they visited Crocker Reef, Conch Reef and three inshore sites. The disease is apparent at Crocker and Conch reefs, but no evidence of disease was observed at the inshore sites at Cheeca Rocks and near Hens and Chickens. Disease has not been observed at Cheeca Rocks since the 2014 bleaching event (black band). It is possible there is an inshore/offshore gradient with the white disease.
- Relevant to the disease outbreak and its potential progression, Karen Bohnsack updated attendees about information that came up at a recent meeting of the Sanctuary's Water Quality Protection Program about current patterns in the Keys. A water current patterns study previously conducted in FKNMS showed that the counterclockwise gyres that come off the Florida Current and inside of Hawks Channel reach to about Tennessee reef (near Long Key), but south of there the hydrodynamics change and the primary water flow comes from Florida Bay. Thus, there has been some speculation that these current patterns may help buffer the reefs in the middle and lower Keys from this disease outbreak, especially if whatever is causing the disease is waterborne.
    - Lauri Maclaughlin noted that Rob Ruzicka (FWC) explained that during a disease outbreak on barrel sponges (*Xestospongia muta*) in 2012, the pattern of disease distribution was similar to this coral disease outbreak, and only went as far south as Long Key. The current patterns and Florida Bay water created a frontal boundary line that prevented the disease from impacting locations further south. Lauri noted that during recent dives around Marker 45 (East Turtle Shoal, south of the Channel 5 bridge, inside Hawks Channel), no coral disease was observed (not even background levels). Healthy colonies of *Orbicella faveolata* (OFAV), CNAT, DLAB and SSID, among others, were observed.
- Cindy Lewis noted that white plague was observed affecting *Diploria* spp. at Alligator Reef in April. No diseases were observed at inshore patch reefs

between Alligator and Tennessee Reef as of early May. Additionally, Cindy noted that they have observed white plague south of the Channel 5 boundary at Coffin's Patch (near Sombrero Beach). This is primarily affecting DCYL and has been ongoing since the 2014 bleaching event. This site will be revisited and more information available during the next call.

- Dry Tortugas –*TBD*
    - Karen Bohnsack reported Meaghan Johnson has not seen any disease at sites they have been visiting for other projects. Mike Feeley's group will be out in early July monitoring the sites that they observed with disease last summer. More updates are forthcoming during a future call.

Update on Current Response Efforts

- Pillar Coral (*Dendrogyra cylindrus*) Rescue Update – *Karen Neely (FKCC)/Cindy Lewis (KML)*
    - Cindy Lewis noted that…
        - Pillar colonies seem to be very stable at the moment at all the labs and there has been great success with amoxicillin dental paste on the ex situ colonies that show receding tissue. However, these antibiotics cannot be used in the reef environment where fish may be coming in contact due to human interactions.
        - All the remaining samples for the genotyping project were just received last week and these will be completed soon.
    - Karen Bohnsack shared that Karen Neely's group finished their surveys at the southern DCYL sites last month, and have reported only background rates of disease affecting the DCYL colonies. Healthy colonies of EFAS, DSTO, MMEA, etc. were also observed. An updated map that shows all of the DCYL sites across the FRT and the current condition was sent prior to the call.
        - Vladimir Kosmynin made an observation that the bad areas on the map are near populated regions (particularly Miami).
- Coral Disease Outbreak Investigations: Reference site sampling – *Kate Lunz (FWC)*
    - Vanessa collected reference samples from sites theoretically free of disease (other than background dark spots disease). Samples were collected in April from Martin County at MC3 and also West Turtle and Dustan Rocks. Cores were also collected from several species in some of the other affected areas. Samples are being stored in the FWRI freezers and histological samples are with Jan Landsberg.
    - Lindsay: Sites in the Middle Keys were chosen because they were apparently free of disease in March/April during their recruitment work and again when they visited during CREMP surveys in May. The white blotch/bleaching band was absent at all Middle Keys sites including Tennessee, Sombrero, and all of the patch reef sites.
    - Karen made a comment regarding the timing of disease observations in Martin County right after reference sampling (only weeks later). Are these colonies really healthy or are they apparently healthy? We will have to wait for the histology results to determine.
- Florida Reef Resilience Program (FRRP) Updates – *Jenni Stein (TNC)*
    - FRRP is gearing up for this year's bleaching season. DRM trainings have been scheduled in SEFL and the Keys.
        - Keys: Monday, July 17th @ Mote Marine Lab
        - SEFL: Friday, August 4th @ NSU Oceanographic Center

- Steering Committee Update
    - The coral disease outbreak was a topic of discussion at a recent FRRP Steering Committee meeting. Discussions were mainly on whether to include more in-depth disease monitoring in conjunction with DRM. Phil Kramer thought that DRM captures disease, but we might need to increase the transect size, etc. Steve Smith felt that we should not increase the transect size, but rather do more transects. Ultimately, it ended in a discussion on whether we need a more intense sampling through the entire region, or just focus our efforts on the southernmost disease boundary.
- Disease surveillance protocols
    - DEP requested some assistance from TNC to identify the disease front boundary between the Upper and Middle Keys. TNC reached out to university research partners regarding disease surveillance protocols to identify this boundary. Right now, we are waiting on responses from them, but hoping to finalize these over the next couple weeks. More discussions are needed to talk about whether to do this before, during, or after DRM to get the best information. Once we identify the methodology, we need to reach out to partners to help with this effort if it is outside of DRM season. We will have more updates during the next call.
    - Jenni highlighted that this is not a protocol for regular disease monitoring. For now, this is just an assessment to identify the boundary, which would allow for monitoring of the progression and research how disease is being transmitted.
- Lauri Maclaughlin – Is there an opportunity for other folks to weigh in on the disease protocol?
    - Jenni – Yes, James will be reaching out to a few partners for feedback, Lauri is on the list. First, looking to get a sense of the statistical significance of each option, then will reach out to other partners to review for feasibility.
    - Lauri – I remember when we were doing SCREAM surveys we had Bill Precht on board for earlier roving surveys of the MMEA outbreak. Even if we have a fixed transect (linear or belt), we should also have a roving component. When doing coral disease or bleaching transects, it's inevitable to miss the disease. This might be worthy of discussion at some point.
    - Jenni – One of the options we presented was a roving diver or visual census over a larger area and characterizing disease levels above or below 5%. This can be quick and cover a lot of area. Issue is being able to identify what is background and what's not and deciding whether to move further south or north to find the boundary. Each habitat within the reef strata will probably show different levels of coral disease based on density and species. The roving diver option would be great as an initial assessment, but in terms of quantifying the disease this would be difficult.
    - Lauri – In addition to any type of quantified monitoring effort, it'd be good to have a roving dive buddy to do both.
    - Jenni – Traditionally, DRM had data sheets to document disease outside the transect (via rapid surveys), but there was not as much success with this. This

year, I've included an area at the bottom where you can list disease observations (species, abundance, etc.) outside of the transect.

- Coordination with USGS National Wildlife Health Center – *LeAnn White (USGS)*
    - Regarding the USGS/NSF internship opportunity they posted to support their engagement with the FL disease outbreak for 12 months, unfortunately they did not have an intern select the project. Instead, they applied for a USGS funded cyclical position that was due last Friday for the same type of work involving statistical simulation techniques to look at the various surveillance designs to figure out the best way to monitor coral health and disease. The outcome would eventually develop a web-based tool that can be used by managers. This individual would also be doing a more in-depth analysis of these parameters. We know there is a big need for support so one of the other ways we can help is just by getting the word out. One of the ways we can do this is through the Quarterly Mortality Report in the Journal of Wildlife Diseases. And we just need about two paragraphs so if people are interested we can help.
        - Karen – Regarding the surveillance design modelling discussion that arose during the last call, we have not forgotten to bring the relevant partners to the table to weigh in. We are just waiting on the USGS NWHC position to lead that effort. When that time comes, we'll make sure the key players are involved in the discussion.

Working Group Updates

- NSF RAPID Grant Proposal – *Val Paul (Smithsonian Institution)*
    - We have applied for and received the NSF RAPID money! Money came through with a June 1 start date. Greta Aeby and Blake Ushijima (former grad student of Greta's at Oregon State) are part of the project and they will be here from the end of June through August, including for the US Coral Reef Task Force meeting. They have been successful in isolating causative organisms in bacteria of white plague-like diseases in a variety of locations from the Pacific, including Hawaii.
    - Goals:
        - Transmission experiments (understand rates of transmission).
        - Antibiotic treatment to determine if it's a bacterial organism.
        - Isolating the causative organism (Julie Meyer will be doing some microbiome and metagenomic analysis). They will coordinate with Jan about getting the samples to FWC.
    - Val requested assistance from the partners on this project: Erich Bartels and the Coral Reef Nursery have a lot of corals to play with including MCAV/OFAV corals. They need help getting in the field to collect some diseased colonies. Kate has listed her as a collector on the FWC SAL and she can add others if anyone is interested. If someone can point us to a good dive site at the disease boundary (e.g. Conch Reef), that would be helpful because they also want to get Greta out on the water (with us or point us to the appropriate dive site).
        - Ken Banks – Willing to help (Broward County)
        - Joanna Walczak – Willing to help (Miami)
        - Lauri Maclaughlin – Willing to help (FKNMS)

- Target species: Already have a lot of colonies of MCAV/OFAV, but any diseased species with white plague-like symptoms. If this is the same disease across species, then it does seem to be affecting a lot.
- Karen Bohnsack noted that Greta Aeby has also expressed an interested in providing a ~1/2-day training while she is in the state working on the NSF project. Planning is still underway, but the goal is to provide seminar presentations on the drivers of disease and potential management actions; coral disease ecology, identification, and investigative techniques; coral lesion identification, including those associated with disease vs. non-disease processes (predation, competition, sedimentation, etc.); and terminology used to describe and quantify disease lesions. This is tentatively being scoped for July 24th or 25th and will hopefully include a webinar for remote participation. Additional information and invitations will be sent via email.

- Coral Disease Field Interventions – *Margaret Miller/Dana Williams/Lauri Maclaughlin (NOAA)*
  - Karen Bohnsack reminded attendees that the topic of disease interventions originated two calls prior, so this working group was developed to explore potential options.
  - Dana Williams: The group has had one call thus far, during which they discussed the types of options that could be relevant. They do not have a conclusive plan yet.
    - Some of the methods discussed included aspiration, epoxying over lesions, creating fire breaks ahead of the disease margin, and antibiotics, including their effectiveness and potential for field use.
    - The group's consensus is that this the application of antibiotics is not ready for field application, however they are thinking about how to apply this technique in a closed system.
    - Dana plans to create a rough outline of a potential field plan for moving forward. This will be used as the basis for feedback, and another call will be held to finalize a plan to implement sooner rather than later.
  - Lauri Maclaughlin: Techniques other than antibiotics, such as chlorine powder (which may be less problematic for permitting) were also discussed.
  - Dana clarified that this is a method that Greta published a preliminary study on. The group is considering including this in the proposed nearer-term field trials.
  - Val Paul: This method was used for black band; chlorine powder was incorporated into z-spar marine epoxy and a double band applied. This is a modification of Harold Hudson's black band treatment protocol. There is a lot of chlorine in the ocean already, so this might be OK versus introducing antibiotics into the water. This technique is useful as a firebreak; unknown if there is a slow-release of chlorine.
  - Margaret Miller: In Greta's paper, they did not measure the delivery of chlorine, but this pilot study did show a significant improvement in tissue loss. This might be a good intermediary between basic clay or epoxy and antibiotic treatments.
    - Regarding antibiotics, there is a need for focused experimental work for delivering antibiotics in the water, with a focus on risk mitigation. The RAPID project will help characterize how these antibiotics are working on corals in closed systems, but it will also be important to look at the behavior of the antibiotics themselves (e.g., how much is exuded into the water column vs. being delivered to the coral).

- Cindy Lewis: Had conversations with FWC/USDA/FDA regarding using antibiotics to treat corals in tanks at Keys Marine Lab. They will not permit the use of antibiotics in the open ocean; their concern is this getting into the human food chain. Still, you already find antibiotics in the water already from land-based sources. For use of antibiotics in the tank, there is a requirement that treated specimens be held for a period of time following treatment. The withdrawal time (time between when they last had the antibiotic before outplant into the environment) needs to be determined for each specific coral species and antibiotic. They also indicated that the epoxy is a gray zone; chlorine is not likely to be approved either.
- It will be important to show what the with withdrawal period is and how localized the change in the concentration of chlorine/antibiotic is. To help with these analytics, it may be necessary to bring in additional expertise.
    - Loop in Piero Gardinali to assist with analyzing antibiotic concentrations in water samples, etc.
    - Cheryl Woodley may also be able to provide some guidance. She has had to retreat corals every day because the antibiotic breaks down quickly and is no longer effective. This may also be important to explore further. These treatments have including treating both the whole fragment in a tank of water with antibiotic added, as well as treating localized lesions with dental paste/slow-release amoxicillin. She is also looking at bone cements that they use as a carrier for antibiotic therapy in human medicine.
- Margaret: They will start with the chlorine discussion, but also be proactive regarding the antibiotic discussion.
- Vladimir Kosmynin noted that this is a targeted application of antibiotics, not being released into the broader water column. We are not trying to treat the entire Florida Keys; this would only be applied at the disease front.
- Joanna Walczak offered to help craft these messages and figure out how to best deliver them to the agencies. There are ways to help push that conversation forward.
- Angela Smith: Suggested looking into the fish aquaculture, where antibiotics are heavily used. There is some regulation that allows this.
    - Esther: Regulations allow antibiotics to be used at a certain stage in their cultivation, then they have to be free from exposure for a certain period of time before they are marketed. This is something that cannot be controlled in the wild.
    - Vlad: We should measure to see if we can meet these thresholds in the application of antibiotics on corals.
    - Esther: Antibiotics may not be needed until we know what causes the disease. We do not know if bacteria are the primary pathogen, or a virus, some toxin, or environmental stress (bleaching, exposure to contaminants), etc.
- Esther: Regarding creating a fire break by chiseling a band into the coral's skeleton, this results in an area of denuded skeleton that breaks the connection between polyps and theoretically will break the flow of any organisms throughout the colony. However, we do not know how far throughout the colony certain microorganisms may have gone. In looking at white band/rapid tissue loss lesions on *Acroporids*, which have a lot of gastrovascular canals, they have seen acute necrosis then a secondary

bacteria/ciliates/flagellates come in to clean up. These ciliates can extend a ways up the gastrovascular canals; it is important to know why these ciliates go in the canals and what they're doing. The fire break line with epoxy along the healthy tissue boundary may keep the coral healthy.
    - Erin Mueller: They have been testing some of these techniques, including the fire break with epoxy, with some success. While we're looking to antibiotics, etc., it will also be important to consider these types of mechanical ways to treat corals.
    - Vlad: Cautioned that mechanical options can also spread disease by suspending it into the water column.
    - Esther: This is a concern, which is why it is important to better understand what's causing the initial tissue loss.
    - This conversation will be ongoing.
- Sample Analysis – *Esther Peters (GMU)/Jan Landsberg (FWC)*
    - FWC is continuing to process samples. They are sending extra sets of histology slides from the November 2016 collections to Thierry Work (USGS) and Esther Peters (GMU) for additional analysis.
    - Esther has received numerous samples from the pillar coral rescue, including tissue loss margins and apparently healthy portions cut from above the tissue loss margins that continued to lose tissue. She will try to get these processed soon.

Other Reef Issues

- Lauri Maclaughlin inquired about upwelling events and algal blooms. They experienced some in early-mid May at Molasses deep reef.
- Joanna also noted that with all the rain, the mainland inlets are letting out big pulses of freshwater.

Wrap-Up and Adjourn

- Next call date: Late July.
- Karen will:
    - Send notes from this call.
    - Send final summary from call #7 in April
    - Work with LeAnn and Joanna to provide information for the USGS quarterly mortality report.
    - Reattach Greta's paper on disease interventions.
- Request for additional field support for Val/Greta's field work as part of the NSF Grant.
- Loop in Piero/additional expertise for antibiotic monitoring/analytics.
- Lauri requested information about anyone experiencing upwelling events and algal blooms.