Florida Reef Tract Coral Disease Outbreak

Coordination Meeting #13
December 6, 2018
1:00pm – 3:00 pm

Meeting Summary

Attendees: Amanda Bourque, Meaghan Johnson, Dana Wusinich-Mendez, Jennifer Simms, Christopher Sinigalliano, Derek Manzello, Jennifer Moore, Alison Moulding, Kurtis Gregg, Lew Gramer, Caroline Rogers, Ilsa Kuffner, Christina Kellogg, Natalie Nguyen, Jennifer Derby, Wade Lehmann, Terri Johnson, Caitlin Brucker, Nicholas Rosenau, Xaymara Serrano, Kristi Kerrigan, Aubree Zenone, Iris Krehahn, Joanna Walczak, Karen Bohnsack, Karen Thurston-Chavez, Vladimir Kosmynin, Michelle Kerr, Krissy Fisher, Stephanie Schopmeyer, Erin McDevitt, Lindsay Huebner, Jan Lansberg, Yasu Kiryu, Ananda Ellis, Dave Gilliam, Abby Renegar, Karen Neely, Brian Walker, Cindy Lewis, Lisa Gregg, Julie Meyers, Ilze Berzins, Esther Peters, Martine Strueben, Ian Combs, Abigail Clark, Allison Delaschmidt, Cara Estes, Tanya Ramseyer, Tiffany Allen, Maite Ghazaleh, Jack Stamates, Kathy Fitzpatrick, Allison Garrett, Amanda Kirkland, Michelle Dennis, Ken Banks, Blake Ushijima, Mel Parsons, Jim Ritterhoff, Angelo Fiore, Keith Sahm, Valerie Paul, Maurizio Martinelli

Response Structure Update – *Dana Wusinich-Mendez (NOAA)*

- Reminder to the group that, following a technical workshop held in July 2018, a new response structure was formed. The body of this response is made up of the ten Response Teams (discussed on the previous Coordination Call, #12), as well as an Executive Coordination Team (ECT) that guides the overall response. The ECT is made up of representatives of the three lead agencies: the Florida Department of Environmental Protection, the Florida Fish and Wildlife Conservation Commission, and the National Oceanic and Atmospheric Administration.
- In addition, a need identified during the workshop was to hire a central response Coordinator to work across all ten Teams and the ECT to ensure that all the many facets of the response were working effectively and collectively towards our common goals. The position is supported through Florida Sea Grant with funding from the NOAA National Ocean Service. Maurizio Martinelli will be the new Coral Disease Response Coordinator.

Project Updates

- Introduction to Force Blue – *Jim Ritterhoff, Keith Sahm, Angelo Fiore (Force Blue)*
    - Force Blue is a new partner of the coral disease response. Force Blue is the only non-profit organization that retrains, retools, and redeploys former special operations divers on marine conservation missions. The goal of the organization is to provide a workforce underwater that can also be a benefit to returning combat veterans. Part of what veterans may lack in civilian life is a mission, so Force Blue brings them together in a team format and gives them a new mission: marine conservation.
    - Force Blue trained their first round of divers in May 2017 and came down to the Florida Keys to assist in the response following Hurricane Irma, then to Puerto Rico following Hurricane Maria. The Force Blue team met with J Walczak and K Bohnsack from FDEP at the US Coral Reef Task Force meeting in Washington and began conversations about how Force Blue might get involved with disease interventions. This past summer, Force Blue trained some veterans in Key West and met with many partners (e.g., Mote, NSU, REEF, CRF, etc.) to begin thinking about committing to the mission long-term. Thus, Project Protect was born: a three-year plan to move Force Blue operations down to the Florida Keys to participate in any number of activities aimed at reef rescue, restoration, and preservation.
    - Currently, the Force Blue team is beginning a four-month coral disease intervention effort with the guidance and support of Karen Neely's team from NSU. The two teams came together to discuss mission objectives and other related topics for the upcoming 50 dive days. The next phase (in-water work) is slated to begin early January (weather dependent). The interventions are targeting the Upper Keys to begin with, starting at Molasses Reef.
    - One benefit of the organization is that they have a 'big microphone' – they have a large audience that includes folks that may not normally be engaged with environmental groups. Force Blue can shine a light

on the challenges faced by coral reefs, and bring folks to the table who might be more willing to listen to a veteran than a scientist.
    - M Martinelli: To add, the decision was made by the ECT to target high-use Sanctuary Preservation Areas (SPAs) in order to work on corals that are both ecologically and socially important. An additional benefit is these sites provide a ready-made public outreach and communication opportunity: whenever the Force Blue team is on the surface, they can interact with other reef users to discuss why they are there and what they are doing. Relatedly, the Citizen Engagement Team has been working on a citizen science project where the Force Blue team will tag treated colonies so that citizen divers or snorkelers who come across the tags can take a photo of the colony and submit it (somewhere), and those photos can be used to monitor the colonies through time to help determine if the treatments are working or whether the team has to return for retreatments.
    - E McDevitt: Is the work of Force Blue only focused on coral? Can other reef restoration work be considered as well, once the organization is more established in Florida?
        - J Ritterhoff: Force Blue can consider other aspects under the reef conservation umbrella – for example mooring buoy installation, reclamation work, and restoration related to a grounding in John Pennekamp have all been discussed.
        - J Walczak: To clarify, the 50 dive days that Force Blue is currently funded for are dedicated to coral disease intervention, so other projects/missions will need additional/alternative funding.
        - A Fiore: Force Blue is very 'nimble' in terms of potential conservation activities, and are open to conversations about other projects/missions in the realm of marine conservation!
- SE FL Coral Intervention Experimentation – *Kristi Kerrigan (FDEP)*
    - Last Coordination Call (#12), we heard from B Walker on the large colony intervention project in SE FL, where B Walker's team treated diseased colonies >2m in diameter earlier this year. The team treated 39 colonies with chlorinated epoxy on disease lesions and a nearby firebreak separating apparently healthy tissue from diseased/dead tissue. The treatment saved large portions of healthy tissue initially, but ~6 months after those initial treatments, the team recorded a 55% success rate in margin treatments and a 59% success rate with the firebreak treatments.
    - However, one OFAV colony responded particularly poorly to the treatments. Of the 28 disease margins treated on that particular coral, only 3 were successful. If margins and firebreaks are considered without that colony, the treatments had a 62% success rate in margin treatments and 64% success in the firebreak treatments.
    - Moving forward, permits have been approved to conduct experiments with antibiotic treatments on these large corals to compare with the success rates of chlorinated epoxy. These experiments will be conducted throughout SE FL with more partners – that is to say, this is growing into a larger, more collaborative effort throughout the SE region. The work will be conducted by Nova Southeastern, Florida Atlantic University, Miami-Dade County, and Broward County, with additional support from the Force Blue team.
    - B Walker: As a quick 'update to the update,' B Walker's team visited ~2/3 of the colonies that they are monitoring, and they are still finding new lesions on the corals. In particular, there was one large SSID that was identified with disease back in April 2018 and was treated, but the disease seemed to taper off over the summer. The untreated portions, however, have now started to show disease signs.
    - V Kosmynin: Are there more SSIDs involved in the project?
        - B Walker: No, they almost completely died in 2014. There is only one SSID colony included in monitoring at the moment.

- Coral Rescue Update – *Jennifer Moore (NOAA)*
    - The Coral Rescue effort is a collaborative effort across federal and state agencies, academia, and NGOs. The objective of the team is to develop a reef tract-wide collection and care plan for SCTLD-susceptible species to ensure that an appropriate number of individuals are held in captivity for genetic preservation and future restoration. Key components of the rescue plan include identifying areas where corals need to

be collected, calculating the number of colonies necessary to capture sufficient genetic diversity, identifying and securing appropriate on-land housing, and data management. In addition, the Team will collaborate with others in the response effort, especially in the realm of reintroduction and restoration.

- Pilot collections were conducted in September 2018 targeting 12 high-priority species based on susceptibility, rate of mortality, and importance to reef building in the vulnerable zone. Following consultation with Management, three additional species were added to this list for a total of 15 high priority species. To note: DCYL rescue is under a different effort. The pilot collections targeted 8 colonies of each of the original 12 target species for a total of 96 colonies (due to rarity of some species, the goal of 8 colonies was not met, but for six species, the goal was surpassed). Supplemental collections were conducted in October 2018 for a total of 180 corals. These pilot collections allowed the team to test assumptions and techniques, as well as to have sufficient colonies for genetic marker development.
- The corals are currently housed at the Keys Marine Lab. The collections are aimed at the vulnerable/pre-invasion zone to reduce the chance of transmission and make logistics more feasible (i.e., don't require multiple levels of quarantine). A key component of this effort is coral care post-collection. The team has learned a lot already about caring for these species, including trimming and mounting the corals to avoid tissue touching the tank and using a sanitizing solution (Lugol's dip) right as corals arrive.
- The next phase of the rescue is the full collection of high priority species from the vulnerable zone: 200 colonies per species (15) for a total of 3,000 colonies. This aims to collect at least 50 unique genets per species, as it is assumed that 50 unique genets will contain 90% of the genetic diversity of a population.
- To house 3,000 corals, the Team is working to identify facilities than can take and care for rescued corals. Four 'intermediate housing' facilities have been identified thus far: UM, NSU, FLAQ, and Mote. Funds have been solicited to get these off the ground. In addition, the Association of Zoos and Aquariums (AZA) has joined the effort to identify longer term housing facilities in their network. The AZA has hired a coordinator to work on this effort. One important component of this effort is to distribute the rescued corals among multiple facilities to ensure that no single catastrophic event will endanger the entire captive population.
- Future phases include the collection of medium priority species within the vulnerable zone, the transition of corals from intermediate- to long-term housing, performing collections within the endemic zone, developing a reintroduction and restoration plan, developing field-based propagation infrastructure, and conducting a brooder connectivity study to determine the genetic connectivity of brooder species along the Florida Reef Tract.
- V Paul: Are brooders affected by the disease?
    - J Moore: When creating a table of target species, one of the considerations was the reproductive approach. There are no brooders in the high priority species list, but can follow up on the brooders found in lower priority tiers.
- X Serrano: Great work so far on this challenging project! There is limited data on population genetics, especially genetic connectivity of brooders in Florida. However, X Serrano and colleagues published on connectivity of the brooder PAST that might be of help.
    - L Gregg: Thank you! Any previous work conducted on this topic will be incorporated to avoid any duplication of effort (e.g., using existing genetic markers). But this work will be important when considering reintroduction of these species.

Research Updates

- 2018 Histology Update – *Jan Landsberg (FWC)*
    - This is an update on work that has previously been shared on these calls, and includes some information that has been shared previously as well as new information gathered since April 2018. The overall sampling effort covers histology, electron microscopy, microbiology, etc. but the presentation here is solely on histology.

- Tissue collection was performed at five sites and on five target species (MCAV, OFAV, PSTR, CNAT, and SSID). Collections were made of apparently healthy tissue and actively diseased tissue. The presentation here covers only diseased tissue from MCAV, OFAV, PSTR, and CNAT.
- Previous histology on MCAV found lesions in the gastrodermis (lower tissue layer, contains zooxanthellae) prior to lesions in the epidermis (upper tissue layer). These same patterns have now been observed in CNAT, OFAV, and PSTR as well (slide 17). The lesions appear to start in the basal gastrodermal layer (the deepest of the gastrodermal layers) and move towards the surface.
- Crystalline inclusion bodies (CIBs) are small crystalline arrays found in disease tissue samples. The early histological investigations found CIBs in ~70% of the MCAV samples; since then, these CIBs have also been observed in PSTR. Generally, the CIBs are co-associated with active lesions but are absent in post tissue necrosis. Slide 7 is a good example of a high density of CIBs in the basal gastrodermal layer right as tissue necrosis is getting underway (i.e., the vacuoles surrounding the zoox are beginning to change). Slide 8 shows similar high-density CIBs and slide 9 shows co-association of CIBs and tissue necrosis, both in a different stain from what we have seen previously.
    - This may support the hypothesis that the disease is viral – the CIBs are formed while the virus is active in the tissue but dissolve once the virus has moved on.
    - Slide 10 shows high magnification of the CIBs, showing that they target the cytoplasm – they have not yet been shown to affect nuclei. The CIBs tend to appear near zoox, but they may not be directly targeting the symbionts.
    - As noted in the table on Slide 18, CIBs have not been observed in OFAV or CNAT; they might still be there but are being identified as byproducts of granular cell processes or amoebocytes. They have been identified in samples from four of the five collection sites.
    - Locating CIBs can be challenging due to sampling factors such as timing and direction of cross sections. Perhaps the slower progression of disease in MCAV allows for the CIBs to be more readily detected.
- The histology has also found additional opportunistic microbes, including ciliates and filamentous bacteria (slide 19).
- C Kellogg: The CIBs shown in the photos look like crystal proteins created by *Bacillus thuringiensis* used to control mosquitos. Could this be a toxic crystal protein that is used to control mosquitos somewhere in Florida? Or, from another bacterium that produces crystal proteins?
    - J Landsberg: There is a broad spectrum of possibilities of what they could be. There is also consideration of heavy metal crystals or some unidentified metabolites. It is difficult at this time to rule anything out, but would like to follow up!
- B Ushijima: Do you see the CIBs associated within bleaching zones as well as non-bleached tissue?
    - J Landsberg: They are found more commonly in areas where the zooxanthellae are being compromised, and less frequently in tissue where the zooxanthellae are already gone. However, most samples still have zoox – either 'alive' or in dying *in situ*.
    - V Paul: If the zoox are dying *in situ*, that might be leading to the bleaching zone (as commonly seen on MCAV) instead of zoox expulsion.
    - V Kosmynin: How common is that bleaching zone?
    - V Paul: It's variable, sometimes even on the same colony. It has been observed on MCAV and other species, too. On MCAV it is commonly a polyp or two wide (but sometimes just a half polyp wide)
    - E Peters: The bleaching margin can indeed be due to zoox dying in situ instead of expulsion. This was observed during other bleaching events: the zoox experience shrinkage and necrosis but not expulsion. It may also be the case that they are still in the tissue but not producing pigment.
    - J Landsberg: If folks in the field target that tissue, these questions can be explored.
    - V Paul: That can be collected at the Fort Lauderdale site.

- K Neely: The table on slide 18 shows that 28 colonies have lesions but only four exhibit CIBs. Would you expect to see a higher percentage of samples showing CIBs if this were a driving force in the disease (as opposed to secondary impact)?
    - J Landsberg: It is difficult to say, but we might not expect to see CIBs in every sample if they are associated with a single stage of the disease. For example, if caused by a virus, the CIB may only be apparent when the virus is present (and otherwise just dissolve away), so timing of preparing the sample would be central to finding the CIBs. In addition, some of the 'unknowns' might be positive but the inclusion bodies appear different between species (e.g., OFAV has other inclusions that might be these same CIBs).
    - E Peters: Timing can be everything when detecting viral crystalline arrays. It is important to keep looking at samples to get a better sense of timing of cellular/molecular processes.

International Updates

- International Reports from St. Maarten – *Maurizio Martinelli (FDEP)*
    - David Vaughn of Mote Marine Lab shared photos and a video transect from St. Maarten. The photos and transect show some of the susceptible species showing similar looking disease signs. In addition, the International Society for Infectious Diseases' Program for Monitoring Emerging Diseases (called ProMED) reported on the outbreak in St. Maarten, tying it to what we're seeing here in Florida. As with previous international reports, we don't have the capability to say with complete certainty that this is the same disease, but the signs are worryingly similar and worth keeping an eye on. We are working to figure out the best means to filter through any international reports and to make sure information is flowing to and from the appropriate sources. However, for those that have international reports or are asked about where to send them, you can send them to the International Coordination team co-lead by Judy Lang (AGRRA), Dana Wusinich-Mendez (NOAA CRCP), and/or Jen Koss (NOAA CRCP); otherwise, you can send to M Martinelli who will forward it as appropriate.
- Visit from CONANP (Mexico) managers – *Maurizio Martinelli (FDEP)*
    - Last Coordination Call (#12), we heard reports of similar disease signs on susceptible species showing up in Mexico, particularly near the Cancun area. Since that time, there has been exchange of information between managers in Florida and Mexico, and a small delegation of MPA managers from Mexico are visiting Florida to observe the reef conditions and receive some training on the interventions being utilized in Florida. The hope is that the delegation will take this information back to Mexico and try their hand at these and other interventions and continue the exchange of information.
- E Peters: Funding has been secured for histopathological work to be conducted on Caribbean samples at Ross University in St. Kitts. E Peters and colleagues will help researchers there review and interpret histology slides, and will share any relevant information with this group!

Wrap-up and Adjourn

- If you are interested in joining a Response Team, please don't hesitate to reach out to the relevant Team Lead or to M Martinelli. Info on the Teams and Leads can be found in the summary to Coordination Call #12.
- Standing reminder: please submit disease reports to SEAFAN (www.seafan.net) for the entire reef tract, including the Keys!
- Next Coordination Call (#14) will be held: **March 21, 2019 @1-3pm EST.** Please look for an invite from M Martinelli's new University of Florida email address.