Southeast Florida Coral Reef Initiative (SEFCRI)
Technical Advisory Committee (TAC)
Meeting Minutes

November 4-5, 2020
Virtual Meeting

Meeting Objectives:

1. Report out from SEFCRI Team meeting and updates on DEP staff reorganization.
2. Update TAC on status of CRCP and LAS projects.
3. Continue the water quality discussion from last meeting, inform of WQ Action Plan process, connect with Keys "TAC".
4. Present changes to revised turbidity criterion proposal and get TAC feedback on them.
5. Provide an update on the ongoing coral disease response activities including the latest research on alternative intervention treatments.
6. Provide an update on restoration efforts throughout Florida's Coral Reef and brainstorm potential datasets that would be needed to inform site selection for a future restoration strategy.

Attendees:

- TAC Members: Erick Ault, Ken Banks, Don Berhinger, Richard Dodge, Phil Dustan, John Fauth, Piero Gardinali, Dave Gilliam, Lew Gramer, Kurtis Gregg, Dale Griffin, Jay Grove, Judy Lang, Joe Lopez, Caitlin Lustic, Arthur Mariano, Valerie Paul, Esther Peters, Stephanie Schopmeyer, Manoj Shivlani, Jack Stamates, Josh Voss, Brian Walker, Dana Wusinich-Mendez

- Staff: Allie Shatters, Jaime Monty, Kristi Kerrigan, Joana Walczak, Michelle Graulty, Shelby Wedelich, Jenn Coley, Mollie Sinnott, Wendy Wood, Murphy McDonald, Giancarlo Chaparro

- Presenters: Kristi Kerrigan, Joana Walczak, Karen Bohnsack, Daryll Joyner, Allie Shatters, Maurizio Martinelli, Valerie Paul, Blake Ushijima, Julie Meyer, Michelle Graulty, Mollie Sinnott, Shelby Wedelich, Jaime Monty, Kurtis Gregg, Dave Gilliam, Joana Figueiredo, Diego Lirman, Andrew Baker, Margaret Miler, Amber Whittle,

- Public: Rovira Angel (Broward County), Christie Hurley (Cummings Cederberg), Gary Jennings (American Sportfishing Association), Jessica Ward (Broward County), Kathy Fitzpatrick (Martin County), Kirk Kilfoyle (Broward County), Kristin Anderson (NSY), Lauri MacLaughin (FKNMS), Mark Ladd (NMFS), Melissa Sathe (FOFR), Pat Quinn (Broward County), Rebecca Ross (MD DERM), Sara Thanner (MD DERM), Tori Baker (National Coral Reef Management Fellow), Kellie Ralston (American Sportfishing Association), Kirk Dolston (FOFR), Pepper Uchino (FSBPA), Lisa May (NOAA/ NCOSS), Derek Cox (FWC), Stephanie Brown (MIAPBC), David Ehrens, Jocelyn Karazsia, Maurizio Martinelli (Florida Sea Grant), Gabrielle Johnson (NOAA), Jackie Larson, Joey Massa (Callaway Environmental), Marina Garmendia, Nathan Smith, Lisa Armbruster, Alexandra Wenn, Alastair Harborne, Kelsey Johnson-Sapp, Louis Pierre

Day 1, November 4, 2020
12:30 – 5:00 PM

SESSION I: Announcements

- Rob Rumbaugh has resigned from the TAC
- Caitlin Lustic (The Nature Conservancy) is a new TAC member. Caitlin is taking over leading the Coral Reef Resilience Program and specializes in reef restoration.

SEFCRI Team Meeting Report Out- *Kristi Kerrigan, DEP CRCP*

- The DEP had to cut back on projects and team meetings to accommodate resources needed for the SCTLD response activities, but SEFCRI is now prepared to reinvigorate many of these projects. At the September meeting, SEFCRI discussed statewide initiatives and discussed two new projects that will be prioritized for the next year:
    - **MICCA 28**:(A) Improve the methodology of measuring turbidity during coastal construction projects, and (B) test those turbidity monitoring techniques identified in (A). The current standard of 29 NTU is not protective of corals but need data to support a change.
    - **FDOU 51**: Identify and understand trends and gaps in existing water quality, fish, and benthic data; interpret data and protocols to inform research and management strategies.
- SEFCRI LAS- New Projects
    - Most of the 2004 LAS have been completed or are ongoing, and there has been progress made on 2017 projects. Currently gathering information on all of these LAS projects and making it available on SEFCRI website.
- Current Active Project Teams
    - Awareness and appreciation
        - 20/23: Outreach & Community events
        - 35: Travelling Trunks
        - 36: Volunteer Speaker's Bureau (VSP)
    - Land-Based Sources of Pollution
        - 4: Technical Advisory Committee (TAC)
        - 20/23: Best Management Practices (BMPs) to reduce pollution hotspots
    - Maritime Industry & Coastal Construction Impacts
        - 28/28B: Identifying & testing methods of measuring turbidity and suspended sediments
    - Fishing, Diving, and Other Uses
        - 29/30/32: Marine Debris Reported and Removal Program (Reef Cleanups)
        - 52: Data Needs for Fisheries Management
        - 55: Coordination of a Reef Management Plan
        - 51: Assessment of Gaps, Trends, Protocols of existing WQ/ Fish/ Benthic Data
    - Reef Resilience
        - CRCP 2: Citizen Science Programs (not original LAS)
- Potential Outreach Opportunities
    - **Volunteer Speaker's Bureau (VSP)**- The DEP team and TAC members provide targeted outreach and education to the community on key topics. FDEP provides PowerPoints and talking points for you and helps coordinate the events, where speakers can discuss one of following topics:
        - Florida's Coral Reef/ Coral ECA

        - Water Quality/ BMP Manual
        - Citizen Science- SEAFAN/ Bleach Watch
    - Within a month a survey will go out to sign up and join any of these project teams.

Regional Announcements- *Joanna Walczak, DEP ORCP*

- DEP received over $5 million in SCTLD efforts and WQ monitoring projects, and $10 million for coral protection and restoration (this is ~50% of the National Budget [$26 million])
- DEP has made a new coral restoration and protection program to focus on the effective administration of these funds. Joanna Walczak will oversee this project- she will remain the national contact and will also lead new priorities for the state including new restoration strategies for the entirety of Florida's reefs. Jaime Monty is taking over position in charge of place-based management efforts and taking coastal resilience offices in southeast Florida region.

SESSION II: Water Quality

Links to Keys Water Quality- *Karen Bohnsack, NOAA*

- Water Quality Protection Program Priorities
    - This program was mandated by legislation that created the sanctuary with the purpose of achieving good water quality and healthy resources. A revised set of priorities has been reviewed and accepted after consulting a working group, reviewing the WQPP purpose and activities, identifying the top FKNMS water quality issues, and refining existing WQPP strategies.
    - The key considerations when establishing these new priorities were top issues, WQ benefits (effectiveness of that action in reducing pollution or improving quality), meaningful impact, level of completion (how much is something already being addressed?), and expert opinions of the working group.
    - Recommended priorities:
        - **External WQ influences**
            - South Florida Regional Influences: engage with everglades restoration, improve mainland wastewater infrastructure
            - Tidal Flooding and Climate: adapt infrastructure for climate change
        - **Local WQ Issues**
            - Stormwater: update stormwater master plan, implement effective stormwater projects
            - Wastewater: implement a wastewater master plan, including remote area connections; ensure infrastructure functionality (collection systems, comparability with non-municipal sources, shallow injection wells)
            - Canal restoration: implement canal master plan
            - Sargassum and organic debris: develop sargassum best management practices
            - Marinas and liveaboards: ensure vessel pump out facilities and services
            - Emerging pollutants of concern: research emerging pollutants of concern, incorporate emerging pollutants into monitoring programs
        - **WQPP: Core Responsibilities**

- WQPP Administration: make sure there is enough staff to manage the program
- Data Collection, Analysis and Reporting: continue long term monitoring programs, make sure the data is being made available,
- Education and Outreach: ensure that data is available for the public, increase outreach for WQ

- Initial progress on priorities
  - **Shallow injection well study:**
    - The Keys have shallow injection wells that dispose of effluent at a minimum depth of 90 ft. There is concern that that treated effluent is migrating through the limestone and into the nearshore waters. To address this question, TAC convened to review and develop a study design to assess nearshore impacts associated with shallow injection wells. TAC recommended complementary groundwater and surface water sampling. The project has been submitted to the EPA for funding.
  - **Joint WQPP/ SAC Everglades Restoration Working Group**
    - We are developing a new joint south Florida ecosystem working group with the intent of providing a mechanism for greater stakeholder engagement to oversee everglades restoration
    - The idea is to push information down- make sure SAC and WQPP and community are engaged and informed through regular updates, dialogue and recommendations, and to identify new opportunities for reporting up and making sure that the interests of SAC and downstream resources are represented in the decision-making process. Currently this is focused on the everglades, but the hope is to make it flexible to redirect attention to other WQ issues that affect the Keys on a needed basis.
- Next Steps:
  - Want to reinvigorate WQPP and TAC and develop a more formal and routine TAC for reviewing priorities so we can advance science where it is needed. Want to continue to explore opportunities for more regional collaboration on WQ issues of mutual interest.
- **Questions**:
  - Kurtis Gregg: Is your group commenting on the Biscayne Bay and Southeastern Everglades Ecosystem Restoration Feasibility study?
    - KB: Yes, that will be in the attention of this group. We are just setting it up now, but that's one of the driving reasons for getting this group going again now
  - Dale Griffin: You are aware of the tracer studies done on the shallow injection wells in the 90s. Those were pretty clearly showing that they were a bad idea. I don't understand what additional research is needed- money might be better spent modernizing these plans to scrub the water in these systems.
    - KB: Yes, we have proven the connectivity between the shallow wells and the nearshore water. The issue that remains is that those studies were conducted prior to putting in advanced wastewater systems. The question is what impact the current effluent is having on the environment. These are expensive projects, before decisions are being made, we should confirm that these are impact before we pursue these upgrades. The science now is not sufficient for regulatory changes.

        - DG: There was rapid transport out of those shallow wells. The only way to continue to use those is if you treat the water to the degree that there are not pollutants in it. A focus to study the effluent is the way to go.
        - KB: Thank you, I will pass on the suggestion
    - Pierro Gardinali: I have a similar comment to Dale. One of the issues is that there are different technologies in different places- you need to look at what technologies are doing better than others. Some expensive systems have been installed, we can test whether we need to go that expensive or not yet.
        - KB: That's the gist of it. We've spent $1 billion on infrastructure and we're a small community. It would be wise to figure this out even if it requires a lot of extra steps to make sure we have the right information and are making the right decisions. I would be happy to facilitate having some report out when a project is implemented for you all.
    - Kurtis Gregg: I would like more details of the process; can we connect offline?
        - KB: Yes, we will chat!
    - Joanna Walczak: The commissioner recently asked for best wastewater technology to use in south Florida over the long term. Some systems are good in the short term but harmful in the long, like biosolids. It's an opportunity for the work that's been done in the Keys to inform that decision- that has been requested by elected officials, sending that information to them is a high priority if we really want to make a difference.
        - KB: I am happy to see that this has the attention of the leaders in South Florida. It's a big issue with a lot of complications associated with it, I have been meaning to put some thought into who has done studies that could weigh in on a future meeting, we should chat about that.

<u>Potential Revisions to Proposed Coral Turbidity Criterion- *Daryll Joyner, DEP DEAR*</u>

- DEP conducted a comprehensive literature review and concluded that 29 NTUs over background is not protective of corals/ hardbottom communities, but existing data is insufficient to establish a specific numeric criterion. There is a potential criterion range from 3 to 7 NTU, but the EPA indicated that they would not approve an incrementally better criterion. This must also address natural spatial and temporal variability, which impacts duration and frequency.
- Turbidity Criterion
    - Proposed a "narrative criterion" to maintain background variability. Key phrases are "Turbidity shall not be increased above background conditions" and "background conditions shall take into account the natural variability of turbidity levels and shall be established following the methods described in the document *Implementation of the Turbidity Criterion of the Protection of Coral Reef and Hardbottom Communities"*
- Proposed two new definitions
    - "**Coral Reef**": a limestone structure composed wholly or partially of the living or dead skeletal remains of marine invertebrates in the Class Anthozoa and the Orders Scleractinia (stony corals), Stolonifera (organ pipe corals), Antipatharia (black corals), and Hydrozoa (hydrocoral).
    - "**Hardbottom community**": a marine benthic community of organisms characterized by the presence of corals and associated reef organisms or work reefs created by the genus Phragmatopoma
- Spatial Extent

    - Criterion would apply in all marine waters within the Florida's Coral Reefs (FCR, formally known as the FRT) and other marine waters where coral reef or hardbottom communities are present. Coral and hardbottom communities are known to either currently or historically occur within the FRT, and are patchy outside of the FRT (generally, coastal waters from Brevard to Manatee Counties).
- Turbidity Implementation Document
    - Noted that the document would be adopted by reference
    - Addressed application in permits (dredging and beach nourishment) and Impaired Waters Rule (IWR)
    - For permits, the document described the sampling needed to determine pre-construction background conditions, including the minimum data needed and when sampling could not be conducted, and a calculation of permit limits based on the natural background turbidity range during normal tidal cycles (determine "delta" or allowable increase of compliance station turbidity relative to background station).
- Determining natural background variability
    - Natural background variability to be established based on pre-project turbidity data collected at "baseline" stations. Sampling must follow standard DEP SOPs (FT 1600 Field Measurements of Turbidity). Pre-project baseline stations are required for each project sub-area (offshore borrow areas, nearshore placement stations, nearshore dredging areas, and offshore dredging areas) and should be located above living coral or hardbottom community if any are present. Samples must be taken in areas with minimal man-induced alterations (no boat traffic, storms, or when weather fronts move through the area)., and at the surface and near the bottom. Must sample within 3 months of the project and projects expected to last longer than three months may have season-specific turbidity limits.
    - Document provided equations on how to determine natural variability at baseline stations.
    - Permit limits are expressed as the allowable increase between the project background and compliance stations. Allowable increase or "delta" based on upper confidence interval of the mean difference between min and max turbidity range over a tidal cycle. This is intended to maintain the background turbidity magnitude, frequency and duration. Upper 90% confidence interval used if baseline turbidity levels are provided for 3 to 4 pre-project tidal cycles. If background turbidity levels are provided for 5 or more pre-project baseline tidal cycles use the upper 95% confidence interval.
- Key Public Comments
    - Concerned that criterion would greatly increase costs, which ultimately are born by taxpayers
    - Sampling constraints did not allow capture of full natural variability
    - Suggested DEP should conduct survey to determine baseline levels
    - Said criteria was applying an OFW-based standard to areas that were not outstanding Florida waters (ECA)
- Revisions under consideration based on these comments
    - Criterion would apply wherever corals or hardbottom communities occur or have occurred since 1975, rather than geographic area.
    - Better define "hardbottom" to address substrate- "a consolidated hard structure with a living veneer of organisms characterized by the presence of corals, octocorals, and associated reef organisms". Would not apply to worm reefs because they typically occur in highly dynamic conditions with high turbidity.

    - May define “associated reef organisms”
    - Proposed criterion uses term “background” and OFW rules refer to “natural background”
        - Background is defined as the condition of waters *in the absence of the activity or discharge under consideration*, based on the best scientific information available to the department
        - *Natural* background is defined as the condition of waters *in the absence of man-induced alterations* based on the best scientific information available to the Department
    - For this criterion, we will use “baseline,” which is based on pre-project turbidity data, to acknowledge difference between baseline and true natural background (baseline represent best available site-specific estimate of natural background conditions)
        - Will provide permittees options to establish baseline:
            - Use interquartile range of values of existing available turbidity data for the area where the project is located
            - Use interquartile range of baseline data from previously permitted projects in the area, or
            - Use pre-project turbidity data collected specifically for the project at “baseline” stations
        - Provides flexibility on how to establish baseline turbidity but permit limits will be more conservative if an applicant relies on existing data (available historical data may not incorporate the full range of site-specific variability). This provides incentive to collect site-specific data.
        - The goal is to collect representative data, but dropped some constraints on when the samples could be collected
            - Can sample when boats are in the area for dredging in ship channels
            - Can sample when fronts are moving through since this is part of background variability
            - No longer need to sample within 3 months of the project (many large projects have multi-year planning phase)
- IWR Assessment
    - Given change in scope of criteria (only applies to where coral/ hardbottom are present), we are dropping IWR assessment from document. Appendix A now presents baseline turbidity data that can be used to establish permit limits
        - Used the department’s waterbody identification units (WBIDs), but split WBIDs surrounding FKNMS
        - Required at least 20 turbidity measurement
        - Excluded data collected within 200 meters of shore since this is an area average (would likely need site-specific data for beach nourishement sites)
- **Questions**:
    - Richard Dodge: Can you review the two definitions for coral reef and hardbottom?
        - DJ: I didn’t show you the revised one, the main reason that I wanted to be upfront is that we originally proposed coral reef is pretty similar, hardbottom is changing the one that’s changing.
        - RD: Is it the same criteria for both?
        - DJ: Yes, it is the same for both. We have a narrative criterion for the natural background variability at both types of communities. It may not be as critical if the same criterial applies to both, that is true.

- John Fauth: As data are collected through this program, will the state have any capability or program enabled to compile that data to allow eventual establishment of numeric criteria to produce the type of maps you just showed us, to facilitate efficient sampling? The data should come in for some areas pretty quickly- if we can compile that we can save everyone a lot of work.
    - DJ: Yes, that would be very good. We had a meeting with the dredging community, and they noted on that on the permitting side the data being entered by hand into the database was too time consuming, we have offered to get the consultants and data collectors to have the data in electronic databases. We may have more data to fold in before we even get to adopting this rule, but we are open to that. The more data the better. In our appendix there is all the currently available data distilled down, and that can be updated over time.
- John Fauth: The means and the SD—in theory, those are independent to sample size, so there is no reason to use different confidence intervals based on the prior sampling. The only reason you would do that is because more sampling means more variability. The time scale of the project should be the same as the time of sampling: for a year-long project with 20 dredging days, you should have 20 days of sampling the year before. Other points: the difference between 2 means, when you transform it and look at the confidence interval, it is not a linear back transformation. So do not use the difference between the mins and maxes, you are really only interested in the maxes anyway. The approach with the standard deviations and confidence intervals is assuming they will be normally distributed. They usually are not. The construction people are right, there will be exclusions in the data. You need to look at other methods. Like the Monte Carlo simulation that is distribution-free.
    - DJ: We have discussed a lot of the issues you have mentioned, like assuming a normal distribution. In the current draft of the document, we have the parametric and non-parametric equations. The statisticians that put them together are bottom-line that with the sample size we are using, there wasn't much benefit to using the more complicated approach. To me, if that addresses that term then I would just as well use the other approach. Maybe I will keep that in there so that the TAC can see both proposals. I welcome more comments, the more we get the better. At some of these sites its expensive to collect this data, from my experience its less money than the project itself, but we are trying to compromise. As far as the duration of the project, I don't see it going that way, they are trying to get as many cycles in one sampling trip. But I appreciate the comment.
- Jack Stamates: I believe that the turbidity data expressed in NTUs is logarithmically distributed. Filtering out the variability is tricky because little pieces of things in the water will set off the reading really easily. In practice that may need to be looked at.
- Jack Stamates: Under ideal conditions, every 4 hours for 12 hours, surface and bottom. Are they grouped together or individually?
    - DJ: We break them out so that there is a different allowable increase for each. I think we would have a different requirement depending on the depth of the water, and we haven't decided what that cutoff would be- something like less than 6 m depth sample would be okay but more than that there would have 2 required.
- JS: Okay, so site dependent, of course.

        - DJ: We think that the permitting program is based on surface values, and we feel that the bottom is more important from a resource perspective. If it's really shallow, it doesn't seem like you need both sample separate. Regardless, if we require 2 different samples, we will aggregate the data at that depth, and we would have 2 separate limits.
    - Brian Walker: It might be worth considering the same definition for coral reef and hardbottom as the Coral Reef Protection Act.
        - DJ: I think we have looked at that, and in our document, we acknowledge that, and it includes worm rock in the definition of hardbottom- we are not including it for this specific purpose.
    - Joshua Voss: How would the revised language and definitions apply to worm rock reefs with substantial coral communities on their surface? Thinking of St. Lucie Reef e.g.
        - DJ: I am not an expert, but I would have thought that if it has corals it would be defined as hardbottom. I will double check on that.
    - Judy Lang: We were concerned that there were no mechanisms for preventing prolonged levels of exposure when dredging sediment below the baseline area. I'm wondering if the sum total of all that has been done since then that will adequately address that concern?
        - DJ: I'm not sure that we have addressed that if it was barely above background. From what I've heard, its related to previous projects and 29 NTUs was the threshold that was causing impacts. If we maintain background that shouldn't be a problem, though I can't swear by that.
    - Kurtis Gregg: I was just reacting to what Daryl had mentioned the potential combination of coral on worm reef. My experiencing on permitting is that the worm reef exclusion would be used to not apply the criterion in that situation, I can hear the argument (Joshua Voss: that was my concern to).
        - DJ: I appreciate that- I will check with the program on that.
    - John Fauth: Another approach is to model turbidity as a function of the tidal cycle (i.e., a sinusoidal function) and then establish C.I.'s along that function and determine the upper threshold. That also will aid understanding the duration of high-turbidity events.
        - DJ: Putting that comment in the record is a good idea, it is definitely more ambitious than what we were approaching.
    - Judy Lang: My next short comment is that for hardbottom the mention of "associated reef organisms" might be amended to "associated coral reef organisms"?
    - Richard Dodge: What is the "cure" if the limits are exceeded?
    - Jack Stamates: there will be sites where the tide is not what primarily drives the turbidity.

<u>Continued water quality program discussion – *Allie Shatters, DEP CRCP*</u>

- Analytes:
    - Chlorophyll a: It was previously decided that chlorophyll a would be added to the WQ assessment project starting in July of 2019. At that point we had only added it to 5 sites per ICA (inlet centroid and east, outfall centroid, and 2 reefs closest to the mouth of the inlet). In May and June of 2020, we added 6 more sites (north and south of the inlet, 2 reef sites furthest from the inlet, and 2 sites closest to the inlet). We had some extra funding from COVID spillover, so we added a few sites including some bottom samples at reef sites (previously these were all the surface). We now have funding to sample

chlorophyll a at all sites including surface and bottom when available. With the extra gap funding we also added TOC samples at all sites, surface and bottom.

- WQ Assessment with the goal to reduce LBSP through management
    - 1. Characterize nutrient loads/ sources: Starting with characterizing nutrient loads and sources, working from reef -> landward, we want to define what areas to focus on and what partners to include, and we want to collaborate with existing and forming programs for continuity.
    - 2. Data analysis: The data from the start of the project through 2018 has been analyzed and will be published. The next goal is to get the 2019 data analyzed. We are working on developing a format of occasional formal reports and more frequent smaller data summaries. As we work on defining this format, we need to define what questions we are trying to report on in doing these analyses.
    - 3. Additional sites/ analytes: Additional sites and analytes will depend on funding. The plan is to continue chlorophyll a sampling at all sites through next year. There have been some discussions about adding additional sites and analytes, TOC and DOC are of interest. If we chose instead to add more sites, we will keep the existing analytes- we would need to either cut from the current protocol or find new funding sources and contractors. There are internal conversations about this and may be seeking advice in the future.
- WQ Action Plan:
    - To set WQ standards for our reefs, the process is initiated by the jurisdiction and is approved by the EPA. The jurisdiction defines products, and the EPA helps bring coral and WQ experts together. All steps of this process will be documented to create a model for other jurisdictions to use.
    - This is in the beginning stages. We are currently diving into data and tools already in place in Florida (see Dave Whitall presentation on WQ assessment, and Ken Weaver's presentation on nutrient criteria creation in S. Florida and the Florida Keys) and are working on defining goals, products, and partners. Future meetings will be used to create products and action plans that define next steps, will keep TAC update.
- Government Cut Inlet Contributing Area
    - This is one of many areas of interest. NOAA internal PI's have applied for funding to create a Gov. Cut ICA Watershed Management Plan. This will include modelling work to asses pollution input to inform that planning effort. There is an effort to improve connectedness of WQ projects in the region, starting with the GCICA, to ensure comparability and usefulness of data across the ICA.
    - CPR Grant WQ Projects: we are in the process of accepting project proposals, and hopefully some of them will address inputs.

SESSION III: Coral Disease and Intervention Treatments

Stony Coral Tissue Loss Disease (SCTLD) Update- *Maurizio Martinelli, Florida Sea Grant*

- Disease Progression: In Florida, SCTLD has spread throughout the entire Marquesas' islands. The entire contiguous reef tract is now affected, though the Dry Tortugas are still unaffected. The disease is persistent, and can still be found present and active throughout the FRT. There have been 4 more reports in the Caribbean.
- Response activities:

- 1. Priority Research Questions: (selected from participant ranking taken during the annual SCTLD Technical Workshop)
  - Is SCTLD a biotic, abiotic, or combination disease?
  - What is the role of Symbiodinacea in SCTLD?
  - What factors (genotypic, colony specific, or environmental) drive resistance and or/ resilience to SCTLD?
  - What conditions (environmental, ecological, anthropogenic, and/or in the coral populations) have allowed the outbreak to persist and spread?
- 2. Interventive Meetings
  - Part 1: evaluate the unintended impacts of antibiotic treatments (this is driven by regulation needs- we need to provide some assurances that we are not doing more harm than good, we are now focusing on research to demonstrate that)
  - Part 2: Setting intervention goals (it has been challenging to decide what we are trying to do- in these meetings we will create a vision for intervention moving forward and will update the intervention plan accordingly).
- 3. Endemic Coral Rescue
  - There was a big coral rescue ahead of the disease margin of highly susceptible adult coral colonies that had never been exposed to SCTLD, we have now expanded this project to include corals from the endemic zone. So far, 89 corals representing 8 species ha e been collected from fisher island. The goal is to incorporate these resilient genetics into future restoration efforts. Work is being done to insure responsible biosecurity. Right now, there are 2000 recued colonies holding in 22 facilities across 11 states.
- 4. Replicated outplanting project
  - Pilot outplanting has begun on a project to conduct coordinated outplanting of over 6,000 SCTLD-susceptible coral fragments at 24 sites throughout Florida's reefs. The outplants and surrounding coral communities will be monitored for 2 years. The high number of replicates will help us understand location differences in restoration rates and success.
- 5. Recommendations for coastal construction
  - The regulatory team has compiled a document that outlines concerns and recommendations for coastal construction and dredging projects as they relate to both overall ecosystem resilience and coral disease. These are applicable to all projects regardless of size. The document can now be used for the agencies to have stronger conversations about mitigation.

- **Questions**:
  - Kurtis Gregg: considerations for large scale dredging projects were made in restoration activities- is that included in the document that will be available for review?
    - MM: There is nothing specific to a given project in that document, it is more general recommendations that can be applied to small and large projects. The concerns should be applicable to the large-scale projects as well.
    - KG: Jocelyn and I have been working with army corps of engineers and DEP conservation program to review port deepening projects. One of the asks when Jocelyn looked at agenda was to see if there were ideas for disease intervention approaches that would be appropriate for a large-scale project. Do you have some ideas?

            - MM: Jocelyn was very involved in the implementation of this document and we have had discussions about including information like that. I can follow up with you when the document is in front of me.
        - KG: I want to make a point that in the conversations that we've been having, the paradigm of "throwing out some boulders and that offsets the impact" is being shifted. It has been shifted in NOAA fisheries service and we are trying to find other option for mitigation other than outplanting out boulder reefs. We are considering land based coral nurseries. Are there some things that are ripe for that type of approach, if there are people on the TAC that know, we appreciate the input?
            - MM: I would say definitely we have opportunities, especially in land-based propagation- we are hoping to scale that up significantly. Also in supporting those field based activities.
    - Phil Dustan: I'm wondering if the commercial coral aquarium trade has been involved with this effort to rescue corals
        - MM: To a limited degree. One of the coral holding facilities works in the commercial trade, but most are in the public aquarium system. So not coral production yet, but we are open to it if there are things they can assist with.

Developments of alternative *in situ* treatments for SCTLD (I) – ***Valerie Paul****, Smithsonian Marine Station; Blake Ushijima, University of North Carolina Wilmington; Julie Meyer, UF*

- The goal of this project is to develop a multi-strain probiotic treatment and identify additional potential probiotics for corals. To accomplish this, this project will (1) continue screening of resistant corals for potential probiotics, (2) will test combinational treatments of different probiotic strains on a wider variety of diseased coral species, and (3) will characterize effective probiotics with complete genome sequencing and chemical analysis before potential deployment in the field.
- Library of isolates:
    - We now have a good collection of isolates that seem to have antimicrobial activity or ways of conferring it onto the host. They have come from a variety of species, including some resistant species (MCAV, OFAV, MMEA, CNAT, DSTO, SSID). In total, there are 2000 isolates from healthy and more disease-resistant fragments to date, and 400 of those display antibacterial activity, seen as a "zone of inhibition" on an agar plate.
- Strain McH1-7
    - McH1-7 is currently being tested in the field. This strain has a large zone of inhibition indicating antimicrobial activity. We were able to isolate Koromicin, Marinocine (creates reactive oxygen species), and Tetrabromopyrrole (TBP; antibiotic, thought to induce oxidative stress and stimulate coral larvae settlement) from the Pacific *Pseudoalteromonas* sp. Strain, isolated from Palau.
    - Lab Treatment Trials:
        - Trial design: Diseased corals are cut in half to create a treatment and a control. The probiotics are administered in high doses in aquaria from dense bacterial cultures. In the control fragment, disease continues to progress in all of the tested fragments, in the treated fragments, disease was arrested in 55% and slowed in 14%.

        - Treatment frequency: most of the assays were three weeks, with some corals treated once and some treated every other day, but there was no significant difference in effectiveness between the two frequencies.
        - Safety testing (to ensure that the strain does not impact other corals): MMEA, SINT, SSID, CNAT were inoculated with McH1-7 and monitored daily, no fragments showed signs of stress over 9 days.
    - Field Treatment Trials:
        - A pilot field trial of probiotics on the reef was conducted in January, and additional trials have been done in August and September by Brian Walker and Kelly Pitts. The microbial community (Illumina), probiotic concentrations (dPCR), and metabolomics are monitored over time. The probiotics were administered by squirting bacteria into a bagged colony at the same concentration as was administered in the lab. The data for these later trials is just beginning to come in, but preliminary results suggest that disease is slowing on treated corals:
            - 13/28 colonies healed before initial treatments
            - 1 colony was Vcor+ and it healed after being treated with probiotics
            - 3/7 colonies treated with probiotics healed
            - 1 control treated with ocean water and 2/7 background controls healed
        - Considerations for future *in situ* treatments:
            - Refine the bagging technique with smaller, thicker bags with more lead line
            - Test freeze-dried probiotics for easier preparation for fieldwork
            - Test both lesion-specific and whole colony treatments (a paste of sodium alginate was developed by Kelly Pitts, which stays well on the lesion and can provide an alternative method for local treatments).
- Combinational probiotic treatments
    - Using multiple probiotics in one treatment can reduce resistance evolution and increase the range of activity, and some combinations have increased activity against putative pathogens. We are testing isolates with lower antagonism with McH1-7.
    - There is a hint that a combination (McH1-7 + SMS1) gives a better result than when McH1-7 is alone, but when applied to coral, there is no significant difference indicating that the combination treatment is more effective.
- Searching for probiotics in OFAV:
    - A strain of *Pseudoalteromonas* sp. was isolated from on OFAV that did not get disease. There was no significant difference between the effectiveness of this strain and the McH1-7, so there is no reason to pursue this strain instead. We are still working on some other OFAV and CNAT strains.
- **Summary**:
    - We have 2000 isolates of which 400 show antibacterial activity against putative pathogens
    - Chemical analysis of McH1-7 and Of7M-16 shows they both produce three antibacterial compounds
    - McH1-7 may be effective at treating different coral species
    - Combinational probiotic treatments may reduce resistance evolving and increase range of probiotic activity; however, we have not yet found combinations to be more effective than single strains.

- **Questions**:
    - Kurtis Greg: Are there some trials that a large-scale project could support to move these interventions forward as mitigation? If there is an opportunity for a project to support something that could lead to a stronger conservation outcome for coral reef resources, we've got the opportunity to make the ask.
        - VP: That's what we're hoping to do with the field trials. We'd love to team up with anyone willing and interested in helping. Really, we are limited by manpower, but Karen Neely has been super helpful in the Keys and she and Mote are keeping an eye out for diseased corals. The disease does seem to die out in the summer months when there is bleaching, and for a few months we weren't able to get any. We didn't see that same thing in the Broward reefs, the disease seemed to be more active then. I don't know that the corals do not bleach as much up there… its somehow related to bleaching. But we just don't know.
        - Brian Walker: Makes sense to ask. Must be careful about expectations or success criteria.
        - Judith Lang: Kurtis, thanks for following up on this potential new avenue of support.
        - Richard Dodge: In the past, sometimes recommendations of "research" as a type of mitigation has been viewed an anathema by permitting agencies. Would agencies view this kind of mitigation as possible?
    - Dana Wusinich-Mendez: Kurtis are you suggesting that probiotic testing could be a mitigation project?
        - KG: I think the direction of the question was "is there a place for mitigation to fund research"? If the probiotics aren't ready for large scale field trials and we are in experimental phase, the discussions are being had as to what other support entities could provide.
        - Brian Walker: I think proven disease interventions would be an easier tie in to mitigation.
            - Val Paul: there could be a role if we continue to do antibiotic treatments, there could be a role for the probiotics work to tie into that in the sense of some probiotics helping mediate problems with antibiotics.
            - Brian Walker: Yes. Antibiotic paste to stop disease immediately and probiotics to reduce reinfections
        - KG: that's what I'm hearing for mitigation options other than boulders, looking for mitigative approaches. We are open to them
        - VP: we did on experiment where we pretreated some healthy corals with probiotics and then exposed them to disease and they did not get it. One of our goals is to try to incorporate this into restoration activities, talking to (Andrew) Baker and Joe etc. want to give it a try.
    - Joe Lopez: I wonder if bringing up a few diseased corals and put into a closed experimental aquaria system could be less labor intensive, and permit better quantification of doses/dilutions of cultures
        - VP: That's exactly what we do to first test them. They go through extensive lab projects before we would even dream of putting them out. Extending the lab to the field has its challenges, but we got a lot of good information in the lab before this.

        - JL: so you are increasing your sample size if you are testing on different genotypes in aquaria
        - VP: right, the problem is scale, working with the bags, that's why the paste may be good, but the bag seems to work better. The idea is to get the probiotic incorporated into the microbiome and have it stay and working better.
    - Dale Griffon:L we used to go out and get isolates and bring them back and challenge them, then you can isolate viruses and use the viruses to challenge the disease coral. Like a phage therapy.
        - Blake Ushijima: Yes, we're working on phage therapy. It's not here, but I can talk about it.
    - Maurizio Martinelli: Do we think that support can go to basic research? We definitely have SCTLD research that could be supported...

Developments of alternative *in situ* treatments for SCTLD (II) – *Valerie Paul, Smithsonian Marine Station**; Blake Ushijima**, University of North Carolina Wilmington; Julie Meyer, UF*

- Objective: attempt to culture potential bacterial pathogens responsible for SCTLD
- Current status:
    - Have not found a pathogen yet, but efforts are continuing
    - Potential secondary bacterial pathogens are being cultured and identified
    - The bacterium *Vibrio coralliilyticus* (VCOR) may be causing coinfections on a subset of diseased corals as its presence strongly correlates with more acute lesion progression.
- Culturing potential pathogens
    - (Note: the following isolates are not believed to be the primary cause of SCTLD, but are potentially pathogenic organisms associated with disease lesions, and some may be exacerbating the effects of SCTLD
    - Workflow: diseased corals are used to infect 8 healthy fragments -> 400 isolates are acquired from those infected corals -> those 400 are split into 80 groups of 5 isolates -> 72 of those groups did not elicit disease, 8 groups did elicit disease (40 total isolates) -> of these 40 isolates, 27 did not elicit disease, 13 did elicit disease -> of those isolates that caused disease, 9 were from Rhodobacterales and Alteromonadales, 4 were from Vibrionaceae -> all 4 of the isolates belonging to Vibrionaceae were identified as VCOR (which has been shown to cause tissue loss in ~10% of exposed healthy MCAV or OFAV).
- *Vibrio coralliilyticus*
    - VCOR is a known pathogen of various corals and shellfish.
    - There is evidence that it can cause disease, but It does not always- it can exist on healthy Pacific corals at sub-infectious levels, but production of the toxic protein VcpA is indicative of infection.
    - Some strains respond to temperatures and are more virulent in the summer months, but others do not. Some strains cause bleaching, but all pathogenic strains can cause tissue loss.
- Vibriosis RapidTest Immunoassay (mAbDx Inc.)
    - Antibody-based assay to detect the toxic protein VcpA, a potent metalloprotease that can degrade living tissues. Gives semi-quantitive results within 10-15 minutes using a 100-200uL sample. This is more indicative of an active bacterium than DNA (it detects the protein itself and does not pick up DNA from dead bacteria). This technology could be

applied to other microbes, and potentially the SCTLD bacterial pathogen if one is ever identified- in collaboration with Dr. Michael Marusich (mAbDx. Inc.)

- Detection of VcpA
    - Screened diseased corals from the field for use in a lot of our ongoing experiments to determine if VCOR was playing some role in SCTLD. Found that there was a subset of wild MCAV and OFAV populations that are positive for VcpA:
        - MCAV: 23.8% of 67 total colonies, 16.7% (4 of 24 colonies) positive from Broward county, 27.9% (12 of 43 colonies) positive from Fl. Keys
        - OFAV: 20.8% of 24 total colonies, 25% (1 of 4 colonies) positive from Broward County, 20% (5 of 20 colonies) positive from Fl. Keys
    - The presence of VcpA strongly correlates with more virulent MCAV and OFAV lesions
    - Collection location did not correlate with disease progression in captivity (Fl Keys vs. Broward), regardless of where it was collected, the presence of VcpA always made lesion progression rate and mortality rates worse.
- *V. coralliilyticus* may be interfering with probiotic treatments
    - 8 of the 10 corals where McH1-7 treatment did not stop disease were VcpA+
    - McH1-7 was only able to slow disease progression on VcpA+ fragments at best, but never stop it entirely.
    - 90% of VcpA- fragments treated with McH1-7 survived 21 days versus 45% of VcpA+ fragments
- Additional consequences of *V. coralliilyticus*
    - This demonstrates that various pathogens may be at play in SCTLD. This pathogen can efficiently kill off competing bacteria (probiotics) using an antibacterial system (Type 6 secretion system).
    - Various studies suggest that *V. coralliilyticus* can disrupt the coral microflora.
    - This species is known to be resistant to various antibiotics and carry multiple antibiotic resistance genes (such as beta-lactamases that confer resistance to antibiotics like amoxicillin)
    - A VCOR strain from the Keys is unique in that it readily produces a biofilm in culture; biofilms alone can protect bacteria from disinfectants and antibiotics.
- **Conclusions**
    - Roughly 20% of diseased MCAV and OFAV may have coinfections with VCOR
    - Suspected presence of VCOR are associated with higher mortality rates and faster disease progression but is not the primary cause of SCTLD.
    - Infections by this pathogen may make treatment more difficult
    - We can efficiently detect infections using a rapid immunoassay or with digital droplet PCR
- **Future Directions**
    - Continued screening of diseased corals using the immunoassay and isolation of additional VCOR strains
    - Probiotics that target VCOR and better compete with this bacterium
    - Continued manipulative studies with diseased corals to narrow down which groups of bacteria are involved with infection
    - Searching for primary agents of SCTLD and other potential coinfections

Developments of alternative *in situ* treatments for SCTLD (III) – *Valerie Paul, Smithsonian Marine Station; Blake Ushijima, University of North Carolina Wilmington;* ***Julie Meyer****, UF*

- Objective: To evaluate the colonization efficiency by probiotic bacteria and the identification of factors that may reduce treatment efficacy
- Highlights of completed work:
    - Have sequenced the genomes of potential probiotic bacteria and coral pathogens
    - Developed digital PCR targets for 4 probiotic strains and VCOR
    - Quantified koromicin genes in aquarium and field trials with McH1-7
    - Quantified metalloprotease vibriolysin genes in VCOR
    - Comparative genomics of VCOR strains from Pacific and Atlantic
- Biosynthetic gene targets used for development of unique markers for probiotic *Pseudoalteromonas* strains and the coral pathogen VCOR in digital PCR:
    - *Pseudoalteromonas* McH1-7: koromicin (antibiotic)
        - 14 biosynthetic gene clusters, including korormicin. Additional products: tetrabromopyrrole, marinocine
        - Sampling scheme in aquarium trial: 4 separate tanks with coral tissue and water. Most samples had a very low level, but one outlier (a clump of cells?)
            - McH1-7 is detectable in water, 1 hour and 1 day after application in all samples. McH1-7 is detectable in tissue, 1 hour and 7 days after application (in some samples, at very low levels)
        - Sampling scheme in field trial: tagged corals were sampled before treatment and 2 weeks after. Control samples had a bag only, probiotics treatment corals were dosed with McH1-7. Both healthy and diseased corals received treatments
            - McH1-7 detected at very low levels, and there was no difference in levels with treatment, condition, or date.
            - One tagged coral showed increase in levels over time
            - In the future, should sample earlier after treatment
    - *Pseudoalteromonas* McH1-42: part of chalcone/ stilbene biosynthesis (T3PKS)
    - *Pseudoalteromonas* SMS1: N-acylhomoserine lactone (quorum sensing)
    - *Pseudoalteromonas* Of7M-16: thiomarinol (tmlY) (antibiotic)
    - VCOR: metalloprotease vibriolysin (vcpA) (virulence factor)

Day 2, November 5, 2020
12:30 – 5:00 PM

SESSION IV: CRCP and LAS Project Updates

Awareness and Appreciation - *Michelle Graulty, DEP CRCP*

- AA35- **Traveling Teacher Trunks**
  - The travelling trunks were paused last Spring and Fall while more time was devoted to developing lesson plans. There is enough interest among teachers to resume the trunks this coming spring. May not be able to ship any trunks this fall- are working on supporting virtual learning with existing and new lesson plans
  - 4 Elementary school trunks and 5 middle school trunks served 28 school and reached 5,398 students in the 2019-2020 school year
  - Created a new high school trunk
  - Contracted teachers to write new lesson plans to create 3 trunks for K-2 with modified lessons for grades 3-5 (topics: design your own coral reef, food web chain reactions, coral reef rescue mission), 3 middle school trunks (topics: coral reef reproduction, reef relief, reef restoration), and 3 new high school trunks (coral reef 101, preventing coral reef catastrophes, saving Florida's coral reef). Each trunk contains three lessons and all supplies needed to cover topics in coral reef biology, threats to Florida's coral reef, and improving resilience of coral reefs.
- AA10- **Public Service Announcements**
  - Premiered a new PSA in June and are in the final stages of creating another one that tells the story of Florida's coral reef.
- AA5- **Maintain SEFCRI Website**
  - The SEFCRI website is morphing into more of a website for a club to serve as a source of information for team members, project trackers, coral members, and a calendar page where people can add events
- AA20/23- **Community Events and Promo**
  - 4Ocean Village, Hollywood cardboard boat regatta, Miami shores Green Day, Broward County Ocean fest, Fort Lauderdale Winterfest/ 3rd Annual Stoked on Salt Ocean Conservation Day, Super Bowl Live, Sierra Club Earth Day 50th Anniversary, Gumbo Limbo Sea Turtle Day, Broward BUSH Club, Force-E Facebook Live, Loggerhead Marine Life Center Making Waves through Community Action Panel, Coral Reef Webinar Week (1,711 people attended online)

Reef Injury Prevention and Response Program Updates – *Mollie Sinnott, DEP CRCP*

- **Florida's Coral Reef Protection Act** (Florida Statue 403.93345)
  - The goal of the CRPA is the reduction of coral reef impacts through increased legal authority. Became law on July 1, 2009- makes it illegal to anchor on and/or otherwise damage coral reef in state waters (includes 5 counties on the East side of FL), making it possible to pursue damages and penalties for any unplanned unpermitted impacts to the reef. The revised language became effective on July 1, 2020 and includes FL HB 1091: Environmental Accountability.

    - The CRPA has a defined civil penalty schedule, which increases based on the area of impact and is calculated per sq. meter. Penalties may be increased with repeat violations, aggravated circumstances, and if the injury occurs within a state park or aquatic preserve.
        - <1m^2 of damage has increased from $150 to $225, between 1$m^2$ and 10m^2 increased from $300 to $450 per sq meter, >10 m^2 of damage increased from $1000 to $1,500 per sq meter. Penalty cap increased from $250,000 to $375,000 max, per occurrence. Compensatory mitigation still has no maximum dollar cap.
    - 66 incidences were reported in 2019, 63 were checked (did not investigate a beached barge or 2 potential groundings), 6 of these are being currently pursued as CRPA cases. The majority are reported through port vision and reports through AAS transmitters on larger vessels, fewer from public stakeholders. If you notice anything, report it through Seafan or contact directly.
- Other projects:
    - Clipper Lasco/ Spar Orion Restoration: Monitoring report coming out next year analyzing 5 years of post-restoration monitoring data
    - Supporting individual mooring buoys with supplies and maintenance, prevents damage to reefs by providing public moorings
    - Outreach efforts such as brochures and continuing the partnership with USCG
    - Marine events, though the majority of 2020 events have been rescheduled
- **Questions**:
    - Brian Walker: How much reef was damaged from these cases? Any major ones?
        - MS: All 6 CRPA cases opened in 2019 were related to anchor damage. Four were smaller in scale, but two had overlapping anchor swings that caused damage to a larger linear area
    - Stephanie Schopmeyer: are there plans for biological restoration at sites?
        - MS: As for the Clipper Lasco/Spar Orion restoration sites, there are no plans for additional biological restoration right now - we'll likely wait until after we finish the monitoring report. But we are open to suggestions for the future
    - Jay Grove: Were the anchor damages in Broward and Miami reported for small private vessels and/or commercial vessels (cargo ships etc.)? Was damage generally <1m., <10m, etc.
        - MS: of the 2019 cases, 1 was a recreational yacht and 5 were commercial vessels. These were all greater than 10m^2 of damage

<u>Maritime Industry & Coastal Construction Impacts Focus Area Updates – *Shelby Wedelich, DEP CRCP*</u>

- CRCP 9- PAR-NTU-TSS Translator
    - Research Questions:
        - What are the relationships between NTUs/ TSS, NTUs/ PAR, and TSS/ PAR?
        - How do these relationships change during dredging or by project area/ sediment type?
        - What is the difference between background samples taken during construction and samples taken closer to construction activities (e.g., within plume, at mixing zone edge and beyond the mixing zone in the plume) (is there is a clear trend of improving water quality away from dredging activities)?
        - What is the overall variability in the different types of background samples- NTUs, TSS, and PAR? What explains this background variability?
    - Sampling design:

        - Goal: to complete sampling of PAR- NTU- TSS pre-construction, during construction, and post-construction in beach nourishment projects with native material in the coral ECA
        - Concurrent PAR, NTU, TSS measurements taken and surface and mid-depth, high and low tide
        - Phase I: sampling during and post-construction in Martin County
        - Phase II: Sampling pre, during and post-construction in Palm Beach County
        - Phase III: Sampling in ambient background in Palm Beach, Broward, and Miami Dade counties
        - Site locations and frequency: site locations for phases I & II were driven by construction. Sites for Phase III at the Lake Worth Inlet, Port Everglades, and Port Miami were sampled in May and June during times of no construction or boat traffic. Sites were at least 150 m north and south from the channel (some as far as 2000 m), and along the shore on coral reef and hard bottom habitats.
    - Results:
        - No statistically significant relationship between sediment characteristic data for PAR, NTU, TSS
        - Relationship between NTU and PAR and TSS and PAR showed similar negative correlation across all sites in Phases I & II
        - These correlations were absent at the sites from Phase III indicating they likely change during dredging activities
        - NTU and TSS values also showed positive correlations at all but Lake Worth Inlet, with stronger correlation values for projects in Phases I & II again indicating a change in relationship during dredging.
        - Comparison data among sites in Phases I & II appear to validate a trend of increasing water quality moving away from dredging activities. Comparison among Phase III projects showed site-specific variability.
        - NTU-TSS Correlations:
            - NTU an TSS were correlated in Jupiter, Delray, Ocean Ridge, Bottom Lake Worth, Everglades, and Port Miami. Max turbidity measurements were in Everglades and Port Miami.
            - Positive relationship was stronger in Delray and Ocean Ridge, during construction in mixing zones were able to get higher TSS values to establish the relationship.
        - Data will be included in report.
    - Lessons Learned:
        - Should include salinity and more detailed current data
        - Light data changes with cloud cover and set times of day, irradiance corrections needed
        - Should use PAR spherical/ terrestrial ratio rather than reporting separate values
        - Sediment collection more frequently and independent from compliance reports may strengthen correlation
        - Communication and flexibility is key with construction associated projects, especially for pre- and post- timing
- **Questions**:
    - Phil Dustan: If you want to figure out what a water mass is doing you need drifters. Point measurements will always be vague- but if you have devices that you can tow or a water

pump where you can take measurements to define the water mass, you can take continuous measurements. Need continuous sample measurements going on at a station or transects.

- Phil Dustan: The other thing is there is confusion between apparent and inherent optical properties of water masses. PAR is an apparent optical property; it changes with angle of sun. The sediments suspended are inherent in the optical property of that water mass. That becomes difficult. The other thing about PAR is that what we're dealing with is the wavelengths between blue and red, and the diffuse attenuation coefficient is dramatic in first 5-10 meters. Depending on depth you may be getting an artifact from that on the PAR measurements. When you are using a spherical collector, you are measuring irradiance. That is appropriate for measuring the light that phytoplankton observe. But a coral is a flat plate collector- so they are more like a terrestrial collector depending on its morphology. So, I see that as a difficult measurement because it is an apparent measure. You would want beam transmittance to quantify. Or a scatterometer that measures one of the properties correctly.
- Richard Dodge: If comparisons are restricted to the range of NTUs mentioned by the DEP speaker, how do relationships between NTU, TSS, and PAR change?
    - SW: The relationship between NTU TSS and PAR change based on water clarity and how much sediment is in the water. It is stirred up by precipitation, wind, or construction.
- Richard Dodge: Are there regulatory limits for TSS?
    - SW: There aren't regulatory limits for TSS in offshore environment, all the statues are in NTUs. There might be some TSS load limits in streams, can get in touch with another division to answer that.
- Richard Dodge: What are generally acceptable and not acceptable levels of PAR?
    - SW: That's the same thing w/ PAR, that does not have regulated levels.
- Richard Dodge: How is data of NTU, TSS, and PAR distributed? Normal? Skewed?
    - SW: Generally, turbidity data is skewed left
- Richard Dodge: Why is Terrestrial to Spherical Ratio of PAR better?
    - SW: The PAR ratio would require terrestrial spherical measurements and add light into flat surface and as it bends through the water column. Terrestrial for surface, spherical for at depth. The appropriate way for this data would be the difference between terrestrial and spherical, and depth, and sun, and where the water is coming- and use all that to correct the PAR. We need a relationship between terrestrial and spherical to correct that for the time of year and cloudiness conditions. We think the corrections are possible and are also looking to people who know PAR and are working with me.
- Richard Dodge: For Port sampling, how was Plume limit defined? What was the plume from? Tidal? High Rain? Other?
    - SW: Because it was during background there was no plume. Collection was at surface med/ high/ low from specific locations on the grid that we thought would be relevant. The plume that's part of that didnt have a strict line. It depended on the influx of different parts of the water column with different salinities. Moving forward we should include salinity. That was an oversight on my part.
    - Brian Walker: I see a plume every tidal cycle out of my office window
    - Richard Dodge: I do too

        - SW- Sorry, I guess I should have clarified that we didn't observe a construction associated plume. However, we might be able to detect that plume from tidal cycle data at the 150 m stations outside the channel.
    - Ken Banks: Walt Goldberg tried to correlate transmittance with NTU in early 90s....no luck
    - Jack Stamates: You're dealing with three types of physical and measurements and they all have their own issues. On the scatterplot you showed, there seemed to be a branch of data of high TSS values but not NTU scales. Getting the data out is tricky.

Fishing, Diving, and Other Uses Updates – *Jaime Monty, DEP CRCP*

- **FDOU 52: Data needs for fisheries management- Phase II**
    - Second Committee Meeting: Sept 3, 2020
        - Welcomed 4 new members and discussed committee member perceptions of reef ecosystem status and management / conservation issues. For year one, the plan is to adapt plans to COVID-19 for remainder of the year, with shortened online meetings and science webinars.
    - Next Committee Meeting: Nov. 12, 2020
        - Will review the status of science related to SE Florida reefs, identify management and conservation options, and review committee membership.
        - Going forward, want to host bi-quarterly meetings and educational webinars (topics: Our Florida Reefs Overview and Results, WQ Overview, Fisheries Status, Coral Status/ SCTLD, Management)
- **FDOU 53: Marine Planner Tool**
    - Needed for fisheries committee and management plan. Have updated existing layers, there are more layers to be added (WQ, SCTLD, others? Much has changed in the past few years that are relevant to planning in the future.)

Land Based Sources of Pollution Updates – *Allie Shatters, DEP CRCP; and Kurtis Gregg, NOAA*

- **Jewell Cove Mangrove Pod Project**
    - This is a pilot-scale project now in its final stages to demonstrate what we can do on a local scale to reduce LBSP. The goal is to improve water quality and create habitat for oysters and mangroves. Construction has been completed, are now moving forward with the DEP to do WQ monitoring and ERM to do oyster recruitment and mangrove planting monitoring
    - Have partnered with Palm Beah County ERM
- **Low Impact Development and Green Infrastructure Manual for Southeast Florida**
    - This document was created to help local municipalities and practitioners in environmental planning to have the tools available to reduce LBSP. This document targets methods for South Florida. The project was led by UF and consultations with local experts.
    - Examples:
        - Green Roofs, bioretention areas to remove nitrogen from stormwater, rain gardens, nutrient-separating baffle box, etc.
    - A matrix has been developed to guide the project practitioners through designing a project. The manual is interactive, with links to different sections to guide the user to what is appropriate for their site.

    - We now want to distribute the manual to a broader audience- asking TAC for suggestions for a coordinated roll-out using any groups, professional networks, groups, points of contact, etc.
    - Find the full document here:
        - https://floridadep.gov/rcp/coral/documents/low-impact-development-green-infrastructure-pollution-reduction-guidance-water
    - Find the decision matrix tool that was designed with this manual here:
        - https://floridadep.gov/rcp/coral/documents/low-impact-development-green-infrastructure-decision-matrix-tool
- **Questions**:
    - Michelle Graulty: Sharing the manual and tracking the # of projects that use it is something I'd like to include in our CRCP Communications Plan as well.
    - Esther Peters: Great stuff, Kurtis!
    - Phil Dustan: question about the wood chips. Are you finding this works in urban situations as well?
        - KG: People are building dams and add runoff pits filled with wood chips, over time the nitrogen removal gets better. Dissolved nitrates are converted to N gas going into the atmosphere.
        - Phil Dustan: So, are people are using that in urban areas?
        - KG: Yes. It has been tried in S Florida. It started on the west coast but there have been a few installations on the east coast, and it is effective. The further upstream we can do these, the more effective the reduction in pollutants and more cost effective the technologies are to implement. At the estuary we have missed the opportunity for the biggest reduction.
    - John Fauth: for Kurtis- this project was for SE Florida, is there anything about that area that would make it different from central Florida or east central coast
        - KG: The difference is how close groundwater is to the surface here in S Florida. In Miami Dade the options for underground treatment are more limited. There are a number of difference as well as similarities
        - JF: Orlando is up relatively high, the groundwater here at UF its basically surface water. This will be useful. Love the decision support tool as well.
        - KG: Other parts of DEP are working w/ Evan Bean's group and TNC to make a BMP manual for sensitive resources, like springs and watersheds. They are using the wheel we invented to expand the applicability to other parts of the state

SESSION V: Restoration

Coral spawning hubs – *Dave Gilliam, NSU*

- Purpose: to establish 2 stony coral spawning hub sites in the Coral ECA initially targeting *Pseudodiploria clivosa*. This restoration activity promotes (1) recruitment driven by natural sexual reproduction by bringing corals into closer density for natural gamete mixing in the water column and (2) efficient spawning observations and gamete capture by condensing efforts to a single site. So far, this is a pilot project using one species to test feasibility.
- Site Selection:
    - Defined potential area for the sites based on local conditions. Sites are nearshore ridge and inner reef habitat, are more than 500 m from shore, are a minimum of 1 km north of

Port Everglades, and are south of the navy range (south of Port Everglades). The northern limit is Lauderdale-By-The-Sea, the southern limit is Miami-Dade County.
    - *A. cervicornis* and *M. cavernosa* connectivity models were used to select 5 target sites north and 5 target sites south of Port Everglades. The models estimate a "source" index for each area, based on the number of potential larvae released from the reef and the number of potential reefs seeded from that source reef.
    - Recon dives at 10 target sites (5 north and 5 south) recorded the following attributes: depth, substrate (consolidated substrate, min sand/ rubble, space competing community (minimum presence of Playthoa, macroalgae, dense octocoral, etc.), presence of disease-free SCTLD-susceptible species, recent or past physical disturbances (overturned corals, sheared barrel sponges, lobster pot line, fishing line, etc.), and general impression of the site based on experience.
- Colony Relocation Plan:
    - Relocated 30 *P. clivosa* colonies to each hub site. Donor sites are located a minimum of 50 m apart to maximize the potential genotype diversity.
    - Target size: ~20-50 cm diameter.
    - Were visually healthy- no diseases or boring sponges and with >75% live tissue
    - Reattached to substrate using Portland cement, spaced 1-2m away from one another.
    - Colonies were mapped with colony tags and a pin at the center of the site to provide bearing.
- Post-Relocation Activities:
    - 1. Relocated colony monitoring was scheduled for initial, 1 month, and 3 months. Recorded colony size, colony images, % live tissue, % old mortality, and % recent mortality, and conditions such as bleaching, disease, predation, overgrowth, etc.
    - 2. Reference coral monitoring: mapped and assessed SCTLD-susceptible species ~20 m of the center pin (min diameter ~10 cm)
    - 3. September spawning observations and gamete collections (funded through Joana Figueiredo)
    - 4. Additional "value added" work:
        - Samples collected from all colonies will be added to the Rescue Coral genetic bank
        - Small core samples from 6 colonies were analyzed by Dr. Abby Renegar to assess current reproductive state and by Dr. Val Paul for metabolome and microbiome analysis before the corals were moved. These samples will permit before and after comparisons of these metrics of coral health.
- ~1 month status 29 September 2020
    - 100% of relocated PCLI colonies are attached and alive at both hubs. There was some recent mortality from predation (20 of 60, average loss <5%), mostly from stoplight parrotfish and 4-eye butterflyfish. There was no recent mortality from disease.
- Spawning observations and histology
    - North hub observations: 6-10 September 2020, no spawning observed.
    - Histology: 6 colonies were sampled on Sept 2, 2020, "4 of the 6 samples had late-stage oocytes (stage 3-4) and/or spermaries (stage 4-5) present" – Dr. Abby Renegar
- Southeast Florida Coral Restoration Hub (DEP Coral Reef Protection and Restoration Grant)
    - Collaboration between U Miami, NSU, SECORE, FLAQ, SMS, Frost Science (PIs: A. Baker, D Lirman, J Figueiredo, D Gilliam, A Renegar, B Walker, M Miller, A Whittle, K O'Neil, J Sneed, V Paul, A Dehart

    - Will expand current sites to include more species
        - 40 colonies/ hub site, combination of *P. strigose, D. Lyrinthiformis, C. natans, and O. faveolata*
    - Will continue spawning observations and will do collections using SECORE Int. and larval cradles. Many "value added" research opportunities.
- **Questions**:
    - Esther Peters: Maybe this will help, this is really cool that you were able to accomplish this, hopefully we'll learn a lot from it
        - DG: It will be an interesting resource site, and there is a lot of potential for the future
    - Phil Dustan: This could be in a Kim Stanley Robinson scifi book about the future managing of planet earth!
        - DG: It's a shame that we have to do so much work to bring the corals together, but that's where we are. We're fortunate that we have the resources to do it.
        - Phil Dustan: It is a sad commentary of what's happening in the sea, in some respects it's like these books. In some others it can be a PSA to tell how dire the conditions really are in the sea; we have to go through these measures like reproducing pandas in the zoo
        - Stephanie Schopmeyer : do you know when you might be able to add those other species to those sites?
            - DG- I think administrators are working to figure out when funds will be moved and agreements will be signed, it's frustrating waiting for office stuff. We haven't been able to get much done. I don't know. We'd like to do it before the end of summer, and before July/ August/ September spawning.

<u>Coral Spawning and Rearing Efforts- *Joana Figueiredo, NSU*</u>

- Objectives: to expand the infrastructure of the land-based nursery at NSU, preserve genotypes of SCTLD- impacted species from the endemic zone (Broward County), and propagate corals sexually (collect spawn from reefs, from colonies that were brought into the lab, and from corals that were induced to spawn in captivity) and asexually (micrografmentation).
- The land-based nursery at NSU now includes:
    - 12 outdoor independent recirculating tanks with filtration, sterilizers, and temperature controlling equipment (8 built new, 4 updated pre-existing)
        - Mission: preserve genotypes of endemic zone corals and induce gonad maturation and spawning, and grow-out of sexual recruits
    - 2 indoor recirculating tanks (2 raceways each)
        - Mission: preserve genotypes from endemic zone and induce gonad maturation and spawning
    - 1 mass scale larval rearing system
    - 1 indoor recirculating tank with 2 raceways
        - Mission: larval settlement and early grow-out of sexual recruits
    - 7 in-line outdoor recirculating tanks (pre-existent)
        - Mission: Grow out of microfragments (corals of opportunity) and sexual recruits from the endemic zone
- Endemic corals now held at NSU:

- 55 *Montastrea cavernosa*, 24 *Pseudodiploria strigosa*, 4 *Colpophylia natans*, 15 *Pseudodiploria clivosa*, 29 *Orbicella faveolate*, 4 *Diploria labyrinthiphormis*, 14 *Siderastrea siderea*, 5 *Agaricia agaracites*

- Coral Spawning 2020
  - Field operations:
    - Spawning hubs (PCLI): no spawn observed in September window
    - Large OFAV: no spawn observed in September window
    - PCLI, PSTR, OFAV, MCAV, CNAT in the lab (but collected right before the expected spawning window in September): no spawn observed in the September window
  - Lab operations:
    - MCAV: induced gonad maturation and spawning *ex situ* at NSU by mimicking annual temperatures (based on data collected on Broward reefs omitting bleaching years, min= 73F, max=85F), moon and sun cycles (lights: Ecotech Marine Radion CR30 Gen 4 controlled by the Neptune Apex System using timeanddate.com for Fort Lauderdale, FL), and irradiance (obtained from NASA surface meteorology and solar energy, min PAR= 140, max PAR= 250). Fed 6 days per week (PolypLab Reef Roids, PolypLab Colors, Reef Nutrition Real Oceanic Eggs, Reef Nutrition Oyster Feast).
    - Spawn Times:
      - Atlantic and Caribbean MCAVs are expected to spawn 5-10 days after the full moon of August or September, 15-165 minutes after sunset (August 8-13, 8:20 pm – 9:50 pm, September 7-11, 7:45 pm – 9:15 pm)
      - Spawning was observed on August 8-12 at 8:28 pm – 10:31 pm; September 6-8, 8:30 pm – 9:54 pm
      - 20/23 MCAV colonies matured gonads according to histology, 14/26 colonies spawned synchronously within the expected time window
  - Larval Rearing:
    - After fertilization, sperm was removed, and larvae were reared in the mass scale larval system (200-300,000 larvae per conical tank). Survival and settlement were both very high, and recruits developed well with some getting symbionts in the first week.
    - Also acquired *Dendrogyra cylindrus, Colpophyllia natans, Pseudodiploria strigosa*, and *Diploria labyrinthiformis* that were spawned in FLAQ's *ex situ* spawning system
    - Total Recruits (>2.5 months old):
      - MCAV= 154 tiels (1-111 corals/ tile), DCYL= 162 tiles (1-5 corals/ tile), PSTR= 57 tiles (1-14 corals/tile), CNAT= 146 tiles (1-5 corals/ tile), DLAB= 292 tiles (1-10 corals/ tile), ACER= 14 tiles (1-3 corals/ tile)
  - Needs and future directions
    - Expand *ex situ* spawning induction to all SCTLD-impacted species
    - Optimize and scale up sexual propagation to be relevant at the reef scale
    - Determine spawning times of corals in the endemic zone through systematic sampling for histology
      - Most ACER patches in Broward spawn 7-10 days before the full moon of August (way outside of the documented spawning window).

- OFAV were fecund with late-stage gametes 2 days before the expected September spawning window but were not observed spawning during the expected spawning window; in October they had less eggs and no spermaries, but we still do not know exactly when they spawned.
- PCLI, 67% were fecund before expected September spawning window, but were not observed spawning during that window, so we still do not know exactly when they spawned.

- **Questions**:
  - Stephanie Schopmeyer: Do you have plans to cryopreserve?
    - JF: I would love to. We need to be trained and have the facilities and equipment to do it. We would like to because sometimes the days don't line up and this way we could mix them up. Also for future storage. No funding at the moment to dedicate to that, but we are all interested.

100 Yards of Hope Restoration Project – *Diego Lirman, UM*

- Super Bowl Legacy Plot (in collaboration among US Veterans (FORCE BLUE), U Miami, and Frost Science Museum): Planted 100 staghorn corals in the shape of a football fiels at Rainbow Reef, Miami, FL, in June 2019. 99% survivorship over 6 months, and many of the colonies spawned in August 2020.
- This first plot was funded by the NFL and NFL Green (runs a small conservation project in each super bowl city before the game) as a celebration of the NFL's 100th season and Super Bowl LIV in Miami. Now, with funding from the DEP, were able to expand this initial 100-yard plot into a larger restoration project. Want to use this as a showcase site for the many visiting snorkelers and divers, and would like it to develop into one of the iconic sites outside of the Florida Keys that combines expertise and techniques at a high-density restoration site:
- Targets:
  - (1) To outplant 1,000 ACER, 150 APAL, 750 massive coral fragments, 100 ACER and 75 OFAV juvenile corals, and 1000s of coral recruits, (2) SCTLD monitoring and intervention, (3) high-res landscape mosaics, (4) *Diadema* urchin relocation, (5) fish and water quality monitoring, (6) museum exhibits, (7) citizen science on coral restoration expeditions, (8) public outreach activities, and (9) a documentary film detailing the "100 Yards of Hope" project
- Progress to date:
  - 3 plots have been selected, baseline reef DRM/ FRRP surveys have been completed, 1,000 nursery ACER have been outplanted, 100 ACER sexual recruits outplanted, 120 SECORE substrates with OFAV recruits outplanted, SCTLD monitoring ongoing (none reported so far), Pre-Outplanting High-res landscape mosaics completed, WQ monitoring has been initiated, documentary filmmaking has begun.

South Florida Coral Reef Restoration Hub (I): From Colonies to Coastlines – ***Diego Lirman****, UM; Andrew Baker, UM; Margaret Miller, SECORE; Amber Whittle, FLAQ*

- This is a big project funded by NFWF and NOAA that combines the activities of U Miami, NSU, and all partners working within Miami Dade and Broward into this restoration hub. PIs: Diego Lirman, Andrew Baker, Brian Haus (U Miami), Landolf Rhode-Barbarigos (UM College of Engineering), Brian Walker, Dave Gilliam (NSU), Margaret Miller (SECORE International), Shannon Jones, Lad Akins (Frost Science Museum), Amber Whittle (FLAQ)

- Framework of goals:
    - 1. **Restoration**:
        - Outplant >150,000 coral and larvae of multiple species onto 20+ reefs to progress towards the recovery of 3 endangered coral species, increase the spatial connectivity of coral populations, and increase the genetic diversity of coral populations through genotype exchanges and the use of sexual recruits and juveniles.
        - Create a field- and lab-based genetic repository for Miami-Dade and Broward County
        - Mitigate Disease impacts and restore old-growth colonies
        - Evaluate the role of introducing sea urchins into restoration
        - Enhance reef structure and provide fish and invertebrate habitat
        - Increase recreational opportunities for locals and visitors
    - 2. **Adaptation** (boosting thermal and disease resilience)
        - Conduct cross-county exchange of nursery corals (relocate colonies from "warm" habitats that survived recent disease and bleaching events to "cool" environments, and relocate colonies from "non-reef" environments that survived recent disease and bleaching events to reef environments)
        - Establish nurseries in challenging thermal environments to stress-harden corals by eliciting acclimatization responses
        - Outplant stress-hardened corals to boost thermal tolerance
        - Seed coral recruits with heat-tolerant algal symbionts
    - 3. **Coastal resilience**
        - Quantify the impacts of restored corals on bottom friction and wave-energy buffering (having dense, complex populations of ACER over a breakwater can enhance the wave mitigation capabilities, want to determine how to best maximize this locally and also on the adjacent shorelines)
        - Develop models of restored coral density and spatial distribution to maximize coastal resilience (i.e., wave energy reduction) using UM's SUSTAIN tank
    - 4. **Citizen science, education, and outreach**
        - Recruit and train citizen scientists at UM's Rescue a Reef program to plant 10% of our proposed corals
        - Develop a lecture series for team members to disseminate findings
        - Utilize Frost Science and FLAQ to disseminate project accomplishments to 10,000 visitors each year
        - Post social media updates on our activities and develop a dedicated web page for project outcomes

South Florida Coral Reef Restoration Hub (II): Incorporating interventions into restoration efforts to increase climate resilience – *Diego Lirman, UM; **Andrew Baker**, UM; Margaret Miller, SECORE; Amber Whittle, FLAQ*

- 1. **Building genotypic diversity and thermotolerance in offshore corals**
    - Multi-partner cross-county exchange of nursery corals
        - FWC "genotype swap" in June 2020: 85 genets of ACER from 5 nurseries (Monroe, Miami Dade, Broward) reciprocally swapped between nurseries

        - Tissue from 64 genets (Broward = 15, UM=, CRF = 10, Mote= 24, FWC= 9) used in a controlled thermal stress trial to rank thermotolerance within and between nurseries (led by Kelsey Johnson-Sapp, PhD Student)
        - Shedd cruise (Ross Cunning), October 2020: Broader survey of variation in thermotolerance across Dade and Monroe (192 genets of ACER and 40 genets of APAL). 39 genets from Mote shared with UM nursery at end of the cruise (some overlap of genets from June)
        - Next steps: genotyping (SNP-CHIP, whole genome resequencing?)
    - CBASS: Coral Bleaching Automated Stress Systems
        - Pioneered by Dan Barshis (ODU). Built out as part of a new NSF project in the Bahamas led by PIs Kenkel, Baker, Cunning, Dahlgren, Parkinson. Relatively cheap portable units that can be lab, shore, or ship-based to expose corals to a short-term extreme thermal stress.
        - Consists of independent modules with range of temperatures (32-37 C, two replicate tanks per temperature), multiple replicate genets (2.5-3 cm cores or 3-4 cm fragments). Equipped with temperature controllers, heaters, chillers, pumps, loggers, and incoming water.
        - 3-hour ramp up to target temperature, 3-hour hold, 1-hour ramp down to ambient temp
        - Records Photochemical efficiency and symbiont:host ratios before ramp-up and after ramp-down
    - Relocate colonies from "warm" habitats that survived recent disease and bleaching events to "cool" environments ("Local Managed Relocation")
        - Led by Kelsey Johnson-Sapp, PhD student.
        - Builds on earlier work that found that corals sourced over a small temperature gradient (0.25-0.3 C) in Miami-Dade varied in their thermal tolerance. This project expands the temperature gradient to ~0.5 C, from south Miami-Dade to Broward County.
        - One-way translocation of colonies from warm southern sites to cooler northern sites (63 fragments of 12 ACER genets, 64 fragments of 12 OFAV genets)
        - Reciprocally-crossed translocation of colonies from sites across thermal gradient at two sites at the northern and southern extremes (368 fragments of 35 ACER genets, 264 fragments of 36 OFAV genets)
- **2. Building resilience using inshore and salvaged corals**
    - Relocate colonies from "non-reef" environments that survived recent disease and bleaching events to reef environments. We are currently site scouting and performing initial collections, have deployed temperature loggers, have started permitting for permanent structures for inshore nurseries through DEP and USACE. Led by PhD students Carly Dennison and Rich Karp
    - Salvaged corals:
        - October 2020: 224 colonies form Fisher Island seawall were fragged and maintained in outdoor raceways for outplanting and research. Additional corals are arriving soon from Monroe County (Terramar)
        - OFRA: 76, SSID: 96, MCAV: 174, OFAV: 368, PCLI: 34, PSTR: 25. Total frags: 773
    - Determine the role of pre-exposure ("stress-hardening") in boosting resilience (adults and recruits)

        - Led by PhD Student Rich Karp
        - Acute pre-exposure of adult corals does not induce long-lived increases in thermal tolerance unless it induces symbiotic community change. Chronic exposure may be more successful in inducing symbiont changes in adults of some species, including ACER. Chronic exposure of recruits may also be more effective in eliciting long-lived compensatory responses.
- **3. Building resilience of coral recruits through algal symbiont provisioning**
    - August 2020: ACER had its first spawning in Miami. Nursery and outplanted colonies spawned, ~20 different genotypes over 2 nights. OFAV: 3 genotypes spawned at Emerald Reef
    - September 2020: 2 genotypes of OFAV and one MCAV spawned at Rainbow Reef.
    - Sperm Cryopreservation
        - Led by PhD Candidate Liv Williamson
        - 3 ACER preserved in August from Key Largo parents
        - 6 APAL preserved in August from Key Largo parents
        - 4 OFAV preserved in August from Miami, 2 OFAV preserved in September from Miami
        - 3 MCAV preserved in September from Miami
    - Algal symbiont provisioning
        - Led by PhD Candidate Liv Williamson
        - *In situ*: exposed thousands of OFAV and APAL recruits in SECORE pools to sources of thermotolerant symbionts prior to outplanting to Rainbow Reef
        - *Ex situ*: Seeded DLAB and CNAT recruits (from FLAQ) with thermotolerant *Durisdinium* in the lab, exposed ACER and APAL and OFAV to thermotolerant symbionts in the lab
    - Outplanting of seeded recruits
        - September 2020: Outplanted 200 substrates with APAL to Rainbow Reef (mostly aposymbiotic)
        - October 2020: Outplanted 120 substrates with OFAV to Rainbow Reef (seeded with *Durisdinium*)
        - November 2020: Outplanted 60 substrates with APAL and 60 substrates with OFAV to Emerald Reef (subset seeded with *Durisdinium*)

South Florida Coral Reef Restoration Hub (III): Focus on developing in situ methods for upscaling coral restoration via breeding and larval propagation
– Diego Lirman, UM; Andrew Baker, UM; ***Margaret Miller****, SECORE; Amber Whittle, FLAQ*

- For 30 years, SECORE has been working on enhancing the steps of larval propagation for restoration (gamete collection, fertilization and embryogenesis, larval rearing, settlement, and outplanting).
- Upscaling theory: SECORE has identified 23 components for being successful in upscaling restoration that fall into three categories: Biology (life history studies, settlement cues, post-settlement survival), Technology and Logistics (collection, rearing, and outplanting technology, manufacturing and transportation, and deployment), and capacity building (identifying partners, training practitioners, and building networks).
- Much of the focus in the last few years has been on the Biology, to increase larval propagation *in situ*.

- CRIBs (Coral Rearing In situ Basins) were developed for mass scale rearing during larval development steps, and larval settlement substrates were development for settlement and deployment (self-stabilizing, don't need to be nailed to the reef, and have microhabitats for coral recruits). This approach has been used in a lot of places, but in the S. Florida habitat the conditions are harsher for coral larvae. We worked with Frost Science and their large outdoor temperature-controlled tanks these CRIBs. It was a successful proof of concept.
- In an extensive spawning effort with a lot of partners, we were able to collect and fertilize OFAV, MCAV, and ACER. There was good fertilization, but not enough material to run the full-scale CRIBs, so only APAL provided by Dana Williams were reared in the CRIBs.
- The APAL were used to test whether settlement was better when the substrates were in crates or were hanging. Overall settlement was modest but was significantly higher on the lower hanging rungs and in the bottom crates. The hanging arrangement worked well. A subset of APAL substrates (600) were outplanted, and a subset (200) was maintained in *ex situ* sites (FLAQ and U Miami).
- Lessons Learned:
    - Nearshore Brain corals (Bill Baggs State Park) did not spawn despite robust appearance and robust observation effort
    - Frost BEC facility provides a good platform for large scale, CRIB-based larval propagation, and can maintain substrates for several months
    - Need better focus in the future on timely symbiont inoculation and feeing

South Florida Coral Reef Restoration Hub (IV): *Ex Situ* Coral and Diadema Sexual Reproduction – *Diego Lirman, UM; Andrew Baker, UM; Margaret Miller, SECORE;* ***Amber Whittle****, FLAQ*

- FLAQ is currently holding 6% of the 2000 corals collected as part of the Coral Rescue project so far. They are kept in two separate tanks and are growing rapidly, many have spawned. Some are held in induced spawning chambers that mimic the natural cues in moonrise, moonset, etc. There are currently 2 of these chambers, but we are adding 16 more.
- The larvae that we produce in these systems are either raised here or sent to collaborating institutions, have also provided juveniles of CNAT and OFAV to UM.
- Our *Diadema* reproduction lab is currently doing a genetic study to determine how often we need to change the adult broodstock, and are building a settlement chamber to settle them more successfully. We have had 3 successful runs where we have gotten juveniles, and have also sent some larvae to U Miami where they are doing well.
- **Questions**:
    - Judy lang: I could see all the *Diadema* juveniles. I wonder what they are doing that's different to have such success?
        - AW: We are more successful than anyone else in the last 25 years. We have high quality algae, but we also have a long way to go with settlement. The UF partnership is good for research- I hope we will crack it.

SESSION VI: Florida's Coral Reef Restoration Strategy

Restoration Overview for Florida's Coral Reef and the Coral ECA – *Kristi Kerrigan, DEP CRCP*

- Restoration across the system is challenging with so many management bodies and shifts in baseline conditions are making it harder to restore coral reefs health. Florida has been a leader in restoration and outplanting- we have pioneered a lot of efforts on acroporids, and are now focusing more on massive and bouldering corals.
- Working groups:
    - 1. Coordination and Infrastructure (enhance information sharing and coordination)
        - A) **Coral Restoration Consortium**: a large network focused on how to conduct restoration in Florida and the Caribbean, subdivided into 6 working groups (field-based propagation, land-based propagation, larval propagation, genetics, monitoring, and management)
        - B) **USCRTF Restoration Working Group**: Focused on restoration at the national level but continues to assist coral reef jurisdictions working on the ground, helps managers develop restoration plans
        - **C) SCTLD Response Teams**- there are 3 teams focused on restoration elements (Coral Rescue, Restoration Trials, and Propagation). All of these groups exist in their own entities and a lot of the partners move between them and are working amongst multiple groups.
            - **Coral rescue**: focused on preserving genetic diversity of the susceptible species. Have a good partnership with AZA, and are scaling up facilities throughout the country. The focus up to now has been ahead of the disease margin, we are now focusing on endemic collections.
            - **Coral Propagation**: has built the infrastructure and capacity to grow corals for large-scale reef restoration
            - **Restoration Trials Team**: developed an experimental design to conduct a large-scale replicated outplanting effort in response to SCTLD using OFAV, MCAV, and PCLI
    - 2. Intervention Projects (restore ecosystem services to improve reef resilience)
    - 3. Restoration Planning (enhance decision-support for managers and practitioners)
        - Want to create a restoration framework with specific goals in mind (restoring ecosystem services, improving productivity, etc.)
        - **Mission Iconic Reefs**: developed a proposal that provides a coordinated approach to restoring 7 sites in the Florida Keys with corals and several species of grazers. The major components are site preparation, coral outplanting, grazers, stewardship and maintenance, and creating an adaptive management plan. The ECA is using Mission Iconic Reefs as a model to do something similar. Conversations have just started but want to involve stakeholder engagement.

<u>Restoration Site Planning Activity</u>

- Goal: focus on creating a network of restoration sites that will eventually help re-populate the reef naturally. Brainstorm the types of data and research that would be essential for sites selection to occur within the coral ECA.
    - **Group 1**: Kristi Kerrigan (facilitator), Dave Gilliam, Erick Ault, Dana Wusinich-Mendez, Joe Lopez, Judy Lang, Dick Dodge, John Fauth
    - **Group 2**: Jamie Monty (facilitator), Brian Walker, Jay Grove, Ken Banks, Esther Peters, Jack Stamates
    - **Group 3**: Caitlin Lustic (facilitator), Kurtis Gregg, Stephanie Schopmeyer, Dale Griffin, Piero Gardinali, Val Paul, Phil Dustin, Josh Voss, Don Berhinger

- **Step 1: Existing Data:** discussing the various types of datasets/research that already exist that would help inform site selection for restoration within the Coral ECA. Are these datasets available and in what format? Do shapefiles exist? Have any kind of analyses been done on these datasets that we could pull from?
    - Benthic Data (SECREMP, NCRM, FRRP-DRM, OFR Marine Planner)
        - Parameters: species, diseases presence, proximity to stressors (turbidity, thermal stress, dredging and beach renourishment projects)
        - Sponges and Octocorals (SECREMP)
        - 3D relief/ rugosity data
        - Historical community structure
        - Species composition N to S
    - Water Quality (DEP WQA)
        - Evaluate WQ gradients for outfalls, etc.- dilution zones off of inlet and plumes from outfalls
    - Bathy data, habitat maps (historical and current)
        - Brian Walker mapping data
        - Data from the OFR Marine Planner
    - Remote sensing for surface water color (HYCOM)
    - Modelling
        - larval connectivity models (J. Figueiredo) that incorporate all the elements including historic habitat maps, hydrodynamics, etc.
        - Metapopulation Modelling: appropriate spacing between sites to restore, proximity to pollution sources or other stressors, disease maps
        - Output of Hannerot & Figeredo model
    - Genetics
        - compatibility/ relatedness between genotypes of the same species
        - genotype data for both coral hosts and symbionts
    - Hydrodynamics (multiple years, 10-15 years ideal, and during spawning months, ideal scale is <100m^2), including currents to better understand the dispersal movement of larvae (Emanuel M.)
    - Nearshore data associated with beach projects, data from further inland to locate pollution sources.
        - Land-based pollution studies from 2004-ish
        - Human traffic along FRT
    - USGS reef erosion/ accretion data
    - Protection status
    - Baseline transplants
    - *Conclusions:Sshould follow a similar site selection process as was done for the spawning hubs, and should use an adaptive management approach that can be modified along the way. Should also have a publicly accessible database (ex is GOM Research Initiative:* https://data.gulfresearchinitiative.org/*). Might have to set different targets for different areas.*
- **Step 2: Needed Data**: any potential datasets/research missing that would help inform site selection for the Coral ECA. Understand that these datasets may never be available in order to select sites, but what would be needed in an ideal world. Don't just think about what should be gathered, but also how would that data/research be applied (e.g. map layers, analyses to run,

decision-support tools, etc.). Are there analyses/manipulations that could be run on the existing datasets that could fill some of the gaps in information?

- Exact spawning times (species specific)
  - Would improve the simulations/ models suggested above
  - Can be achieved through systemic histology (every 2 weeks throughout the summer)
  - Sponge spawning dates
- Competency and larval dynamics for every species
  - Would allow us to create more species-specific larval connectivity models
- Recruit/ juvenile coral abundances and diversity
- Testing the backends of the connectivity models
  - Need genotypes from a restored site and recruits in surrounding reefs to determine genetics
- Demographic connectivity vs. genetic connectivity
- Dredging / pollution data
  - Data on inlet plumes- where does it go, how long does it linger?
  - Outfall discharge rates and salinities and dilution zones
  - Good maps to determine nutrient pollution/ stress
  - Exclusion zones around known sources of pollution and sedimentation
  - Future construction projects and impact area maps
  - Groundwater contributions
  - Salinity issues from estuarine outflows
- Microbiome data
- More hydrodynamic data (currents)
- Scaling site location
  - After existing data helps us pinpoint a location, need to visit the site and determine whether it is a good choice. Need criteria? Photomosaics? Data before restoration begins?
    - Groups at NOAA AOML in the keys are doing photomosaics
  - Look at coral spawning range
  - past success of restoration activities
- Current disease prevalence and occurrence data
- Connect with dive shops and charter boats for feedback on where would be good from a citizen science perspective
- Missing WQ Data
  - Experimental evidence that bad WQ leads to coral decline
- Heat maps for entire ECA
- Light levels for deeper reefs

- **Additional comments from group chat boxes:**
  - Lauri MacLaughlin: FKNMS has been working on addressing water quality, and studying the benefits or improvement to the ecosystem over time, some benefits have already been realized since central sewage system implementation. Yes more work is needed, and we heard the direction of the WQPP yesterday. There is also a focus on addressing up-stream inputs and impacts.
  - Joshua Voss: need to quantify not only the levels of water quality, what we are often missing is stronger experimental evidence that water quality (perhaps in combination with thermal stress) results in coral decline/death. We could use restoration as a grand experiment to test these factors

- Lauri MacLaughlin: On topic, FKNMS MIR science support staff have been piloting site characterization surveys and groundtruthing in support of restoration site selection for MIR/7 icons.
- Lauri MacLaughlin: We so have datasheets and protocols for these surveys, which are now also being adapted, tweeked and applied in a pilot project effort designed to support our Blueprint for Restoration planning for zone expansions, new SPA or Wildlife management zones. This is a recent effort just being kicked off as one of the science teams FY21 Priorities.
- Maurizio Martinelli: Folks at USGS are collecting data on reef accretion/erosion rates through time that can be used to ID areas of 'stability', which may be good candidates for outplanting. They have presented on data for the Keys, not sure if this is being collected in the ECA
- Lauri MacLaughlin: FKNMS uses characterization considerations as criteria for site selection already worked up and defined, which might be adapted or utilized for consideration. These include stony corals, gorgonians, zoanthids, sponges, bottom type (eg. consolidated, unconsolidated, or sand), macro algal cover, inverts presence (herbivorous, snails, diadema) and diversity & % coverage of the differing benthic groups.
- Lauri MacLaughlin: Step 2: Lidar mapping, FL Benthic Maps/coral reef benthic communities (FWC), groundtruthing is such an important component of using many of these or other remote sensing tools.
- Piero Gardinali: We don't even have flows from most of the land-based sources (including groundwater and storm-water flows) Most flows are based on structures, Not real measurements at the entrance to the bay
- Lauri MacLaughlin: FRRP, SECREMP & NCRMP have data that IDs cells or specific HB/reef sites surveyed that might be tapped for high diversity bottom types to be targeted (eg. already been groundtruthed by fish or coral demo surveyors.
- Stephanie Schopmeyer: where is current restoration already being conducted? what has their past success been and should restoration be continued at those sites? If people don't go there, it most likely won't be a good restoration site
- Stephanie Schopmeyer: Andrew Baker showed heat maps for Miami-Dade where they are transplanting- do we have heat maps for the rest of the ECA?
- Lauri MacLaughlin: Josh: recruits data is just starting to get attention, I have been tallying my anecdotal & historical data for Andy to show recruitment potential at reefs of interest for our zoning and MIR projects. So I am a huge proponent of considering natural recruits data gathering and survival tracking, and applying these data or observations in site selection and potential for increased success in support of our restoration efforts.
    - Stephanie Schopmeyer: Josh- FWC just completed a large natural recruit study if you are interested in those results
    - Lauri MacLaughlin: yes, thanks Steph... exactly what I was thinking, great work and a huge contribution on FWC's behalf to the management of FKNMS reefs and resources!

Public Comment

1. John Fauth, UCF: TAC members may be interested to know that Orange Co, FL just passed an amendment to its county charter that grants legal rights to all waters of the county, and which gives county citizens standing to bring lawsuits against governmental and corporate polluters. See https://righttocleanwater2020.com/text-of-charter-amendment
2. Melissa Sathe, FOFR: Is it ok if I share in the chat the website for FOFR's latest fundraising for MEEC? https://www.floridareef.org/meec-match-challenge.html