

**Southeast Florida Coral Reef Initiative (SEFCRI) Technical Advisory Committee (TAC)  
October 30 & 31, 2019**

Nova Southeastern University, Oceanographic Center, 3<sup>rd</sup> Floor Auditorium  
8000 N. Ocean Drive, Dania Beach, FL 33330

**List of Attendees:**

TAC Members: Erick Ault, Ken Banks, Don Berhinger, Rob Brumbaugh, John Fauth, Piero Gardinali, Dave Gilliam, Lew Gramer, Kurtis Gregg, Judy Lang, Jose Lopez, Arthur Mariano, Valerie Paul, Esther Peters, Stephanie Schopmeyer, Manoj Shivlani, Jack Stamates, Josh Voss, Brian Walker

Guest Speakers: Rachel Zuercher, Kai Lorenzin, Susana Hervas-Avila, Andrew Baker, Marissa Baskett, Jane Carrick, Joana Figueiredo, Ken Weaver, Daryll Joyner, Kevin O'Donnell, Maurizio Martinelli, Thomas Dobbelaere, Nick Rosenau, Kelsey Watts-FitzGerald

DEP Staff: Alycia Shatters, Jamie Monty, Kristi Kerrigan, Michelle Gaulty, Joanna Walczak

Public: Wilson Mendoza, Pat Quinn, Kristin Anderson, Joshua Farmer, Sara Thanner, Alastair Harborne, April Price, Doug Seba, Kirk Kilfoyle, Kirk Dotson, Lauri MacLaughlin, David Vance, Erik Neugaard, Sabrina Fischer, Scott Sheckman

**Session I: Follow Up from Last TAC** – *Alycia Shatters (DEP CRCP)*

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- The last meeting in April came up with some recommendations that were brought to the SEFCRI meeting in June, such as summarizing John Fauth's presentation on the dangers of sunscreen for the public and prioritizing baseline studies for use by the EPA.
- NOAA and the EPA are currently doing scientific reviews, and information from those studies will be used to inform next steps.

**Session II: LBSP (Land Based Sources of Pollution) Project Updates** – *Alycia Shatters (DEP CRCP)*

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- **The Green Infrastructure/ Low-Impact Development Best Management Practices Manual**
  - Eban Bean (UF IFAS) has held a workshop for feedback on Manual, which was presented in April's meeting. The manual has information on designing and developing low-impact development techniques in local SE Florida communities, complete with a decision matrix tool to help you decide on the best options for a given site.
  - The manual is now available on the DEP Website:  
<https://floridadep.gov/rcp/coral/documents/low-impact-development-green-infrastructure-pollution-reduction-guidance-water>
  - Next steps for the manual are to continue to get the word out and make sure it is disseminated to all partners. We will send a link to the PDF (too large for email) and the decision-making excel to TAC members directly.
- **Pilot projects implemented in Boynton Beach: rain gardens and bioswales**

- The DEP is partnering with the City of Boynton beach to implement pilot projects to give an example of things that the local communities could do at a small scale to help reduce the amount of LBSP that is reaching downstream ecosystems.
- Will be monitoring the flow and nutrients to determine the effectiveness of the rain gardens and bioswales, details on the monitoring plan are pending.
- **Water quality monitoring and assessment**
  - This project is collecting WQ samples from inlet, reef, and outfall sites along 9 inlets in the SE Florida region.
  - Effort continues- thanks to the NSU field crew who has never missed a sampling day, and to the Broward labs analyzing samples.
  - Started a new contract in July 2019:
    - Did not remove any analytes
    - Added chlorophyll a to a subset of sites at each of the inlets
      - Added 5 sites at each inlet for chlorophyll a samples
  - Currently working on final data report for September 2017-2019 (in internal review by NOAA, should be complete for next TAC meeting).
  - Data is also being added to the WIN database.

### **Session III: Reef Fisheries Modelling** – *Rachel Zuercher (FIU) and Robert Brumbaugh (TNC)*

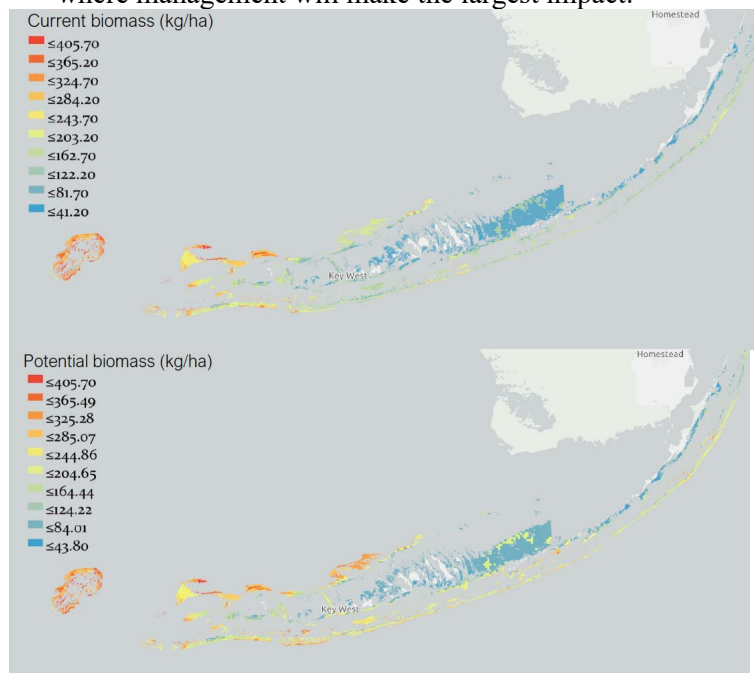
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- This work will describe the mapping of fisheries across the FRT as an extension of a larger global initiative to map our global wealth. The objective of this project is to take an ecosystem services approach to express the value of the ecosystem, with the goal of gaining spatially explicit data that helps us understand where we should invest, and what we expect as a society to get back as a return on that investment. We have done modelling at different scales to look at ecosystem services, the goal is to dissect the big number into what it consists of, how it is made, and where it is made along the FRT.
- Objectives:
  - (1) to create a high-resolution map of current reef fish biomass as a spatial scale to inform area-based management
  - (2) to develop a high-resolution map of potential reef fish biomass to estimate the biomass that is possible on a reef given the biophysical conditions there
  - (3) using these two, calculate a time to recover- how long to get from current to potential?
- General Methods: “Model to Map” approach
  - Take the biomass from the RVC survey data (actual abundance data), model against biophysical data and socio-economic data to help us create math relationships between all of these variables and biomass.
    - Biomass excludes fish less than 5-cm
    - RVC surveys do not include lobster data [DB]
  - Then go to sites that have not been surveyed and run the model in a predictive way to estimate the biomass at sites that RVC has not been to.
- Model characteristics
  - Ran from Martin County to the Dry Tortugas with 1 ha resolution
  - Specific to coral reef and hardbottom habitats, and includes all coral reef fish species recorded by RVC (300+)
- Explanatory variables:
  - **Habitat related:** habitat type, coral cover, rugosity, area of reef within vicinity

- We didn't have rugosity and coral cover for all RVC sites, so used regional means by habitat sites from ENCREMP surveys for the predictive model. The first model was run with RVC data from actual sites.
    - The model was run and trained through the entire FRT and habitat type is just a variable. [BW] Suggests splitting habitat type by region, his previous work shows that differences in region and habitat communities affect fish and benthic cover data. Suggests splitting SE Florida from the Keys and the Keys from the Tortugas because the relationships are very different.
    - *This excludes everything shallower than 2m, so does not consider the nearshore hardbottom in the Keys, which makes up 30% of habitat and nursery grounds in the area [DB]*
    - *Because water quality is not a variable and because coral cover is included as a proxy, [KG] suggests using a ratio of algae to coral cover. Coral cover is one of the slowest-responding metrics to use for water quality. Algae data is included in RVC surveys.*
  - **Oceanographic:** sea surface temperature, primary productivity, wave exposure
  - **Ecological** variables: larval delivery (on every parcel of reef, how many larvae might be delivered from downstream), availability of nursery habitat (mangrove and seagrass within 12km, the distance where nursery grounds might influence biomass according to literature), artificial reefs (which tend to be high in biomass, but also are heavily fished), depth and distance to deep water (distance to reef drop-off, 30 m contour), distance to spawning aggregation
  - **Socio-economic** variables: fishing impact, level of protection (open or closed to fishing)
- **Results from the snapper-grouper complex:**
  - **Fishing impact had the highest influence on fish biomass**, relationship is inverse
  - Depth was the next most important predictor, with more biomass at deeper sites.
  - Area of reef within 20 km also influenced biomass, reef surrounded by other reefs had higher biomass.
  - When ran predictively for the entire FRT:
    - For All species, biophysical variables are the most important, but fishing impact is in the top 4.
    - For snapper-grouper complex, fishing impact is the most important
    - For herbivores, rugosity is the most important, then distance to depth, fishing impact is NOT important.
      - *There is a fishery for herbivores [KB], but it is not a commercial fishery. It will be interesting to compare this data to the Bahamas, where parrotfish fishery is bigger.*
    - For aquarium species, distance to deep water is most important, fishing impact is not.
  - *KB- Rugosity appears to even out after reaching a maximum, is there a critical point where structure stops mattering?*
    - *Most of the data is concentrated in higher-rugosity areas- there is just not enough variability to create the relationship past a certain point.*
- How we **calculated fishing impact:**
  - Things such as abundance, biomass, length of species/ groups can tell us how much fishing is happening now or in the past.
  - In testing all these metrics on Florida sites, found that **the best metric to use is snapper-grouper biomass** to see how much fishing is happening on a reef.
  - Did a similar model with snapper-grouper against all variables influencing biomass but did not include fishing impact- instead used socioeconomic variables to characterize **how**

**fishing activity was happening.** (To do this, split the RVC sites into 2 bins and modelled impact with one set and biomass with the other, so it's not circular).

- Socioeconomic variables: commercial fishery landings (by FWC reporting area), snapper-grouper permits (by zip code), snapper-grouper charter permits, number of recreational fishing licenses (within 50 km of reef site), community fishing engagement and reliance metrics (NOAA reports number of tourist reef fishing days, able to take those estimated reef fishing days and distribute across reef based on location of hotel units), marine slips (<45 ft) within 25 km, launch ramps within 25 km, population, protected area status, market gravity.
- Of these, **number of recreational licenses within 50 km was found to be most important** (fewer licenses means more biomass until a point (4 million) where biomass drops off), and **number of marina slips** was found to be second most important (fewer slips -> higher biomass).
- Then used these 2 variables to back-predict snapper-grouper biomass, which was then converted into a metric fishing impact (scale 1-10). This is a single metric that helps see pressure, and is useful for communicating with stakeholders. It is currently being used in Bahamas and will soon be used in Antilles to help prioritize management areas and for marine spatial planning.
- Note: Fishing impact is not necessarily fishing pressure- it is the cumulative impact that fishing has had on the assemblage, as estimated using the snapper-grouper biomass. This does not express current hot-and-cold spots for fishing, but historic fishing pressure.
- **Potential fish biomass**
  - The single variable of 'fishing impact' can be set to zero to simulate no-take throughout the entire FRT, as an exercise to calculate the biomass possible given biophysical properties.
  - By **comparing these current and potential maps**, you can look at particular pixels where management will make the largest impact.



- **Recovery time- how long to get from current to potential?**

- From what is known in the literature about how reef fish respond to not fishing, in areas not heavily impacted right now we can expect **10-15 years to recover to 90% of potential biomass in the higher areas (upper ECA), and full recovery might take 60-70 years.** Having these numbers can help set reasonable management expectations.
- Next steps
  - Received feedback that it would be useful to see models at the spatial scales of management. Right now, we are running models in Biscayne National Park. Results so far are interesting- for example, fishing impact does NOT show as an important variable, but this is because fishing impact is uniformly high within the space. At this smaller scale, we can look at smaller variables such as SST and coral cover. We hope to run this for different areas in the Keys and Coral ECA.
    - *[BW] points out that there may be a gap in survey data in Biscayne because different groups are charged with surveying north and south of the area, so Biscayne may be a challenge.*
  - Data will be up within the next few months on Oceanwealth.org. Right now it is as a static display approach, but can talk to RB to get the data that is behind the web mapping service.
    - <http://maps.oceanwealth.org/>
- **Questions & Concerns:**
  - BW- Different fish species may contribute to biomass differently based on their specific ecologies and locales- I don't see how you can relate the combined biomass of snapper and grouper to fishing impacts without splitting them up at least by some ecological function. In past work we have shown that there are varying relationships depending on the proximity to mangrove habitat, and that relationship is only specific to mangrove obligate species. In Corey Aimes thesis we separated assemblages, and the assemblage in the Keys is very different from up here. They should not be treated the same.
  - BW- If you have gotten the hardbottom relationship from data skewed in this region, and then apply that to the rest of the keys, that's probably not appropriate. I think that the model and predicting model should be limited to the footprint of the survey data that you have so you are not reaching out (unless it's to comparable habitat)
    - That's what we did- There is a big hardbottom area in the Keys and not much RVC data, so those estimates come mostly from SEFCRI in the same level two classification.
  - BW- Also, they are using PSU for their dataset, with SSU it's a smaller scale. A PSU is larger than a hectare (we are using PSU here, pair of buddy pairs within one map grid, depending on region, 50 m). Previous data sets are 200 m grid, that changed in 2013.

## Session IV: FDOU Project Updates

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1. **Data needs for fisheries management: Situation Analysis & Phase II Process Suggestions** – *Kai Lorenzen and Susana Hervas-Avila (UF)*
  - Fishing is a key use of coral reef ecosystems. Stakeholders can be a powerful voice for conservation, and effective management of fishers and other stakeholders is very important to coral conservation.
  - Fishing in the OFR Process:
    - Fishing stakeholders were included in the OFR process but it was difficult to get them to participate.

- There is a gap between fisheries information and engagement in OFR. We attempt to fill that gap by collecting information about management from fishing stakeholders and by facilitating their engagement.
- Did a situation analysis as a way of understanding the landscape of stakeholders and revisiting the OFR process from their perspective. The aims of this analysis were to:
  - 1. Identify and characterize the stakeholders in relations to fisheries management in the SEFRCI area
    - Stakeholder, position, interests, power, and history with OFR
  - 2. Characterize their experiences and attitudes towards conservation and OFR
  - 3. Develop an engagement plan to be used over the next 2 years to reintegrate the community more than they currently are
  - 4. Inform the stakeholders about what was found in this analysis and plan for future engagement.
- Methods of the situation analysis:
  - Conducted a set of semi-structured interviews with 45 people representing different groups. In addition to these interviews, also revisited a 2013 survey from goliath grouper stakeholders that included questions about perceptions of threats to coral reef ecosystems. These interviews allowed us to extract how these different groups view threats to coral reefs.
    - *Susana Hervas-Avila (present) did all the interviews, Joy Hazel is a Seagrant agent who specializes in facilitation and participation processes, Chelsea Krendel also specializes in participation processes, and I am the team leader.*
  - A report of findings is being finalized and will be made available.
- **The big take-away of this analysis is the fishing stakeholders perceive the existence of two separate networks:**
  - 1. **“Angler” network:** fishers, fishing charters, marine industries, FWC
  - 2. **“Diver/ Environment” network:** divers, diver operators, E-NGOs, DEP
  - The interviews expressed the **perception that the OFR process was associated with the diver network, and that the angler network was underrepresented.**
- Perceived impacts on reefs ranked by how important the groups thought they were:
  - 1. Water quality (water run-off, sewage, storm-water discharge, Okeechobee water-ways, dredging, coastal development); 2. Disease outbreak; 3. Climate change; 4. Anchoring; 5. Overfishing; 6. Lobster traps; 7. Diver pressure; 8. Artificial reefs.
- There were some differences in perspectives from people in the “angler” network vs. the “diver” network
  - All members of fishing network were similar in their perceptions, which drives the overall ranking.
  - Conservation groups ranked all threats as equally high, divers were between both groups.
  - Most fishing stakeholders find fishing to be an important threat. Though it is less than the perceived threat than by conservation groups, which see it as very high, they are **not oblivious to the effect of fishing on coral reef ecosystems.**
- The commonalities in perceptions are important:
  - Fishing stakeholders rank water quality, habitat loss, coastal development, and invasive species as more important threats to coral reef ecosystems, but are not oblivious to fishing impacts.
  - Fishing stakeholders are variable in how they perceive the threat of fishing- 2/3 perceive it to be important to very important. This variability is not well captured in super-stakeholders such as CCA and ASA, which tend to express that the threat of fishing is not important.

- This shows that **the views of big super-stakeholders like corporations do not reflect the thinking of the fishing community** at large, and when you bring a diverse set of fishing stakeholders to the table to discuss conservation concerns, this can lead to more conservation-oriented actions.
- Experiences and attitudes to engagement: what went wrong with the engagement of fishing stakeholders in OFR?
  - The “angler” network feels that OFR process was unfair, driven by the “diver” network and that fishing stakeholders were marginalized. Nonetheless, fishing stakeholders are interested in re-engaging.
  - The “diver” network felt that the OFR process was fair, and that the fishing stakeholders did not participate constructively in this process that they were intended to be included in. Also felt that the “angler” network opposed OFR recommendations and ultimately sunk the process outcomes.
- It doesn’t have to be like this: If you **put the fishing stakeholders at the center of the process**, where they are not marginalized, these fishing stakeholders can give you a better outcome than you would have otherwise:
  - In the FishSmart process for king mackerel in S. Atlantic, engaged fishing stakeholders recommended more restrictive regulations than were originally planned.
  - In the FWC Snook Workgroup, they recommended more conservative regulations to bring the biomass up, allowing the agency to make changes without the opposition that would have occurred if the regulations had come from the agency alone.
  - They can be important advocates for broader conservation objectives, such as Captains for Clean Water or the Sarasota Fisheries Forum.
- **Conclusion: there is an information and engagement gap in OFR, and the key to filling it is to have a smaller fisheries-centric process that is aimed at capturing the aims of fishing stakeholders** to advance conservation. Need to allow for the diversity and different perspectives within the fishing community.
- Proposed stakeholder engagement process:
  - Objective: to harness the capacity of the fishing community to advance conservation of the SE Florida Coral Reef ECA. This capacity includes knowledge/ experience, outreach/ advocacy, and standing and commitment to reef conservation outcomes.
  - What we propose:
    - A process that will involve a **central committee made up of different members of the fishing community**.
      - *The committee will not have member representative from the other network to avoid internal divisions. The committee will be entirely fishing-centric and will interphase outputs in SEFCRI.*
    - We will support this committee and activities through facilitation of participation processes, access to science, etc.
      - Rather than providing science for them to translate, allow the committee to look at what they want to prioritize and then provide the science related to these topics- want to allow science to enter the stakeholder process rather than dictate it, and to give the stakeholders more power in allowing them to take a proactive role.
    - The committee with the project team will undertake some outreach and some survey research of the fishing community at large
      - Want to integrate the community within the fishing network to facilitate *constructive* communication- there is active communication within this network that has been used to sink OFR recommendations in the past.

- The committee will then communicate with SEFCRI and TAC about the process, what they want to prioritize, recommendations, etc.
  - This is meant to be fisheries-centric but will complement the outputs of the OFR process.
  - This will be managed by a team at UF.
- **Questions & Concerns:**
  - DG- The OFR has its challenges, but we are proposing to fix a process that is too conservation-centric by making it fisheries-centric?
    - We are not proposing to redo OFR with fishing people, but the primary focus will be on the fishing areas of concern. We are focused on the fishing stakeholder group, but we are not looking to re-do the non-fishing parts of the OFR. It is not meant to be separate, but to fill the gap of fisheries.
  - DG- One thing that was challenging about OFR was that FWC and FDEP were separate in actuality. How is that separation avoided in the future?
    - FWC is not opposed to MPAs, but it was close- they weren't opposed, but that method is a last resort. We want to provide access. Before we take something away, we want to make sure that all things are exhausted before resorting to that. We make recommendations to a council, and they make decisions.

## 2. Coordinated reef management plan update – *Jamie Monty (DEP CRCP)*

- This is a preliminary overview of an idea of how to create a management plan for the ECA. Please give feedback as we move forward.
- In July 2018, the SE Florida Coral Reef Ecosystem Conservation Area (ECA) was designated by Florida legislature (same area/ formerly known as SEFCRI). This encompasses the state waters between St. Lucie inlet to the northern boundary of Biscayne National Park.
  - Right now, the ECA is not offered any protection and it is not similar to other designated areas because it does not have a management document associated with it
  - There is no mandate within the development of the ECA to make a management plan. It was given to the DEP, but we are working with the FWC to manage
- The next step is to identify goals and priorities and receive guidance on future steps.
- The Florida Reefs community planning began in 2013 with community meetings about the process and what we proposed to do, now we need to make a reef management strategy.
- Working on creating local action strategies based on recommendations from SEFCRI in 2004
  - 68 Recommended Management Actions (RMA):
    - LBSP, FDBOU/ Restoration, MICCI, Education and outreach, Enforcement, and Place-Based Management.
  - Current studies:
    - Address gaps in RMAs, particularly from fishery stakeholders.
- The way SEFCRI currently manages things is by threat area, but the Biscayne National Part and others are instead separated by management program area. We want to implement those management areas into the ECA using the same structure.
- The ECA was designated by the state and tasked to the DEP- we are charged with all **aquatic preserves already, so we want ECA management to be consistent with that existing document.**
  - *Making this document consistent with aquatic preserves is how we can make this a legal document. After this placeholder, the DEP and SEFCRI can go through a process to determine what teeth we want the ECA to have, case-by-case. Some of that already exists from the OFR working groups.*



- *The aquatic preserves protects the WQ levels at the level on the day it was designated at the preserve, but it doesn't limit use in areas. Not entirely protective, but a start.*
- **Vision for management plan:**
  - Provide a background of what has occurred within this region to date and listen to recommendations
  - Address threat areas, but be organized similar to existing plans in the region
    - This MP should be the one guiding document that references all other documents that have contributed over the years, and integrate any overlap.
  - Reference agency reports such as the socio-economic data released by USGS
  - Include recommendations for governance and authority
  - Needs to respond to emerging threats as they come up, like the coral disease
  - Should be designed to inform not only us, but also others like researchers and funders.
- SEFCRI team roles- the draft will be reviewed by TAC, then a revised document will undergo a public review process, which will produce the final version of the ECA MP.
- In the meantime, FDEP continues to implement the following projects:

CRCP/SEFCRI FUNDED PROJECTS	FY 19/20	FY 20/21
CRCP 2: Southeast Florida Action Network (SEAFAN)	X	X
CRCP 7: Marine Planner Website Hosting and Maintenance	X	X
CRCP 9: Updated Water Quality Standards and Biocriteria Establishment	X	-
CRCP 11: Coral Disease Bacteriological Analysis	X	X
CRCP 12: Watershed Management Plan (Best Management Practices) Support	X	X
CRCP 13: Sediment Profile Microbial Analysis	X	X
CRCP 14: Coral Reef Public Communications Campaign	X	X
CRCP 15: Support Land Based Coral Nurseries	X	X
RIPR 2: CRPA Printed Materials Outreach	X	X
RIPR 3: Mooring Buoy Program Support	X	X
AA 5: Maintain SEFCRI Website and Mass Email Service	X	X
AA 35: Educational Traveling Trunks Distribution	X	X
AA 42: Coral Reef County Curriculum Messaging	-	X
FDOU 52: Data Needs for Fisheries Management	X	X
FDOU 55: Coordination of Reef Management Plan	X	X
LBSP 4: Technical Advisory Committee (TAC) Support	X	-
Coral Disease Response	X	X
Water Quality Monitoring Program	X	X
Education & Outreach Events	X	X

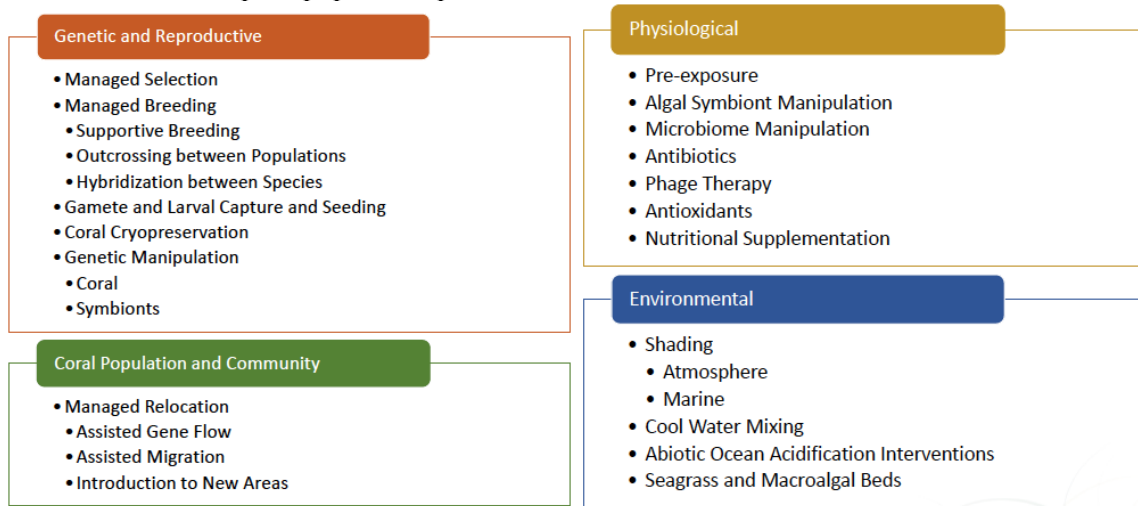
- **Questions & Concerns:**
  - KB- Fisheries is a good idea, but OFR took years. Are you going to wait for that to happen?
    - We can't finalize anything until we have the fisheries information.
  - VP- Have you engaged with Florida's Chief Scientist?
    - Joana has been able to have a couple of meetings with him and I have met him at a workshop, so he is aware on a high-level basis and is supportive. But the details of what that looks like is going to depend on the coming recommendations that we can bring to him so that we can get a gauge on the politics that will happen to the ECA.

## Session V: Intervention Strategies for Reef Resiliency Overview

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**Research review of interventions to increase the persistence and resilience of coral reefs –**  
*Andrew Baker (UM)*

- Purpose: insight into a recent set of reports by the Academy of Sciences (link below) to study the feasibility of doing interventions to increase climate change resilience.
  - <https://www.nap.edu/catalog/25279/a-research-review-of-interventions-to-increase-the-persistence-and-resilience-of-coral-reefs>
- The task of the first report is to **review and summarize scientific research on a range of intervention strategies**, including evaluation of the state of readiness. Information in the interim report is not exhaustive, it is a snapshot of a fast-moving field. This report does not consider the societal/political/legal implications of these strategies, it is only to discuss the science, costs and risks.
- The approach is to look at each intervention and assess: 1. What it is; 2. Its benefits and goals; 3. How it is done; 4. Its current feasibility; 5. The potential scale; 6. Risks; 7. Limitations; and 8. Infrastructure. The committee held public workshops in Miami, FL, and Honolulu, HI, and created a webinar to prompt public input.



- **Genetic and Reproductive Interventions**
  - Goal: to increase resilient genotypes or diversity of genotypes.
  - Ex: **Managed Selection**: find colonies that are already more heat tolerant than others for reproductive studies
  - Ex: **Managed breeding**: mixing parents to create new genotypes.
    - Example: outcrossing between populations on the N and S Great Barrier Reef. Larvae with a northern parent (heat tolerant) had higher heat survival. However, this has limited feasibility: difficult to implement, potential incompatibility, and risk of swamping out native genotypes.
  - Ex: **Genetic Manipulation**: Use of CRISPR/Cas9 to modify genes in coral (has been demonstrated in one paper that attempted to alter growth factor and fluorescence protein genes). Currently limited in feasibility because corals need to be a single cell, fertilized egg, so that any gene editing is propagated as it splits. There is also a lack of gene targets and unknown risks of gene engineering.
- **Physiological interventions**
  - Goal: to improve the health and function of the coral holobiont to increase its resistance to stress (pre-exposure, algal symbiont manipulation, microbiome manipulation) and help it recover from stress (antibiotics, phage therapy, antioxidants, nutritional supplementation).
  - Ex: **Pre-exposure**- exposing a coral to stressful conditions can increase its tolerance to subsequent re-exposures. Approaches vary in scale- exposure can be acute in the lab, or

*in situ* through nurseries, or can focus on corals in the wild that experience stressed conditions.

- The longevity of ‘stress hardening’ can differ- gene expression can be fast acting but short lived, epigenetic responses and shifts in symbiont communities can be longer lasting.
- Ex: **Microbiome manipulation**- attempts to assemble a microbial cocktail to increase thermal tolerance have had mixed success, still in the early stages of experimentation.
- **Coral population and community**
  - Goal: to directly alter the population or community composition in order to 1) move vulnerable corals to lower stress areas, or 2) move stress-tolerant coral to more high-stress areas.
  - Can occur at a variety of scales (within range= assisted gene flow; just beyond range = assisted migration; across ocean basins = introduction to new areas), with increasing effort and risk as scale increases.
  - Ex: **Managed relocation**- can move corals latitudinally to areas that are expected to warm or other areas of interest. Risks to this strategy include vectoring diseases, outbreeding depression and depressed viability of remaining corals. The effects this has on thermal tolerance has not been tested formally, but it has happened accidentally in areas of natural heterogeneity.
- **Environmental Interventions**
  - Goal: to reduce coral exposure to stress at a local level (which may reduce the potential for adaptation or acclimation of corals themselves).
    - Instead of trying to toughen the coral, this is a strategy to reduce the stress to which corals are exposed.
    - Ex: **marine cloud brightening**- projecting aerosols into the air to reduce solar irradiance and cool the water. The risks of this strategy are if we remove the forces that cause a coral to acclimate/adapt, any future failure of this strategy could be catastrophic.
    - Ex: **marine shading**: induced turbidity, physical or chemical shading layers, microbubbles. This has been tested in very small-scale trials and is likely to have a small-scale impact, and is limited by infrastructure needs.
- ALL interventions range in their feasibility and have limitations in potential scales and risks. **No intervention strategy outlined in the report are currently available for use at regional or global scales.**
- Conclusion: there is no silver bullet, and all things are case and context specific. What is needed is a **fast-fail approach**- if we are going to try some of these interventions we need to figure out quickly which will fail, or force them to fail so we can move on quickly to the next thing.
- For more information and to subscribe to updates:
  - <http://bit.ly/2yLDvIN>

## **A decision framework for interventions to increase the persistence and resilience of coral reefs- Marissa Baskett (UC Davis)**

- Purpose: this is the second report by the Academy of Sciences interventions to increase climate change resilience, which provides a framework for **evaluating risks, describes a decision pathway from research to implementation, identifies research needs, and assesses the potential** interventions to meet management objectives for the Caribbean/ Atlantic (see above section by Andrew Baker).

- a. <https://www.nap.edu/catalog/25279/a-research-review-of-interventions-to-increase-the-persistence-and-resilience-of-coral-reefs>
- The approach was to outline the best practices for decision making using the tools that have or can be applied to coral reefs, and to provide an illustrative modeling exercise using example interventions. Implementing this decision-making framework would have to be a stakeholder-driven process that considers all political, legal, and ethical drivers.
- The overall **decision framework** has the classic structure of active management framework: **Plan, Act, Evaluate, Respond**. This is suited for cases with high uncertainty (such as how these interventions would work, how dramatic a change in exposure/ tolerance is needed, future climate scenarios, etc.) and a lot of trade-offs (such as different management objectives for different communities)
- **Step One: identify goals and objectives with community involvement** (this is a stakeholder-driven process).
  - a. Selecting interventions within a local community depends on community values and feasibility: which are ready (none are able to be deployed on a large scale), the management setting (local governance, resource availability, jurisdiction sizes, cooperation), environmental settings (where benefits are maximized and risks reduced), and interdependencies across interventions (some interventions are less costly and more beneficial in pairs).
- **Step Two: create a model to say what we expect from these interventions** (how do we chose between them, and how do we monitor them?)
  - a. The model needs to be **tailored to local considerations**- the outputs need to relate to the objectives, and the inputs should reflect the community
  - b. Possible analyses include interventions (individually and in combination), baselines (no action and conventional management scenarios), and sources of uncertainty (e.g., multiple climate scenarios, parameter sensitivity)
  - c. The report includes a very simple example model exercise comparing intervention strategies with thermally tolerant vs. fast growing coral colonies to illustrate the process and potential insights
    - i. Some example insights can be the conditions necessary for the benefits to outweigh the risks and decide context-dependent implementation (when and where), which interventions are expected to be most effective, and possible interactions between interventions (if a few are complimentary, can be implemented sequentially)
- **Step Three: select interventions and associated evaluation metrics**
  - a. Models can predict expected outcomes and detectability over time. Must include metrics of both benefits and risks, to identify suitable “off-ramps” if the project needs course correcting.
- **Step Four-Five: implement interventions** with a monitoring plan
- **Step Six: Evaluate by comparing expectations to actual outcomes.** Where they don’t match, learn why.
- **Step Seven: Communicate progress to stakeholders** and decision makers
- **Step Eight:** Based on learning, **update both approach and models** to continue the cycle.
- **Conclusion:** this will take a lot of effort and time, but the result will be a scientifically-informed process of risk mitigation.

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## Session VI: Local Examples of Intervention Strategies

## 1. Growing corals to save shorelines: validating the use of restoration and hybrid artificial reefs for coastal protection – Jane Carrick (UM RSMAS)

- ~40% of the global population lives within 100 km of coastlines, where storm surge, wave-driven flooding, and shoreline erosion are a major threat. Coral reefs are able to dissipate ~97% of wave energy through waves breaking over the reef (a function of reef depth) or friction (a function of reef architectural complexity). Reefs have undergone systemic flattening as corals have been lost to events such as bleaching, hurricanes, disease, and other pressures. Losing the top 1m of reef would mean a loss of coastal protection, which is currently valued at ~\$675M.
- It is not possible to regain 1m of reef height through coral growth alone in a meaningful time frame. However, merging engineering with coral restoration to create a cement-based substructure breakwater system covered with coral fragments may quickly provide the depth-induced wave-breaking and frictional wave energy dissipation that restores the protective functions of the top 1m of reef.
- UM has a fully programmable SUSTAIN tank system that is able to simulate any wave height and frequency. **This study tested a bare cement breakwater and one covered in panels of branching corals to compare the energetic dissipation of both structures.** With both structures the wave energy drops significantly as it reaches the structure, but with the **added coral cover energy is reduced nearly 100%**. In all tests under different wave conditions, the structures with added coral cover were more effective at dissipating wave energy.
  - Key finding: Frictional dissipation from the corals on top are important. They do tend to have a higher proportional effect in shallow water waves, but maybe other types of coral arrangements might have a different effect in steep amplitudes.
  - **Restoring the substructure height AND coral cover/rugosity are necessary to see major results (>25% reduction in wave energy)**
- Next steps are to determine whether this is practical in the field (permits, deployment processes, coral growth on structures) and whether different substructures might be better at mitigating waves than others. Currently seeking a permit to test a few structures in the field (~10 ft deep)-this is an ongoing feasibility study that is still in the planning stage but should be completed within one year.
  - [JM] will put in contact with Sarah Thanner who has helped on permitting projects.
- **Questions & Concerns:**
  - KB- Hans Raech in West Palm Beach tried to use hydrodynamics to change wave velocity in the 90s, but the structures accelerated erosion behind them and transported sediment out. You need to show that these won't cause that.
    - The plan is for small scale deployment, not at the scale that it would change anything at this point. We plan to have structures that prevent it from sinking into the sediment.
  - RB- did you manipulate the range of densities of corals on top of the structures?
    - We haven't tested yet, but we will arrange the corals differently to see if there is a threshold and test the effect of different species.
  - JM- I am concerned about people seeing these things and thinking about deploying these all over the place. Make clear that there is a purpose to doing this, it is not the same as dropping reef balls.
    - We have a communications PI who is trying to design a communications strategy to engage the community that might have an interest in this.

## 2. Local projects using intervention strategies – Andrew Baker (UM)

- This will build on the earlier talk about all possible intervention strategies by focusing specifically on **projects that are happening in Florida.**
- **1. Managed relocation**
  - On a local scale, can we move corals over a small distance as a way of minimizing risk while building reef tolerance? There is an example of this by Steve Palumbi in the American Samoa- can we apply this to Florida?
  - **We can exploit latitudinal variation in staghorn corals to build climate resilience in restoration programs.** In Florida, there is little temperature variation along the FRT except for an area in Key Biscayne where warm BNP water is separated from cooler Miami-Dade water- it's possible that this area could be exploited for its natural variation to test managed coral relocation.
  - UM has 30 genotypes of ACER that we are using to test for fixed genetic effects from heat exposure (not just acclimation- we want fixed gene effects to be transported to a new area). These ACER were exposed to 5-6 degree-heating-weeks to see if there were differences in thermal tolerance and genomes.
    - Results showed that the 30 genotypes do vary, with 'thermal tolerant' individuals surviving twice as long in the bleaching threshold than the low tolerance groups.
    - The genetic studies identified biomarker genes associated with thermal tolerance.
    - Also looked at the growth rates of these corals and found that **thermal tolerant genotypes grew ~25% slower**, so there is a tradeoff. In looking for spatial patterns that might correlate with these characteristics on the FRT, found that thermal tolerant corals were correlated with southern latitudes, which correlates with differences in temperature regimes- **corals from regions that are only 0.25° C warmer can survive the bleaching threshold twice as long, so even fine-scale differences do result in substantial differences in thermal tolerance.**
    - If you run climate projections with this information, find that moving corals short distances can extend the projected lifespan by 20 years. The question is, to what extent do we roll this out knowing the tradeoff in growth rates?
  - In conclusion, small differences can mean big changes, beyond just acclimatization. These could be used as restoration corals- doing a pilot study moving corals between nurseries in different locations.
- **2. Algal manipulations**
  - Have been testing the flexibility of corals to develop different symbionts through stress-hardening, where we bleach them and inoculate them with *Durisdinium* symbionts, and then expose them to the same thermal stress and see that their tolerance is increased by 1.5° C.
    - There are some species differences- OFAV needs to be severely bleached to take up the new symbiont, whereas SSID and MCAVs will do it quickly.
  - Can we artificially bleach in the field to scale this up?
    - Attempted to bleach corals in a nursery setting by holding them in subsurface rafts during the warmest time of year. Had moderate success and found that it is not feasible for thin-tissue species like acroporids.
    - Instead of using acute stress we are now using chronic stress by mounting nursery trees in stressful environments. After a year in areas where temperatures reach 32-33°, acroporids have finally switched to *Durisdinium*.
    - There is a lot of scope for using chronically-stressful environment for sexual and asexual propagation, especially recruit exposure.
  - What about large, older corals?
    - Have tried using **tissue implants to bring different symbiont inoculations to larger colonies.** Bleach one of two tissue cores and let it recover with target

- symbionts, then do reciprocal tissue swaps to see how that affects the larger colony.
- When you transplant a cold symbiont into a ‘hot’ colony, over time the core becomes a thermally tolerant ‘hot’ symbiont. If you do this with a hot symbiont core into a cold-symbiont colony, the opposite happens.
  - In August began trying this in the field on a small scale and will be repeating experiment in February. This cannot be scaled up for restoration due to the effort involved but will answer questions that we currently don’t know.
- Seeding larval recruits with thermotolerant symbionts
    - There is a strong effect of symbiont availability on the composition that larvae and coral recruits eventually acquire.
    - By raising coral recruits at different temperatures and in proximity to different target symbionts, we can control their future composition.
      - The simple addition of a D-containing coral to the proximal area doubles the amount of D taken up by recruits.
      - This effect is stronger than temperature- raising in high and low temperatures had no effect on the symbiont composition acquired.
    - Now testing in the field with SECORE to inoculate clade D into coral recruits by exposing them to adults with those symbionts, and will monitor the fate of those recruits/ symbionts over time.
  - *Some studies have shown that symbionts revert back to original conditions within 18-24 months, some say that when you make the change it is difficult for the coral to ever revert back again. How long the change lasts depends on the thermal conditions we put them in, and depends on the bleaching we see in the future and pulse-stresses they see.*
- Big lessons from Florida:
    - **We could be smarter about sourcing corals for restoration if we were able to accept slower growth rates**
    - Florida is positioned to try a lot of different intervention experiments, we are leading the world right now in restoration science. We cant wait to further progress- we need to adopt a fast-fail approach, try multiple strategies at once, and avoid pet theories.
  - **Questions & Concerns:**
    - EP: Where is your funding coming from?
      - These activities are small scale. The funding that would be needed to scale up is not available.
      - Australia has announced a \$500 million investment in resilience of the GBR, with \$200 million for interventions and restoration, and they want that doubled and tripled by private investment. On the National Academy of Sciences Committee we see that the US government has not really responses, but we are still in the early days. There is a lot of interest in foundations filling this need- for example the Vulcan Foundation supported initial gene flow experiments, there are funding streams out there that can support this.
    - JLOPEZ- For the assisted gene flow through translocation, Florida could be poster child for this. Florida panthers were endangered and inbred, bringing in a few genes has improved the population. For those that are wary of moving corals around, and the logistics of moving things across boundaries, we’re really not looking at genetic rescue but really the algae rescuing the coral.
      - Its hard to prove that exogenous symbionts get in regularly to the adults, which is why we want to make genetically labelled symbionts that fluoresce so we can see it’s the one we added. My feeling is that it happens, but it is overwhelmed by

residual proliferation already within the colony that overrides anything we are seeing from the environment.

## Session VI Cont.: Local Examples of Intervention Strategies

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### 1. Coral spawning efforts in Southeast Florida – *Joana Figueiredo and Brian Walker (NSU)*

- According to SECREMP preliminary data, SCTL has left us with very low coral density and the colonies that remain are smaller than they used to be. This means that less gametes are produced, and that coral colonies are further apart, which dramatically reduces success for fertilization in the field.
- **We sought to collect spawn from MCAVs**, because they are so important in the region, **and also from OFAVs** because the remaining colonies are so old and large that it's important to keep their genes in the system.
  - MCAV colonies were brought into the lab, OFAV spawn was to be collected in the field at 2 sites: Broward and Miami
- The project was not successful: in August neither species spawned, and in September bad weather prevented us from going out.
- However, OFAVs did spawn elsewhere:
  - In the Keys they spawned on night 6-7 in September
  - In the Bahamas there was some offshore in August, in most of the Caribbean they spawned mostly in September
  - This leads us to believe that **OFAVs are mainly a September spawning species** that may go partially in August.
- In the future, we plan to do histology to confirm that these large colonies are reproductive in the month that they will spawn, and will try to induce spawning OFAV fragments that have been brought back into the laboratory.
  - There has been work by Jaimie Craggs that has shown that manipulating temperature, irradiance, and controlling the sun- and moonrise/sets you can induce spawning in the lab at the same time that they would spawn on the reef. The Academy of California and FLAQ have successfully done this with *Dendro*, we will try also using the same technique.
  - We will be doing this in both indoor and outdoor systems.
  - The 21 colonies of MCAV that were collected for this spawning will stay in captivity in these spawning systems to hopefully induce them to spawn next year.
- The **MCAV** colonies that were collected for spawning this year had very **low fecundity**, and even those that spawned had very **low fertilization**, possibly due to low sperm density. The few larvae that were successfully fertilized did not survive to the swimming stage.
  - Recommendation- we should do histology before the spawning window to determine the fecundity and sex of colonies.
- On a side note, we did receive some larvae from Dana Williams that we settled on tiles that were conditioned in the Broward nursery, but we had very high mortality immediately after settlement. We believe that there was something harmful on the tiles that caused them to die.
- We are also **developing a mass-scale larval rearing and settlement system**, funded by Friends of our Florida Reefs.



- Will allow us to rear a very large quantity of larvae from numerous species at the same time. We will use unconditioned tiles sprinkled with CCA to induce settlement and then grow recruits in land-based and offshore nurseries.
- Future directions are to optimize the size and age that we are able to outplant coral recruits, and to try to maximize the cost-benefit for growout.
- **Questions & Concerns:**
  - VP- There is no remaining settlement substrata out that is receptive to larva. I think we need to create settlement areas that are managed.
    - Right. In Australia they are doing capture and release, but it is not viable here. The outplants need to be at a size where they are able to deal with macroalgae.
    - [DG] We see recruits of MCAVs and SSIDs, and some deeper areas that have recruits. Even in the GBR there is a decrease of 90% in recruitment.
    - BW- we have a lot of dead corals in the last few years that are probably settlement areas that could be coming in, we can look at them and see what's happening there.

## **Session VII: In-Water Coral Spawning Hubs Guided Discussion**

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- At the coral propagation workshop held earlier this year, one of the ideas that was discussed was **to consolidate the remaining coral colonies** that occur at too low a density for natural reproduction into “**spawning hubs**”, so they are close enough for their gametes to mix and for us to monitor. This is an idea that could be implemented next year.
- The goal is to 1) increase tissue biomass, 2) increase genetic diversity, and 3) avoid genetic inbreeding.
- Things that we need to discuss:
  - **Where would they be located? (Inshore, offshore, depth)?**
    - [BW] was funded to do some comprehensive surveys, could look for sites with high density
      - [DG]- we may not need to spend time and money on surveys, we can never move enough corals to do more damage.
    - [BW]- I would want to lean heavily on some of the SLIM model outputs in the southern part of the ECA that can seed the ECA, with the idea of having different sites and depth ranges
    - [BW]- We want to hedge our bets and nearshore has advantages and disadvantages to spawning sites. We may want to have something that is removed from nearshore stressors.
    - [KG]- We could recover some tissue from here sites outside of Port Everglades where we recently completed some transects. The hubs would need to be at least 3 km away so there is not sublethal to lethal sediment stress.
      - [JS]- during the Miami dredging a bunch of corals got moved and relocated, I assume they were concentrated.
      - [KG]- Miami-Dade County is monitoring the ones that got moved, I can get the numbers.
  - **Do we need a couple of them in the endemic zone? How big are the sites?**
  - **What species, and where are we sourcing these corals from?** (could rescue corals work in Phase 4? Would surviving corals on the reef be relocated into these hubs)?

- [JV]- To start, focus on what we know abundance and success isn't a problem. Do the ones that you expect the most success with first, learn from that, and then apply to others.
- [BW]- I think that incorporating species that used to be more populous that are still out on the reef and still having success.
  - [DG]- Maybe MCAVs for proof of concept. We should choose several species of those like MCAV that we know we can relocate as well as other ones that have been affected by the outbreak. MCAVs were significantly affected by the event, and they define out cover.
- [KG]- We have a lot of information on OFAVs
- [JF]- DSTO?
  - [DG]- Things like MMEA and PSTR have more coral to work with.
- **How close should the corals be to one another?**
- **How far in advance would we need to do this?**
  - [DG]- They can be moved and still create gametes. So before conditions are generally more stressful, before May
  - [EP]- We would have to take small sample before for histology and genetic relatedness
- **Who will do this, and will we be contracting other later on?**

#### Discussion:

- **Comments in support:**
  - [DG]- There is some hope that we can do something in the future to return us to year 2000 conditions, when a histology test found MCAVs SSIDs and DSTOs were fecund. This could serve a long-term benefit of having corals close together for when conditions do improve and they can spawn together, and also for the practical use of grabbing corals that are together and more dense. We could never move enough corals to risk making it worse than it already is. Maybe the possible gain outweighs any risk of losing more corals.
  - [MM]- We don't know much about their spawning habits, so it's also an opportunity to learn more about them *in situ* and in one place.
  - [AB]- There can be overlap between projects, can benefit from integrating a lot of activities of which this hub is just one component.
  - [AB]- Some places are looking for places for putting *Diadema* out, this would be a great place for that.
    - [VP]- we should also cultivate the right CCA.
  - [JV]- There is a recent paper that shows recent evidence of isolation across 5 locations in the FRT, so there is evidence that they have become too far apart to reproduce. There is also the potential for temporal variation in spawning times if you have the same species even a short distance away.
  - [AB]- I can think of three foundations that want to fund concentrated restoration effort at a particular site that they can point to as a flagship.
- **Comments of concern or recommendation:**
  - [EP]- Corals might be more unhappy from the move than they already are. It's a good idea to have corals close to each other to facilitate spawning, but I don't know.
  - [VP]- If we don't get the substrate right for recruitment than moving them around won't do enough on its own.
    - Larvae would both be reared in the lab and left for in situ recruitment. That might help with some of the substrate issue because they would be reared in controlled systems.

- [JLOPEZ]- is it beyond capacity to make settlement hubs?
      - [RB]- if monitoring and evaluation of settlement tiles was done at the right frequency, we could learn a lot about how this model is working.
  - [DB]- Are there any unintended consequences, like creating a reef that people want to fish on? Can this be protected?
    - There is no protection that we can implement at this time, but possibly in the future
  - [AB]- We should consider leaving some pieces on the reef you took it from so you still have corals out where they were and have insurance.
  - [JL]- This is so depressing. The action plan for responding to SCTLTD in Mexico focuses a lot on how and why we need to clean up the environment from local threats. In Cozumel, they closed off the entire park for 3 months.

## Session VIII: Water Quality

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1. **Revised turbidity criteria follow-up** – *Ken Weaver and Daryll Joyner (DEP DEAR)*
  - DEP DEAR reevaluates our WQ standards every few years to make recommendations, this is one piece of that review regarding turbidity criteria.
  - The conclusions drawn from an extensive literature review were not sufficient for a numeric recommendation, but we were able to conclude that **29 NTU is not protective of corals or hardbottom**. There were some conversations about a 7 NTU recommendation, but first we need to demonstrate that that number is completely protective of the biology and addresses natural spatial/ temporal variability.
  - This led to a **narrative that expresses that turbidity is not allowed to increase above background conditions**. This is an enforceable rule and includes an implementation document on how we interpret that background / natural variability.
  - **Turbidity implementation document:**
    - First addresses application in permits (dredging and beach nourishment) and Impaired Waters Rule
    - For permits, the document describes the **establishment of a pre-construction background condition**, and a **calculation of permit limits** based on the natural background turbidity range during normal tidal cycles.
    - This is applied to all waters along the FRT because we know that coral or hardbottom are currently or historically there. In other areas, these rules only apply if there is coral or hardbottom known to be present.
  - **Determining the background**
    - A “**pre-project baseline**” must be established **independently for each project** area. All the data collected must be collected following the QA plan and DEP SOP for collection of turbidity. The samples for this baseline must be taken in areas with minimal man-induced alterations and from areas above living coral or hardbottom community, if present.
    - Projects expected to last longer than three months may have season-specific turbidity limits.
    - **Background variability is established based on pre-project “baseline” data from a minimum of three tidal cycles** (catching the peak of each tidal state), with measurements taken from the **surface and from the bottom** taken a maximum of 4 hours apart. Because this is a small sample set, outliers are screened from the dataset (values greater than the mean plus 3SD).

- The permit-required turbidity limits are intended to maintain the background turbidity, magnitude, frequency, and duration, and are **expressed as the allowable increase between the project background and the compliance stations.**
- The **limits are calculated as an upper confidence interval of the mean difference between the min and max turbidity.**
- Assessment during construction
  - Permittees must sample turbidity at both representative background and compliance stations, which should be located in an area clearly outside of the influence of any construction activities.
  - The number of stations and sampling frequency are: a minimum of 3 samples / day collected 4 hours apart, minimum of one background station and one compliance station for each mixing zone. Samples must be taken from the surface and bottom and be independently compared to the corresponding depth-specific background turbidity value.
  - This turbidity value at the compliance station cannot exceed the background turbidity level plus the permit-required limit.

Ambient Assessment/ IWR implementation

- DEP will assess the turbidity criterion for all coral reef and hardbottom communities in the IWR, which includes the FRT and open coastal waters within Manatee, Sarasota, Charlotte, Lee, Collier, Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie, Indian River, and Brevard counties.

WBID	Area	Sample Size (N)	Mean (NTU)	90 <sup>th</sup> (NTU)
8091	Coral ECA	54	1.8	3.6
8100	Coral ECA	76	0.6	1.2
8101	Coral ECA	158	1.0	2.0
6001	Biscayne Bay	9470	1.3	2.9
8088	Biscayne Bay	339	1.3	1.8
8089	Biscayne Bay	316	1.7	2.7
8076	Florida Keys	464	1.7	2.1
8079	Florida Keys	723	1.6	2.2
8080	Florida Keys	281	1.6	2.4
8065	10,000 Islands	125	4.8	8.9
8066	10,000 Islands	253	5.9	8.2
8050	Gulf of Mexico	91	2.8	6.1
8051	Gulf of Mexico	364	2.7	5.8

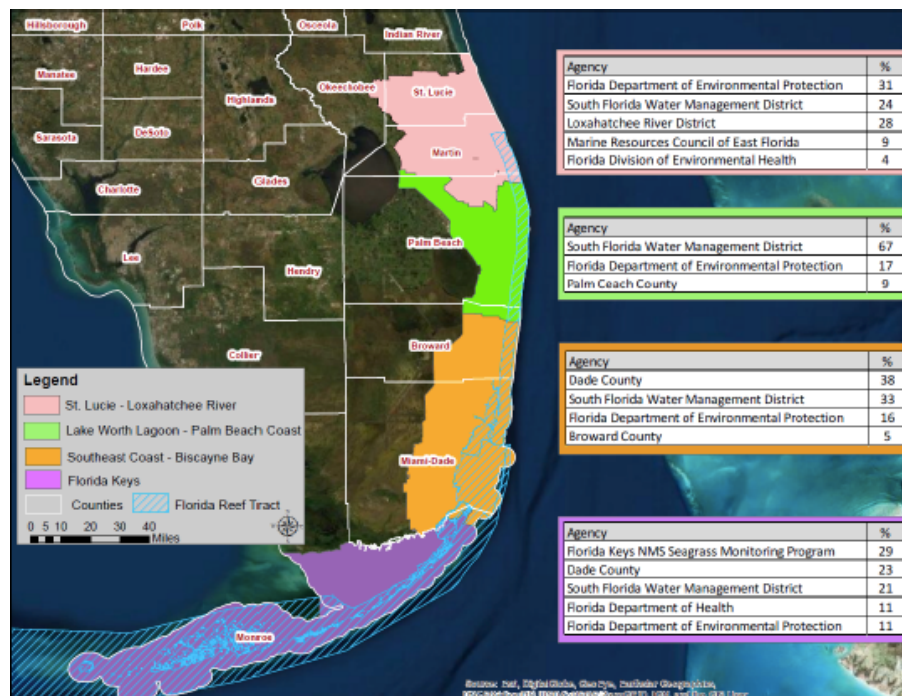
- Appendix A has the baseline turbidity levels for all WBIDs in these areas. Waterbodies that exceed these levels will be placed on the Planning (80% confidence level) and Verified Lists (90% confidence level) (see below section: **Impaired waters and data collection for the coral ECA – Kevin O’Donnell (DEP DEAR)**)
- **Questions & Concerns:**
  - JF- Those sample sizes are inadequate. If you want to describe the mean and the variance in a population you would need at least 20 data points. If you have a permitting project that will last a week, you should take a week of data. If it’s a 3-month project, you should have 3 months of data.
  - JF- The confidence intervals you chose assume a normal distribution, which is not probable. In the realm of experimental biology, there are outlier tests designed to point to data that may be problematic, but you don’t just exclude those data based on the tests.
    - JS- mounted instruments at the site that take data for a while might be a solution.
  - RB- During the operation, you’re allowed to be at the upper confidence limit. I’m not sure how well that protects corals that may not see that duration of elevated turbidity

- EP- Corals in the area may not necessarily be adapted to the background levels, increased sediment levels even a few NTUs above normal for any period of time could put them at greater risk of dying.
- KB- Has DEP considered measuring turbidity all the time so they know what the number is so dredging contractors know how to bid? If we have the large dataset that is protective and provides that known number and lowers the cost of that project, it might be cheaper for the taxpayer.
  - That's an alternative approach. I think in some areas we are limited in the amount of data, I would be worried about the spatial scale necessary. Alycia Shatters is the manager on this project.
  - KB- you are just pushing the samples onto the people doing the projects, and the DEP is paying for the projects, so the tax payer is already paying for this, I suggest you have a controlled effort upfront.
- JF- turbidity has 2 components- light attenuation and sedimentation. How much additional pushing would be needed to add a level of sedimentation or have some measure of that for just turbidity?
  - I don't know about sedimentation, logistically that's kind of an issue, in a long range for corals I would like to look at light attenuation.
- *Will send out an email requesting formal comments for Ken.*

## 2. Impaired waters and data collection for the coral ECA – Kevin O'Donnell (DEP DEAR)

- Overview of the **watershed management approach**:
  - Section 303(d) of the Federal Clean Water Act requires states to submit lists every two years of areas that do not meet water quality standards (referred to as “**Impaired Waters**”).
  - DEP implemented TMDL program as part of the watershed management approach in 2000, which divided **state's basins into five groups, then established a five-phase cycle that rotates through all basins over 5 years**. This year is the 4<sup>th</sup> cycle- we have completed Group 1 and are beginning Group 2.
  - Through our assessment we are trying to preserve these designated uses through monitoring these parameters: 1. Aquatic life (metals, turbidity, pesticides, biological assessment); 2. Primary contact and recreation (bacteria, beach advisories); 3. Fish and shellfish consumption (pathogenic bacteria, mercury, shellfish classification); 4. Drinking water (metals, pesticides, bacteria).
    - *For bacteria assessment we are collecting data that tries to incorporate chemical tracers and human markers tied to endocrine disrupting compounds. Our lab has identified numerous human markers and animal markers for dogs and 2 different birds. We are trying to incorporate this and will work with the country to get more of that information.*
  - The primary rules used are:
    - 1. Water Quality Standards (62-302, F.A.C)
    - 2. Impaired Waters Rule (62-303, F.A.C.)
    - 3. Total Maximum Daily Loads (62-304, F.A.C.)
    - 4. NNC Implementation Document
  - The assessment units are WBIDs (water body IDs). The boundaries are intended to be watershed or sub-watersheds that capture all discharges and are representative of WQ in the area. The boundaries are constantly assessed and revised to make sense because there are different criteria depending on the waterbody.

- All assessments are compiled on a Master List and then separated into their respective lists depending on their measured parameters:
  - Verified list- impaired, needs a TMDL
  - Delist list- removals from the verified list
  - Study list- impaired, but needs additional information or data
  - Study list removals- removals from the study list
- Assessment category descriptions:
  - Category 1- not impaired (attains all uses)
  - Category 2- meets standards, not impaired
  - Category 3- insufficient data
  - Category 4- does not meet standards, but a TMDL is not needed
  - Category 5- does not meet standards, impaired by a pollutant
- Primary data sources used for assessments:
  - WQ data → FLSTORET/WIN → IWR Database → WBID/ Parameter Assessment
  - Also: SBIO- FDEP biological database; FDOH- Fish and Beach advisories; DACS- SEAS Classification; USGS
- WQ databases:
  - STORET Public Access (SPA): <http://prodenv.dep.state.fl.us/DearSpa/public/welcome>
  - Watershed Integrated Network (WIN) <http://prodenv.dep.state.fl.us/DearWin/public/welcomegeneralpublic?calledBy=GENERALPUBLIC>
  - Information for mapping data to WIN requirements provided at: <http://publicfiles.dep.state.fl.us/DEAR/WIN/MDQS/>
  - Watershed assessment webpage: <http://floridadep.gov/dear/watershed-assessment-> (this is where the IWR database is located)
- To view an interactive map of water quality assessments, TMDLs, and BMAPs: <https://fdep.maps.arcgis.com/home/index.html>



- Some highlights of verified listings:
  - Lower Keys, Biscayne Bay, and Port of Miami are high in nutrients
  - Some middle Keys and intercoastal waterways are high in copper
- Florida TMDLs
  - The St. Lucie basin has had a Category 1 TMDL in place since 2008 working on reducing nutrient loading in the estuaries.
  - Have been working on a Restoration Plan for Loxahatchee, looking at bacteria, nitrogen/ phosphorous and chlorophyll parameters.
    - *Kevin will check with Julie on how current Loxahatchee watershed restoration projects such as replumbing are playing into this.*
  - There are not many current nutrient-related TMDLs- the only ones are the Pompano Canal and Broward, which have both done a great job of implementing nutrient improvement projects to reduce the flow that have resulted in improvement in chlorophyll and other conditions.
  - We are working on developing TMDLs for lakes later this year.
- A Reasonable assurance plan for the Florida Keys to address nutrient impairments has been in pace for 8 years at two sites. The Florida Bay is in Category 4, but rather than putting it on the Verified List we have been working with the Everglades program to identify projects that are ongoing or completed to address water quality progress. This is ongoing, and we will readdress when we have new data.
- Implementation of the new turbidity criterion
  - The turbidity criterion and how it is achieved is discussed in above section “**Revised turbidity criteria follow-up – Ken Weaver and Daryll Joyner (DEP DEAR)**”
  - This will be implemented through the Impaired Waters Database or IWR run, and data will be organized similar to the estuary nutrient region concept- stations used in the assessments will be assigned to appropriate WBIDs and nutrient regions.
- **Questions:**
  - BW- where does the human health aspect of this fall in terms of sewage outbreaks, E.coli, and that type of sampling and reporting?
    - That is done by the Dept. of Health.
  - JLOPEZ- Is there a connection between your department and integrating new sewage requirements for new housing and wastewater? Are sewage connections required or are we still using septic systems?
    - If there is a BMAP then they are trying to incorporate that. With new developments we are concerned with whether there is a waterbody that discharge is going to go into as identified by environmental resource permits. They are in charge of net improvement of nutrient loading.
  - MENDOZA, WILSON- How do we know that our surface water is impaired since there is no WQ criteria established?
    - There is not a numeric criterion, but the narrative is still applicable for the canal. It gets interpreted through the rule for the canal assessment. They are working on developing numeric criterion for the S. Florida nutrient region. They are going to be leading public meetings soon for that, I can follow up with you on dates.

- A task force was assembled by Tom Fraser looking for expertise on these blooms in the early 2000s. An advisory body was appointed by the governor after he took office. This force reports science-based recommendations to the FDEP with the goal of expediting improvements for Florida water bodies.
- This is mostly freshwater algae that cause extremely impactful blooms- the estuaries in Pt St Lucie and Caloosahatchee can carry a bloom in Okeechobee to the coast. The blooms correspond with very wet years, when the lake levels get too high and the algae is able to get into the estuaries, which are converted into freshwater bodies.
- So far, the force has had 5 meetings which began in May, which have covered:
  - Regulatory aspects-
    - learned that there is a BMAP controlling phosphorous in Okeechobee, but not a nitrogen one. Nitrogen is what is fueling these bacteria, so we really need a BMAP for nitrogen.
  - Technologies for response and prevention, monitoring, and forecasting.
    - Learned that septic tanks are only designed to treat 10-15% of nitrogen, so they are not considered an effective means of nitrogen-reduction. There are also sanitary overflows during extreme events, and inundation into the sewage system. In addition, much of the Florida infrastructure dates back to the 50s, so there is leakage all the time
  - Public Health
    - Microcystis produces algal toxins. There are EPA-regulated levels of exposure. There is a need for signage that cautions people in areas of freshwater laden with these toxins.
    - The DOH was present for recent meetings. The EPA has just set some new guidelines and the state EPA is looking at whether to adopt those or some other standards, if the public wants them to be stricter.
    - We know a bit about the acute levels and effects, and the liver toxins that lead to liver cancer, but very little about other human impacts (such as when it is aerosolized, and how it affects people with asthma).
  - The force has developed a general consensus document of covered topics, science-based decision making, and data needs.
- Some topics that still need to be discussed:
  - Wastewater/ technology to reuse water
    - The water is nutrient-laden and often has biosolids, which are not well regulated (some is put into landfills, some are re-used as fertilizer), and are also nutrient- and toxin-laden.
    - A public comment at one of the meetings was that by spreading biosolids as fertilizers, we are taking a point source problem and making it non-point source. Need decision making tools that allow up to weight short-term vs. long-term costs of these strategies
    - *[JS] points out that in 2025 waste-water systems are going to be converted to deep-water injection, and a good deal of reuse water is going to be made available that we don't currently know how to reuse*
  - Wetlands protection
    - *VP will follow up with the task force about expanding the environmental services program for the Florida ranch land, where ranchers are paid to hold water back on their ranches*
  - Herbicides
    - There is some evidence that glyphosate can be used as a nitrogen source, so its use (ingredient in roundup) may be fertilizing the blooms.



- The threat of warming temperature, which are known to fuel algal blooms even in pristine areas.
- **Questions & Concerns:**
  - [JLOPEZ]- Has a grant from the army corps to do cyanobacterial characterizations with metagenomics and genomic methods to understand the community underlying the blooms in an artificial mesocosm experiment, and are working with Florida water management and USGS to look at several sites in lake Okeechobee. Have some samples and are now partnering with CosmosID in Maryland and other partners like Gulf Coast University on other army corps project, looking to get some good data from that with good results by next year. I have a new post doc that hopefully will be able to show some data soon, looking at the upstream portion of what algae does in freshwater.
  - JLOPEZ- Do chemical ecologists see a silver lining in this as far as toxins? We want to explore what can be produced, how they colonize, and aspects of new algae and microcystis?
    - There is so much literature on what microcystis does in the environment, from allelopathic effects and feeding deterrents, but its not very clear cut. A lot is strain specific, grazer specific.
    - There are over 200 different microcysins and a lot of other compounds, we don't even know whole array yet, and it can change very quickly.
  - JW- How do we make sure the connection to the coastal ecosystems and to reefs is in the conversations? The department appointed me to the lake discharge schedule conversation as the "coral expert".
    - Josh (Voss) studied the Pt Lucie reef and saw a lot of death after big discharges- was that because it was freshwater or because there is another level resulting from the algae?
    - Freshwater or toxins or the combo, or the blocking of light, I'm sure it's all a problem.

## **Session X: Coral Disease Update**

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### **1. Coral disease efforts update- Maurizio Martinelli (Florida Sea Grant)**

- Update on the extent:
  - In April, the disease was 10 miles west of Key West and 18.5 miles away from the Dry Tortugas. As of November, the disease is 32 miles west of Key West. The current map is showing all reports that have been occurring on outer shore reefs, the inner shore has not yet been affected.
  - The disease has been progressing outside of Florida. The first report was in Jamaica in 2017, then in Norther Mexico in July of 2018, which prompted the question of whether the disease was moving with the currents or if there was another vector. Then St. Martin was affected, and there are no currents moving that way. Then the disease was reported in Dominican Republic in January 2019, Turk and Caicos in March 2019, then to northern Belize in August 2019.
- Update on ballast water:
  - A Marine Safety Information Bulletin was widely distributed that outlined best practices to reduce the chances of spreading pathogens and SCTLD, which include:
    - Diverting 200 nm offshore to conduct ballast water exchanges, or if not that distance, at least 50 nm offshore in waters of at least 200m deep.

- If discharging unmanaged ballast outside of US water, discharge beyond 50 nm of any shore and in 200m deep waters.
    - Minimize ballast uptake and do not conduct partial exchange within 50 nm
  - The bulletin can be found here: <https://www.dco.uscg.mil/Featured-Content/Mariners/Marine-Safety-Information-Bulletins-MSIB/>
  - *[JF] Suggests that because anything shipped to PR must come from a US shipping line, we might expect PR to lag behind ocean currents in contracting SCTL D. Also, because Cuba ports are very restricted, should also lag behind.*
    - *PR is lagging behind- we think there is a specific port in the southwest that has been flagged as most likely next potential spot for disease.*
    - *Cuba has been advised to look for the disease.*
- Update on the 2019 SCTL D Technical Workshop
  - August 6 (propagation workshop), 7-9 (full disease workshop), with 75 attendees from 29 organizations.
  - Highlights:
    - Got an update from the different response teams at this one-year mark into response structures, refined the vision for moving forward as we course correct and refocus spending.
    - Created and **introduced a full Propagation Team** for growing out corals and coordinating future restoration efforts
      - Our partners for the coral rescue outside of Florida have agreed to hold corals for three years, two remain. Need a plan for what to do with the corals at that time.
    - Had breakout session with small focus groups for restoration, research, and intervention.
    - Full discussion on large scale construction projects.
  - **Key Outcomes**
    - Amended the response structure to include a **steering committee** for technical decision making and **propagation team**, which will work closely with the rescue and restoration teams.
    - Want to coordinate a **large-scale restoration trial** with replicated outplanting in the endemic region
    - Want to establish ***in situ* spawning nurseries**
    - Want to **scale up propagation.**
  - **Research Priorities**
    - 1) A **fractionation experiment** to determine the potential size of the SCTL D pathogen, to both help us narrow our focus on pathogen identification and to understand its movement
    - 2) Study **pathogen persistence** to understand how and why it has stayed present for so long and what implications it will have for future restoration
    - 3) Collect **time-series samples** to analyze SCTL D progression, including histology and microbiology
    - 4) pursue more “-omics” studies (genomics, proteomics, transcriptomics, metabolomics)
  - **Intervention Priorities**
    - 1) **abandon the use of chlorinated epoxy**
    - 2) determine the effectiveness and **antibiotic treatments**, and possible the mechanism by which it is working
    - 3) Begin field trials for **probiotic research** (though there are still many regulatory hurdles for this)
  - **Regulatory priorities**

- 1) engage with Port Everglades Interagency Working Group to ensure that disease concerns are incorporated.
- 2) determine permitted mitigation opportunities- large-scale construction projects mean large-scale remediation efforts, so there are several ways to potentially leverage this for our benefit. We want to translate disease work into language and figures that will fit into regulator concerns.

## 2. Ballast water and coral disease – Nick Rosenau (EPA)

- We know that there is the possibility that ballast water is correlated with the spread of disease, but we do not currently have available data to say with certainty.
- We have created and circulated the Marine Safety Information Bulletin with voluntary best ballast water practices: <https://www.dco.uscg.mil/Featured-Content/Mariners/Marine-Safety-Information-Bulletins-MSIB/>
- The Key Research Question: **is there a relationship between the movement of the vessels themselves, or of the ballast water itself, and the spread of coral disease?**
- All data comes from the coast guard managed database of ballast water- The National Ballast Information Clearinghouse (NBIC), which interprets data from commercial ships operating in US waters. There are limitations in the disease being reported outside of US waters. Data is from 2013-2019.
- Uptake and discharge summary:
  - USVI and Florida are the only 2 areas where both disease is present AND Florida-sourced BW was discharged.
  - We are unable to evaluate discharges in Jamaica, Mexico, DR because the data is not in NBIC.
- **Ballast water discharge by vessel type:**
  - 2% of total discharge by passenger vessels
  - 11% of total discharge is by Container/Cargo/Other vessels.
  - 87% of total discharge is by Tankers, and the majority of these travel to the Gulf of Mexico
  - In general, Tankers and Cargo/Container vessels uptake ballast closer to shore than passenger vessels.
- **Key ballast water movements from 2013-2019:**
  - 742,693 m<sup>3</sup> of Florida-sources ballast water was discharged back to Florida waters
  - 21,218 m<sup>3</sup> was discharged to PR
  - 58,613 m<sup>3</sup> was discharged to USVI.
- **Ballast water exchange by vessel type:**
  - Tankers = 84% by volume. Tankers exchange ballast close to the FRT, in many instances <12 nm.
  - Container/Cargo = 16% by volume. These vessels tend to exchange outside COTP (Captain of the Port) zone.
  - Passenger vessels = <1%
  - In 2014, there is no clear evidence of and association between ballast water exchange and SCTLD
  - In 2015-2019, there are a number of discharges very close (<12 nm) to coral. The three main offenders were Tankers.
- **Ballast water discharge in St. Thomas, USVI**
  - 37,617 m<sup>3</sup> of SE Florida-sourced ballast water was discharged in St Thomas between 2013-2019

- 99% of this water originated in Port Everglades
- Only 4 different Cargo/Container vessels accounted for this discharge
- **Ballast water discharge in St. Croix, USVI**
  - 20,996 m<sup>3</sup> SE Florida-sourced ballast water discharged here
  - 99% of this originated in Port Everglades
  - Only 3 different vessels accounted for this discharge
    - One tanker was responsible for 97%. Cargo containers were only responsible for 3%.
- **Ballast water discharge in Puerto Rico**
  - 21,218 m<sup>3</sup> was discharged in PR
  - 90% originated in the Port of Miami
  - 9 vessels accounted for this discharge
  - One tanker accounted for 84%, Cargo for 10%, and passenger vessels for 6%.
- **Ballast water/ vessel movement from SCTL D-affected areas**
  - All Mexico-sourced BW was discharged to US ports in Jacksonville, Louisiana, and Texas.
  - On cargo vessel travelled from Jamaica to St. Thomas in 2017 to discharge ballast water, and an exchange was made along the way.
- **Florida disease spread and ballast water uptake and discharge summary**
  - Data from CREMP, FRRP, Irma Cruise, FWC-RVC, and Mote were used to determine “diseased” vs. “not diseased” source water
  - Example of 2016 data analysis:
    - BW sourced from non-disease areas
      - 972 discharge reports, 379 unique events, 152,805 MT of water discharged (85%)
    - BW sourced from disease areas
      - 177 discharge reports, 55 unique events, 27,530 MT discharged (15%)
  - Summary:
    - 721,700 m<sup>3</sup> of FRT-sourced BW was discharged near corals in US waters of the Caribbean between 2014-2019
    - 177,00 m<sup>3</sup> (25%) of this BW was sourced in the vicinity of diseased corals along the FRT AND was discharged in the vicinity of non-diseased corals in US waters
      - In 3 instances the disease showed up within 3 months of discharge
      - In 9 instances the disease did not show up within 3 months of discharge
      - In 5 instances, the disease became present after discharge of non-diseased source water. *It is possible this is false non-disease water [JF][EP].*
    - 76,007 m<sup>3</sup> of the diseased BW was discharged in areas where the disease was already present.
- **No correlation has been established between ballast water and the spread of SCTL D**
  - *[JF] suggests looking at an independence test in the center of the matrix because the rate of disease prevalence is a magnitude higher than [inaudible].*
    - *Could do a Fisher Exact test on 2x2 table. [JF] runs t-test and gets significant p-value, suggesting a relationship between vessels and SCTL D.*
    - *Important to determine whether they are all independent or whether it is one vessel responsible (NR points out that one vessel accounts for most).*

- Next steps in data analysis
  - Explore movement of all vessels (not just BW) across the Caribbean
  - Examine the movement of non-Florida sourced BQ to USVI and PR
  - Search for other Caribbean-wide BW data
- Next step by EPA and partners
  - NOAA is exploring additional funding opportunities
  - EPA and USCG to hold a coordination call with SCTLTD researchers (FDEP/ NOAA/ USCG/ UofVI/SERC) on 11/15 to discuss further collaborations
    - Want to conduct research to expose healthy coral in lab to field-collected BW

### 3. No Discharge Zones – Kelsey Watts-Fitzgerald (EPA)

- Sewage can harm the environment by introducing pathogens, nutrients, and other pollutants. It can impair WQ by increasing nutrient levels, decreasing clarity and oxygen levels, and altering pH. It can spread disease by introducing viruses and bacteria and contaminating aquatic life used for human consumption.
  - Examples- 19% of Puget Sound shellfish beds are closed due to fecal contamination
  - There is a connection between coral disease and sewage contamination on reefs (Sutherland et al 2010).
- Under the Clean Water Act, Congress told the EPA to protect coastal waters from inadequately treated sewage waters.
  - Vessels with toilets must have USCG-certified marine sanitation devices (MSD)
- Different players have different roles in this regulation:
  - EPA- sets performance standards for the MSDs
  - USCG- certifies and enforces the MSDs
  - States- preempted for setting MSD limits, and have the ability to establish no-discharge zones for particular water bodies

MSD	Function	Vessel Length	Effluent Standard
Type I	Treat and discharge	≤ 65 feet	- No visible floating solids - Fecal coliform ≤ 1000/100mL
Type II	Treat and discharge	Any	- Total suspended solids ≤ 150 mg/L - Fecal coliform ≤ 200/100mL
Type III	Holding Tank	Any	“Designed to prevent the overboard discharge...” 33 CFR 159.53(c)

- **No discharge zones-**
  - All discharge is prohibited, even if it is treated. It must be retained on board until the vessel is further than 3 nm from shore, or can be pumped to a holding tank facility.
  - Three types of NDZs:
    - 1. CWA 312 (f)(3): State-designated, where the state determines that the water body requires greater environmental protection and the EPA finds that adequate pump-out facilities are reasonably available. This is the most common (90 designations)
    - 2. CWA 312 (f)(4)(a): Federally designated, the state applies to the EPA who then decides that an NDZ should be established (3 designations)
    - 3. CWA 312 (f)(4)(b): Federally designated, the state applies to the EPA who then prohibits the discharge of sewage within a drinking water intake zone (1 designation)

- Requirements for applying for an (f)(3) NDZ
  - A certification that the waters require greater protection than standing federal standards, a map and description of the location of pump-outs, a schedule of pump-outs and the draught requirements for each facility, information indicating that the treatment of waste from facilities conforms with federal law, and information on the vessel population and usage of the waterbody
- Requirements for an (f)(4)(a) NDZ
  - Information on the water where prohibition is desired, recreational areas, drinking water intakes, sanctuaries, fish-spawning and nursery areas, and areas of intensive boating
- Current EPA activities
  - Updating the EPA guidance for (f)(3) NDZs- the current document does not differentiate between recreational and commercial vessels. Will be finalized this summer.
  - Creating a GIS map of designated NDZs. Publishing a guide for recreational boaters on vessel sewage requirements
  - Evaluate pending NDZ applications in VA, MD, and NY.

4. **Coral disease modelling results** – *Lew Gramer (NOAA AOML) and Thomas Dobbelaere (UC Louvain)*

- This model is intended to inform coral disease management by modelling SCTLTD disease dispersal with SLIM and LPT through August 2016-Feb 2017.
- A biophysical model can help answer questions about the spread of SCTLTD. This is a high-resolution (100 m resolution) SLIM model coupled with an epidemiology model for disease transmission
- The model can be used to test whether disease agents are transported within materials transported by bottom, mean, or surface currents, and how fast corals get infected once in contact with the causative agent.
- For each simulated month, this model will:
  - 1) **Simulate diseased material exchanges** between reefs for **bottom, mean, and surface currents**
    - Bottom currents take 60% of mean currents, and are 15 degrees to the left
    - Surface currents add 1.5% wind speed and are 45 degrees to the right
  - 2) feed the obtained connectivity to an epidemiological model and **try to reproduce the spread of disease.**
- The SLIM currents serve as inputs for a particle tracker:
  - When particles pass over a reef, they lose material onto that reef. The exchanges of material between reefs are recorded in a connectivity matrix. This resulting matrix represents a reef network and is then used to spatialize an epidemiological model.
- 3 states of the epidemiological model:
  - 1) Susceptible, 2) Exposed (infected but not yet infectious), and Infectious
  - There is also a value for the time after which a susceptible species becomes exposed, and for the time after which an exposed individual becomes infectious.
  - Infectious individuals can infect susceptible individuals from other reefs through the connections of the connectivity matrix.
  - *[JF] Points out that you need to also include mortality of infected, not doing so will make the model spread disease too fast. [TD] will discuss this with Erinn Muller.*
- Results of disease spread:

- The mean currents spread the disease too fast (showed a spread through the entire FRT in 3 months), the **bottom currents showed a slower and more realistic spread.**
  - *[JF] suggests that including infected colony mortality might slow progression, instead of needing to run different currents altogether.*
- Once we have the right mode of transport, we can look at other disease parameters.
- Results available online: [http://maps.elie.ucl.ac.be/coral-disease/disease/display\\_sei.html](http://maps.elie.ucl.ac.be/coral-disease/disease/display_sei.html)
- Next steps are using data from FRRP, FWC, and DAC members to further validate the model.
  - In the future, could extend the simulated period to the whole outbreak (right now it does not go beyond Feb 2017)
    - 1 simulated month = 2 days of set up and 2 days of computation on 100 CPUs + 4 days of reanalysis, support is needed.
    - *[BW] suggests that it would be important to include the period of Irma (August 2017), which affected bottom currents and likely disease spread.*
      - *Thomas has produced some initial runs with an air-sea model, with particular focus on that period of Irma's passage, that includes a sediment transport component. This would be good to consider.*
  - Or backtrack the disease progression.
- **Questions & Suggestions:**
  - BW- If the model is pointing towards bottom currents because it gets the timing right but the other piece (such as speed of observations) that is causing the timing isn't correct, it may be that the hydrodynamic model is not correct.
    - It is possible, but I don't think that adding an r component to the epidemiological model is likely to prevent it from spreading across the FRT in 2 months. The mode of transport is worth looking closely at, regardless of the epidemiological model. But we will take more refined recorded observations.

## 5. Education and Outreach disease talking points – Michelle Grauly (DEP CRCP)

- The SCTL D communications team creates communication products to coordinate the messaging between the teams and the response. These are some of the talking points from 2018, which are being continually updated.
- “Since 2014, the FRT has had a historic outbreak of SCTL D. It only affects stony corals. Our response is coordinated by 4 lead agencies: FDEP, PS, NOAA, and FWC. SCTL D has spread to the greater Caribbean. We have a response team in the Caribbean and are making sure that lessons learned are shared. We are not solving problems for them but are giving them all the tools to allow them to make decisions accordingly. This outbreak is unprecedented, and 90% of reefs have been affected as it has spread over the last 5 years. 22 of 45 species of stony coral are affected, with 5 of those species on the ESL. Not all reef-building corals are susceptible- ACER and APAL are not impacted. There is high prevalence in affected areas, with some species seeing disease in 66%-100% of colonies. There are very high rates of transmission and mortality- once a coral starts losing tissue, it can die in a number of weeks to months. Because a coral is not a single animal, but a colony, part of the colony can survive. The response to this outbreak has been unprecedented, with scientists working to document, identify pathogens and factors, and to come up with treatments and interventions. As global threats are increasing, natural resource agencies are challenged to use resources and prioritize. The public can report disease through the SEAFAN-FDEP public reporting tool. This is different from the tags in the Keys, which are for monitoring. We are using this data

- to identify key areas for research and interventions, and to monitor healthy reefs. This is urgent, but it is not too late. We have been pushing for ocean optimism. Research cruises have been getting attention. Media tracker on the disease, so we are hearing everything that is coming out. (If you would like access to the media tracker, reach out). Restoration of resilient species is the key to the future. We need bold restoration with efforts to mitigate stress on the ecosystem.”
- Specific language:
    - “lesion specific interventions to prevent mortality on the most important corals”
    - “fire break, chlorinated epoxy/modelling clay/ shea butter”
      - *[BW] suggests taking out everything that we are not currently using, such as shea butter and modelling clay*
    - “recuing corals ahead of the disease front”
    - “collecting tissue and land-based holding”
    - “goal to maintain as much genetic diversity as possible and prevent ecological extinction”
  - Values
    - Global
      - The future of reefs is tied to the future of people
      - Reefs are biologically diverse, culturally significant, and economically valuable.
      - 500 million people depend on reefs, with 30 million entirely dependent
      - Climate change, ocean acidification,
      - Local fishing and LBSP
      - Reefs protect against weathering and flooding, and dissipate 97% of wave energy.
    - Reef tract
      - S.Florida economy is significantly linked to reefs
      - Support 71,000 jobs
      - We have the largest recreational fishery in the country and second largest seafood
      - Tourism is valued at 1.1 billion annually
      - In Florida reefs provide \$350 million in flood protection and \$320 million in economic activity.
  - This will be emailed out.
  - **Questions:**
    - Would it be useful to have in-person learning experiences in the Caribbean? We should flout coordination and things.

## **Session XI: Restoration**

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### 1. **USCRTF Restoration resolution** – *Kristi Kerrigan (DEP CRCP)*

- In response to global shifts in reef states and local reef extinctions around the world, there is a need for immediate action and response. We have formally **established a national working group** focused on restoration that will be proactive rather than reactive.
- Main goals:
  - 1) develop strategy to **improve resistance using stress hardened coral**
  - 2) get corals in land-based and in-water nurseries ready for **reintroduction onto the reef.**



- The group is made up of task force members from each jurisdiction. In addition to the group, each jurisdiction will start their own working group and will tailor that to meet their own needs. Some things are cutting across all jurisdictions, like the need for infrastructure in in-water and land-based facilities housing corals.
- This group will continue to support these jurisdictions by providing financial support and through new partnerships with the tourism industry and other private entities. This group is collaborative, and is not intended to replace existing groups.
- The restoration trials team (part of the larger disease response effort) is trying to do small-scale trials to see what happens to corals being outplanted post-disease. This group was formed last September to build the current state of knowledge, identify priorities, and continue to identify funding opportunities for the future.
- Current state of knowledge
  - A document is important for detailing where nurseries are located from all restoration practitioners, as well as the survivability of their outplants.
  - This information is important for assembling an action plan, which is designed to answer three main questions:
    - 1) Are acroporids vectors for disease?
      - *Work by Mote suggests that there is no evidence so far that that is the case.*
    - 2) Will outplant sites of disease-susceptible species serve as a source of disease flare ups?
    - 3) can susceptible species be outplanted to different disease zones for scaling up restoration efforts?
  - This is a living document that will adapt as it progresses. When it was started it was focused on the Middle Keys, not on the endemic zone.
- Where are we today?
  - Continuing to update the action plan as new information becomes available, and continuing to update the Current State of Knowledge to determine how previous outplanting can give us a better understanding for future efforts.
  - Working with data management teams to better visualize information
  - Will be holding a one-day workshop for a proposal for a large scale replicated outplanting project in the Keys and in the endemic zone, will sent information to funding partners
  - The key is to start scaling up outplanting and propagation, and to do this we need infrastructure. We want to focus on wild resilient corals that have survived the disease, rescue corals from ahead of the outbreak, corals of opportunity, and other conditioned corals in the lab.
- **Questions & Concerns:**
  - JFIG- There is a workshop next month, **Dec. 14<sup>th</sup>**, to put together and design a proposal to emulate the work that is being done in the Keys in these other regions.
  - EP- are [rescue] corals being treated with antibiotics before being put in the nursery?
    - [SS]- Rescue corals are quarantined for 30 days before being shipped. Then they go through another 30-45-day quarantine at their destination. If they deem it necessary, they are treated with antibiotics. Within the coral rescue there has been no evidence of SCTLD0 they have developed some types of tissue regression but nothing that follows the pattern in the field.
  - JF- I'm not confident that we can find a place on the reef where we can put them and say that they will survive 5-10 years.
    - RB- We do need to fix the big problems, but this is an opportunity to learn a lot about the corals as species and about the ecosystem in which they are

being placed. We should be thoughtful about how we would use this opportunity and experimental design.

- JW- we know that restoration is not the future if we don't fix these bigger issues. We consider in-water work to be triage, just buying time while we clean up these bigger things
- SS- A lot of this is focused on regaining the pre-disease population, not necessarily on restoring the ecosystem after 50 years of decline.
- KG- We should compile all these ideas and cross-pollinate with the hubs and the 7 iconic sites, and really focus our efforts on some areas that we can accept that are away from point sources.

## 2. **7 Icons Project- Joana Walczak (RCP SE Region)**

- The sanctuary has been working on a restoration planning project called the “7 Icons” Project, that will find 7 reef locations to consider “icons” to be restored to the best of our capabilities using ALL existing knowledge about ecosystem conservation. (An official announcement is coming from the sanctuary, so details pending).
- To do this, we will focus on the ecosystem services that we need to maintain. The new USGS report for the value of shoreline protection is vital for focusing on protection. The disease has given us a platform to showcase the economic benefits that are at stake.
- An ECA plan will be developed at some point in the future.
- **Questions and Suggestions:**
  - [JFIG]- Has submitted a final report for NOAA CRCP grants where we developed a model for the whole FRT, with a 500m grid resolution, that tells us how good a location is as a source for larvae. This may help choose sites.
  - [JFOUTH]- We should be going after local adaptation on micro-geographic scales.
  - [JFOUTH]- We should be including some ecological geneticists
    - There is an inclination toward hybrid vigor, but you can really get outcrossing depression.
    - For preserving genetic diversity that is dying in the wild, you want to establish 20-30 populations in isolation and inbreed them to fix rare genes, where in actuality there is the inclination to do a lot of outcrossing. But that actually loses some colonies or variation.
      - FWC has a good geneticist, but if you have recommendations for people we love to have new voices.
  - BW- I recommend trying to find a way for the agency to bridge the gap between the regulatory and conservation sides to allow for the mitigation of large projects in the region to fund these types of activities.
    - My leadership has just reorganized the program. There are three main divisions: we are resource management, the regulatory arm is separate, and we are trying to coordinate. They are bringing the permitting people into resource management so that we are in the same family as of tomorrow.

## 3. **100 Yards of Hope project – Force Blue**

- The Super Bowl is in Miami this year, and partners like Force Blue, Frost Museum, and UM, and others, have gotten the NFL to sponsor the outplanting of 100 yards of ACER fragments. 10 m chunks of the area are sold to donors to support the program.
- The goal of this project is to raise awareness of Florida's issues and potential. Right now, the project is still in planning mode and is soliciting donors.

## Public Comment

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- **John Fauth- Sunscreen Update**
  - Legislation:
    - USVI, Mexico, Hawaii, Bonaire, Palau, Aruba, Key West have all written some sort of restricting legislations
    - Marshall Islands, Puerto Rico, and Florida have proposed bans
    - CVS, Whole Foods, Walgreens, and REI have stopped carrying oxybenzone-containing brands (even non-sunscreen products)
    - *[JF]- The EU has different requirements and different regulatory processes. There is a lot of attention on this in the EU because the Mediterranean Sea is the hottest tourist spot in the world, so there is a lot of concern. But not sure that it has been outright banned.*
    - Right now, there is no effort to remove it from other products such as plastics and other cosmetics.
  - The FDA is still reviewing sunscreen ingredients, but do not yet have enough data to determine if they are safe or effective. They may have recommendations soon but will likely extend the window.
  - Science news:
    - The National Toxicology Program showed that oxybenzone had carcinogenic activity when introduced through the diet of rats
    - Sunscreen that used titanium instead released nutrients and heavy metals into seawater.
    - Current recommendations from NOAA are to stay out of the sun using protective clothing and gear.
      - Physical protection is better than sunscreen- rates of skin cancer have actually gone up since sunscreen was invented.
  - Suggests that Zinc Oxide is the best sunscreen for now.

## Closing Remarks and Meeting Adjourn – DEP CRCP

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- We have started making a **quarterly disease bulletin** based on the Florida disease response. If you would like to receive this, contact Michelle Graulty.
- JW- The **Florida Keys is undergoing a review of its management strategy**, we need everyone to pay attention and comment.
  - BW- I got a request from the National Foundation of Supporting Scientists that they are going to support the proposed actions. So, we could have that conversation moving forward.
  - JW- If you want to learn more about the process, the commenting process is on the websites. It is really important to hear from the coral folks about what is being proposed. There is a lot of pushback from stakeholders on WQ, so we need to hear the balanced perspective.
  - Will send along information

*Congrats to Judy Lang, who wins the Halloween Costume Contest as a Tropical Diving Enthusiast.*