Technical Advisory Committee to the Southeast Florida Coral Reef Initiative (SEFCRI) Meeting
April 10-11, 2019
Nova Southeastern University

List of Attendees:

TAC Members: Erick Ault, Robert Brumbaugh, Dick Dodge, John Fauth, Piero Gardinali, Dave Gilliam, Lew Gramer, Kurtis Gregg, Dale Griffin, Judy Lang, Arthur Mariano, Valerie Paul, Esther Peters, Manoj Shivlani, Jack Stamates, Brian Walker, Dana Wusinich-Mendez.

Guest Speakers: Nijole Wllendorf, Kevin O'Donnell, Daryll Joyner, David Whitall, Maurizio Martinelli, Blake Ushijima, Thomas Dobbelaere, Emmanuel Hanert, Jay Grove, Jennifer Stein, Eban Bean.

DEP Staff: Alycia Shatters, Nicole D'Antonio, Francisco Pagan, Joana Walczak, Emilie Stump, Kristie Kerrigan.

Public: Kurt Reynertson (Johnson + Johnson), Henry Briceno (FIU), Nicole Sharp (Broward County), Sara Thanner (Miami Dade), Eugene Shinn (USF), Maurice Pierre (Miami Dade DERM), Kirk Kilfoyle (Broward County), Pamela Sweeney (Miami Dade DERM), Rob Menzies (Acad Mar Sci), Doug Seba (Acad Mar Sci), Kathy Fitzpatrick (Martin County), Katie Bowes (Martin County), Kirk Dotson (FOFR), Jenna Soullion (MDL), Lystona Kabay (CSA Ocean Sciences), Jamie Monty (Coastal Systems).

Session 1: Achieving More Now for Florida's Environment – *Joanna Walczak (FDEP CRCP)*

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1. **Southeast Florida Coral Reef Ecosystem Conservation Area (ECA)**
    a. A legal boundary has been created around the area from the northern boundary of Biscayne National Park to the Port St. Lucie Inlet. As of yet, there are no legal protections of this area, it is only a boundary description. Please use this name (or "Florida ECA", "Coral ECA", etc.) when referring to the southeast region of the Florida Reef Tract (replacing the use of the term "SEFCRI" region).
    b. FDEP is working on gaining authority of this region- when the boundary was created, it was not assigned a management number, so it is not yet under any management section. The DEP will be working with the counties on future legislation that will provide language as to what should happen with the ECA. There will be some information on this project at the June meeting.
    c. While there is not currently any additional management authority given to the ECA region, the new conservation-centric name and large body of existing research on the ecosystem will make future management efforts prompt and effective.
2. **Gov. Ron DeSantis: Bold Vision for the environment**
    a. The newly elected Gov. DeSantis is focused on protecting Florida's environmental resources, with a special emphasis on water quality.
        i. JW is pushing for appropriate marine nutrient thresholds. There are good systems in place for estuaries and freshwater, but there is a gap in the marine realm, and this gap may be hurting corals. Part of this meeting's

discussion will be on how to prepare the necessary data to inform that change.

ii. Want to focus on the ECA- management should be effective for the entire FRT, but especially in the northern portion where the impact of high population densities and coastal development are highest (esp. in regard to turbidity, sedimentation, and water quality). This governor supports a new document that provides background and recommendations for the ECA that can be presented to leadership.

b. In his 2019-2020 budget, DeSantis recommends $6 million for protecting coastal areas (creating resilient coastline, protecting the population from sea level rise) and $3 million for coral disease work, doubling the current coral disease budget.

c. DeSantis appointed **Florida's first chief science officer: Thomas Frazer** (Director of the University of Florida's School of Natural Resources and Environment and former Director of the UF Water Institute).

d. Information about the 2019-2020 budget recommendations by Gov. DeSantis can be found here: http://www.boldvisionforabrighterfuture.com/content/current/Environment.htm

3. Coral Reef Task Force

a. Composed of high-level leadership personnel from 12 government agencies that oversee coral reefs, just concluded meetings and working groups for national policy issues

b. Main focus of meetings was on **FEMA**:

i. Corals need to be identified as national infrastructure to be eligible for FEMA funding before and after storms. A FEMA rep was present at meetings and is willing to help work with FEMA on how to get funds.

ii. **TNC and USGS is working on a modelling effort to identify the dollar value of coastal protection of Florida's reefs** (flooding reduction, protection of people and infrastructure, etc.)

1. Once available, this number can be used in equations used for management including cost-benefit analysis, and can be included in all work and presentations.
2. The number will be location-specific- rather than one big number pasted on the entire FRT, can quantify regions and potentially specific reefs.

c. Updates on the **National Academy** Study

i. Coming up with a report that will summarize what will help us help coral evolve in the short term as threats worsen

ii. This information will eventually become a regulatory model that ranks actions

1. Ex: green= doable, yellow= interesting and feasible but needs work, red= cutting edge but too many hurdles make it unfeasible at present

d. Update on **insurance initiatives**:

i. Mexican Reef Insurance works with private hotels and resorts to establish a trust of money and purchase insurance. When wind speeds reach high

levels, triggers a sum of money to be immediately dispensed for coral restoration work. Still in its infancy, but it is a promising model.

ii. Want to know if Florida would be interested in doing a feasibility study here to see how it applies.

e. X-Prize for Coral Restoration

i. Coral Restoration has been chosen as this year's X-Prize theme. $10 million in funding will be awarded to an innovative coral restoration idea that will aim to protect 5 hectares and 3 species of coral in 2 years. Would like the idea to be implemented in Florida/ Atlantic Caribbean. X-Prize is also looking for advisors to help guide the project effort.

ii. More information on X-Prize can be found here: https://community.xprize.org/saving-coral-reefs/discussion/14/launching-the-saving-coral-reefs-community

f. Update on **Coral Disease**:

i. Stony Coral Tissue Loss Disease (SCTLD) is now present beyond Florida, and has now been reported in USVI, Jamaica, Mexico, St. Marten, and others. There have also been reports of bad coral disease events that are not SCTLD.

ii. Maurizio Martinelli is the leader of the disease response effort across all partners (DEP, NOAA, FWC, NPS). The coral fellowship position will be realigned to support Maurizio in this new role and will be stationed in Key West.

iii. A priority is uncovering how SCTLD has spread- because it has moved contrary to any circulation patterns, need to investigate possible vectors.

1. Ballast water? If so, that would make it a national issue and that SCTLD cannot be contained to the Atlantic Caribbean. Would need the EPA and Coast Guard to take action.

iv. Doug Smith has been pivotal in mobilizing counties on all coral reef work and playing a role in getting legislation about emergency mechanisms for coral reef issues.

g. Restoration Priorities

i. The US Coral Reef Task Force and All Islands Committee have decided that restoration is an urgent need, and that action is needed now at the national level to build infrastructure.

ii. Need to focus on maintaining shoreline protection and fisheries habitat and tourism- what do we need to do to engineer a reef to provide the services that humans value?

iii. The disease event has made the future of restoration unclear- we don't know yet what the effect of outplanting would be on survival and disease prevelance. There is an outplanting trials team that will work on this with the disease response team.

iv. Martin and Broward counties should be the most prepared to restore because they have been longest without disease.

v. Marco Rubio has given $1 million for restoration projects specific to the disease event.

1. Frost Museum would like to put in a joint proposal for this. Discuss with JW if interested in providing input.

Session II: Management Decisions Process Overview

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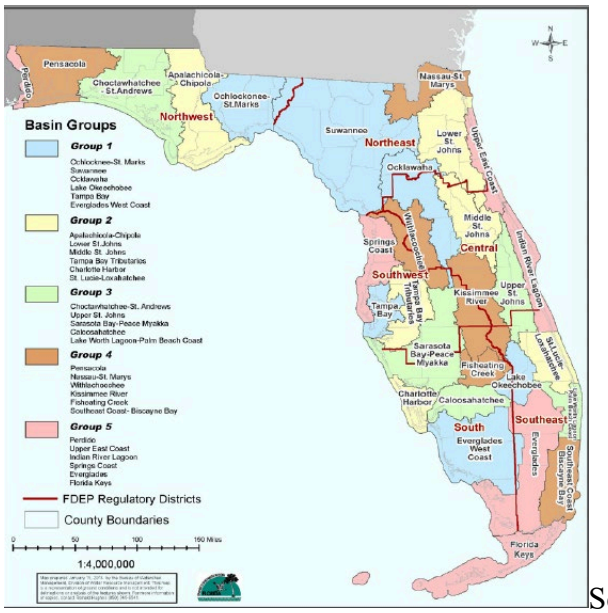
1. **QA Methods- Overview of DEP Quality Assurance Requirements-** *Nia Wellendorf (FDEP DEAR)*
    a. DEP's ability to use data is dependent on how well the quality assurance (QA) process works to make sure that all data is scientifically valid and legally defensible. To ensure that data is usable, the DEP wants to implement a system that sets data quality requirements for environmental data and specifies the criteria by which the data will be evaluated (used or rejected) by the dept.
    b. Authority and Obligations
        i. Chapter 403.0623, Florida Statutes
            1. Directs DEP to establish quality assurance requirements and the criteria for data rejection
        ii. Chapter 62-160, Florida Administrative Code
            1. Requirements for field and lab data
            2. **QA rule** (more below)
        iii. DEP Directive 972
            1. Establishes internal agency policy and responsibility distribution for QA throughout DEP
        iv. Quality Management Plan (QMP)
            1. Explains DEP's QA processes to EPA, requirement for EPA-funded programs
    c. QA Rule
        a. **Applies to all entities** involved with sampling, field testing, lab analysis, data review and presentation and vending services for sampling supplies or instrument calibration.
            i. Sample collection, handling, transport, preservation, field measurements, and site evaluation
            ii. Laboratory activities (sample receipt, analysis, data review, and data validation)
            iii. Additional data review, summaries or data presentation activities
            iv. Other activities that impact data quality, like providing sample containers, instrument calibration services, or reagents and standards
        b. Most sampling and field testing is routine and **must follow the DEP SOPs** (key requirements):
            i. Collect and evaluate blanks
            ii. Adhere to preservation and holding time rules
            iii. Field testing must include verifications that bracket sample readings chronologically and quantitatively

iv. **Any deviations from SOP requirements must be approved** as an alternative method, and field methods that are not covered by DEP SOP must be documented and provided to the DEP

c. Most lab methods are routine and are approved by DEP and may be specified in DEP rules, contracts, orders or permits. Alternative field and lab procedures and methods must be pre-approved by DEP
d. Research field and lab procedures must be pre-approved via work plans, sampling and analysis plans, or contracts that provide required information.
e. There are minimum **documentation and reporting requirements** for both field and lab records
f. Most lab analyses must be performed by **certified labs** in the DOH Environmental Laboratory Certification Program.
g. Most sample preservation and holding time procedures are standard and are required as listed in the DEP SOPs (FS 1000 tables)
h. **DEP can audit** samplers, field records and lab records at any time (can include on-site audits)
i. Specific data qualifier codes must be used for reported data associated with quality control failures
j. Field and laboratory work conducted under legal agreement (contract, grant, PO) with DEP must adhere to QA rule, and QA for all sampling and analysis must be described:
    1. Work plan
    2. QA plan
    3. Contract scope
    4. Project proposal
    5. Other related documents

ii. QA Website Resource: https://floridadep.gov/dear/quality-assurance

2. **Impaired Waters Assessments- Watershed Assessment Overview**- *Kevin O'Donnell (FDEP DEAR)*
    a. Overview of the **watershed management approach**:

i. 

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**").

ii. 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**

iii. **Watershed management cycle**:

1. Phase I: preliminary assessment
    a. Produce planning list
2. Phase II: targeted monitoring and listing
    a. Monitor, verify impairment, and adopt verified list by secretarial order
    b. (Basin Group 1 is currently in this phase)
3. Phase III: develop and adopt TMDLs
4. Phase IV: Implement TMDL
    a. Develop basin management action plan or
    b. Alternative restoration plan
5. Phase V: Implementation

b. How are **water assessments** done?

i. **Designated uses** addressed by assessment

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

ii. Assessment Units: **WBIDs** (waterbody ID)

1. WBID boundaries change based on local stakeholders with knowledge of their local watersheds, delineation of freshwater and

saltwater and control structures, or delineation of nutrient criteria boundaries

iii. Depending on the assessment status and category, **waters are placed on different lists**:
   1. Verified list- impaired, needs a TMDL
   2. Delist list- removals from the verified list
   3. Study list- impaired, but needs additional information or data
   4. Study list removals- removals from the study list

iv. Assessment Category Descriptions:
   1. Category 1- not impaired (attains all uses)
   2. Category 2- meets standards, not impaired
   3. Category 3- insufficient data
   4. Category 4- does not meet standards, but a TMDL is not needed
   5. Category 5- does not meet standards, impaired by a pollutant

v. Primary **data sources** used for assessments:
   1. Water quality data → FLSTORET/WIN → IWR Database → WBID/ Parameter Assessment
   2. Also: SBIO- FDEP biological database; FDOH- Fish and Beach advisories; DACS- SEAS Classification; USGS

c. Water Quality **databases**:
   i. STORET Public Access (SPA): http://prodenv.dep.state.fl.us/DearSpa/public/welcome
   ii. Watershed Integrated Network (WIN): http://prodenv.dep.state.fl.us/DearWin/public/welcomegeneralpublic?calledBy=GENERALPUBLIC
   iii. information for mapping data to WIN requirements provided at: http://publicfiles.dep.state.fl.us/DEAR/WIN/MDQS/
   iv. Watershed assessment webpage: http://floridadep.gov/dear/watershed-assessment- (this is where the IWR database is located)
   v. WIN Coordinators for questions:

District	Coordinator	Phone	E-mail
WIN Administrator	Julie Zimmerman	850-245-8508	Julie.Zimmerman@dep.state.fl.us
Central, South, Southwest & Statewide Orgs (that do not use the DMT)	Tommy Adams	850-245-8467	Thomas.l.adams@dep.state.fl.us
Northeast, Northwest, & Southeast	Justin Nelson	850-245-8510	Justin.m.nelson@dep.state.fl.us
Statewide Orgs (that use DMT)	Lina Sengupta	850-245-8049	Lina.Sengupta@dep.state.fl.us
WQX and SPA Coordinator	Lisa Schwenning	850-245-8509	Lisa.Schwenning@dep.state.fl.us

3. **Data Needs for Setting Water Quality** Criteria - *Daryll Joyner (FDEP DEAR)*
   a. Methods used to establish water quality criteria (WQC): Aquatic Life
      i. EPA publishes national recommended criteria that the DEP usually relies on for toxics (adopted into Rule 62-302.530, F.A.C, and express as a single-sample max).

ii. Mostly derived using **laboratory toxicity data** from carefully designed studies with control, controlled doses, and established endpoints.
iii. Need data from at least **8 families**, and then calculate criteria based on the **4 most sensitive genera**. Also need data to protect Endangered Species.
iv. Need **species-appropriate test durations**, including full life cycle and early-life stages.
v. **Endpoints** include long-term mortality, growth, and reproduction
    1. Test endpoints include EC20s ('effective concentration 20', concentration that results in a 20% effect relative to control, current preferred endpoint), N0ECs ('no observed effect concentration'), and L0EC ('lowest observed effect concentration')
vi. Procedures for deriving aquatic life criteria are described in Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses
    1. https://www.epa.gov/sites/production/files/2016-02/documents/guidelines-water-quality-criteria.pdf

b. Turbidity criterion as example/case study:

i. DEP conducted comprehensive search for studies addressing effects of turbidity on coral species, and found a lot of information indicating negative impacts to corals due to increased sedimentation, total suspended solids (TSS), and turbidity.
ii. However, the literature was inadequate for establishing a criterion:
    1. Many of the studies were for total suspended solids or sedimentation, which are difficult to measure in situ
    2. Very few of the studies were for Florida species
    3. Few of the studies had a control, constant dose, and consistent endpoint
    4. In many cases, it was not clear whether the most sensitive species or most sensitive life stage had been selected
    5. None accounted for natural turbidity fluctuations
iii. The DEP was thus unable to establish a specific turbidity criterion, but the literature did demonstrate that the current regulation (29 NTU above background) is not protective.
iv. The current plan is to pursue a narrative approach that applies to all waters, with language that would not allow turbidity to increase above background conditions within areas with corals or hard bottom
    1. "nor shall turbidity levels be increased to levels that negatively affect designated uses or result in increased sedimentation or reduced light transmission to the point that the normal growth, function, reproduction, or recruitment of aquatic life is impaired"
v. The long-term goal is to work with Florida researchers to conduct needed toxicity studies that will establish the **magnitude, duration, and frequency values necessary to inform a new criterion.** These studies will:
    1. Be dose-response studies modelled after similar studies conducted in Australia and NSU

2. address effects on adults, larvae, and larval recruitment, including both brooding and broadcast spawning species
3. consider federally listed endangered or threatened species

c. Sunscreen as a case study:

i. The EPA does not have recommended criteria for oxybenzone or octinoxate, and the DEP has concluded that there is currently insufficient literature to develop criteria.
   1. Though the EPA's ECOTOX database states that corals are sensitive to oxybenzone, existing studies have been conducted for shorter than standard duration of 96 hours and many are on non-Caribbean corals
   2. Negative impacts on reproduction have been found on other taxa, but not enough families of corals have been tested
   3. There is no toxicity data available for corals and octinoxate

ii. To develop a criterion in the future, it would be helpful to have ambient/Florida data to determine potential for these parameters to exceed potentially toxic levels

Session III: Water Quality Updates – *SEFCRI Water Quality: Update on Current Dataset and Data Utility- David Whitall (NOAA)*

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1. Sampling for the SEFCRI Water Quality Project began in Sept 2016 at sites in Government Cut and St. Lucie, and has now expanded to include all nine ICAs as of 2017. The project collects over 2000 samples per year and generates over 15,000 data points.
2. **Influence of inlets and outfalls**
   a. High TSS values around inlets clearly show freshwater inputs as well as the relationship between inlets and sediments.
   b. High silica values around inlets show freshwater inputs from coastal erosion
   c. Turbidity is highest near inlets, lowest near outfalls, and has medium values around reefs
   d. NH4+ is highest near outfalls, is lower near inlets and reefs
3. **Differences between ICAs**, (can either be attributed to land use or physical oceanographic features)
   a. **Turbidity** is highest in Jupiter and Lake Worth
   b. **Silica** is highest in Jupiter and Hillsboro
   c. **Orthophosphate** is highest at Jupiter and Port Everglades
   d. **NO3** is close between almost all regions, but is highest in Port Everglades and Bakers, followed by Boca and Lake Worth, lowest in Boynton and Jupiter.
4. Can use this data to evaluate the **water quality status at individual sites as it relates to previously proposed water quality thresholds**
   a. Multiple researchers have proposed threshold values for nutrients on coral reefs (Lapointe 1997; Kinjo 2011; GBRMP 2014); these observations will be compared to the values proposed in Lapointe 1997 because they are specific to S Florida
   b. **DIN threshold**: 1 uM

        i. The mean values of DIN at every site exceed the published threshold values above which we might expect to harm corals
    c. **SRP (soluble reactive phosphorus) threshold**: 0.1 uM
        i. For most of the reef sites in the study area, phosphorus levels do not exceed published threshold values above which harm to corals would be expected. The exception to this is near Miami and near Port St Lucie where the reef sites do exceed the threshold
    d. There are large swings (order of magnitude difference in concentration) evident at different reef sites, but do not yet understand what is driving those patterns.
5. Other potential uses for this data:
    a. Comparison with relevant disease data to look for correlations
    b. Comparison with relevant biological data to look for correlations
    c. Development of SEFCRI specific water quality thresholds
    d. Other analytes (like sunscreen related compounds or sucralose) could be added to the sampling effort, but both the analytical costs and logistical effort involved need to be carefully evaluated
6. Data will be available in May 2019, planning on publishing early 2020.

Session IV: Discuss Current LBSP Reduction and Water Quality Projects

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1. **Water Quality Assessment - *(FDEP CRCP)***
    a. *The objectives for this discussion were to revisit water quality assessment strategies from the viewpoint of the governo'rs new guidance. Right now, we are focused on nitrogen (N) and phosphorous (P) as the main analytes…*
        i. Can we enhance the information used for land-based pollution initiatives on how these affect corals to try to join under same regulatory umbrella?
        ii. Are N & P the best analytes to be using? Are there any other criteria we should be looking at?
        iii. Should we modify our assessments, and how?
    b. Should we be considering other things besides N & P?
        i. Proposal to add **microbiological criteria** that is more actionable, easier for the public to understand, links to human health risk [DGRIF]
            1. Targeting a **genetic marker for antibiotic resistance** [DGRIF]
                a. Will demonstrate that there is an urgent contaminant in the water that poses a human health risk. There is no standard for this type of analysis yet, but it may be valuable to move in that direction regardless, even if it takes a few years to establish a process. If it is something that more effectively engages the public, than it is worth exploring.
            2. **Enterococci** [KG]
                a. A tracer study demonstrated that outflow from the Hollywood outfall was entrained and brought in to Port Everglades with the high tide, something like this might resonate well with the public

b. There is a standard for enterococci [DGRIF]. There is a large plume offshore, might be worth looking into on a trial run.

3. Reasons for exploring microbiome data instead (or in addition to) N & P:
    a. Linking WQ (N/P) with *in situ* data at any scale will not produce actionable information if the public cannot engage. Need to focus on identifying 'smoking gun' and using lab experiments to get answers [DGRIF]

ii. Proposal to add **chlorophyll a** [VP, JW, Water Quality Team]
1. Right now, the criteria for chlorophyll a levels is low. This would require science to find something more protective (what kind of nutrient level would cause an imbalance) to inform a revised criterion.

c. How can we relate this to coral health?

i. Problems with assessing coral cover [VP]
1. We will not be able to see risks to corals with water samples alone, would need to couple with all benthic surveys, which is a difficult task [VP]. A gradient analysis to identify point source pollution is not feasible because reefs change drastically from one area to another [JL], and coral cover is so low that comparing percentages between areas will not work (ex: comparing 1.6% cover to 1.8% cover) [VP]. There is also a scaling issue: it is not possible to link WQ information to specific sites- possibly local and regional scales, but to the site level [DGIL].
2. There is possibly not enough benthos left at any scale to produce actionable data, may need to focus on identifying 'smoking gun' with lab experimentation to produce actionable information that will cause policy change [DGRIF].

ii. **Indicators for reef health** [BW]
1. PR efforts [BW]
    a. There are ongoing efforts to link reef health to point sources by developing different metrics that will be used to assign ecosystems a damage score, but the process is still being developed. Would like to apply it to Florida, but it's a slow process.
2. **Paraphytes** [JL]
    a. Jack Stamates and Tom Carsey did a study that involved collecting nutrient, coral, and macroalgae data to find correlations, includes 12 cruises worth of data [JL]. This data might be able to tell us what a healthy community on the FRT looks like, and how it is related to water quality. The report has not yet been released and not sure whether the raw data is available, LG will follow up [LG]
    b. If there is a correlation between nutrient loading at any scale and macroalgal cover, and we know that macroalgae

is damaging to corals, that is sufficient for the index of 'Impaired Waters' (read above section "Impaired Waters Assessments- Watershed Assessment Overview" [KO]). We don't necessarily need the habitat to be alive or dead, we just need this attribute to use as an indicator to control N levels [RB]

c. Considerations:
    i. Algal populations are highly variable with seasons, would need to use data from the same time every year [VP]
    ii. This threshold would be based on biology, not on toxicity to corals. We might like to see if there is anything that will let us know what is killing corals, the most susceptible species in the whole ecosystem [FP]

iii. Overlay with **disease prevalence** map [BW]
    1. BW has looked at the FRP data in terms of disease prevalence and spatial context, has found patterns of disease hotspots (all coral diseases, not just SCTLD) that are consistent through time [BW] (even pre-, post-, and during the SCTLD outbreak).
    2. This indicates that there is something in those regions that is stressing corals beyond normal. The cause is unknown, but the pattern is evident.

2. **Watershed Demonstration Projects** - *(FDEP CRCP)*
    a. There are several green infrastructure projects beginning in support of the Watershed Management Plan created with NOAA last year. The DEP is working with UF to create a green infrastructure best practices manual- there are some demonstration projects beginning in Boynton Beach as examples of this manual:
        i. **Rain Gardens**: shallow retention basins planted with deep-rooted native Florida plants that will receive stormwater runoff
        ii. **Bioswells**: same concept as rain gardens, but as a channel that the stormwater can run through, lined with vegetation to slow nitrogen leaving the swell.
    b. Would like to test WQ analytes to measure the efficacy of these projects after they are implemented. Should contact entities already working with green infrastructure to determine what before/ after analytes would best showcase the impacts of these projects.
    c. (For more information, read below section "Green Infrastructure/Low-Impact Development Best Management Practices Manual" [EB])

Session V: Sunscreen

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1. **Science Behind the Sunscreen Conversation –** *John Fauth (UCF)*
    a. **Legislative and regulatory response**/ testing
        i. Current bans: Mexico has sunscreen limits; Hawaii, Bonaire, Palau, Aruba, and Key West have banned oxybenzone.
        ii. Some retailers taking action: REI and Whole Foods will both stop carrying oxybenzone products
        iii. Recently US Food and Drug Association passed a new regulation to make sure sunscreen components are 'safe and effective', the two mineral components- zinc and titanium oxide- have met this requirement
    b. **Research** into the safety and ecotoxicology of oxybenzone: over 40 peer-reviewed publications rejected the null hypothesis that oxybenzone is safe.
        i. Toxic to green algae and cyanobacterium (Mao et al. 2007)
        ii. As toxic as heavy metals to marine invertebrates (Paredes et al., 2014)
            1. Study did not include other sources of UV filters like water outfalls and its distribution through wastewater treatment plants, so the UV filter concentration in actuality may be orders of magnitude higher
        iii. Endocrine disruptor in Siamese fighting fish (Chen et al., 2015)
        iv. Transferred from mother to fetus dolphin (Alonso et al., 2015)
            1. This study recorded the highest concentration of UV filters in living biota
        v. Implicated in Hirschprungs disease (birth defects from prenatal exposure) (Huo et al., 2000)
        vi. Sunscreen in US schools
            1. The USFDA considers sunscreen to be an over-the-counter drug, and many schools require authorization from a physician before a student can apply sunscreen, possibly because it is a contact allergen.
        vii. There is very few studies on octinoxate compared to oxybenzone [DW]
    c. **How oxybenzone harms corals:**
        i. Very low concentrations kill *Acropora*
        ii. Causes bleaching, promotes viral infections in zooxanthellae (Downs et al., 2016; Danovaro et al., 2008)
        iii. Genotoxicant (causes breaks in DNA)
        iv. Phototoxicant (effects are exacerbated by light)
        v. Skeletal endocrine disruptor (caused planula to be entirely encased in its own skeleton)
        vi. Synergistic effects: bleaching was faster in systems that were subjected to different stressors (Danovaro et al. 2008)
        vii. Hazard assessment by NOAA using EPA method in Hawaii found that the **concentration in the water is high enough to cause acute or chronic damage to the corals**. The concentrations in Miami Beach, Bahia Honda and Key West are comparable to the highest concentrations in the Hawaii study. There is also data from Hong Kong with concentrations high enough to damage coral planula.

1. The data in the Florida study of water concentrations was not intended as part of a publication, but it exists [VP, JF]. The data of field concentrations is critical to know, a new study is needed [VP]

d. Oxybenzone is so important because corals are suffering from many stressors at many scales, and oxybenzone seems to be synergistic with these stressors. Removing oxybenzone from the system may break the synergisms with light, heat, and other variables, making the benefits of its regulation potentially greater than expected.

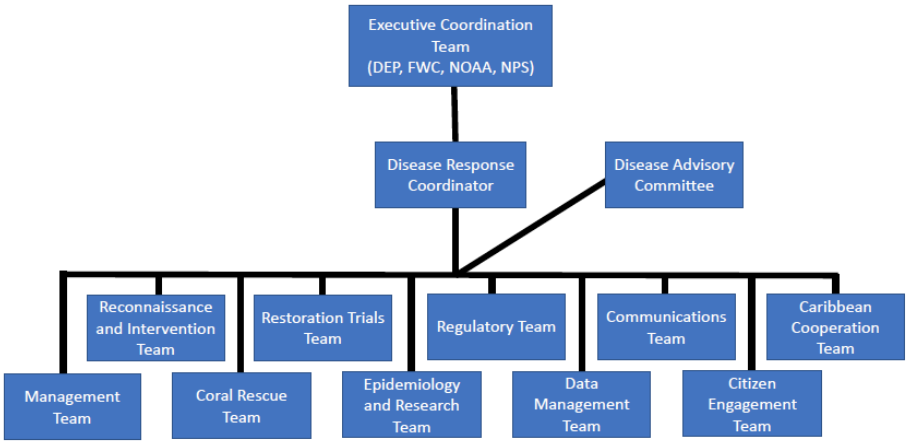
e. Question: [JW] are there products besides chemical sunscreens that use these compounds?

i. Oxybenzone was initially developed for use in paint and primers, today it is still used in cosmetics and plastics.

2. **Open Forum: Unifying the Message** – *(FDEP CRCP).* What information should be shared with SEFCRI?
    a. JF's **presentation of sunscreens**, and all of the publications cited therein [VP]
        i. This presentation should be compiled into a **one-page summary document** with all citations and take-home messages to be used as a resource [RB, KB]. This document should **emphasize the synergistic effects** apparent in some of the research- the question isn't necessarily "does it cause bleaching or not", it is something that we can remove from the mix of all these stressors [RB].
        ii. Breaking synergisms: the concentrations will be higher in the summer months with more swimmers, also when the temperatures are warmer for the corals and when there is increased runoff from land. The sunscreen ingredients may be the low hanging fruit that can be dealt with easily. Corals might be able to handle more than we think, but they are overwhelmed with so much at once [JF]
        iii. There are also other extensive **presentations made for Hawaii legislations**, one from Woodley and one from Downs, there is also letters written in support of legislation that would have additional references [JF]
    b. **Immediate actions** needed:
        i. Research project to get the **detectable levels in the water** [VP]
            1. Should sample areas where people are regularly present (sites with coral close to shore) [JL],
            2. Places with the highest levels of tourism and recreation all line up with the disease prevalence clusters [BW]. Sampling for oxybenzone within and outside of these locations might make a compelling statement [BW].
        ii. Get action on the state level to **ban it in all of Florida** [GS]
            1. DEP is separate from state legislature. However, there was a bill introduced recently to take the Key West ordinance state-wide, but there was a reinforcement issue [JW]
        iii. Should **start measuring oxybenzone levels in addition to N and P** [DGRIF]

Session VI: Coral Disease Update *(Spring 2019)*

1. **Coral Disease Update** – *Maurizio Martinelli (Florida Sea Grant)*
    - **Overview of SCTLD**
        i. Infectious, waterborne disease that is impacting over 20 species of stony coral. Outbreak has been ongoing since 2014 (high levels in Miami Dade county, today is active past Key West around Sand Key, moving against prevailing currents suggesting another vector) with prevalence rates of 66-100%, and mortality rates of >80%. Data from SECREMP suggests that SCTLD may have been active as early as 2013 (read more below, [DGIL]). SCTLD has now been reported in other areas in the Caribbean (first Jamaica, then Mexico, then St. Marten and DR and USVI).
    - **Response Structure**:



        i. Management Team: extra people from DEP, FWC, NOAA, NPS
        ii. Recon and Intervention: detail location of latest edge
        iii. Coral Rescue Team: collect colonies ahead of the margin
        iv. Restoration Trials Team: determining how we can approach restoration, especially of susceptible species, in a way that we are not reintroducing disease
        v. Epidemiology and Research Team: disease investigations, coordinating research so as not to duplicate efforts
        vi. Regulatory Team: streamlining the process, permitting things correctly
        vii. Data management Team: helping to organize and visualize the information coming out of effort
        viii. Communications Team: producing and disseminating info to the public and media
        ix. Citizen Engagement Team: dive and snorkel operators
        x. Caribbean Cooperation Team: sharing info from other jurisdictions, using collective capacity
    - **Key research findings to date**:
        i. Transmission experiments demonstrate that this is **infectious** both between and among species through sterile seawater [VP]
        ii. Therapeutic diagnoses suggest **bacterial pathogens are involved**
            1. [DGRIF]- The pathogens must be spreading through vectors, because bacteria cannot swim against current (however, there are also eddies and countercurrents, so it is not definitively moving against the current yet [VP]-

see below section "Ocean Modelling Aimed at Coral Disease", LG). This also fits the vector-borne patterns of mosquito diseases.
    a. [MM]- looking into biofilm and ballast water, also biological vectors
2. [GS]- suggests looking into African Dust also, points out the *Diadema* epidemic also moved upcurrent
3. [DGIL]- in addition to pathogens and sources, need to also consider the history of regional stressors, such as the several years of warm water and extreme cold before that leading up to the outbreak, anything that put the reef in this susceptible condition. Need to consider larger temporal scales to figure out how to keep this from happening again in the future.
    a. [JW]- we do make clear that efforts are a Bandaid and that we really need to address the larger issue of restoring resilience to the reef
    b. [DW]- notice that disease is also high in relatively unimpacted reefs, so it can't be only correlated with a stressed system (however, even relatively unimpacted areas still have ship traffic [JW]

iii. Histology suggests that **lesions begin in the gastrodermis**, progresses toward tissue surface. How is the pathogen getting into the coral- ingestion? Skeleton?
1. Has implications for management- 'apparently healthy' may not be truly healthy if disease is beginning in deeper tissue levels. Also, if the disease begins internally, a lot of infected tissue may be released and act as a passive vector [FP].
2. Also found that there is some impact to zooxanthellae- is the pathogen affecting the symbiont or the corals? On an inshore and outshore monitoring site, the inshore bleached heavily and the disease was stopped, the outshore did not bleach and the disease continued.

iv. There is a **signature temporal progression across species**. SCTLD also does not spread in a linear line across the reef, it affects offshore before inshore

v. **Ongoing research** in comparative microbiology (comparing microbiome at different sites and different stages of disease, and water and sediment samples), colony monitoring (how it progresses faster on corals in different regions. It seems that disease is progressing faster on corals in the keys than in SEFRT), and treatment plots.

- **Intervention**
    i. Teams are going into the field to apply treatments, either chlorinated epoxy or antibiotics via 'Base2'to individual corals (read section below: Coordinated Intervention Efforts in ECA Region [BW]. Next steps are to develop colony-level treatments and scale intervention to the site or reef level.
- **Coral rescue**
    i. Efforts are underway to rescue colonies of priority species ahead of the disease front to be kept in on-land facilities for future restoration efforts. Recently 33 colonies safely arrived at the National Mississippi River Aquarium in Iowa, and some of the corals in captivity have spawned.
- **Restoration trials**
    i. once we have propagated our rescued corals, where can we outplant them? How to not reintroduce disease?
- **Needs**:
    i. On the ground capacity: Researchers and lab technicians, Intervention practitioners, Restoration specialists and infrastructure
    ii. Address larger scale environmental issues (Waste water and storm water, Nutrient pollution, Coastal acidification)

iii. Support for colleagues in the Caribbean

2. **Pathogen identification and probiotic development for stony coral tissue loss** – *Blake Ushijima (SI)*
    - SCTLD is transmissible through physical contact and sea water, and the spread of disease is arrested when treated with amoxacillan, suggesting that bacteria are important for SCTLD progression. It is still possible that bacteria are not starting the disease, it might be environmental factors that are allowing bacteria to infect and spread.
    - **Objective #1: to identify potential pathogens responsible for SCTLD**
        i. **Results**:
            1. Efforts to culture a potential pathogen have **not been definitive so far**- screened 4000 isolates and none repeatedly caused disease in healthy corals, they could be causing a secondary infection (there may still be a missing primary pathogen that has not been cultured)
            2. **Metagenomics sequencing is being pursued** as a culture-independent approach to identify potential pathogens to focus future culturing and or diagnostic efforts
                a. Illumina sequencing does not provide high enough resolution to genus and species level
                b. Metagenomic sequencing uncovers all the DNA (prokaryotic, eukaryotic, viral) with no initial amplification PCR, which can be a source of bias
                c. Will use transmission fragments in FSW to reduce background microbiota (which is a common feature of samples collected from the field) or repeated transmissions to 'enrich' for pathogenic microbes
            3. The **toxic protein produced by the known pathogen *Vibrio coralliiticus*** was detected at higher levels on MCAV with acute tissue loss, suggesting a secondary infection.
                a. There seems to be differences in disease progression among individuals- the small sample size from Ft Lauderdale is progressing slower than corals from the keys. The corals that have the fastest progressing disease have this *Vibrio* toxin at levels that are considered toxic for fish.
                b. This is not necessarily the primary cause, but variability such as this in the secondary infections may explain why the lesions can be variable between individuals and species.
        ii. **Ongoing and follow-up**:
            1. **Metagenomics sequencing** of disease transmission fragments
            2. Filtration-based experiments to **determine if potential viruses play a role** in the infection process (may not be causing disease but contributing to host susceptibility)
            3. Development and **testing of different bacterial growth mediums** to continue pathogen culturing efforts

- **Objective #2: to develop effective coral probiotics to treat rescued diseased corals and/or prevent SCTLD transmission among captive corals**
    i. **Results**:
        1. Created a characterized **library of inhibitory isolates** (potential probiotics) from seemingly more disease-resistant coral genotypes from a variety of species (MCAV, OFAV, MEAN, CNAT, DSTO)
        2. Probiotic strain McH1-7 appears to **stop or significantly slow disease** progression on diseased MCAVs
            a. Doing more testing for this particular probiotic, it needs to slow/stop progression in all tested fragments. Not sure yet if it is species specific and needs to be developed separately per species or if it is universal.
        3. Initial experiments show promise; **contact with probiotic-treated corals may slow SCTLD progression** (though these are only preliminary results, only 4 replicates and on MCAV that already has slow/variable progression).
        4. In the process of **creating multi-strain treatments** for a potentially greater effect then single probiotics. This might reduce the event of pathogens evolving resistance to the probiotics and might tackle any potential secondary infection.
    ii. Ongoing and follow-up:
        1. **Continued testing** and optimization of probiotics
        2. Characterization of potential **probiotics library**
        3. Development of **multi-probiotic treatments**
        4. Continued **screening of corals seemingly more resistant** to SCTLD
            a. [DG]- have you considered redoing transmission experiments with corals that have survived the outbreak? There might be something interesting to learn from survivors.
                i. [BU]- yes, but these are the most precious on the reef we wouldn't want to take survivors out of the system
                ii. [DG] but there might be value in taking them to study and breed them- if they have strains that are resistant to a pathogen that may potentially become endemic, that should be preserved. This is why putting potentially susceptible corals back on the reef is problematic, it might relight the fire.
                iii. [FP]- would be collecting their spawn be enough?
                iv. [DG]- I think a small percentage should be collected and studied and bred. Or small frags off of larger colonies.
- **Questions**:
    i. [DW]- if probiotics show promise as a colony-level treatment that is efficient and cost effective, **what is the prospect for scaling this up**? Are we comfortable with field trials? What will it take to move to *in situ* experimentation?

1. [BU]- would need more experiments for safety and impact, currently **was only envisioning these for the captives**, as some do have high sensitivity in recirculating systems and pathogen build up in aquaria. However, they do use this in aquaculture, so it is possible with more experimentation.

3. **Coordinated Intervention Efforts in ECA region** – *Brian Walker (NSU)*
    - SE Florida has **large coral colonies (>2m diameter)** of OFAV and other species that are seemingly resistant to most stress. This project is designed to spare these large monitored colonies from the outbreak by in situ treatments.
    - **295 total colonies** (85% OFAV, 10% MCAV, 5% SSID)
        i. 48% are dead (though not necessarily recently or as a result of disease), 14% are almost dead, 38% healthy (112 colonies with 5% tissue on them or greater)
        ii. Colonies were located through high-resolution aerial photography. Most of these colonies are located on the inner reef because they are easier to distinguish in photographs. Outer reef is too deep for these corals to be present.
        iii. 115 colonies were assessed in 2015 and 2018. Saw a significant shift in tissue lost over three years, much more with 75%-100% tissue loss.
    - **Disease smothering and trenching treatments** consisted of smothering disease margins and creating firebreaks using hammer and chisel and a Nemo underwater Grinder. These were only treated with chlorinated epoxy, not amoxicillin due to permitting and logistics.
        i. prioritized the top 60% healthiest looking colonies to monitor and treat. Visited/ retreated monthly, very labor intensive and expensive. Less re-treatments have been required over time, will see if that trend continues.
    - **OFAV success**:
        i. 53% of margin treatments stopped disease spread
        ii. 47.5% of firebreak treatments stopped disease spread
    - **MCAV success**:
        i. 0% of margin treatments stopped disease spread
        ii. 53.3% of firebreak treatment stopped disease spread
    - **New infections over time**:
        i. Spike in 2018 of many newly infected colonies
        ii. 22 large monitored corals have been resistant to infection to date
    - **Moving forward: SE Florida reef-building coral response to amoxacillin intervention and broader-scale coral disease intervention**
        i. Establish **disease intervention strike teams**
            1. **Preform disease intervention** on the remaining reef-building coral species with active disease in SE Florida using the aforementioned chlorinated epoxy treatments as well as amoxicillin
                a. Current research suggests that success with amoxicillin is low and may not be good to commit to in long term, especially considering the possibility of antibiotic resistance (there is

already evidence of antibiotic-resistant microbes on the reef [DGRIF], and there is evidence of resistance in the pre- and post- mucus samples on colonies treated with amoxicillin in the keys [DGRIF]. However, the scale of what we are doing here is very small [JW], all experimental while we try to understand what antibiotics are already out there. DEP does acknowledge that we are trying to move away from this to find something less risky (like probiotics [VP, JL]).

b. The materials being used were developed by a pharmaceutical company to allow the ingredients to leach out over a matter of days. Have concentrations, but don't know about dosing.
    i. [DGRIF]- for humans, the dosing recommended is every 4 hours, which seems infeasible to scale up. But, this is not intended to scale, this is only to survive the large OFAV individuals [BW].

2. The broader-scale efforts will run from project execution through June 15, 2019 and will be conducted in partnership with FAU, FDEP, Broward County, and Miami Dade County. In the past few months, have established the teams, gotten commitments of support from DEP, hired people through NSU dedicated to this task, and received permit modifications to begin using amoxicillin

ii. Conduct **disease intervention trainings**

iii. Conduct **coral disease intervention recon**
    1. Need sites with fixed central locations (such as around county moorings, and avoiding sites like monitoring and disease stations) with GPS coordinates, where we will select large coral locations spread throughout the counties

iv. **Compare the success of antibiotics and chlorinated epoxy** on MCAV
    1. 40 colonies with amoxicillin, 40 with chlorinated epoxy, and 40 no-treatment controls will be mapped, treated, and revisited to determine the efficacy of applied treatments.

- **Voss experimental intervention planning**
    i. ~monthly roving diver surveys in the northern portion of the FRT with strike team activities and use of both treatments types, along with 3D imaging of tagged SCTLD colonies.
- **Present work status and immediate plans**
    i. April 10- visited 10 mooring buoys and didn't find suitable locations to conduct disease intervention. Need more effort in recon to find suitable sites for the experiment.
    ii. Plan to continue monitoring and treating large priority corals monthly
    iii. Plan to conduct large coral assisted sexual reproduction and propagation in land based nurseries until disease subsides (funding acquired from SWG)

4. **Ocean Modeling Aimed at Coral Disease** – *Thomas Dobbelaere*, *Lew Gramer (NOAA AOML)*

- The goal of this work is to understand coral connectivity and **how disease might be progressing along the reef tract using modelling**. To see if it is possible for diseased mucus and tissue to be transported by the currents, we used SLIM (models **geophysical/ environmental flows**) with a fine-grained sediment model to trace plumes and **particle tracker**, with an unstructured mesh with high resolution around islands that can **capture small-scale phenomenon like circulation eddies**.
- This model is **able to capture water movement around and between islands of the Florida Keys**, but one of the issues is that biological material can be positively buoyant, and thus be subject to wind speeds atop the surface layer, or can be negatively buoyant and be effected by Ekman's transport. Both will change the SLIM output. Can modify the model for near-bottom and near-surface transport, and **run the particle tracker for transport in the surface layer, in the water column, and in the bottom layer, for different degradation rates, and then simulate disease spread** in the obtained networks.
- This can then produce a **potential connectivity matrix**, with a habitat map superimposed on the mesh to see where reefs are. These connectivity matrices can then be **used in an epidemiology model to simulate disease dispersal** during the month. (Transmission rate within a reef is a function of the reef area, transmission rate between reefs is a function of the distance between them).
- We want to make this as useful as possible to the response, so will take suggestions for the most important data to consider (like the buoyancy of mucus), but where to seed is the most important question [LG]
- Questions:
    i. [J. Figueiredo]- is it possible to work backward from how the disease has already spread to find the vector pelagic duration (how long the disease remains in the water column)? We know how the disease moved throughout the Keys, mapped what happened and when, can we get the model to do the same thing and then it would map for a future amount of time [VP]?
        1. LG is working on that, but the state of the spatial observations, especially in the early stages of the outbreak, is not extensive or high quality, so it is difficult.
        2. [DGIL]- should take into account SECREMP sites, have documented the disease since 2013.
        3. [JW]- we have also connected with Nick Alcaraz to compile all observations, including verbal ones. [DGIL] if this information is important, there should be another meeting to reenergize the process of getting all early data from everyone. [LG] it would be very valuable to know earliest times and cross-reef spread.

Session VII: National and Local Reef Monitoring Updates *(Spring 2019)*

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1. NCRMP 2018 Update: General program and 2018 benthic and fish surveys - *Jay Grove (NOAA)*

- CRCP's National Coral Reef Monitoring Program (NCRMP) started in 2013 sampling in the Florida Keys and Dry Tortugas. As of 2018 sampling includes SEFCRI, now will be a program comparing all coral reefs in the US using the same methods.
- **Sampling cycles**:
    i. 2013- FGB & USVI
    ii. 2014- FL & PR
    iii. 2015- FGB & USVI
    iv. 2016- FL & PR
    v. 2017- USVI
    vi. 2018- FL & FGB
    vii. 2019- USVI & PR
- **Fish Surveys:**
    i. 360 sites in Dry Tortugas. NOS and NOAA led cruises (completed 94%)
    ii. 400 sites in the Florida Keys. FWC, NPS, NOAA led boats (completed 100%)
    iii. 300 sites in SEFCRI. NSU, NOAA, FWC, DEP, Miami-Dade and Broward Counties led boats (completed 100%)
    iv. total target: 1060 sites (completed 100% overall)
        1. (there are so many more fish sites than benthic sites because there is a lot more variability in fish surveys, and they need this number of sites to achieve 15-20% coefficient of variance).
    v. **accomplishments**: first sampling after Irma, new management in 2017 for hogfish and mutton snapper, black grouper status uncertain (status is very low- can be caught at 62 cm but are not mature until 83 cm, needs to be addressed in new management).
- **Benthic Surveys:**
    i. 140 sites in Dry Tortugas. NOAA, NCRMP, DRM (completed 100%)
    ii. 150 sites in Florida Keys. DRM, NOAA (completed 100%)
    iii. 130 sites in SEFCRI. DRM, NSU, and NOAA (completed 86%)
    iv. total target: 420 sites, (completed 100% overall)
    v. **Methods: Benthic Assessment**
        1. Single 10x1m transect with 2 divers, recorded benthic composition (LPI), topographic complexity, macroinvertebrates, and ESA-listed coral
    vi. Methods: Demographic Assessment
        1. On all corals >4cm diameter recorded density, Size, Richness, and Condition (bleaching, disease [added coral disease with tissue loss], mortality)
    vii. **Accomplishments**: first sampling after Irma, added coral disease with tissue loss, new partnership with DRM, discovered new pillar coral colony off Key West.
- **Data is public on CoRIS** (coral reef information system) website. Data report summary will be out this fall, Florida status report will be out May 20th.

2. **Disturbance Response Monitoring (DRM) Program 2018 Update** – *Jennifer Stein (FWC)*
    - The Disturbance Response Monitoring (DRM) Program was established in 2005 by the Florida Reef Resilience Program (FRRP, a collaborative program guided by a steering committee of managers, scientists, and conservation organizations to implement resilience-based management on Florida reefs) to survey the shallow coral reefs from Martin County to the Dry Tortugas during the months

of peak thermal stress. DRM is the largest unified monitoring program for the entire FRT and is the largest coordinated coral condition monitoring program in the world.

- **DRM Surveys**
    i. Surveys are designed to monitor coral reef health after a disturbance, where trained experts survey corals during peak annual temperatures (mid-August through mid-October). In 2005-2016 these surveys focused on coral bleaching, in 2017 they focused on coral disease, hurricane impacts and coral bleaching, and in 2018 focused on coral disease and coral bleaching. Post-bleaching surveys are also completed after bleaching years (2014-2015), 3-4 months after the event if it is considered 'severe'. From 2005-2017, more than 2,500 DRM sites have been surveyed along the FRT.
    ii. **Survey Methods**: 2 replicate belt transects with 1-2 roving diver surveys at each site. Roving divers are to document disease on 6 target species (OFAV MEAN MCAV CNAT PSTR SSID), which are binned into abundance categories. Corals are only tallied as diseased if they are experiencing tissue loss.
- **DRM transition, changes, and improvement**
    i. 2018 marked the formal transition of the coordination and management of the FRRP DRM program to the FWRI coral program. The structure of the DRM program will remain the same, but there will be a new website, data entry system, report generator, database format, and quality assurance procedures. New data fields were also added to the DRM methodology to better document the unprecedented coral disease outbreak.
- **Communication of survey results**
    i. Each year, a quick-look report is produced based on the survey results. These results inform both reef managers and reef scientists on the health and condition of corals along the FRT. Quick look reports from 2011-2018 can be downloaded directly from the DRM website on the 'Survey Trainings and Resources' page (http://ocean.floridamarine.org/FRRP/Home/About). This summary report describes the prevalence of bleaching, paling, and coral disease.
    ii. Prevalence values were calculated by pooling all corals across all zones within a particular subregion. Subregions were broken down by latitude and county, zones were classified by cross-shelf position, distance from shore, and depth (inshore reef, mid-Channel reef, offshore patch reef, forereef).
- **2018 Survey Results:**
    i. 195 surveys on shallow reefs across the FRT, only three in Palm Beach County and none in Miami-Dade.
    ii. When compared across the years, **bleaching prevalence was higher than the past two years but still lower than conditions found during the more severe bleaching years** of 2014-2015.

1. Mild bleaching (0-20%) along most of the FRT, only moderate (21-50%) in Upper Keys forereef and Palm Beach County.
2. Prevalence is higher when combined with paling: moderate (21-50%) in Miami Dade forereef, Broward County, Upper/ Mid-Upper keys, and Dry Tortugas, severe (>50%) paling in Palm Beach County and Upper/ Mid-Upper Keys

iii. Although 2018 represented only a mild-to-moderate bleaching season, a **higher prevalence of coral disease** continues to persist in the Broward-Miami subregion and the Upper and Middle Keys due to SCTLD.
1. When all coral diseases are pooled, the inshore Upper Keys is the only area with >10% (high) prevalence. When considering only SCTLD, there was 13% prevalence in this zone.

iv. North of the Palm Beach subregion, no surveys were completed along the northern portion of the reef system. therefore, the results of this report do not reflect conditions experienced in the Martin County subregion during the 2018 bleaching season.

v. **Roving Diver Results for coral disease**:
1. Broward and Miami
    a. Mostly single-colony observations of MCAV and SSID, few observations of OFAV
    b. More multi-individual (2-10) observations in Miami
2. South Biscayne and Upper Keys
    a. Biscayne was mostly OFAV and SSID, few MEAN
    b. Upper Keys was mostly MCAV and SSID (many SSIDs)
    c. Mostly single colony or multi-individual (2-10) observations
3. Middle and Lower Keys
    a. Most observations in middle keys were of 2-10 individuals, most in the lower keys were single colony observations.
4. Dry Tortugas
    a. Mostly single-colony observations, with one site having abundant (>30) diseased OFAVs. Likely that many of the disease observations were actually white plague due to differences in lesions, which has been previously observed here.

- Update on the **Benthic Working Group**

i. The Benthic Working Group is a select group of experts tasked with making decisions about the DRM program and expediting the review process of summary reports and media material. The first meeting in May.

ii. **Agenda**:
1. Review and discuss the new disease data fields
2. Review and discuss the roving fiver survey- is there a better way to capture disease?
3. Provide feedback on the only data entry interface

4. What data outputs would be the most valuable to our end users, what should make it into the summary reports?
5. Discuss the future of DRM as it evolves with changing disturbances

3. **SECREMP**: Annual Report - *David Gilliam (NSU)*
    - SECREMP is an annual project utilizing permanent stations to provide relevant and timely information on current status and temporal and spatial trends of coral reef resources within the Coral ECA. It is an expansion of the Keys and DRTO coral reef evaluation and monitoring project (CREMP-FWC) so that the entire FRT is effectively monitored.
    - SECREMP has added sites and changed methodology throughout different events and management needs. Currently there are 22 sites: 8 Miami Dade, 7 Broward, 5 Palm Beach, 2 Martin County
    - **Site and Station Set-up:**
        i. Each site has **4 permanent stations**
        ii. Each station has:
            1. **1 still image transect**
                a. percent benthic cover- 0.4 x 22m transect
                b. digital camera ~40 cm above reef substrate
                c. 15 random pts/image, ~50-60 images/ transect
                d. functional groups: stony coral species, octocoral (branching/ encrusting), macroalgae, CCA, substrate
            2. **1 belt transect**
                a. **Stony corals**= 1x22 m transect
                    i. ID and measure all colonies >2cm diameter (down from 4cm to capture more of population)
                    ii. Record % mortality, # isolates, health conditions
                        1. In response to disease event new descriptions for mortality and conditions:
                            a. Type: tissue loss, color loss, discoloration, growth anomaly, mucus sheathing
                            b. Distribution: focal, multi-focal, diffuse, whole
                            c. Margin: rate and % affected
                    iii. Tally of all species <2cm diameter (looking at recruitment to give a sense of future recovery)
                    iv. Count long-spined sea urchins
                b. **Barrel Sponges**= 1x22m transect
                    i. Record location
                    ii. Measure max diameter, base diameter, height, osculum diameter
                    iii. Record condition and injury
                    iv. Images

c. **Octocorals**= 1x10 m transect (cut down from 22 m because they are so abundant)
    i. Count all individuals
    ii. ID 3 target species: *Gorgonia ventalina, Antillogorgia Americana, Eunicia flexuosa* (stopped recording *Eunicia calyculata* and *Pseudoplexaura porosa*)
    iii. measure height
    iv. record disease (% affected)
    v. compromised health including predation and overgrowth
3. **1 temp recorder per transect** (2 total)

- **Annual Report**:
    - **i. Regional disease prevalence 2013-2018**
        1. Rapid increase from 2013-2016, then prevalence continues to decline. There is a similar trend in SCTLD and non-SCTLD diseases in the same timeframe
        2. Half of species are infected (15 of 29 total species in region).
    - **ii. Regional Stony coral density**
        1. Significant decrease in 2016, no change in 2017. Coral density is a measure of the health of the resource by measuring the entire loss of a colony- a significant loss of density is an important proxy for entire system health.
    - **iii. Regional diversity**
        1. Significant decrease in all three diversity indices, but did not have continuous loss in 2017-2018 after peak loss in 2016.
    - **iv. Live tissue area (LTA)**
        1. LTA is a finer scale index- uses demographic data (height and diameter and partial mortality) with ellipsoid equation to calculate live tissue area. Doesn't rely on loss of entire colony.
        2. Have lost more than 40% of LTA between 2014-2018, with most lost during 2015-2016. Loss has been reduced in 2017-2018.
    - **v. Species-level changes**
        1. DSTO
            a. Loss in LTA- 75m^2 to 5m^2
            b. Increase in LTA between 2017-2018
        2. MEAN
            a. Dramatic loss in LTA- 114m^2 to 5 m^2
            b. Have lost all large colonies, only a few small ones remain
        3. MCAV
            a. Dramatic loss in LTA and density- 445m^2 to 231m^2
            b. Affected both large and small colonies, but there has been an increase in smaller colonies
        4. OFAV
            a. Dramatic loss of LTA- 24 m^2 to 11m^2
        5. *S. bournoni*

        a. Measurable loss of LTA and colonies
        b. Affected many size classes
    6. PAST
        a. Increase in LTA and increase in abundance of smaller size classes. This shows a shift from larger reef building corals that are being lost and weedier species winning for space.

vi. New size classes

1. There is potential for recovery, there are many colonies <4cm that have not been lost for a wide variety of species (though this does not distinguish between recruits and frags [MM])

vii. 2018 Functional Group Cover Trends

1. stony coral cover: decreasing regional trend
2. octocorals: decreasing regional trend for cover, increasing regional trend in density
3. sponge cover: stable regional trend
4. macroagal cover: increasing regional trend
5. Barrel sponge density: increasing regional trend

- **Recent Products and Presentations**
    i. Annual SECREMP reports
    ii. Completed MS thesis: Nick Jones
    iii. Publications
        1. 2018: Impacts of a regional, Multi-year, multi-species coral disease outbreak in southeast Florida (Frontiers in Marine Science)
        2. Submitted: Drivers of coral reef community phase shifts (coral reefs, in review)
        3. In prep: Recovery potential following a regional stony coral disease outbreak along the SEFLRT (Nicole Hayes, will include 2018-2019 data)
    iv. 2019 Benthic Ecology Meeting
        1. Nicole Hayes: Potential for recovery after a stony coral disease outbreak along the SEFLRT
        2. Alex Hiley: long term trends of octocoral community on SEFLRT
        3. Nick Jones: drivers of coral reef community phase shifts
        4. Alanna Waldman0 the impacts of hurricane Irma on the Giant Barrel Sponge on the SEFLRT
- SCTLD outbreak- we still have the narrative that it began in Miami in 2014, but there is data that suggests it began in 2013. The accurate start of the disease is important to know and get right. We also tend to say that it was first reported in fall, but we know that pillar corals were impacted as early as June that year.
    i. [JW] the language that we have tried to use in the narrative is that the disease was observed in 'high levels' in 2014. There is agreement that we should investigate 2013 more carefully [BW, JL, DGIL, VP]
- Questions:
    i. [BW] Should we be adding additional sites with higher coral cover or diversity?

1. [DGIL] the more sites and colonies in the population being monitored the more robust the data and the more we can say about change.

ii. [JW] We cannot add more sites, but how can we use these existing sites to track restoration trials? Can we build this into what we do in the future?

1. [DGIL]- working around these sites is valuable because we have this data, but we should not work within these sites. We should leave these only for long-term monitoring, that is where their value lies.

Session VIII: LBSP Project Updates and Introductions

1. **Outfall Project Data**- *Dale Griffin (USGS)*

a. Antibiotic resistance in microbes is an effective way to assess sewage, because microbes adapt and change the quickest and therefore make a valuable tool to detect change. Studies can do this by using different targets to look at different genes that might promote resistance to different antibiotics.

b. There is a lot of literature on people getting infections in the marine environment, and there are previous studies along the east coast of the US that demonstrate high abundances of antibiotic-resistance genes associated with outfall sites.

c. Preliminary sample plan:

i. 26 total samples: 50mL tube of sediment with water, only need a quarter gram to get extraction.

1. 18 within 40-50 meters of the outfall pipe
2. 10 within 20-25 meters
3. 8 within 40-50 meters
4. 8 along N & S transects (100, 200, 400, 600 meters)
5. influent and effluent

ii. Sampled twice, one time each during wet and dry seasons.

iii. Samples will just provide presence/absence data of the genes, not the organisms that have these genes.

d. On a small sample size taken from a reef before and after antibiotics were used in coral disease treatments, antibiotic resistance genes showed up 2 weeks after treatments where none were present before. Other than these samples, the Keys show low abundance of antibiotic resistance genes.

e. Around Fort Lauderdale, there is a higher abundance of antibiotic resistance genes with the highest prevalence around the outfall, suggesting that the pipe may be leaking and the plume is delivering antibiotic resistance to the environment.

i. These results are from a single sample grab from the Hollywood outfall (there is a second set of samples that have not yet been run). The plume produced here is massive, and the samples did not reach its full extent. These results suggest that a full study is warranted in order to do that [DGRIF]. This is a good tool to see stress on the environment, and may imply some human health recreational use risks.

2. **Green Infrastructure/Low-Impact Development Best Management Practices Manual** – *Eban Bean (UF IFAS)*
    a. **Purpose**: want to develop a resource to work with global governments and the private sector to start promoting practices in urban development that will help mitigate some land based sources of pollution. This manual will inform public and private entities of the impacts of development on pollutant exports, and will include a framework for incorporating **low impact development and green infrastructure** into projects.
    b. Background that makes this manual necessary:
        i. There are 7 million people in the 4 SE Florida counties, and by 2030 there will be 1 million more. When looking at land use, everything outside the wetlands has been largely developed, and there only remains ~1% for future development projects. Most of the area draining into the inlets is already developed, but there is an opportunity for re-development, with the goal of restoring the functionality that might have been lost.
    c. **Audience**
        i. Local government (policy officials, public works, planning departments)
        ii. FDOT (subcontractors)
        iii. Engineering consultants
        iv. Design and development community
    d. **Manual organization (Chapter list)**
        i. Local environmental context (hydrology & geology, climate, regulatory, impairment- Trying to bring in the critical regional information with respect to managing water and how it carries land to the waterways)
        ii. Site planning (The many things that need to be considered before beginning construction, how to preserve the resources on existing sites, etc.)
        iii. Plan for storm water control measures (SCMs)
        iv. Low-impact development SCMs
            1. Non-structural LID SCMs
            2. General structural SCM design criteria (common design steps for common SCMs)
            3. Structural SCMs (designed to capture a volume and retain it)
            4. Flow control SCMs (intended to mitigate the high velocities of concentrated runoff)
            5. Flow-through SCMs (for example, nutrient-separating boxes that remove coarse material that would otherwise flow into the waterway)
            6. Off-lot SCMs (ex: disconnected septic systems)
            7. Other treatment systems (ex: advanced treatment systems, living shorelines)
        v. Assess applicability of candidate SCMs (what would work for the system that we have? How might certain SCMs fit into a landscape of design?)
        vi. BMP Matrix (goes over the benefits that each SCM can provide, ex: source control, flow through treatment, etc. Meant to help the designer

narrow down the selection and choose what criteria are most important to consider).

vii. Operation and maintenance of SCMs
viii. Performance verification and validation
ix. Public education (increase the acceptance and get it adopted into the community)
x. Ancillary community benefits (ex: providing habitat, increasing green space, reducing heat island effect, public health, etc., in addition to removing pollutants from stormwater flow).
xi. Conclusions and next steps

e. Project tasks
    i. Draft LID & GI Guidance Manual has been distributed to certain groups of stakeholders for review and comment
    ii. Manual workshop in late-May early-June will include local government officials and private entities
    iii. Final version of manual expected mid-late June