PORT EVERGLADES' TECHNICAL SUB-TEAM MONITORING PLAN WORKSHOP

Prepared by Xaymara Serrano, Ph.D. and Drew Condon, Ph. D., P.E.

October 23-24, 2018

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AGENDA

October 23rd

8:30 Introduction, Participants, Lunch orders

1. Review of Agenda and Meeting Goals - Marie
2. Monitoring Plan Goals - Marie
3. Stepping through the DEP Draft Plan: *Review of Draft Biological Monitoring Methods for the Port Everglades Navigation Improvements Project dated February 16, 2017.* – Xaymara + IWG

12:30 Lunch

1:30 (Cont'd) Review of draft monitoring plan.

5:30 Wrap up of the Day

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AGENDA

October 24th

8:00	Summary of yesterday's meeting & continuation or wrap up issues on Biologic Monitoring Draft Plan.
9:00	Implementation of the BMP - Xaymara + IWG
11:00	Lunch & Learn - Best approaches for measuring turbidity and suspended sediment concentrations in/near reef areas presented by Lew Gramer.
11:30	Goals & Parameters for Water Quality Monitoring – Overview – Xaymara and Drew Linking Benthic Habitat Monitoring & Water Quality Monitoring
3:00	Wrap-Up and Next Steps including how to address unfinished topics if any.
3:30	Close

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MEETING GOALS

1. Agree on the specific goals for each monitoring event (pre, during and post-construction) and best methods to collect the data.

2. Identify specific protocols to be used for each survey, define the timing and sampling locations for surveys.

3. Determine most effective approaches to reduce time lag of data output and speed up communication process between contractors, USACE and IWG during construction.

4. Review DEP's proposed biological monitoring methods for the project and identify areas where USACE is considering supplementing these with additional monitoring (water quality/instrumentation) to address lessons learned in Miami.

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BIOLOGICAL MONITORING PLAN GOALS

- Provide the reasonable assurance that any unpermitted impacts will be identified, should they occur.

- Identify project-related unpermitted impacts and to determine their
  - Distribution,
  - Spatial extent (acreage),
  - Severity (functional degradation / loss), and
  - Persistence (during and after construction), should they occur.

- Commensurate with the scope and scale of the project and the potential spatial extent of sedimentation impacts.

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MONITORING PLAN GOALS – CONT'D.

- Provide adequate input parameters for uniform mitigation assessment model (UMAM)
- Include input from the modeling (i.e., Starting point at from which to base monitoring stations) with goal of minimization and avoidance of impacts.
- Document changes in the condition of the resources/site over time.
- Define the appropriate temporal and spatial scale for the sediment impact and biological response to stressors.
- Differentiate between naturally induced (ambient) sedimentation and those from dredging (before/after impact design). Accounting for sedimentation impacts from all sources

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MONITORING PLAN GOALS – CONT'D

- Feed into AMP.
- Define how the monitoring plan translates into mitigation requirements for both the direct (up-front) and indirect impacts (prediction) and what happens if the impacts for both are exceeded (unpermitted impacts).
- Defines what the data is yielding and the level of data resolution (deliverables). Data presented and how the results should be communicated…and deadlines
- Must define how the information from monitoring feeds the functional assessments and mitigation
- Must reach consensus on statistical analysis details
- Agreement that AMP is separate but related and is fed by the triggers from data identified in the monitoring plan

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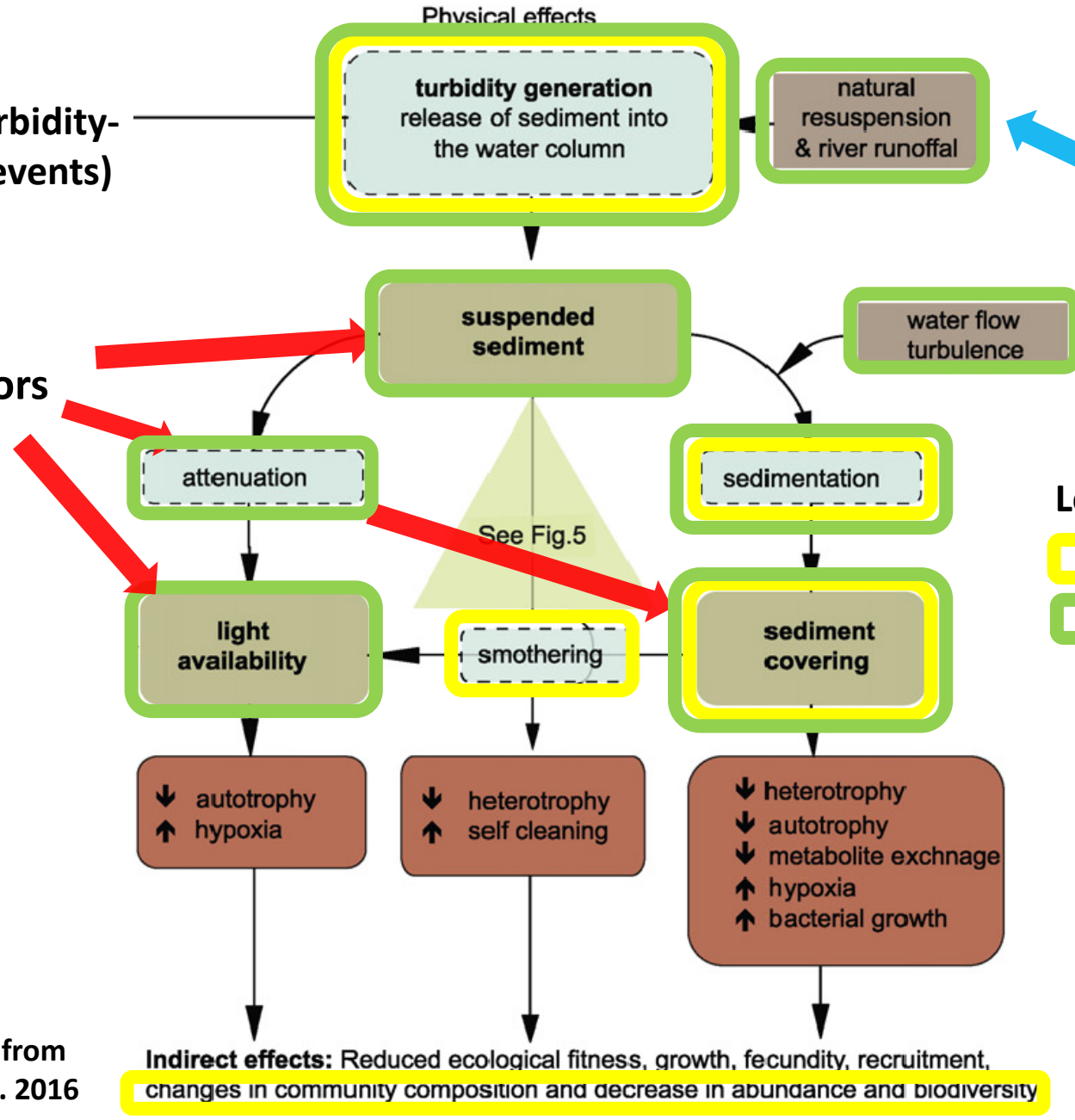
Dredging
(or other turbidity-generating events)



Key interacting factors

Key stressors

Legend:
- Biological monitoring
- Water quality monitoring

Modified from Jones et al. 2016

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BIOLOGICAL MONITORING PLAN GOALS

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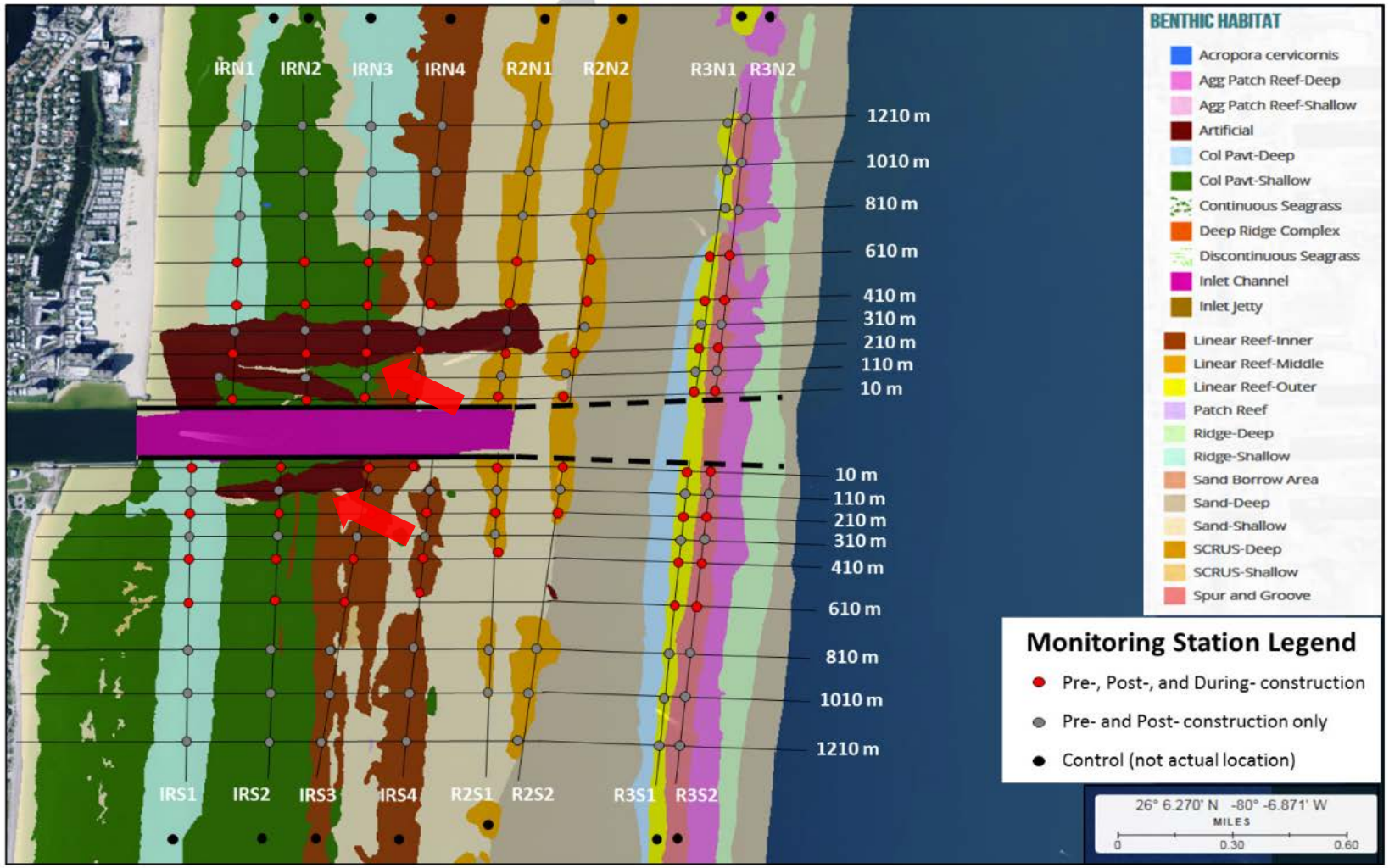
2.0 Assessment Area and Control Site Monitoring

2.1 Spatial arrangement of permanent monitoring stations [Before-After-Control-Impact (BACI) design]



For discussion: Alternative placement of ~12 sites proposed on breakwaters (artificial)?

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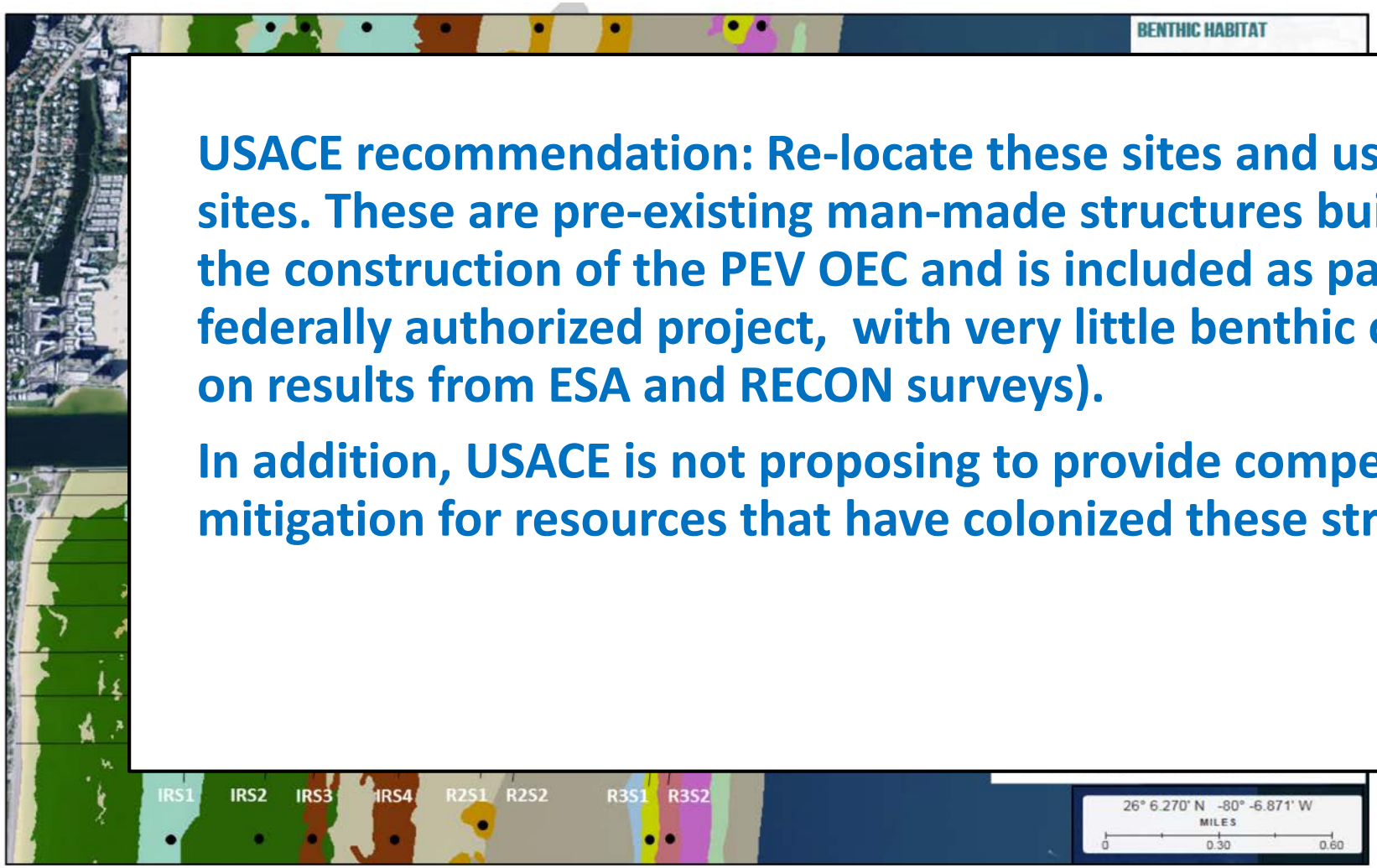
2.0 Assessment Area and Control Site Monitoring

2.1 Spatial arrangement of permanent monitoring stations [Before-After-Control-Impact (BACI) design]



For discussion:

placement
proposed
ters

USACE recommendation: Re-locate these sites and use as control sites. These are pre-existing man-made structures built as part of the construction of the PEV OEC and is included as part of the federally authorized project, with very little benthic cover (based on results from ESA and RECON surveys).

In addition, USACE is not proposing to provide compensatory mitigation for resources that have colonized these structures.

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2.0 Assessment Area and Control Site Monitoring

2.1.1 Selection of Control Stations – Review of alternatives

- **Alternative 1: no control stations**
  - **Pros: Less effort**
  - **Cons: Can't do a BACI design**
- **Alternative 2: include control stations**
  - **Pros: More powerful design**
  - **Cons: May require large amount of effort prior and during construction**
  - **For discussion:**

How many and how far from the project area should control sites be?

What is the most appropriate way to select control sites?

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2.0 Assessment Area and Control Site Monitoring

2.1.1 Selection of Control Stations – Review of alternatives

- Alternative 1: no control stations
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USACE recommendation: Include control stations (alternative 2). Suggest using a total of N = 16 control stations located ~2 km outside project area (N = 8 both north and south of channel) but need to discuss with IWG how to best identify where to specifically locate the control sites (in order to identify similar attributes and benthic species make-up as the non-control sites).

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2.2 Monitoring Events

- **Pre-construction (Baseline) survey**
  - **For discussion: One full scale survey prior to begin construction or split effort into multiple surveys?**

USACE recommendation: Will consider splitting effort into 2 surveys (wet and dry seasons ~spring and fall) if the IWG feels is appropriate. If that is the case, USACE suggests alternating sites from grid in each survey to get same spatial coverage, which results in no significant net increase in costs associated with the survey.

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2.2 Monitoring Events

- **During construction monitoring (scaled-down design; less tasks and spatial coverage)**
  - **For discussion: FDEP recommends an interval (2-6 months). This makes it challenging to use data in adaptive management plan and more frequent surveys = huge increment in costs; not necessarily a better outcome (Miami as example - ~10,000 dives).**

USACE recommendation: Conduct 3 surveys per year to capture seasonal variability (spring-summer-fall). Avoid winter when weather is expected to hamper ability to conduct surveys due to high winds and associated high seas.

In addition, USACE is considering conducting additional scaled-back surveys (e.g. spot dives) if triggered by adaptive management plan (TBD).

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2.2 Monitoring Events

- **Post-construction survey**
  - **For discussion: FDEP recommends completion within 90 days after project ends.**

USACE comment: Agree but surveys could take longer to be completed, for example if the project ends at the beginning of the winter season. Survey initiation also dependent upon the season when project is completed. Would like to discuss with IWG what to do if any of these cases happen.

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2.2 Monitoring Events

- **GENERAL CONCERN FOR ALL MONITORING EVENTS: What if we have a natural event (e.g., storms) or other weather issues in the middle of a monitoring survey?**

USACE recommendation: Continue/complete survey as soon as possible but note which sites were surveyed before and after (e.g., RECON). Alternatively, need to discuss with IWG if we want to start over if we just started a survey or if we want to stop the data collection if the survey was close to completion prior to the event. Need agreement from IWG on what percentage of sites completed/remaining triggers the do over/stop decision.

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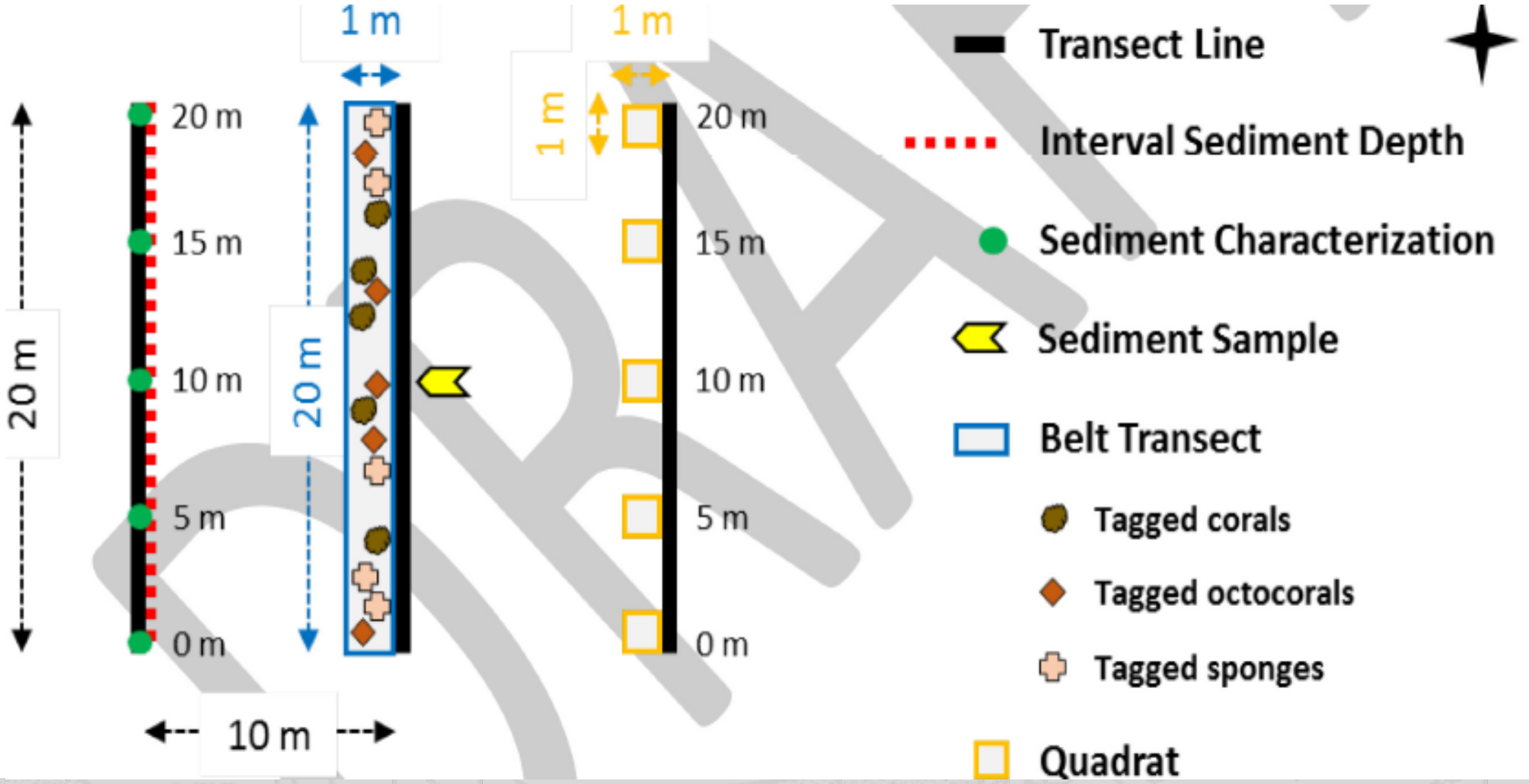
2.3 Monitoring Protocols

2.3.1 Transect, belt transect, and quadrat configuration and establishment

2.3.2 Survey Methods



2.3 Monitoring Protocols

2.3.1 Transect, belt transect, and quadrat configuration and establishment

2.3.2 Survey Methods

For discussion: How to accomplish tasks with limited bottom time at sites with depths of ~60-90 ft (outer reef)?

- **USACE recommendations: USACE does not allow the use of mixed gases for their employees and/or contractors (diving regulation EM 385-1-1), so conducting tasks will likely require multiple days of diving at each site to be able to complete transects.**
- **One alternative for consideration is to use Remote Operated Vehicles (ROVs) for benthic data collection at these sites (USACE currently owns a few ROVs, but a minimum specification for the ROV could be developed with the IWG). In addition, USACE could deploy acoustic altimeters at all these sites (N = 16) long-term to assess temporal and spatial changes in bed elevation (as a proxy for sediment accumulation).**

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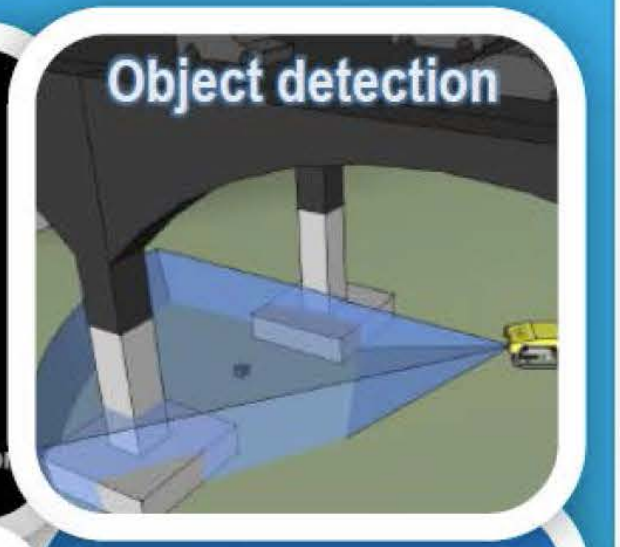
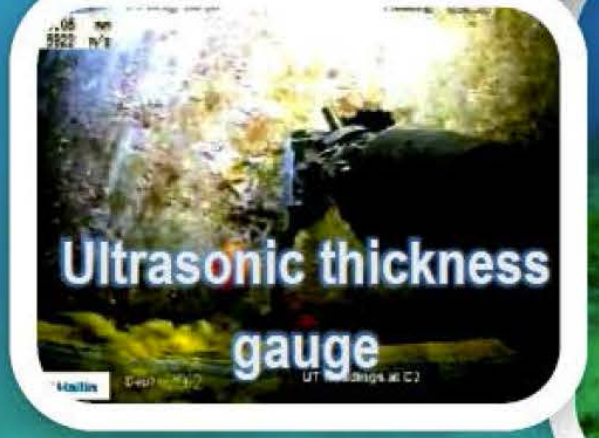
Jacksonville ROV Program: One Team with all the tools to get the information that you need.





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Journal of Experimental Marine Biology and Ecology 333 (2006) 115 – 128

Journal of EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY

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A comparison of video and point intercept transect methods for monitoring subtropical coral communities

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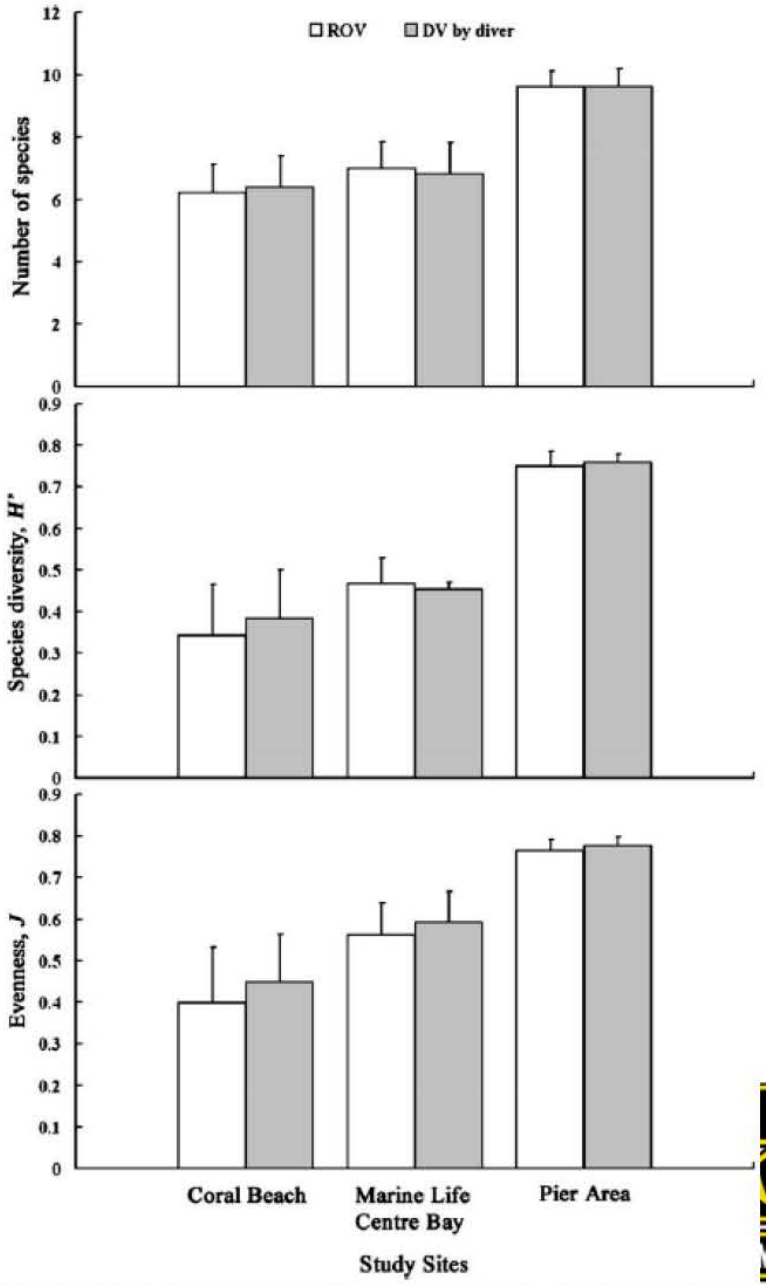
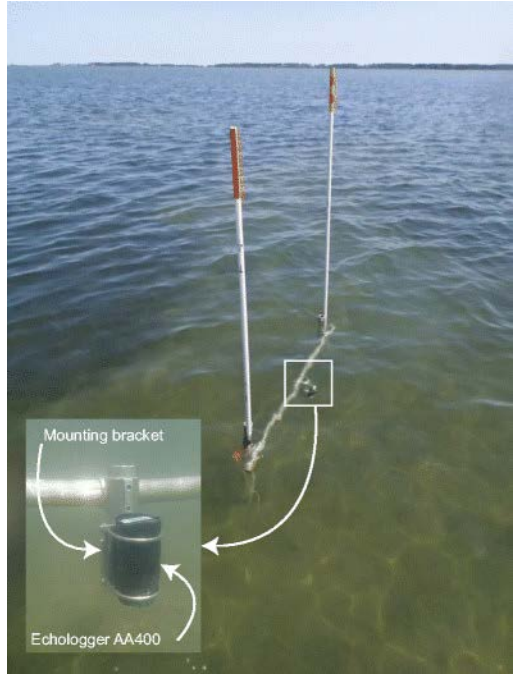
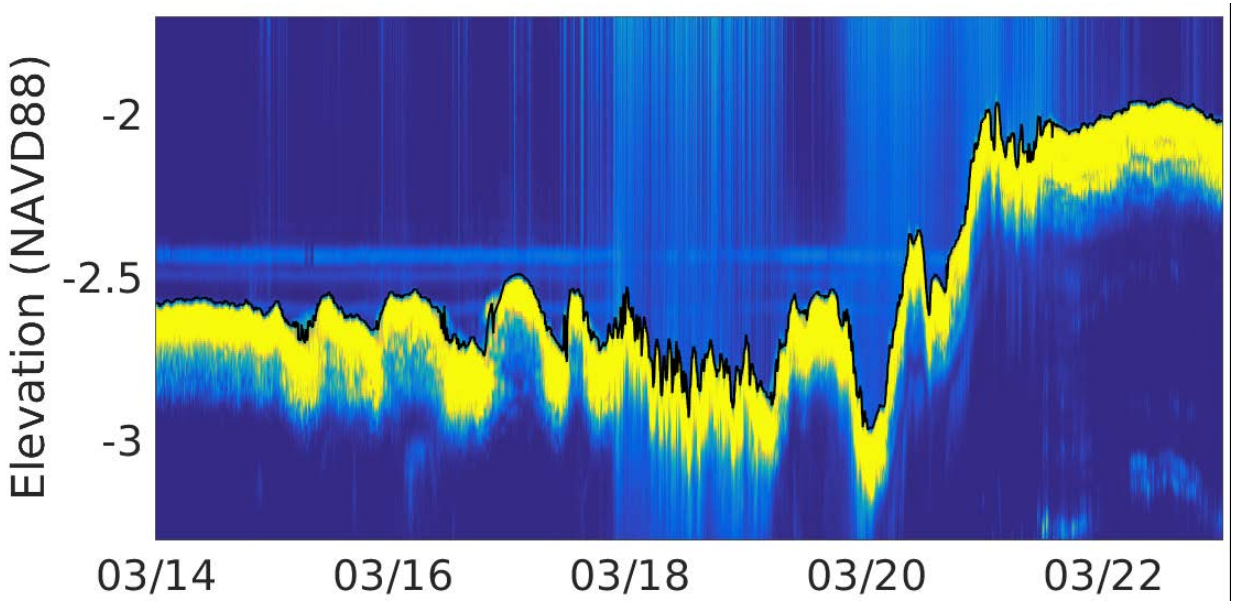
Abstract

This study evaluated the use of video transects obtained from SCUBA divers or remote operated vehicle (ROV) and point intercept transect (PIT) method from divers for monitoring subtropical coral communities. Comparisons were made between the datasets obtained by the ROV and SCUBA diver video transect ('Diver') and the PIT method on three nearby coral sites with different hydrographies, scleractinian coral composition, dominant species and percentage cover. There was no significant difference between the ROV and 'Diver' datasets whereas the PIT method tended to over-estimate percentage cover at sites where corals are not extensive. Power analysis showed that the minimum detectable change in coral percentage cover, δ, had low mean values between 0.39% and 1.65% for the ROV dataset, 0.66% for the "Diver' dataset, and 12.11% for the PIT dataset. This implied that the ROV and SCUBA survey methods can produce higher precision in terms of detecting temporal changes in coral communities and are thus more suitable for scientific research and management purposes than the PIT method. Other advantages of using video transects by SCUBA divers or ROV include provision of permanent records for subsequent studies and public information, less field time incurred and wider survey areas.







Acoustic Altimetry

- Compact / relatively inexpensive sensor
- Uses sound to track seabed elevation – erosion / deposition
- Resolution = ~ 1 mm
- Profiling and bottom tracking versions
- Used these and similar technology in estuaries, surf zone, and continental shelf

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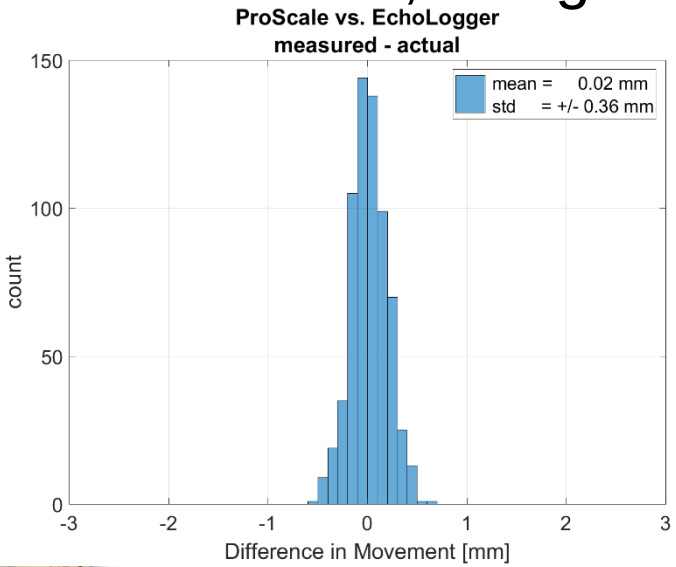
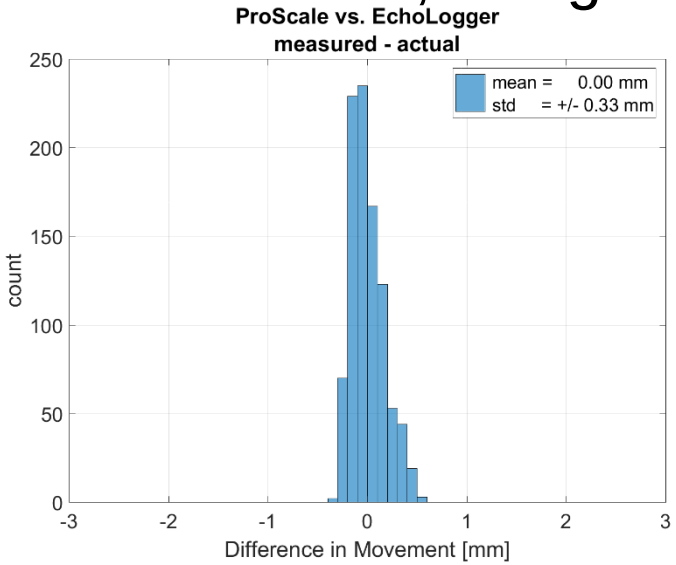
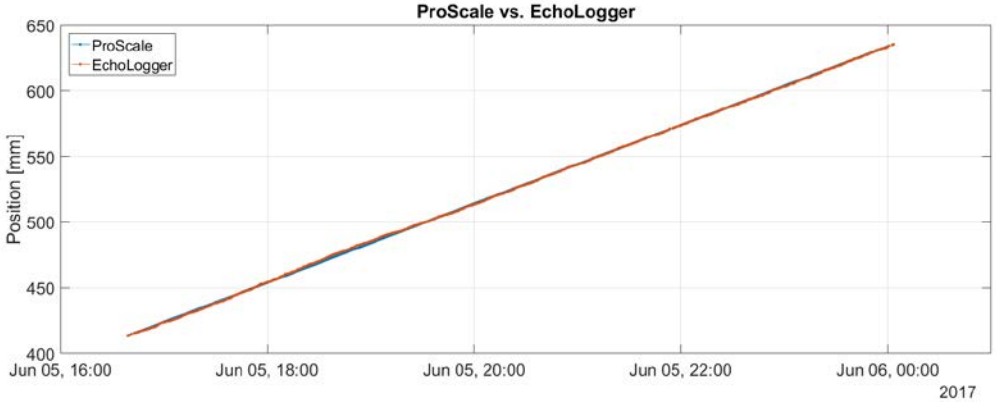
Laboratory Evaluation

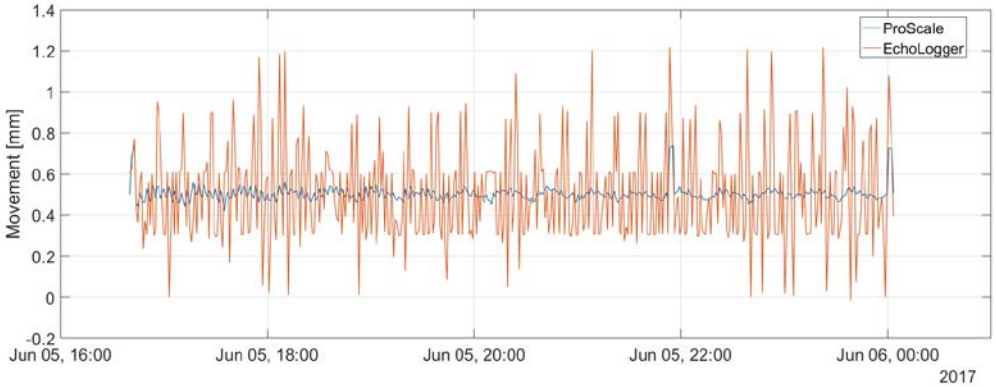
100% Sand, Range: 34 cm



100% Silt, Range: 47.5

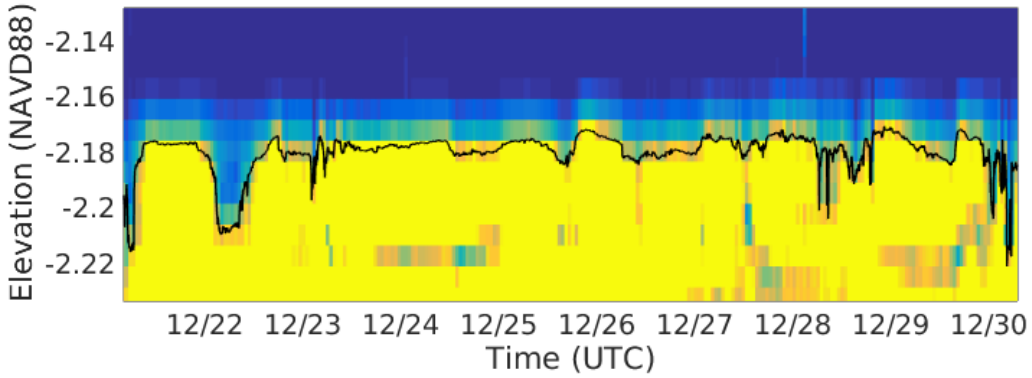


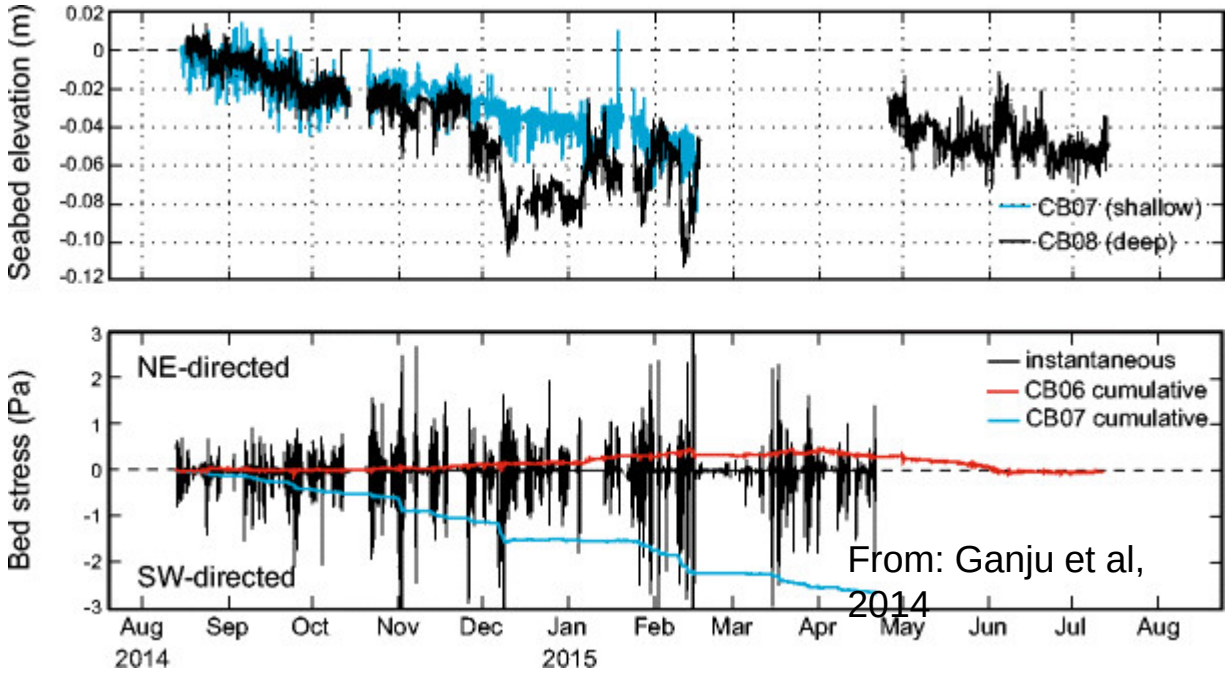




Example Field Data

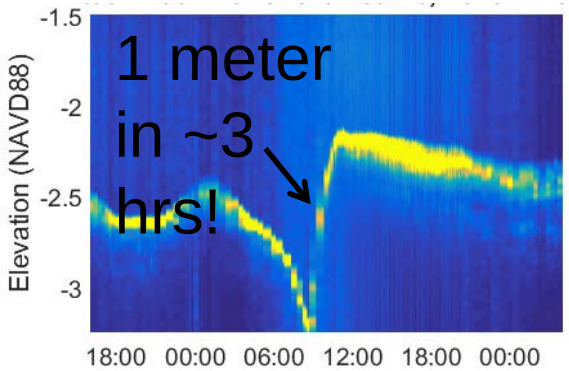
Estuarine

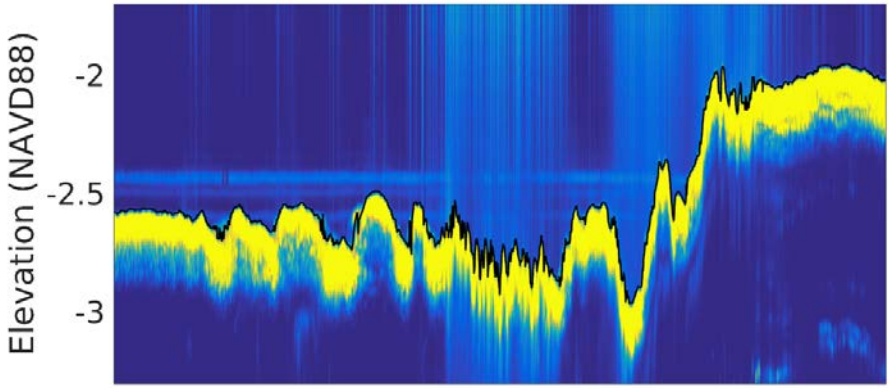


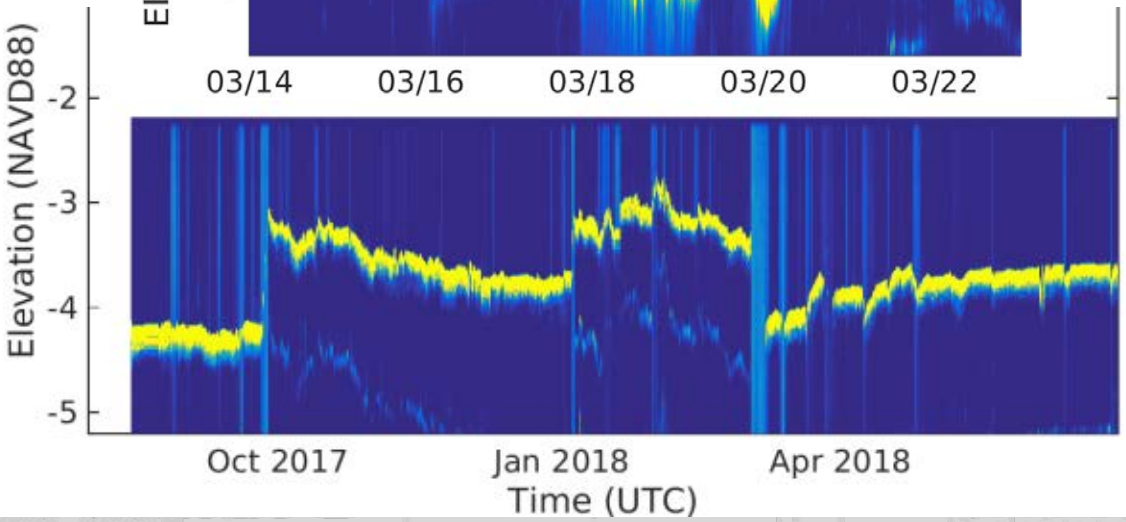


From: Ganju et al, 2014

Surf Zone







2.3 Monitoring Protocols

2.3.1 Transect, belt transect, and quadrat configuration and establishment

2.3.2 Survey Methods

For discussion: How to accomplish tasks with limited bottom time at sites with depths of ~60-90 ft (outer reef)?

- **USACE recommendations: If the IWG thinks is appropriate, similar methods could be used for monitoring potential downslope impacts (given similar depth ranges) (i.e., ROV, unsure if altimeters could be deployed in this area due to dive safety regulations).**

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2.3 Monitoring Protocols

2.3.1 Transect, belt transect, and quadrat configuration and establishment

2.3.2 Survey Methods

For discussion: If using 2 dive teams at all times (recommended), N = 3 transects per site (20 m long each) make it difficult to split roles among teams.

USACE recommendation: Increase transects to N = 4 per site to split roles appropriately among dive teams, but use 15 m long transects to get similar spatial coverage and bottom time.

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2.3 Monitoring Protocols

2.3.1 Transect, belt transect, and quadrat configuration and establishment

2.3.2.1 Digital video surveys

For discussion: FDEP recommends this as an archival dataset- quantitative analyses are not a requirement.

- **USACE recommendation: Analysis of the video data would be done as the surveys are completed, results and video archived which would enable immediate review of the analyses as a result of a triggering incident instead of waiting months to begin the review of the video data associated with the triggering incident. This data would not be provided to the agencies until such time as a triggering event required discussions of the videos. Would like input from the IWG as to the type of analyses proposed; e.g. point counts using CPCe).**

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2.3 Monitoring Protocols

2.3.2.2 Sediment survey protocols

2.3.2.2.1 Interval sediment depth measurements

For discussion: Need to ensure consistency in data collection among observers and appropriate cross-training & calibration exercises. This applies for all data collection, not just sediment depth measurements.

- **USACE recommendation: Need to discuss with IWG appropriate cross training and calibration exercises to be conducted by observers PRIOR to each monitoring event. In addition, contractor will need to coordinate with IWG to ensure appropriate methods of data collection prior to beginning the baseline survey.**
- **For adaptive management, USACE is considering supplementing sediment depths with monthly/bi-monthly bed elevation data collected from acoustic altimeters at ~20 sites spread across project area (subset of locations proposed for biological monitoring).**

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2.3 Monitoring Protocols

2.3.2.2 Sediment survey protocols

2.3.2.2.1 Sediment characterization

For discussion: FDEP recommends a visual (diver) characterization + photograph. Visual sediment characterizations may take a long time (increasing bottom time) and everything is likely to be labeled as "mixed" (fines + sand).

- **USACE recommendation: Use photographs for visual characterization and for archival purposes. Can also use the data from the digital video surveys to characterize the sediments.**

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2.3 Monitoring Protocols

2.3.2.2 Sediment survey protocols

2.3.2.2.1 Sediment collection

For discussion: FDEP recommends analyses of samples if triggered by data indicating potential project-related impact. However, it could be challenging to clearly define what constitutes a project-related impact based just on sediment depths + benthic data.

- **USACE recommendation: Run ALL sediment samples for particle size distribution (PSD) analyses, not just when triggered by other data, in order to assess temporal and spatial changes in grain size should they occur. Recommend collecting 2 samples per transect (for a total of N = 6-8 per site). Additional samples may be collected for PSD when servicing proposed instrumentation (at the subset of stations with monitoring devices) for the water quality monitoring component.**

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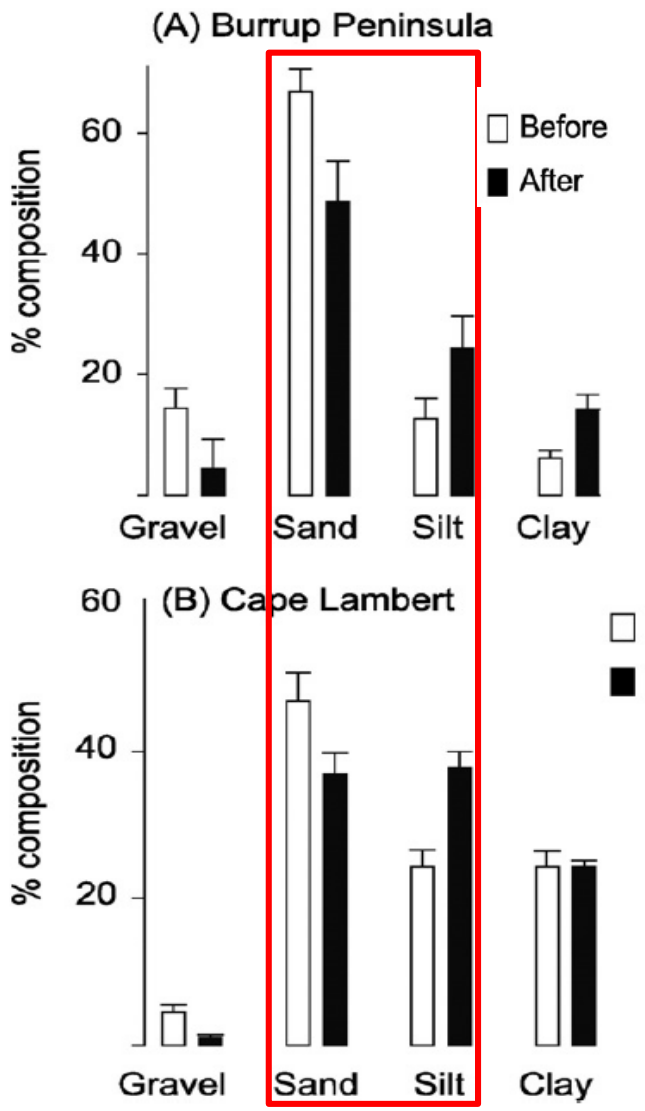
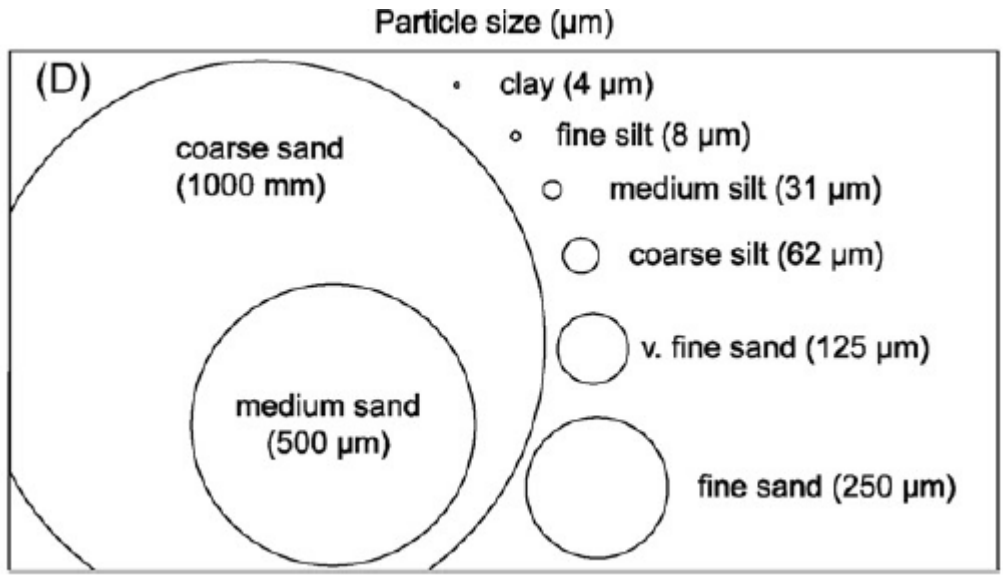
Data example: grain size analyses of surficial sediments before and after dredging





Jones et al. 2016

Results show a shift to finer grain sizes (silts, clays) after dredging

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2.3 Monitoring Protocols

2.3.2.3 Belt transect surveys

2.3.2.3.2 Assessment of tagged corals, octocorals and sponges

For discussion: Need to develop appropriate visual guides (flash cards, etc.) for divers to use prior to beginning the baseline survey to assess the different health "conditions" (bleached, diseased, sediment halo, etc.) of these groups, in particular for octocoral and sponges (for which there may be more limited data compared to scleractinian corals).

- **USACE recommendation: Would like FDEP to provide assessment criteria/protocols for octocorals and sponges to ensure adequate assessment of these functional groups per FDEP's monitoring plan. Recommend either peer reviewed criteria, or criteria developed for other projects permitted by FDEP.**

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3.0 Monitoring Team

For discussion: Minimum qualifications of each team member and essential field/office staff requirements for data collection/QAQC/submittal.

- **FDEP/USACE recommended minimum qualifications: 1) BS or MS degree in Marine Biology, or similar degree (specific requirements for each team member listed below), 2) documented experience monitoring hardbottom / coral reef communities, and 3) Scientific knowledge of marine benthic ecosystems and organisms, including but not limited to scleractinian corals, octocorals, sponges and algae.**

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3.0 Monitoring Team

For discussion: Minimum qualifications of each team member and essential field/office staff requirements for data collection/QAQC/submittal.

USACE recommended essential staff requirements

Field team staff (2 dive teams working simultaneously):

- **Divers/boat operators: BS degree**
- **Field team leader (2): MS degree**
- **Onsite QA/QC officer (1): MS degree**

Office staff:

- **Data entry staff (2): BS degree in Biology/Environmental Science or commiserate experience**
- **QA/QC officer (1): MS degree**
- **Data manager: BS degree in Computer Science (or similar) or commiserate experience**
- **Digital Video Survey Analysis: BS degree**

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3.0 Monitoring Team

For discussion: Minimum qualifications of each team member and essential field/office staff requirements for data collection/QAQC/submittal.

USACE recommended essential staff requirements

Environmental management firm (3rd party contractor on-site):

- **Environmental manager: MS degree**
- **Other team members: Appropriate degrees or qualifications**

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4.0 Additional Quality Assurance/Quality Control

For discussion: Other factors to consider for successful implementation of the plan

- **Reducing the time lag of data output and improving the communication process between contractors, USACE and IWG (especially during construction)**

USACE recommendation: USACE is considering using an environmental contractor SEPARATE from the construction contractor to serve as the 3rd party contractor/monitoring firm. This contractor will hold multiple responsibilities including hiring the primary biological (data collection) monitoring firm, provide additional QA/QC, coordinate data management, reporting, deliverables/timelines, and serve as the primary contact (on-site) between contractors, dredge company, USACE and IWG. Responsible party for AMP data collection, analysis, dissemination TBD.

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4.0 Additional Quality Assurance/Quality Control

For discussion: Other factors to consider for successful implementation of the plan

- **QA / QC process- roles and responsibilities and 3rd party contractor oversight**

USACE recommendation: Need to discuss with IWG but the plan is to have at least 3 levels of QA/QC (field, office and 3rd party contractor). FDEP recommends that the 3rd party firm QA/QC is done with 10% of the data and that surveys are conducted immediately AFTER the primary biological monitoring firm is done with the survey using a random set of control and non-control (project area) stations. Alternatively, the 3rd party QA/QC could be conducted at the same time as the primary monitoring firm using a subset (10%) of the sites already completed by the primary monitoring teams. QA/QC team will follow all of the same data collection requirements, archival and QA/QC for their data as is done by the primary teams.

USACE is also considering creating an in-house dive team which can serve as support personnel for proposed operations and will be trained on the protocols used to conduct surveys, service instrumentation, etc. as needed. Can also be part of the QA/QC process along with a sub-set of IWG members if such protocols are developed.

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4.0 Additional Quality Assurance/Quality Control

For discussion: Other factors to consider for successful implementation of the plan

- **Data management**

USACE recommendation: Hire a data management person, with duties including storage of data, organization of files, submitting to data storage and dissemination website/location, etc. This will be part of the responsibilities of the environmental manager/firm.

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4.0 Additional Quality Assurance/Quality Control

For discussion: Other factors to consider for successful implementation of the plan

- **Reporting requirements, timelines, data formats, mechanism for data submittal and communication process among parties Reducing the time lag of data output and improving the communication process between contractors, USACE and IWG (especially during construction)**

USACE recommendation: Tiered approach for data analyses (See table)

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Review of USACE's proposed Water Quality (WQ) monitoring plan

Purposes:

- Assess how effective are minimization techniques put in place.
- Help establish water quality-based triggers/thresholds (e.g., Fisher et al. 2017) to use during dredging operations and assess if these have been exceeded.
- Obtain continuous, real-time WQ data, from project area during construction.
- Compare turbidity data collected at permanent stations with turbidity data monitored for standard compliance.
- Use in conjunction with biological monitoring data to help discern project-related vs. unrelated impacts to benthic resources, should they occur.

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Effect → Impact

?

Potential indicators of a project-related impact

Visible signs of stress*

Partial/total mortality*

Sediment depths*/bed elevation

Fine sediments (silt or clay-sized)*

Turbidity

Total suspended solids (TSS)

Light (PAR)

*Biological monitoring

Natural stressors (project-unrelated impacts)

- Freshwater releases (decreases salinity/ increases turbidity)
- Temperature (causes bleaching; dredging can exacerbate effects)
- Storms and other weather events (may cause partial/total mortality and changes in water quality)
- Local hydrodynamics (may change patterns of sediment transport, turbidity, etc.)

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Review of USACE's proposed Water Quality (WQ) monitoring plan

What is under consideration?

- **2 seasons or up to 1 year of baseline monitoring prior construction**
- **Permanent (or mobile) stations housing instruments which MAY include:**
  - **OBS turbidity sensor**
  - **Altimeter ("Echo-logger")**
  - **Salinity/temperature data logger**
  - **Light (PAR) data logger**
  - **Fixed view underwater camera**
  - **Acoustic Doppler Current Profiler (ADCP)/Acoustic Doppler Velocimeter (ADV)**
  - **Tilt meter**
  - **Telemetry (for real-time data acquisition)**
- **Daylight camera on high-rise building near channel**
- **Boat-towed ADCP measurements during construction**

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INSTRUMENTATION PRESENTATION OUTLINE

- Objectives
- Instrument Introduction
  - Hydrodynamics
    - ADCP
    - ADV
    - Tilt meter
  - Water Quality
    - OBS (Turbidity meter)
    - Altimeter (‘echologger’)
    - Salinity / Temperature data logger
    - Light data logger
  - Telemetry

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INSTRUMENTATION OBJECTIVES

- To provide (near) continuous monitoring of hydrodynamic forcing and concurrent water quality response across the spatial domain.
- Reduce time-lag in identifying and responding to impacts to resources

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INSTRUMENTATION INTRODUCTION – HYDRODYNAMICS: ADCP

Acoustic Doppler Current Profiler (ADCP)

- Measures:
  - Current profile
  - Waves
  - Suspended Sediment Concentration (SSC)
- Difference in frequency between sound waves the profiler sends out and the waves it receives is called Doppler shift. ADCP uses this shift to calculate how fast the particle and the water around it are moving
- Can be bottom-mounted, side-mounted, or vessel mounted
- Estimated Cost: ~$25k per instrument

- Data Uses:
  - Background physical data and forcing
  - Can be correlated with benthic data to help discern project-related impacts

- Advantages
  - No moving parts = less biofouling
  - Measures current profiles exceeding 1,000 m
  - Standard technology used for wave and current measurements in depths between 2 and 100 m

- Disadvantages
  - Sidelobe interference leads to lost of information close to the surface
  - Expensive
  - Backscatter isn't very precise at any concentration, little to no value at low concentrations

Teledyne Workhorse Sentinel ADCP

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INSTRUMENTATION INTRODUCTION – HYDRODYNAMICS: ADV

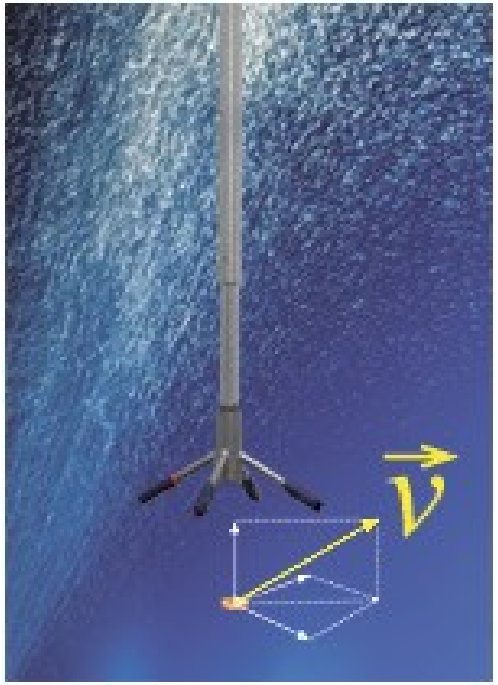
Acoustic Doppler Velocitymeter (ADV)

- Measures:
  - Instantaneous velocity at a single point
  - Suspended Sediment Concentration (SSC)
  - Waves using PUV (Pressure signal and directional estimates from orbital velocity measurements (U and V)
  - Altimetry function when pointed down with precision ~ 1 cm
- Measures the velocity particles (sediments) at a point in the water column from the Doppler shift in frequency of the emitted and received acoustic signals
- Estimated Cost: ~$20k per instrument

- Data Uses:
  - Point SSC
  - Point velocity, can be used to determine near bed velocity with high precision

- Advantages
  - Very precise u,v,w profiling
  - Insensitive to fouling
  - Widely used, proven technology

- Disadvantages
  - Small profiling zone (~3 cm)
  - Expensive



Nortek Vectrino

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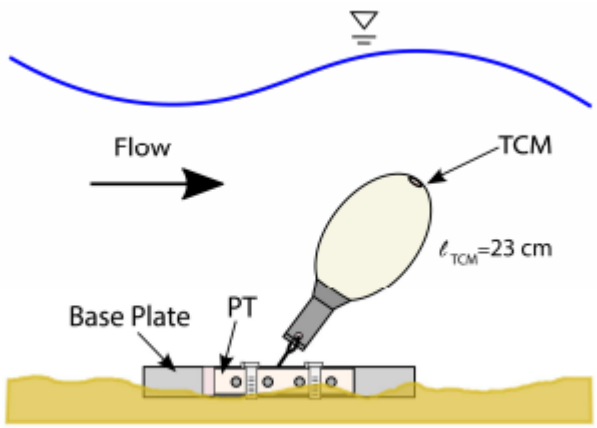
INSTRUMENTATION INTRODUCTION – HYDRODYNAMICS: TILT METER

Tilt Current Meter (TCM)

- Measures:
  - Current velocity
- Estimated Cost: ~$2k per instrument



From: Anarde and Figlus, 2017

- Data Uses:
  - Lower level velocity in low wave energy environments
  - High spatial coverage
- Advantages
  - Inexpensive
- Disadvantages
  - Only collect data near bed
  - Not as accurate as ADCP/ADV
  - Influenced by presence of waves
  - Susceptible to fouling
  - Not considered industry standard, not widely used/proven technology

From: Technical University of Denmark

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INSTRUMENTATION INTRODUCTION – WATER QUALITY: OPTICAL BACKSCATTER SENSORS

Optical Backscatter Sensor

- Measures:
  - Turbidity
  - Suspended Solid Concentration
- Detects infra-red light scattered from suspended matter
- Estimated Cost: ~$5k per instrument

From: Campbell Scientific

- Data Uses:
  - Turbidity data
  - Combine with water samples to correlate to TSS
- Advantages
  - Relatively inexpensive
  - Sensitive to fines
- Disadvantages
  - Each sensor has to be calibrated using sediment from the site of interest
  - Biofouling, but can purchase with wipers to significantly reduce

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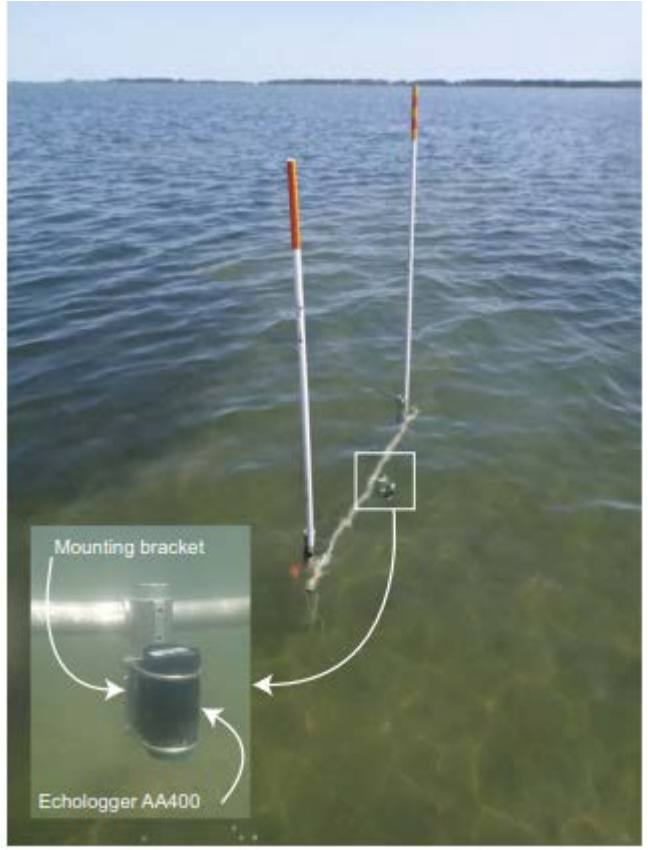
INSTRUMENTATION INTRODUCTION – WATER QUALITY: ACOUSTIC ALTIMETER

Acoustic Altimeter

- Measures:
  - Bed elevation
  - Suspended Solid Concentration
- Acoustic pulses sent straight down to sea bed and returned to instrument. Time (corrected speed of sound in water) is used to calculate the distance
- Estimated Cost: ~$5k per instrument

From: EchoLogger

- Data Uses:
  - Bed elevation change
- Advantages
  - Relatively inexpensive
- Disadvantages
  - Frame can lead to scour in nearby area
  - SSC measurements are suspect at best



From: Ganju et al. 2016

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INSTRUMENTATION INTRODUCTION – WATER QUALITY: SALINITY/ TEMPERATURE DATA LOGGER

Salinity / Temperature Sensor

- Measures:
  - Temperature
  - Salinity / Conductivity
- Determines salinity based on electrical conductivity. Measures how much electrical current flows through the water. The more salt dissolved in water, the better the water will conduct electricity
- Estimated Cost: ~$7k per instrument

From: Sea-Bird

- Data Uses:
  - Temperature data
  - Salinity data
- Advantages
  - Low cost
- Disadvantages
  - Susceptible to biofouling
  - Longer deployments may need external data logger

From: HOBO

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INSTRUMENTATION INTRODUCTION – WATER QUALITY: LIGHT DATA LOGGER

PAR sensor

- Measures:
  - light
- Recorded at or just above flora
- Estimated Cost: ~$6k per instrument

From: YSI

- Data Uses:
  - PAR
- Advantages
  - Low cost
  - Can be integrated with CTDs
- Disadvantages
  - Biofouling – need wiper
  - External data logger need
  - Real time capabilities?

From: Sea-Bird

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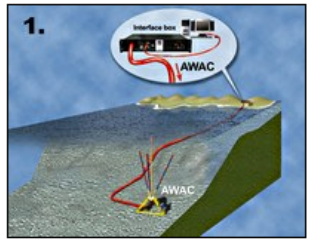
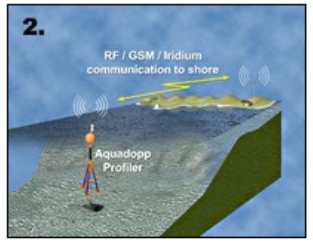
INSTRUMENTATION INTRODUCTION – TELEMETRY

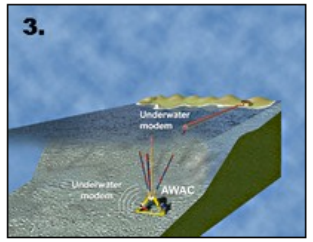
Real Time Systems (from Nortek) (~$40 - $250k per)



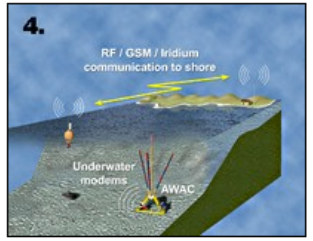
1. Bottom mounted instrument with power & data cable to shore



2. Surface buoy mounted instrument with Radio Modem, GSM or Iridium telemetry to shore



3. Bottom mounted instrument with underwater acoustic modem transmission to shore or offshore structure



4. Bottom mounted instrument with underwater acoustic modem transmission to surface buoy with final Radio Modem, GSM or Iridium communications to shore

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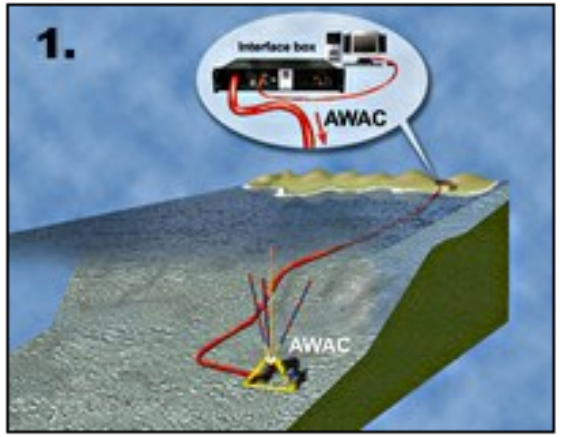
INSTRUMENTATION INTRODUCTION – TELEMETRY

Real Time Systems (from Nortek) (~$40 - $250k per)



1. Bottom mounted instrument with power & data cable to shore

System 1

Pros

- Deployment length and sampling interval not limited by power
- High bandwidth communications
- Direct communication with instrument
- Low Maintenance

Cons

- Cable damage by boating and fishing activities
- Lots of cabling

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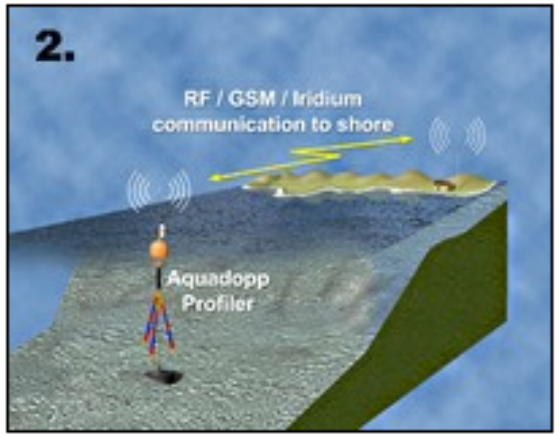
INSTRUMENTATION INTRODUCTION – TELEMETRY

Real Time Systems (from Nortek) (~$40 - $250k per)



2. Surface buoy mounted instrument with Radio Modem, GSM or Iridium telemetry to shore

System 2

Pros

- Do not require divers (surface buoy)
- Can profile upper portion of water column
- Relatively high bandwidth for data transmission
- Opportunities to charge batteries via solar or wind

Cons

- Possible damage by ships, storms, and vandalism
- Cannot measure waves, near bottom parameters
- Local RF noise or GSM coverage may cause communication problems offshore

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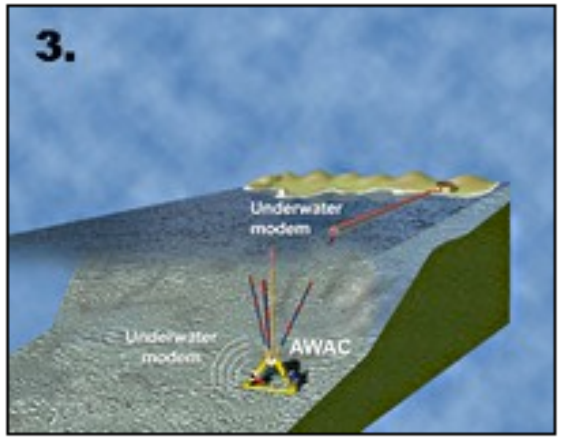
INSTRUMENTATION INTRODUCTION – TELEMETRY

Real Time Systems (from Nortek) (~$40 - $250k per)



3. Bottom mounted instrument with underwater acoustic modem transmission to shore or offshore structure

System 3

Pros

- Can be located in areas with heavy boating and fishing activity
- Less cabling
- Direct communication with instrument
- Need to pre-process data internally for efficient data transmission

Cons

- Relatively low bandwidth communications
- Period battery replacement

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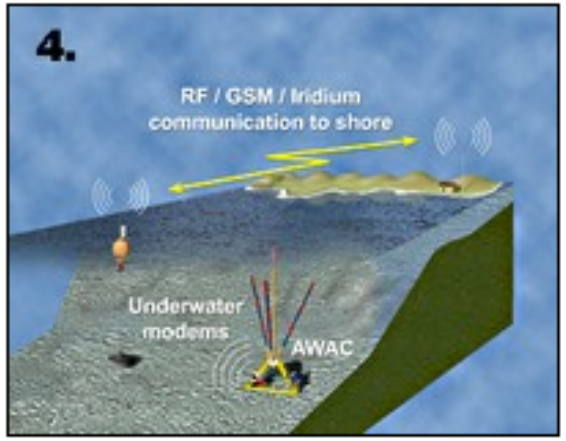
INSTRUMENTATION INTRODUCTION – TELEMETRY

Real Time Systems (from Nortek) (~$40 - $250k per)



4. Bottom mounted instrument with underwater acoustic modem transmission to surface buoy with final Radio Modem, GSM or Iridium communications to shore

System 4

Pros

- Bottom mounted instruments
- Can be deployed without regard for nearby communication structure

Cons

- Relatively low bandwidth
- Periodic replacement of batteries
- Requires surface buoy

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Review of USACE's proposed Water Quality (WQ) monitoring plan

Factors to consider for placement of WQ monitoring stations:

1. **Have large spatial coverage; high density of "low" cost stations.**

2. **Collect high resolution data in areas of sensitive resources or expected impacts; few "high" cost stations with real-time data acquisition during construction.**

3. **Change timing of real-time acquisition (pre-, during- or post-construction).**

4. **Consider having mobile stations, location to vary depending on where dredging is occurring at any given period. Requires more logistics.**

USACE is considering a mixture of "low" cost and "high" cost stations placed across project area.

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Review of USACE's proposed Water Quality (WQ) monitoring plan

Equipment under consideration

"Low" cost array	"High" cost array
OBS turbidity sensor	OBS turbidity sensor
Acoustic altimeter "Echologger"	Acoustic altimeter "Echologger"
Light (PAR) data logger	Salinity/temperature data logger
Tilt meter	Light (PAR) data logger
	Fixed view underwater camera
	ADCP and/or ADV
	Telemetry package
~$18K	~$100K

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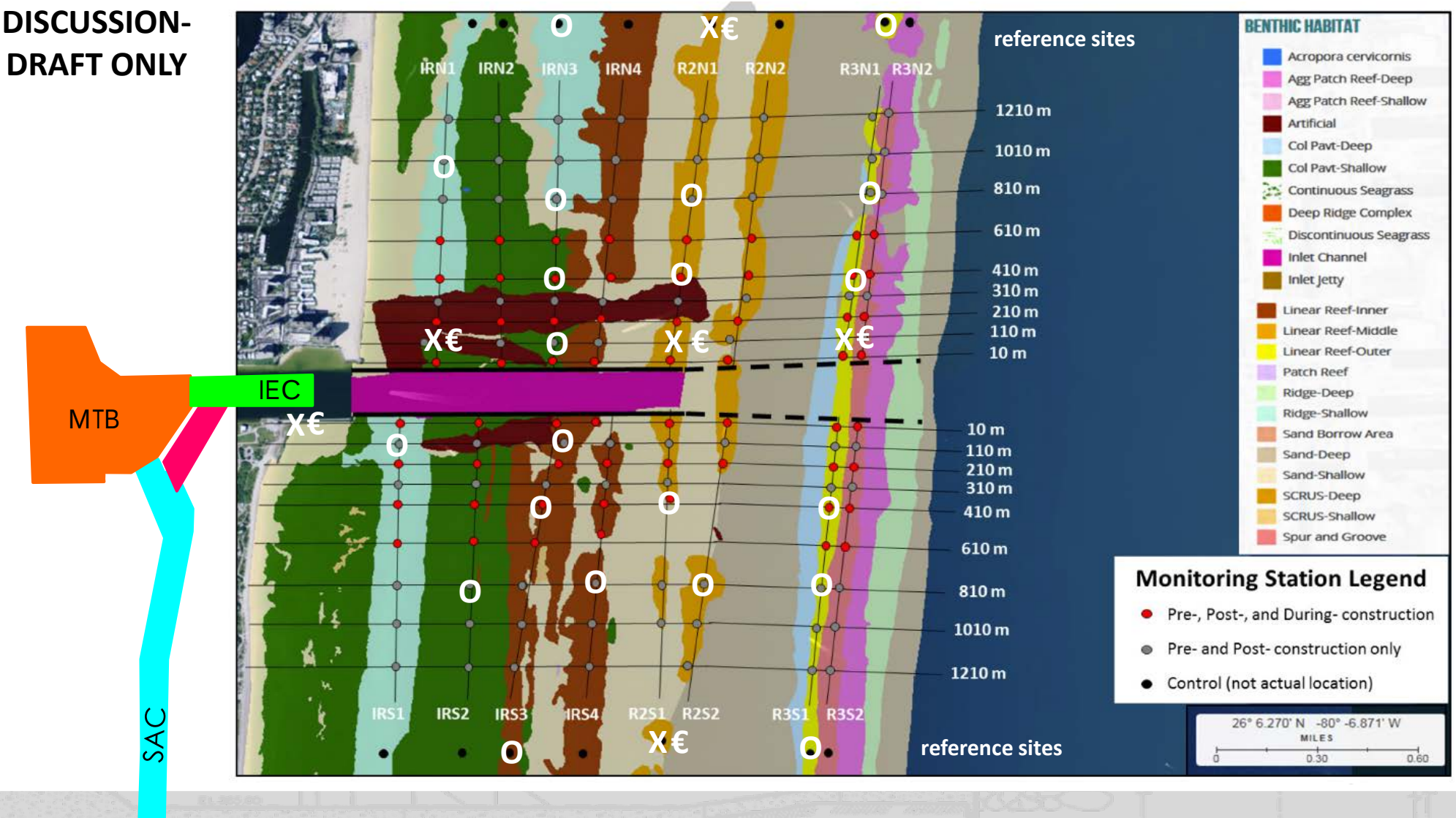
Review of USACE's proposed Water Quality (WQ) monitoring plan

What is the ideal scope and spatial extent?

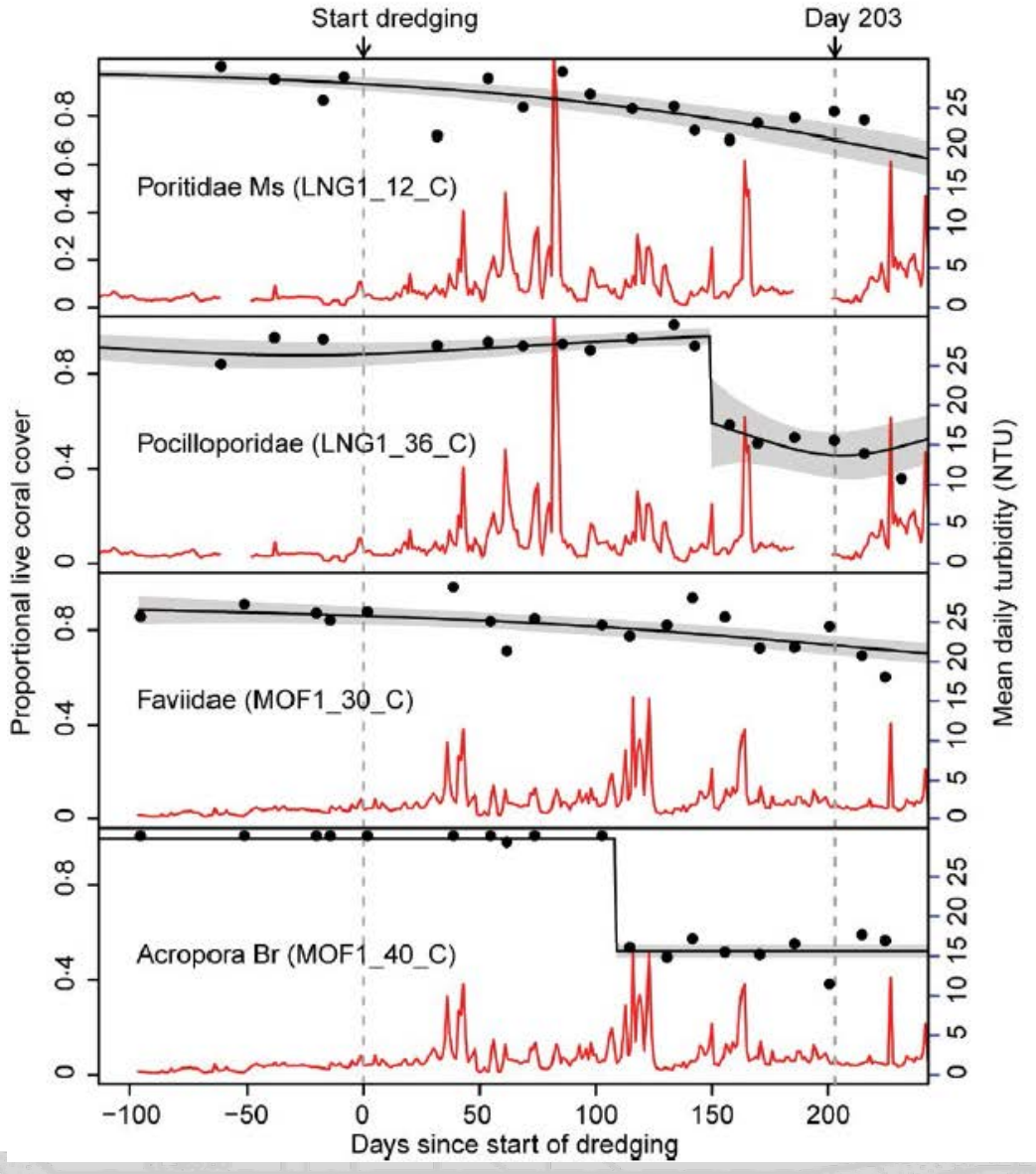
FOR DISCUSSION-DRAFT ONLY

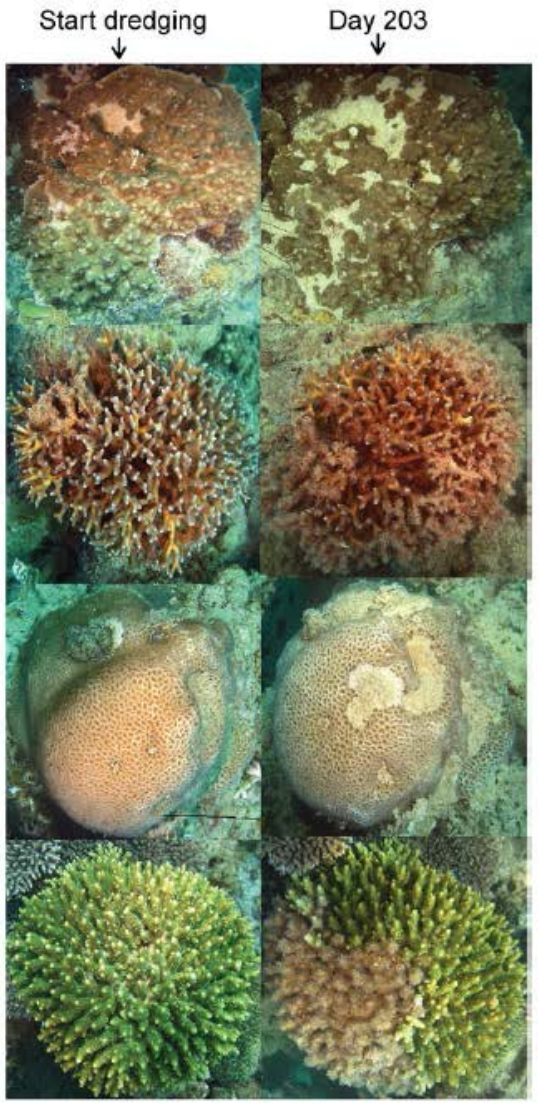
Legend: X= high cost array, O= low cost array, € = real-time during construction



Review of USACE's proposed Water Quality (WQ) monitoring plan

How can we link the Biological and WQ monitoring data?





Fisher et al. 2017

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Review of USACE's proposed Water Quality (WQ) monitoring plan

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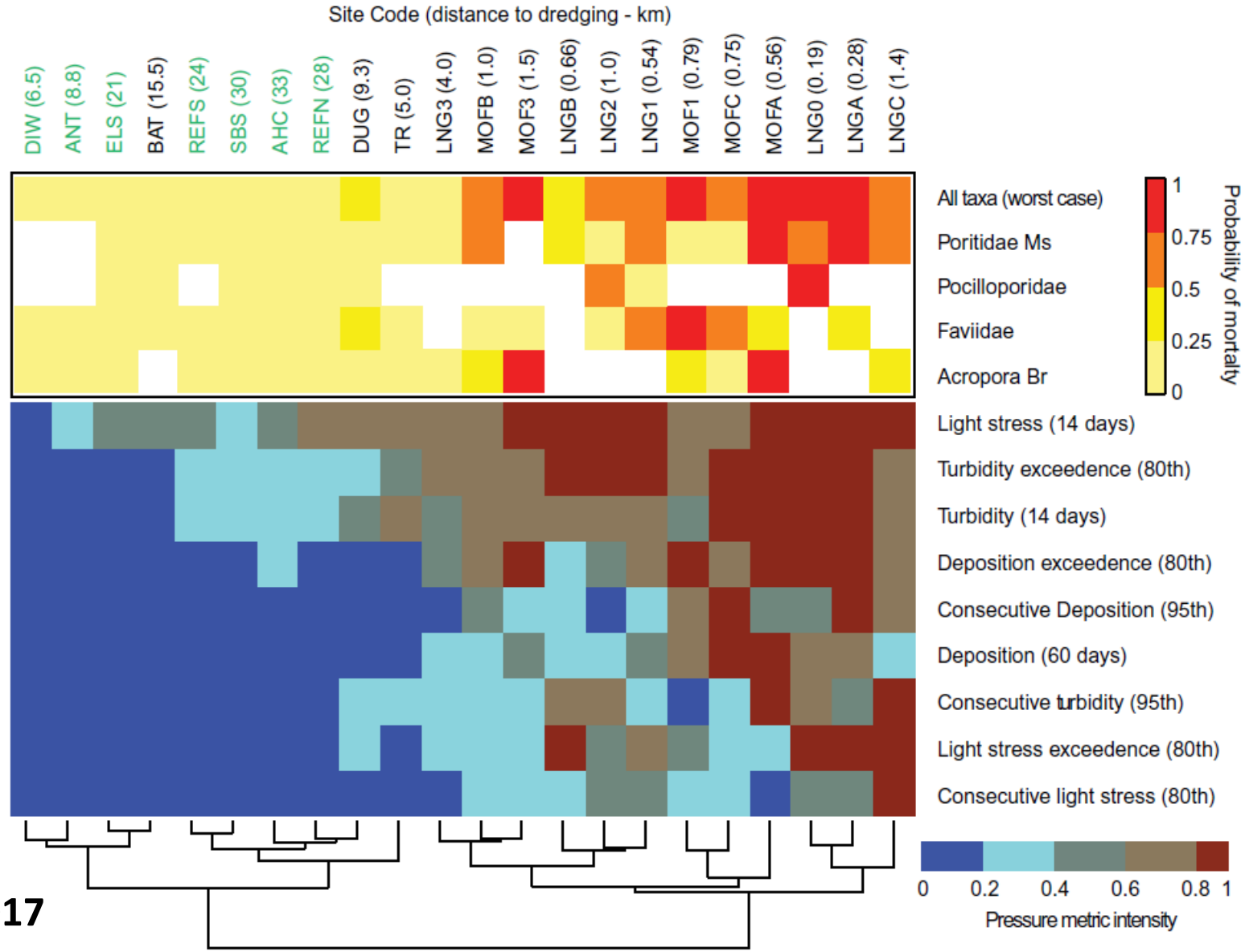

Fisher et al. 2017

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WRAP-UP AND NEXT STEPS INCLUDING HOW TO ADDRESS UNFINISHED TOPICS IF ANY.

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