Oyster Mapping Guidance Document

Oyster Integrated Mapping and Monitoring Program &
Florida Oyster Recovery and Science Workshop

May 10, 2022, St. Petersburg, FL

FORS Mapping Sub-committee

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Jonathan Brucker, Vincent Encomio, Laura Geselbracht, Anthony Gillis

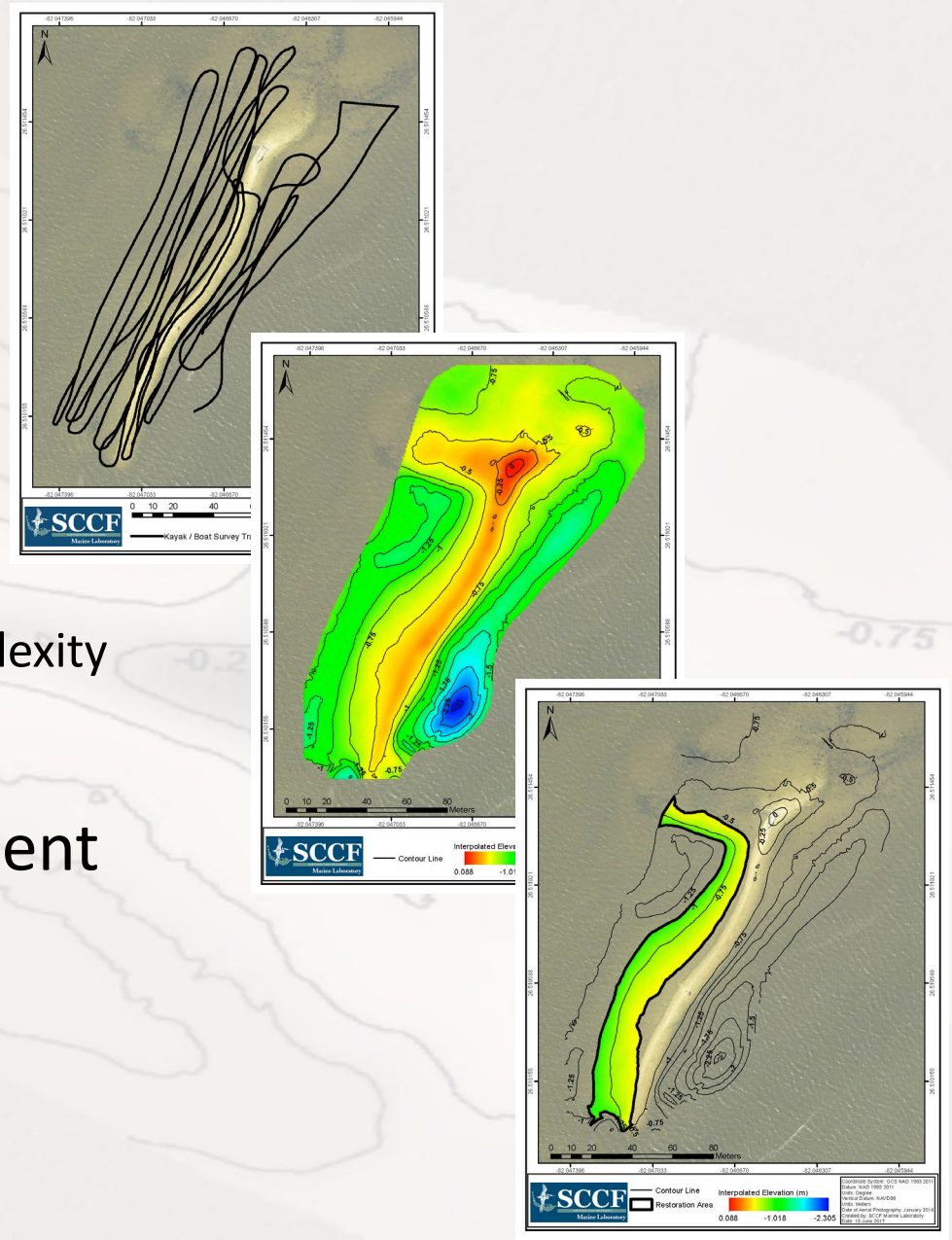
Goals

- Develop science-based mapping guidance to inform oyster recovery and management of Florida's oyster habitat and fisheries.
- Foster comparability among mapping metrics, methods, and models.
- Compile, compare, and provide technical guidance on existing and new mapping metrics and methods.

Contents

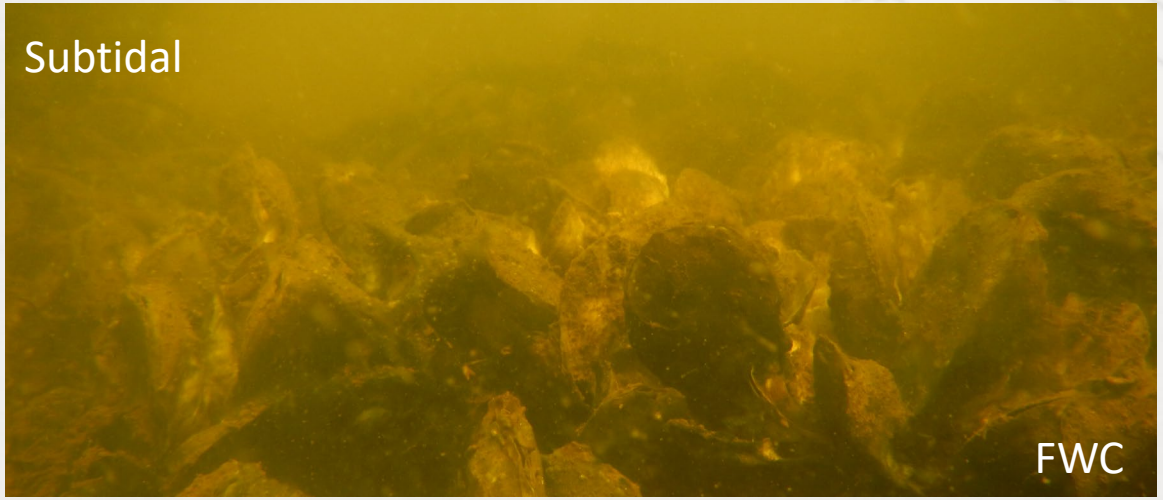
Applications of Mapping Data

- Oyster Resource Mapping
- Oyster Mapping as a Monitoring tool
  - Some metrics can be derived from mapping
    - Area, height, emerging methods for structural complexity
- Oyster Resource Restoration and Enhancement
  - Suitability modeling
  - Ecosystem services quantification

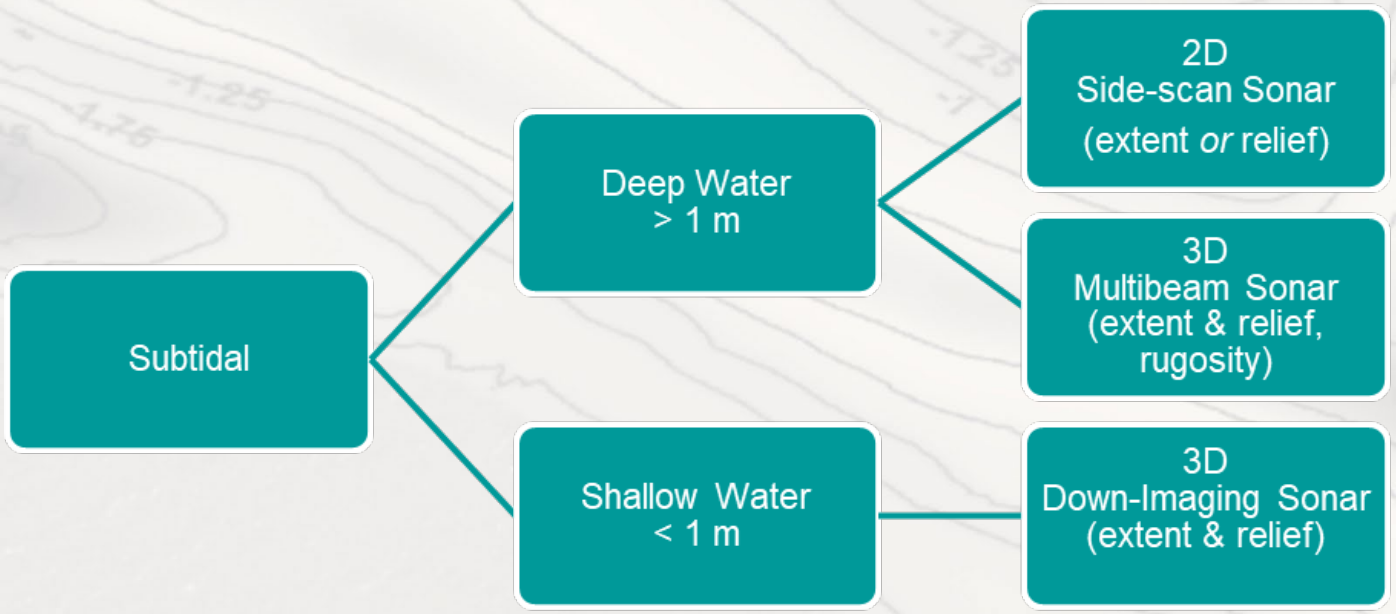


Mapping Methods

- Subtidal & intertidal habitats
  - 2D & 3D methods
  - Method comparison tables
    - Costs, limitations
  - Application decision trees
- Data products
- Ground-Truthing and Data Quality



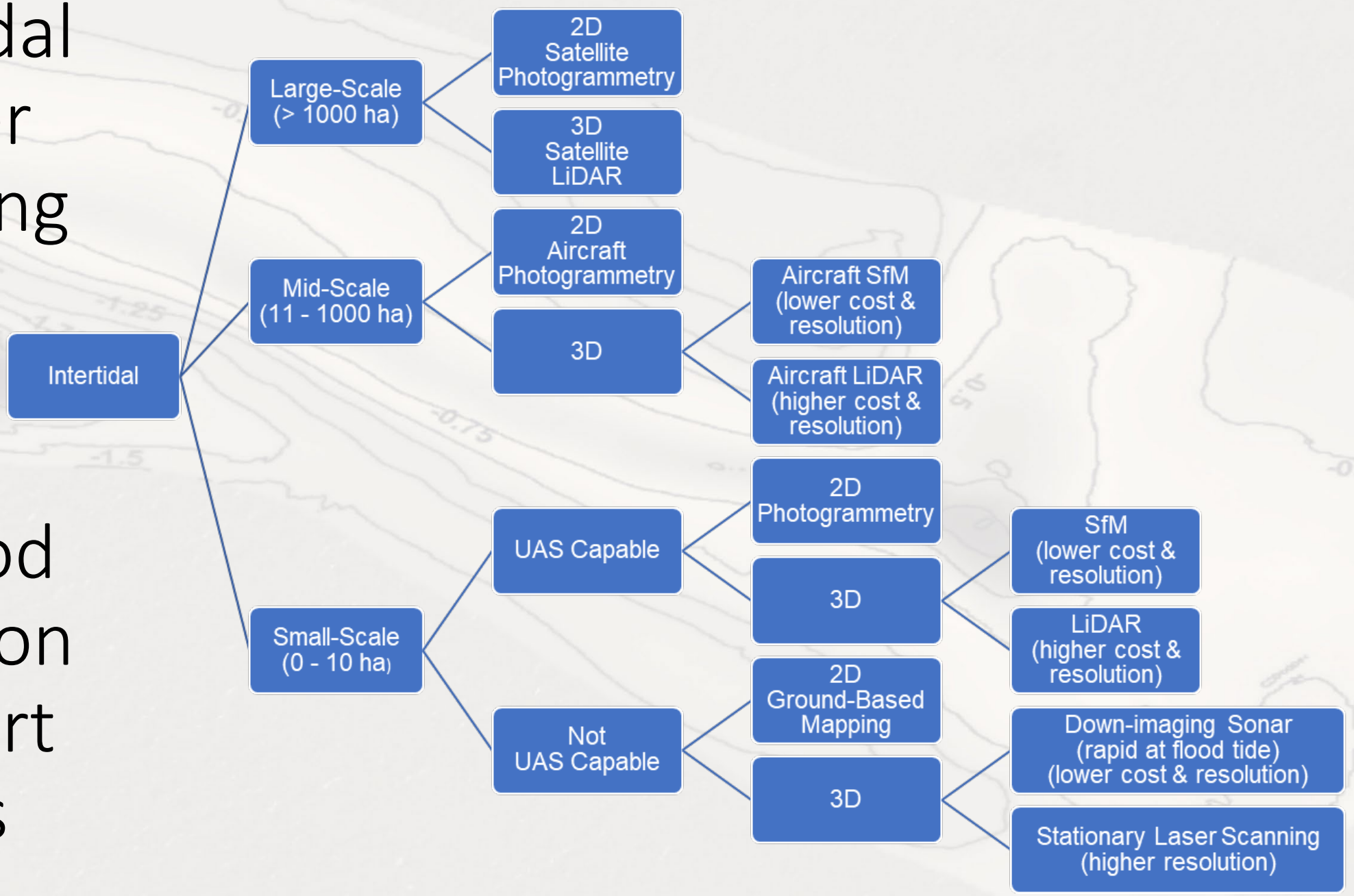
Subtidal Oyster Mapping Method Selection Support Tools



Method	Best Application	Possible Uses	Limitations	Cost	Ease of Use	Resolution and Notes
Side-scan sonar	Subtidal reef mapping	Reef height Reef area	Applicable in waters at least 0.8 m deep.	Dependent on sonar swath spacing and whether processing is included. $4,700/km^2 (76 m spacing of lines for surveying. Contracted post- processing can double or triple costs).	Requires software skill for accurate post-processing.	Preferred for “cleaner” sonar swath edge than multibeam in moderate-depth waters.
Down-imaging sonar	Subtidal or intertidal reef mapping	Reef height Reef area	Metrics modeled through GIS.	$16,000 (Sonar plotter, transducer, mounting hardware, battery and housing, RTK GPS, GNSS receiver, and antenna rod. Additional costs of boat or kayak, GIS license, field time, and processing not accounted for.)	Requires GIS skill for accurate post-processing.	GPS accuracy +/- 10 cm horizontal. Sonar accuracy +/- 8 cm vertical.
Multibeam sonar	Subtidal reef mapping, substrate type	Reef height Reef area Substrate type	Requires intensive effort in shallow waters; Requires knowledge for accurate post-processing.	Unmanned surface vessels $2,000/day. Up to 5.2 km^2 of surveying per day.	Post-processing can be challenging & technically intensive.	
Sub-bottom profiling	Subtidal, sub-bottom hard bottom mapping	Detection of buried hard substrate	Vertical profile x-section. Only useful to detect buried hard bottom (e.g., remnant reef).	$600/day including post-processing time. 32 km of track per day on average.	Best when operator owns the equipment. Rental costs are unpredictable & escalate when weather delays operations.	This is an add-on tool to complement sonar imaging. Provides information on what is buried beneath the near surface.

Intertidal Oyster Mapping

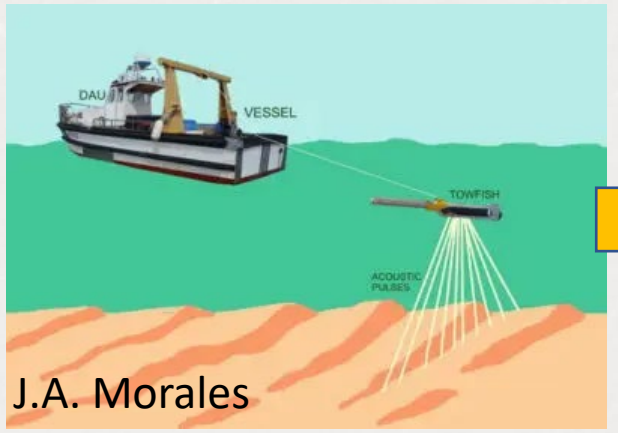
Method Selection Support Tools



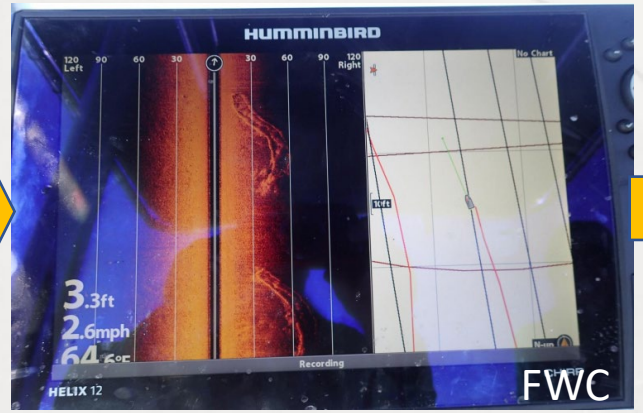
Method	Best Application	Possible Uses	Limitations	Cost	Ease of Use	Resolution and Notes
LiDAR - UAS (Unmanned Aircraft System, "drone")	Intertidal reef mapping	Reef height Reef area	Cost prohibitive for large areas. Field logistics (weather). UAS prohibitions may exist in some areas.	Sensor hardware - $75,000 – $100,000. Software license $40,000 – $45,000/year. Contracted: $300/ flight, (processing models, photo mosaics, and travel).	Requires experienced pilot & data processor. Open-source software exists, and processing can be done in GIS.	Sub-cm resolution.
LiDAR - Satellite acquired	Intertidal reef mapping	Reef height Reef area	Lower resolution, or cost for high-resolution, unable to map under mangrove. Poor water penetration.	Global Ecosystem Dynamics Investigation (GEDI) and NASA IceSat-2 LiDAR data are available free.	Many digital models have been developed. Uncommon to task satellites with custom data collection.	Resolution GEDI-25 m up to 1 km; IceSat2- as high as 0.7 m, but varies with cloud cover and reflectivity
LiDAR - Planes	Intertidal reef mapping	Reef height Reef area	Cost for high-resolution. Unable to map under mangroves. Poor water penetration. Flight logistics (weather, tide).	$215 – $300 per km^2 ($0.87-$1.21 per acre). Variable based on area & resolution. Larger areas have lower per-unit cost	Many contractors available that can customize flight times/locations; contractors are able to process data.	Resolution varies by contractor/ equipment used, but can be as high as 1 cm.
LiDAR - Bathymetric	Subtidal reef mapping	Reef height, Reef area, Reef rugosity.	Aerial, surface, and subsurface technologies exist.	Bathymetric LiDAR is much more expensive than conventional LiDAR (Dewberry 2017).	Possibly difficult to compare data with other methods if not aerial.	Highest vertical resolution currently available is +/- 0.25 m.
Stationary 3D Laser Scanning	Intertidal reef mapping	Georeferenced reef height, Reef area, Reef rugosity.	Intertidal only, limited to small areas (line of sight).	Hardware cost approximately $20,000 and up.	High-resolution. Low startup cost. Useful where UAS disallowed.	Resolution as high as 1 mm. See charts in Massot-Campos & Oliver-Codina (2015).

Data Analysis

- Processing data and interpreting output
  - Workflow Appendix
  - High level examples that point toward primary sources
    - Side-scan sonar
    - SfM
    - LiDAR
    - Imagery digitization



J.A. Morales



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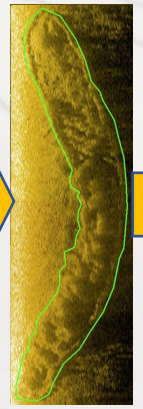
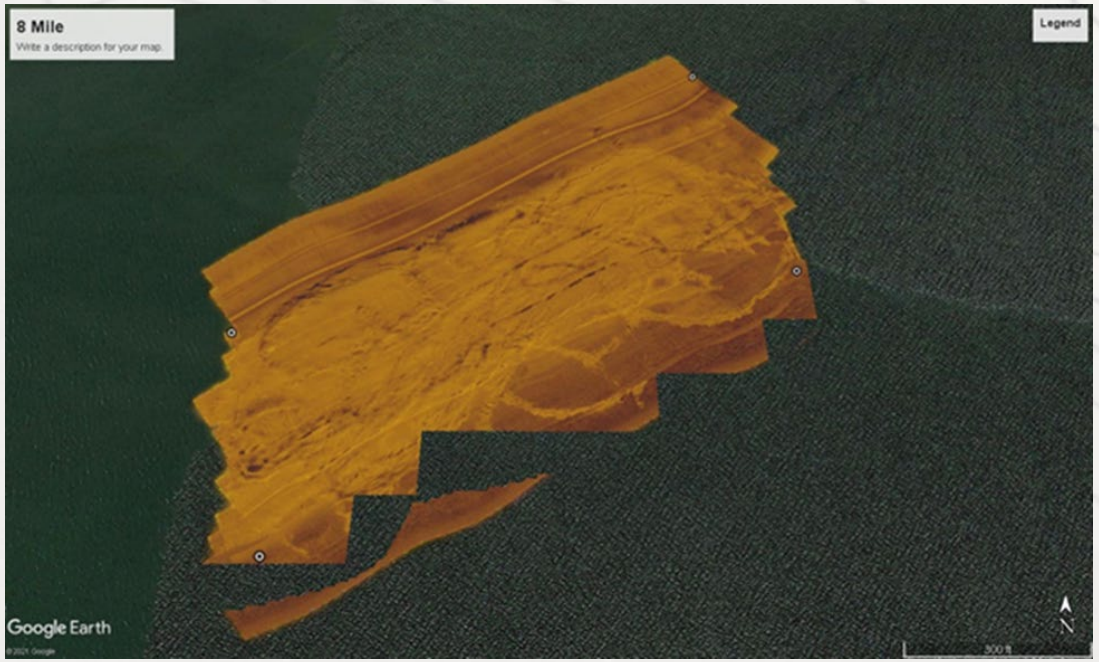
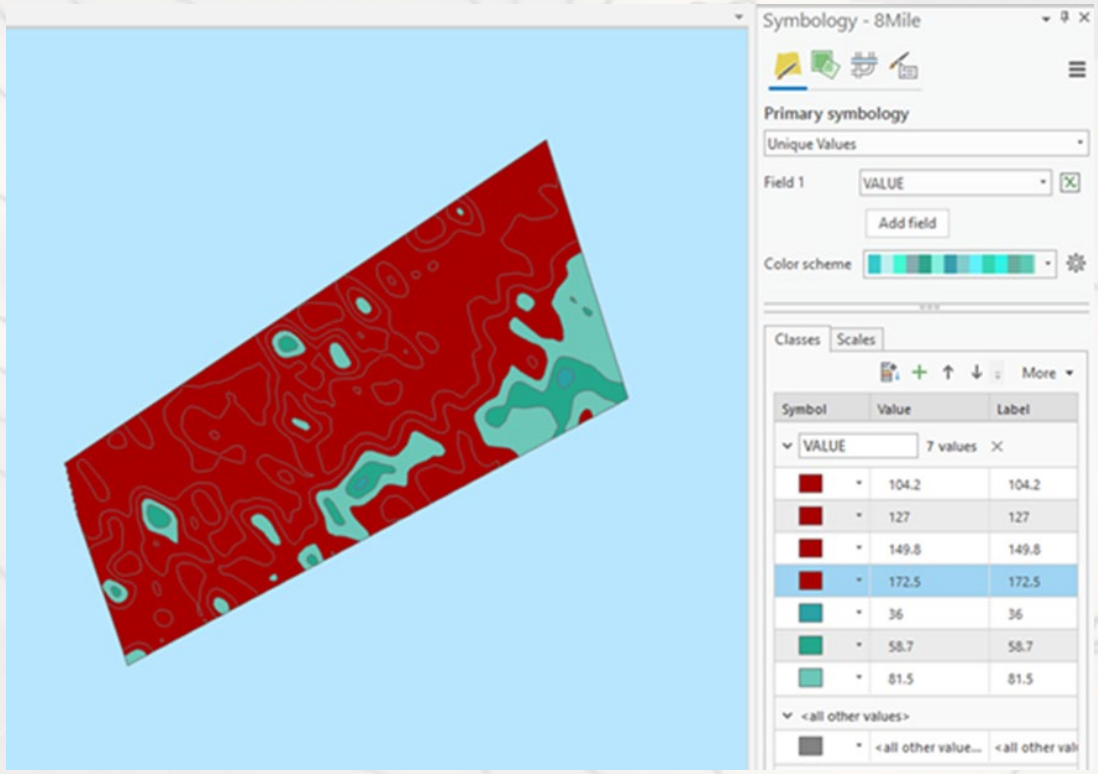
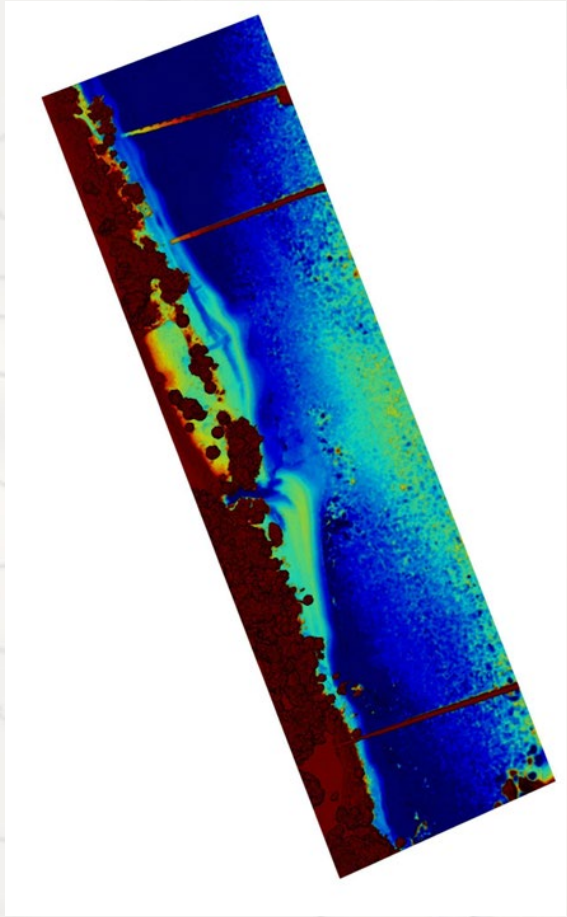


Side-scan Sonar Oyster Mapping Workflow

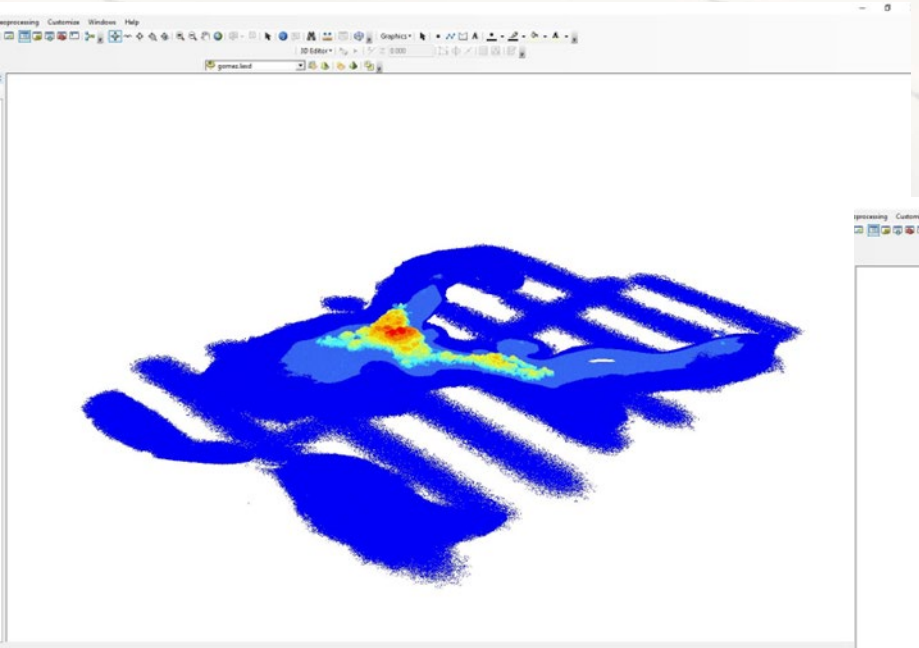


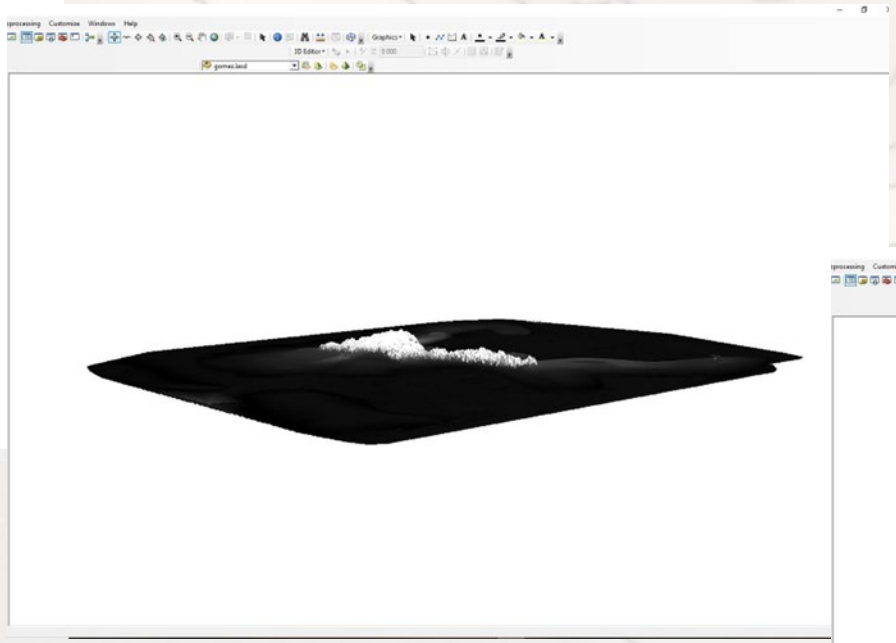


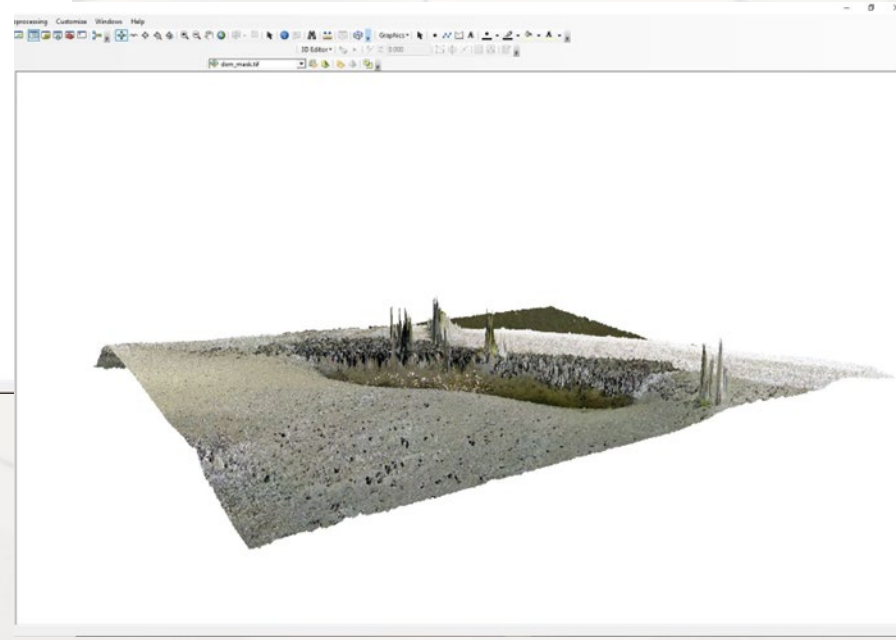
SfM Oyster Mapping Workflow



LiDAR Oyster Mapping Workflow







Acknowledgements

Florida Oyster Recovery & Science working group Mapping Sub-committee

- Corey Anderson
  Correspondence: Corey.Anderson@MyFWC.com
- Brittany Bankovich
- Jennifer Bock
- Sandra Brooke
- Jonathan Brucker
- Vincent Encomio
- Laura Geselbracht
- Anthony Gillis

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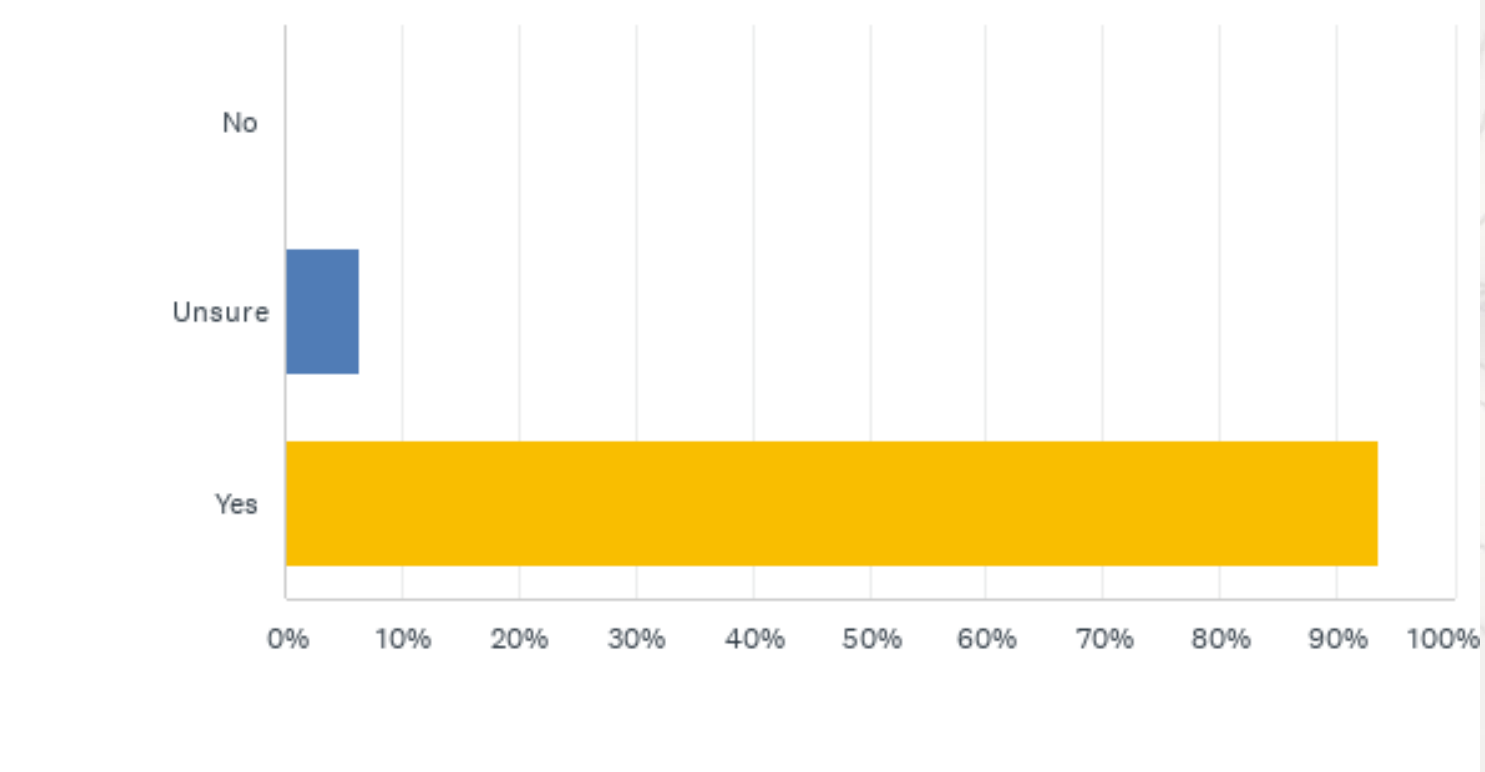
- Becca Hatchell
- Kristen Kaufman
- Katie Konchar
- Kara Radabaugh

FORS Mapping Discussion Question & Answer Session

- Tuesday, May 10, 2022
- Complete Responses: 31

Q1: Is this kind of document useful in your work?

- Answered: 31 Skipped: 0



Q1: Is this kind of document useful in your work?

- Answered: 31 Skipped: 0

ANSWER CHOICES	RESPONSES	
□ No	0.00%	0
□ Unsure	6.45%	2
□ Yes	93.55%	29
TOTAL		31

Comments:

But how to define features and deal with progression of habitats over time?

I would have no idea where to even start with mapping a reef as I am new to the field.

Addressing the different techniques, their advantages & pitfalls, where to use/not use, how to interpret and analyze, how to use over time and compare with historical information, how to ground truth, and what are the resolution capabilities of each method - very research question specific.

I don't do mapping projects myself, but my program uses mapping data frequently and improving standardization/consistency/quality of methods used and the data collected will benefit me.

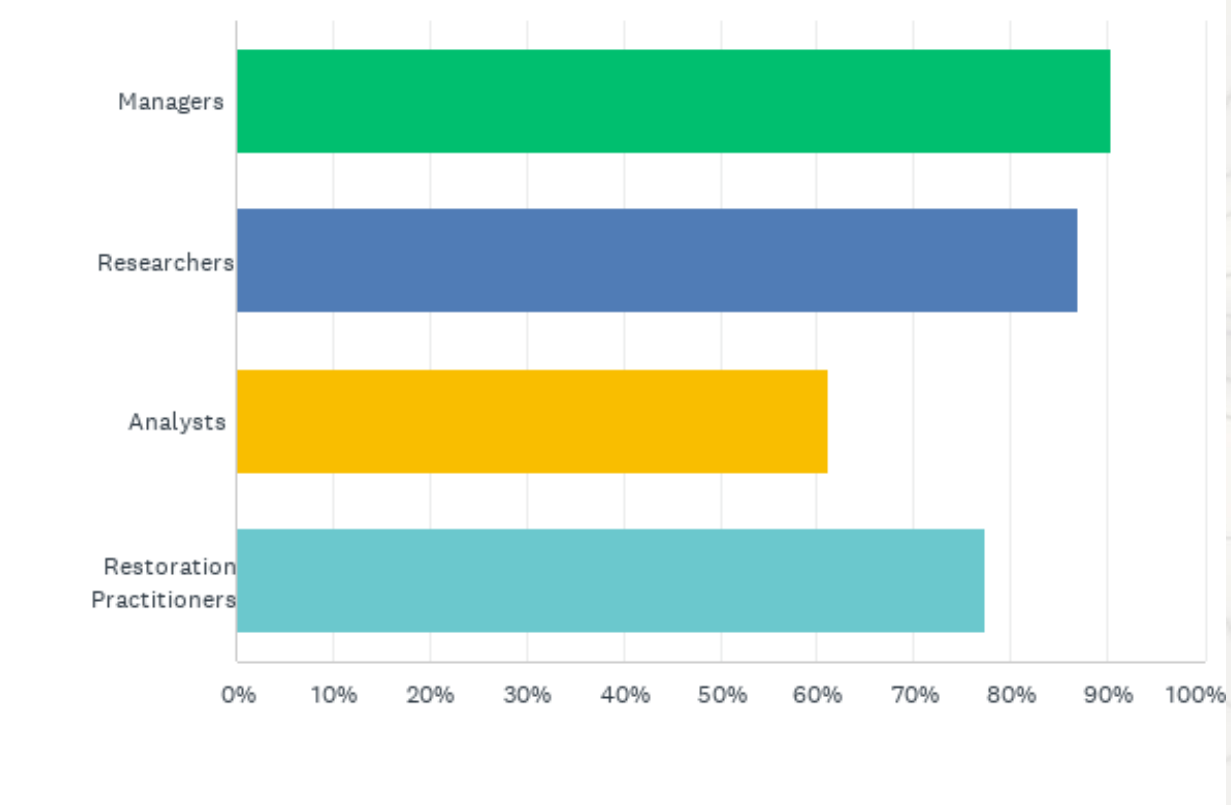
Have not pursued mapping efforts yet but hoping to. Projects will likely be small scale.

I personally do not do mapping like this, but it could be useful for my lab should we go down this route

I think this mapping effort is informative, but the mapping is not matched with other spatial elements such as shellfish harvest or restoration efforts.

Q2: Who do you feel this document applies to most? Check all that apply:

- Answered: 31 Skipped: 0



Q2: Who do you feel this document applies to most? Check all that apply:

- Answered: 31 Skipped: 0

ANSWER CHOICES	RESPONSES	
Managers	90.32%	28
Researchers	87.10%	27
Analysts	61.29%	19
Restoration Practitioners	77.42%	24
Total Respondents: 31		

Q3: Are there any mapping techniques not covered that you would like to see included?

- Comments:

Repeat mapping in an area.
How to deal with differences in scale. How to compare with previous work/interpretation.
Change analysis - this is an ongoing conversation at the NERRS too for all coastal habitats.
Fine-scale resolution, but this is really research question specific. Rugosity measurements are very limited in terms of reef complexity (resolution constraints) and correlate more to surface area (which is already captured by the scan) than actual complexity (holes, overhangs, crevices, etc.)
I'm not sure mapping efforts provide the context needed to inform management because it is hard to inform "rates" used in management (lambda, mortality, etc.) from spatial information. What IS needed from a mapping context is trying to understand successional processes such as marsh converting to oyster reef.

Q4: We would like this document to be as accessible as possible, do you have platform suggestions for hosting it?

Comments:

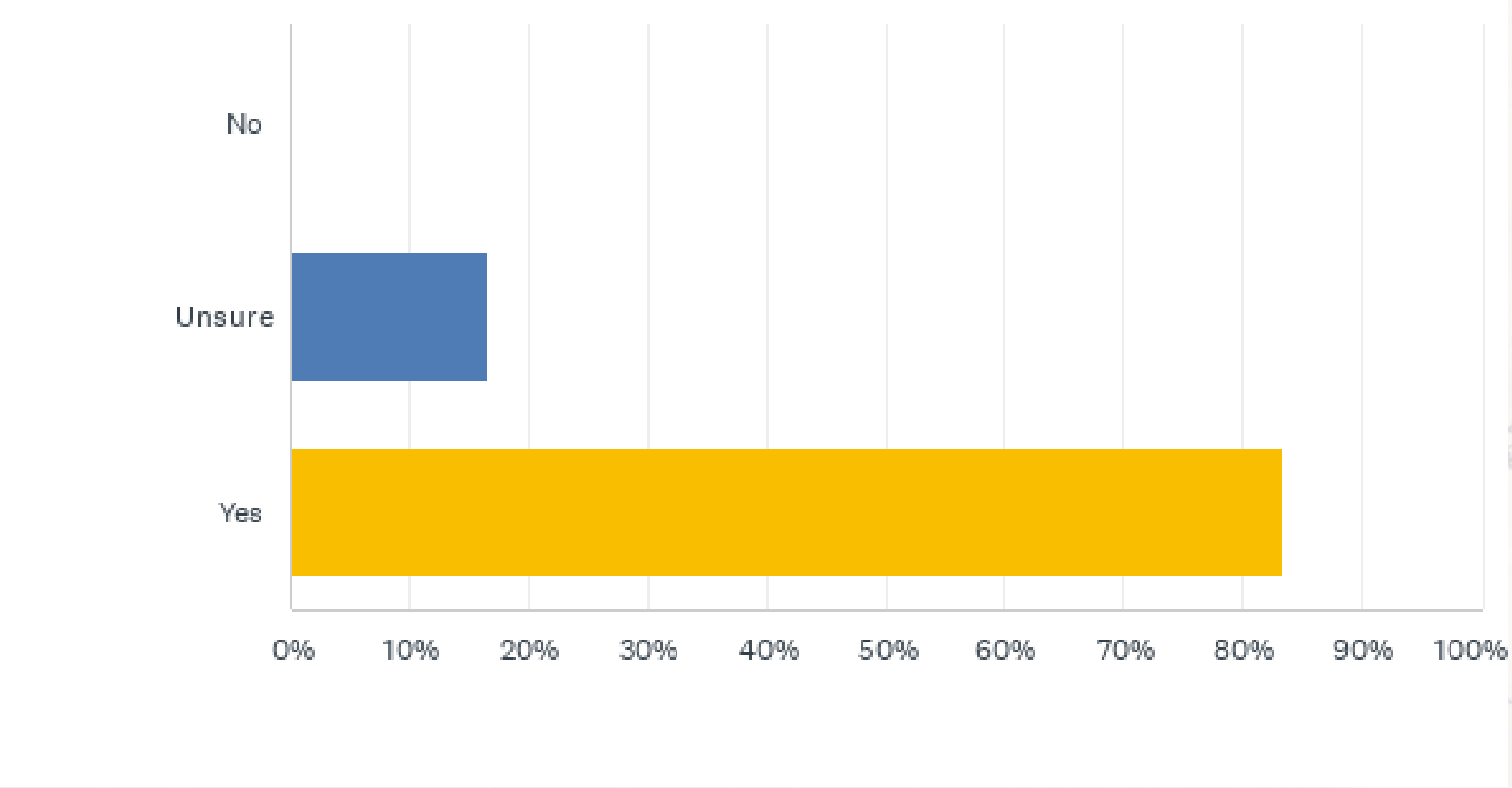
- Host on OIMMP page
- Host or promote through Federal agency, e.g., NOAA
- http://www.oyster-restoration.org/
- PDF posted online
- PDF on FWC website
- ScienceBase
- open source
- DEPs SEACAR database

Q5: How can this subcommittee support you as technology and expected skills advance for mapping?

- What training is needed? This can be a good reference on the various techniques & helpful for comparisons.
- Resources on how to connect with people with relevant expertise.
- Links to techniques (or SOP for methodology) for mapping online.
- Connect to online training, etc. for tool use. Guidance for new managers/researchers.
- Guidance document updates every 3 years; a list of publications that apply technologies
- Offer classes or certificates in mapping techniques. Could be a good way to raise some money and get more people involved.
- Update the document as more resources and technology develops and becomes widely available (at least every 3 years)
- Guidance on interpretation and analyses of the data. Workflow with images and examples would be great.
- Communicate updates/news through an email list, maybe info about training opportunities?
- Informational webinars, training workshops on new mapping techniques and software.
- Database of methods used by year, study size, cost etc.
- Develop SOPs or best practices for mapping tools.
- Offering trainings.
- Protocol workshops/documents to help share knowledge among skill levels.
- Support through workshops / meetings of practitioners to discuss techniques and protocols
- Be available for contact and questions and receive new information.
- Continue to update and share new efforts and technologies.

Q6: Based on your knowledge and experience, are relative values for cost of data resolution helpful in deciding which mapping techniques to use?

- Answered: 30 Skipped: 1



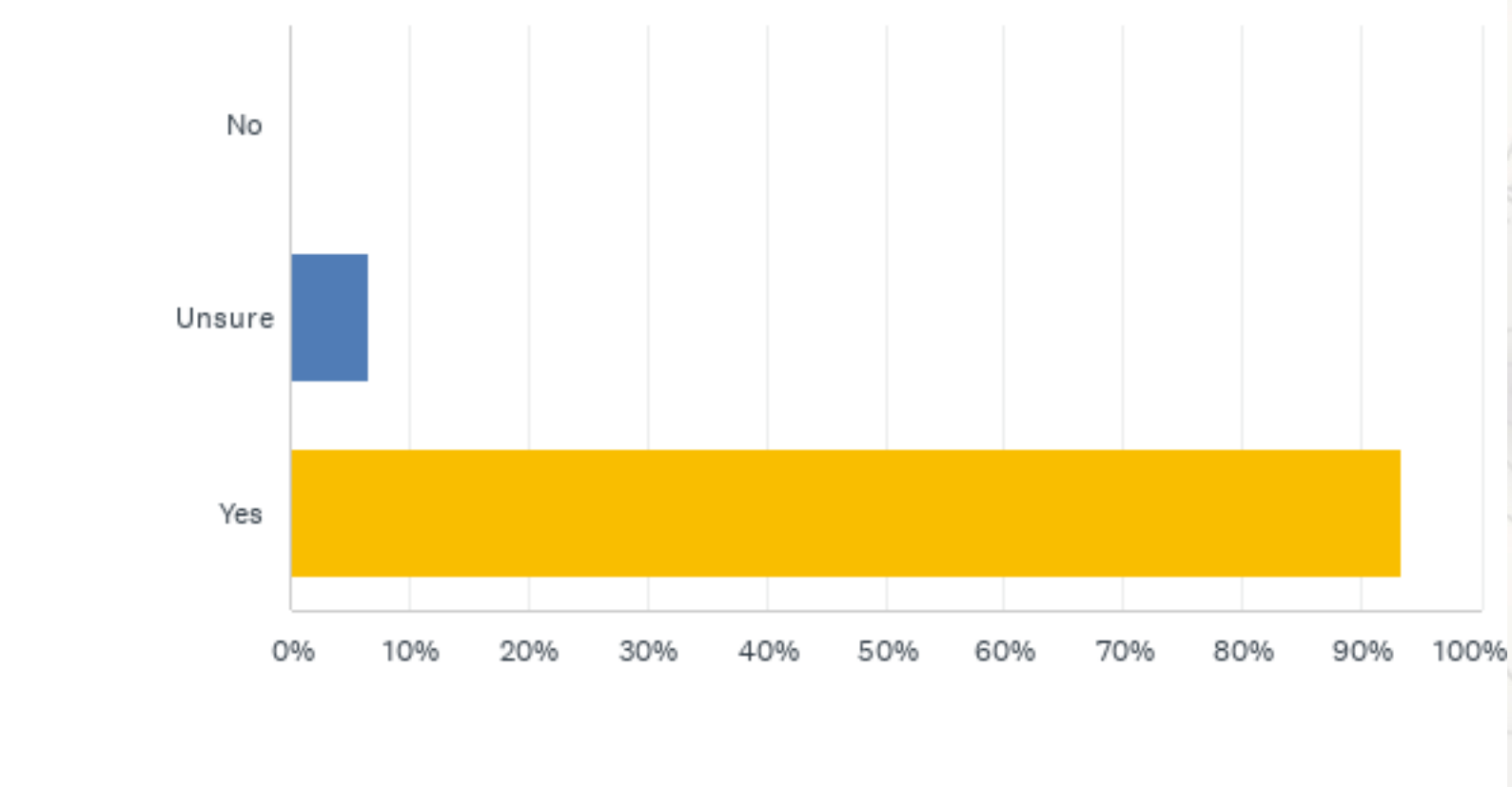
Q6: Based on your knowledge and experience, are relative values for cost of data resolution helpful in deciding which mapping techniques to use?

- Answered: 30 Skipped: 1

ANSWER CHOICES	RESPONSES	
□ No	0.00%	0
□ Unsure	16.67%	5
□ Yes	83.33%	25
TOTAL		30

Q7: Do you feel that workflow images and instructions are helpful for planning oyster mapping and data processing?

- Answered: 30 Skipped: 1



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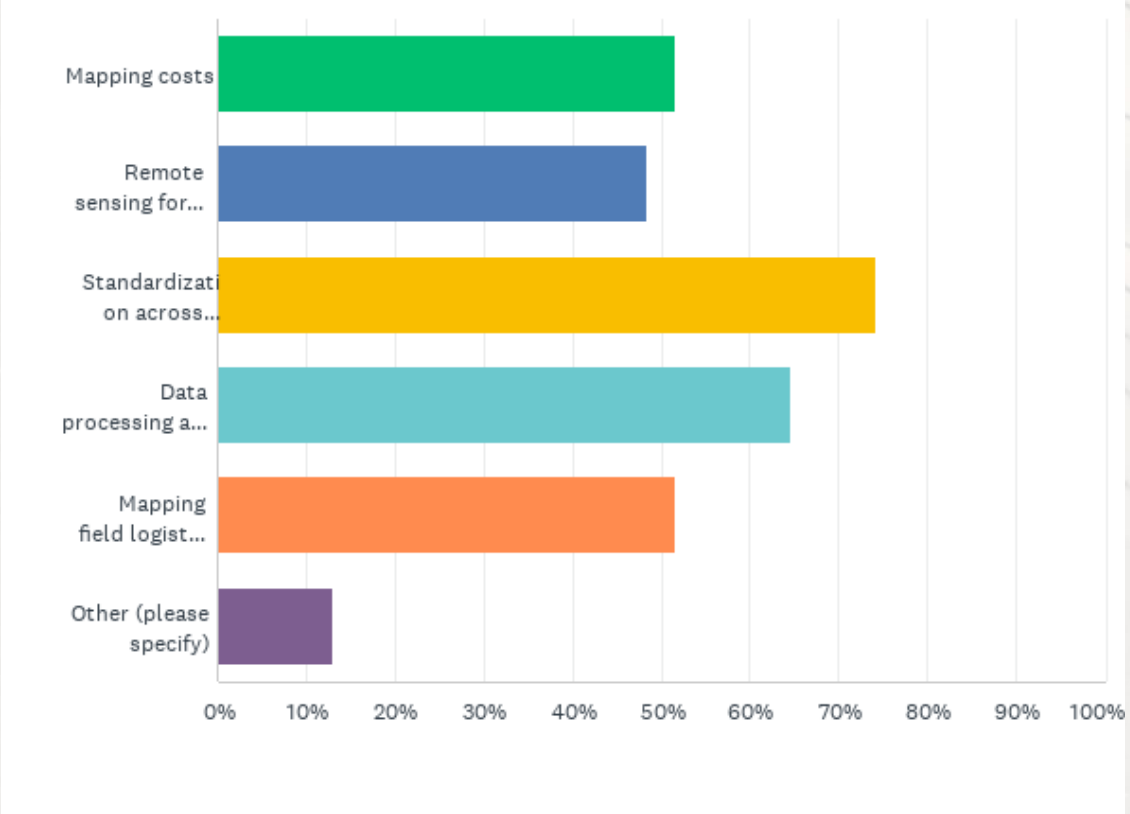
- Answered: 30 Skipped: 1

ANSWER CHOICES	RESPONSES	
□ No	0.00%	0
□ Unsure	6.67%	2
□ Yes	93.33%	28
TOTAL		30

Q8: The document provides general guidance. Would you prefer more in-depth instruction from this document on specific topics? Check all that apply:

- Answered: 31 Skipped: 0



Comments (other):

List/links to companies for hire in FL. Links to successful reports on topics.

Links to example reports/outputs would be helpful.

Any of these topics that are not treated in detail in an appropriate, publicly available reference.

In general, spatial information like this is only useful if linked tightly to demographic information

Q8: The document provides general guidance. Would you prefer more in-depth instruction from this document on specific topics? Check all that apply:

ANSWER CHOICES	RESPONSES	
Mapping costs	51.61%	16
Remote sensing for mapping	48.39%	15
Standardization across methods	74.19%	23
Data processing and visualization	64.52%	20
Mapping field logistics & planning	51.61%	16
Other (please specify)	12.90%	4
Total Respondents: 31		