



RESULTS – TAKE AWAYS

From

CPC-FSMI Workshop

Mapping Large Segments of a Continental Shelf Margin

A Florida Mapping Initiative – Accomplishments, Use, and Comparisons

May 12, 2025

In Coordination with **GeoHab 2025**, Key West Florida

INTRODUCTION

In cooperation with the Florida Geographic Information Office (FGIO), Florida Department of Environmental Protection (FDEP), and GeoHab, the Circum-Pacific Council for Energy and Mineral Resources (CPC) organized and convened a one-day workshop preceding the opening of GeoHab 2025 in Key West, Florida. The stimulus for the workshop was the collection of multiple coastal and bathymetric data sets, intended to cover the entire Florida State offshore waters, along with the convening of GeoHab 2025 participants that could benefit and add value to the workshop. Sponsors of the workshop included GeoHab, CPC, FGIO, FSDE, Woolpert, Fugro, and Integral Consulting.

In 2022, \$100 million in general revenue funds were provided to the FGIO for the capture of statewide bathymetric data. Two types of data have been collected to date: topo bathymetric LiDAR imaging the seafloor to ~20 m water depth and multibeam echo sounder (MBES) data, which image the seafloor from 20-200 m water depth. The Florida Department of Environmental Protection Office of Resilience and Coastal Protection coordinated with federal partners to maximize funds

and guide data acquisition. Multiple contractors were selected to coordinate, collect, and complete the field work, which is still ongoing. Review and present status of these data were presented at the workshop along with input from the contractors who participated in the exercise. In addition, presentations and open discussions provided insights into next steps and directions that may provide significant follow-on benefits. This will include direct relevance to GeoHab themes and challenges, including identifying the next layer of data required to maximize the value of the program (e.g., habitat assessments, value added by direct environmental measurements such as chemical, photographic, direct sampling, etc.). Especially critical was the discussion on how large data sets such as the Florida Mapping Initiative (FMI) can be handled, processed, transferred, distributed, and archived.

In an Era of large data collection, accelerated technological advancements, and an AI hunger for all data, a need for new insights and supervised interpretations are now required for the handling of these data sets. Comparisons of similar U.S. State's big data collection efforts (e.g., California and Washington states) were briefly presented to stimulate discussions on the usefulness of such large data sets, including multi-year to decades of continued relevance.

Topics, presentations and open discussions included:

- Background and history of the effort.
- Specific presentations by each of the operators under contract with a focus on their tools, preparations, data examples, operational, and technological findings.
- Instrument manufacturers and their observations and ideas for future products.
- Comparisons of similar U.S. State's big data collection efforts (e.g., California and Washington), which will be briefly presented to stimulate discussions on the usefulness and applications of such large data sets.
- Future plans and applications of the Florida data set were discussed as well as ideas useful to other States and Countries.

Objectives

The objectives of the workshop consisted of the following:

- Presentation of latest seafloor mapping efforts in Florida
- Investigate methods to integrate the various data into a major data set
- Discuss additional data products available
- Discuss how such data sets can be distributed
- Explore useful applications of the data
- Consider standardization of the data set
- Compare lessons learned

- Describe complications/challenges

This included the **goals** to:

- Increase awareness of problems and improve efficiency of data collection
- Share insights into seafloor mapping and techniques
- Determine path forward in handling large data sets
- Determine how best to facilitate usefulness of the data

Four major **success criteria** of the workshop were presented and included:

- Participants learn something new that is useful to them
- Current and additional applications of Florida data are identified
- A good dialog occurred
- Potential partnering displayed

RESULTS

The workshop was opened with greetings from the conveners and introductions by CPC Chairman, Edward Saade. A brief description and history of the Circum-Pacific Council for Energy and Mineral Resources was presented by CPC President and Executive Director H. Gary Greene with encouragement of participants to visit the CPC web page at: <https://www.circum-pacificcouncil.org/>. This was followed by a brief description of GeoHab by the GeoHab 2025 Chairman Vincent Lecours.

Kim Jackson, Director of the Florida Geographic Information Office, and her team followed up with a presentation of the Florida Mapping Initiative stating the following:

- The SMI arose from the need to improve/modernize the Florida coastal database.
- Highlighting the need for improvement of geographic information.
- Noted the existence of the Statewide Land and Marine elevation model and emphasized the whole mapping effort (terrestrial combined with marine) needs to be completed as continuous and seamless as possible, and at the highest resolution possible.
- Emphasized the ties in mapping with emergency response needs (e.g., Hurricanes).
- Listed the ties that FGIO has with multiple partners involved in the initiative.

Critical items being focused on by the mapping teams included:

1. Development of cloud storage and pre-planning efforts (the presentation revealed that the current large, collected data set is >10peta bytes, and increasing),
2. Increased transparency during all stages of data collection and processing should be considered along with the understanding that:
 - Under the 5-year project of 2022-2027 all spending is to be completed in 2026,

- And that development of an interactive status map with links to show status and important information or data is underway.
- 3. Provisions for public access, custom deliverables, and outreach consisting of:
 - Multiple formats and examples of maps and illustrations, and
 - A Florida State sponsored LiDAR education web site now exists where an individual can obtain certification after completion of a two-hour course.

Consultants' Presentations

Following the FBIO presentation, six of seven excellent technical presentations were provided by the various contractors that have been collecting and continue to collect and process both LiDAR and MBES data. The presenters consisted of:

- Richard Goosen – Fugro LiDAR
- Rick Householder – Woolpert LiDAR
- Emily Kipp – Dewberry LiDAR
- Catalina Rubiano – Saildrone MBES
- John Redmond – CMOR MBES (unable to Attend in person)
- R.J. Kozich – Woolpert MBES
- Richard Goosen – Fugro MBES

Take home lessons from technical contractors' presentations include the following highlights and notable specifics:

- LiDAR data covered 48km of coastline in the Florida Keys.
- It was critical to be mindful of standards and specs necessary for consistency.
- The need to complete all field work and data deliverables by end of 2026
- Awareness of the incredible amount of data collected (e.g., LiDAR collection is reaching 3 petabytes per area!) and how to handle such data sets.
- Seek ways to be a solution, not a roadblock for data collection and processing.
- Conform to technical Specs of 3X Seiche Depth, 2 points per sq meter for LiDAR collection.
- All MBES data collection includes in-fill for missed areas with LiDAR.
- Important to keep in mind that the goal for Coastal Resilience addresses the following:
 - Damage assessment from storms.
 - Coastal Hydraulic and Hydrographic conditions and change.
 - Natural Resources (e.g., corals, seagrasses, deep corals) conditions and change.
 - Archeological (e.g., shipwrecks, cultural campsites) locations.
 - Navigation and Planning for construction, dredging, beach renovation and replenishment.
 - Artificial reefs (SS United States and more) locations and potential sites.

- Types of LiDAR sensors used: Fugro 2 (RAMMS), Woolpert 5 (Leica Systems), Dewberry 3 (CZMIL Systems); Each obtain 3 Petabytes of data (also note multiple aircraft operating simultaneously)
- Saildrone uses NORBIT MBES systems with navigation control center in Florida, backed up from Alameda, CA, and Proprietary software for processing.
- Woolpert uses Kongsberg MBES, multiple vessels, USV, “Follow-the-Sun” processing via offices in South Carolina to Alaska to Australia to Dublin back to USA, software processing with QPS/QIMERA.
- Fugro uses five vessels (deployed to date) all using Kongsberg MBES systems except one with dual head RESON. Web Portal for data movement and display.
- All contractors above utilize STARLINK in-field operations for the movement and delivery of massive amounts of data

Previous State Mapping Projects

Previous and ongoing U.S. state seafloor mapping projects that obtained large data sets were described by Gary Greene and Holly Woytak, which included California and Washington states. In California, nearly the entire state waters were surveyed from the mean high-water line out to three 3 nautical miles, producing detailed bathymetric and backscatter maps for the entire region (~2007-2013). Many different entities, including federal, state, academic and private sector, funded, collected and processed the data that were obtained by Fugro, USGS, MBARI, and others. However, only about two-thirds of the collected data were interpreted to construct marine benthic habitat maps. Like the FMI, the State managed the project through the California State University, Monterey Bay’s Seafloor Mapping Lab and the USGS compiled the data sets to produce an offshore geophysical atlas that included seismic-reflection profiles and seafloor sampling data. One direct application of these data has been using the results to aid in defining/establishing Marine Protected Areas (MPAs) in State Waters. Expansion of additional applications and effort is ongoing in cooperation with MBARI and Fugro. For example, through a partnership between MBARI’s Central and Northern California Ocean Observing System (CeNCOOS) and Fugro, a U.S. West Coast Habitat and Ecological Map Classification Study was constructed. This project involved using bathymetric data from publicly available sources combined with benthic environmental model layers to generate habitat classifications using reproducible geoprocessing workflows. This type of work will aid in UN Ocean Decade goals and provide links between habitat and ecological quantities as well as aid in areas of offshore wind development and create applications towards place-based management, marine sanctuary monitoring, resource management, and marine carbon dioxide removal. Unlike other habitat maps, these include water mass structure (temperature, salinity) and particulate organic carbon flux (food supply).

For Washington State, the Salish Sea, and inland sea that extends across the border of Canada and the U.S. was demonstrated to show how large seafloor bathymetric mapping data sets can be used for multiple purposes. The data has been interpreted for marine benthic habitat

characterization, identification of oil spill distribution and accumulation sites, determining pelagic foraging locations, and tidal energy assessments, to mention a few applications. Currently, these data are an essential part of developing an interactive Urban Sea Digital Twin for the Region.

New Products/Applications

Monica Giona Bucci described the new Voxal multi-spectral MBES system presently being developed by R2Sonic and its ability to image in near 3D. A system that may prove useful in the type of seafloor mapping efforts being undertaken by the FMI.

Daniel Doolittle presented the multi-faceted seafloor mapping efforts underway with Integral Corp regarding wind farms and other marine energy and communications infrastructure projects. Something that the FMI might want to consider include the ability to establish ground truth for all the data types being currently collected. The SPI-PV system is a rapid, low cost, and efficient approach to providing grain size, CMECS substrate and biotic features data set. Ground-truthing the bathy data will provide significant benefit for permitting and other state uses of the data. The 'successional stage' approach has been well-documented in the literature and provides a "health check" of the seafloor ecology. This may also be of interest to state planners. There are up to 20 parameters that can be obtained from the image pairs. Additionally, the imagery has proven to be a huge success with developing positive stakeholder engagement. Fishermen, divers, beach lovers all respond positively to being able to see "from the fishes eye view, or the worms eye view" as it were. SPI-PV images are well suited for website, printed, and other media given their digital nature and high resolution.

PANEL DISCUSSION

At the conclusion of all presentations a panel consisting of the consultants and the FMI team fielded and discussed questions from the participants. The questions asked and the responses are listed below:

Poor Weather Conditions – a problem for all contractors - Examples of challenges: including snow in the Panhandle causing critical support delays, weather impacts from multiple El Niño generated storms from the Pacific, and hurricanes. Water clarity varies and changes during the seasons.

- **Hurricanes, Turbidity, and Algal Patches (a problem)**
 - Many hurricanes interrupted field work, considerably more than in the past and were not predictable, making it difficult for contractors to work/schedule in offshore Florida.
 - Impacts from hurricanes probably going to get more severe with global warming due to climate change and along with potential loss of accurate predictions may decrease ability to take advantage of preferable survey weather windows.
 - How does one plan for a major offshore mapping program not knowing when a hurricane will occur in the future? What can be done?

- Large patches of Sargassum approached survey areas and had the potential to severely disrupt operations, needs to be monitored during field work.
- **Response**
 - Consider forecasting hurricane events and expand timeline for operations.
 - Need to expect that more storms will occur, thus add more weather windows in survey planning. “Plan for the worst, hope for the best”
 - Track each storm to determine the time it takes for calm conditions to return and water to clear (for LiDAR)
 - Use historical data to predict future events and develop a risk assessment for areas to avoid and prioritize time on areas that calm rapidly (less turbidity for LiDAR).
 - Take advantage of JALBTCX data, a national coastal mapping program (mapping coast every 8 years) along with “smart” sampling
 - Save areas that are less turbid after a storm such as a rocky seafloor compared to a sedimented ones for more rapidly renewing operations after a storm event.
 - Consider a digital twin for forecasting storms (based on history, better predictions).
 - Fall and winter are ideal times for offshore work in Florida; colder water, clearer water, less winds, need to contend with El Niño storms that are trackable/predictable but difficult to determine storm impact specifics.

Large Data Sets – As reported during the consultants’ presentations very large data sets have been collected and are being transferred to the state. This appears to present a future problem in distribution/handling.

- **Data Transfer and Archiving (a problem)**
 - The question arose on how to best make data available to end users and the public, and how to best present it, as the datasets are getting bigger and are presently in flux; should contractors pass on all data collected including backscatter data? Raw data?
 - Where will the data eventually be housed and how can one find it?
 - AI community is data-hungry and how data will be used in the future is a concern.
 - There is a need to focus on community use, how can it benefit society?
 - How will maintaining security of the data be handled to prevent bad actors from distorting what the data means?
- **Response**
 - NOAA NCEI is largest data repository in U.S. and would archive data.
 - Keep all collected data because new technologic advances in the future could improve the existing data sets. (The audience agreed there are many examples of past or recent successes in marine data sets, including multichannel seismic processing).
 - Backscatter data are especially critical as it is being used more extensively in marine benthic habitat mapping.
 - Raw data, especially backscatter, could be compressed and organized in a more strategic way for use and archiving.
 - Regarding maintaining control and security of data, licensing might be considered. However, data needs to be available to the public with no restrictions.

- It is possible to consider “slip and ship” as a data distribution technique.
- USGS EROS Science Division I Sioux Falls, SD is presently managing and formatting the FMI data sets, appear to be doing an excellent job.

Field Coordination – Improvement of coordination in field work by consultants was suggested although it appeared that regarding overlap of various project sites, coordination was being accomplished.

- **Variable Data Sensing Devices (a problem?)**

- Of necessity for such a large mapping project, many contractors were required, along with the use of multiple sensors, vessels (one autonomous), and aircraft.
- How do the various data sets match?
- Will the use of autonomous sensing platforms improve data matching?
- Can better coordination improve joint contractors’ response to inclement weather conditions?

- **Response**

- Safety and scale are issues, especially in aviation with drones. Presently there is a need to consider safety, geopolitical situation, and regulations, solutions that are a long way off.
- It was suggested that the use of autonomous vehicles is the future and may be a solution to many of the present-day problems.
- Matching of various data sets need expert interpretations. The user of the data should be involved in how the data matching process is undertaken.
- Make sure there is good overlap between areas, look at variations, stack various mapping components together to form a comprehensive map (e.g., backscatter data).

Value Exploitation (added value) – A recurring question arose about how the data are intended to be used with the quote of “collect data once and use many times”. Consideration of what values should be added to the data set needs to be addressed.

- **Value added (a problem?)**

- While little discussion was expended on this topic, there were questions about use of data other than for marine benthic habitat studies; what other use of the data were foreseen?
- It was reported that use of the bathymetric data would be in selecting sites for artificial reef emplacements.
- Anticipation of the data for use in evaluating sediment erosion and accumulation after a major storm event was stated.
- Evaluation of coastal resiliency was another stated use of the data.
- Monitoring of coral reefs was mentioned as a potential use of the data.
- Archeological features mapping (e.g., shipwrecks) was another stated use of the data.

- **Response**

- Potential critical fisheries habitat designation was suggested as an added value to the data sets.

- Mapping potential aggregate and beach renourishment take zones might be considered.
- Participants from Norway and Finland mentioned that searching for sites to sequester carbon was underway in their countries and might not this be an added value to the FMI?
- While tile fish habitats are generally deeper than the depths presently surveyed, there may be other infauna and benthic fish habitats that may be worthwhile using the data to distinguish these areas.

Future Monitoring Potential – With the collection of such a comprehensive seafloor and coastal mapping data future assessments of oceanic processes can be undertaken. There were expressions of how such a data base could help in monitoring change.

- **Development of a Base Map for Monitoring Purposes (a problem?)**

- Are the data being collected under standards, QA/QC procedures, and in a manner that it can be easily replicated in the future?
- Can such a base map be provided to those interested in following up with FMI?
- Will there be support for the construction of interpretive products?

- **Response**

- More reason to keep the raw data collected for the mapping effort.
- The purpose of the base map should be to focus more on scientific problems solicited from end users.
- A base map could be used to highlight good findings as well as perceived impacts.
- Suggest setting standards for the various maps to be constructed.
- Must include backscatter in any mapping effort.

WRAP-UP/SUMMARY

From inquiries, unsolicited comments, and general discussions the feedback that we received indicates that the objective and goal of the workshop was accomplished. The contractors displayed a willingness to work together and exhibited good cooperation. Many participants went away feeling that they learned something and were satisfied with the outcome. All feedback related to the Panel Discussion were very positive and noted the excellent, active and enthusiastic continuous participation of the entire audience. Based on the presentations, panel discussion, and interface with the participants several specific points were highlighted and here are reported as Recommendations.

Recommendations

1. **Weather** – While weather conditions are always a concern in any marine and coastal mapping effort, planning for field operation during the most calm and clear weather seasons are critical to success. With global storm events occurring more often than in the past, and becoming larger (more severe), accurate prediction modeling is needed to avoid delays and cancelations of field operations. A digital twin process of modeling and prediction would improve the present-day forecasting methods.

2. **Large Data Sets** – With such large data sets being generated from the FMI, it appears that cloud processing and other means of handling such data sets need to be investigated/expanded. Perhaps having the USGS, FGIO, FDEP and others involved with FMI should consider partnering with Esri and their Digital Twin group, or other companies (Fugro, Woolpert, etc) would be beneficial in handling the large data sets.
3. **Backscatter Data** – Process all Backscatter data and include the product as an overall/enhancement to the base MBES data maps. All contractors stated they were collecting backscatter during the data collection and thus would not require any additional field activity or funding for collection. In addition, it is by far the quickest (shortest time needed) to produce results and provide this ‘new’ data to the State. As was noted during the several days of GeoHab presentation on various global studies, backscatter was almost universally included in the data sets presented and always praised as a significant part of the successful interpretative processes.
4. **Interpretations** – Interpretation of all the collected data should be for geology, habitats, hard bottom, sediment transport, debris fields, Indigenous people, campsites, habitats, gardens, more... This is an ideal activity for a wide variety of agencies, universities and research groups, individuals, schools, that will touch virtually every person that has any interest, relation, profession, or need related to the Florida coast and seabed. It can also be designed to be completed in stages and over multiple years.
5. **Data Gaps/Next Generation** – Resurveys and data gap infills should take priority in finalizing data collection procedures. This is especially critical for the development of a base map. Imagery and targeted remote sampling such, including photography, video, SPI Camera, eDNA, more, are all recommended for consideration for near term, cost effective next steps.

ACKNOWLEDGEMENTS

CPC wishes to acknowledge the assistance received from GeoHab, especially from Vince Lecours and his staff in organizing the venue and refreshments and the contributions of the contractors. Generous support for the workshop was provided by Woolpert, Fugro, and Integral Corp. The workshop was heavily attended by GeoHab Conference attendees and a lively discussion occurred. Thank you all for your attendance and participation.

The CPC Team