CPC-GeoHab 2026 Eelgrass Workshop Report

Malta, May 11, 2026

A half-day Circum-Pacific Council (CPC)-GeoHab workshop was convened at the beginning of the GeoHab 2026 Conference in Valetta, Malta to address the latest mapping techniques used in assessing eelgrass and other seafloor flora. The workshop was based on the recent extensive and comprehensive seagrass multi-sensor survey of the entire Italian National coastal waters by Fugro, who sponsored the event, for Italian Institute for Environmental Protection and Research (ISPRA) that moved beyond mapping to decision support for national stakeholders. More than 60 scientists, engineers, and government representatives participated in the workshop (see participants list of GeoHab 2026). Twelve presentations ranging from mapping methodologies, technologies, and vegetation types (various seagrasses, algae, and kelp) with case histories from Malta, Italy, the Indian Ocean, Australia, and the Pacific Northwest of the U.S. (see attached abstracts). In addition, two seagrass related posters were displayed during the GeoHab poster session. Industry presentations by Fugro and R2Sonic/R3Vox reported upon newly procedures, data management, and recently developed acoustic systems useful in eelgrass mapping. Fugro mentioned that mapping eelgrass is an issue of national security for the Italian government and all stakeholders, enforcing the importance of such studies. Such data derived is used to inform decision-making, and that water column data was found as an effective dataset in the evaluation of eelgrass concentration.

The presentations were followed by a panel discussion focused on new and evolving technologies, methodological preferences, and suggested protocols for mapping seagrasses. The objective of the workshop was to outline a technologies and methodology procedure for mapping seagrasses based on the experiences of the workshop participants and to formulate a list of recommended instruments and methodologies useful in undertaking a comprehensive investigation of eelgrass specifically, but also of all seagrasses, algae, and kelp in general (see Tables 1 and 2 below). Table 1 reflects the general attitude of the participants in relation to their use and desirability to comprehensively map seagrasses, while Table 2 reflects what the participants felt were the most important objectives in mapping seagrasses. These tables should be considered as an initial protocol recommendation and are expected to be refined with further community input and potential working group discussions.

Globally, seagrass meadows are declining, and the reason for its demise is basically unknown. While ongoing studies are underway to determine the cause of eelgrass decline, no "smoking gun" has yet been found. Eelgrass, like most seagrasses is diverse, productive, ecologically and economically significant, a critical habitat for forage fish recruitment, and is a major plant that sequesters significant amounts (~18%) of CO_2. Mapping eelgrass is a critical link to regulatory drivers (e.g. restoration, monitoring obligations) and the need for consistent repeatable monitoring at scale, not just mapping once.

TABLE 1

Instrumentation

Type	**Preference**	**Application**
Acoustical:		
Echosounder (Single Ch.)	Low	Reconnaissance
MBES (bathymetry)	High	Detail surveys
MBES (backscatter)	High	Detail surveys
MBES (water column)	Desirable	Canopy type
Side-scan sonar (SSS)	High	Detail surveys
SASS	Desirable	High-res. Surveys
Sub-bottom seismic		
3.5 kHz	Low	Substrate ID
2 kHz	Low	Water column ID
CHIRP	Low	Substrate
Light:		
Satellite	Moderate	General mapping
Air Photos	High	Detail surveys
UAV (Drones)	High	Detail surveys
Laser Line Scanners	Desirable	High-res. Surveys
Underwater video	Moderate	General survey
LiDAR	Desirable	Supplemental
Drop/Towed camera	Desirable	Ground-truthing
Sampling Gear:		
Grabs (e.g., Van Veen, Ponar)	High	Substrate ID
Cores	Moderate	Sub-bottom strat.
SCUBA	Moderate	Sediment sampling
ROVs	Desirable	Combin. Data collect.
Sensors (In-Situ/Remote):		
CTDs	Desirable	Oceanographic data
Turbidity	Desirable	Photic analyses
Open-cell foam	Experimental	Chemistry

TABLE 2

Mapping objectives

Determination	Preference	Tools
Presence/Absence	High*	Acoustics/Photos/Drones
Canopy Coverage	Low#	Acoustics/Photos/Drones
Plant Quantity/Density	Low#	Acoustics/Photos/Drones
Depth Range		
Intertidal location	Moderate	Photos/Drones
Outer (deepest) limit	High	Acoustics/Photos
Substrate Type	High	Grabs/Cores/Photos
Grain size	Moderate	
Organics High	Moderate	
Monitoring/Health	High	
Repeat Surveys	High	MBES/Video/seismic
Plant Declines/Expanding	High	MBES/Video
Substrate Type change	Low	Backscatter/Grabs/Cores
Physical Condition change	Low	MBES
Oceanographic change	Low	
Temperature	High	CTD
Salinity	High	CTD
Turbidity	Low	Seci Disc

**The high preference here was based on the majority of the participants' objectives for mapping seagrasses.*

#The low preference here was based on facts that canopy and density change seasonally and really do cannot be used to determine overall health of a seagrass bed.

A need exists for the assessment, establishment, and maintenance of such habitats. Mapping eelgrass is an issue of national security of strategic national importance for environmental management and policy. Due to this need, mapping of eelgrass has become increasingly important but challenging, as it is generally an intertidal plant extending from zero to approximately eight meters water depth and requires multiple methodologies and technologies to map. However, with modern technologies such as shallow water multibeam echosounder systems, autonomous surface and aerial vehicles, LiDAR, and Satellite imagery high-resolution mapping of eelgrass meadows, patches, clumps and even individual plants are now possible.

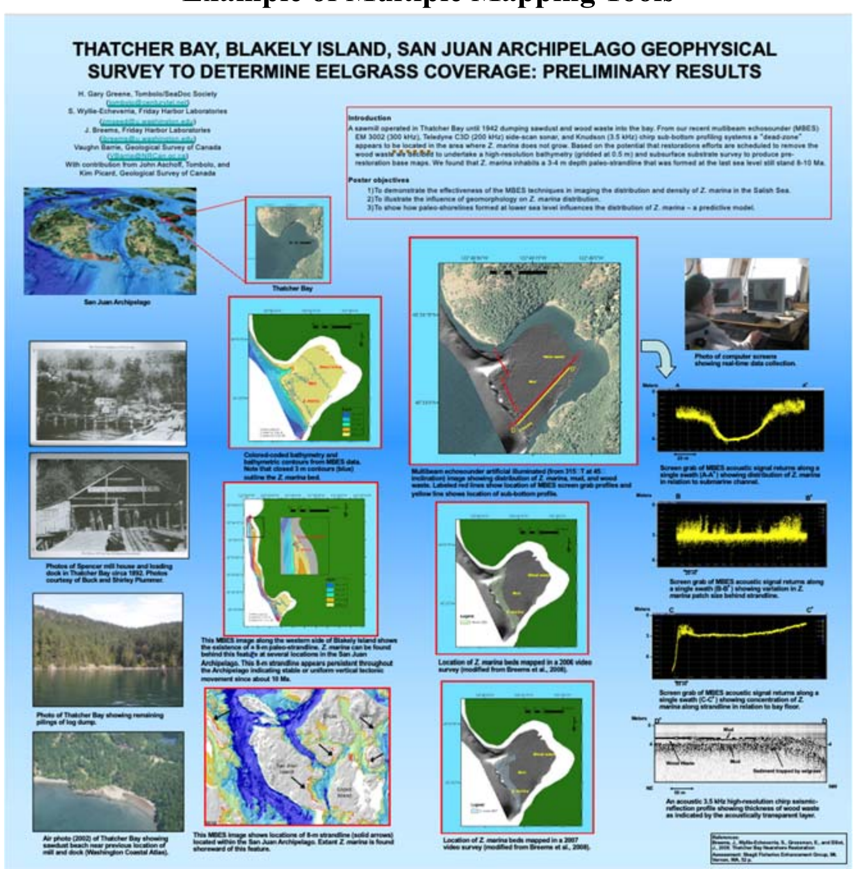
Some discussion was undertaken about defining the nomenclature of eelgrass in a mapping context. For example, it was proposed that terms that are used to describe eelgrass densities such as “beds”, “meadows”, spots”, “patches”, “clumps”, and “sparse” be addressed and assigned a quantity designation. Unfortunately, time did not allow for in depth discussions of this matter, and it was proposed that further discussion is needed. An attempt will be made to continue this discussion within a working group at the next GeoHab conference.

It was mentioned that legacy data should be considered in any investigation of seagrasses. In addition, it was stated that organic carbon studies need to be better integrated with habitat mapping.

Overall, the participants endorsed continued discussions on how to mobilize a mapping protocol for eelgrass and other vegetative substrates that would facilitate the comparisons and contrasting seagrasses globally.

ATTACHMENTS

Example of Multiple Mapping Tools



Agenda:

Characterizing and Mapping Eelgrass: A Globally Declining Biota

A CPC-GeoHab Workshop

Agenda - 0900

- Greetings and introduction from the Circum-Pacific Council (Gary Greene) – 5 min.
- Presentation of the importance and key role of eelgrass in the Mediterranean Sea and Globally (Aaron & Gary) – 10 min.
- Case Studies – mapping accomplished and example projects (Gary, moderator):
    - Project MER – Rob Hoddenbach (Fugro) – Keynote – 15 min.
    - Seagrass mapping along Italian Coast – Tanja Dufek et al, (Fugro) – 15 min.
    - Benthic habitat mapping and assessment of submerged aquatic vegetation abundance in very shallow water: a case study from the Venice Lagoon, Italy– Federica Foglini – 5 min.
    - Mapping Seagrass Density in Australia – Mary Young – 5 min.
    - Mapping Seagrass in Western Indian Ocean – Eylem Elma – 15 min. (Virtual?)
    - Mapping algae and seagrasses in Norway – Malin Nevstad -15 min.
    - San Juan Islands eelgrass mapping, an introduction – Gary Greene – 5 min.

Break 1030 – 10 minutes

- **1040** – Resume Case Studies (Vaughn Barrie Moderator)
    - Lopez Sound mapping – Emily Roland – 15 min.
    - San Juan Islands eelgrass Mapping Projects – Gary Greene - 10 min.
- **1015** – Industry presentations (Holly Wotak, moderator):
    - Fugro GeoAI and delivery platform VirGeo® - Tanja Dufek – 10 min.
    - R2Sonic – Jens Steenstrup – 10 min.
- **1115** – Other, Discussion

Lunch 1200-1300

1300 – Resume – (Daniel Doolittle & Gary Greene lead)

- Round Table discussion and audience participation (2 hours)

1445 – Recap – Define action items – Ending

Posters

- Micro-algae mapping, East Sea, Korea – Choi et al.
- Micro-algae mapping, East Sea, Korea – Woo et al.

Abstracts:

Seagrass mapping along the Italian coast using multi-sensor data and machine-learning-based classification

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As part of the Italian government's Marine Ecosystem Restoration (MER) Project, led by the Italian Institute for Environmental Protection and Research (ISPRA), Fugro is mapping the seagrass (Posidonia oceanica and Cymodocea nodosa) along the entire Italian coast. Capturing the full extent of the seagrass meadows from the shoreline to the water depth of approximately 50 metres requires a multi-sensor approach. Therefore, a variety of sensors and sensor platforms are utilized: satellite EO, airborne bathymetric LiDAR, aerial imagery, ship-borne MBES and AUV orthophotos. These various types of data are then used to generate derivatives such as RGB orthophotos, terrain models and backscatter mosaics.

A crucial step is the data integration, which involves normalizing and combining data sets with different characteristics and resolutions (ranging from 2 metres to sub-centimetres) to create consistent and homogeneous visualizations of the seabed and seagrass meadows. The combination of MBES and ALB data, particularly the backscatter data, is especially relevant as they complement each other in terms of their measurement range and therefore the mapped water depth.

The different data sets and further derivatives are used for a machine-learning-based seabed classification. This process is divided into two steps. First, the data is segmented into areas with similar characteristics. Secondly, the data is classified using the AUV imagery for ground truthing.

This project will run for two years. During this period, approximately 10,200 km^2 will be mapped by satellite, 4,000 km^2 by MBES and 4,000 km of AUV track along the coastline. It stands out not only regarding the large area to be mapped and the versatility of the sensors and platforms used, but also due to its contribution to a sustainable future for Italy's marine heritage.

Mapping Seagrass at Scale to Drive Climate and Biodiversity Policy in the Western Indian Ocean

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Seagrass ecosystems underpin livelihoods across the Western Indian Ocean (WIO), delivering essential ecological and socio-economic benefits such as fisheries support, coastal protection, and carbon sequestration that contribute to climate change mitigation. Despite their importance, the region lacks comprehensive data on seagrass distribution and condition for integration into policy frameworks. This information gap limits effective management and conservation, and leaves seagrass habitats increasingly vulnerable to degradation, unsustainable use and loss. To address these challenges, the Large-Scale Seagrass Mapping and Management Initiative (LaSMMI) is uniting scientists, policymakers, and stakeholders across the WIO to generate the evidence base needed for informed decision-making. The initiative promotes regional knowledge exchange, capacity strengthening, and collaborative development of a standardised, efficient methodology for seagrass ground-truthing. Using verified field data and advanced remote sensing technologies, LaSMMI aims to produce highly accurate, region-wide seagrass maps and carbon datasets to support carbon assessment and ecosystem management. The project will map seagrass along more than 9,500 km of coastline and across over 2 million km2 of marine area in four focal countries – Kenya, Tanzania (including Zanzibar), Mozambique, and Madagascar. These maps will provide foundational data to strengthen conservation and management, enabling countries to more effectively integrate seagrass into policies such as Nationally Determined Contributions (NDCs) under the Paris Agreement and Marine Spatial Planning (MSP) processes. We present progress towards these goals, including the mapping process and outputs, early carbon assessment, and discuss the pathway for integrating seagrass evidence into national and regional policy.

Mapping seagrass density using multifrequency backscatter

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Accurate mapping of seagrass density is critical for monitoring coastal ecosystem condition and plan restoration activities, yet most acoustic approaches remain limited to presence–absence or single-frequency backscatter. Here we demonstrate the use of multifrequency multibeam backscatter from a Kongsberg EM2040P to classify seagrass density across two meadows in Port Phillip Bay, Australia. Surveys were conducted using five operating frequencies (200, 300, 400, 600 and 700 kHz) in multifrequency mode, providing full-coverage, high-resolution acoustic characterisation of seafloor habitats across each site. Bathymetry data were processed in CARIS HIPS and SIPS, with frequency-specific backscatter mosaics generated in FMGT at 50 cm resolution. These single-frequency mosaics were combined into multiple RGB composites representing different frequency combinations, and both single frequency and RGB composites were compiled into a raster stack in R for subsequent analysis. Groundtruthing was undertaken using high-density drop-camera surveys, with a GoPro HERO 13 mounted above a 50 × 50 cm quadrat. For each deployment, two video stills were extracted: one above the seafloor to capture broader habitat context, and one with the quadrat placed on the seabed to quantify benthic cover. Images were annotated in BIIGLE and classified into substrate and habitat categories, including three seagrass density classes (low, medium and high) and bare sediment. These labelled observations were spatially linked to the multifrequency raster stack and used to train a random forest classifier. Model performance and variable importance were evaluated to assess the contribution of individual frequencies and frequency combinations to discriminating seagrass density. This study highlights the value of multifrequency multibeam backscatter as a scalable, quantitative tool for seagrass monitoring and provides a practical workflow for integrating acoustic and optical data to map seagrass densities across the seafloor.

Mapping and Spatiotemporal Variability Analysis of Macroalgal Coverage Using Underwater Orthomosaics and Deep Learning-Based Segmentation: A Case Study of the Hokdomgul in Dokdo(East Sea, Korea)

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Following the international emphasis on marine-based carbon sinks for climate change mitigation, the need for standardized monitoring systems for blue carbon ecosystems has intensified. While current IPCC guidelines officially recognize mangroves, salt marshes, and seagrasses, macroalgal forests are increasingly evaluated as critical candidates for new carbon accounting frameworks. Consequently, establishing scientific evidence and quantitative methodologies to monitor their spatiotemporal dynamics is now an urgent priority. Furthermore, global initiatives such as the COP15 ’30 by 30’ goal underscore the necessity of expanding Marine Protected Areas (MPAs). Macroalgal communities serve as vital primary producers and essential habitats highly sensitive to ocean warming, making them crucial targets for effective MPA management and conservation strategies.

Dokdo, located in the East Sea of South Korea, hosts the nation’s most extensive perennial macroalgal forests, primarily *Ecklonia cava* and *Eisenia bicyclis*. Despite their ecological significance, this region is experiencing the fastest sea surface temperature rise in Korea, necessitating systematic long-term monitoring. This study establishes a high-resolution framework using underwater imagery from 19 surveys conducted at depths of 13-20m between 2022 and 2025. To ensure data fidelity, custom white balance and color correction were applied to mitigate depth-dependent light attenuation, followed by the reconstruction of high-resolution orthomosaics via Structure-from-Motion (SfM) processing.

Currently, supervised segmentation models, including Mask R-CNN and DeepLabV3+, are being developed using a specialized dataset reflecting the morphological and spatial features of macroalgae. Their performance is being rigorously compared against the zero-shot capabilities of foundation models, specifically the Segment Anything Model (SAM) and Grounding DINO to evaluate accuracy and uncertainty in automated coverage estimation. By correlating these results with synchronized sea temperature data, the research aims to quantify annual and seasonal variation patterns in the Hokdomgul area. Ultimately, this study seeks to derive the long-term variation characteristics and ecological significance of macroalgal communities under changing marine environments.

Characterizing spatial and temporal changes in eelgrass meadows of the San Juan Islands, Washington State, USA, using multibeam echosounder mapping

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Eelgrass, specifically the dominant species *Zostera marina,* provides unique habitat within the Salish Sea, an Urban Sea System in Washington State, USA. It provides nursing ground for juvenile salmon and other critical species and may also contribute in an important way to carbon sequestration and filtering of human pathogens. Within the San Juan Islands, focused surveys are finding elevated rates of decline of eelgrass meadows, possibly associated with anthropogenic impacts such as boating disturbances and mooring, but current and movement of sediment in the shallow water environment (< ~10m water depth) may also play a role in the stability of eelgrass meadows. Here we present high-resolution mapping of eelgrass in the shallow waters of Lopez Sound, part of the San Juan archipelago, an area of intense recreational boating activity and crabbing. Using shallow water multibeam echosounder (MBES) bathymetry, backscatter and associated attributes, we clearly image the presence and density of eelgrass. In Lopez Sound, eelgrass extends down to ~6.5 m depth (MLLW) and varies from continuous meadows to local discontinuous beds. We see dramatic variations in density as well spatial ‘patchiness’ of eelgrass meadows that seem to be correlated with boat mooring activity as well as seabed scours, potentially indicating a relationship with tidal current. In addition to mapping the presence and absence of meadows, a primary goal of this study is to explore how MBES observations of eelgrass can be calibrated to provide accurate and spatially continuous estimations of properties like plant density and maturity and used for precise change analysis within the sub-tidal zone. Detailed characterization of the distribution of eelgrass should help us identify the most important causes of eelgrass decline in the San Juan Islands, and contribute to eelgrass protection, monitoring and recovery in the Salish Sea.