

# Marine research in the deep sea: characterizing bioregions and habitats in the Israeli EEZ as a base for conservation planning

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The Hatter Department  
of Marine Technologies  
החוג לטכנולוגיות ימיות ע"ש האטר



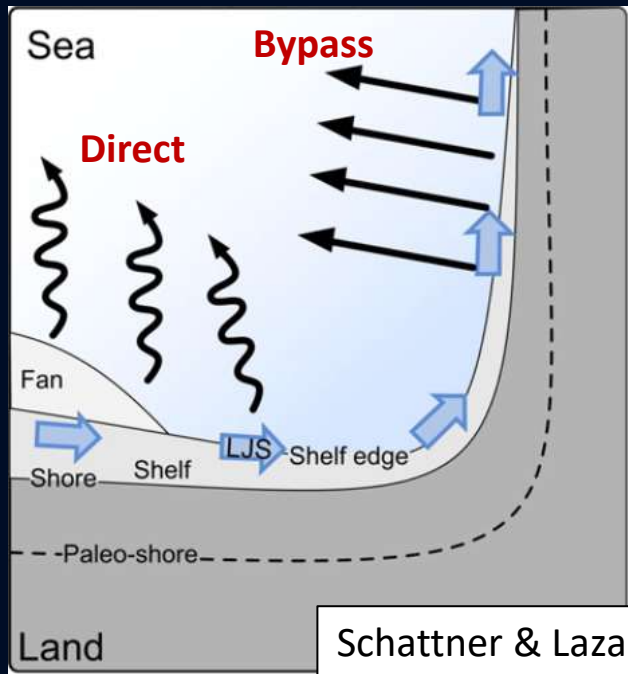
LEON H. CHARNEY  
SCHOOL OF MARINE SCIENCES  
בית המספר למדעי הים על שם ליוון צ'רני



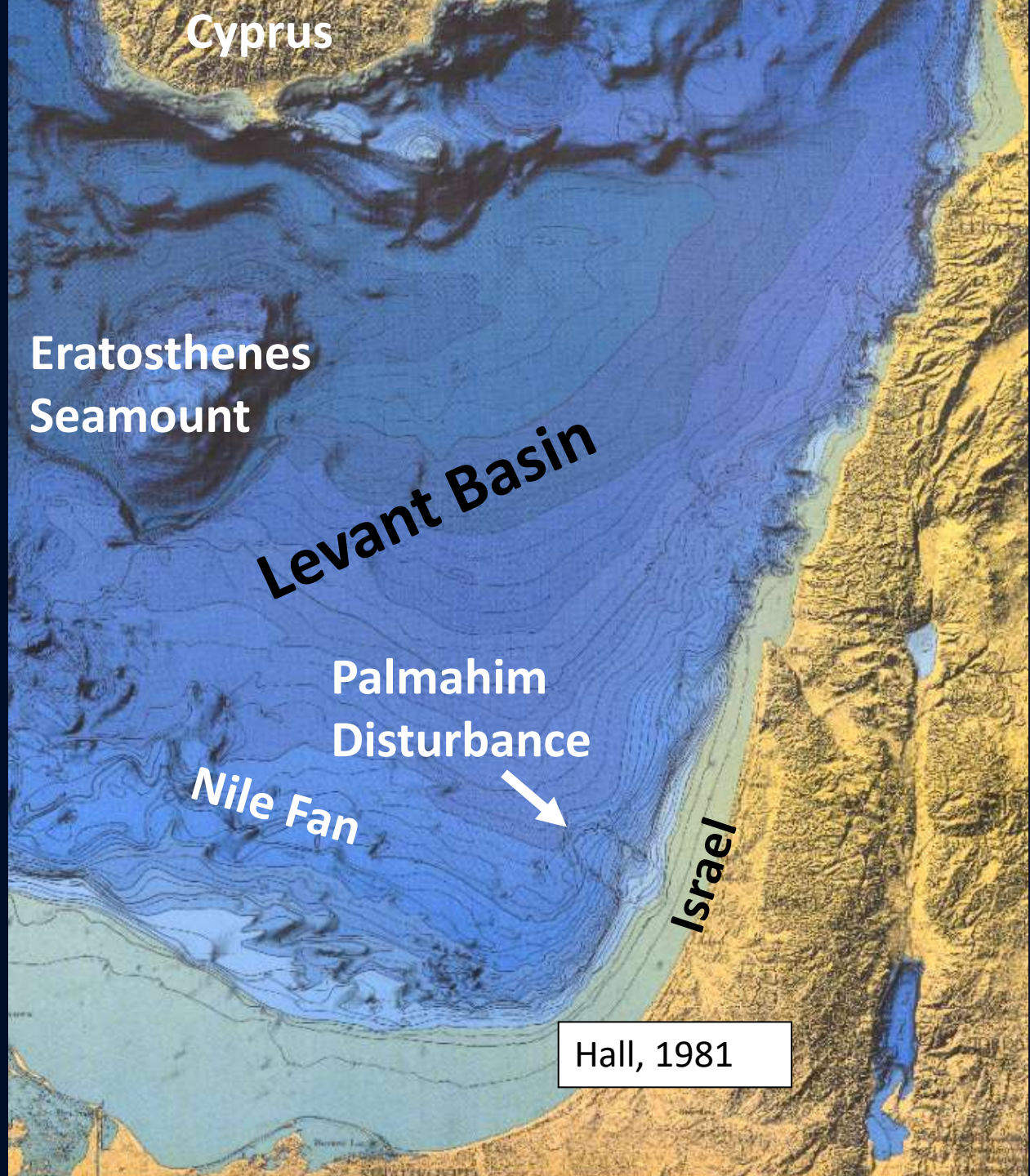
# The Levant Basin – Southeastern Mediterranean Sea

Primarily a part of the Nile Deep-Sea Fan and littoral cell

Palmahim Disturbance – a major anomaly on the southeastern margin of the Levant



Schattner & Lazar, 2016



Hall, 1981

Israel's EEZ is equivalent in its area to the country's land part

A couple of decades ago this territory was essentially unknown

**5** Ports, **7** Marinas  
**11,000** Cargo ships a year  
**22,500** Small vessels



**2,400** tons of fish a year by mariculture

**2,200** tons of fish a year by traditional fishing



**1,000** BCM  
Natural gas reserves (estimate)

**600** MCM  
desalinated potable water a year



EEZ border

Area of EEZ  
**22,000** sqkm



**4,000** sqkm  
Area of Coastal waters

Contiguous zone border

Coastal waters border



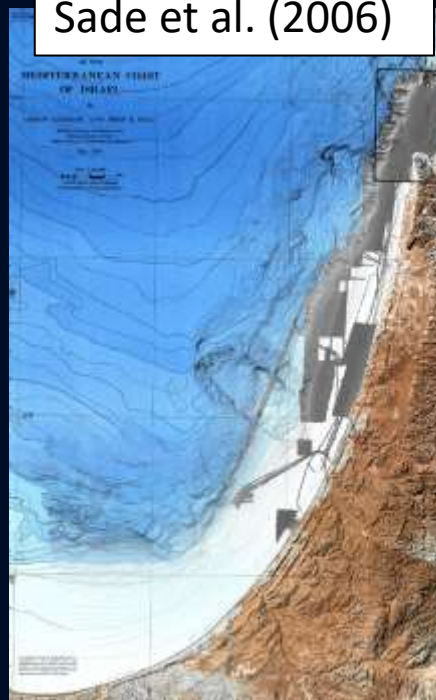
**195** km  
Coastlines

**9** Marine reserves  
**48** Identified habitats  
**600** Known archeological sites

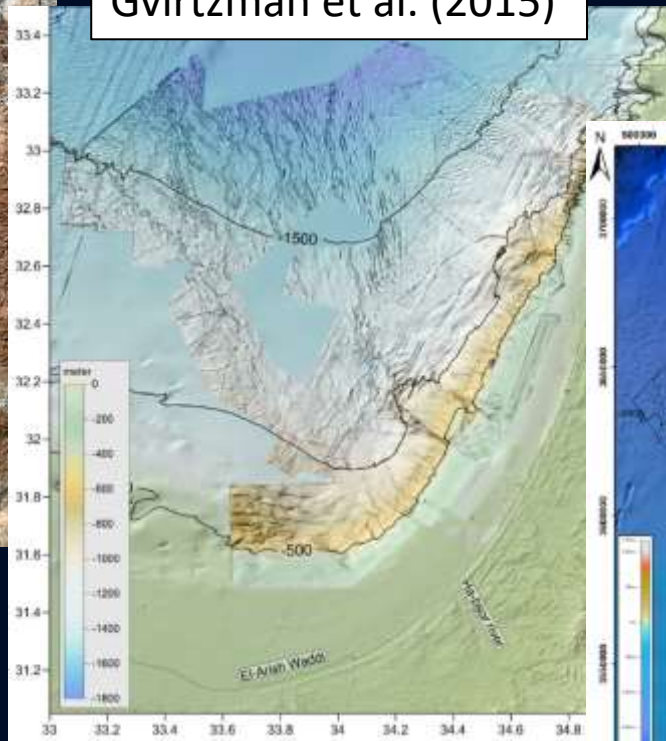


# Mapping gradually unraveled the face of the southeastern Mediterranean seafloor: From a blur to details in less than two decades

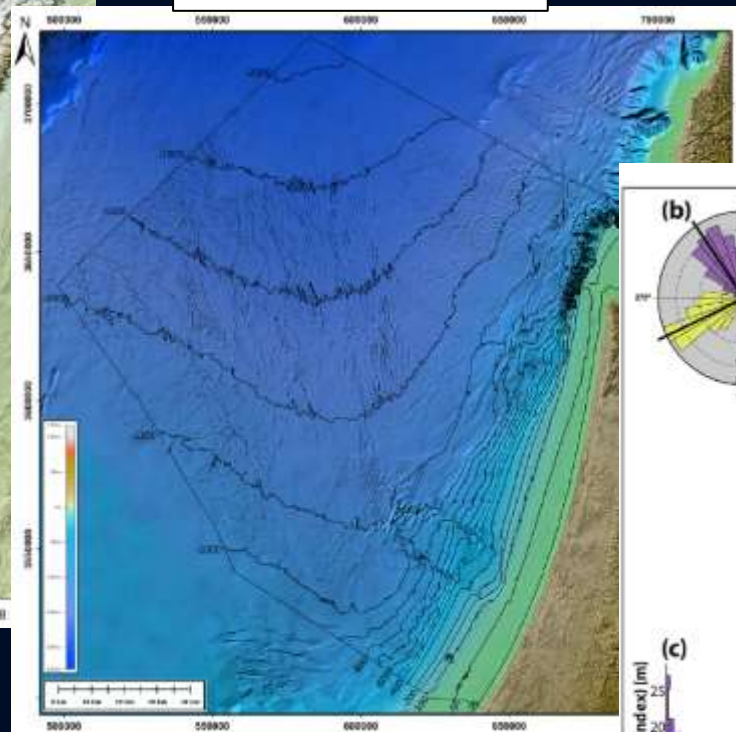
Sade et al. (2006)



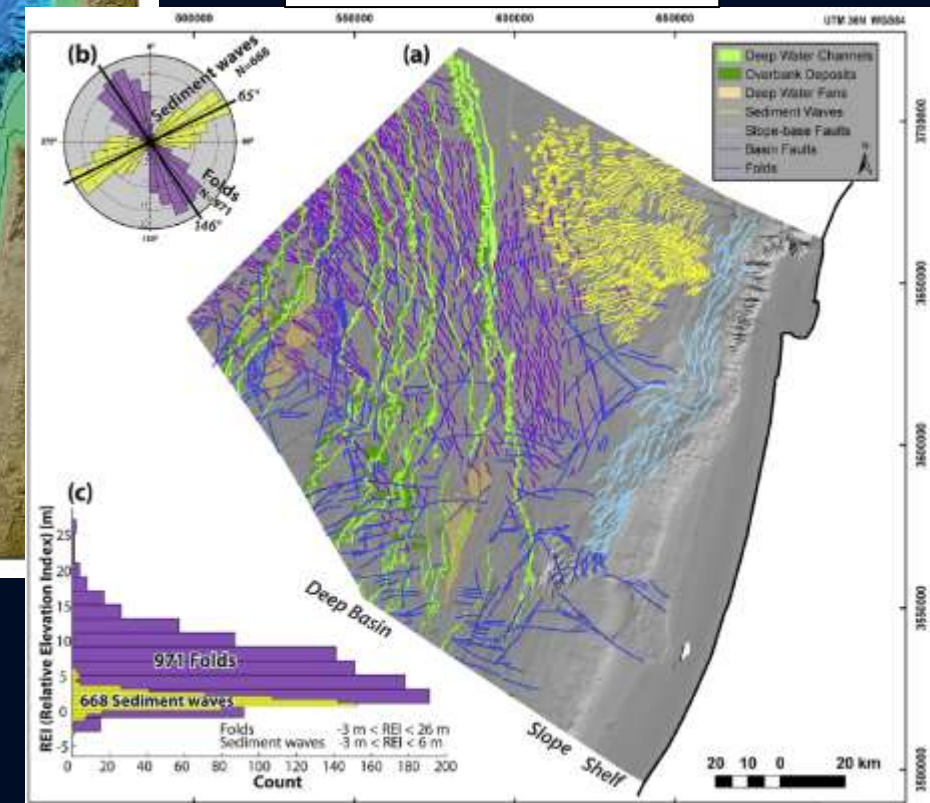
Gvirtsman et al. (2015)



Hall et al. (2015)

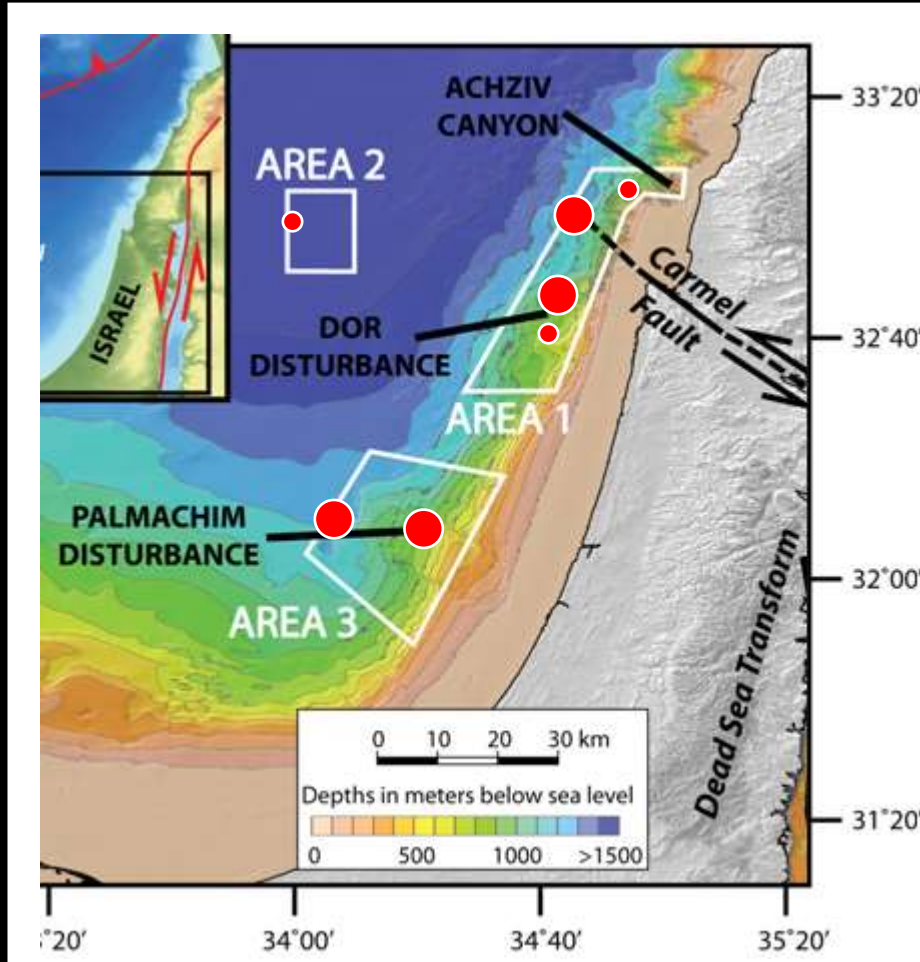


Kanari et al. (2020)



# E/V Nautilus collaborative ROV cruises investigated in 2010 to 2012 the deep Levant offshore at water depths of 500-1700 m

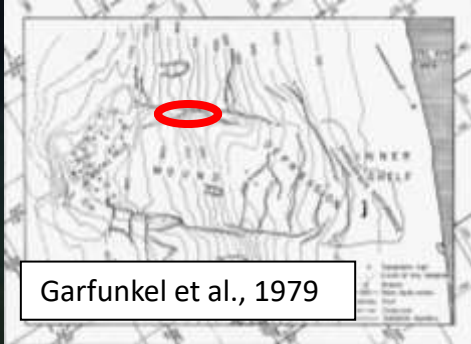
## An opportunistic discovery cruise



# Hard rocks on the north slope of Palmahim Disturbance host an oasis of biodiversity

EV Nautilus 2010-2011 cruises

Water depths of 600-800 m



Garfunkel et al., 1979

**IUCN Red List  
Protected under CITES**

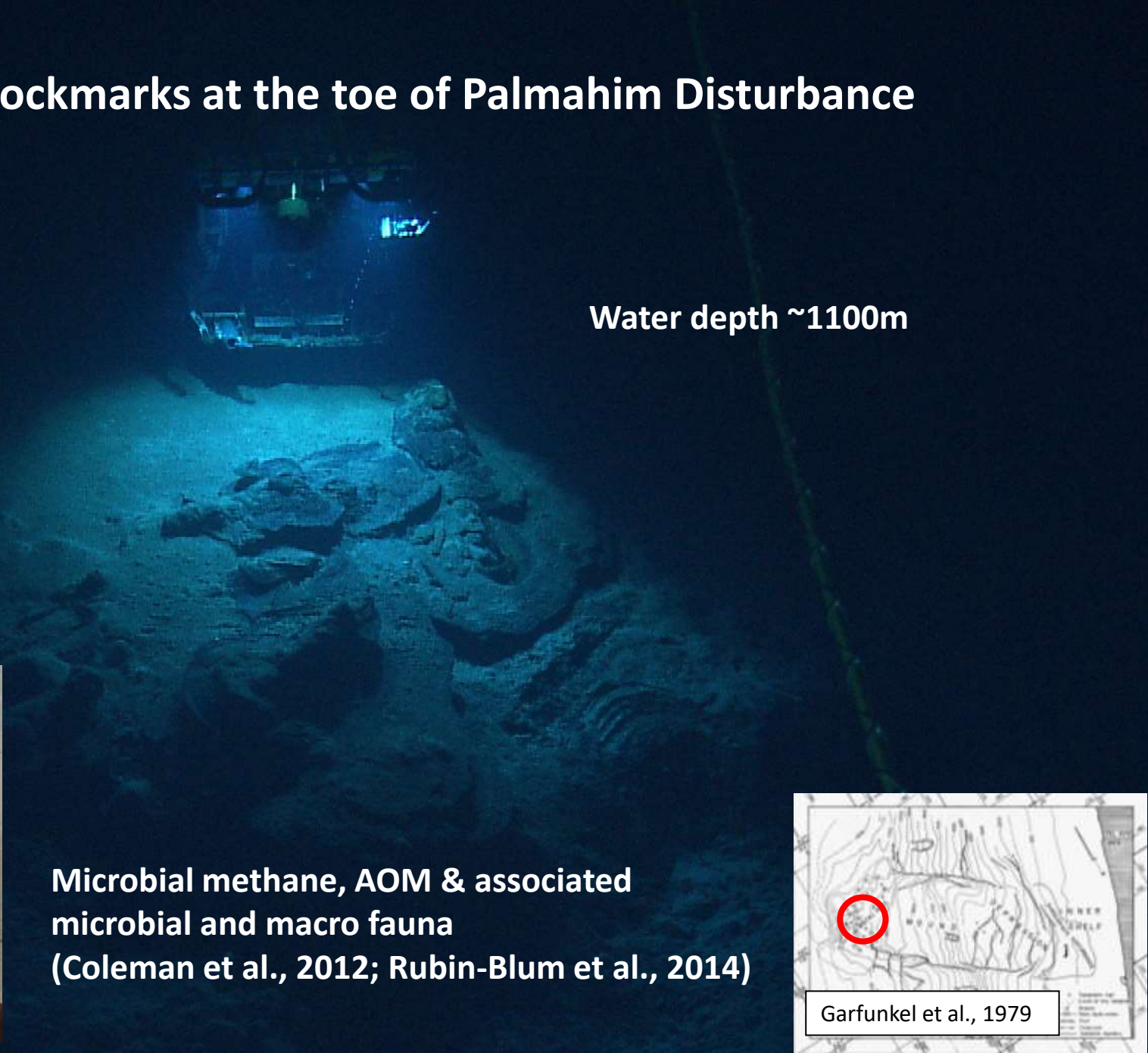


Water depth  
780m



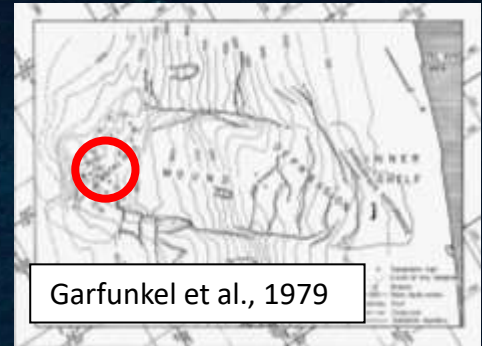
# Active gas seepage within pockmarks at the toe of Palmahim Disturbance

EV Nautilus 2011 cruise



Water depth ~1100m

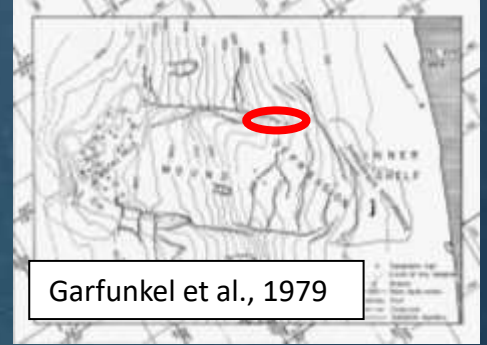
Microbial methane, AOM & associated microbial and macro fauna  
(Coleman et al., 2012; Rubin-Blum et al., 2014)



# Human impact

A trash pile observed along the northern boundary  
of Palmahim Disturbance

EV Nautilus 2010 cruise

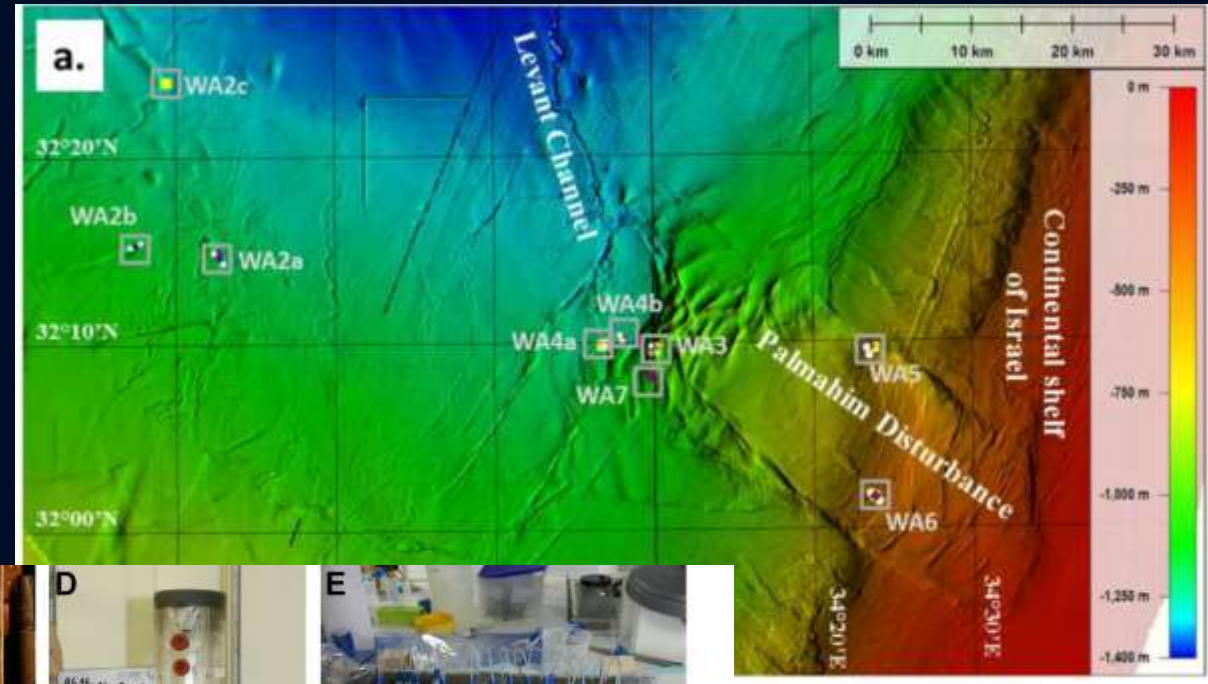


# SEMSEEPS cruise September 2016

**PI:** A. Rüggeberg (University of Fribourg, Switzerland)  
**Chief scientist:** Y. Makovsky (University of Haifa, Israel)  
**CPIs:** B. Herut, D. Tchernov, A. Almogi-Labin,  
 S. Flögel, A. Foubert, G. Zodiatis



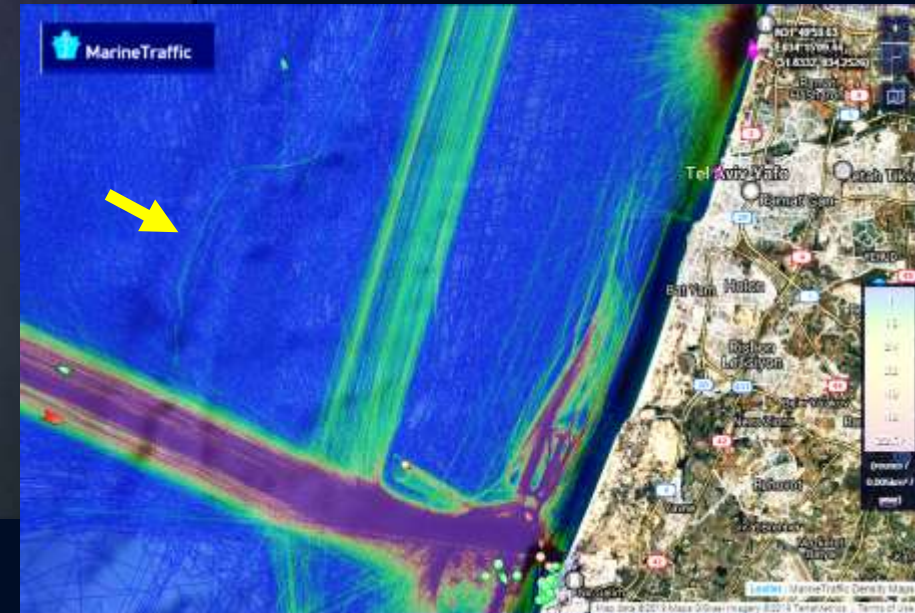
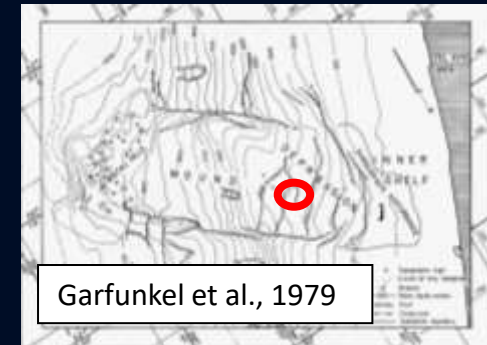
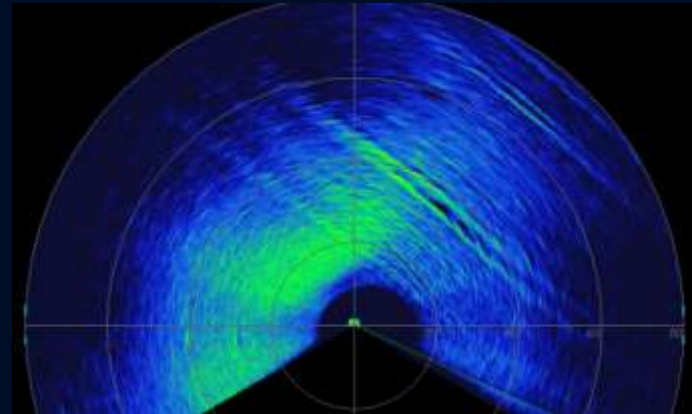
Max Rover



# We also found deep trolling marks and damaged reefs

SEMSEEPS 2016

Palmahim Disturbance @ 433 m water depth



The establishment of the University of Haifa lead Mediterranean Sea Research Center of Israel provided us (on 2016) with the infrastructure needed for deep sea research

UH new medium class ROV



A 9-m piston core



UH high resolution multi-channel seismic system



THEMO+DeepLev observatories



UH deep water surveying AUV



IOLR RV Bat Galim  
A state of the art research vessel

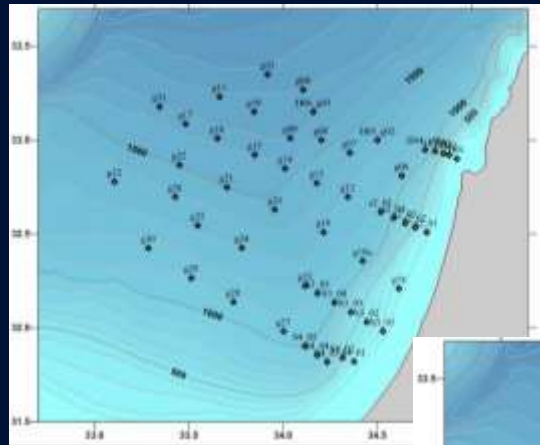


MERCi oceanographic gliders

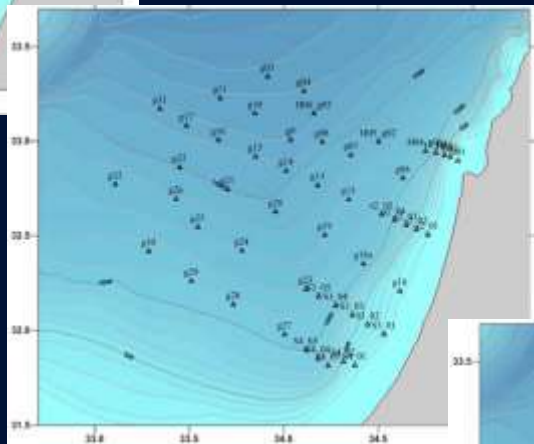


# A National Strategic Environmental Survey Established 2014

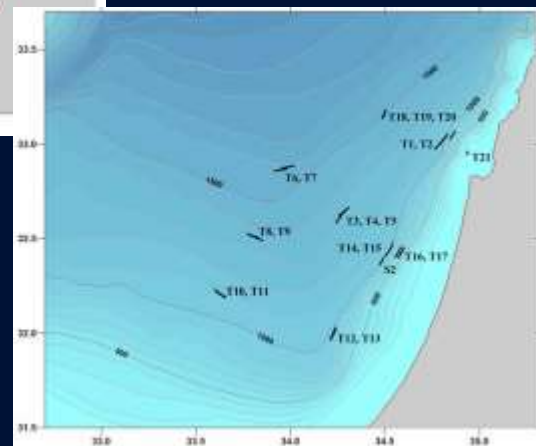
Water sampling stations



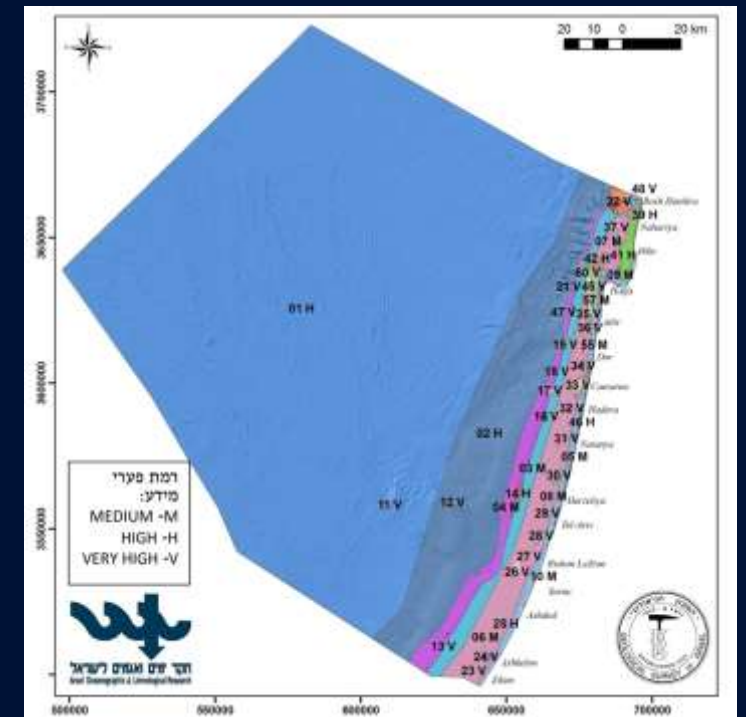
Sediments & in-fauna  
sampling stations



Epi-fauna  
sampling transects



Habitat Zonation across the EEZ of Israel



An acute knowledge gap of the deep sea

# ROV-based sampling and investigation of the deep-sea corals & seepage habitats

## Switching from Exploration to Scientific Research

### Analysis of the combined ROV surveys database

- 4 Cruises
- 65 Video Hours
- 7359 Colonies
- 12 Cnidarian Species
- 8 Fish Species
- 10 Other Invertebrate species

A possible new species discovered



Active reproduction in Palmahim corals



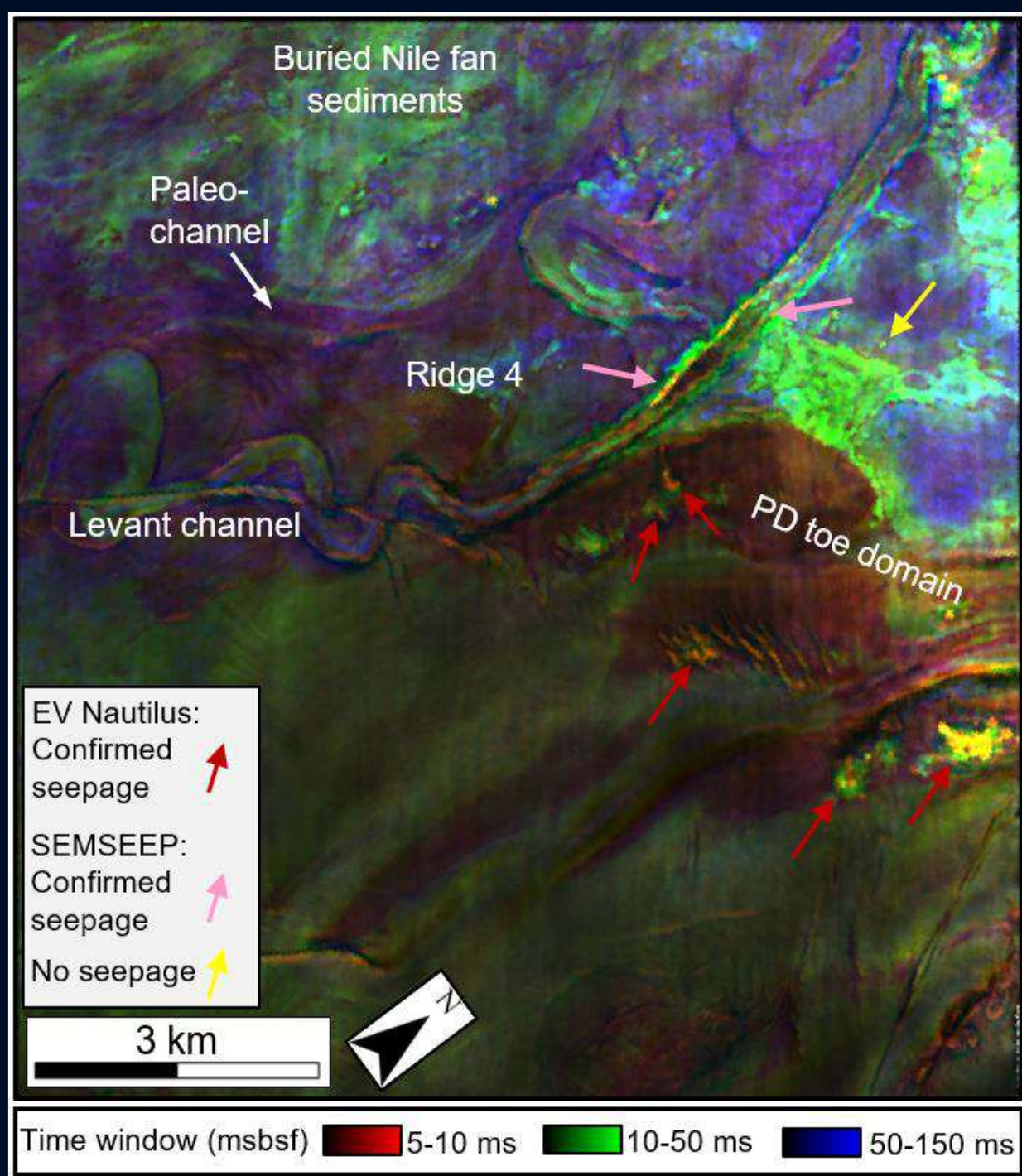
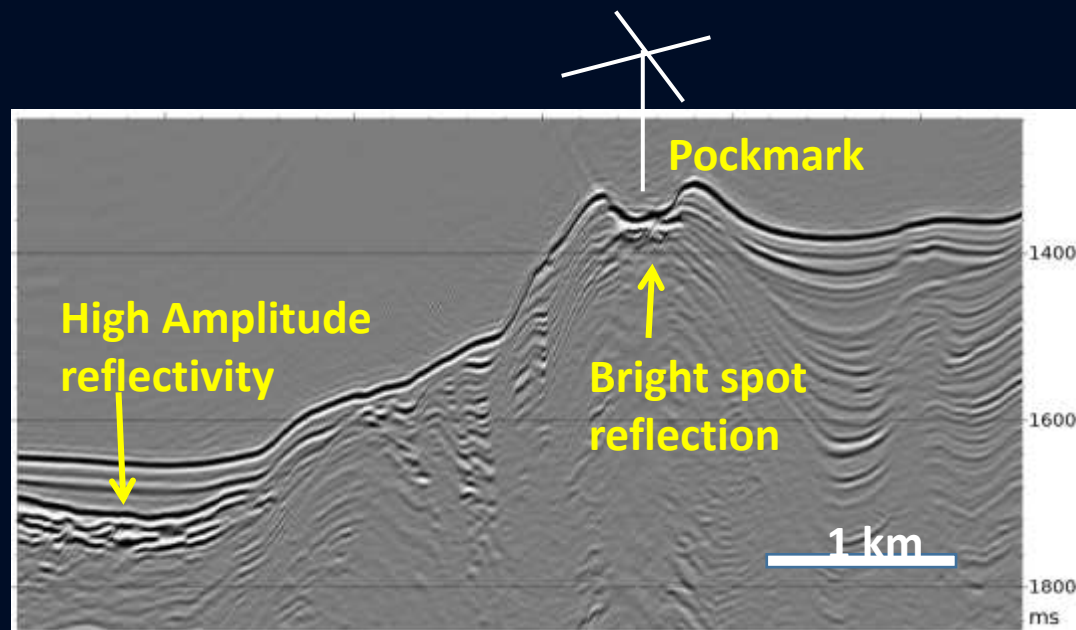
Wide stretching seepage habitats



# Detection of seafloor seepage from Multilevel Composition of commercial 3D seismic data

Amplitudes extraction at sequential depths and RGB rendering

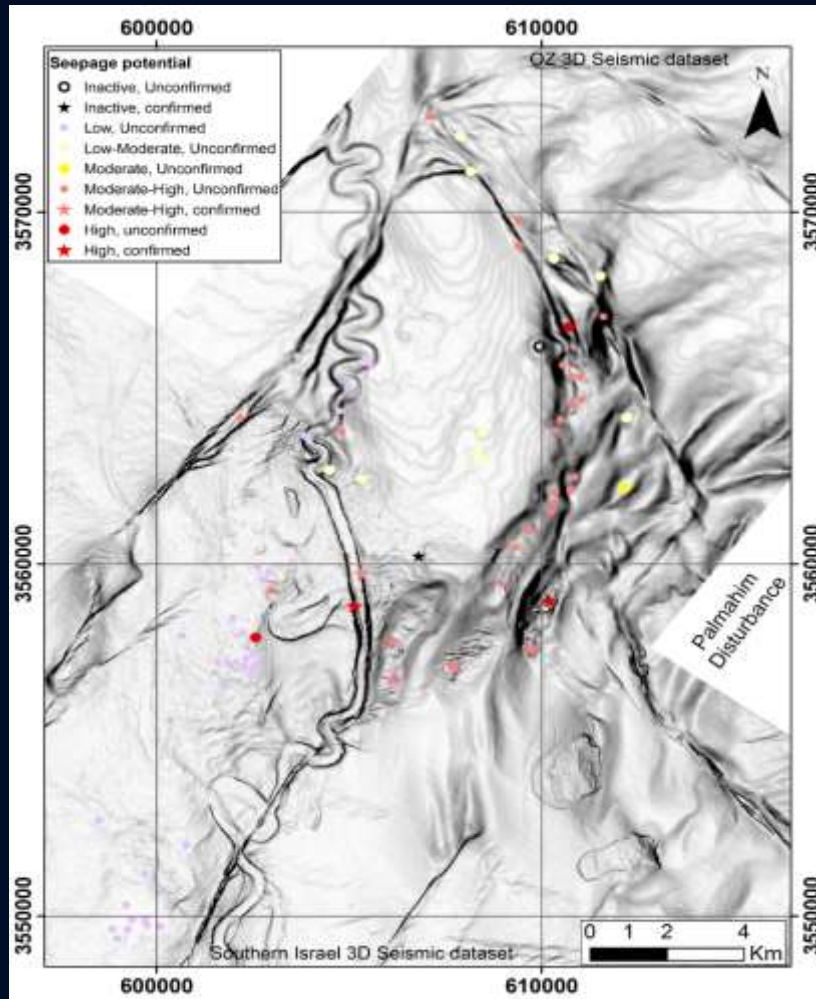
Lawal et al. (2022, 2023a, 2023b)



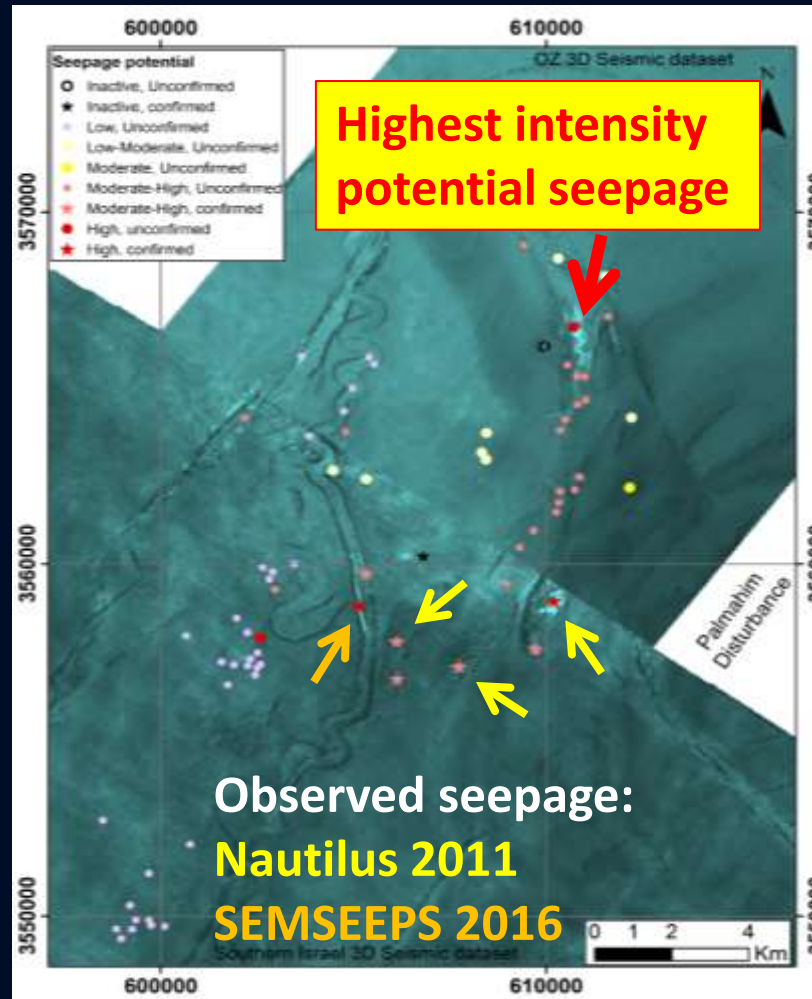
# Calibrated on Nautilus 2011 and SEMSEEPS 2016 ROV observations, Lawal's approach was used to map and classify potential seafloor gas seepage in the west of PD

Lawal et al. (2023b)

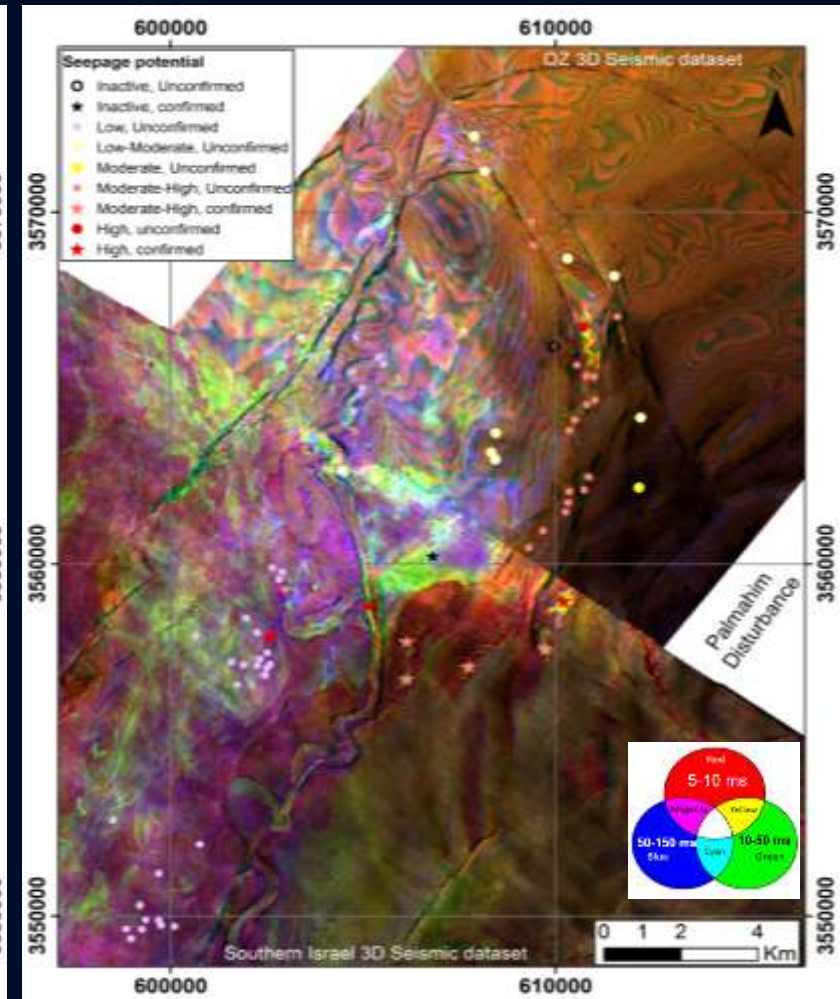
## Seafloor gradient



## Amplitude (1-30 ms below seafloor)



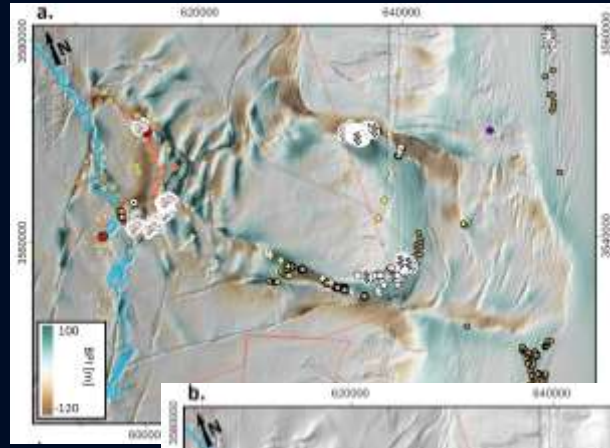
## Multilevel RGB blend



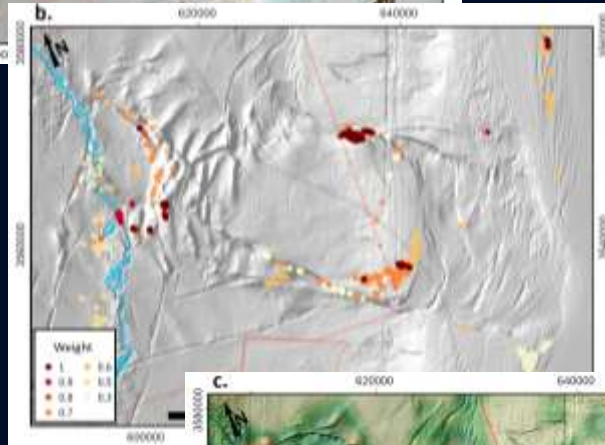
Observed seepage:  
**Nautilus 2011**  
**SEMSEEPS 2016**

Combining our finds into a scientific understanding framework, provide a basis for establishing a deep sea **marine protection area** in Palmahim Disturbance

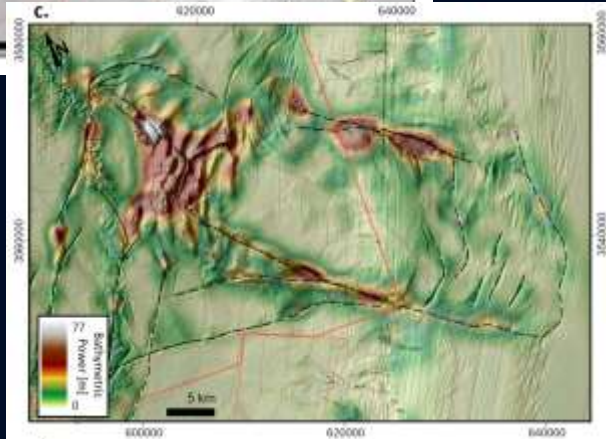
A common database of all observations



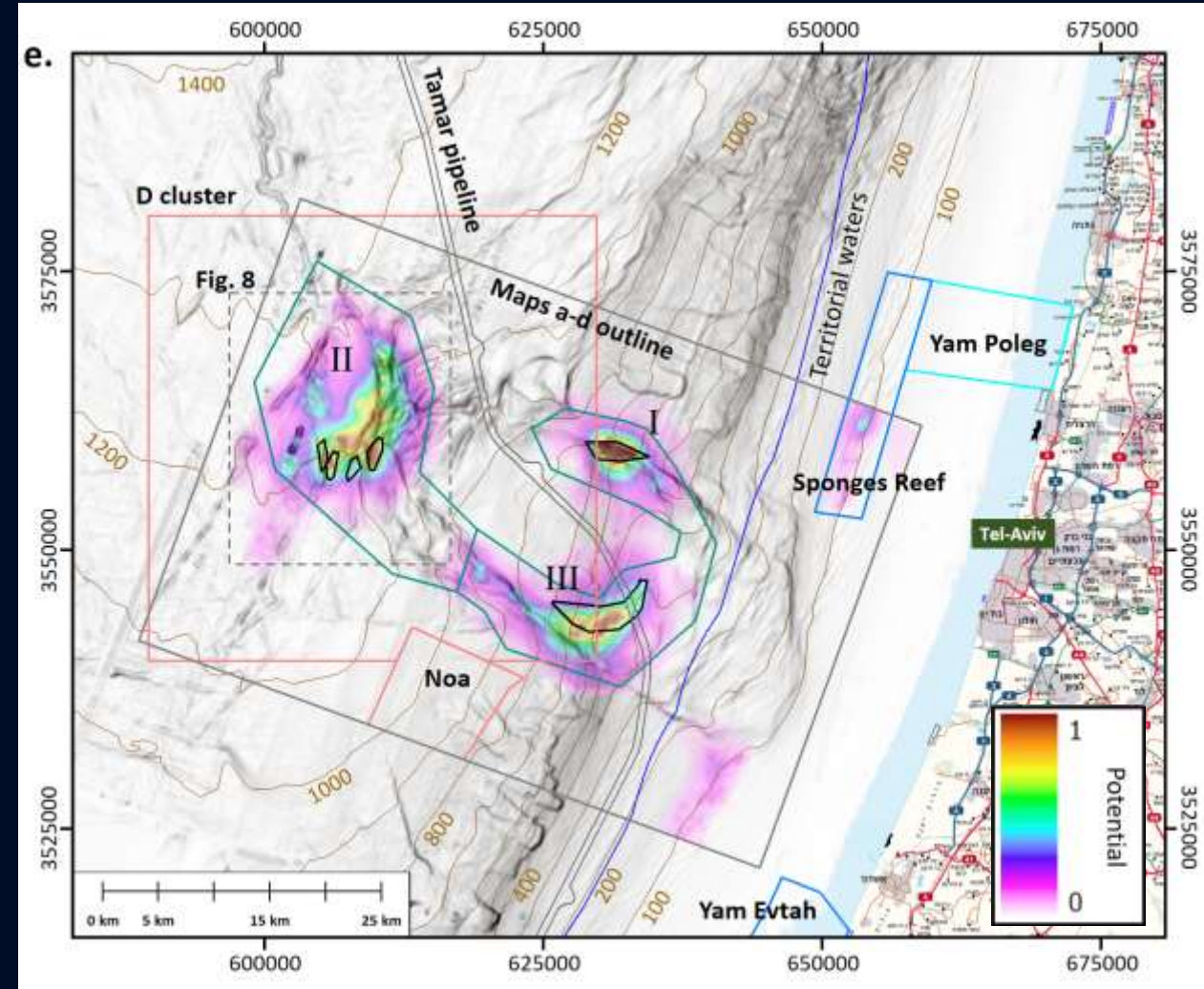
Quantification



Bathymetric complexity power

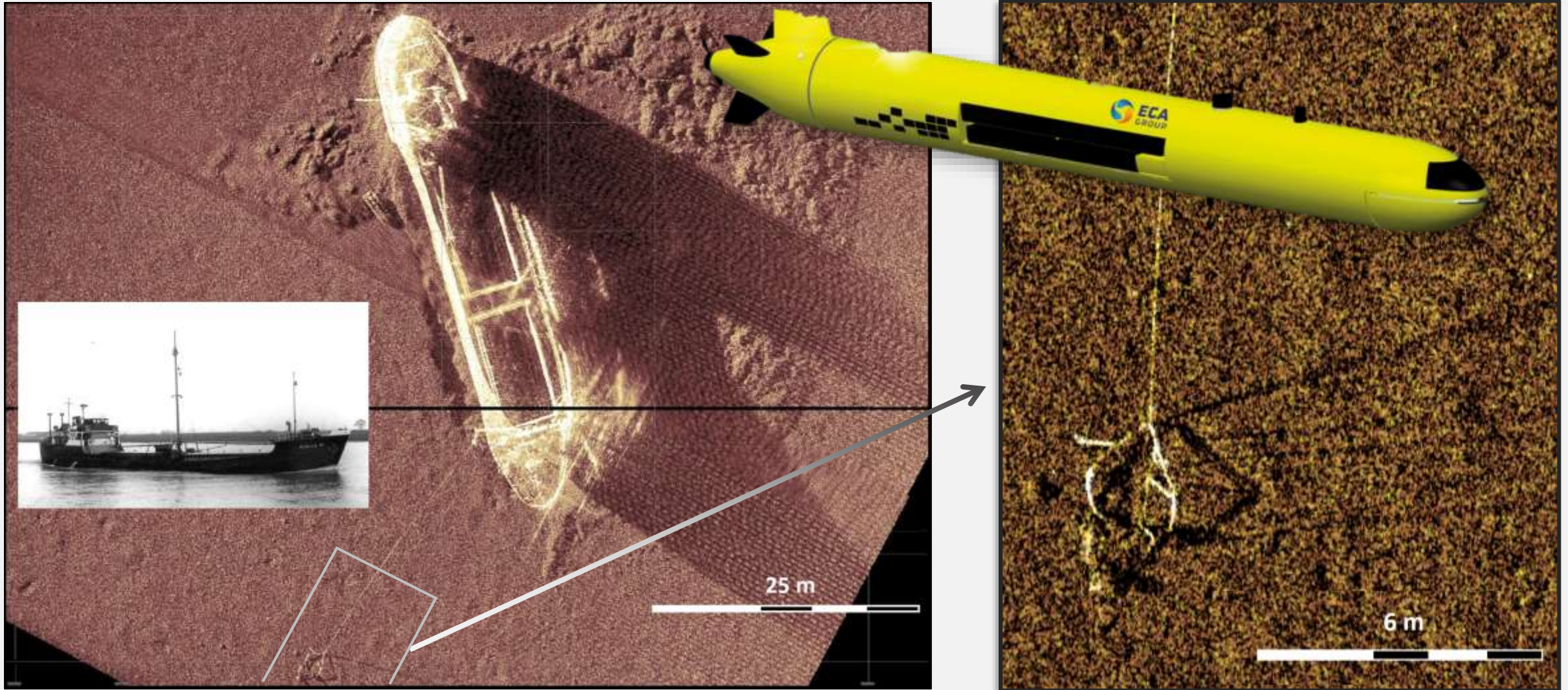


The probability for the presence of rare habitats in Palmahim Disturbance and its vicinity

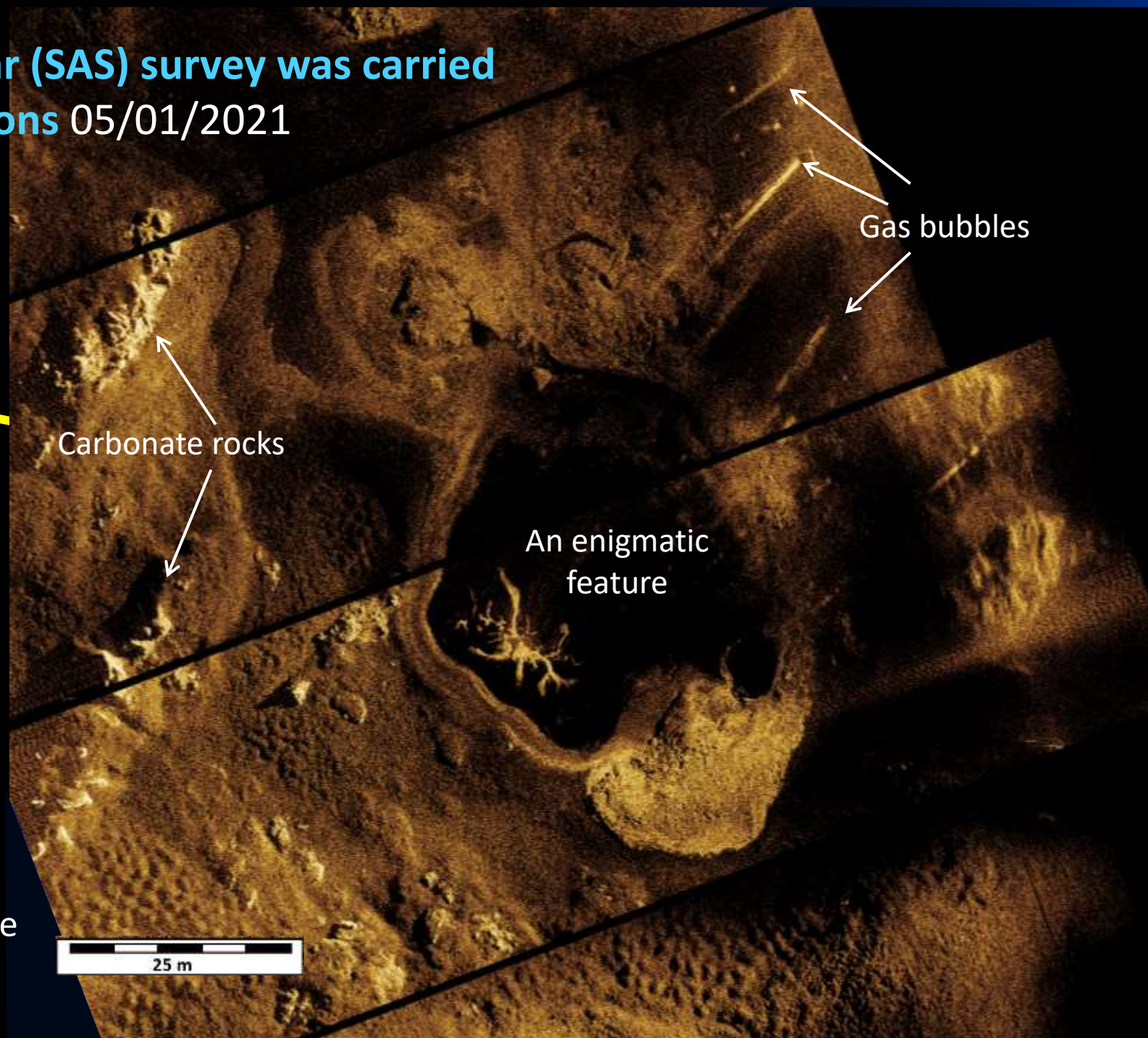
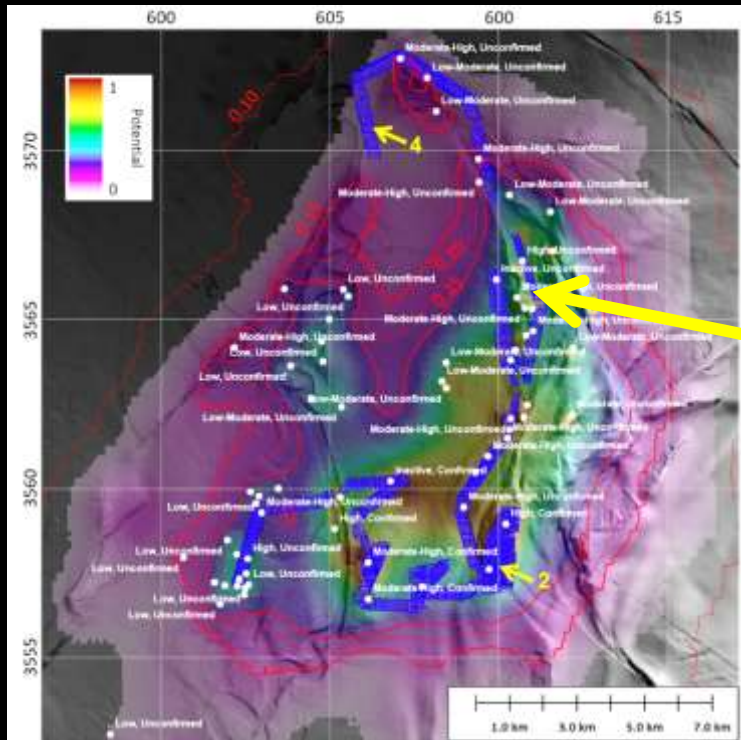


# AUV synthetic aperture sonar (SAS) imaging – the latest & greatest

A demonstration - a wreck surveyed at ~900 m water depth offshore Israel

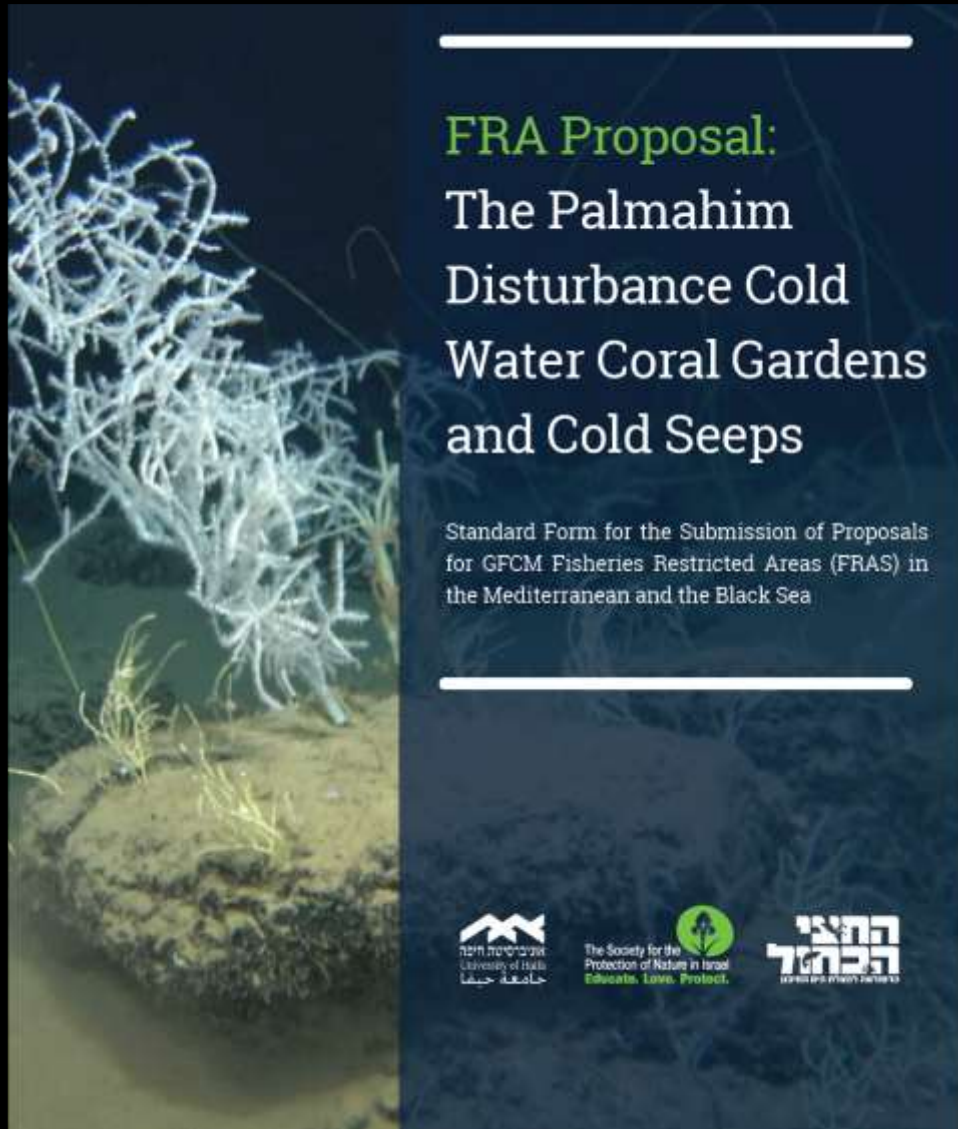


# An AUV synthetic aperture sonar (SAS) survey was carried out to verify the model predictions 05/01/2021






The discovery of an enigmatic seafloor gas seepage feature by the AUV's innovative synthetic aperture sonar (SAS) imaging where our predictive mapping suggested high level of seepage





**FRA Proposal:**  
The Palmahim  
Disturbance Cold  
Water Coral Gardens  
and Cold Seeps

Standard Form for the Submission of Proposals  
for GFCM Fisheries Restricted Areas (FRAs)  
in the Mediterranean and the Black Sea

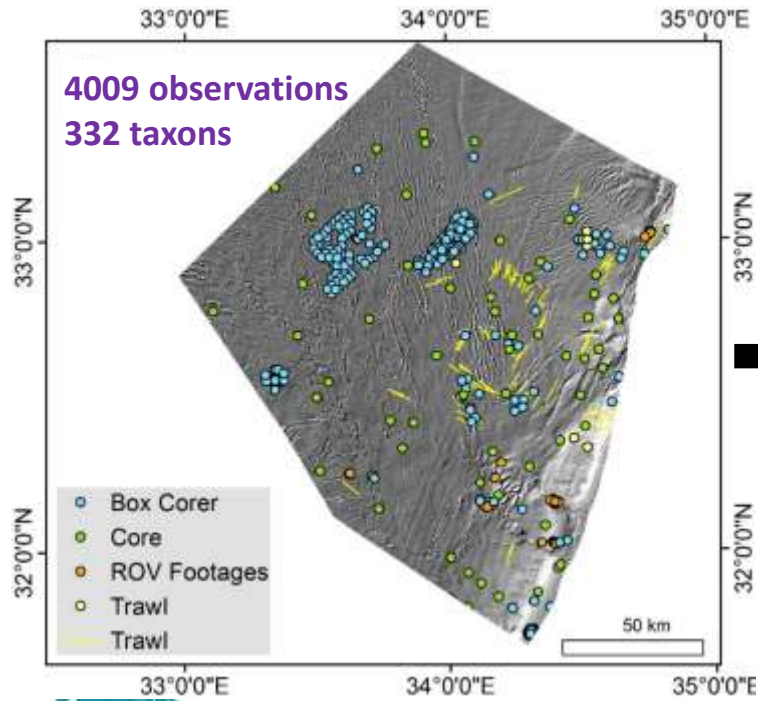
As a result of our work, on September 2022 the **Israeli minister of Environmental Protection** declared the establishment of the **first marine protected area (MPA) in Israel's Economic Zone** (outside territorial waters) in Palmahim Disturbance,



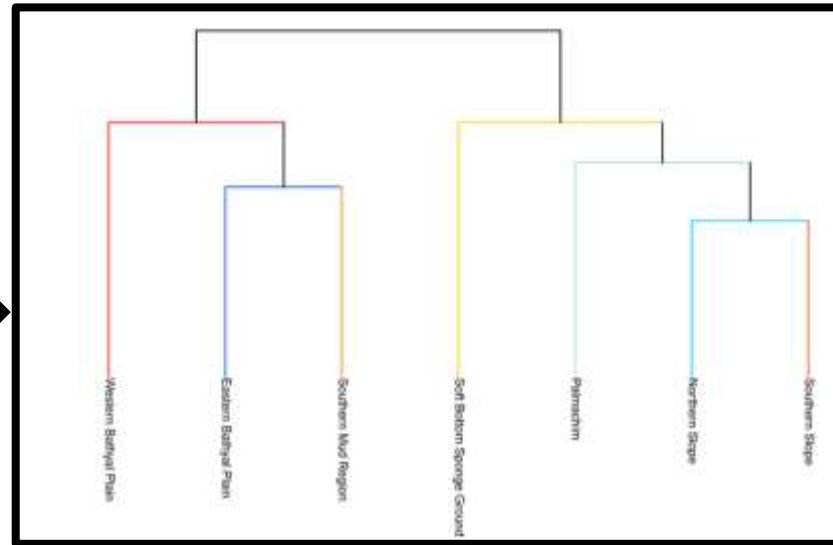
# A strategic definition of conservation targets towards the UN 30 by 30 initiative

A broad & multidisciplinary scientific collaboration with stakeholders supervision

Collection of samples from all available sources & QC



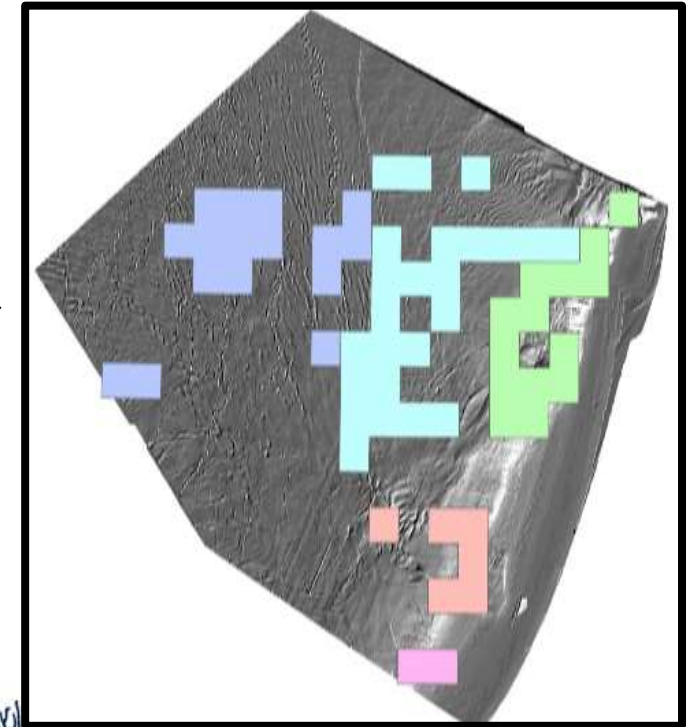
Machine-learning aided classification



\*Simpson dissimilarity index

\*\*Ward's D clustering

Bio-zonation modeling



# A strategic definition of conservation targets towards the UN 30 by 30 initiative

## Incorporating environmental characterization + the bio-zonation to yield basin-wide habitats mapping

### Seafloor

### Water Column

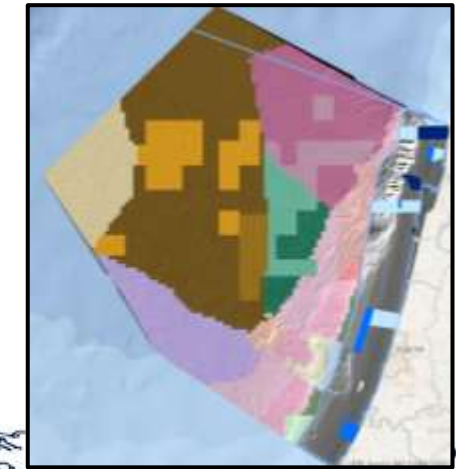
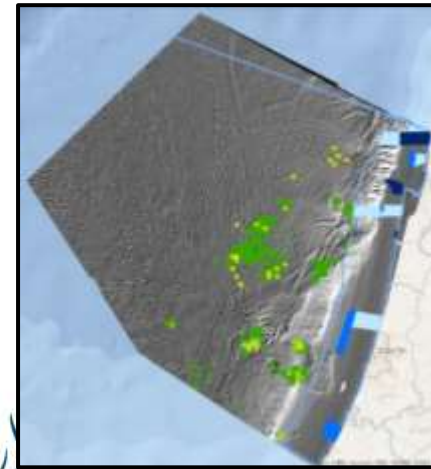
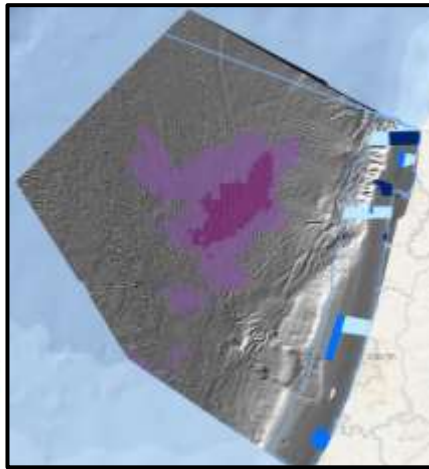
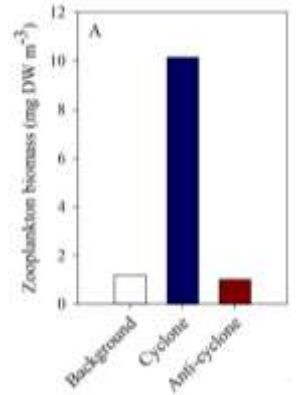
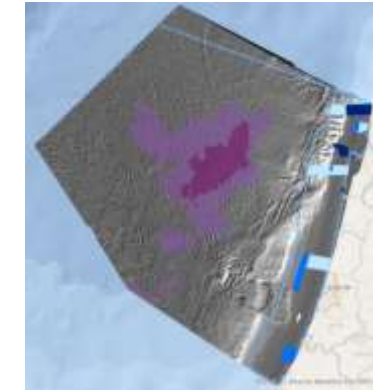
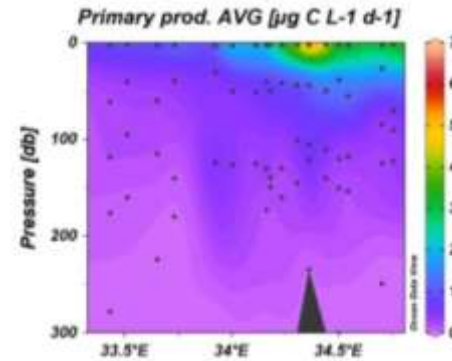
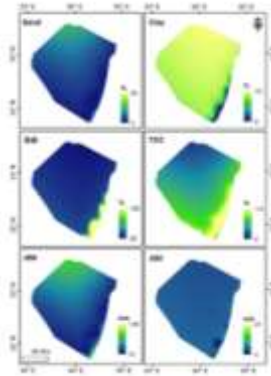
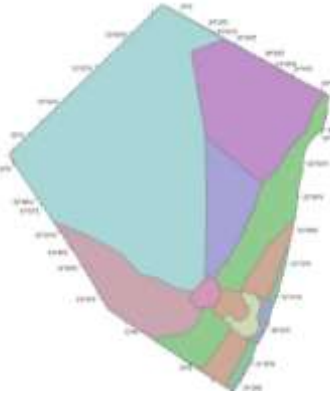
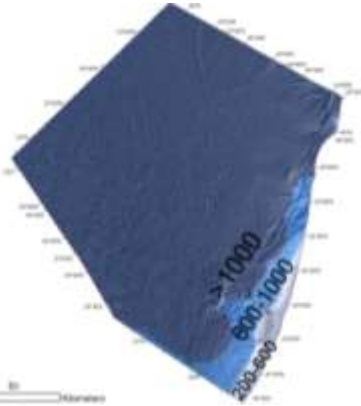
Water depth

Geomorphological Units

Seafloor sediments

Productivity

Long-term Gyres activity & biological impact



Gyres: Unique foci of richness in the water column

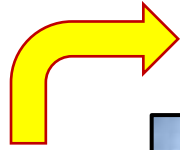
Representative ecological units

Unique seafloor habitats cover 4% of the territory

18 seafloor ecological units

# A strategic definition of conservation targets towards the UN 30 by 30 initiative

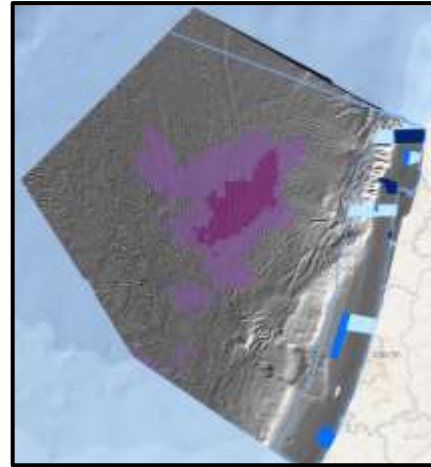
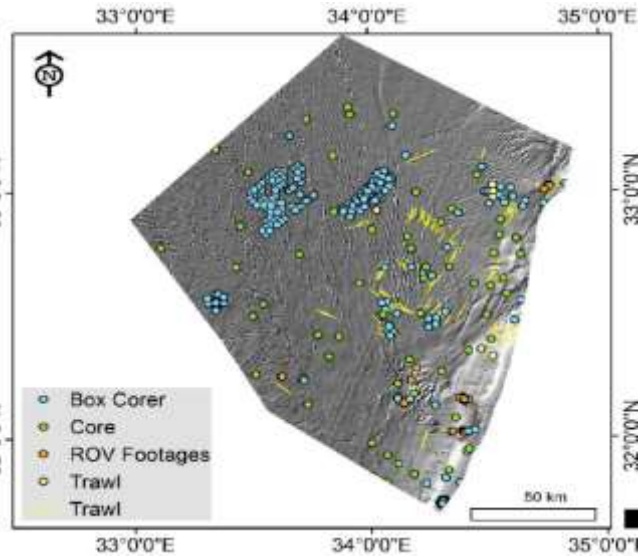
An integrated database of available seafloor data



Environmental characterization

Water body

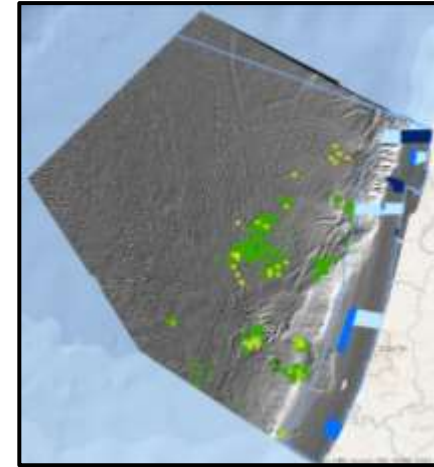
Seafloor



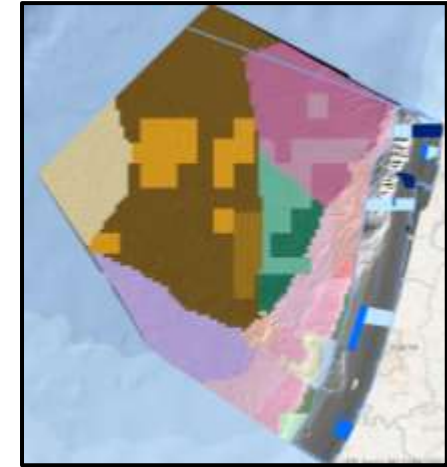
Gyres: Unique foci of richness in the water column



Representative ecological units

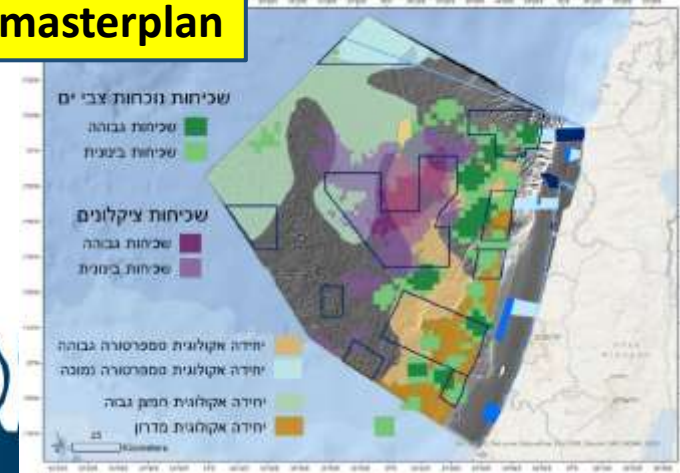


Unique seafloor habitats cover 4% of the territory



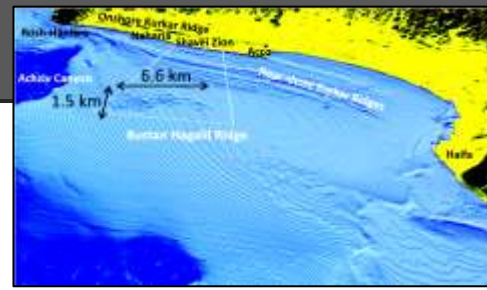
18 seafloor ecological units

MPAs masterplan

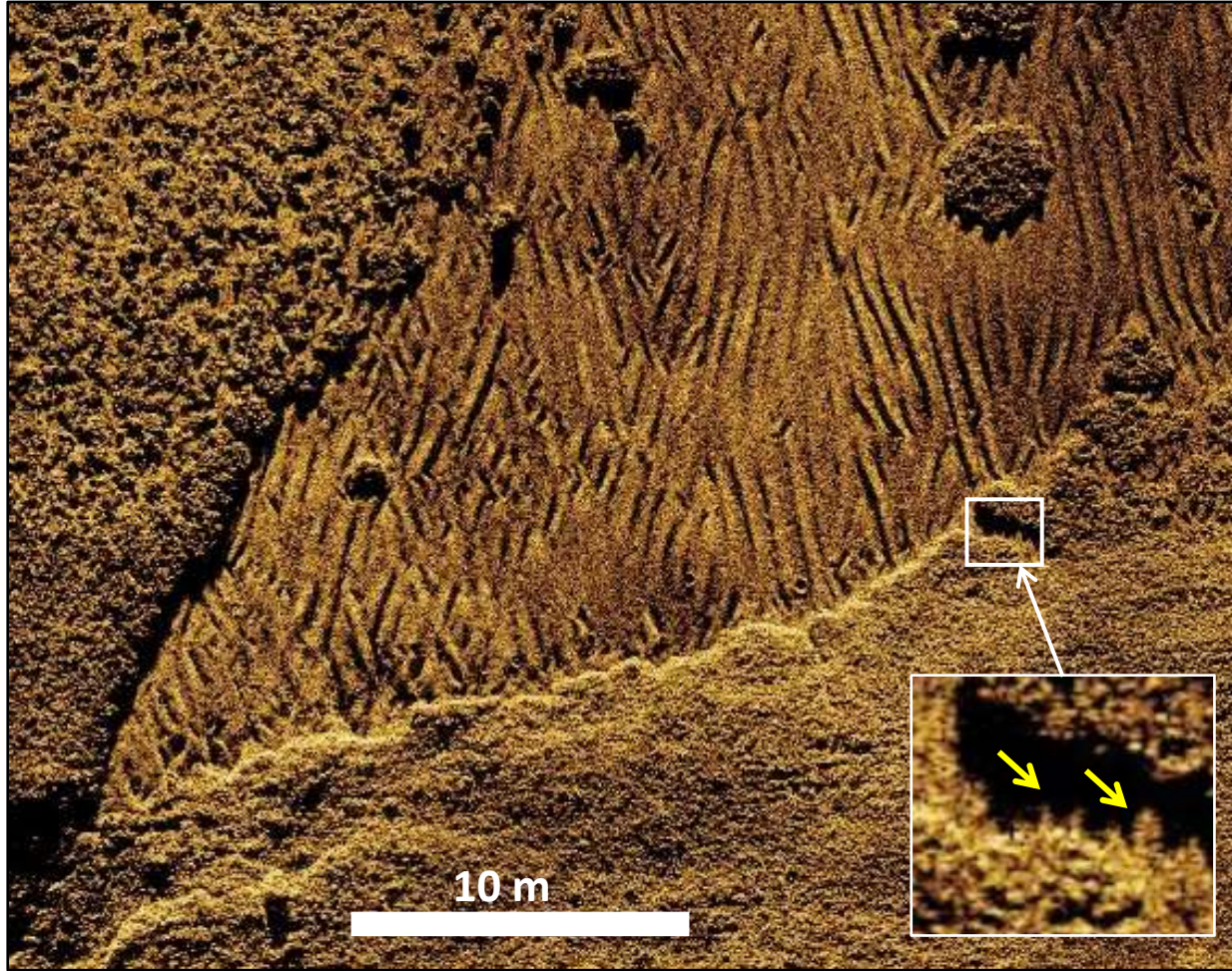


# From AUV SAS Surveying to Habitat Mapping & Management

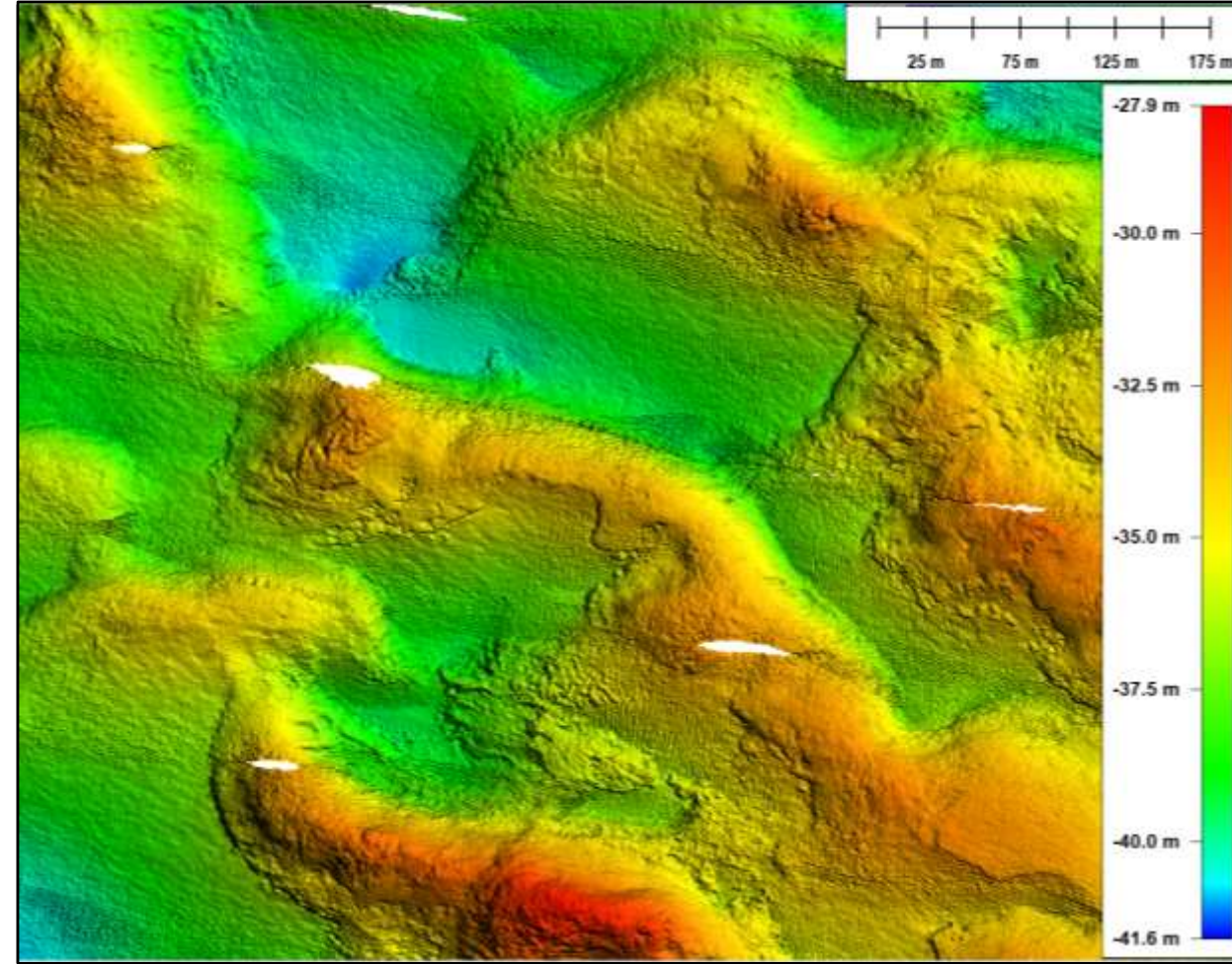
## Bustan Hagalil Ridge AUV multibeam and synthetic aperture sonar (SAS) survey (2018)



AUV SAS backscatter image



AUV multibeam bathymetry

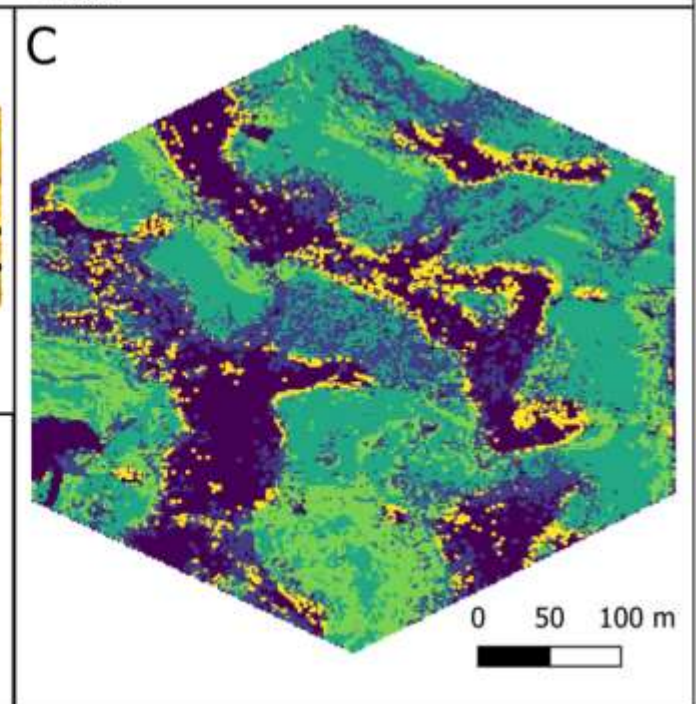
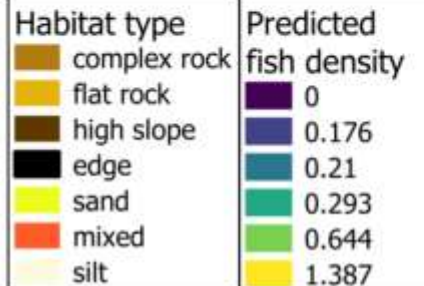
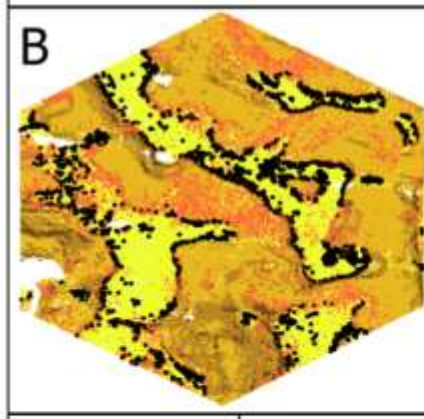
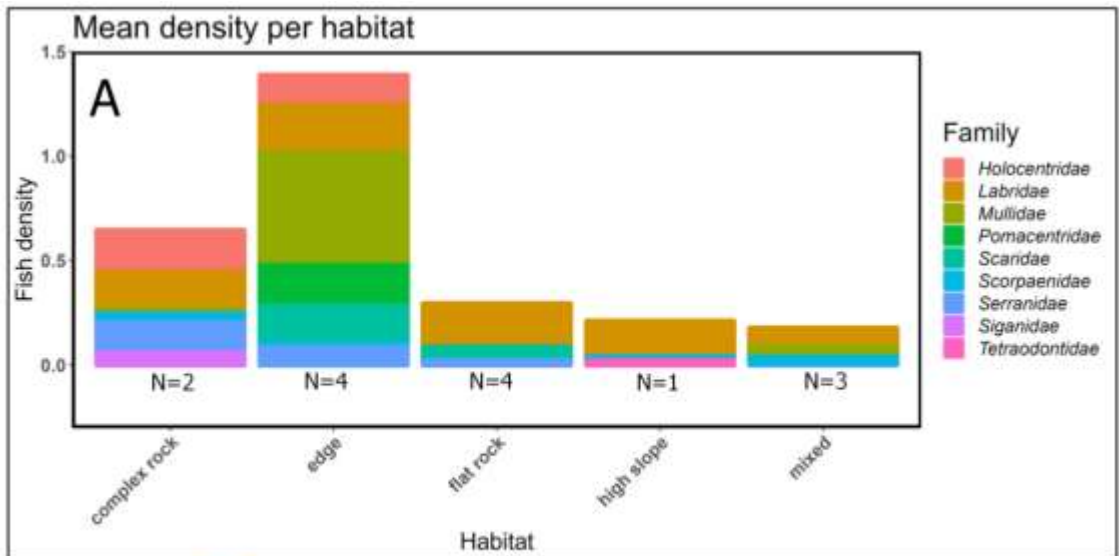
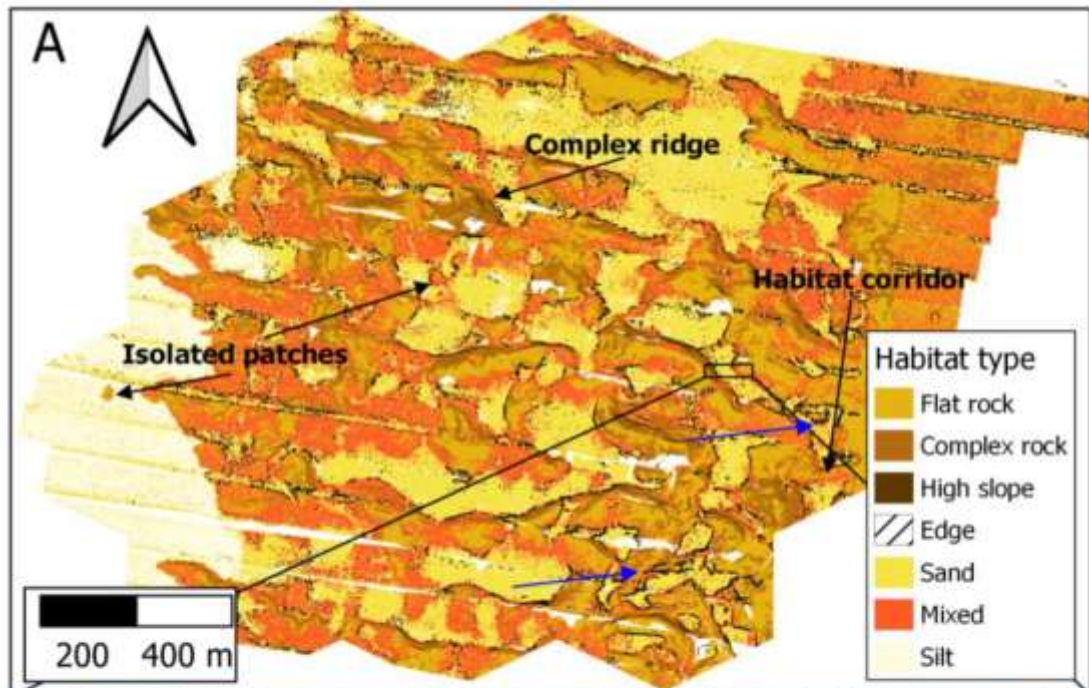


Algae overgrowth on the rocks is clearly imaged by the SAS

# Ecological sampling based on the SAS imaging

- Underwater Visual Census (SCUBA)
- Quadrat images
- AUV

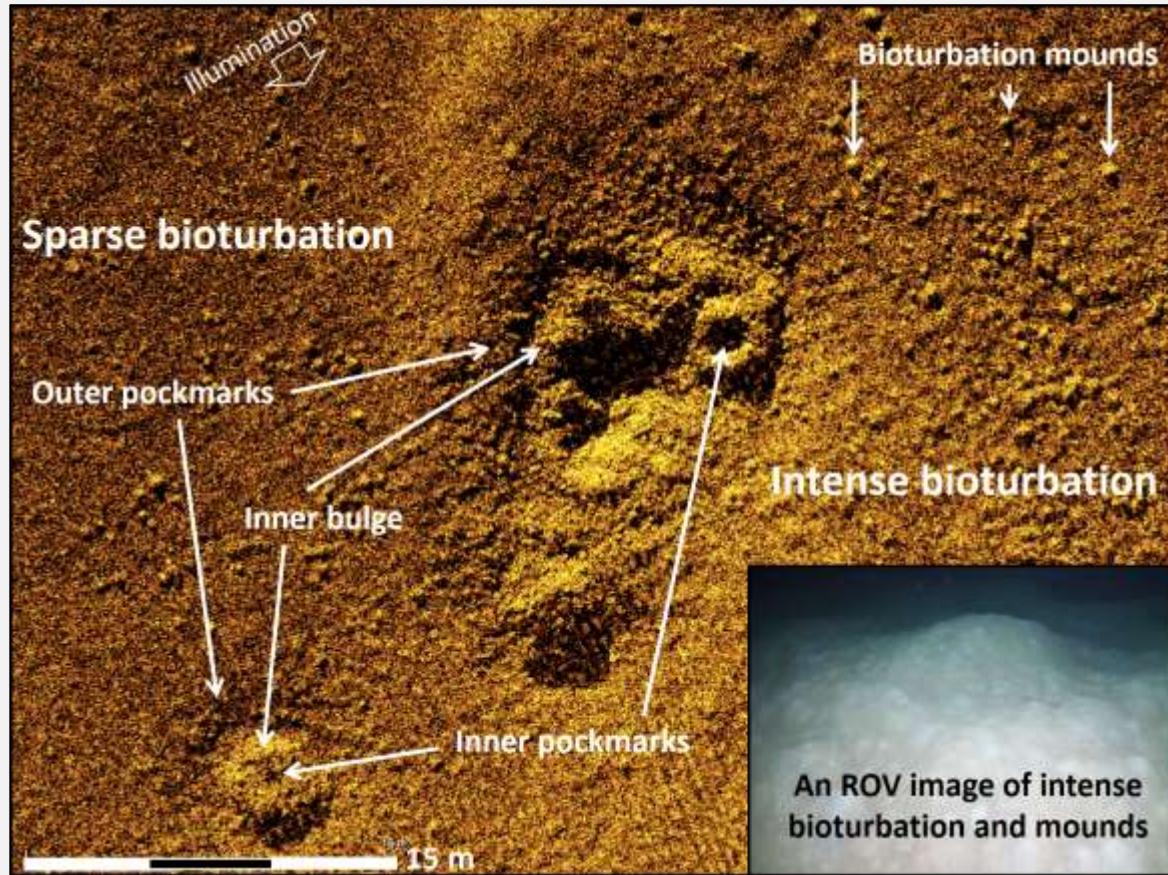




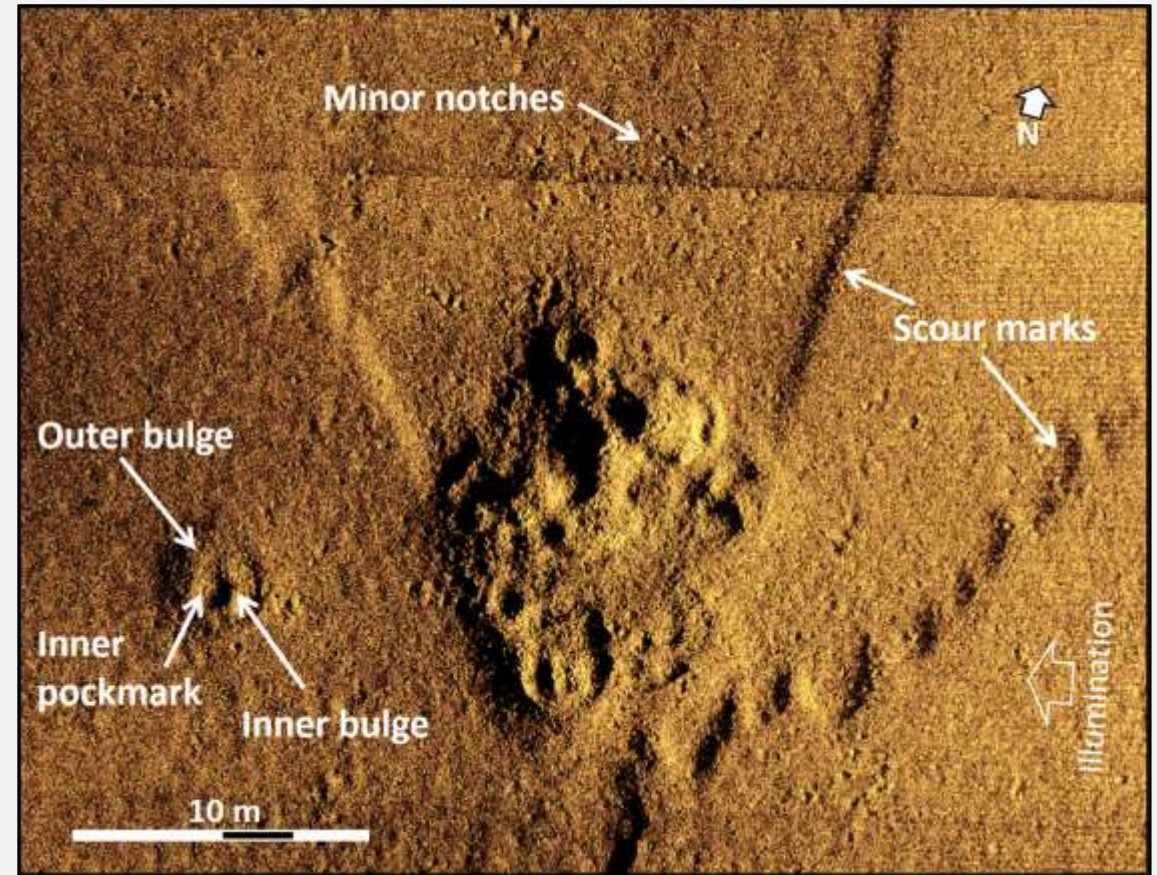
# AUV SAS resolving the activity of seafloor seepage

Two seepage edifices surveyed at ~800 m water depth offshore Israel

Dense bioturbation – active seepage (?)



No bioturbation – inactive seepage (?)



# Thank you



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The Hatter Department  
of Marine Technologies  
המחלקה לטכנולוגיות ימיות ע"ש האטור



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University of Haifa