

INTERREG V-B “Balkan-Mediterranean 2014-2020”  
Regional cooperation for the transnational ecosystem sustainable development

# The marine environment of Cavo Greco

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*Subcontracted by the  
Department of Fisheries and Marine Research Cyprus*

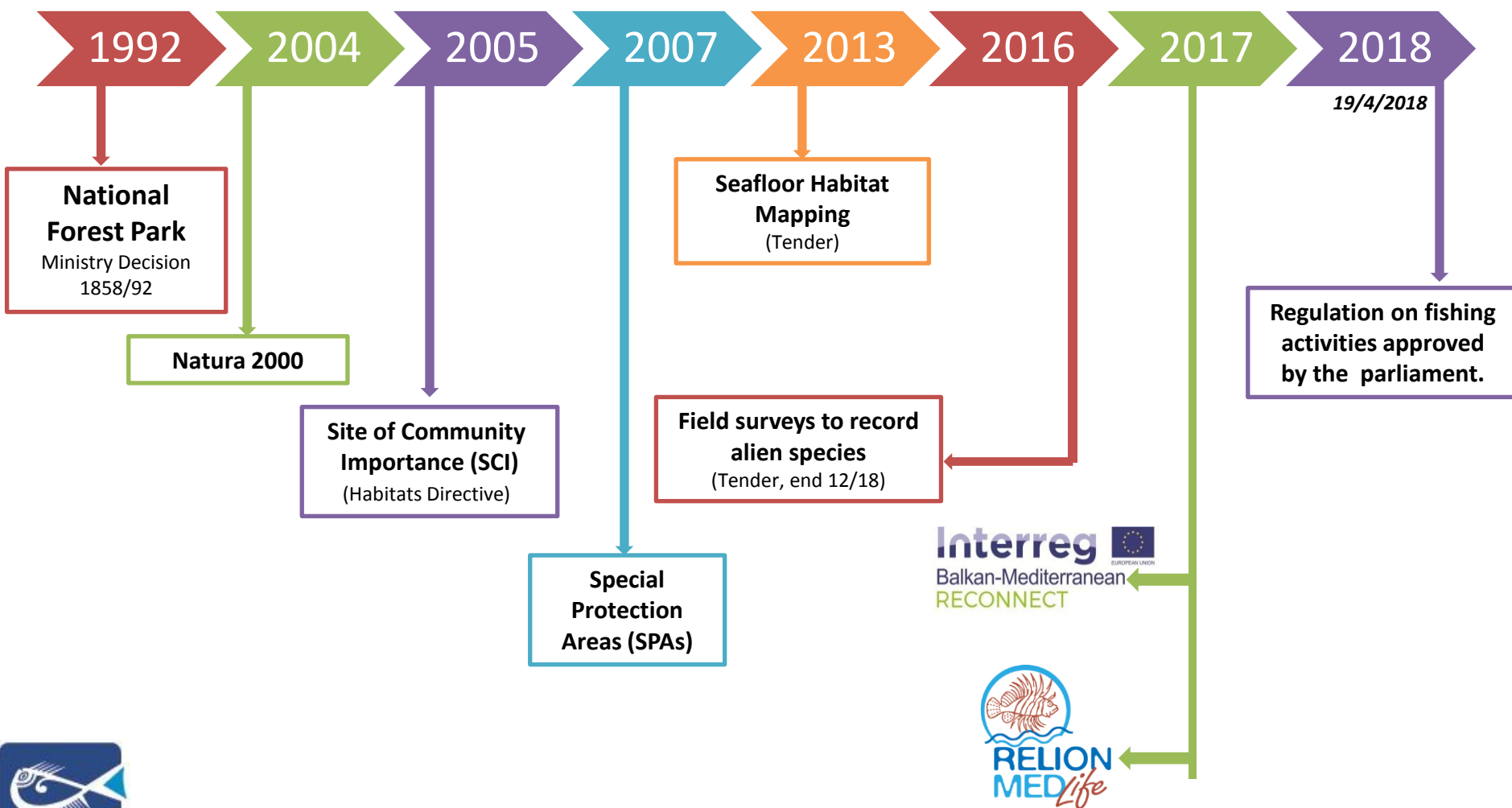


## **CAVO GRECO**

- **Protection status timeline**
- **Marine habitat types**
- **Marine species monitoring**
- **RELIONMED**
- **RECONNECT Project**

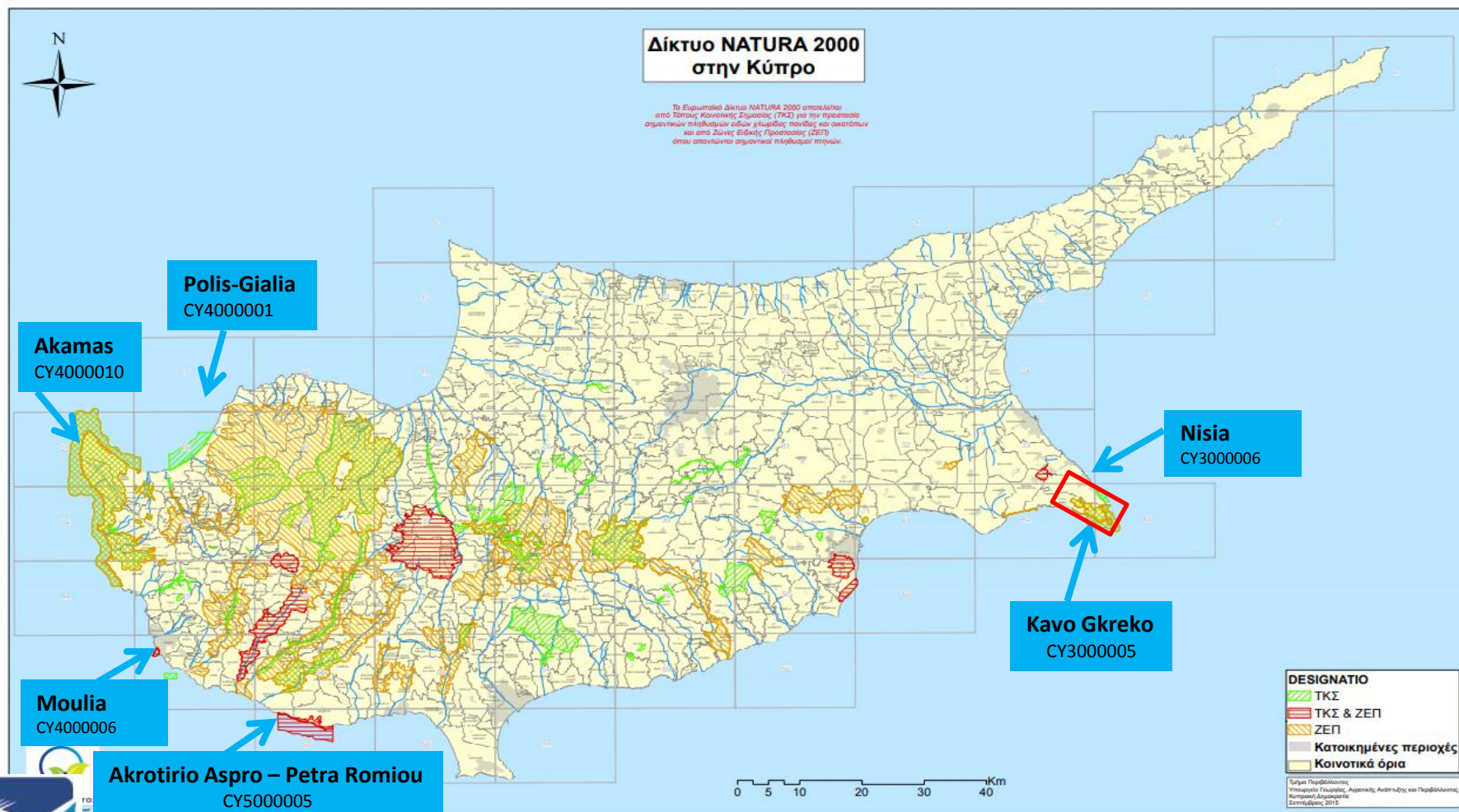


## Background information of Cavo Greco

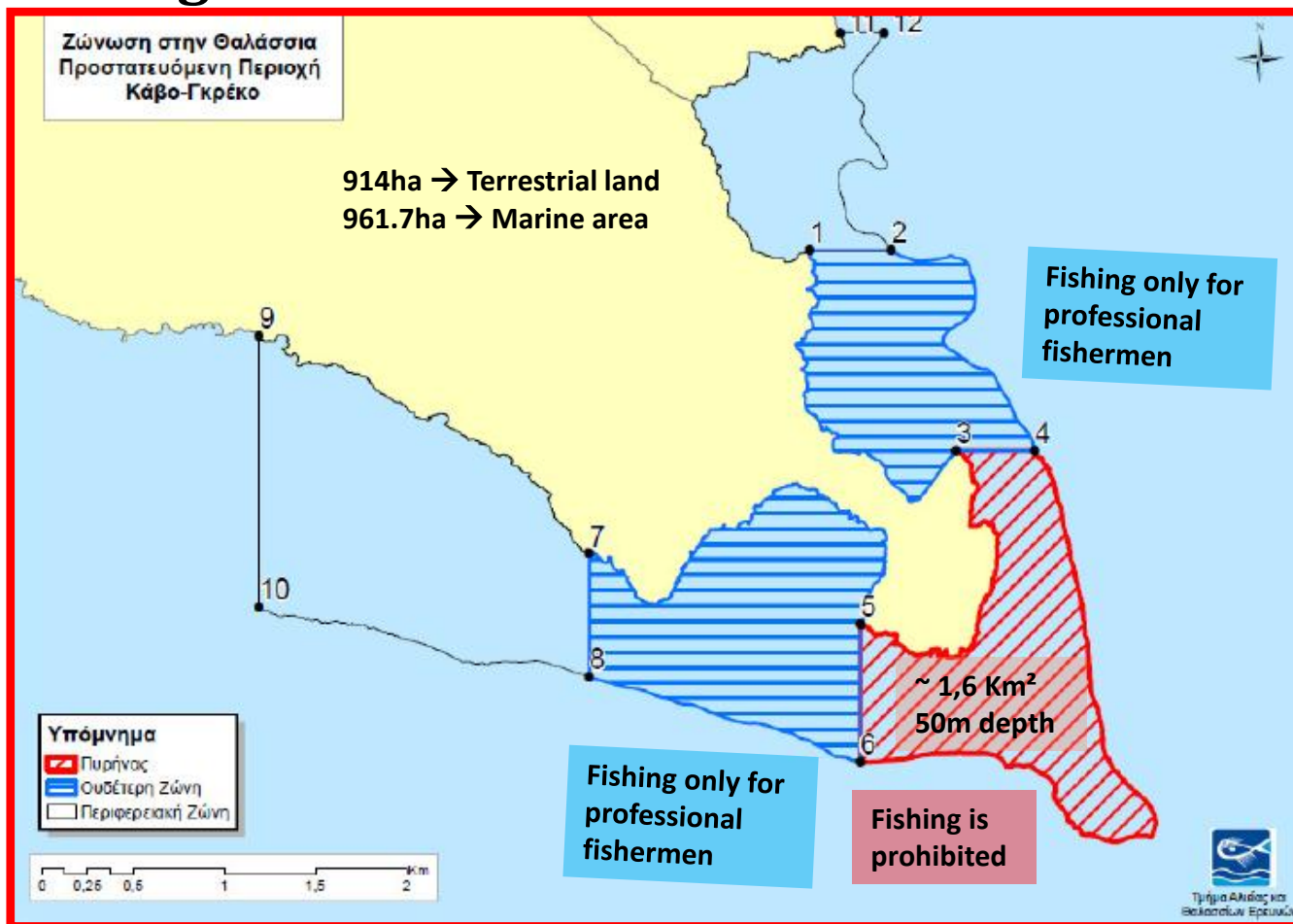




## Background information of Cavo Greko



## Background information of Cavo Greco



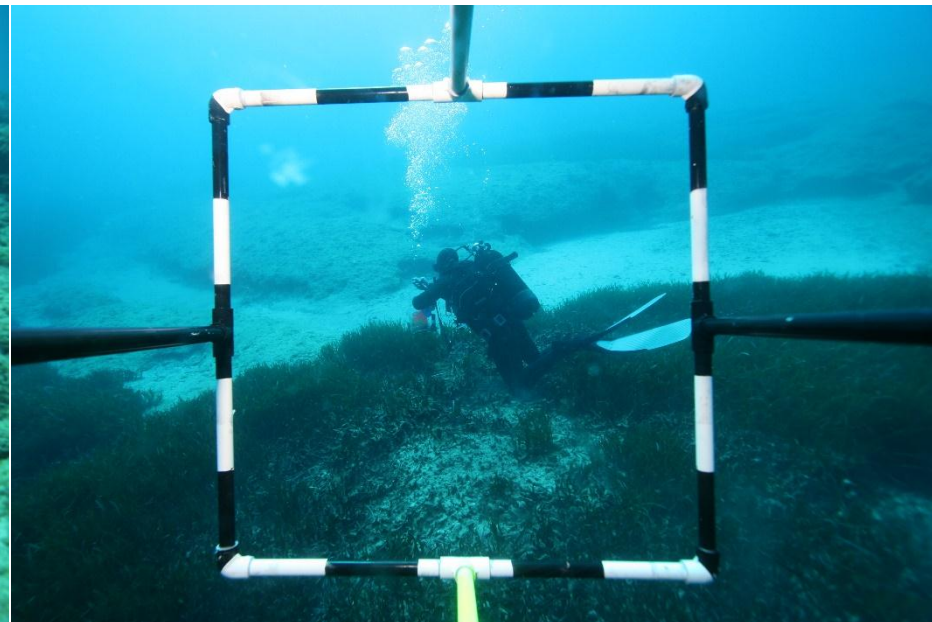
# Marine Habitats of Cavo Greco





## Marine habitat types Habitat Directive 92/43/EEC

- ✓ 1110 Sandbanks
- ✓ 1120 *Posidonia oceanica* meadows
- ✓ 1170 Reefs
- ✓ 8330 Submerged or partially submerged caves



# Marine habitat types Habitat Directive 92/43/EEC

## 1110 Sandbanks





# Marine habitat types Habitat Directive 92/43/EEC

## *1120 Posidonia oceanica meadows*



## Priority habitat *P. oceanica* meadows

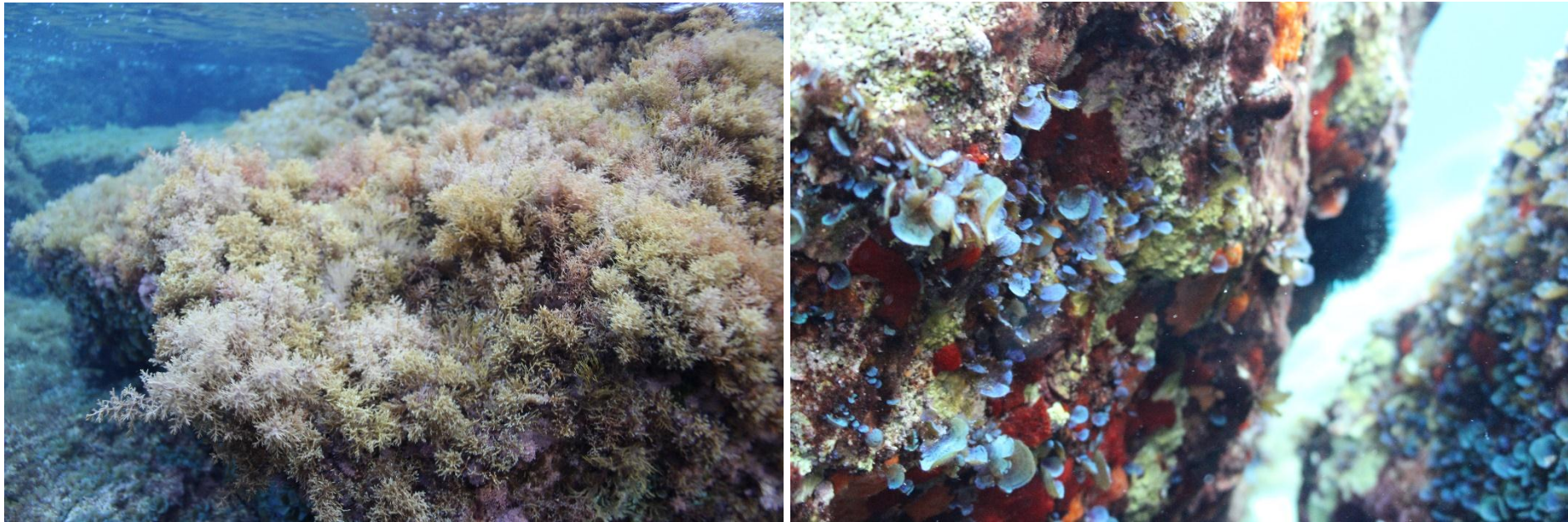
- One of the planet's **most productive ecosystems** exporting large amounts of organic matter and oxygen,
- Form complex ecosystems and **biodiversity hotspots**, supporting high level of biodiversity and trophic interactions,
- Areas of refuge, reproduction and **nursery** for fish and invertebrates also of commercial importance,
- Reduce sedimentation and **stabilizes the seabed**, absorb hydrodynamism, their banquettes **reduce coastal erosion**,
- Absorb nutrients helping improve **water quality**,
- Climate change role as **C sink**





# Marine habitat types Habitat Directive 92/43/EEC

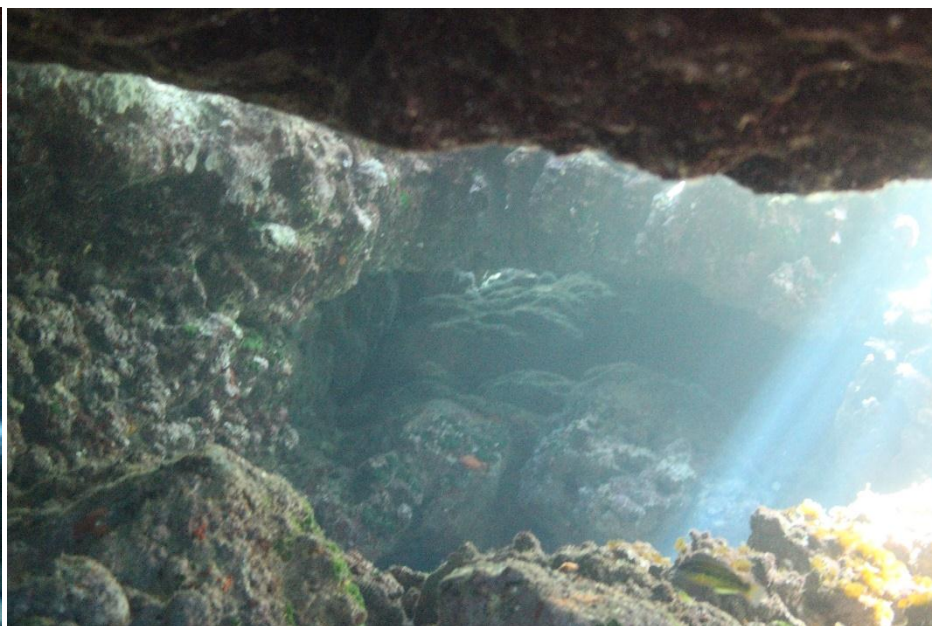
## 1170 Reefs





# Marine habitat types Habitat Directive 92/43/EEC

## 8330 Submerged or partially submerged caves



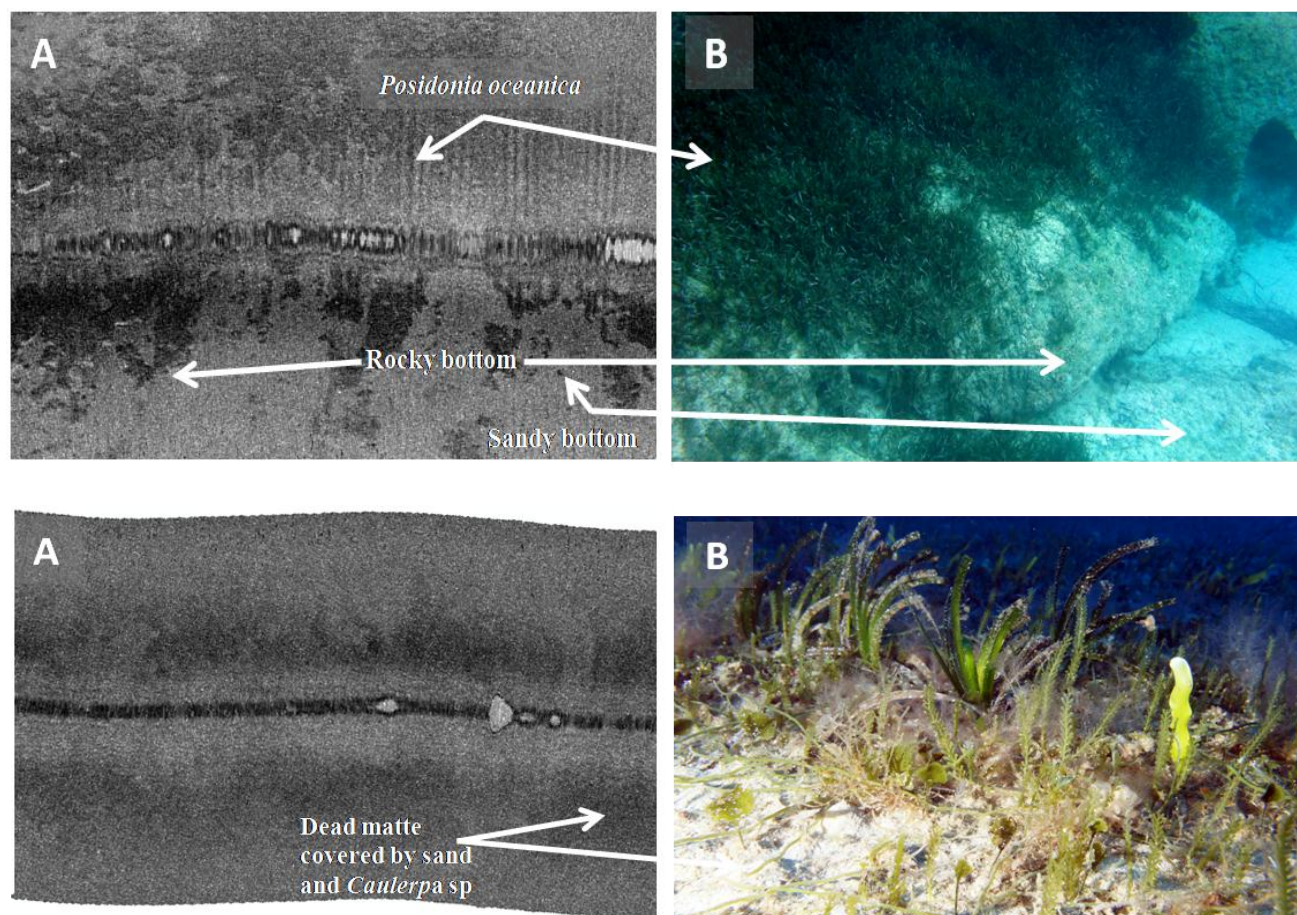
# Sampling surveys: Habitat mapping

## DFMR tender # 11.2010

Funded by the Operational Fisheries Program 2007-2013, co-funded 50% from the European Fisheries Fund and 50% from national resources

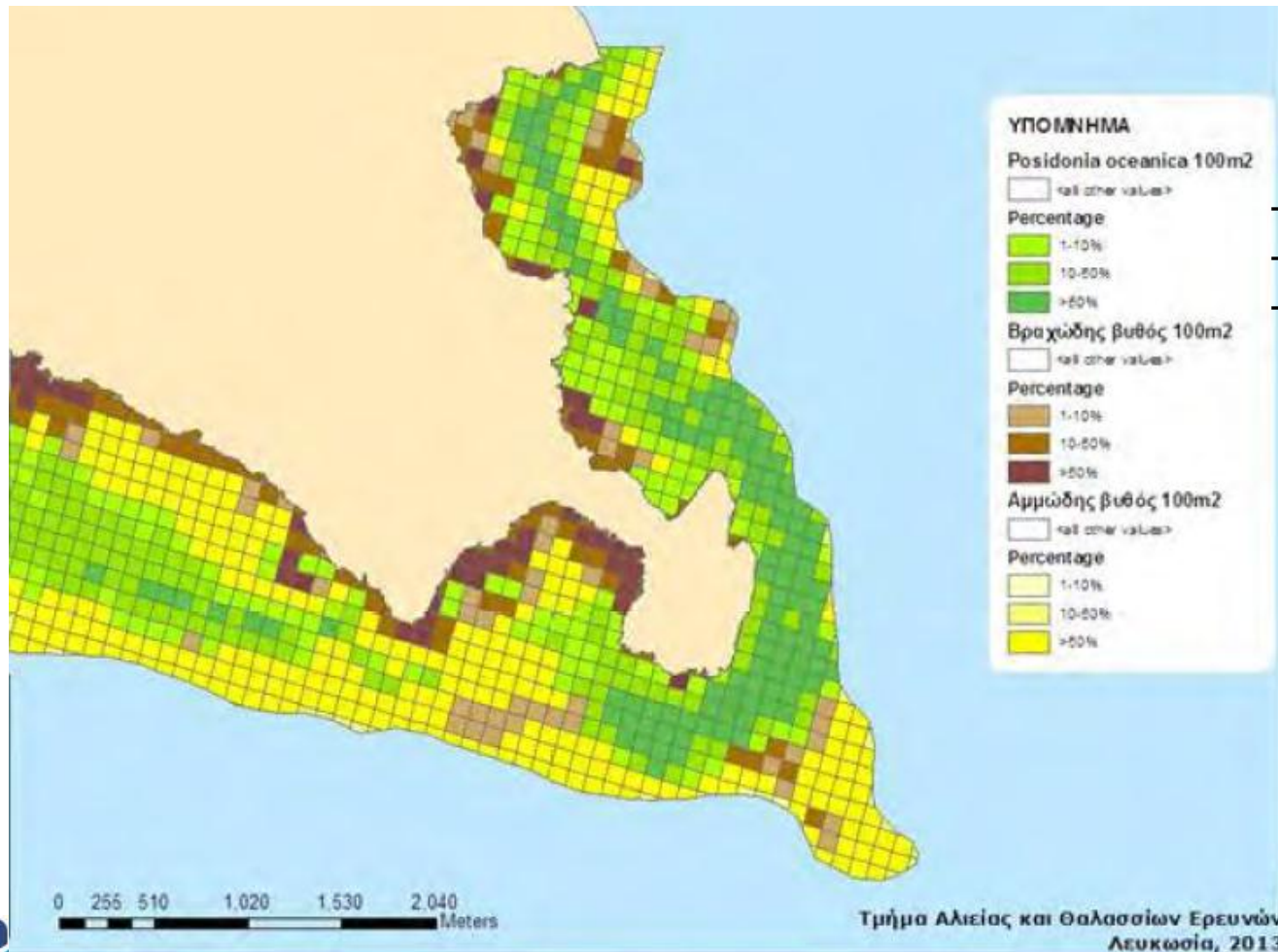
### 2013

- ✓ Aerial photos
- ✓ Side Scan Sonar
- ✓ Multi-beam Sonar
- ✓ Ground truthing
- ✓ Data processing
- ✓ Map development





# Sampling surveys: Habitat mapping

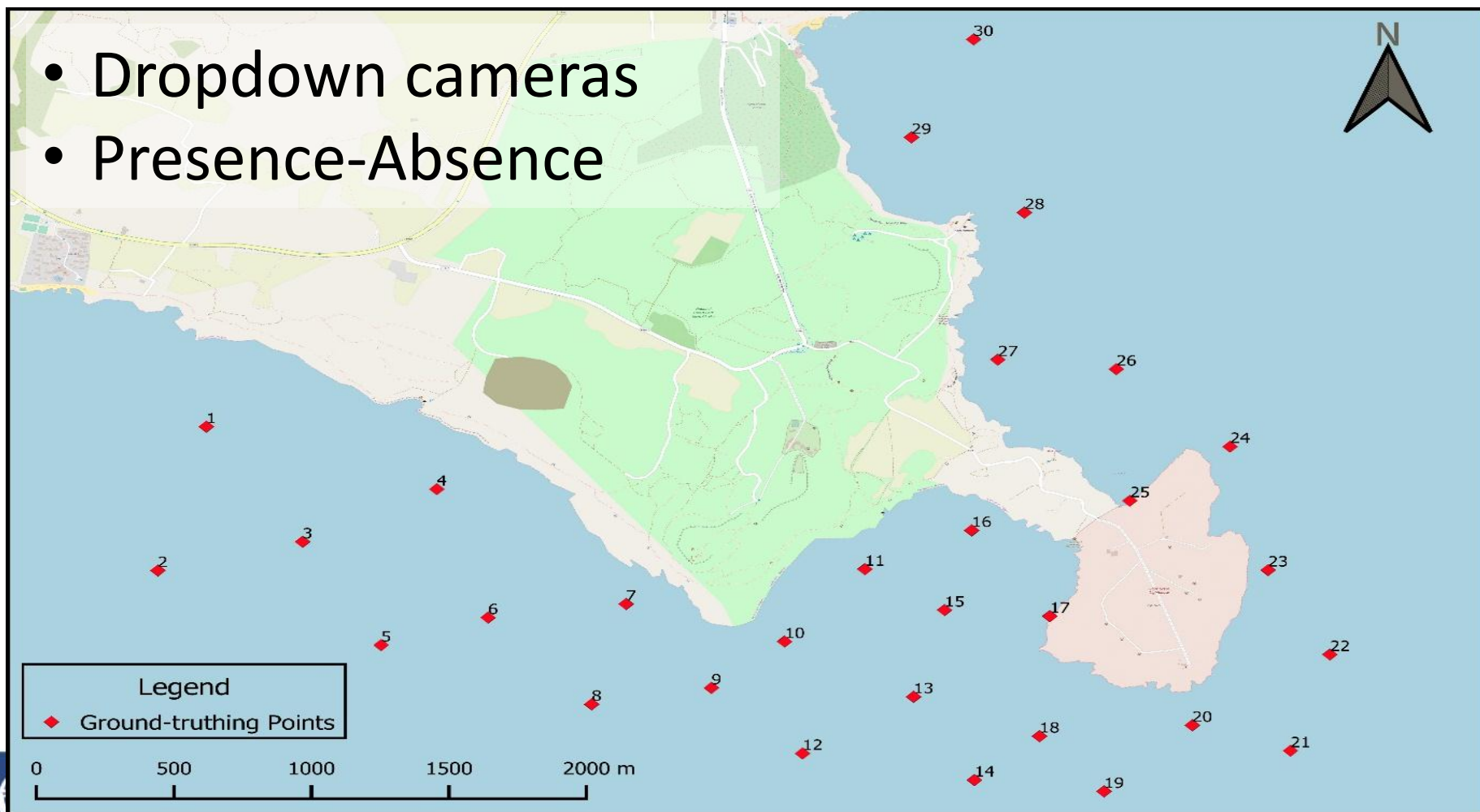


- Less than 10 %
- Between 10 and 50 %
- More than 50 %



# Sampling surveys: Habitat mapping *(Reconnect)*

- Dropdown cameras
- Presence-Absence



# Sampling surveys: Habitat mapping *(Reconnect)*

Diving Point	Longitude	Latitude	Depth	Posidonia Oceanica (Yes/No)	Comments	Groundtruthing Video
1	34.06635046	34.95612481	14.4	No	Sandy expanse	Point 1
2	34.06865977	34.95722616		Maybe	Some leaves visible but can not distinct if its live shoots or just dead leaves	Point 2
3	34.06490956	34.95899084	24	Yes	Sand with Posidonia oceanica patches	Point 3
4	34.06318268	34.95863433	12	No	Sand	Point 4
5	34.07302132	34.96217341	42.8	No	Some dead Posidonia leaves forming stacks of dead leaves due to currents . Can be mistaken for live shoots, however due to depth limitations this can not be true.	Point 5
6	34.09212153	34.97211449	22.4	Yes	Posidonia oceanica patches	Point 6
7	34.06865977	34.95722616	19.6	yes	Sand with Posidonia oceanica nearby	Point 7
8	34.07638294	34.96301442	51.8	No	Dead Posidonia oceanica leaves	Point 8
9	34.07638294	34.96301442	35	No	Some dead Posidonia oceanica leaves	Point 9
10	34.07638294	34.96301442	24.3			Point 10
11	34.07638294	34.96301442	15.8		Sand/Posidonia oceanica nearby	Point 11
12	34.07638294	34.96301442	51	No	Some dead Posidonia oceanica leaves	Point 12
13	34.09497844	34.96469949	32.1	Maybe	Sand with some Posidonia oceanica leaves.A small patch is visible, however can not tell if the shoots are alive or its just dead leaves.	Point 13
14	34.09004007	34.96574758	45.7	No	No Posidonia visible	Point 14
15	34.09497844	34.96469949	18	No	Sand	Point 15
16	34.09497844	34.96469949	8.8	No	Sand with rocks nearby and some Posidonia oceanica leaves	Point 16
17	34.08647493	34.96338484	13	No	Reef	Point 17
18	34.09212153	34.97211449	32	Yes	Reefs with some Posidonia oceanica	Point 18
19	34.09212153	34.97211449	40.5	No	Some Posidonia oceanica dead leaves	Point 19
20	34.09004007	34.96574758	17	Yes	Posidonia oceanica meadow	Point 20
21	34.09004007	34.96574758	30.3	Yes	Posidonia oceanica meadow with sand	Point 21
22	34.09004007	34.96574758	38.3			Point 22
23	34.09004007	34.96574758	12.4	No	Sand	Point 23
24	34.09004007	34.96574758		Yes	Posidonia oceanica on hard substrate	Point 24
25	34.09004007	34.96574758		No	No Posidonia/ Reef	Point 25
26	34.09212153	34.97211449		Yes	Posidonia oceanica with matte (Iagocephalus attacking the camera)	Point 26
27	34.09004007	34.96574758	3.4	No	Rock no Posidonia oceanica	Point 27
28	34.09004007	34.96574758		Maybe	Maybe some Posidonia shoots but mostly dead leaves (Iagocephalus attacking the camera)	Point 28
29	34.09004007	34.96574758		No	Sand	Point 29
30	34.09004007	34.96574758		Yes	Posidonia oceanica	Point 30



# Monitoring Biota

*Baseline survey and monitoring of non-  
indigenous species in Cavo Greco and Nisia  
Marine Protected Areas in Cyprus*

**DFMR tender # 26.2016**

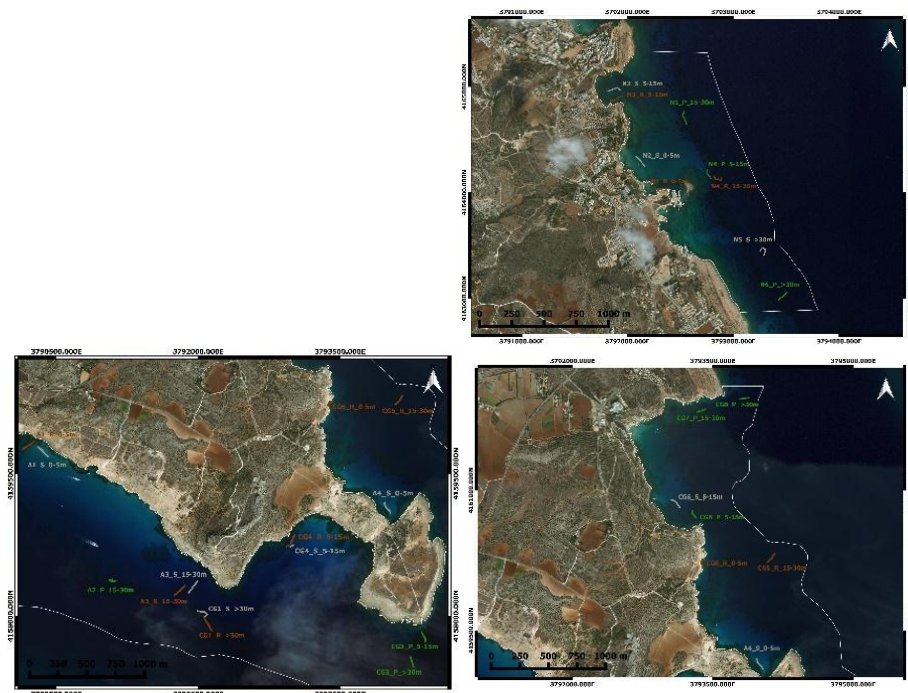
*Project funded by ΘΑΛΑΣΣΑ 2014-2020, co-funded by the European Maritime & Fisheries Fund (75%)  
and national sources (25%)*





# Monitoring Biota

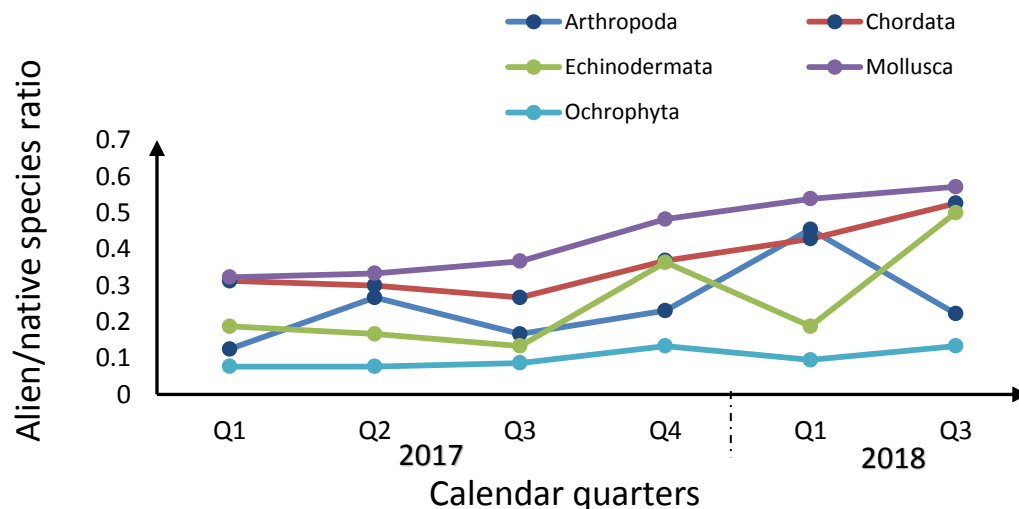
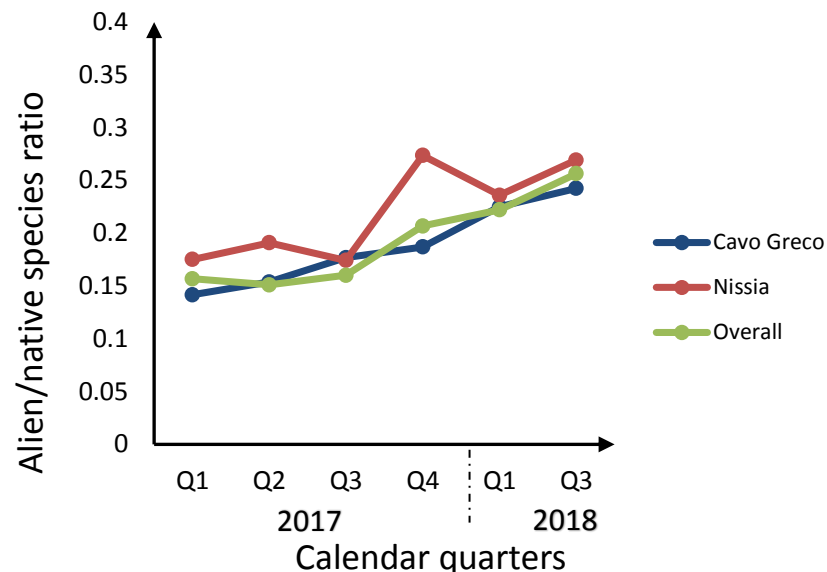
- 2 year project (2017 – 2018)
- 27 sampling sites – stratified random sampling in two Marine Protected Areas.
- 3 habitats (*Posidonia oceanica* meadows, hard substrate and soft substrate)
- Different bathymetric zones (0-5 m, 5-15 m, 15-30 m, >30 m)
- Same methods repeated seasonally.



# Monitoring Biota

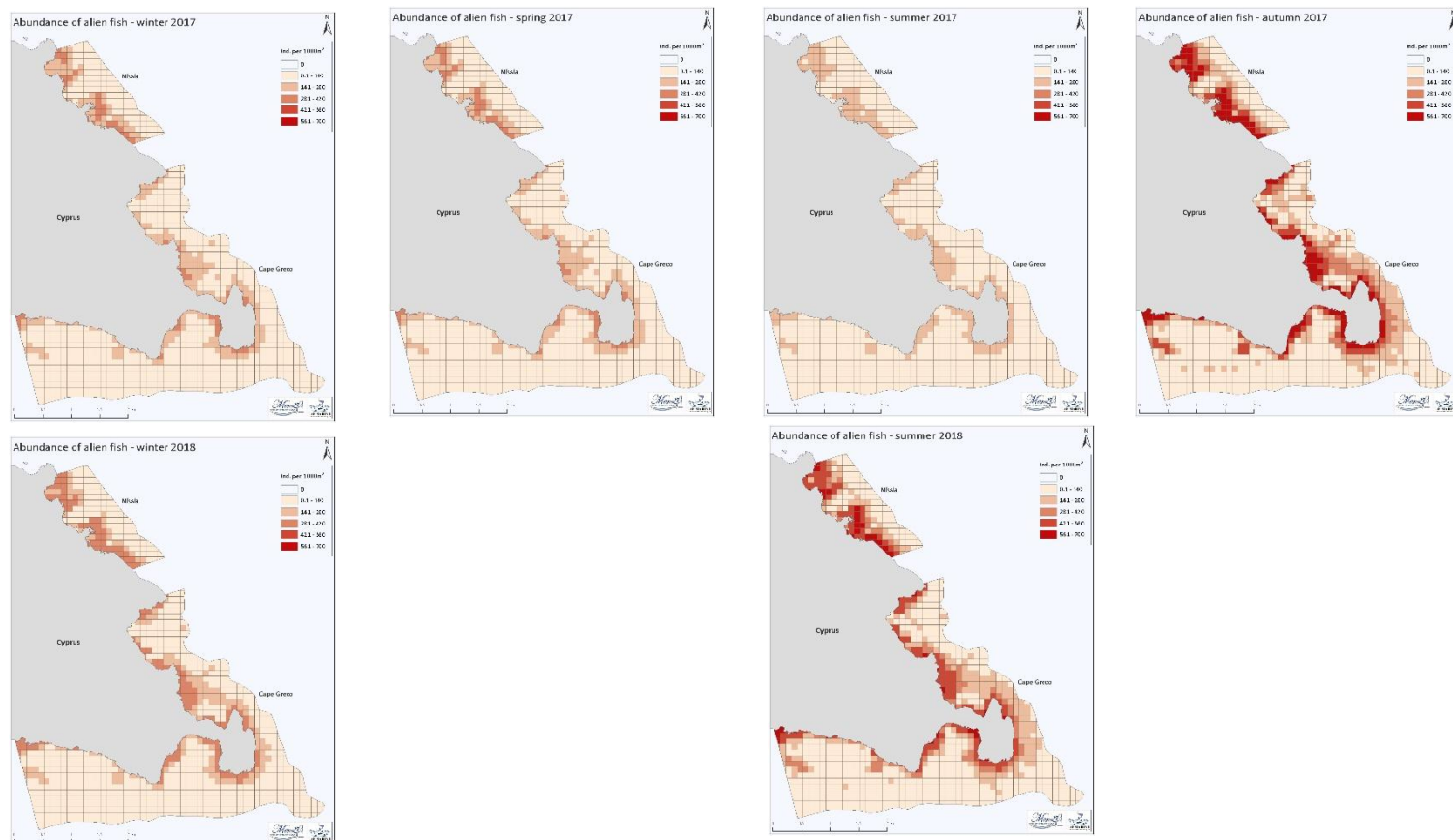
## Key findings

- 272 were characterised as native, 45 as alien, 2 as cryptogenic .
- Number of NIS is rising
- Mollusca and chordata are the taxa with most of the alien



# Monitoring Biota

## Alien fish

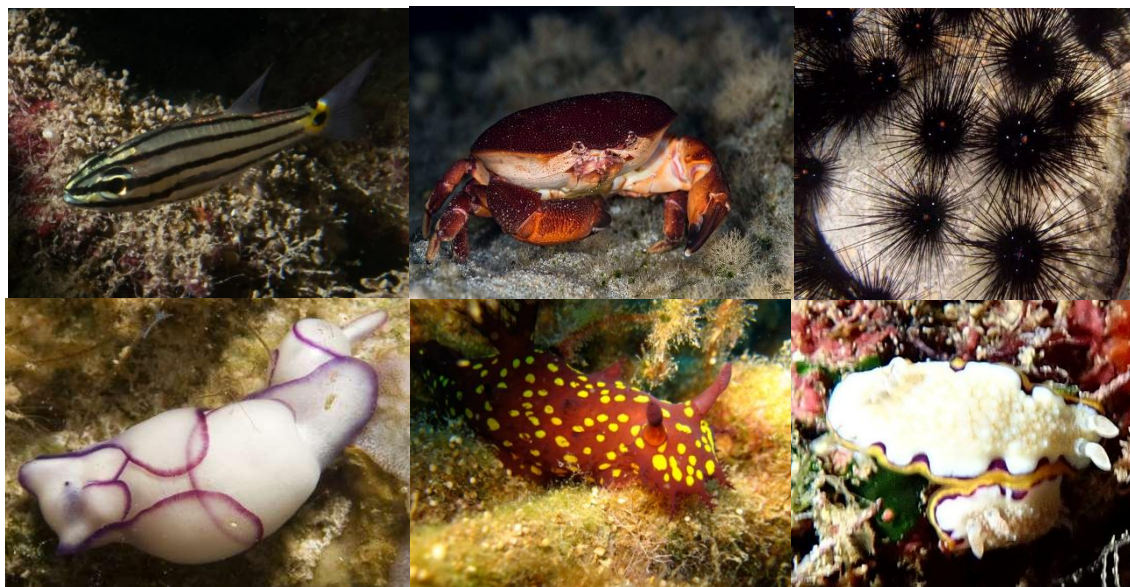
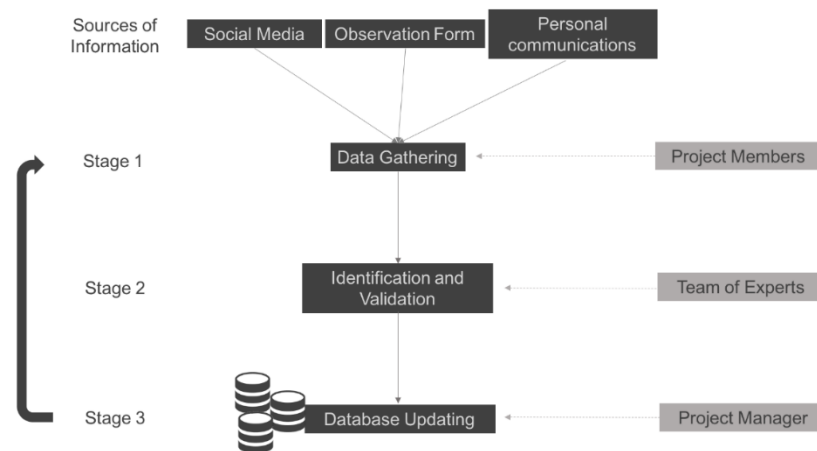




# Hotspot of alien species

## Importance of citizen science

- Through citizen science observations we recorded **six new** NIS from these areas in the past three years:
- Sea slug *Plocamopherus ocellatus* Rüppell & Leuckart, 1828, *Haminoea cyanomarginata* Heller & Thompson, 1983, *Goniobranchus obsoletus* (Rüppell & Leuckart, 1830)
- Crab *Atergatis roseus* (Rüppell, 1830)
- Fish *Cheilodipterus novemstriatus* (Rüppell, 1838)
- Sea urchin *Diadema setosum* (Leske, 1778)



# **RELIONMED LIFE Project**

**Preventing a LIONfish invasion in the  
MEDiterranean through early response  
and targeted Removal**



# RELIONMED Project

A four year European project aiming to tackle the lionfish invasion and create the first line of defence in Cyprus

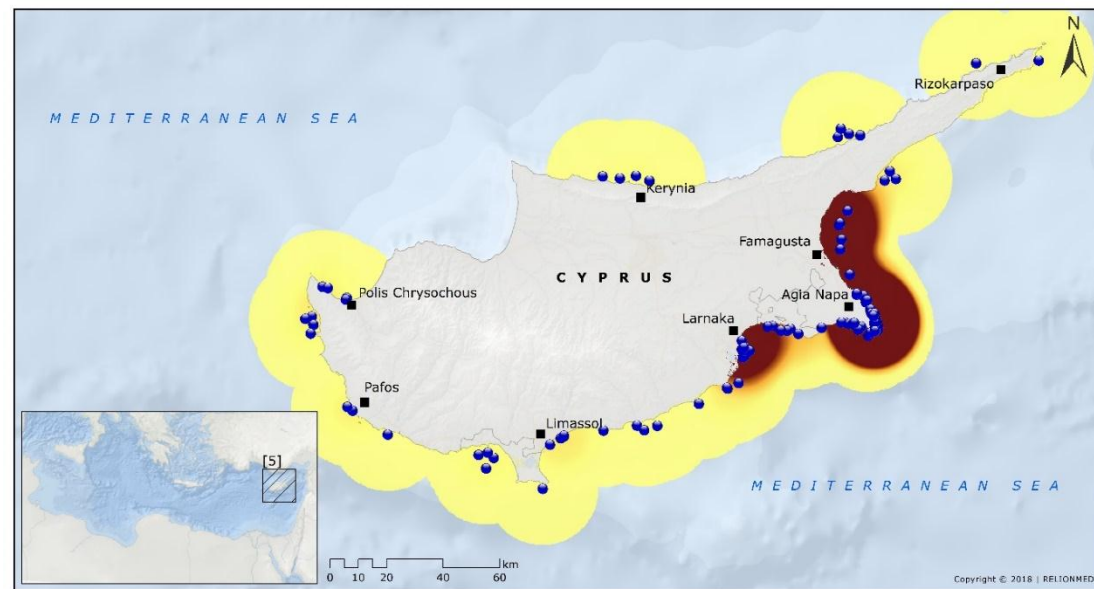




# RELIONMED Project

To improve citizen-capacity and participation

- Surveillance system
- Removal Action Teams
- Lionfish derbies



## LEGEND

 Lionfish Sightings

  
1 Specimens per 15 km radius 4





# RECONNECT PROJECT

- **Biodiversity Assessment**
- **Marine Litter Assessment**
- ***Posidonia oceanica* demography**
- **Water, sediment, and macrofauna**
- **Genetic analyses**
- **Citizen science**

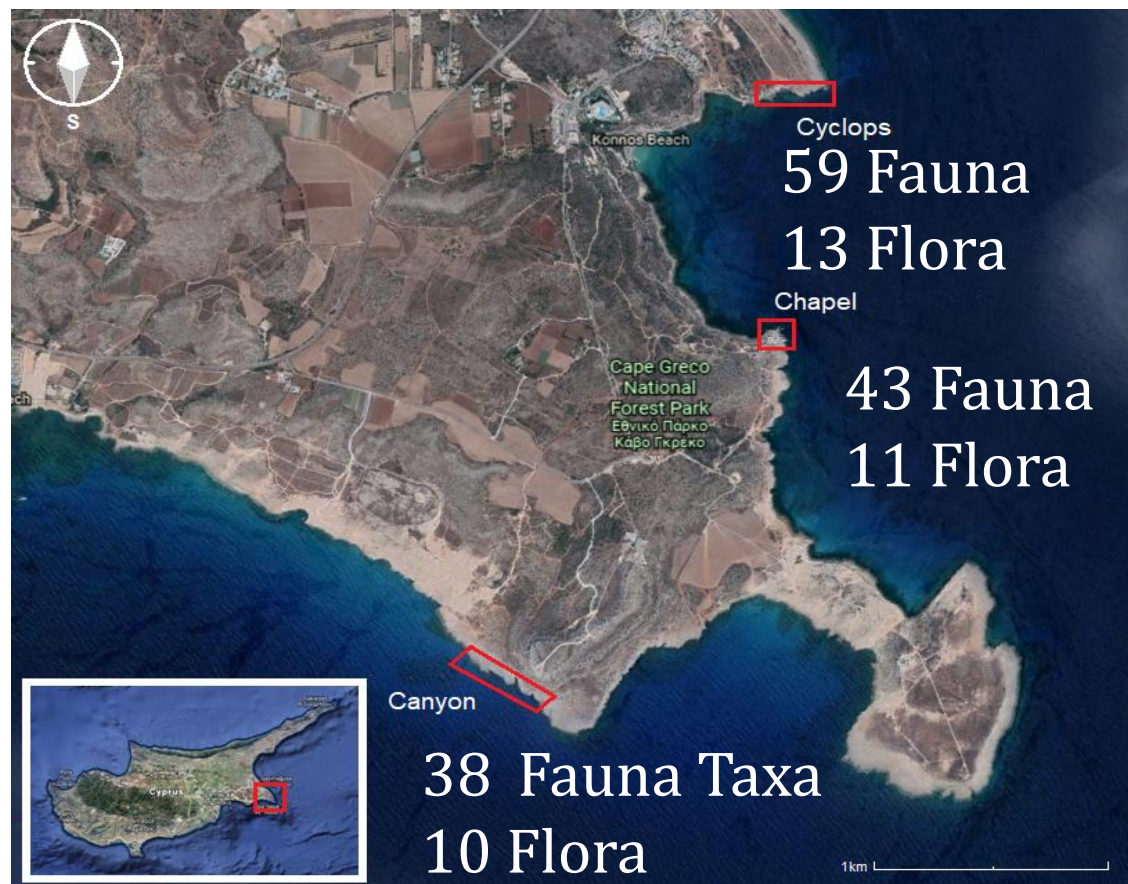


*Open day activity event for the marine environment  
Environmental Center of Cavo Greko, Cyprus 27/03/2019*



# 1. Biodiversity assessments

- 80 Fauna Taxa
- 15 NIS
- 16 Flora Taxa





# 1. Biodiversity assessments

*Aurelia sp.*



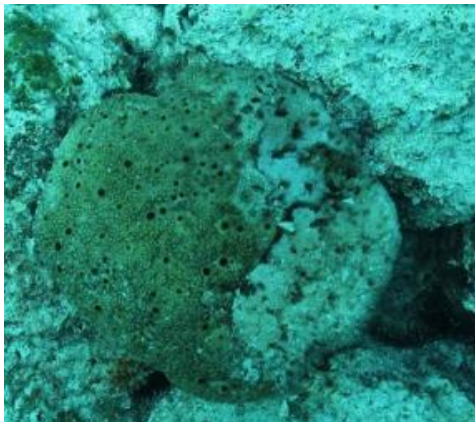
*Hermodice carunculata*



*Sarcotragus sp.*



*Ircinia sp.*



*Echinocardium sp.*



*Phorbas topsenti*



# 1. Biodiversity assessments

*Pterois miles*



*Fistularia commersonii*



*Pinctata radiata*



*Torquigener flavimaculosus*



*Synaptula reciprocans*





## 2. Marine litter assessment (WP3)

- Underwater visual surveys

### 5.4. Protocol for shallow sea-floor (< 20m)

The most commonly used method to estimate marine litter density in shallow coastal areas is to conduct underwater visual surveys with SCUBA/snorkelling. These surveys are best based on line transect surveys of litter on the sea-floor, which is derived from UNEP (Cheshire, 2009). The protocol is actually in use for evaluation of benthic fauna. It requires SCUBA equipment and trained observers. Only litter items above 2.5 cm are considered, between 0 and 20 m (to 40 meters with skilled divers).

- Record & remove litter (> 2cm) along transects
- Categories litter (Master List)

Annex 8.1 - Master List of Categories of Litter Items

Master List of Categories of Litter Items									
TSG_ML General-Code	OSPAR-Code	UNEP-Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota
G1	1	PL05	4/6-pack yokes, six-pack rings	Artificial polymer materials	x	x			
G2		PL07	Bags	Artificial polymer materials	x		x	x	
G3	2	PL07	Shopping Bags incl. pieces	Artificial polymer materials		x			



JRC SCIENTIFIC AND POLICY REPORTS

### Guidance on Monitoring of Marine Litter in European Seas

*A guidance document within the Common Implementation Strategy for the Marine Strategy Framework Directive*

MSFD Technical Subgroup on Marine Litter

2013



Joint Research Centre



## 2. Marine litter assessment



## 2. Marine litter assessment

(WP3)





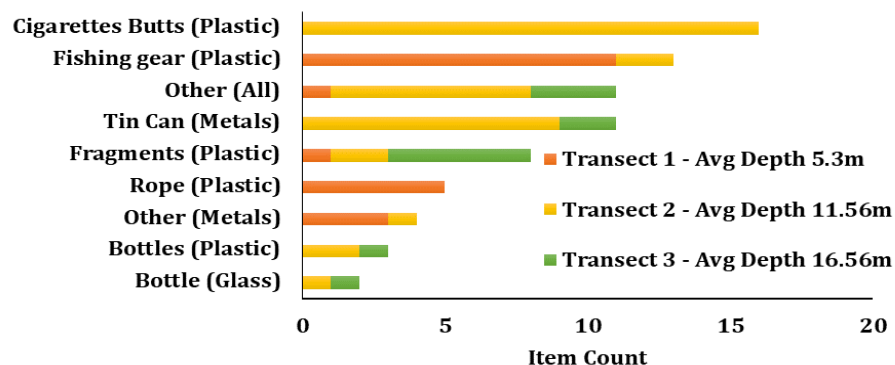
## 2. Marine litter assessment

Site	Litter per m <sup>2</sup>
Cyclop's Cave (Avg Depth 3.08 m)	0.0525
Cyclop's Cave (Avg Depth 5.26 m)	0.015
Cyclop's Cave (Avg Depth 12.48 m)	0.00875
Agioi Anargyroi (Avg Depth 5.3 m)	0.02375
Agioi Anargyroi (Avg Depth 11.56 m)	0.05
Agioi Anargyroi (Avg Depth 16.56 m)	0.015
Canyon (Avg Depth 13.22 m)	0.00625
Canyon (Avg Depth 15 m)	0.03
Canyon (Avg Depth 15.33 m)	0.01625

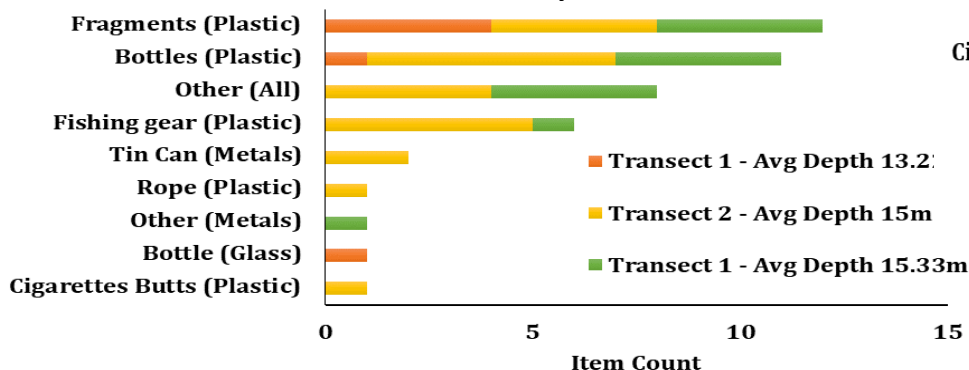




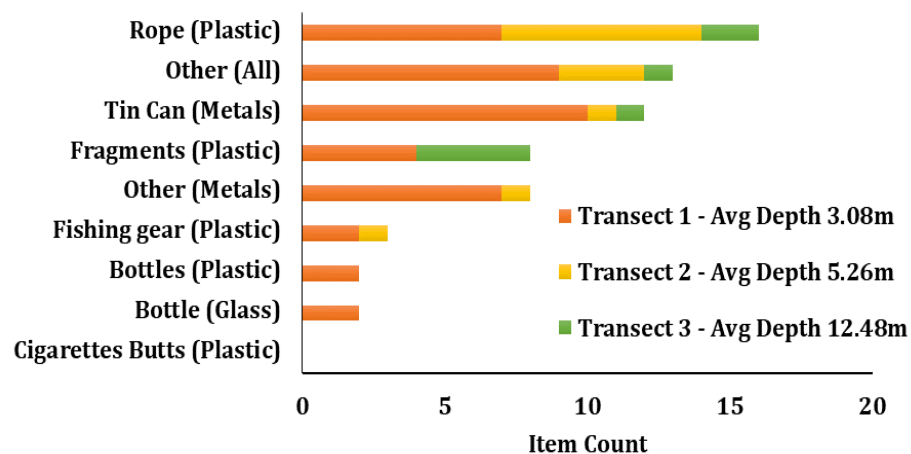
## Ayioi Anargyroi



## Canyon



## Cyclops



## 2. Marine litter assessment

Area	Depth (m)	Items/100m <sup>2</sup>	Source
Cavo Greco (Cyclop's caves)	1-14	2.54	Present study
Cavo Greco (Ayioi Anargyroi)	4-18	2.96	Present study
Cavo Greco (Canyon)	11-16	1.75	Present study
Adriatic Sea	3-24	2.78 ± 3.35	Vlachogianni et al., 2018
Gulf of Aqaba, Red Sea	0-10	280	Abu-Hilal and Al-Najjar, 2009
N. Hawaiian Island, Lisianski Island	10	0.4*10 <sup>-3</sup> – 6.2*10 <sup>-3</sup>	Donohue et al., 2001
Gray's Reef National Marine Sanctuary, USA	16-20	0.52 ± 0.11	Bauer et al., 2008
Eastern Mediterranean Sea, Greece	0-25	1.5	Katsanevakis and Katsarou, 2004



*Open day activity event for the marine environment  
Environmental Center of Cavo Greko, Cyprus 27/03/2019*





*Open day activity event for the marine environment  
Environmental Center of Cavo Greko, Cyprus 27/03/2019*



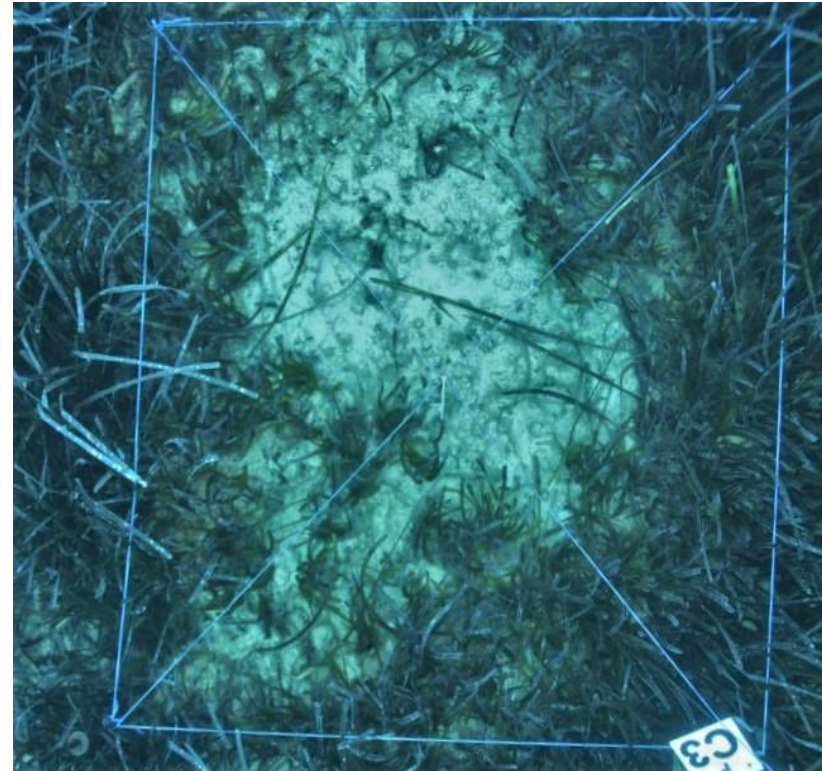
*Open day activity event for the marine environment  
Environmental Center of Cavo Greko, Cyprus 27/03/2019*





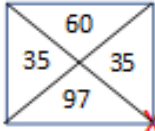

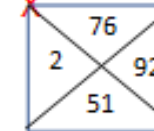
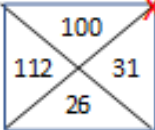
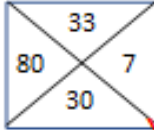
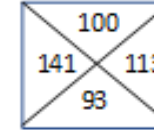
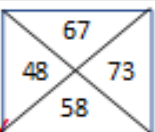
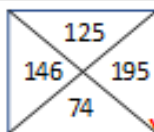
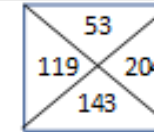
# 3. *P. oceanica* demography (WP3)

- 3 fixed plots per site, surface of 1m<sup>2</sup>, divided in 4 triangles
- Shoot density of each triangular sub-quadrat
- Each quadrat was photographed from the top side → Photos processed with Photoquad software (Trygonis and Sini, 2012) to estimate the % coverage of the canopy.





# 3. *P. oceanica* demography

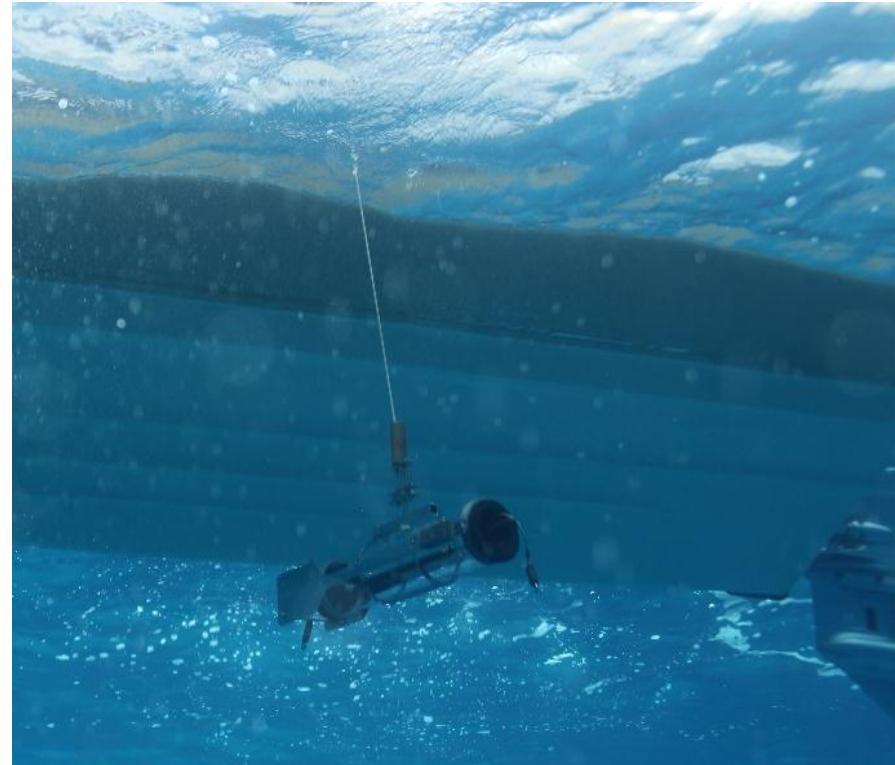
Site:	Cyclops Caves		
Code:	P_A1	P_A2	P_A3
Depth:	12.8	12.1	19.7
Layout of plot / Shoot Counts:			
Shoot density (m <sup>2</sup> )	227	319	221
Coverage (%)	39	63	59
Site:	Agiioi Anargyroi		
Code:	P_B1	P_B2	P_B3
Depth:	19	16.1	14
Layout of plot / Shoot Counts:			
Shoot density (m <sup>2</sup> )	269	150	447
Coverage (%)	50	22	78
Site:	Canyon		
Code:	P_C1	P_C2	P_C3
Depth:	13	12.5	9.9
Layout of plot / Shoot Counts:			
Shoot density (m <sup>2</sup> )	246	540	519
Coverage (%)	47	71	73



## 4. Water, sediment, macrofauna

### KC Denmark Van dorm sampler

- POC
- Chloroplast pigments
- Phosphate ion ( $\text{PO}_4^{3-}$ )
- Nitrate ion ( $\text{NO}_3^-$ )
- Nitrite ion ( $\text{NO}_2^-$ )
- Ammonium ion ( $\text{NH}_4^+$ )
- Silicon dioxide ( $\text{SiO}_2$ )

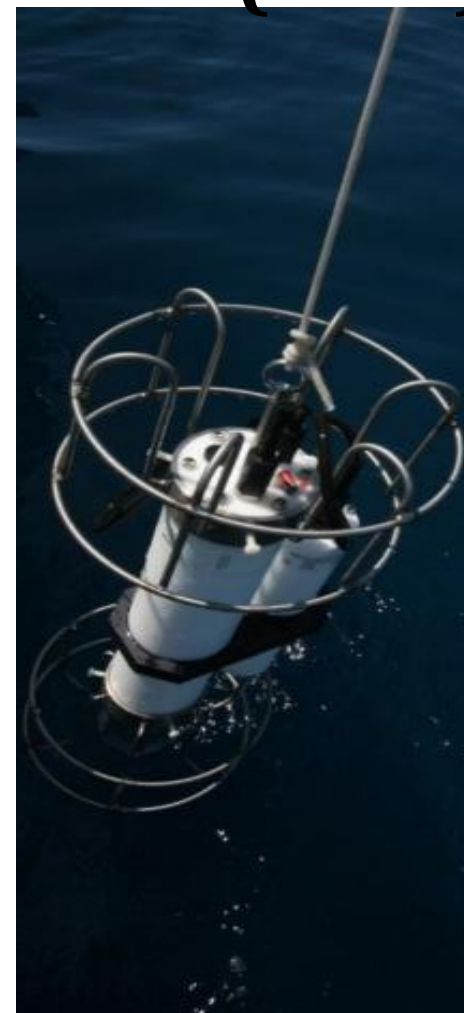


(WP3)

## 4. Water, sediment, macrofauna

### Idronaut CTD

Site	Quadrat Code	Date in 2018	Max. Depth (m)	Temp (°C)	Cond. (mS/cm)	Sal. (‰)	O <sub>2</sub> (%)	O <sub>2</sub> (ppm)	pH	Eh (mV)
Cyclop's Cave	P-A1	08/12	12.8	20.83	54.59	39.74	90.41	6.39	8.61	129.11
	P-A2	08/12	12.1	20.84	54.60	39.75	91.1	6.44	8.61	133.60
	P-A3	08/12	19.7	20.83	54.59	39.75	90.78	6.41	8.61	128.35
Agiol Anargyroi	P-B1	08/12	19.3	20.77	54.26	39.53	89.23	6.32	8.61	115.74
	P-B2	08/12	16.1	20.78	54.48	39.71	89.62	6.34	8.61	113.78
	P-B3	08/12	14	20.77	54.47	39.70	91.15	6.45	8.61	111.77
Canyon	P-C1	29/10	13	25.11	59.66	39.85	90.9	5.96	8.49	139.40
	P-C2	29/10	12.5	25.11	59.66	39.86	90.36	5.92	8.44	140.1
	P-C3	29/10	9.9	25.16	59.75	39.87	93.45	6.12	8.50	149.32





## 4. Water, sediment, macrofauna

- **Sediment**

- 3 sites x 2 replicates x 3 stations
- Analyses: pH, Redox, Particulate Organic Carbon (POC), chloroplast pigments concentrations (chlorophyll-a and phaeopigments), organic matter (loss on ignition), granulometry

- **Macrofauna**

- 3 sites x 3 replicates x 3 stations
- Core samplers with 10 cm diameter
- Sieved 0.5 mm
- Stored in 96% ethanol

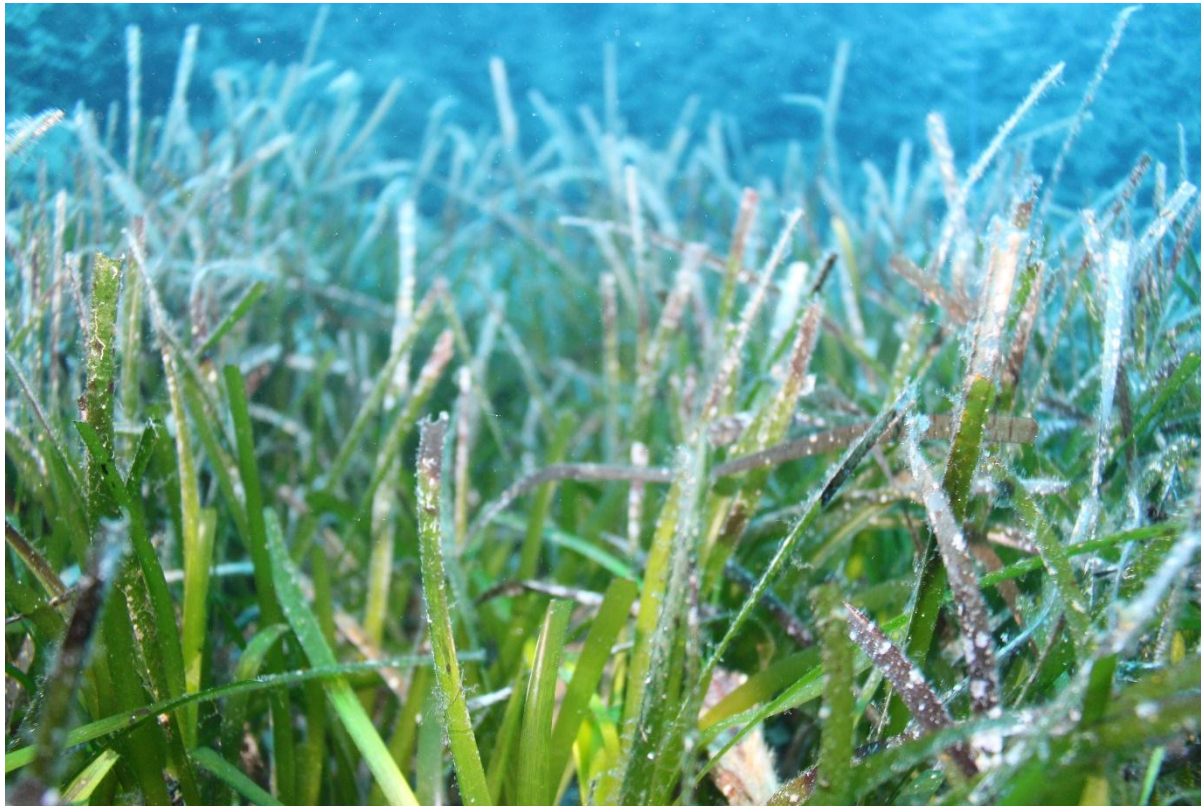


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## Sampling surveys for genetic analysis

### *Key species 1: Posidonia oceanica*

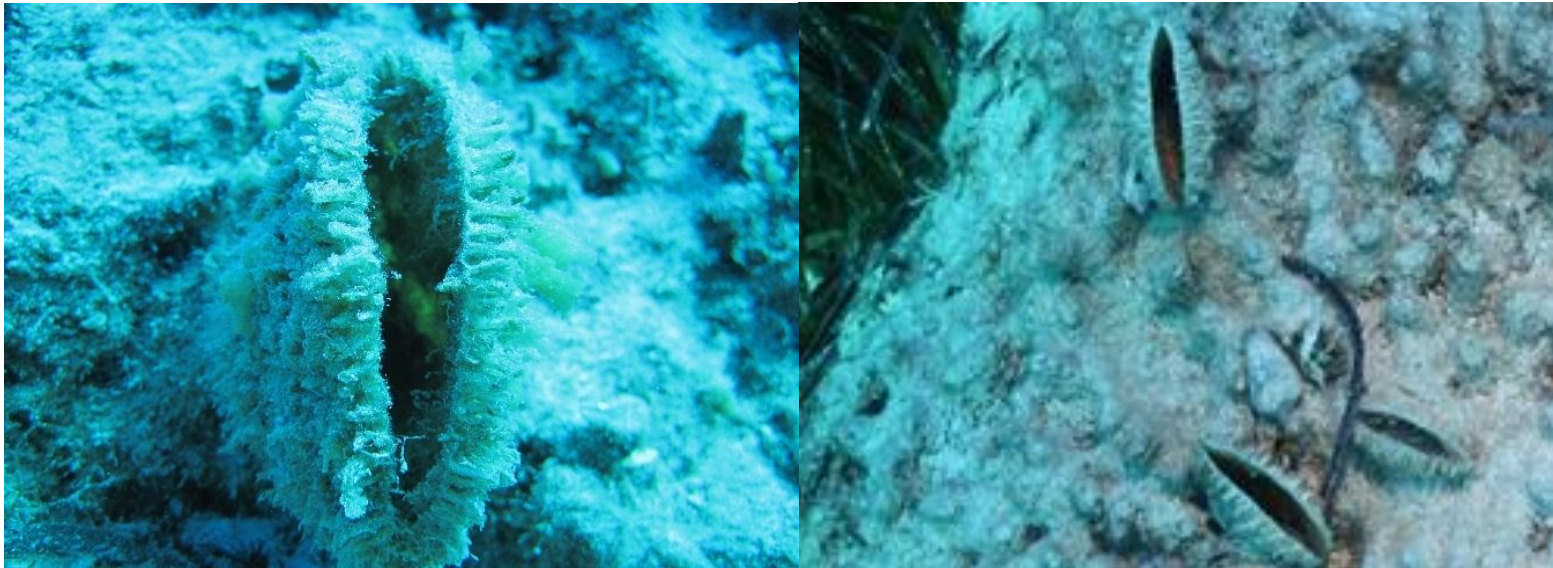




## Sampling surveys for genetic analysis

### ***Key species 2: Pinna nobilis***

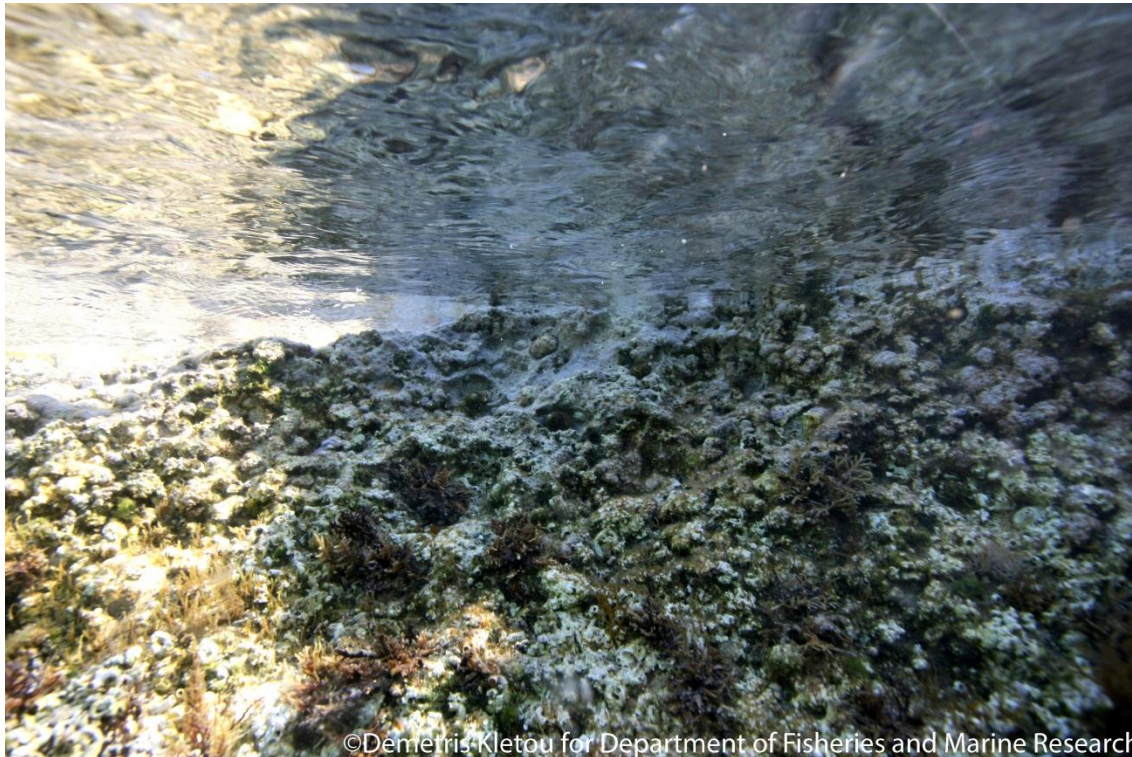
- Only dead *Pinna nobilis* were found
- No alive ones to collect samples
- Replacement of key species





## **Sampling surveys for genetic analysis**

### ***Key species 3: Vermetid reefs***

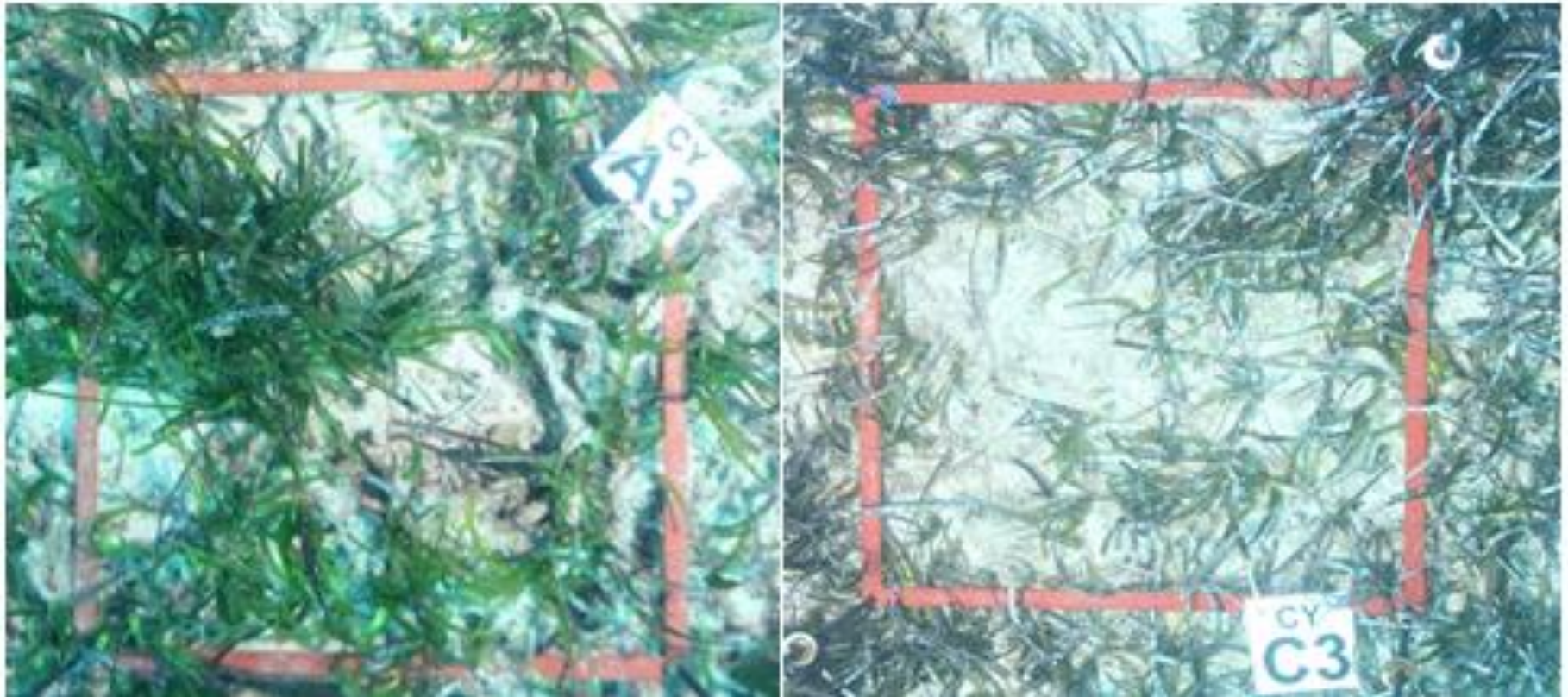


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# Sampling surveys for Citizen Science

**Quadrats:** 5 permanent sampling quadrat frames in *P. oceanica*



**Quadrats: 50 cm x 50 cm**



# Sampling surveys for Citizens Science

## Quadrats (*P. oceanica* beds)

Site	Quadrat Code	Depth (m)	Seagrass Coverage (%)
Cyclop's Cave	CY_A1	10.6	100
	CY_A2	11.4	73
	CY_A3	11.1	65
	CY_A4	16.1	69
	CY_A5	18.9	67
Agioi Anargyroi	CY_B1	20.4	41
	CY_B2	20.4	29
	CY_B3	19.1	65
	CY_B4	17.5	9
	CY_B5	13.7	18
Canyon	CY_C1	12.9	71
	CY_C2	12.2	59
	CY_C3	12.3	39
	CY_C4	9.2	35
	CY_C5	9.8	81

***In the future, the same fixed plots will be photographed by the citizen scientists and change in % coverage over time will be documented.***

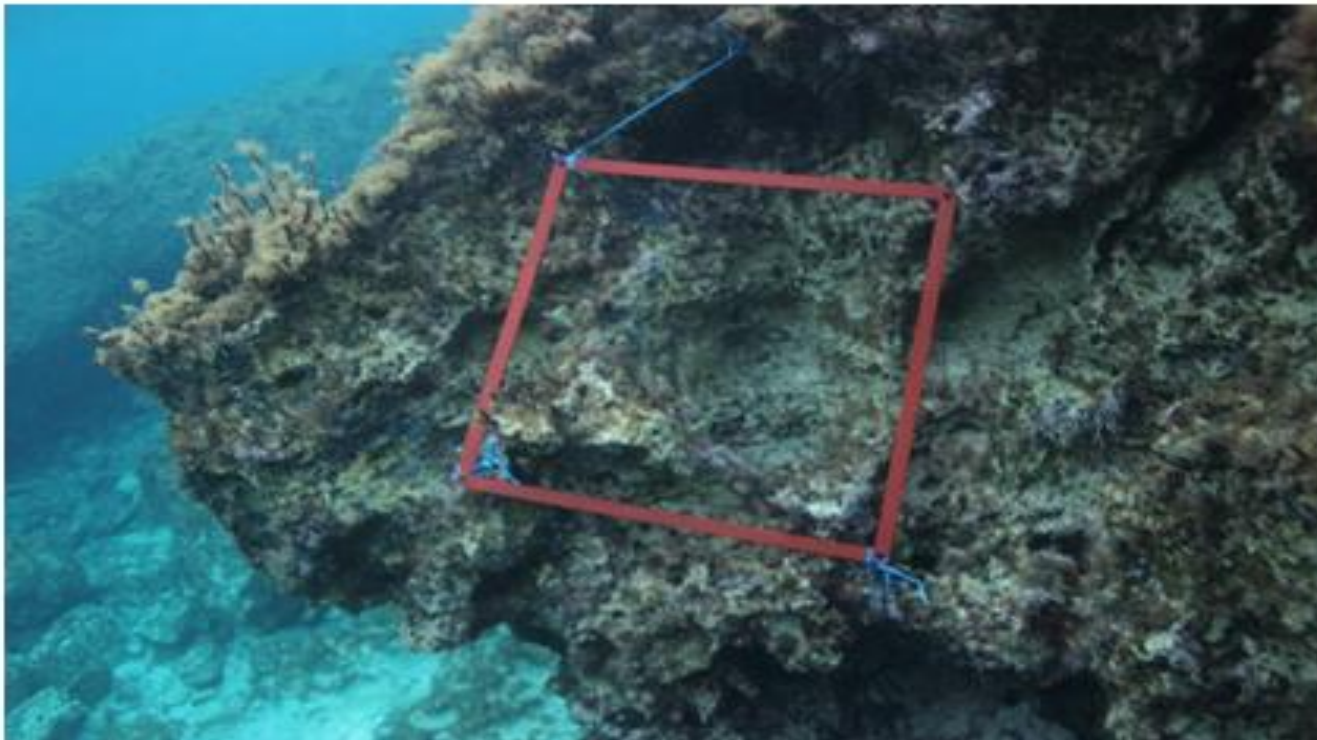




# Sampling surveys for Citizens Science

## *Quadrats (hard substratum)*

- Attached with ropes
- Searching for better alternatives



*Open day activity event for the marine environment  
Environmental Center of Cavo Greko,, Cyprus 27/03/2019*



THANK YOU