Conservation and management of the high valuable Mediterranean red coral: the deep-dwelling commercial populations.

Giovanni Santangelo°*, Cristina Priori°, Lorenzo Bramanti^°, Giorgio Bavestrello**, Marzia Bo**, Michela Angiolillo^^, Simone Canese^^, Mimmo Iannelli***

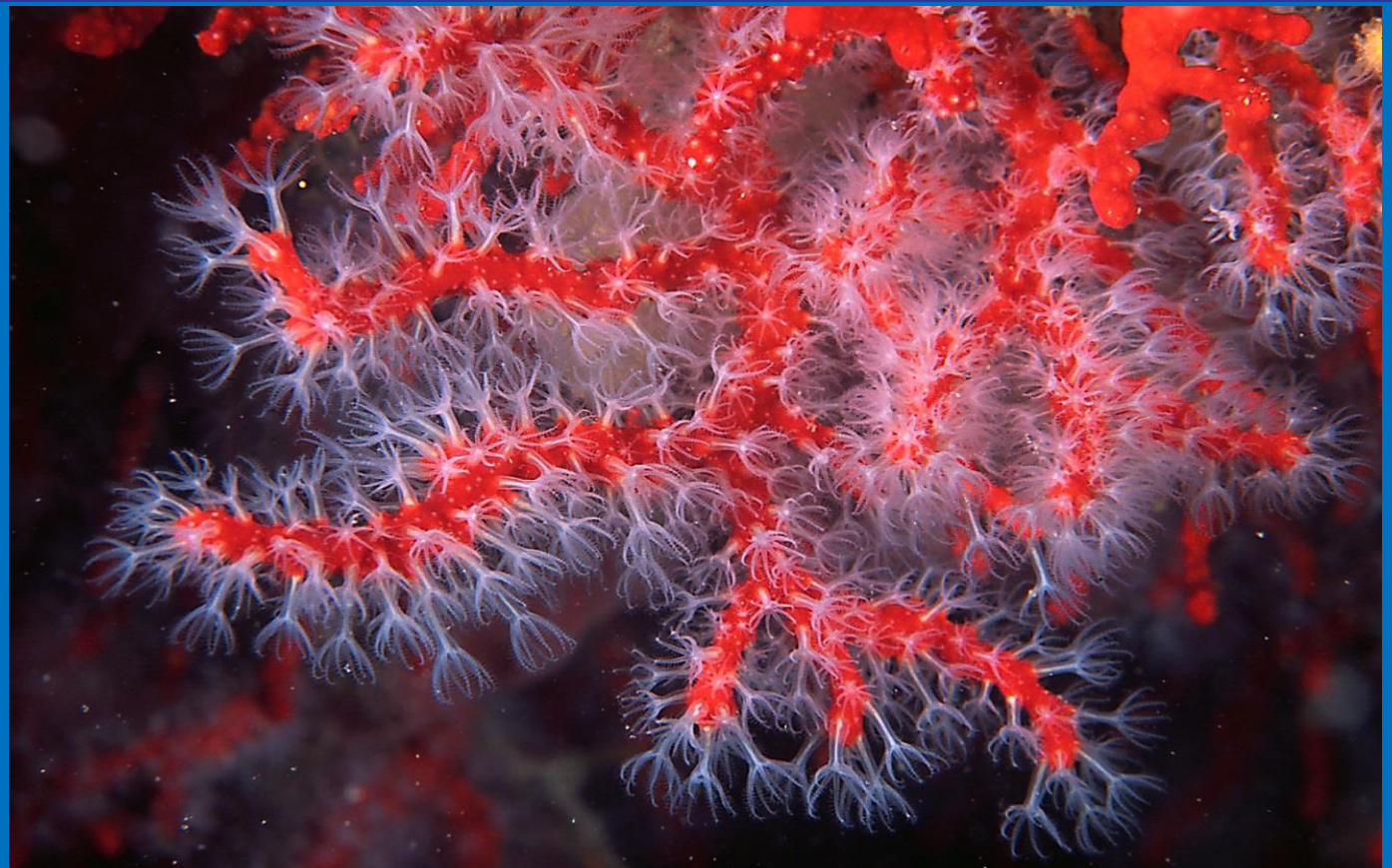
°Dep. Biology-Zoology-Long-lived species conservation and demography group and CISSC. Via Volta 6 I56126 Pisa Italy.

^ LECOB-UPMC Observatoire Oceanologique de Banyuls sur mer Laboratoire Aragò 18 Avenue de Fontaulé 66650, Banyuls sur mer, France

**Dep. DipTerIs University of Genova Italy

.^^ISPRA Environmental Ministry Roma, Italy

*** Population dynamics Group Dep. Mathematics, University of Trento Italy



1 SHALLOW-WATER POPULATIONS

- 20 – 50 M DEPTH (5 M IN CAVES)
- HIGH DENSITIES
- MAINLY SMALL COLONIES
- LOWER COMMERCIAL VALUE
- HIGH TOURISTIC AND NATURALISTIC VALUE

Photo credit: L. De Nigris

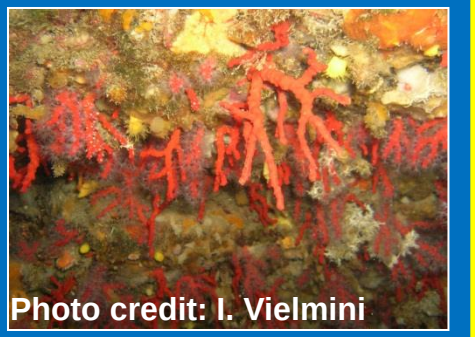


Photo credit: I. Vielmini

Photo credit: G. Santangelo

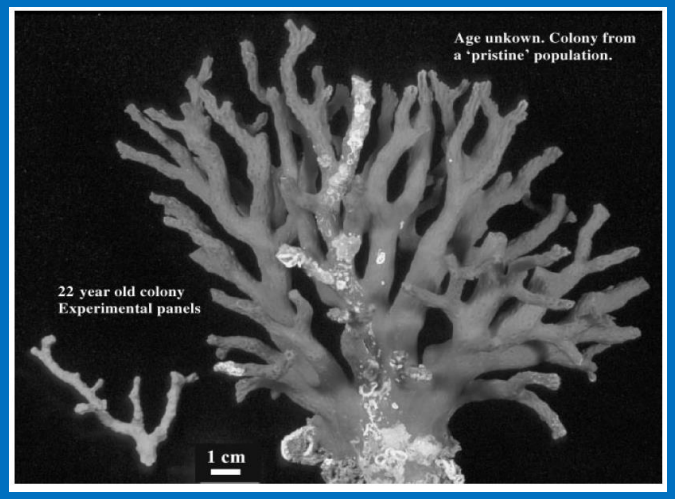
More than 50% of colonies is affected by boring sponges reducing their economic value (Corriero et al. 1997).

2 DEEP-DWELLING POPULATIONS

- 50 -200 M DEPTH
- LOWER DENSITIES
- LARGER COLONIES (MAINLY)
- HIGHER COMMERCIAL VALUE
- AGE AT FIRST MATURITY: **UNKNOWN**
- POPULATION AGE AND SEXUAL STRUCTURE ARE STILL POORLY KNOWN

3 The deepest populations living up to 800 m depth (Costantini et al 2010) composed by small and sparse have no commercial value

EFFECTS OF OVER HARVESTING

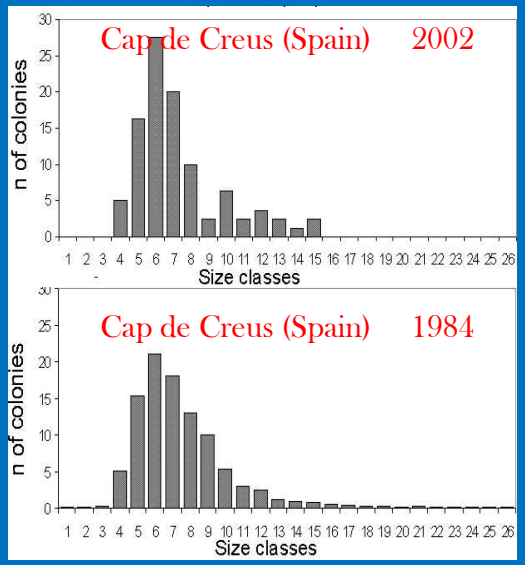


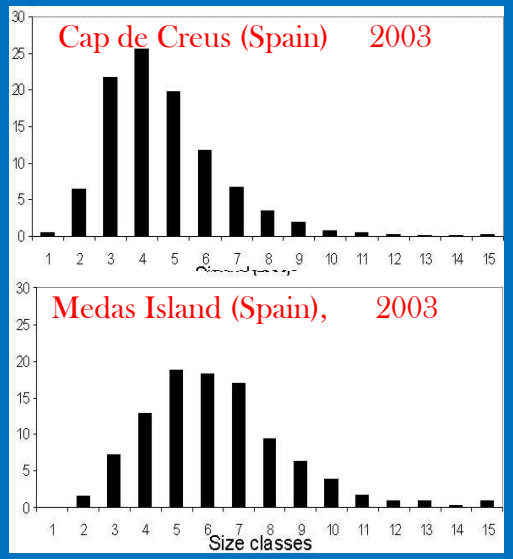
SHIFT IN COLONY SIZE:
MARSEILLE (FRANCE)

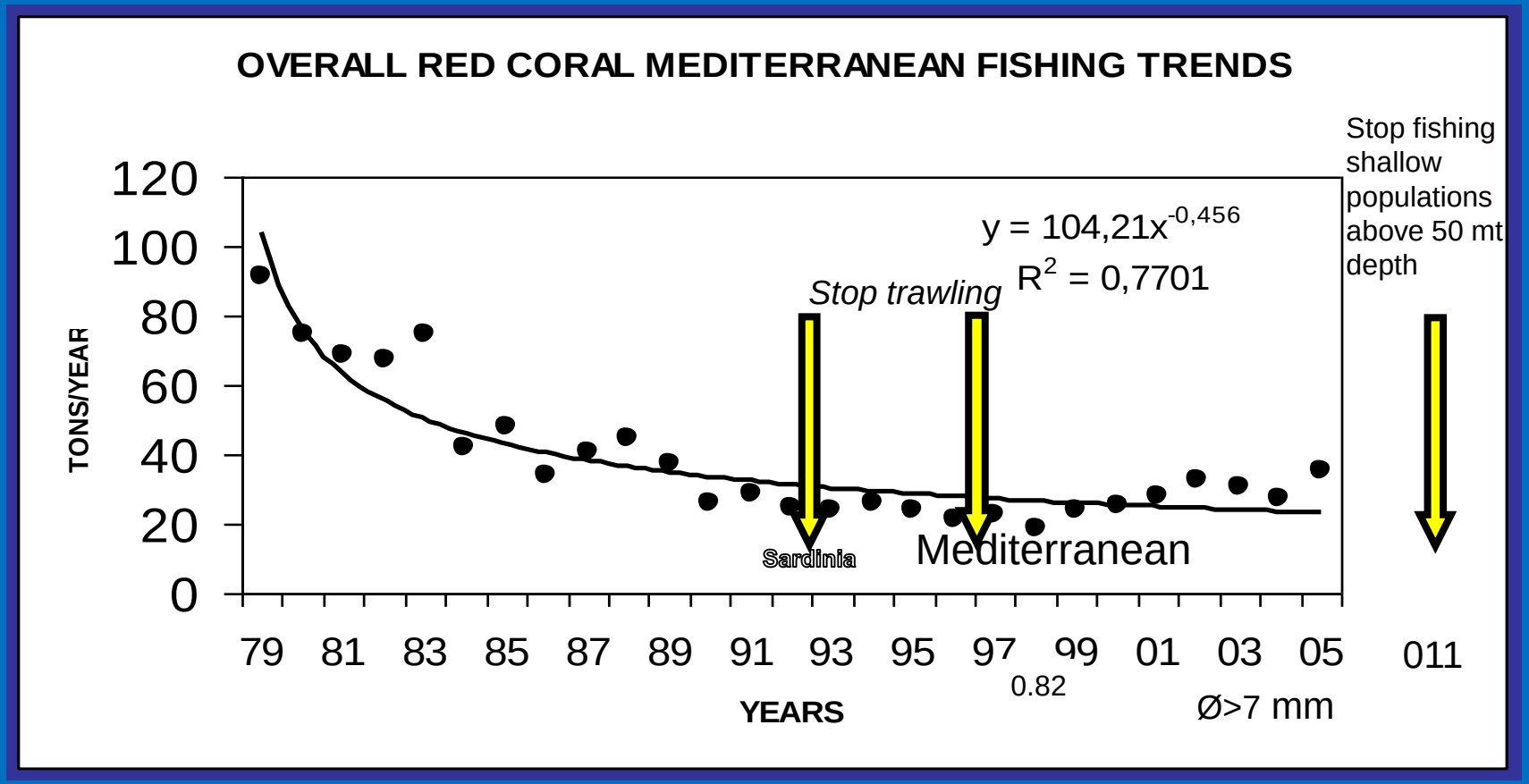
(*Garrabou and Harmelin, 2002*)

SHIFT IN POPULATION
STRUCTURE: COSTA BRAVA

(*Tsounis et al, 2007*)







Since 1983 the overall Mediterranean yield fell by 2/3, remaining roughly constant in the following years.

Historical sources sugget past red coral yields were several times greater still!

2009 – 2010: THE ROAD MAP TO THE PROTECTION OF *Corallium rubrum*

International Forum on Precious Corals. Hong Kong Feb. 2009

International Workshop on Corallium Science, Management and Trade. Hong Kong March 2009

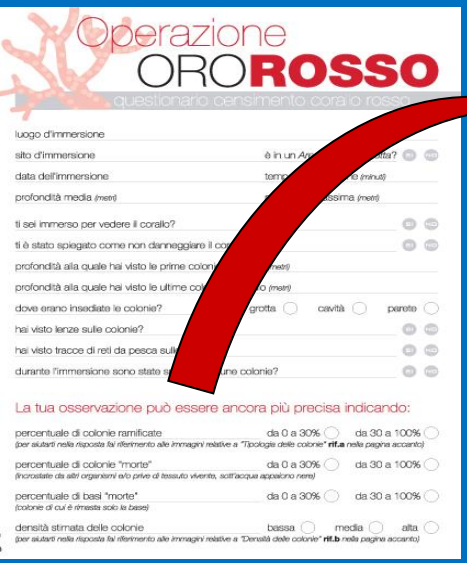
Workshop on red coral. Napoli Oct. 2009

Summit FAO. Roma, Dic. 2009

CITES (Convention of International Trade of Endangered Species). Qatar, March 2010

GFCM Aiaccio Fr October 2011

Red coral questionnaire answers from (500) recreational divers in the western Italian sea; Geographic location of the red coral populations.



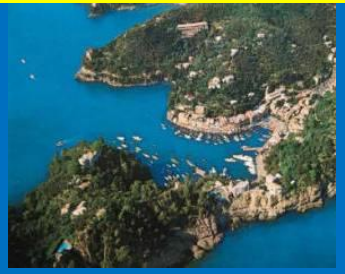
Fishing lines on the colonies	90% NO
Fishing nets on the colonies	95% NO
Colony breaks during the dive	98% NO
Bathimetric range	10 m – 50 m
Dive for red coral?	**70%YES**
Briefing about red coral?	80% NO
Habitat	Cave 5% Crevice 70% Wall 25%

Bramanti I, Vielmini, Rossi, Stolfa, Santangelo(2011). Involvement of receational SCUBA divers in emblematic species monitoring: the case of Mediterranean red coral. J. NATURE CONS.19, 312-318

POPULATIONS UNDER STUDY

Medes Islands
Spain

Cap de Creus
Spain



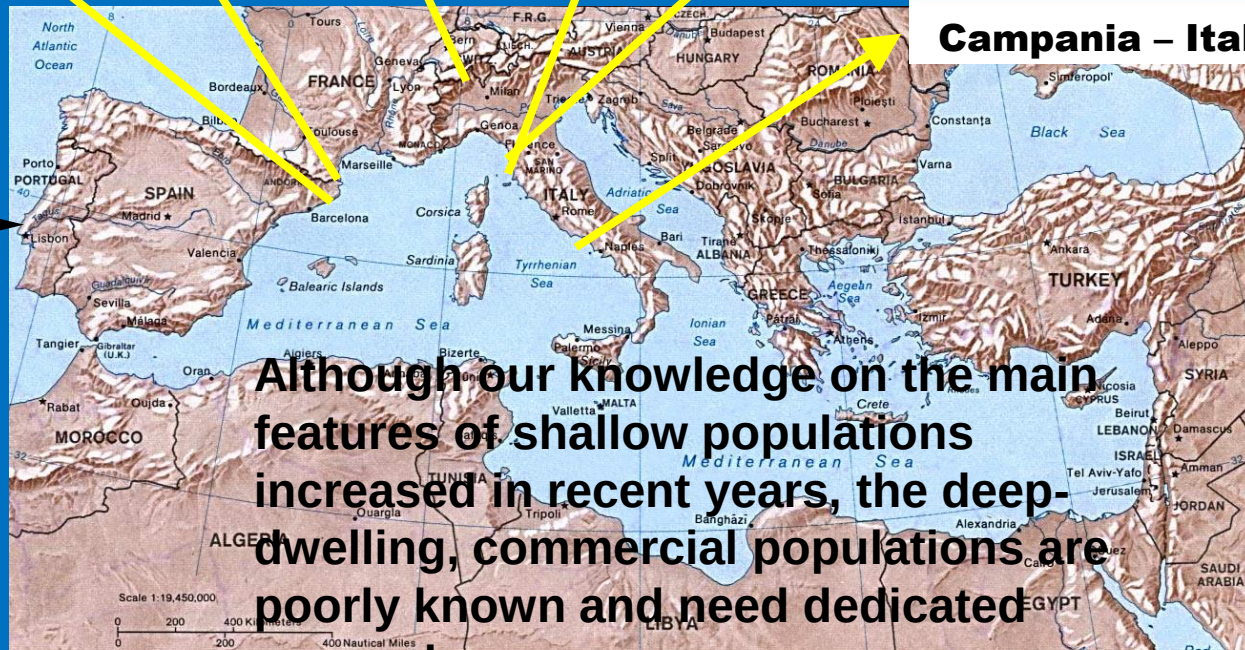
Portofino
Italy

Elba Island
Tuscany
archipelago

Italy

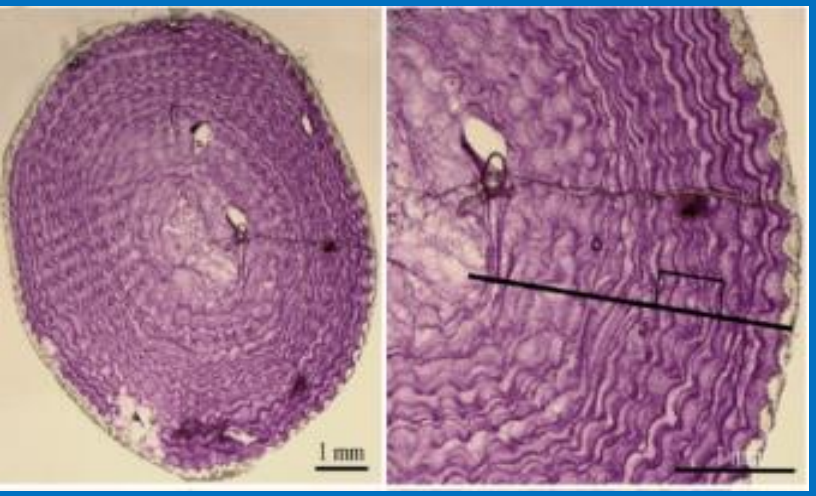
Calafuria Italy

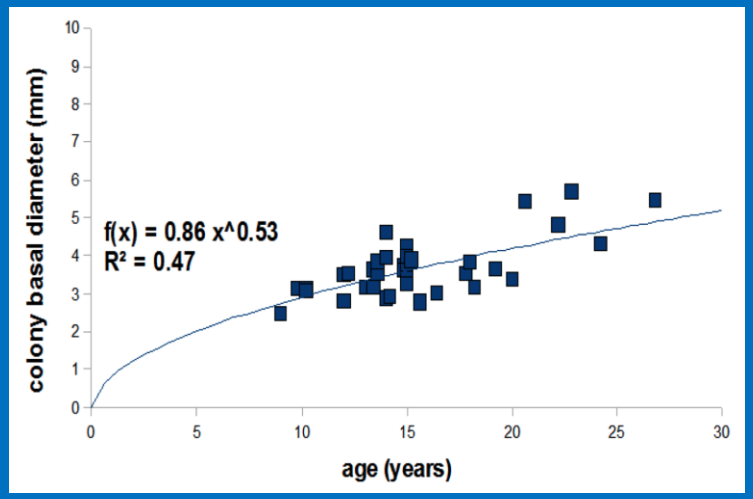
Campania – Ital



Although our knowledge on the main features of shallow populations increased in recent years, the deep-dwelling, commercial populations are poorly known and need dedicated

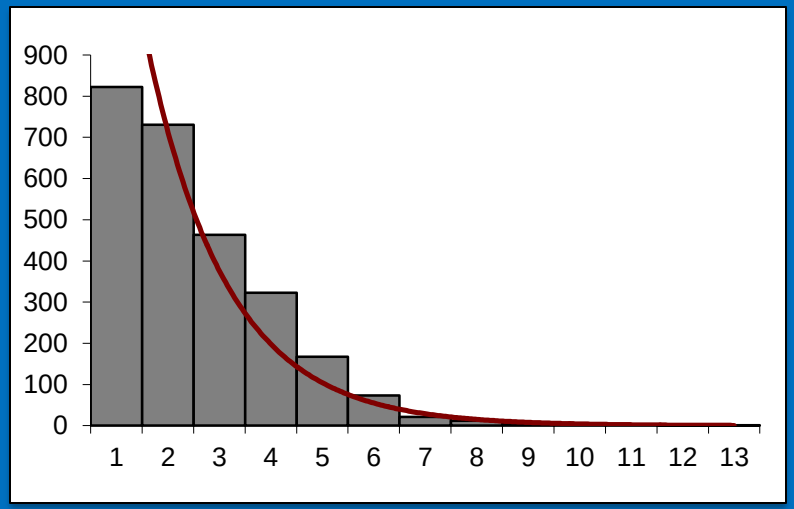
POPULATION AGE STRUCTURE



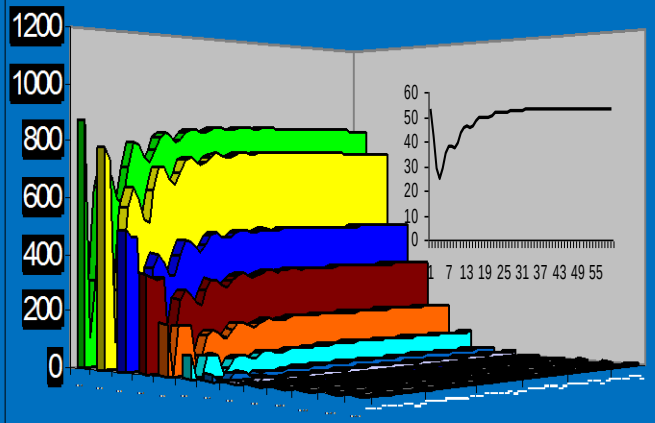


LIFE TABLE

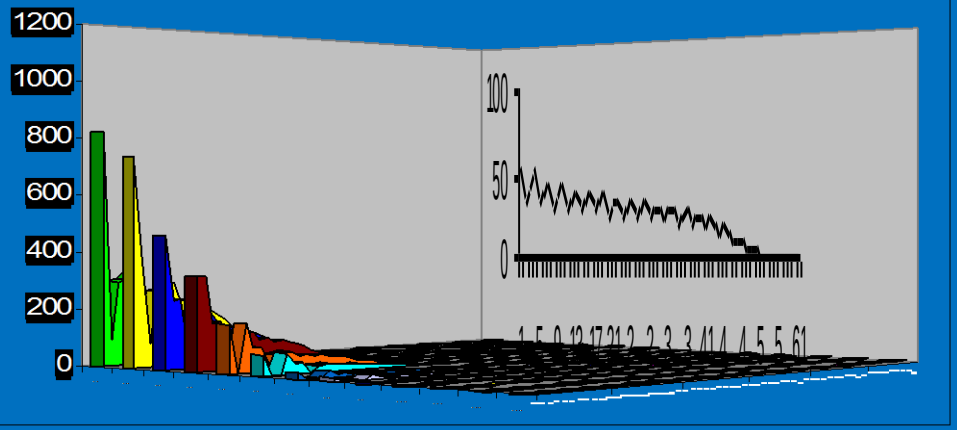
CLASS	N° OF COLONIES	SURVIVAL	FERTILITY	PLANULAE PER POLYP PRODUCED	SEX RATIO	N° OF POLYPS	PLANULAE PER CAPITA PRODUCED	PLANULAE PER CLASS PRODECED
1	822	0,89	0	0,87	0,58	0	0,00	
2	731	0,63	0	0,87	0,58	6,20	0,00	0,00
3	463	0,70	0,36	0,87	0,58	15,91	2,89	1338,86
4	323	0,52	0,64	0,87	0,58	31,06	10,03	3240,58
5	167	0,44	0,82	0,87	0,58	52,18	21,59	3605,88
6	73	0,29	0,97	0,87	0,58	79,72	39,02	2848,47
7	21	0,57	0,98	0,87	0,58	114,06	56,41	1184,57
8	12	0,33	0,99	0,87	0,58	155,58	77,72	932,65
9	4	0,75	1	0,87	0,58	204,24	103,23	412,91
10	3	1,00	1	0,87	0,58	261,33	131,87	395,61
11	3	0,33	1	0,87	0,58	326,14	164,57	493,71
12	1	1,00	1	0,87	0,58	399,23	201,46	201,46
13	1		1	0,87	0,58	480,87	242,65	242,65



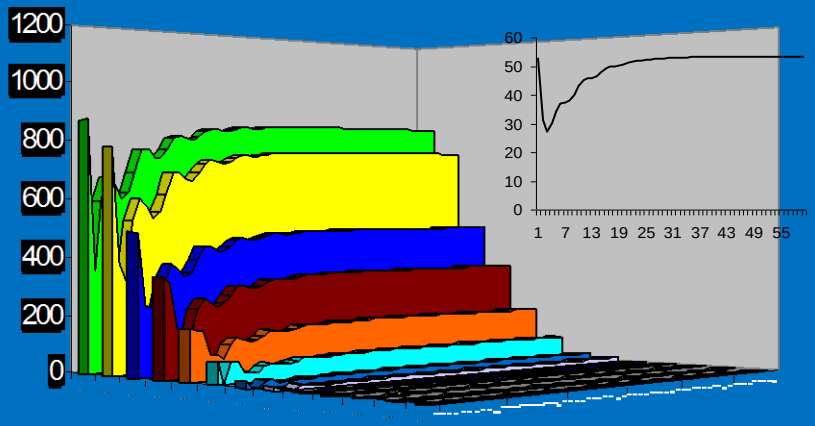
COUPLING EFFECT EXPLOITATION / MORTALITY



EXPLOITATION OF CLASSES 4 - 13

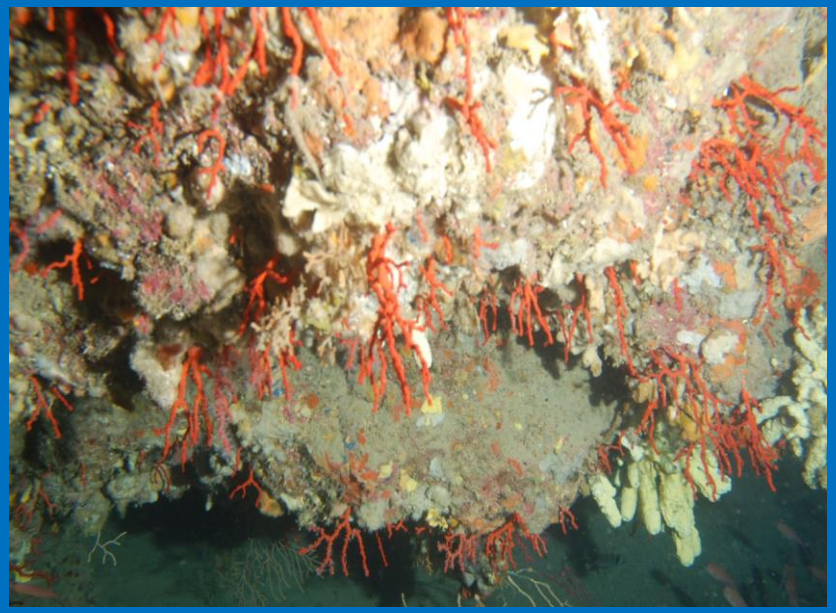


SINGLE EVENT COUPLED WITH 4 - 13 EXPLOITATION



SINGLE EVENT COUPLED WITH 5 - 13 EXPLOITATION

Red coral is provided of a wide bathymetric distribution (20-800 m). The populations living in the shallower part of this range (20-60 m depth) have a limited economic value while the main target of professional fishing are the “deep dwelling populations” (between 60 and 200 m depth), which are generally composed of larger, sparse colonies.



There is little knowledge about the demographic structure of these populations.

To fill this gap of knowledge a pilot survey has been carried out in early summer 2010 along the North and Central-East Tyrrhenian Sea, in areas in which red coral has been historically or recently harvested.

On these bases interdisciplinary researches on deep-dwelling populations were promoted by the Italian Environment and Agriculture Ministries. This project involved the researchers of the "Italian Red Coral Research Group". The cruises were carried out by the RV Astrea of Italian ISPRA Institute in the Ligurian and Tyrrhenian Sea to investigate the following topics:

1) the demographic structure (in terms of size/age, sexual and spatial structure);

2) the population genetic structure;

3) the associated community focusing on epi and endobionts (which greatly affect colony economic value);

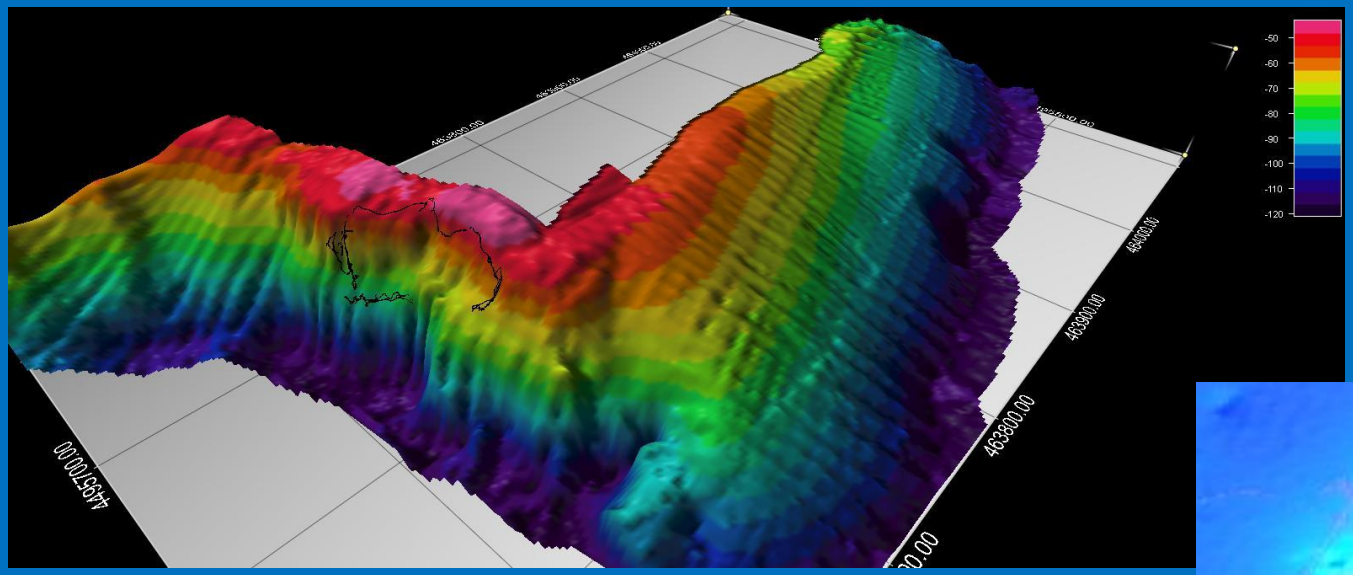
4) the associated microbial community.

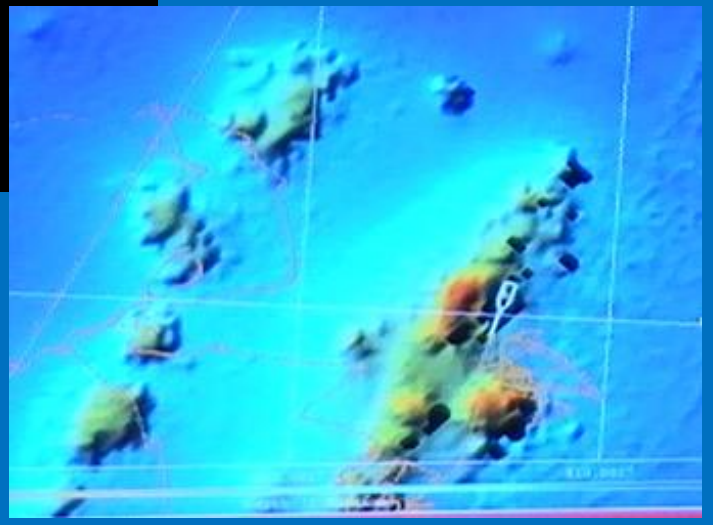
Angiolillo, Gori , Canese, Bo, Priori, Salvati, Bavestrello, Erra, Greenacre, Santangelo. In prep
Population structure of a long lived, overharvest coral: a Row survey on deep-dwelling red coral populations.

Priori, Mastascusa, Erra, Angiolillo, Canese, Santangelo (2013). Demography of deep-dwelling red coral populations. Age and reproductive structure assessment. Est. Coast and Shelf Sci. 118: 43-49.

Aim of the work

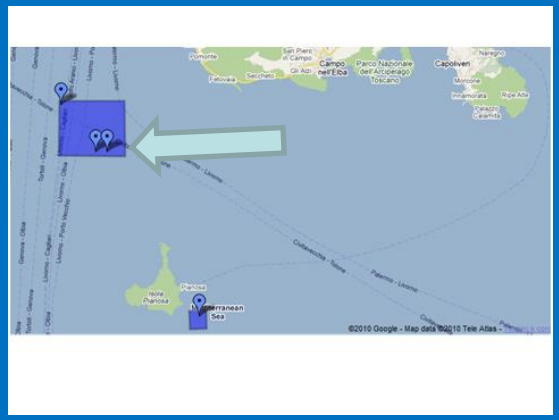
- To define the size/age and reproductive structure of red coral population living below 60 meters depth.
- To assess the reliability of ROV (Remotely Operated Vehicle) to collect demographic data.





The first step was to draw the threedimensional map of the bottom by the Multibeam echo sound In order to identify steep rocky cliffs and boulders on which red coral could dwell

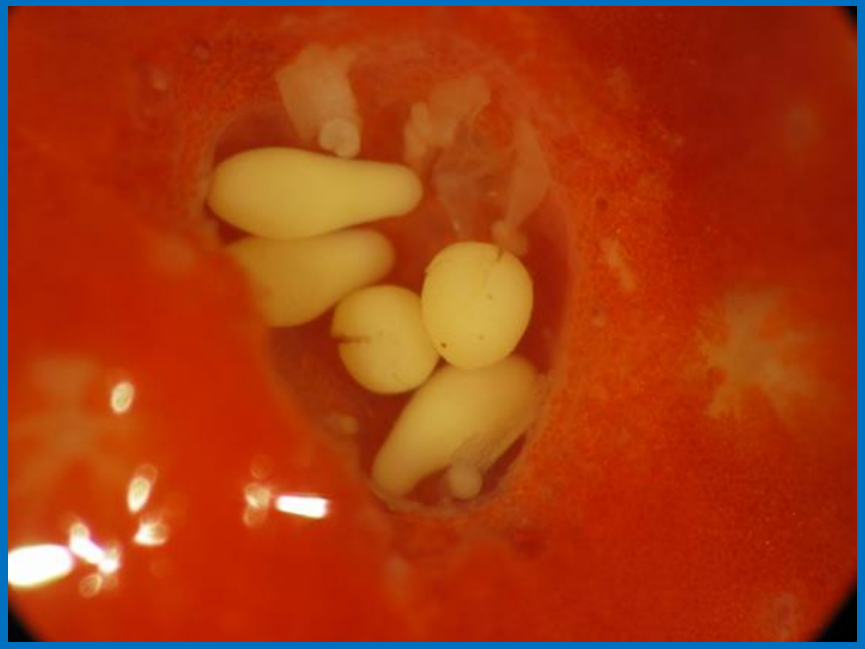
The second step was to explore the areas suitable for red coral settlement by ROV transects. Overall 30 transects were Sono stati realizzati complessivamente 30 surveys in 23 of which red coral was found.



In 2 of the areas explored a sample of intact colonies was collected by rebreather SCUBA divers between 85 and 90 mts depth. Colony growth rate, population reproductive and size-age structure were determined on these colonies.

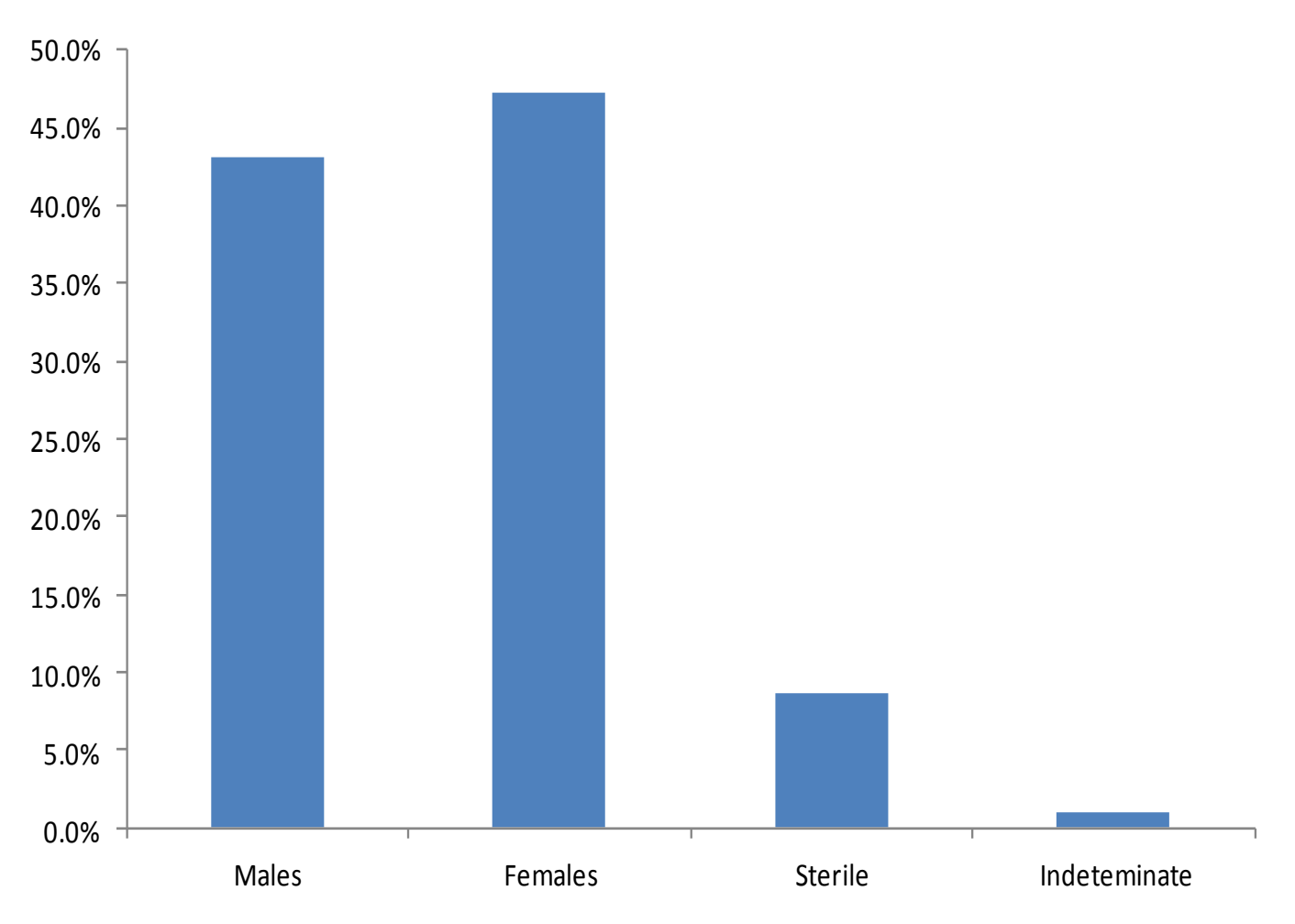
Material and methods

The main **reproductive parameters** (sex, fertility, fecundity) of polyps and colonies were examined: polyps were dissected and analysed under stereo (20-100x) and optic microscope (250-1000x).



Results

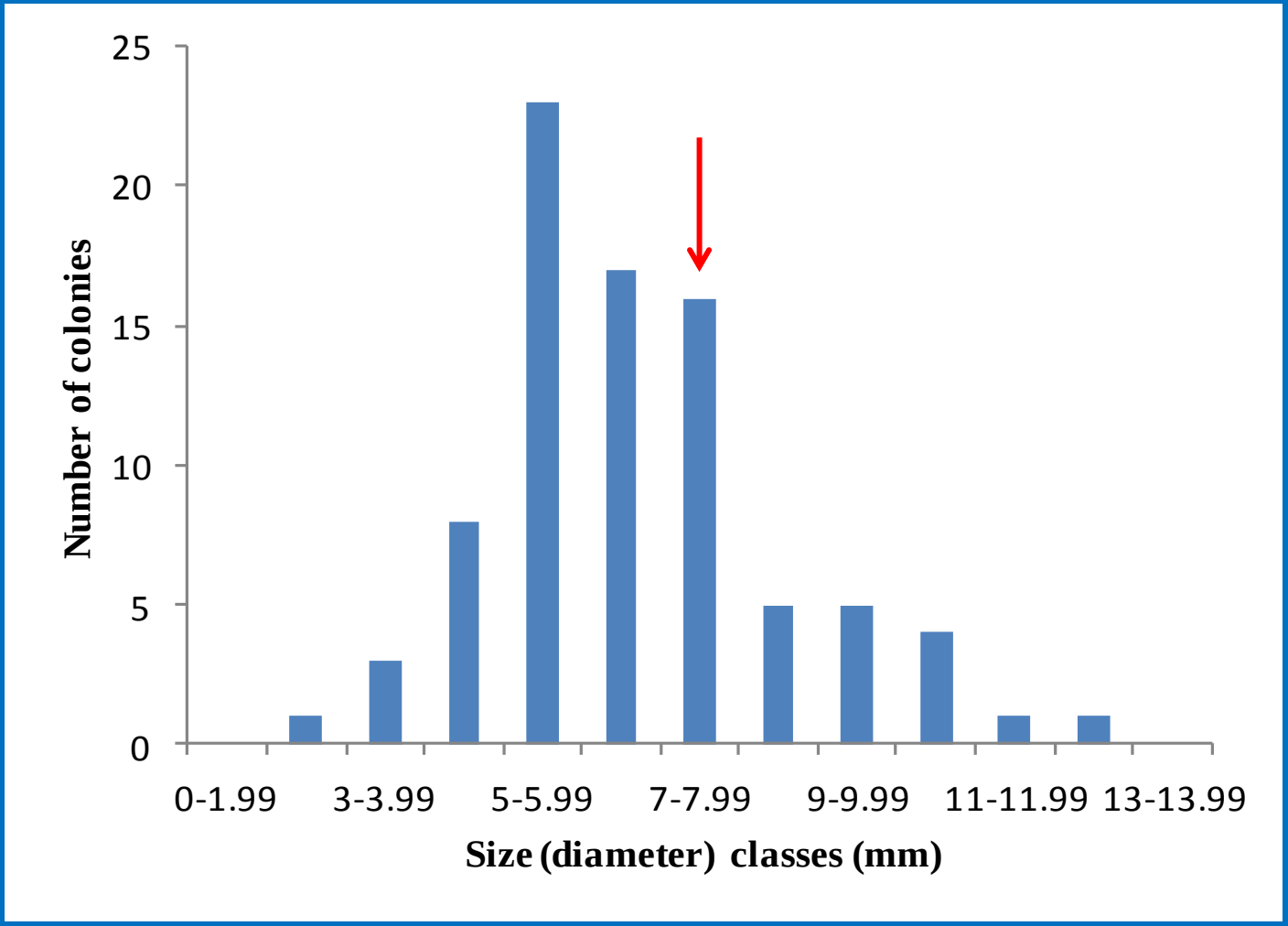
93% of the colonies were fertile. The population Sex ratio was balanced (1:1 χ^2 =0.36, p>0.05). The average fecundity of polyps was 0.83 oocyte per female colonies. The largest colonies produce more than 6.000 oocytes.



Distribution of colonies in different size (basal diameter) classes.

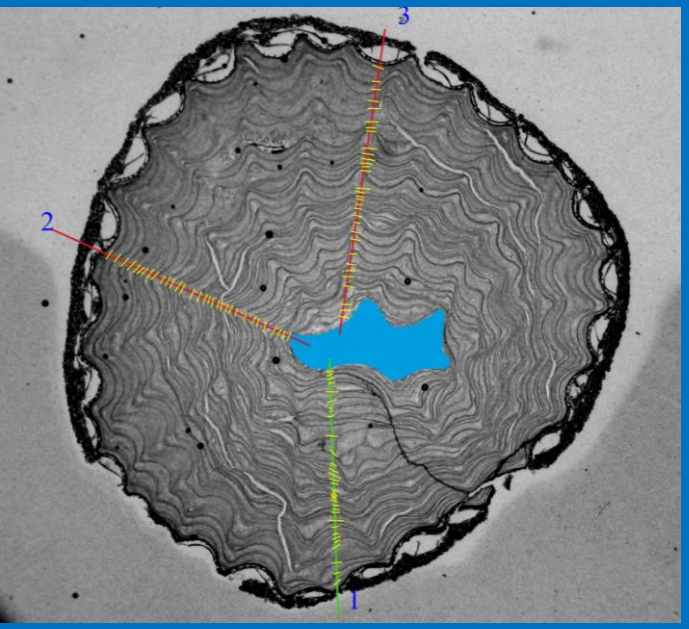
38% of the colonies reached the commercial size (7 mm in basal diameter).

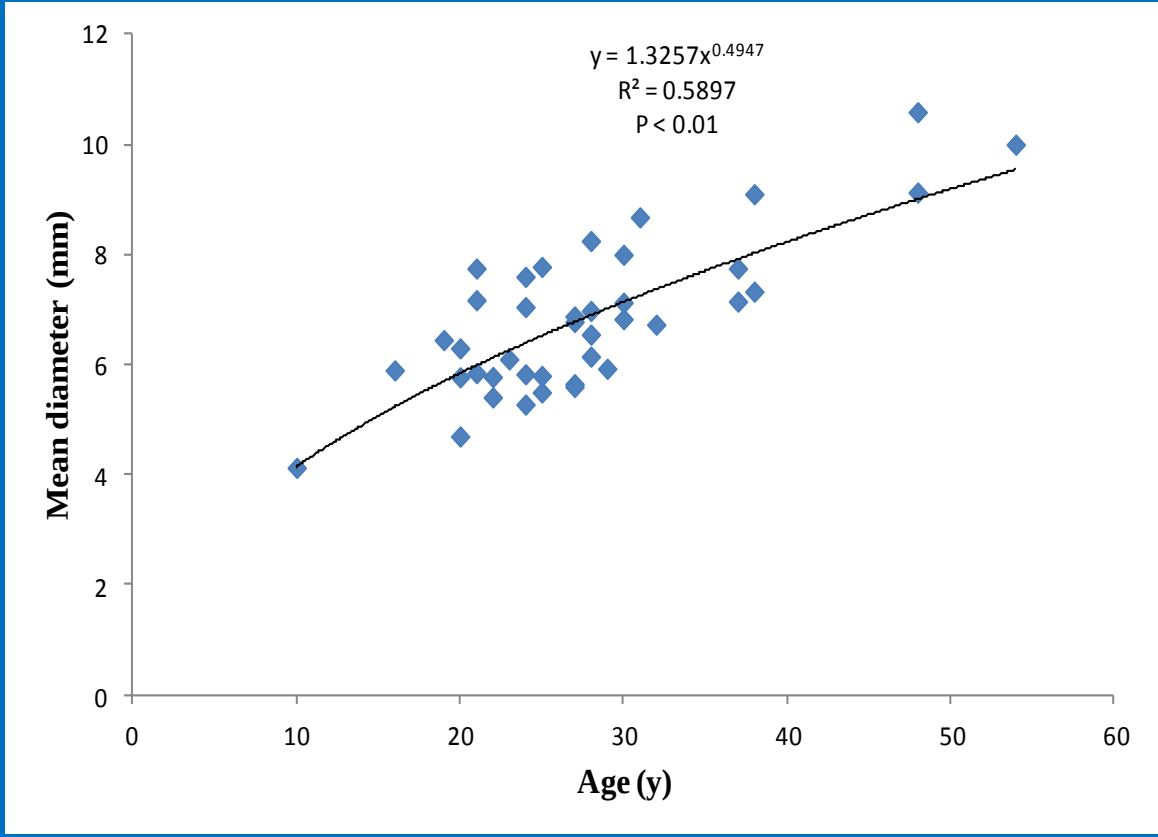
Colonies smaller than 5 mm were underrepresented due to the selectivity of sampling towards larger colonies.



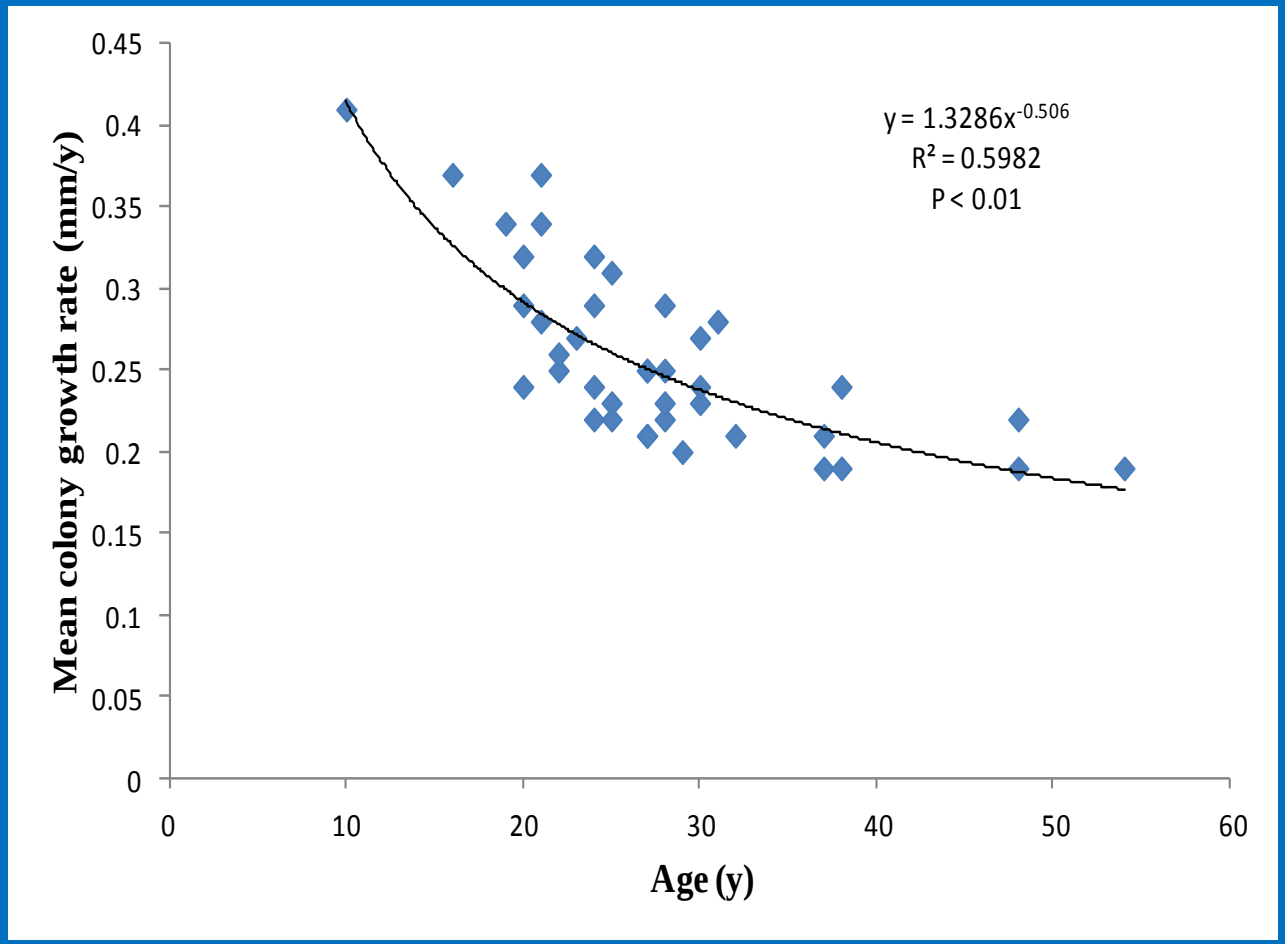
The age and the diameter growth rate of 40 colonies were determined and then, the average growth rate of the population (0.26 mm/y).

The best fit of data provided a monotonic power curve ($y=1.3257x^{0.4947}$) that underlined a decreasing trend of growth (in diameter) with age increase. By this equation it is possible to estimate the age of colonies from their diameter.

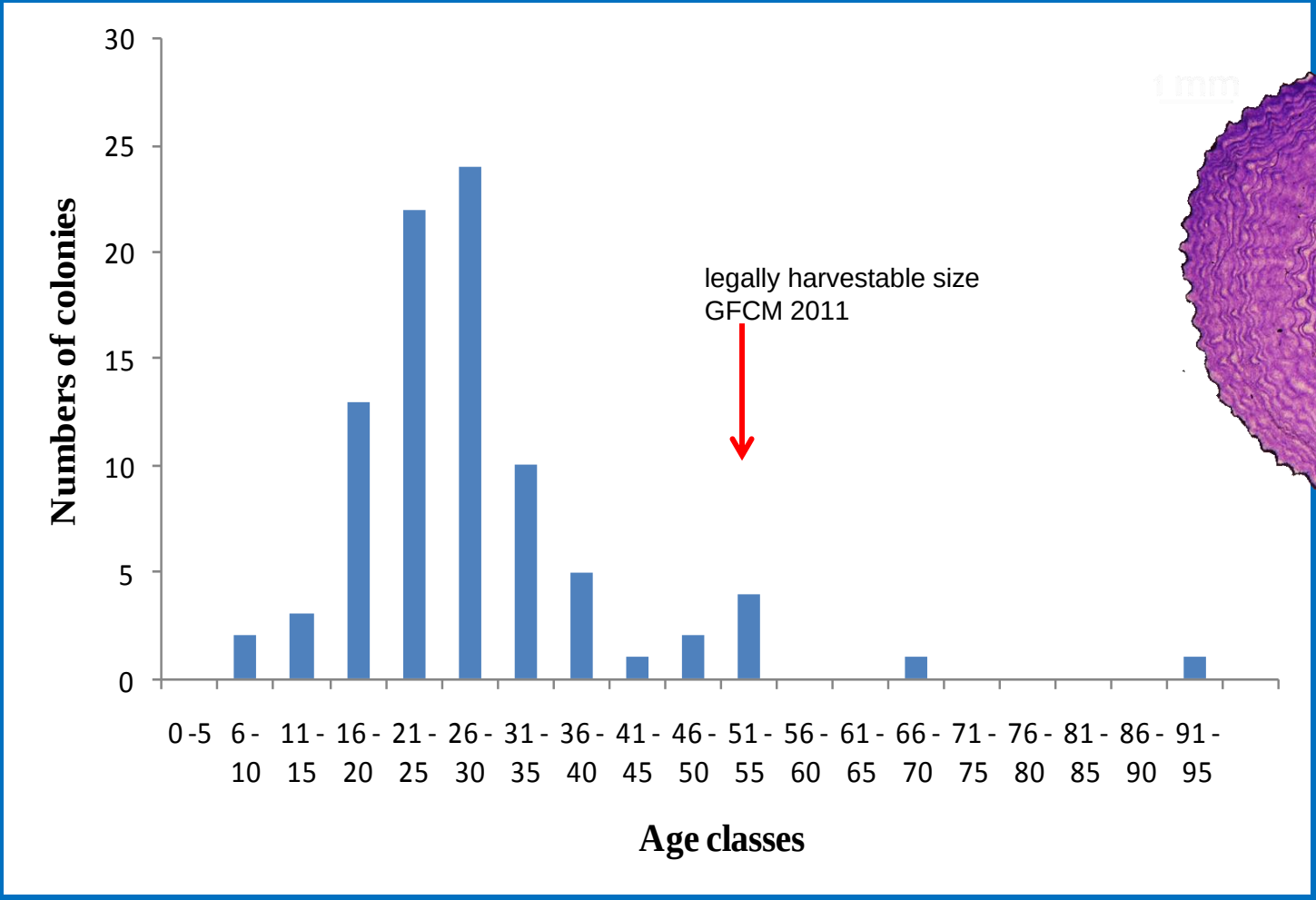


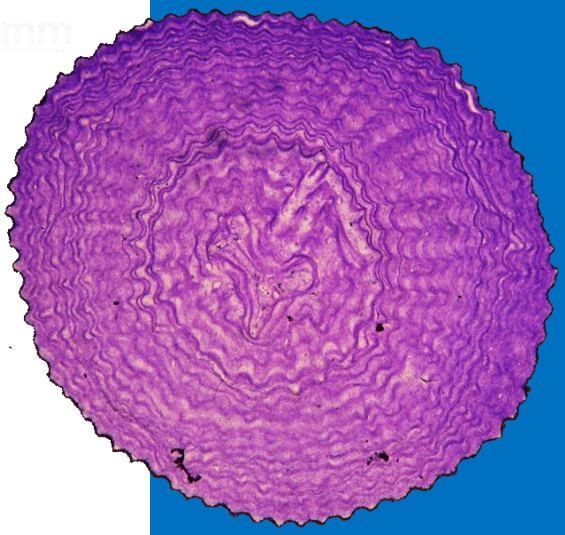


Average colony growth rate decrease s with colony age.



The age of most of the colonies (97.7%) ranges between 6 and 55 years and one reaches the age of 93: this last value can be considered the maximum life-span of this population. More than half af the colonies have an estimated age of 21-30 years. The legally harvestable size (7 mm, GFCM FAO 2011) was reached in 31-35 years.





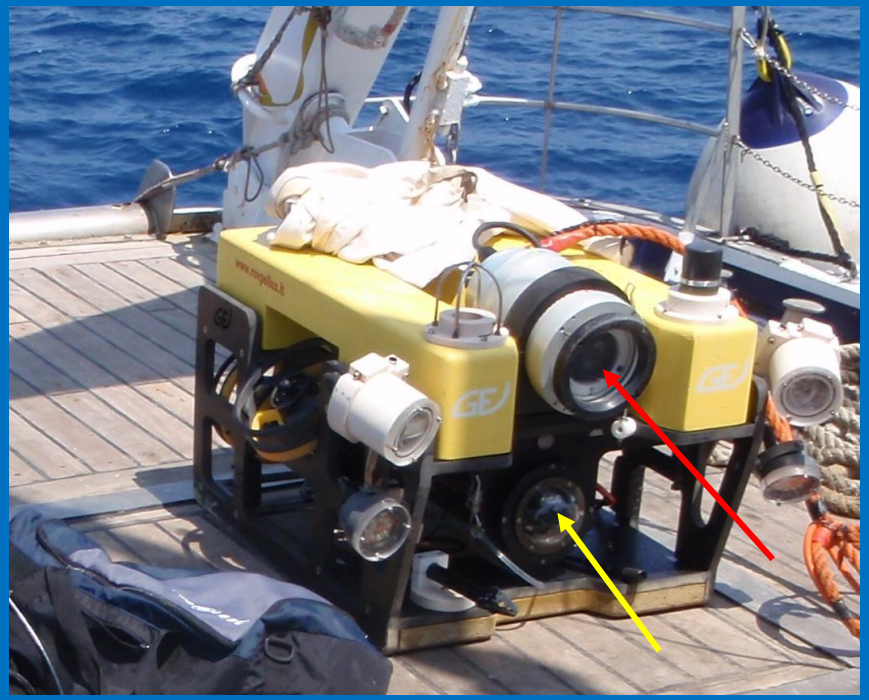
Pseudosimnia carnea (Poiret, 1789; Prosobranchia, Caenogastropoda, Ovulidae) is a species-specific partial predator feeding only on *C. rubrum* colonies: by its highly specialised mouth equipped with a tube-like proboscis this gastropod grazes red coral polyps.

Material and methods (3)

The ROV was equipped with a digital camera (red arrow), an underwater strobe and a high definition video camera (yellow arrow). Three laser beams provided a scale to define width of frames.

Photo, video and HD video were taken and used in order to identify and quantify the red coral colonies. All transects were recorded by ROV.

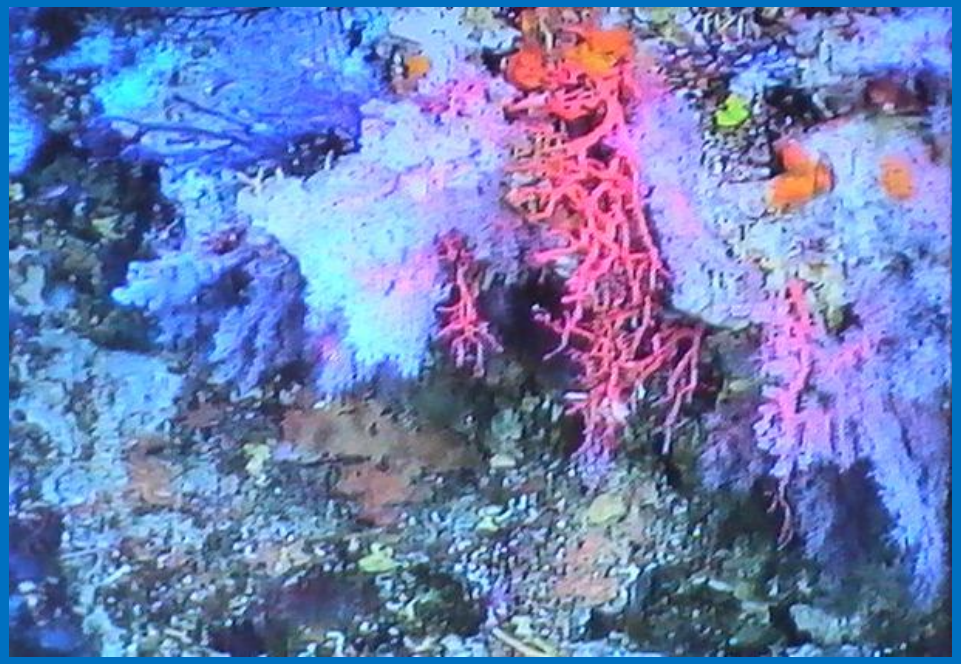
To quantify abundance (occupancy and density) and biometric data of red coral colonies, a random photographic sampling was carried out along the transects.



Frames were processed by Image J software, using as scale reference three laser dots, to delimitate units sampling (50 x 50 cm) and to count the number of colonies.

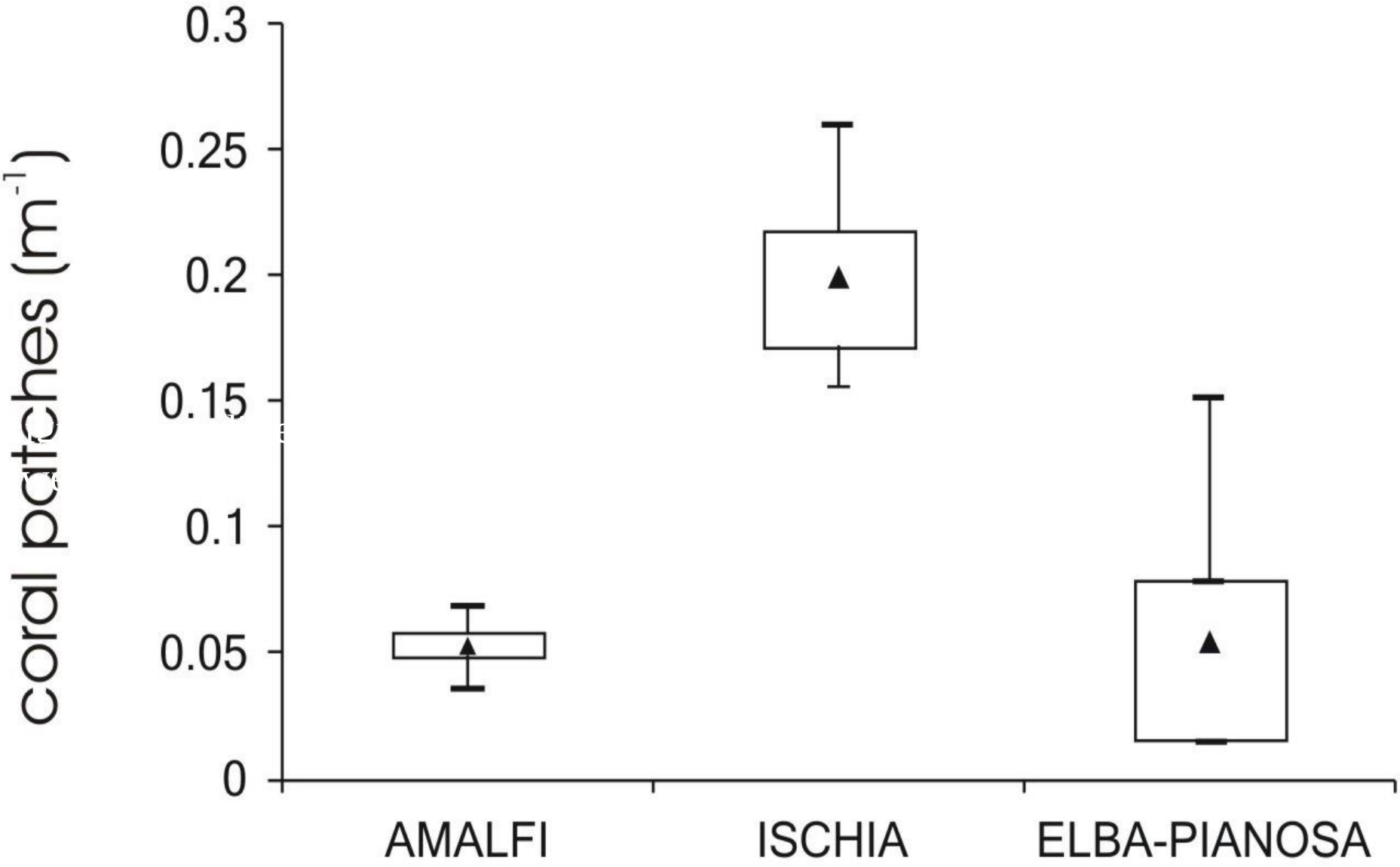
Overall 28 ROV surveys of about 1 hour each at an average speed of 0.5 knots were conducted, corresponding to a total distance of 14 n.m. and a time-recording of about 28 hours.

Red coral was found in the 89% of the surveys (25). Overall 660 m^2 of coral patches have been examined.

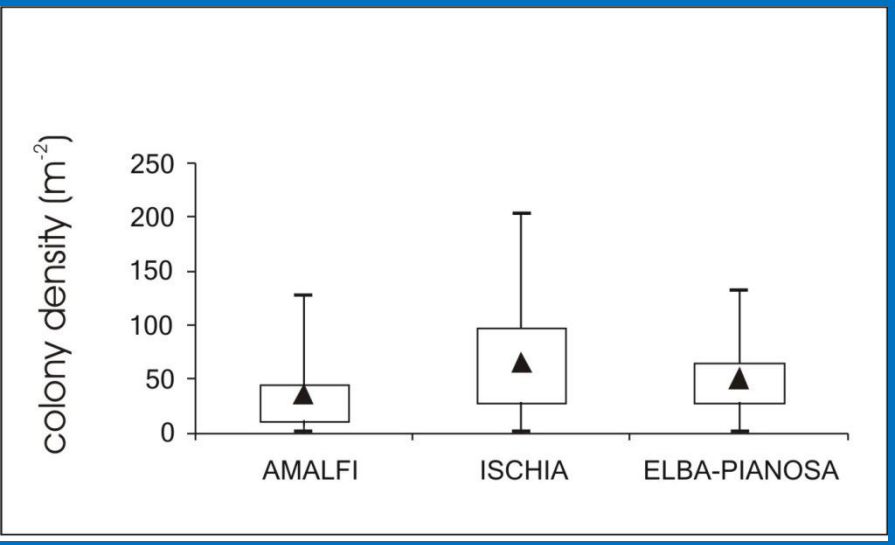


Out of the 25 *positive* ROV surveys, 988 50x50 cm frames with red coral have been examined.

Kruskal-Wallis non parametric
ANOVA test $p<0.01$

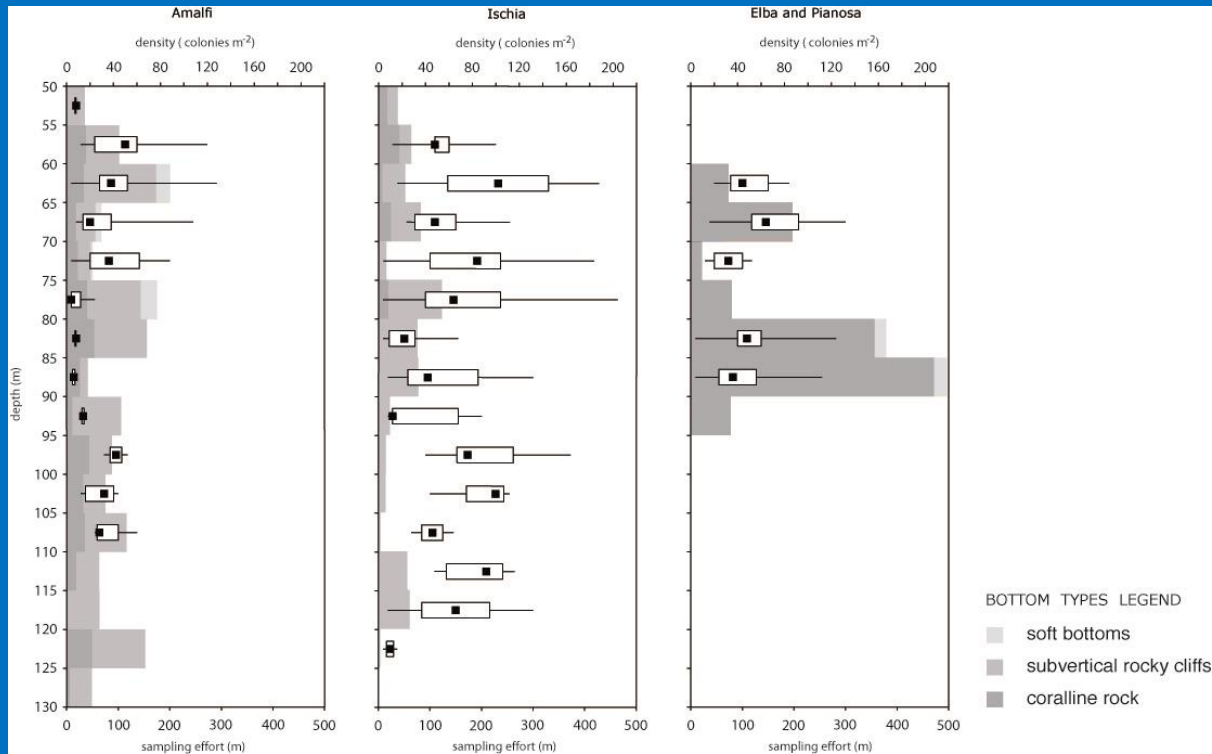


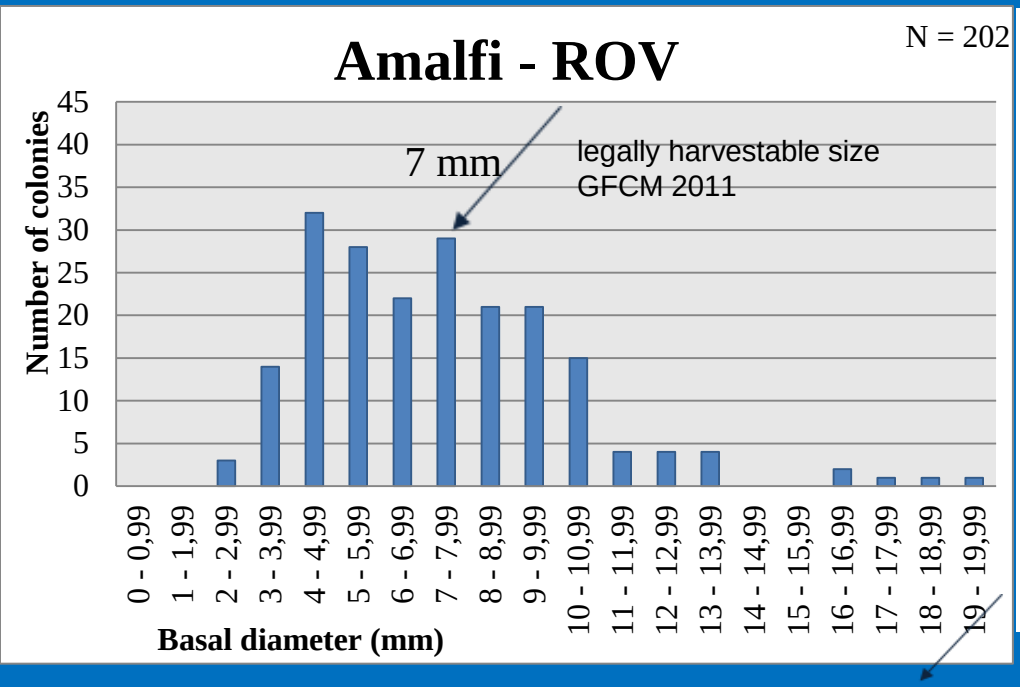
Density



Mean density ranged between 36 col/m^2 at Amalfi to 64 at Ischia: these densities were comparable to those found by Rossi et al. (2008) in the deep, commercial population of Cap de Creus.

In all the areas density showed a bimodal trend with depth.
At Elba-Pianosa the maximum depth is about 90 m.




Amalfi - ROV
N = 202
Number of colonies
7 mm
legally harvestable size
GFCM 2011
0 - 0,99
1 - 1,99
2 - 2,99
3 - 3,99
4 - 4,99
5 - 5,99
6 - 6,99
7 - 7,99
8 - 8,99
9 - 9,99
10 - 10,99
11 - 11,99
12 - 12,99
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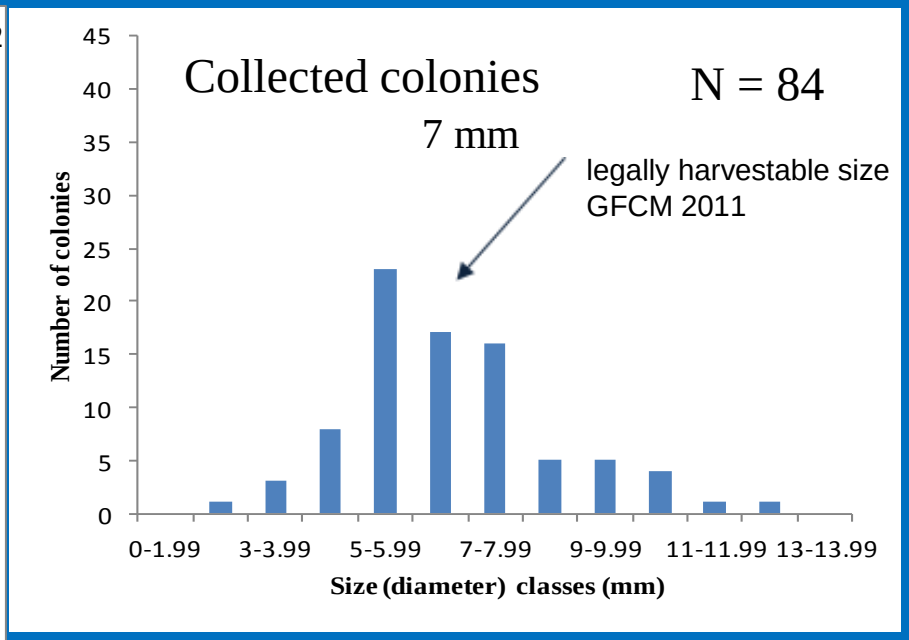
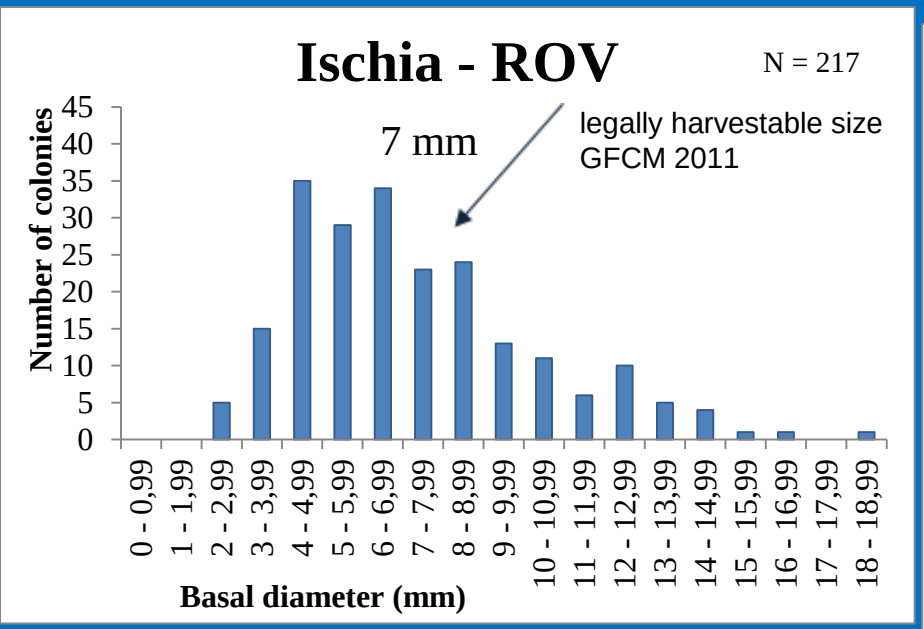
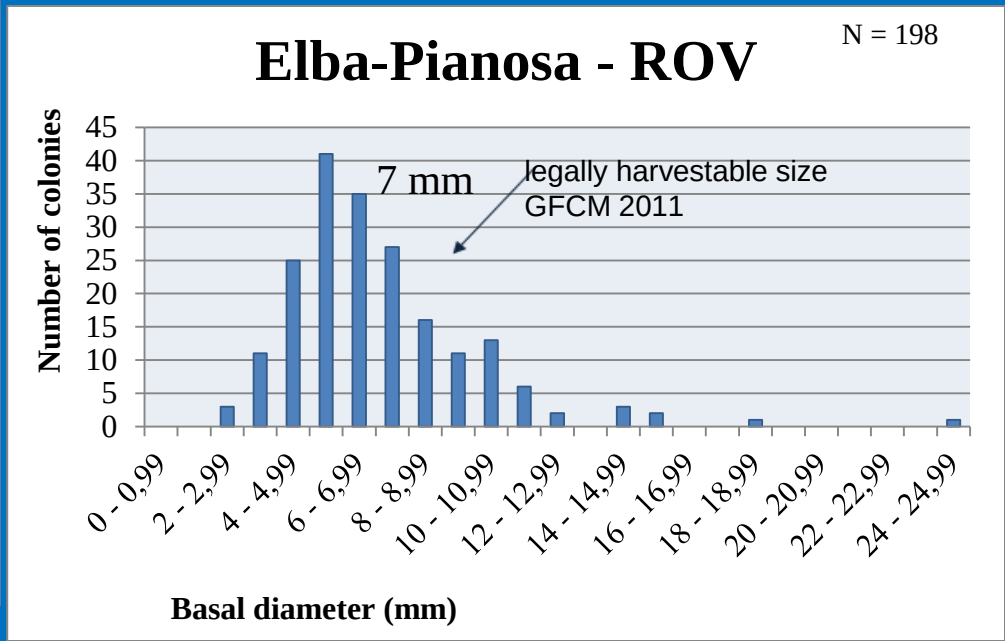
19 - 19,99
Basal diameter (mm)


Collected colonies
N = 84
7 mm
legally harvestable size
GFCM 2011
Number of colonies
0-1.99
3-3.99
5-5.99
7-7.99
9-9.99
11-11.99
13-13.99
Size (diameter) classes (mm)


Ischia - ROV
N = 217
Number of colonies
7 mm
legally harvestable size
GFCM 2011
0 - 0,99
1 - 1,99
2 - 2,99
3 - 3,99
4 - 4,99
5 - 5,99
6 - 6,99
7 - 7,99
8 - 8,99
9 - 9,99
10 - 10,99
11 - 11,99
12 - 12,99
13 - 13,99
14 - 14,99
15 - 15,99
16 - 16,99
17 - 17,99
18 - 18,99
Basal diameter (mm)

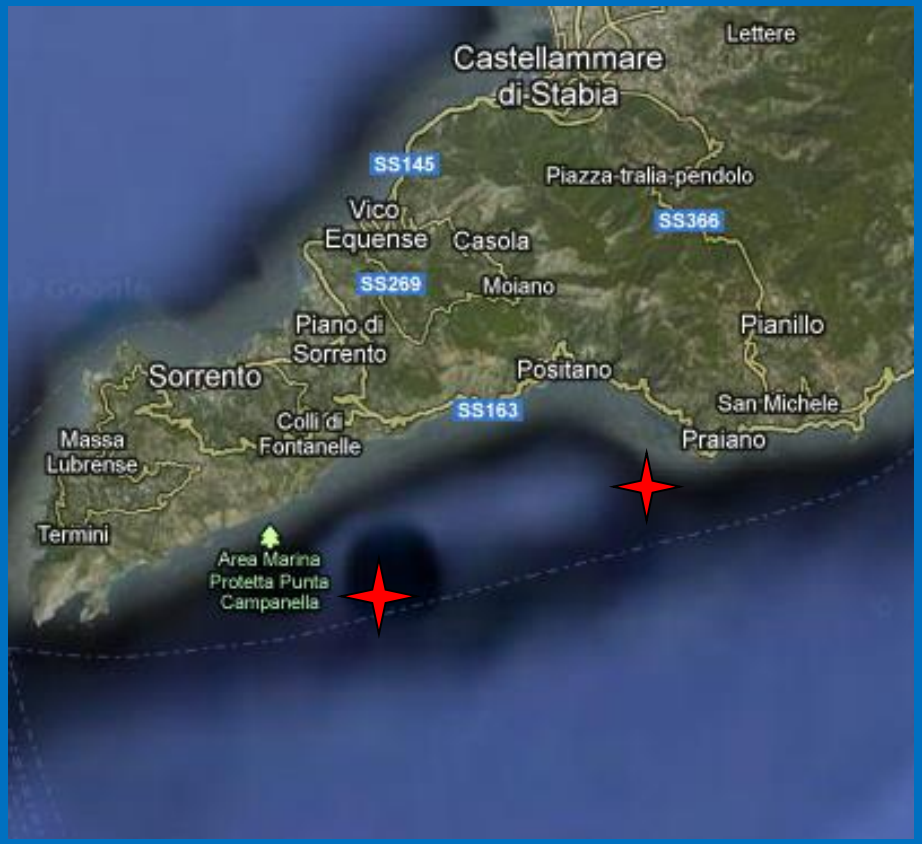

Elba-Pianosa - ROV
N = 198
Number of colonies
7 mm
legally harvestable size
GFCM 2011
0 - 0,99
2 - 2,99
4 - 4,99
6 - 6,99
8 - 8,99
10 - 10,99
12 - 12,99
14 - 14,99
16 - 16,99
18 - 18,99
20 - 20,99
22 - 22,99
24 - 24,99
Basal diameter (mm)

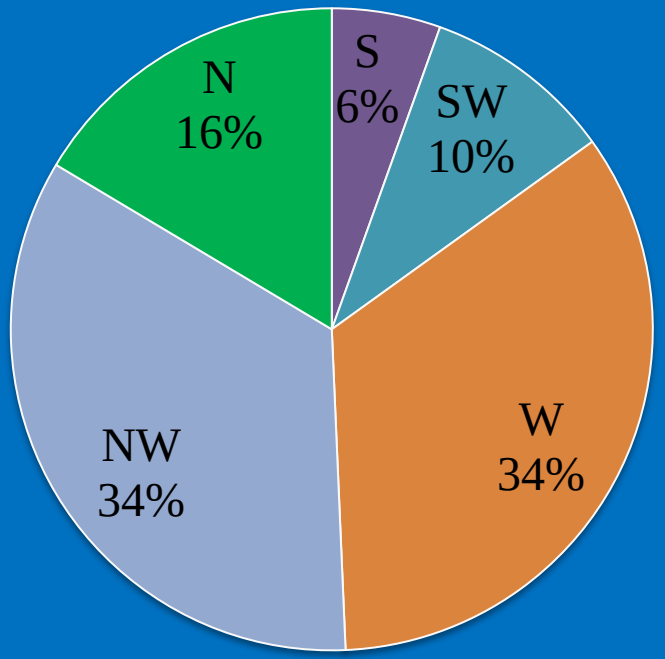
Exposure

Amalfi

N = 73

General Shannon-Weaver Index H = 1.426

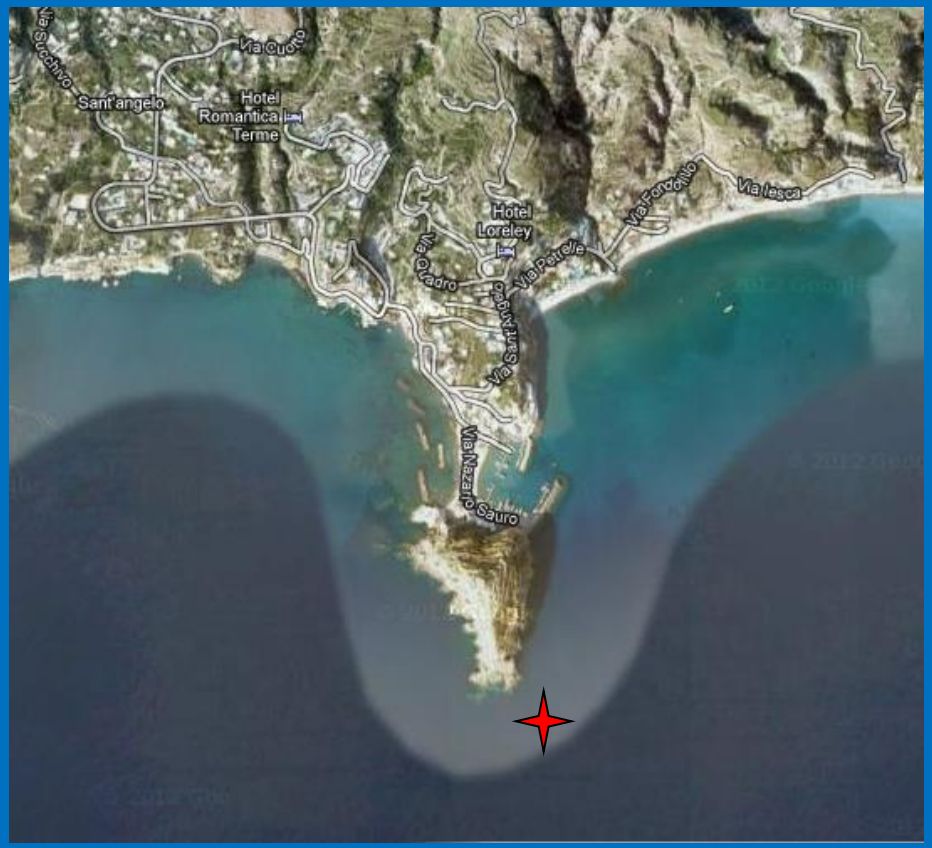


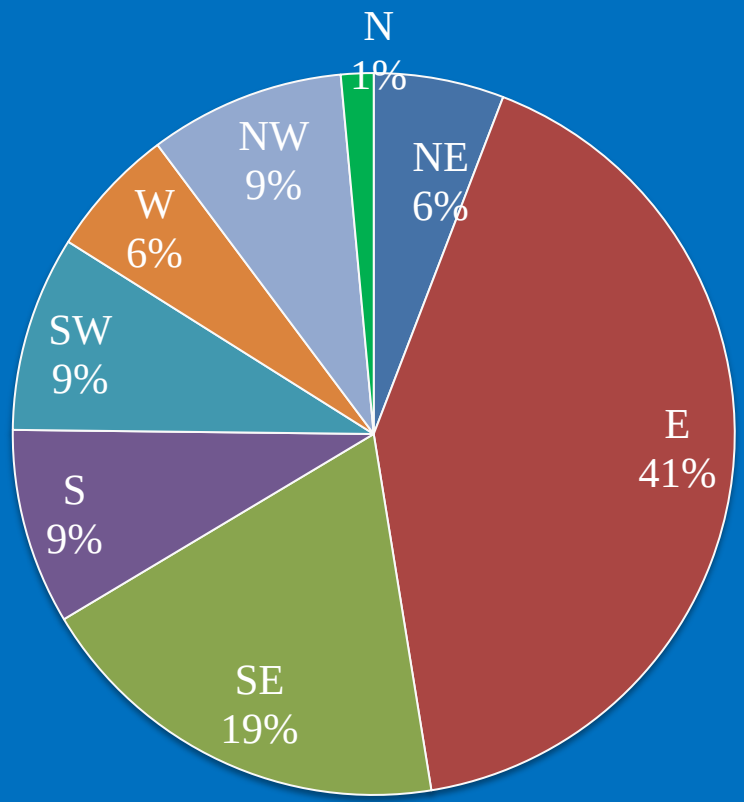


Ischia

N = 137

General Shannon-Weaver Index H = 1.715

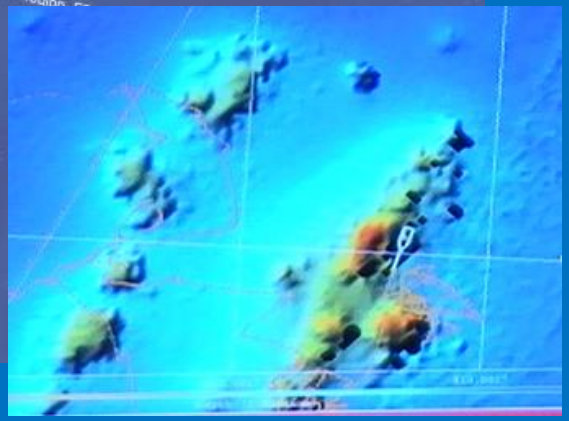


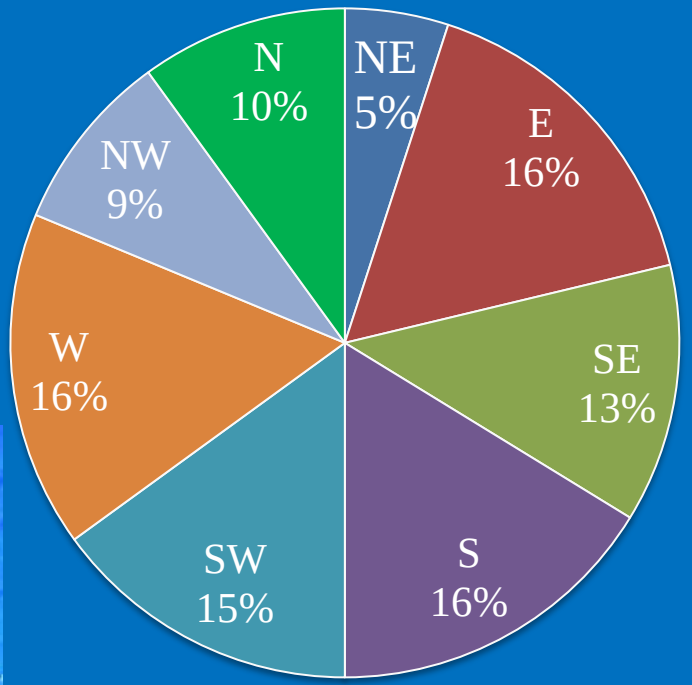


Elba-Pianosa

N = 80

General Shannon-Weaver Index H = 2.026





CONCLUSIONS (1)

The average colony growth rate (basal diameter, 0.26 mm/y) is slightly higher than that found in the majority of the shallow populations studied (0.24 mm/y).

The colony growth rate decreased with age. Even if the deep population we studied harbour larger and older colonies than shallow ones, the mean colony growth rate was higher, confirming that an higher growth rate could really occur in the former populations.

Population age structure revealed a large life span (93y), even if only few colonies exceeded 60 years.

Legal harvesting size is reached in about 30 -35years.

At Elba Island 35% of the colonies was predated by *P. carnea;* predation on female colonies is significantly dominant (3:1); this predation, reducing colony reproductive output, could have a long-term effect on the population dynamics and on its resilience to intense harvesting.

CONCLUSIONS 2 (R0V immage analysis)

ROV analysis is a non destructive method that allows a wide collection of data, even on small size colonies.
It gave reliable results with regard to occupancy, density and exposure.

The results were less reliable for colony diameter measurement.

This failure in measuring diameter can have important practical consequences for the conservation of red coral: recently, coral fishermen asked to use ROV to directly collect colonies after evaluating colony size, without diving. Since this research showed that this method overestimates colony size, of course the same would be for harvesters, which would take colonies below the legal size. For this reason, it is worth that ROV use will be allowed only for the exploration of the seabed and not for coral fishing.

Thank you for your attention!

Red Coral research team at Pisa University

www.red-coral.eu

Giovanni Santangelo: Conservation and demography of long lived species

UnIversity of Pisa Italy

Lorenzo Bramanti Red coral recruitment and population dynamics CNRS UMR, LECOB, France

Mimmo Iannelli: Population dynamics and Numerical Analysis. Univ. Trento Italy

Deep mixed gas divers Roberto Rinaldi
e Aldo Ferrucci

And the unvaulable help of the ASTREA RV crew !

Cristina Priori Univ Pisa

The Italian Red Coral Research Group: Giorgio Bavestrello, Marzia Bo Riccardo Cattaneo-Vietti, Michela Angiolillo, Simone Canese, Roberto Sandulli, Vincenza Mastascusa-