

**Contribution to the Special Issue: Marine Animal Forest of the World (MAF WORLD)
Temporal Shifts of *Posidonia oceanica* and *Corallium rubrum* in Cap de Creus (NE Spain): Recreational SCUBA diver's perception of change**

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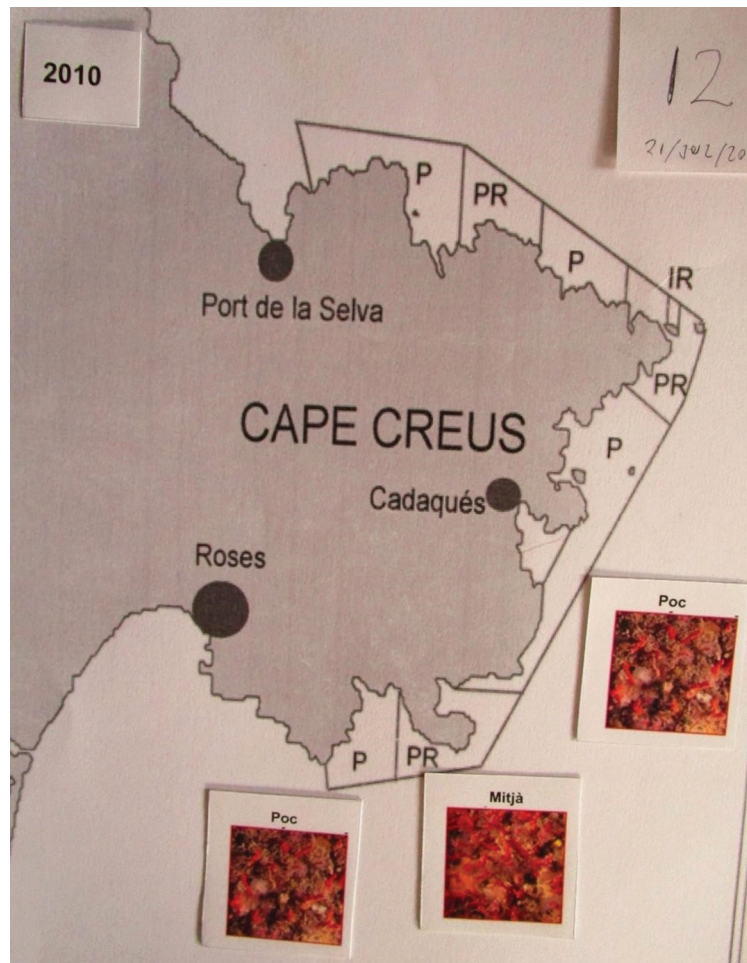


Fig. S1: Example of an answer of the semi-qualitative interviews realized to scuba diving centres owners or managers.

Only answer this section if you scuba dive frequently in the area.

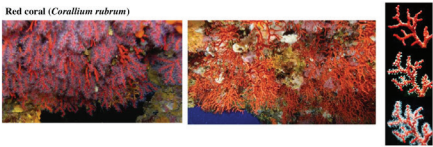
ENGLISH

Have you seen and observed any red coral during your dives in this area?

Yes

No

Red coral (*Corallium rubrum*)



If you answered "Yes" the question above, mark with an "X" how much Red coral (*Corallium rubrum*) in general you consider was present in the area during each decade (one "X" per decade only). Consider both, quantity and size. Leave blank the decades that you did not dive in the area.

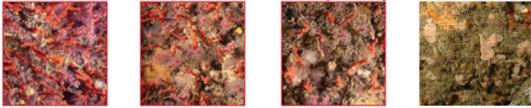
– think in a general way for all the areas that you saw red coral and make a broad estimate

Much

Medium

Little

Absent



Decade	Much	Medium	Little	Absent	Decade	Much	Medium	Little	Absent
Today (2019)					1970s				
2010s					1960s				
2000s					1950s				
1990s					1940s				
1980s					1930s				

How much red coral do you think there will be in 30 years (by 2050)?:

Much

Medium

Little

Absent

Have you seen and observed any Posidonia during your dives in this area?

Yes

No

Posidonia, Neptune grass, Mediterranean tapeweed (*Posidonia oceanica*)



If you answered "Yes" the question above, mark with an "X" how much Posidonia in general you consider was present in the area during each decade (one "X" per decade only). Leave blank the decades that you did not dive or not observe Posidonia in the area.

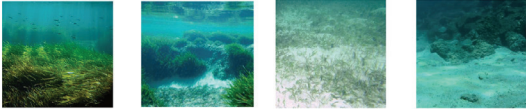
– think in a general way for all the areas that you saw Posidonia and make a broad estimate

Much

Medium

Little

Absent



Decade	Much	Medium	Little	Absent	Decade	Much	Medium	Little	Absent
Today (2019)					1970s				
2010s					1960s				
2000s					1950s				
1990s					1940s				
1980s					1930s				

How much Posidonia do you think there will be in 30 years (by 2050)?:

Much

Medium

Little

Absent

Fig. S2: English version of the questionnaire.

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Mediterr. Mar. Sci., Special Issue 26/2, 2025, suppl.data, 1-9

Table S1. Semi-structured interviews responses (n = 5). Absent = 0, Low = 1, Medium = 2, High = 3. The drivers of change mentioned by the interviewees are found in the last column, regardless of their involvement in a category change.

Inter-view #	Approximate location	Abundance category					Overall trend	Drivers of change
		2017-18	2010s	2000s	1990s	1980s		
<i>Corallium rubrum</i>								
1	Falconera	1	1	1	1	2	Decrease	Overharvesting (including poachers)
	Cap Norfeu	2	2	2	2	3	Decrease	
	Santa Eulalia de la Peña - Sud Cadaqués	1	1	1	1	2	Decrease	
2	Cap Norfeu - Santa Eulalia de la Peña	1	1	1			Stable	
	Cadaqués Bay Surroundings - Port Lligat - Guillola Bay	0	0	1			Decrease	Overharvesting
	Cap de Creus	1	1	2			Decrease	
	Culip - Tres Frares	2	2	2			Stable	
	El Golfet	2	2	3			Decrease	
3	Cap Norfeu - Santa Eulalia de la Peña	1	1				Stable	Poaching. Lack of vigilance MPA
	Cadaqués Bay Surroundings - Port Lligat - Guillola Bay	1	1				Stable	
	Cap de Creus	2	3				Decrease	
	Culip - Tres Frares	1	2				Decrease	
	El Golfet	1	1				Stable	
4	Culip - Tres Frares	1	1	2	3		Decrease	Overharvesting
	El Golfet	1	1	2	3		Decrease	
5	Cap Norfeu - Santa Eulalia de la Peña	0	1	1	3		Decrease	Overharvesting
	Cadaqués Bay Surroundings - Port Lligat	0	1	1	1		Decrease	(especially Poachers). Lack of vigilance MPA
	Guillola - Jugadora	0	-	-	3		Decrease	
	Culip - Tres Frares	0	1	1	3		Decrease	
	El Golfet	0	1	1	3		Decrease	
<i>Posidonia oceanica</i>								
1	Palangres - Falconera	3	3	3	3	3	Stable	Decrease: 80s-90s: pollution.
	Falconera - Cap Norfeu	3	3	3	3	3	Stable	From 90s: Anchoring.
	Cap Norfeu - Santa Eulalia de la Peña	2	2	2	2	2	Stable	Increase: from 90s: people awareness
2	Montjoi - Cap Norfeu	3	3	2			Increase	
	Cap Norfeu - Santa Eulalia de la Peña	3	3	2			Increase	
	Santa Eulalia de la Peña - Sud Cadaqués	3	3	3			Stable	Decrease: Anchoring.
	Cadaqués Bay Surroundings - Port Lligat	2	2	2			Stable	Increase: mainly people awareness, partly vigilance MPA
	Guillola - Cap Creus	3	3	3			Stable	
	Culip - Tres Frares	3	3	3			Stable	
3	Falconera - Cap Norfeu	1	1				Stable	
	Cap Norfeu - Santa Eulalia de la Peña	2	2				Stable	
	Cadaqués Bay Surroundings - Port Lligat - Guillola Bay	3	3				Stable	
	Cap Creus	2	2				Stable	
	Culip - Tres Frares	1	1				Stable	
	Punta de la Creu - Cala Tavallera	0	0				Stable	
4	Culip - Tres Frares	3	3	3	3		Stable	
	El Golfet	3	3	3	3		Stable	
	Badia Port Selva	3	3	3	3		Stable	

Continued

Table S1 continued

Inter-view #	Approximate location	Abundance category					Overall trend	Drivers of change
		2017-18	2010s	2000s	1990s	1980s		
5	Cap Norfeu - Santa Eulalia de la Peña	3	3	3	3		Stable	Anchoring. Lack of vigilance MPA
	Cadaqués Bay Surroundings - Port Lligat - Guillola Bay	2	2	2	2		Stable	
	Culip - Tres Frares	2	3	3	3		Decrease	
	El Golfet	3	3	3	2		Increase	

Table S2. Survey responses. The years on the top columns represent the decades, except 2019 that represents the time of the interview. Obs. = Have you seen and observed any red coral/*Posidonia oceanica* during your dives in this area? Y = Yes, N = No. 3 = High, 2 = Medium, 1 = Low, 0 = Absent. N/A = No answer. You can find the sociodemographic data of our respondents below the table.

Intreview #	<i>Corallium rubrum</i>								<i>Posidonia oceanica</i>							
	Obs.	2019	2010	2000	1990	1980	1970	2050	Obs.	2019	2010	2000	1990	1980	1970	2050
1	Y	1						1	Y	2						N/A
2	Y	1	1	2	2			3	Y	3	3	3	3			3
3	Y	1	1					2	Y	3	3	3				3
4	Y	1	1	2	2			1	Y	2	2	3	3	3		2
5	Y	1	1	2	2			1	Y	2	2	2	2			2
6	Y	1	1					0	Y	3	3					2
7	Y	1	2	3	3	3		N/A	Y	1	2	3	3	3		0
8	Y	1	1	1	1	2	2	1	Y	2	3	3	2	2	2	2
9	Y	1	2					1	Y	2	2					2
10	Y	1	2	2	3	3		0	Y	2	2	3	3	3		1
11	Y	1	1	1	1			1	Y	2	2	2	2			1
12	Y	1	2	3				1	Y	2	2	2				1
13	Y	2						0	Y	2						N/A
14	Y	1	1					1	Y	1	1					1
15	Y	2	2	2				2	Y	2	2	2				2
16	Y	2	2	2				2	Y	2	2	2				2
17	Y	2	2					1	Y	2	2	3	3			1
18	Y	1	1	2				2	Y	0	1	2	3			0
19	N								Y	2	2	2				1
20	Y	2	2					1	Y	2	2					1
21	N								N							
22	Y	1						1	Y	2						1
23	Y	2						N/A	Y	2						1
24	Y	1						0	Y	1						0
25	Y	1	2	3				0	Y	3	3	3				3
26	Y	1	2	3				2	Y	2	3	3				N/A
27	Y	1	1	2	2			0	Y	1	1	2	2			1
28	Y	1	1	2				2	Y	2	3	3				2
29	Y	2	2	1	2	2	2	2	Y	2	2	2	2	3		2
30	Y	2						2	Y	2						2
31	Y	2	2					2	Y	2	2	3				2
32	Y	2						1	Y	2						1

Sociodemographic data

Genre		Place of Interview	
Male	37.50%	Cadaqués	53%
Female	62.50%	Roses	25%
		El Port de la Selva	22%
Age		Education	
18-29 yrs	34%	Secondary school	25%
30-39 yrs	19%	High school	9%
40-49 yrs	22%	Professional/technical degree	22%
50-59 yrs	16%	University	28%
60-69 yrs	6%	Master degree	16%
70-79 yrs	3%	Salary	
		No salary/unemployed	9%
		< 14,000 €/yr	34%
		14-35,000 €/yr	25%
		35-56,000 €/yr	22%
		> 56,000 €/yr	6%
		N/A	3%
Country			
Spain	81%		
France	9%		
Belgium	9%		

Table S3. On the left, *Corallium rubrum* values of its most studied parameters and number of colonies sampled for obtaining them. On the right, the yearly averages and their respective standard deviations of those parameters. This material is modified from Figure 4 and S4 Table in Mallo *et al.* (2019), *PLoS One*.

Data collection year	Ref. Code	# colonies	Ø (mm)	SD	H (cm)	SD	W (g)	SD
2003	(i)	1677 overall	6.55	3.16	4.61	2.90	4.68 []]	1.14
			4.96	1.96	2.57	1.56	3.38 [‡]	1.58
			5.73	1.98	2.65	1.57	0.37 []]	0.09
			4.12	1.85	3.02	1.60	1.19 []]	0.29
			4.07	1.66	2.86	1.72	0.82 []]	0.20
			8.13	2.96	5.56	2.87	6.78 []]	1.65
			4.71	2.20	3.30	1.62	1.81 []]	0.44
			5.77	1.94	3.50	1.42	2.24 []]	0.54
			4.18	1.63	2.20	1.13	1.98 [‡]	0.93
			5.92	2.66	3.72	1.70	2.72 []]	0.66
			4.09	1.31	2.49	1.34	1.82 [‡]	0.85
			4.39	1.64	3.82	2.03	2.94 []]	0.72
			4.12	1.66	3.55	1.84	2.34 []]	0.57
2003	(i)	1722 overall	5.14	1.81	3.60	1.28	2.47 []]	0.60
			4.19	1.26	2.70	1.26	0.48 []]	0.12
			3.63	1.61	2.12	1.07	0.99 [‡]	0.46
			4.93	1.71	3.63	1.67	2.53 []]	0.61
			5.47	2.61	4.27	2.11	3.94 []]	0.96
			5.10	1.88	3.75	2.16	2.80 []]	0.68
			6.22	1.39	5.98	2.84	7.71 []]	1.87
			4.10	1.46	2.16	1.14	1.84 [‡]	0.86
			5.05	1.55	2.54	1.29	3.55 [‡]	1.66
			3.76	1.14	2.41	1.21	1.22 [‡]	0.57
			3.74	1.23	1.98	1.06	1.17 [‡]	0.55
			4.00	1.78	2.29	1.09	1.65 [‡]	0.77
			4.31	2.63	2.85	1.49	0.82 []]	0.20
			4.56	2.05	3.78	1.59	2.86 []]	0.69
2003	(i)	1632 overall	4.98	2.52	2.47	1.51	3.43 [‡]	1.61
			5.20	2.05	1.97	1.36	3.82 [‡]	1.79
			5.25	1.81	2.43	1.67	3.91 [‡]	1.83
			4.69	1.77	2.36	1.32	2.89 [‡]	1.35
			2.97	1.43	1.47	1.04		

Basal diameter (mm)

Height (cm)

Weight (g)

Continued

Table S3 continued

2009	(ii)	143	4.08	1.24	2.92†	0.76	1.80‡	0.84
2009*	(iii)	36	3.67	0.78	2.56†	0.67	1.06‡	0.50
		30	7.22†	1.88	5.66	0.49	11.37	
		181	4.28†	1.11	3.09	0.25	4.28	
		130	3.86†	1.00	2.72	0.13	1.10	
		34	3.57†	0.93	2.47	0.13	4.92	
2017	(iv)	100	3.53†	0.92	2.43	0.14	2.30	
		143	4.15†	1.08	2.98	0.17	3.81	
		52	4.24†	1.11	3.06	0.22	3.35	
		75	3.35†	0.87	2.28	0.12	1.83	

colonies "overall" are stated when no # per station is available and represents the sample size containing all the stations comprised until the next # shown in the table.

(*) after the year means that the publication did not indicate the sampling year, so we assumed collection was done one year before the publication date.

SD: Standard deviation. Ø: Basal diameter. H: Height. W: Weight.

Values obtained through formulas (see Mallo *et al.*, 2019; Fig. 3) are marked with signs: (†): with formula (1), (l) with formula (2), and (‡) with formula (3).

References

- Tsounis, G., Rossi, S., Gili, J.-M., Arntz, W., 2006. Population structure of an exploited benthic cnidarian: the case study of red coral (*Corallium rubrum* L.). *Marine Biology*, 149, 1059-1070.
- Bramanti, L., Vielmini, I., Rossi, S., Tsounis, G., Iannelli, M. *et al.*, 2014. Demographic parameters of two populations of red coral (*Corallium rubrum* L. 1758) in the North Western Mediterranean. *Marine biology*, 161, 1015-1026.
- Vielmini, I., Bramanti, L., Tsounis, G., Rossi, S., Gili, J.M. *et al.*, 2010. Determination of *Corallium rubrum* population age structure. In: Proceedings of the International Workshop on Red Coral Science, Management, and Trade: lessons from the Mediterranean. Bussoletti, E., Cottingham, D., Bruckner, A., Roberts, G., Sandulli, R. (Eds). NOAA, Technical Memorandum CRCP-13. Naples, Italy: Silver Spring, p. 179-182.
- Linares, C., Rovira, G., Cabrito, A., Aspillaga, E., Capdevila, P. *et al.*, 2018. Seguiment de les poblacions de corall vermell al Parc Natural de Cap de Creus i al Parc Natural del Montgrí, les Illes Medes i el Baix Ter. In: *Seguiment del medi marí al Parc Natural del Cap de Creus i al Parc Natural del Montgrí, les Illes Medes i el Baix Ter. Memòria 2017*. p. 71-94. Generalitat de Catalunya. Departament de Territori i Sostenibilitat. Direcció General de Polítiques Ambientals i Medi Natural.