Supplementary information

Mass flowering of the seagrass *Posidonia oceanica* after 2022 record-breaking marine heatwaves: a Pan-Mediterranean study

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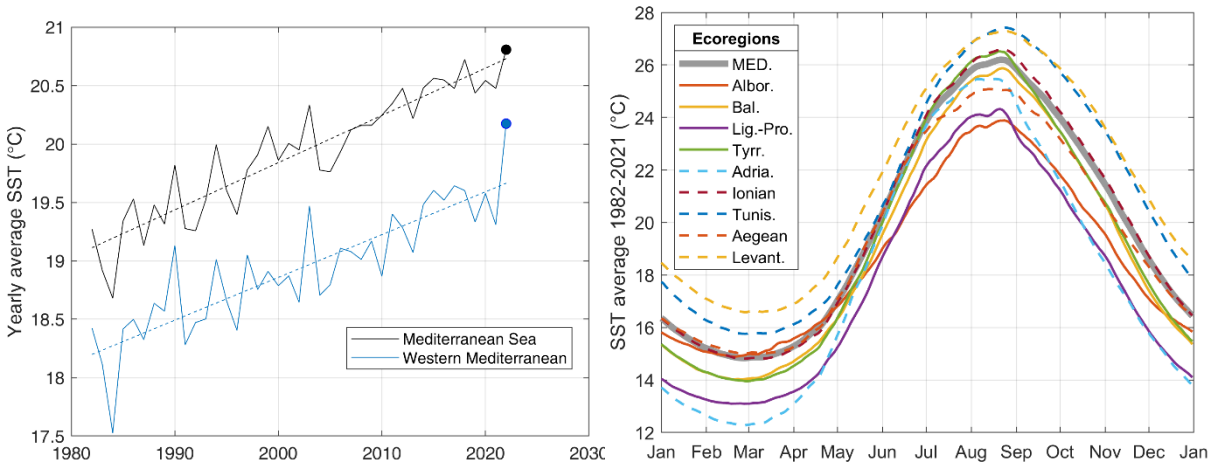
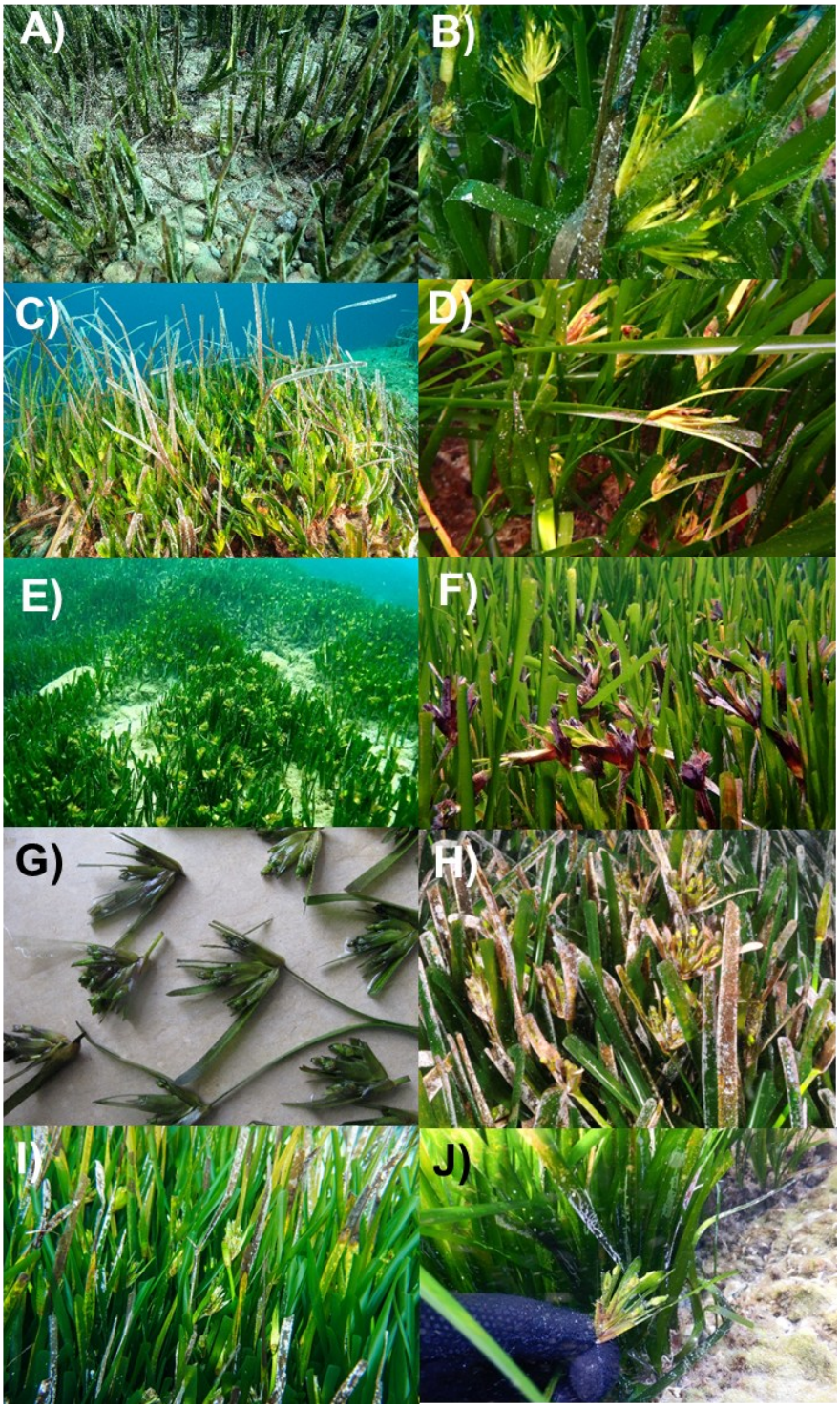
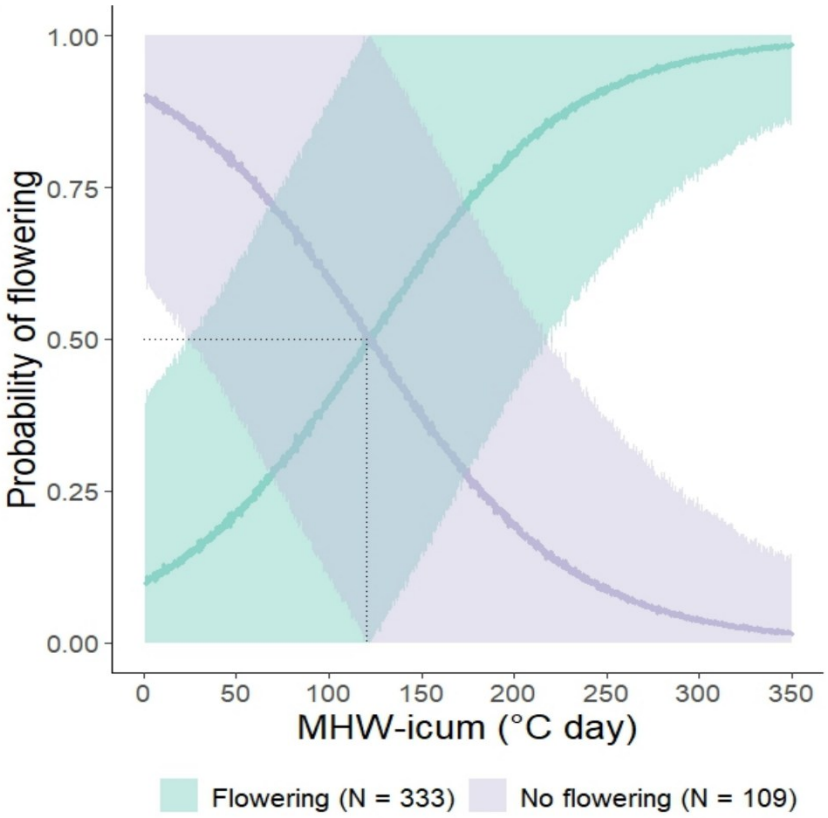
Supplementary figures



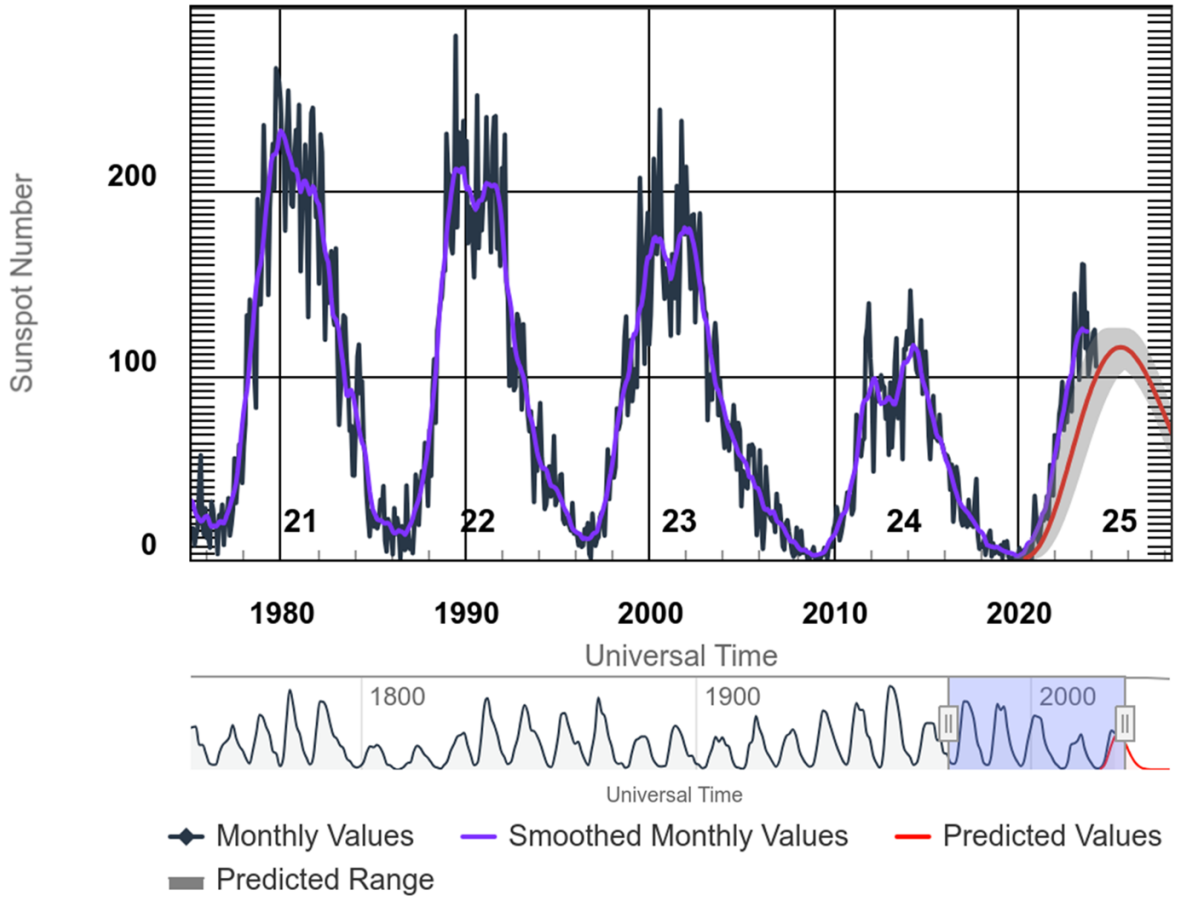
Supplementary Figure 1: Left: Temporal patterns of the annual mean SST for the whole Mediterranean Sea and the western Mediterranean ecoregion (showing 2022 as the warmest year on record); Right: Spatially (per ecoregion) and temporally (1982-2021) averaged annual SST cycle (Ecoregions: MED.: Whole Mediterranean, Albor.: Alboran Sea; Bal.: Balearic Sea; Lig-Pro.: Liguro-Provençal; Tyrr.: Tyrrhenian Sea; Adria.: Adriatic Sea; Ionian: Ionian Sea; Tunis.: Tunisian Plateau; Aegean: Aegean Sea; Levant.: Levantine basin).



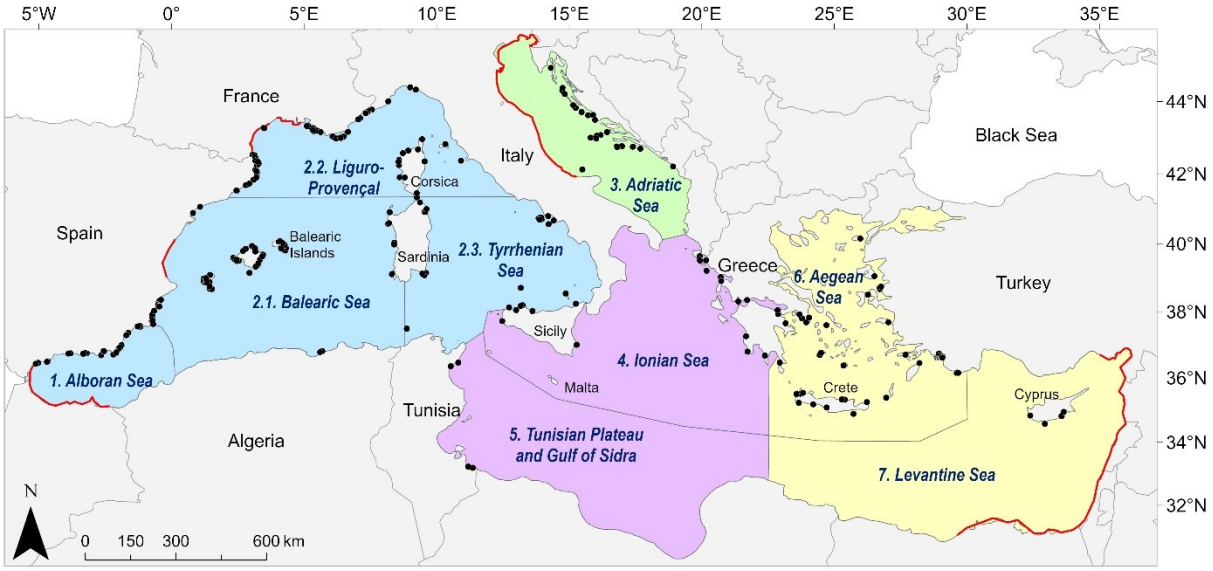
Supplementary Figure 2: *Posidonia oceanica* meadows with inflorescences in different localities detected between autumn 2022 and spring 2023. A) French Catalonia: ©Virginie Hartmann; B) Provence: ©Bruno Belloni; C) Corsica: ©Tristan Estaque; D) Sardinia: ©Patrizia Stipcich; E) Catalan coast: ©Seawatcher; F) Balearic Islands: ©Jonathan Delgado; G) Tunisian Plateau: ©Jamila Ben Souissi; H) Andalusia: ©Diego Moreno/ Sustainable Marine Environment Management Program; I) Greece: ©Daniele Ventura; J) Cyprus: ©Periklis Kleitou. Leaves are approximately 0.8 to 1 cm wide.



Supplementary Figure 3: Probability of flowering according to marine heatwave cumulative intensity (MHW-icum in °Cday).



Supplementary Figure 4: Solar cycle sunspot number progression since 1975 to recent days. Sunspot number values are expressed per month, the cycle 25, starting in 2020 is represented with predicted values (source: Space Weather Prediction Center, National Oceanic and Atmospheric Administration; https://www.swpc.noaa.gov/products/solar-cycle-progression : consulted the 28/04/2024).



Supplementary Figure 5: Location of the sampling sites (black dots) within ecoregions. The red lines localise areas without *P. oceanica* living meadows (Telesca et al., 2015).

Supplementary Figure 6: A) Inflorescences and shoot density estimated in a 20 cm x 20 cm quadrat within the *Posidonia oceanica* meadow on November 17th, 2022 at 15 m depth (Montremian, Port-Cros archipelago, Provence, France, November 2022; ©Bruno Belloni); B) detached floating fruits (Bay of Sant'Amanza, Corsica, France, April 2023; ©Serena André); C) beach-cast fruits and seeds (Santa Guilia beach, Corsica, France, April 2023; ©Bruno Belloni); D) *in situ* developed seedling (Bay of Marseille, Provence, France, September 2023; ©Thomas Schohn).

Supplementary Tables

Supplementary Table 1: Sampling sites distribution according to ecoregions and the data type.

	Type of data			
Ecoregions	**Qualitative**	**Semi-quantitative**	**Quantitative**	**Total**
1-Alboran Sea	-	8	22	30
2.1-Balearic Sea	12	85	37	134
2.2-Liguro-Provençal (NW Med)	19	39	101	159
2.3-Tyrrhenian Sea	7	10	10	27
3-Adriatic Sea	1	22	3	26
4-Ionian Sea	2	5	9	16
5-Tunisian Plateau	-	-	4	4
6-Aegean Sea	-	10	50	60
7-Levantine Sea	-	7	-	7
Total	**41**	**186**	**236**	**463**

Supplementary Table 2: Results (p-value and p-value adjusted) from the pairwise test between ecoregions comparing Flowering Intensity (left: p-value adj.<0.05; right: p>0.05).

Ecoregion 1	Ecoregion 2	p-value	p-value adj.
Alboran Sea	Adriatic Sea	0.00010	0.00036
Balearic Sea	Adriatic Sea	0.00010	0.00036
Liguro-Provençal	Adriatic Sea	0.00010	0.00036
Tunisian Plateau	Adriatic Sea	0.00010	0.00036
Tyrrhenian Sea	Adriatic Sea	0.00040	0.00103
Balearic Sea	Aegean Sea	0.00010	0.00036
Liguro-Provençal	Aegean Sea	0.00010	0.00036
Tunisian Plateau	Aegean Sea	0.00010	0.00036
Tyrrhenian Sea	Aegean Sea	0.00060	0.00135
Balearic Sea	Alboran Sea	0.00100	0.00212
Liguro-Provençal	Alboran Sea	0.00020	0.00065
Tunisian Plateau	Alboran Sea	0.00030	0.00090
Ionian Sea	Balearic Sea	0.00040	0.00103
Tunisian Plateau	Balearic Sea	0.00010	0.00036
Liguro-Provençal	Ionian Sea	0.00010	0.00036
Tunisian Plateau	Ionian Sea	0.00050	0.00120
Tyrrhenian Sea	Ionian Sea	0.01690	0.03202
Tunisian Plateau	Liguro-Provençal	0.00010	0.00036
Tyrrhenian Sea	Tunisian Plateau	0.00190	0.00380

Ecoregion 1	Ecoregion 2	pvalue	Pvalue adj
Aegean Sea	Adriatic Sea	0.07110	0.11536
Ionian Sea	Adriatic Sea	0.10980	0.14640
Levantine Sea	Adriatic Sea	1.00000	1.00000
Alboran Sea	Aegean Sea	0.02880	0.05184
Ionian Sea	Aegean Sea	0.38690	0.43526
Levantine Sea	Aegean Sea	0.10000	0.13971
Ionian Sea	Alboran Sea	0.07370	0.11536
Levantine Sea	Alboran Sea	1.00000	1.00000
Tyrrhenian Sea	Alboran Sea	0.08520	0.12780
Levantine Sea	Balearic Sea	0.52370	0.57131
Liguro-Provençal	Balearic Sea	0.38410	0.43526
Tyrrhenian Sea	Balearic Sea	0.35400	0.42480
Levantine Sea	Ionian Sea	0.06640	0.11383
Liguro-Provençal	Levantine Sea	0.34940	0.42480
Tunisian Plateau	Levantine Sea	0.20000	0.25714
Tyrrhenian Sea	Levantine Sea	0.88660	0.93875
Tyrrhenian Sea	Liguro-Provençal	0.10090	0.13971

Supplementary Table 3: Flowering categories according to the inflorescence density (Giraud's classification) and inflorescence intensity (Flowering intensity level).

Flowering	**Inflorescence density (per m²)** **(Giraud, 1977)**	**Flowering intensity (FI, proportion of shoots bearing an inflorescence per total number of shoots) (present work)**
(I) Isolated flowering	1-20	< 0.05
(II) Low flowering	21-50	$0.1 > FI \geq 0.05$
(III) Moderate flowering	51-100	$0.2 > FI \geq 0.1$
(IV) Large flowering	101-150	$0.3 > FI \geq 0.2$
(V) Exceptional flowering	>150	$FI \geq 0.3$