

MPAs as Nature-based Solutions for Climate Change Adaptation

Results from the MPA4Change Project

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National Research Council
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Interreg
Euro-MED



Co-funded by
the European Union

MPA4Change



AN OVERHEATING SEA UNDER MULTIPLE PRESSURES

The Mediterranean Sea is increasingly impacted by **multiple threats** that do not act in isolation but can combine and break the stability of natural ecosystems. Adding a **changing climate** into this mix, the problems become even worse.

- WARMING **THREE TIMES FASTER** THAN THE GLOBAL AVERAGE.
- PAST 7 YEARS SET TO BE THE **WARMEST ON RECORD**.
- IN AUGUST 2021, **48.8°C** IN SYRACUSE, WARMEST TEMPERATURE IN EUROPE.

The choice is ours: **empowering MPAs** to contribute to mitigate these problems or accelerate them through the unsustainable use of the sea!

#empoweringMPAs

CONTEXT

The living Mediterranean is a unique and spectacular marvel, **rich in species** and habitats that do not exist anywhere else.

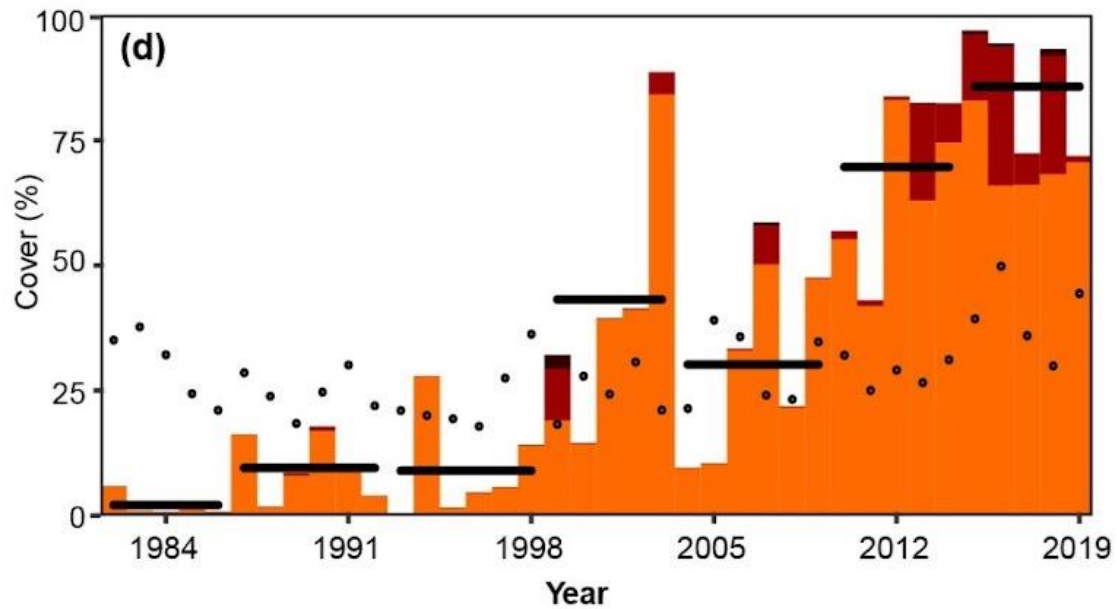
- **17'000 SPECIES WITH 28%** OF ENDEMISMS.
- **7.5%** OF THE WORLD'S MARINE FAUNA.
- **0.7%** OF THE GLOBAL OCEAN SURFACE.

Scientists consider this sea as a “miniature ocean”, the perfect place to understand the ecological effects of climate change and to test possible solutions.

#miniatureocean

CLIMATIC HOTSPOT

Marine heatwaves cover in the Mediterranean Sea



Garrabou et al. 2022 Global Change Biology



3. MASS MORTALITIES

REPORT

A catastrophic mass-mortality episode of gorgonians and other organisms in the Ligurian Sea (North-western Mediterranean), summer 1999

Abstract

In the late summer of 1999, an extensive mortality of gorgonians and other epibenthic organisms was observed in the Ligurian Sea (Mediterranean Sea) from the Tuscan Archipelago to Marseille. Quantitative data from Tino Island and Portofino Promontory indicated that the proportion of affected gorgonians ranged from 60% to 100% in populations having a density of 9–27.8 colonies m⁻², suggesting that

Carlo Cerrano,¹ Giorgio Bavestrello,² C. Nike Bianchi,³ Riccardo Cattaneo-vietti,¹ Simone Bava,¹ Claudia Morganti,³ Carla Morri,¹ Paola

Mortalité massive d'invertébrés marins : un événement sans précédent en Méditerranée nord-occidentale

Thierry Perez^{a*}, Joaquim Garrabou^a, Stéphane Sartoretto^a, Jean-Georges Harmelin^a, Patrice Francour^b, Jean Vacelet^a

^a Centre d'océanologie de Marseille, UMR 6540 Dimar, station marine d'Endoume, rue de la Batterie-des-Lions, 13007 Marseille, France

^b Laboratoire d'environnement marin littoral, faculté des sciences, université de Nice-Sophia-Antipolis, parc Valrose, 06108 Nice cedex 2, France

Reçu le 6 mai 2000 ; accepté le 17 juillet 2000

Présenté par Lucien Laubier

Abstract – Mass mortality of marine invertebrates: an unprecedented event in the Northwestern Mediterranean. An unprecedented mass mortality event has been observed at the end of the summer 1999 along the coasts of Provence (France) and Liguria (Italy). This event has severely affected a wide array of sessile filter-feeder invertebrates from hard-substratum communities, such as sponges (particularly the keratose sponges *Hippospongia* and *Spongia*), cnidarians (particularly the anthozoans *Corallium*, *Paramuricea*, *Eunicella* and *Cladocora*), bivalves, ascidians and bryozoans. Along the Provence coasts, the outbreak spread from east to west. Exceptionally high and constant temperatures of the whole water column (23–24 °C, for over one month,

frontiers in Marine Science

DATA REPORT published: 22 November 2019 doi: 10.3389/fmars.2019.00707



Collaborative Database to Track Mass Mortality Events in the Mediterranean Sea

OPEN ACCESS

Edited by:

Cosimo Solidoro, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy

Reviewed by:

Giovanni Galli, Plymouth Marine Laboratory, United Kingdom
Jason Michael Hall-Spencer, University of Plymouth, United Kingdom

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Joaquim Garrabou

Joaquim Garrabou^{1,2*}, Daniel Gómez-Gras¹, Jean-Baptiste Ledoux^{1,3}, Cristina Nathaniel Bensoussan¹, Paula López-Sendino¹, Hocein Bazairi⁵, Free Espinosa Mohamed Ramdani⁷, Samir Grimes⁸, Mouloud Benabdi⁹, Jamila Ben Souissi¹⁰, Emna Soufi¹⁰, Faten Khamassi¹⁰, Raouia Ghanem¹⁰, Oscar Ocaña¹¹, Alfonso Ramos-Esplá^{12,13}, Andres Izquierdo¹³, Irene Anton¹³, Esther Rubio-Porto Carmen Barbera^{12,13}, Emma Cebrian^{15,16}, Nuria Marbà¹⁷, Iris E. Hendriks¹⁷, Carlos M. Duarte^{18,19}, Salud Deudero¹⁹, David Diaz¹⁹, Maite Vázquez-Luis¹⁹, Elvira Alvarez¹⁹, Bernat Hereu⁴, Diego K. Kersting^{4,20}, Andrea Gori^{1,21}, Núria Vilà Stephane Sartoretto²², Ivane Pairaud²², Sandrine Ruitton²², Gérard Pergent²³, Christine Pergent-Martini²³, Elodie Rouanet²⁴, Nuria Teixidó^{25,26}, Jean-Pierre Gasc Simonetta Fraschetti^{26,28,29}, Irene Rivetti²⁸, Ernesto Azzurro^{26,30}, Carlo Cerrano²⁶

REPORT

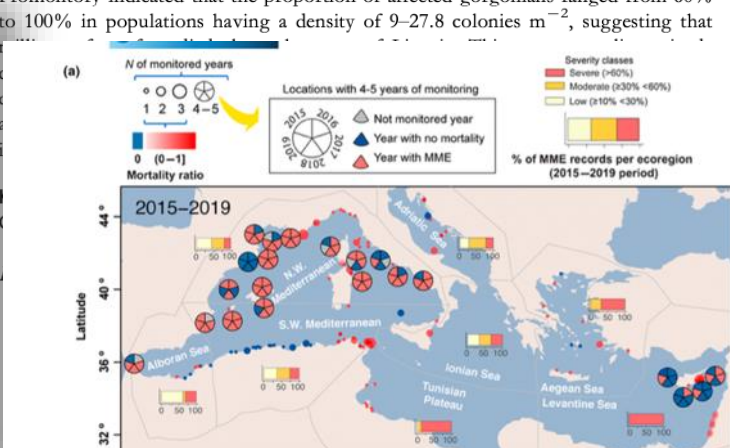
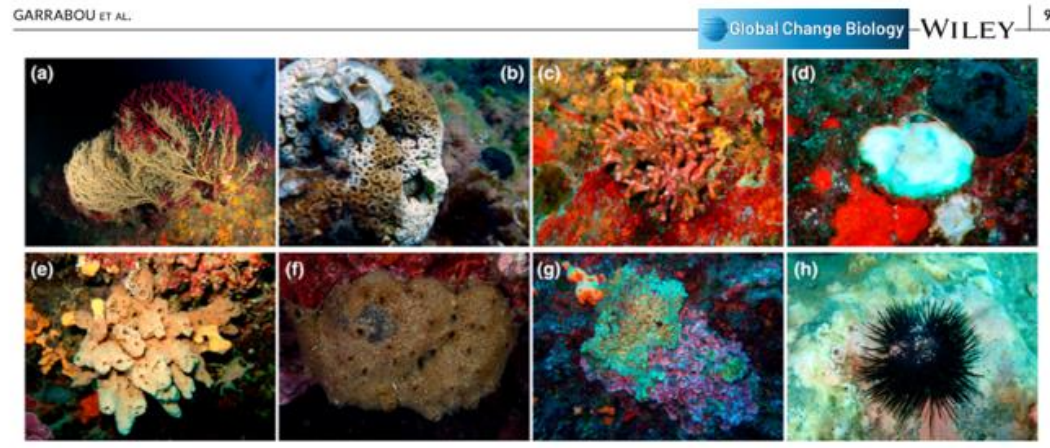
Ecology Letters, (2000) 3: 284–293

A catastrophic mass-mortality episode of gorgonians and other organisms in the Ligurian Sea (North-western Mediterranean), summer 1999

Abstract

In the late summer of 1999, an extensive mortality of gorgonians and other epibenthic organisms was observed in the Ligurian Sea (Mediterranean Sea) from the Tuscan Archipelago to Marseille. Quantitative data from Tino Island and Portofino Promontory indicated that the proportion of affected gorgonians ranged from 60% to 100% in populations having a density of 9–27.8 colonies m⁻², suggesting that

Carlo Cerrano,¹ Giorgio Bavestrello,² C. Nike Bianchi,³ Riccardo Cattaneo-vietti,¹



Immediate and delayed effects of a mass mortality event on gorgonian population dynamics and benthic community structure in the NW Mediterranean Sea

Cristina Linares^{1,2,3,*}, Rafel Coma¹, David Diaz², Mikel Zabala³, Bernat Hereu³, Luís Dantart⁴

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PLOS ONE

RESEARCH ARTICLE

Global Warming and Mass Mortalities of Benthic Invertebrates in the Mediterranean Sea

Irene Rivetti^{1*}, Simonetta Fraschetti¹, Piero Lionello^{1,2}, Enrico Zambianchi³, Ferdinando Boero^{1,2,4}

¹ Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, CoNISMa, Lecce, Italy; ² CMCC Euro-Mediterranean Center on Climate Change, Lecce, Italy; ³ Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, Lecce, Italy; ⁴ Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, Lecce, Italy

Received: 18 February 2022 | Revised: 10 May 2022 | Accepted: 15 May 2022
DOI: 10.1111/gcb.16301

RESEARCH ARTICLE

Marine heatwaves drive recurrent mass mortalities in the Mediterranean Sea

Joaquim Garrabou^{1,2} | Daniel Gómez-Gras^{1,3} | Alba Medrano³ | Carlo Cerrano^{4,5} Massimo Ponti^{6,7} | Robert Schlegel⁸ | Nathaniel Bensoussan^{1,2} | Eva Turicchia^{6,7} Maria Sini⁹ | Vasillis Gerovasilelou^{10,11} | Nuria Teixidó^{8,12} | Alice Mirasole¹² | Laura Tamburello¹² | Emma Cebrian¹³ | Gil Rilov¹⁴ | Jean-Baptiste Ledoux^{1,15} | Jamila Ben Souissi^{16,17} | Faten Khamassi¹⁶ | Raouia Ghanem¹⁷ | Mouloud Benabdi¹⁸ | Samir Grimes¹⁹ | Oscar Ocaña²⁰ | Hocein Bazairi²¹ | Bernat Hereu³ | Cristina Linares³ | Diego Kurt Kersting³ | Graciela Rovira³ | Júlia Ortega³ | David Casals³ | Marta Pagès-Escola³ | Núria Margarit³ | Pol Capdevila²² | Jana Verdura²³ | Alfonso Ramos²⁴ | Andres Izquierdo²⁵ | Carmen Barbera²⁴ | Esther Rubio-Portillo²⁶ | Irene Anton²⁵ | Paula López-Sendino¹ | David Diaz²⁷ | Maite Vázquez-Luis²⁷ | Carlos Duarte^{28,29} Nuria Marbà²⁹ | Eneko Aspilaga²⁹ | Free Espinosa³⁰ | Daniele Grech³¹ | Ivan Guala³¹ | Ernesto Azzurro^{12,32} | Simone Farina³³ | Maria Cristina Gambi³⁴ | Giovanni Chiment^{7,35} | Monica Montefalcone³⁶ | Annalisa Azzola³⁶ | Torcuato Pulido Mantas⁴ | Simonetta Fraschetti^{7,37} | Giulia Ceccherelli³⁸ | Silviya Kipson^{39,40} | Tatjana Bakran-Petricoli⁴⁰ | Donat Petricoli⁴¹ | Carlos Jimenez^{42,43} | Stellos Katsanevakis⁹ | Inci Tuney Kizilkaya⁴⁴ | Zafer Kizilkaya⁴⁵ Stephane Sartoretto⁴⁶ | Rouanet Elodie⁴⁷ | Sandrine Ruitton² | Steve Comeau⁸ | Jean-Pierre Gattuso^{8,48} | Jean-Georges Harmelin⁴⁷

¹ Institut de Ciències del Mar-CSIC, Barcelona, Spain

Climate Change

Touted as a sustainable source of protein, shellfish aquaculture may reach a tipping point by 2050

Aquaculture International (2021) 29:1737–1751
<https://doi.org/10.1007/s10499-021-00713-6>

REVIEWS IN Aquaculture
Reviews in Aquaculture (2021) 13, 504–536
doi: 10.1111/raq.124

Observations on recent mass mortality events of mussels in the Oosterschelde, the Netherlands

Jacob J. Canella, et al. *Full author details at the end of the article*

and hypoxia threaten a valuable scallop fishery: Implications for commercial bivalve ventures in climate change

Maria Byrne

University of Wollongong, New South Wales, Australia

Abstract
Additional supplementary material for this article is available at <https://doi.org/10.1111/raq.124>

Mortality of marine mussels *Mytilus edulis* and *M. galloprovincialis*: systematic literature review of risk factors and recommendations for future research

Coralie Lupo^{1,2}, Stéphanie Bougeard¹, Véronique Le Bihan³, Jean Louis Blin⁴, Gwenhael Allain⁵, Patrick Azéma⁶, Fabienne Benoit⁷, Christian Béchemin⁸, Ismaël Bernard⁹, Philippe Blachier⁹, Léa Briau¹⁰, Morgane Danion¹, Aurélie Garcia¹⁰, Erika Gervasoni¹¹, Philippe Gilze¹², Audrey Laine¹³, Sylvie Lapéque^{2,14}, Cécile Mablouk¹¹, Laurence Poirier¹⁵, Jean Christophe Raymond¹⁶, Michael Treilles⁷, Claire Chauvin¹ and Sophie Le Bouquin¹

¹ Anses, Laboratoire de Ploufragan-Plouzane-Niort, Ploufragan, France

Mass mortality in a population of the mussel *Mytilus edulis* L. Caused by high temperature on rocky shores

Makoto Tsuchiya

A STUDY ON THE MASS MORTALITY OF MUSSELS IN THE LAGUNA VENETA

J. G. Munford, L. DaRos, R. Strada

First published: March 1981 | <https://doi.org/10.1111/j.1749-7345.1981.tb00294.x> | Citations: 10

Received: 25 January 2020 | Accepted: 3 February 2020
DOI: 10.1002/ece3.4349
ORIGINAL RESEARCH | Ecology and Evolution | WILEY

A global assessment of the vulnerability of shellfish aquaculture to climate change and ocean acidification

Phoebe J. Stewart-Sinclair¹ | Kim S. Last¹ | Ben L. Payne² | Thomas A. Wilding¹

Moria di mitili nell'Adriatico a causa del caldo

di Pasquale Raicaldo

Mortalità prossima al 100% nella Costa del Conero, ma il fenomeno sarebbe comune a più aree: tra i principali indiziati le ondate di calore legate al cambiamento climatico. E ora il Cnr lancia un "survey" nazionale coinvolgendo cittadini ed

la Repubblica



Eni con l'Italia

PERCHÉ IL GIORNALE L'AMBA
LE PAROLE PIÙ POTENTI DEL REGIME
QUEI MONOPOLI CHE INSIDIANO LA DEMOCRAZIA

Mass mortalities



Oddfish



Francesco Romeo

Persona più attiva · 4 settembre alle ore 15:07 · 🌐



Anche nella mia zona, Corigliano-Rossano (CS), stanno capitando numerosi avvistamenti di cerniette con occhi opachi, comportamento apatico, spesso con movimenti scordinati, macchie sul corpo e testa e, non di rado, alcune già morte sul fondo. Potrebbe essere encefalo retinopatia virale? C'è qualche ittiopatologo interessato al caso? Si può fare qualcosa?

Vi allego un video dell'ultima cernietta bruna che mi è capitata in questi giorni, potrebbe essere allo stadio iniziale d... **Altro...**



0:02 / 0:30



Visualizza insight

Copertura del post: 2006 >

INVASION HOTSPOT



1011 NIS

748 established

1901



THE HATEFUL EIGHT

- Fistularia commersonii*
- Lagocephalus sceleratus*
- Pterois miles*
- Stephanolepis diaspros*
- Siganus luridus*
- Siganus rivulatus*
- Upeneus moluccensis*
- Upeneus pori*

ORMEF Occurrence Records of Mediterranean Exotic Fishes
Geo Portal



Cite this article: Albano PG *et al.* 2021 Native biodiversity collapse in the eastern Mediterranean. *Proc. R. Soc. B* **288**: 20202469. <https://doi.org/10.1098/rsob.2020.2469>

Received: 5 October 2020

Native biodiversity collapse in the eastern Mediterranean

Paolo G. Albano¹, Jan Steger¹, Marija Bošnjak^{1,2}, Beata Dunne¹, Zara Guifarro¹, Elina Turapova¹, Quan Hua³, Darrell S. Kaufman⁴, Gil Rilov⁵ and Martin Zuschin¹

¹Department of Palaeontology, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria
²Croatian Natural History Museum, Demetrova 1, Zagreb, Croatia
³Australian Nuclear Science and Technology Organisation, Kirrawee DC, New South Wales 2232, Australia
⁴School of Earth and Sustainability, Northern Arizona University, Flagstaff, AZ 86011, USA
⁵National Institute of Oceanography, Israel Oceanographic and Limnological Research (IOLR), Haifa 3108001, Israel

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www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN Collapse of the echinoid *Paracentrotus lividus* populations in the Eastern Mediterranean—result of climate change?

Received: 20 March 2015
 Accepted: 06 July 2015
 Published: 28 August 2015

Erez Yeruham¹, Gil Rilov², Muki Shpigel³ & Avigdor Abelson¹

The European purple sea urchin (*Paracentrotus lividus*) is considered to be a key herbivore throughout its distribution range—North-East Atlantic and Mediterranean Sea. It was also abundant in its eastern distributional edge, on rocky habitats of the coastline of Israel, but its populations have recently collapsed, and today it is an extremely rare species in the region. Field and laboratory experiments,

marine ecology

SHORT COMMUNICATION Full Access
A mass mortality of subtropical intertidal populations of the sea urchin *Paracentrotus lividus*: analysis of potential links with environmental conditions

Dominique Girard, Sabrina Clemente, Kilian Toledo-Guedes, Alberto Brito, José Carlos Hernández
 First published: 11 October 2011 | <https://doi.org/10.1111/j.1439-0485.2011.00491.x> | Citations: 46
 Dominique Girard, Departamento Biología Animal (Ciencias Marinas), Facultad de Biología, Universidad de La Laguna, C/ Astrofísico Francisco Sánchez s/n 38206 La Laguna, Tenerife, Canary Islands, Spain.

E-mail: dgirard@ull.es

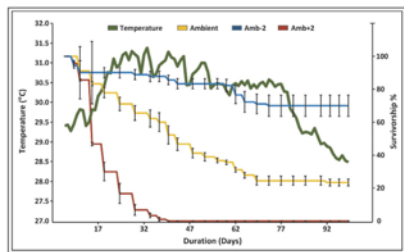


Figure 2. Effects of seawater temperature on urchin survivorship in the lab. Ambient (thick brown line) and sea urchin average \pm SE percent survival rate (among five aquaria per treatment) during the experiment (summer 2012), in the three treatments: AMBIENT -2°C (blue line), AMBIENT (green line) and AMBIENT $+2^{\circ}\text{C}$ (red line).

UNDERWATER DESERTS

Overfishing of predators, outbreaks of grazers, and global warming can have devastating effects on marine ecosystems. This happens when rich algal forests are replaced by underwater deserts dominated by encrusting organisms.



- ABOUT 90% OF THE SHALLOW NATIVE MOLLUSCS IN THE EASTERN MEDITERRANEAN ARE LOST.
- UNDERWATER DESERTS ARE CALLED 'BARRENS'.
- OVER CERTAIN THRESHOLDS RESTORATION IS NOT ACHIEVABLE.

When restoration is not achievable, biodiversity loss is only counteracted by invasive species.

#underwaterdeserts

MPAs goal

30% Protected Ocean by 2030 #30x30

In response to the Kunming-Montreal Global Biodiversity Framework, the European Union (EU) and the Mediterranean Action Plan (UNEP/MAP), which is the main framework for regional cooperation under the Barcelona Convention, is committed to a number of actions that align with the targets, including the "30x30" goal to protect 30% of the world's terrestrial, inland water, coastal, and marine areas by 2030.

Global



Convention on
Biological Diversity

Mediterranean



United Nations
Environment Programme



Mediterranean Action Plan
Barcelona Convention



The Mediterranean
Biodiversity
Centre

European



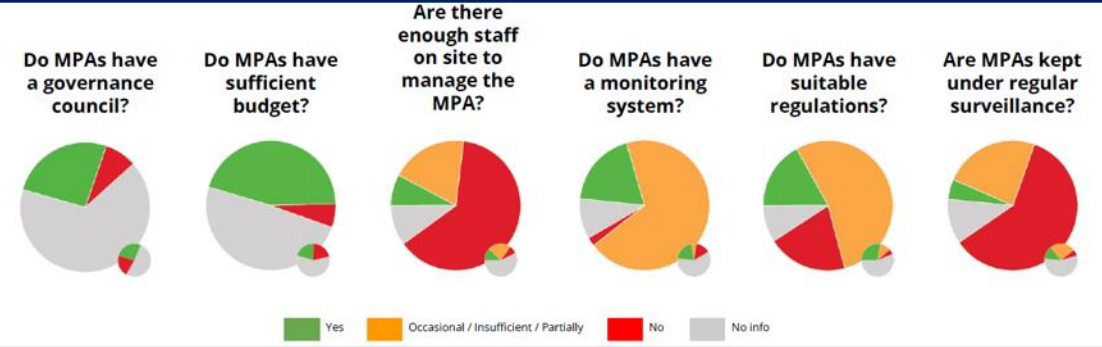
A protection hot spot but...

The system of **Mediterranean Marine Protected Areas** in 2020



Massive work ahead till 2030!!

Deficient MPAs management effectiveness





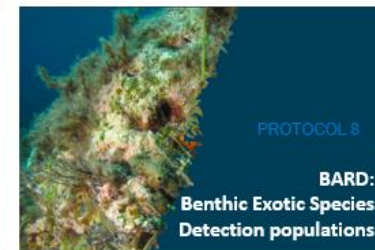
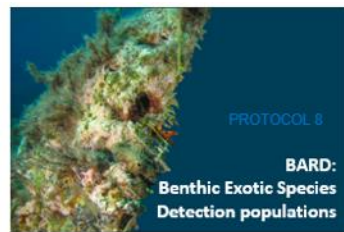
Contribution to assess climate change effects and impacts

1. Temperature

2. Range shift of alien / temperature sensitive species

3. Episodic events

4. Phenology changes



SUPPORT MPAs
MANAGEMENT FACE TO
CLIMATE CHANGE AND BEYOND

BUILD BASELINES

Reconstruct HISTORICAL CHANGES



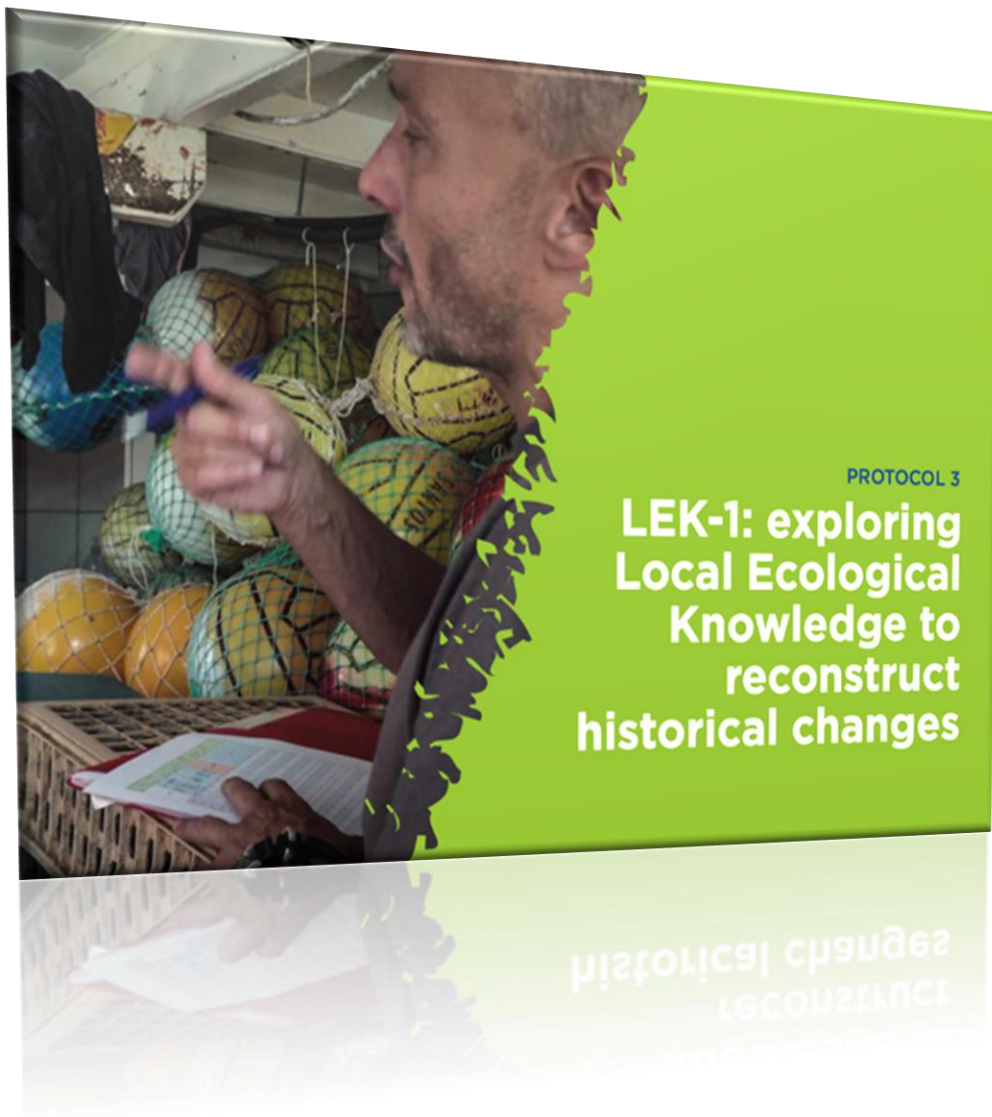
TRACK CHANGES

Build TIME SERIES



MPA at WORK





TOOLKITS AVAILABLE

Not just protocols

Freely accessible at:
<https://mpa-engage.interreg-med.eu>

OUR TRAINING MATERIAL



Webinar presentation here!



The excel file where to input the data-
 DATA_LEK_1.xls

Interview sheet to be printed -
 Questionnaire LEK-1



Video Webinar!

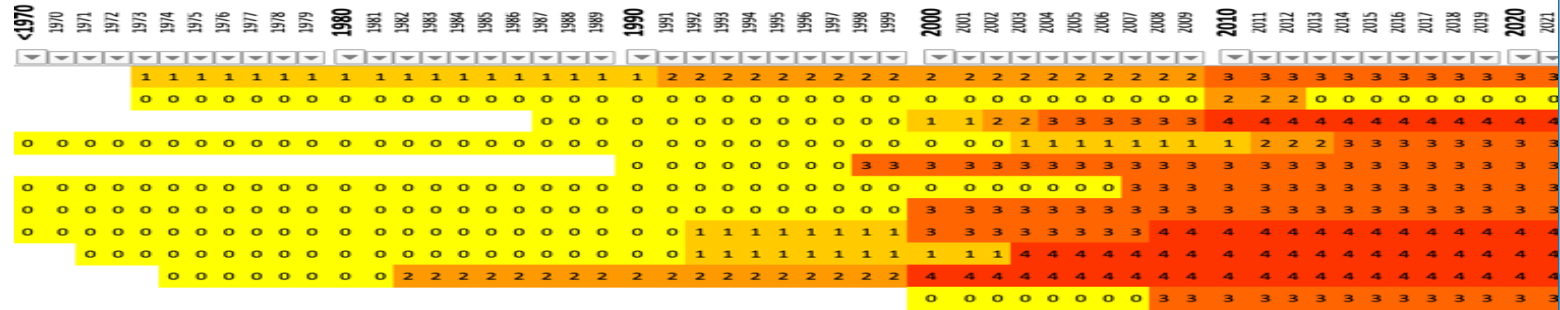
Video Tutorial!

Our video documentary -Trailer

Our video documentary -Episode 1

Our video documentary -Episode 2

SUPPORTING the ENTIRE PROCESS



KNOW HOW

SAMPLING

DATABASE

INDICATORS

DATA analysis

ASSESSMENT



MONITORING

INTERPRETATION

MANAGEMENT advices

01 Vulnerability assessment

Guidance and tools to assess the MPAs' ecological and socio-economic vulnerability to climate change



02 Citizen science

Protocols on how to engage local communities in citizen science activities to monitor the climate change effects and impacts in MPAs



03 Adaptation and mitigation plans

Guidance for planning actions to elaborate climate change adaptation and mitigation plans.



04 Participatory approaches

Guidance on how to apply the Quintuple Helix Participatory Approach for engaging and mobilizing all the key actors



Advisors



Technicians



Trainers



Monitoring protocols 05

Standardised Monitoring Protocols for assessing climate change effects and impacts in MPAs across the Mediterranean and beyond



Scientific support 06

Support for scientific elaboration of data collected during the toolkits implementation



Fund raising 07

Guidance for elaborating fund raising strategies for supporting climate change monitoring, adaptation and mitigation in MPAs



Communication 08

A compendium of resources to support the design and implementation of climate change adaptation, mitigation and restoration plans in MPAs



HELP

The MPA4Change Roster to help MPAs

A pool of experts and advisors specialized in Climate Change (CC) and MPAs. This roster will provide MPAs with access to the necessary expertise to design, develop, and implement Climate Change adaptation action plans.

“100MPAx30 Challenge”

The system of Mediterranean Marine Protected Areas in 2020



8.33 % Share 1

Surface under protection status
209,361 km² / 1,087 officially designated Marine Protected Areas (MPAs) including:
 - 257 MPAs with a national statute (1.88 %)
 - Including the Coasts and Marine Parks Concord in the Mediterranean (Spain, 1.84 %)
 - 107 marine Natura 2000 sites (1.17 %)
 - 1000 Secondary MPAs (0.48 %)
 (France, Italy, Monaco, 0.86 %)

0.04 % Share 2

Cumulative surface of no-go, no-take or no-fishing areas

97.33 % Share 1

Share of the total Mediterranean surface under designation located in the European Union member countries waters

18 % Share 1

Share of MPAs that confirmed having a management plan implemented (10 % fully implemented, 8 % partially implemented, 7 % not implemented or inconsistent, 75 % not reported)

+ 2 points

Overall net gain in the percentage of surface under designation between the end of 2016 and the end of 2019*, including:
 - 23 MPAs with a national statute (10,409 km² added)
 - 340 marine Natura 2000 sites (13,832 km² added)
*2019 data not available for Cyprus and Monaco

Perspectives

The international conservation community is calling to conserve 30% of sea areas through well-connected systems of protected areas and OECMs by 2030.
 The post-2020 MPAs Forum Roadmap aims to support the global and regional efforts towards achieving the 2030 goals.

OECMs

OECMs (Other Effective Conservation Measures) are conservation approaches offering the opportunity to manage the same conservation values as protected areas, but where they are of a different nature, form, or function. OECMs are therefore to be complementary and well-connected conservation systems to the Mediterranean, a number of which should be implemented, including through the use of the concept of OECMs, when they comply with the TED criteria previously defined by Decision 2010/197 of the International Maritime Organization and the same Decision Areas (DAs) (DAs 1 and 2) of the Eastern Mediterranean Conservation Strategy for the Mediterranean OECMs may also be identified.

*An initiative for OECMs was adopted during COP14 of the Convention on Biological Diversity in November 2010.



An insight into management

Managers from 152 nationally designated Mediterranean MPAs shared their experience via an online survey in 2019. Data about various aspects of their management were collected to assess if conditions are favourable for MPAs to ensure an effective management. The trends in these data are shown here in pie charts.



100 MPAs by 2030 have implemented Climate Change adaptation plans across the Mediterranean

~1300 MPAs
 ~ 7% of world MPAs

Mediterranean a protection hot spot

THANK YOU
for your attention!

