



World Organisation
for Animal Health
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CReDiMa
CENTRO
Centro di Referenza Nazionale per le
Indagini Diagnostiche sui Mammiferi marini spiaggiati

Emerging biological threats for cetaceans in the Mediterranean Sea

Cristina Casalone

30th Conference of the Regional Commission for Europe
Seminar “Impact of environmental and climate changes on Marine Mammals health”
Catania, Sicily, Italy, 3 - 7 October 2022



“

We have taken the ocean for granted, and today we face what I would call an “Ocean Emergency”

At the [UN Ocean Conference](#) in Lisbon, UN Secretary-General **António Guterres** urged the international community to commit and unite around the protection of our seas; highlighting that **the ocean connects us all** and is **essential to life on our planet and to our future**.

We reaffirm that **climate change is one of the greatest challenges of our time**. We are deeply alarmed by the adverse effects of climate change on the ocean and marine life.



“Our ocean, our future, our responsibility: call for action”

- **Generate the scientific knowledge** and supporting infrastructures and partnerships needed for sustainable development of the ocean.
- **Provide ocean science, data and information** to inform policies for a well-functioning ocean in support of all sustainable development goals of 2030 Agenda.

The Science We Need for the Ocean We Want



The United Nations
Decade of Ocean Science
for Sustainable Development
(2021-2030)



30th Conference of the Regional Commission for Europe
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Aquatic Animal Health Strategy



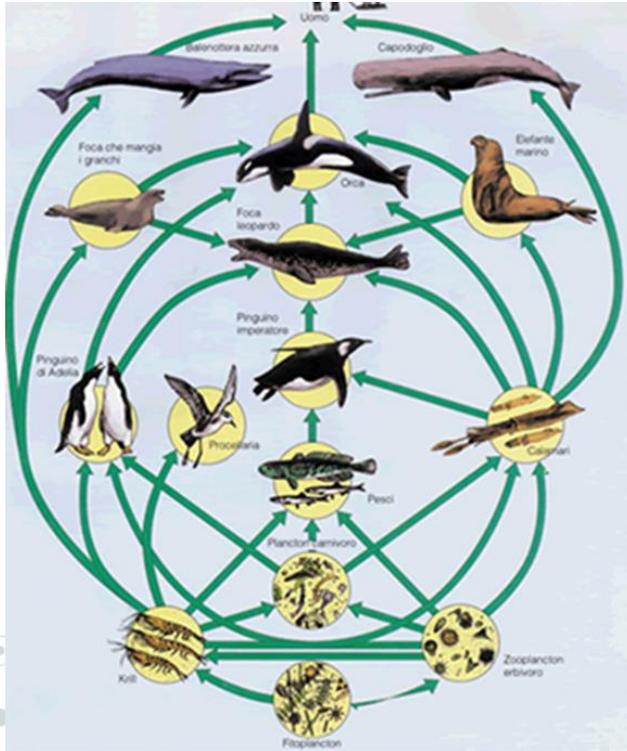
World Organisation
for Animal Health
Founded as OIE

In 2021, the World Organisation for Animal Health (WOAH) launched its global **Aquatic Animal Health Strategy**: an ambitious call to action to improve the sustainability of aquatic animal health systems.



As the **emergence of new diseases is likely to continue**, driven by factors such as climate change, unsustainable farming practices or unregulated trade, careful management of the health of aquatic animals is crucial. **Most of these diseases severely impact the aquatic animal production sector, but also the open ecosystems in which these populations often live.**

Why are these species so important for the environment and for us?



Marine Mammals are sentinels for the health of the Mediterranean

They are physiologically close to humans and at the top of the trophic chain which makes them an early **indicator of effects caused by toxic environmental contaminants**

They are **susceptible to terrestrial pathogens** that are contaminating the marine environment and which also affects humans



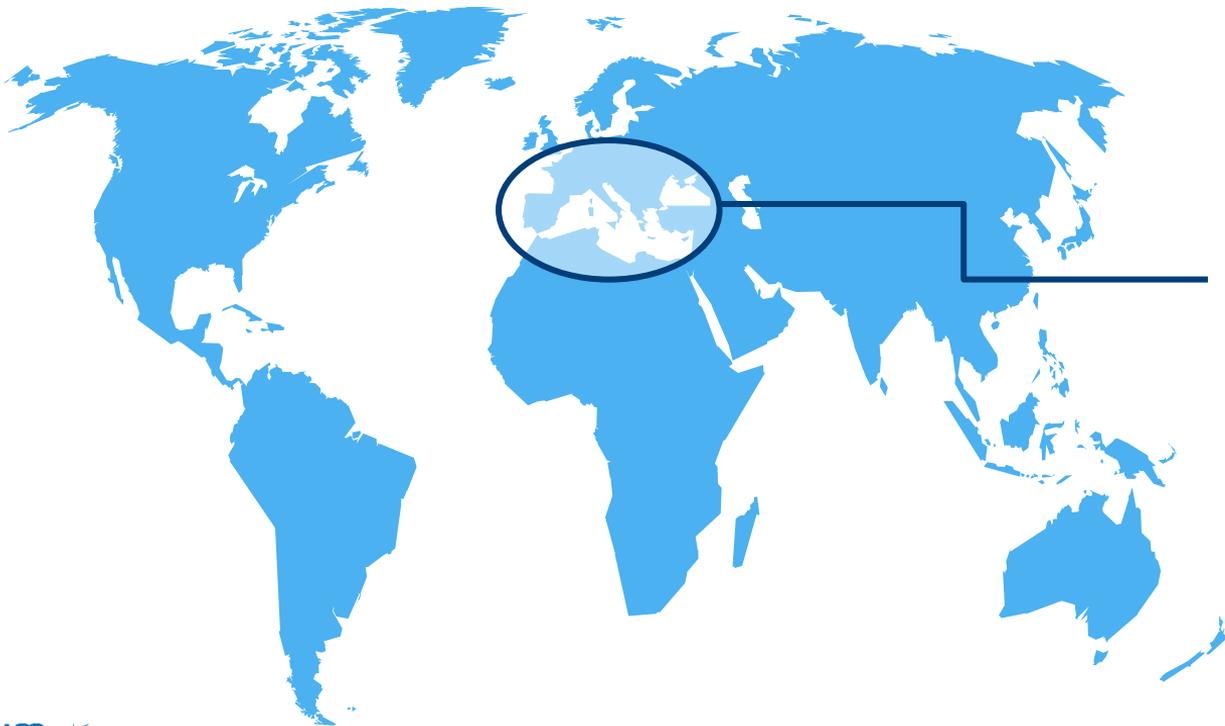
WOAH Collaborating Center for “Marine Mammal Health”

87th OIE General Meeting,
Paris, 2019

Establishment of the WOAH
Collaborating Centre for Marine
Mammal Health.



Mediterranean sea



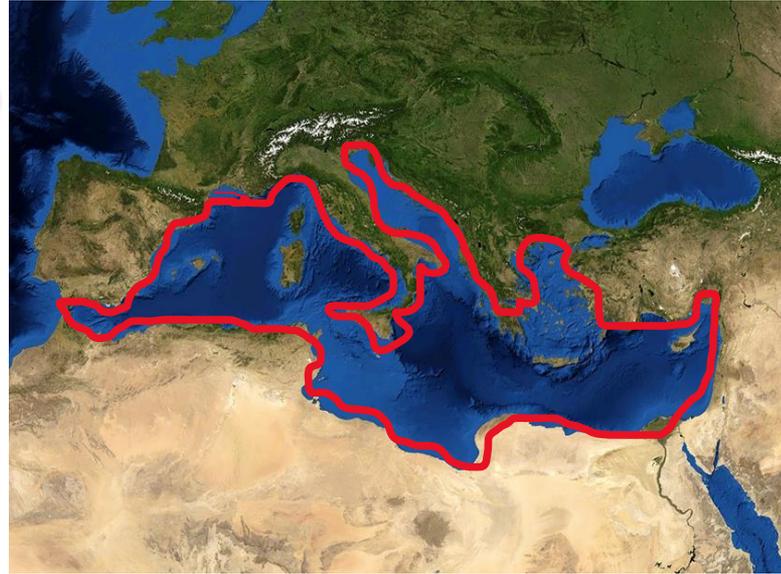
**biodiversity
hotspot**

30th Conference of the Regional Commission for Europe
Seminar "Impact of environmental and climate changes on Marine Mammals health"
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Impact of anthropic activities is proportionally stronger than in any other basin

the largest enclosed sea on earth

surrounded by a heavily populated and industrialized coastline



important biodiversity hot-spot

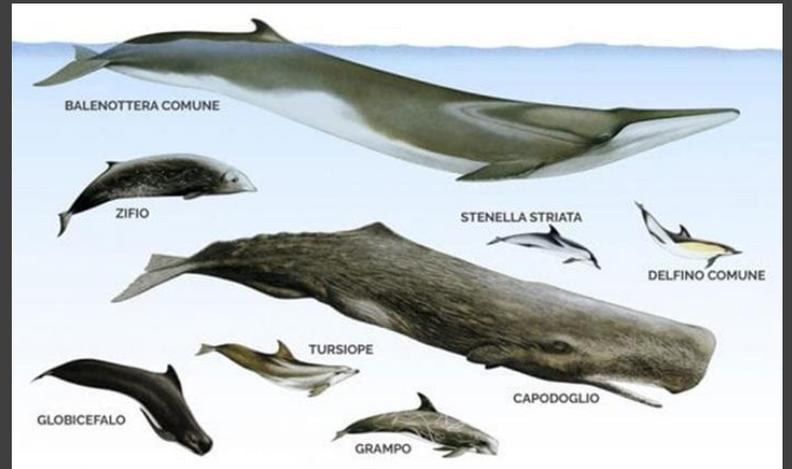
one of the busiest navigation crossroads and top tourist destinations in the world

**CONTEXT:
THE MEDITERRANEAN SEA**

Mediterranean is home to several species of marine mammals

two are now classified as “**endangered**” (*Physeter macrocephalus* and *Balaenoptera physalus*)

one as “**vulnerable**” (*Ziphius cavirostris*) by the IUCN Red List Categories.



C.Re.Di.Ma

Center for Diagnostic activities in stranded marine mammals

The Italian II.ZZ.SS network for the diagnosis of stranded marine mammals

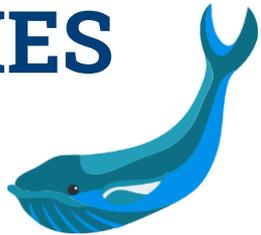


CReDiMa

Centro di Riferenza Nazionale per le Indagini Diagnostiche sui Mammiferi marini spiaggiati



OUR ACTIVITIES



1. Necropsy and sampling



2. Laboratory analysis



Report anno 2020

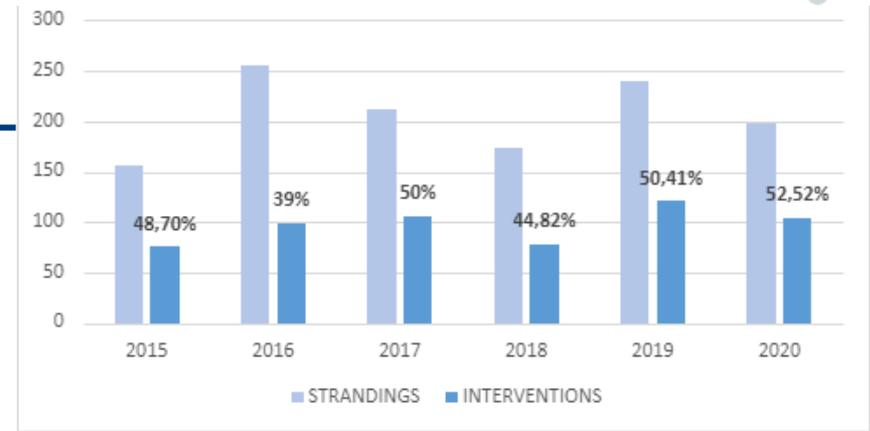
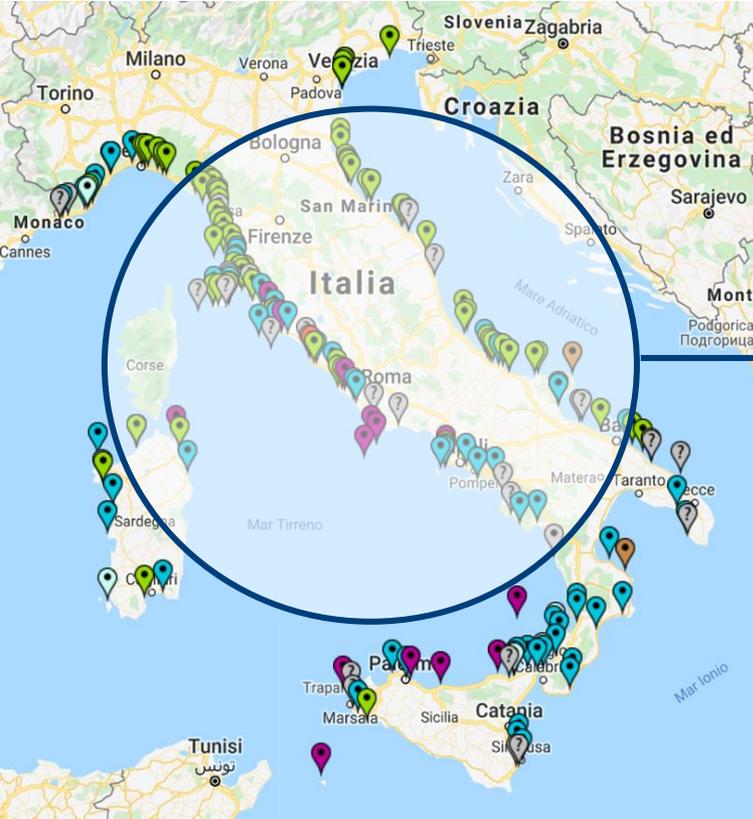
Rilievi diagnostici post mortem nei cetacei spiaggiati in Italia



3. Reporting activities



Our activity results

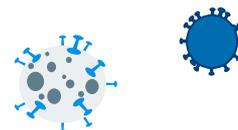
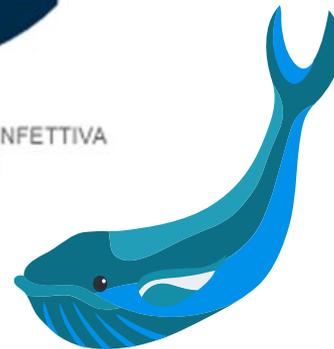
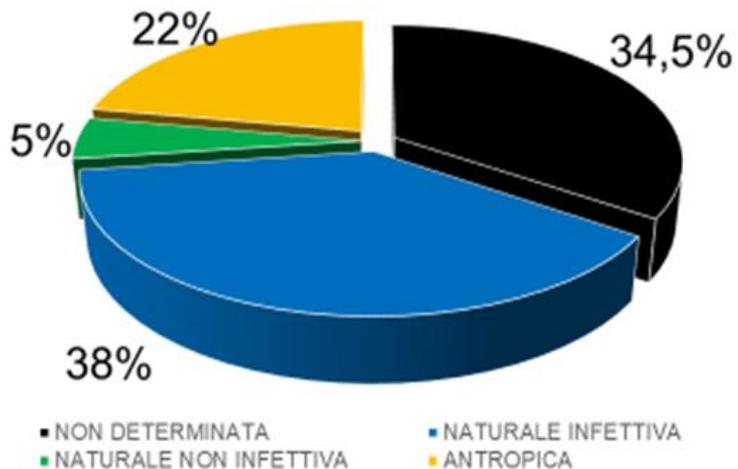


Every year, along the Italian coastline there are about 150-200 strandings, among them our network gets to examine about half of them (39% - 52%).

Our activity results



- 🔍 *Dolphin Morbillivirus*
- 🔍 *Herpesvirus*
- 🔍 *Toxoplasma gondii*
- 🔍 *Salmonella thyphimurium*
- 🔍 *Salmonella enteritidis*
- 🔍 *Brucella ceti*
- 🔍 *Listeria monocytogenes*
- 🔍 *Erysipelothrix rhusiopathiae*



Threats to marine biodiversity

**Climate
change**

**Infectious biological
agents**

By-catch

Marine litter

Ship strike

Noise pollution

Toxicological stress

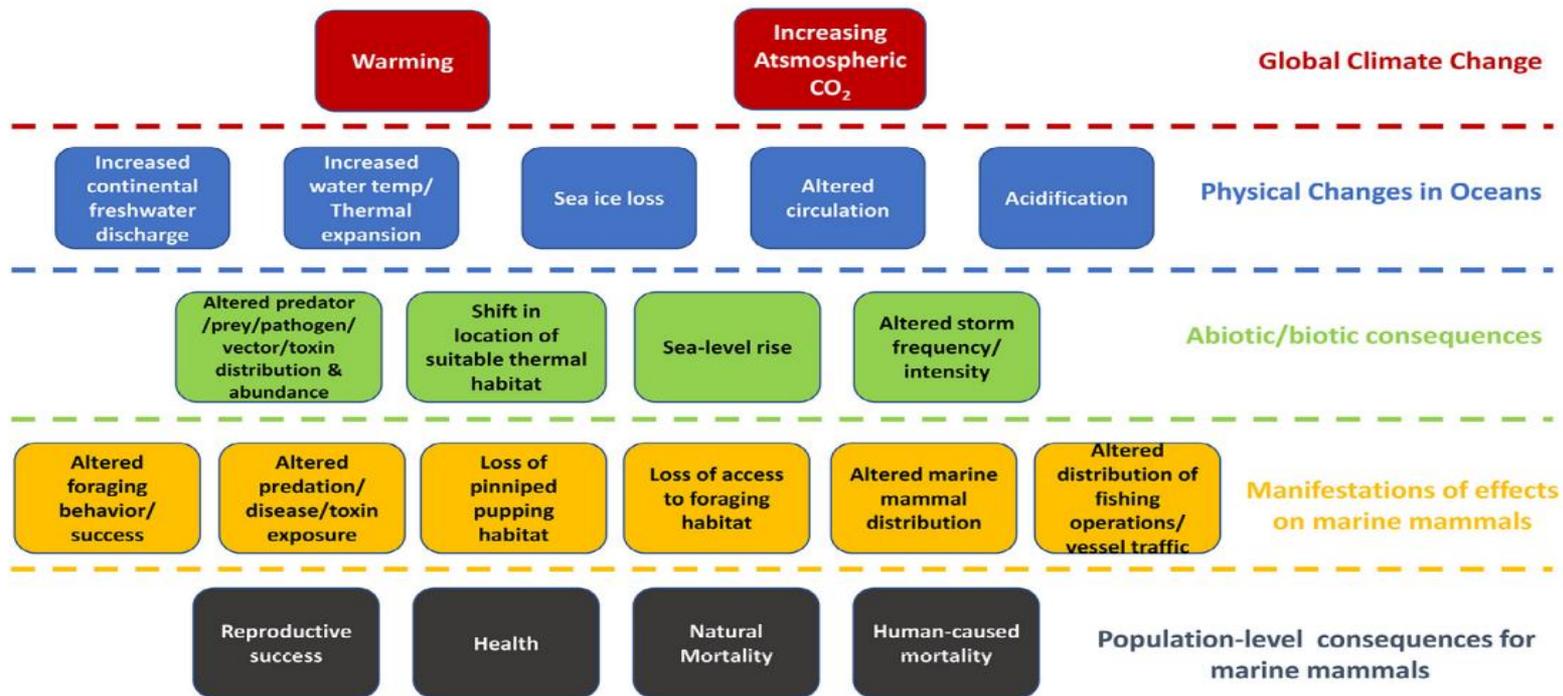
The world's seas and oceans have never been more impacted by human activities than they are today.



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GENOVA

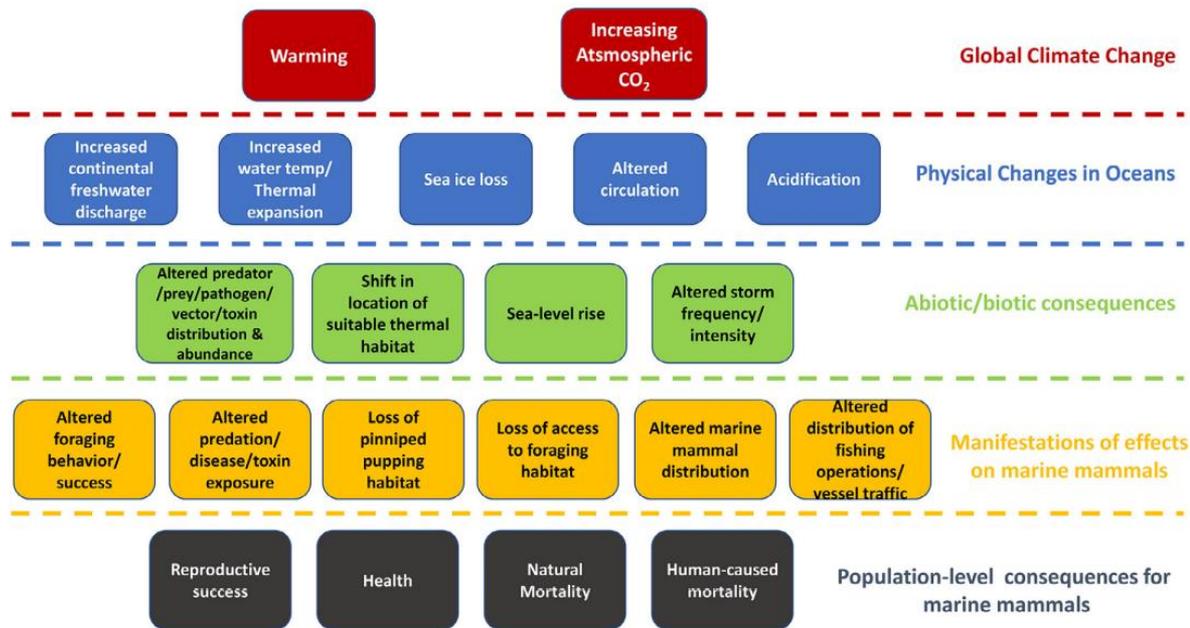
Centro di Riferenza Nazionale per le
Indagini Diagnostiche sui Diagnostici marini sospetti

How is climate change affecting marine ecosystem?



F.M.D. Gulland, J.D. Baker, M. Howe et al., 2022

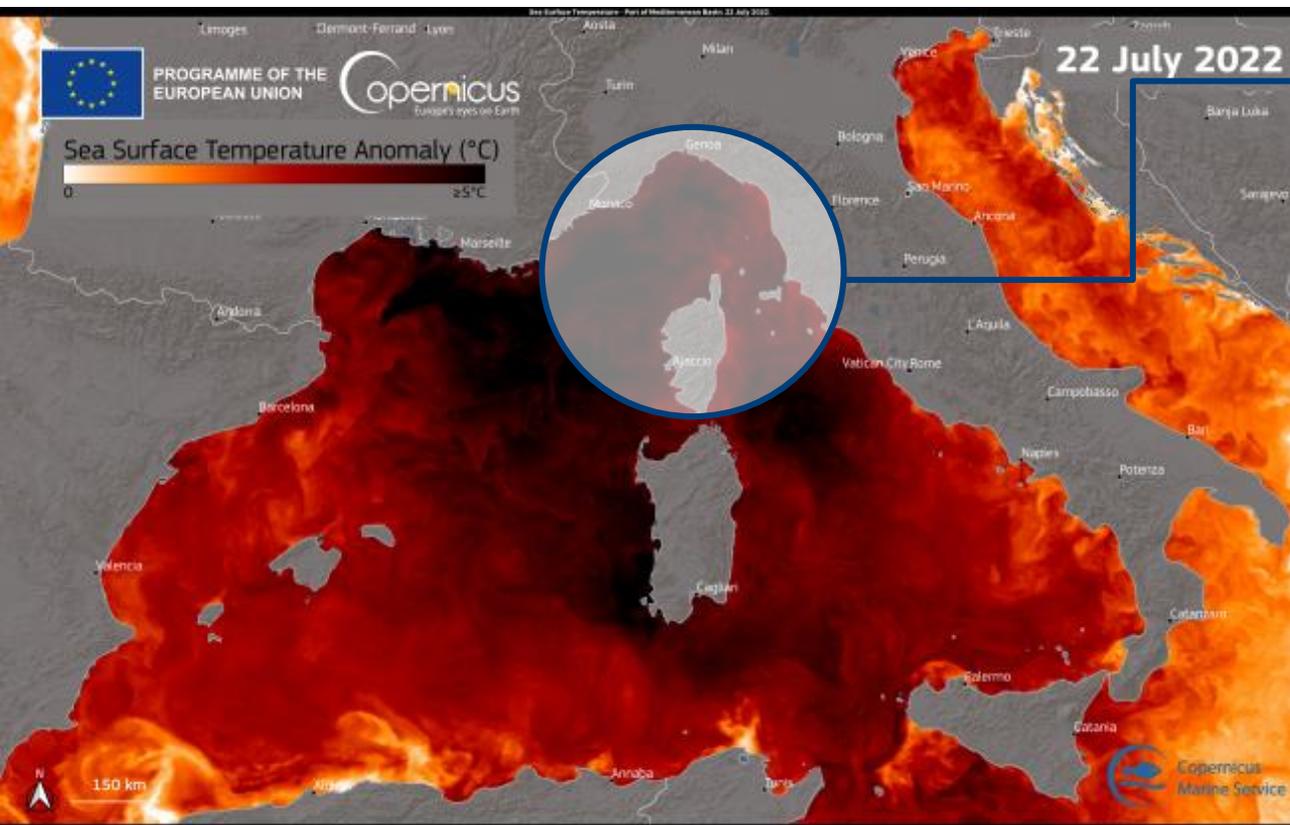
How is climate change affecting marine ecosystem?



These interactions of mechanism are very complex and unfortunately important data are still missing to better understand the interaction between climate change and MM

F.M.D. Gulland, J.D. Baker, M. Howe et al., 2022

Extreme climatic events: record breaking temperatures in the Mediterranean sea



**Pelagos Sanctuary
area**



The Sea Surface Temperature (SST) anomaly recorded on 22 July 2022, data show **up to +5°C** persisting along the coasts of France and Italy.

Credit: European Union, Copernicus Marine Environment Monitoring Service. July 22.

Extreme climatic events: flood events in the Mediterranean sea



Pelagos Sanctuary area



Flood events in recent years cause mud and debris to be washed into the sea by river floods.



wastewaters from human
and animal sources



wastewaters from
ships and boats

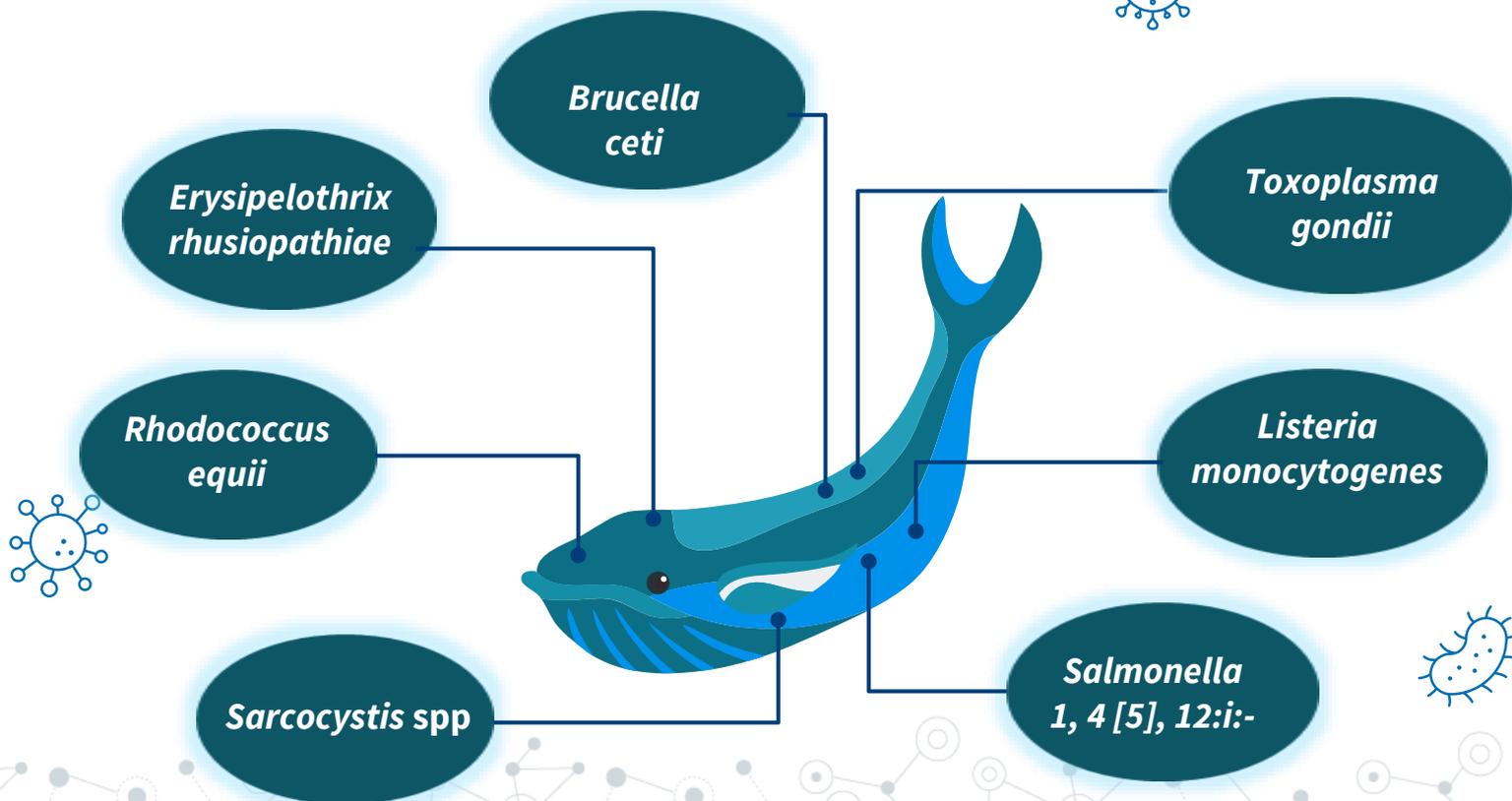


RISK OF MARINE MAMMALS CONTRACTING INFECTIOUS AGENTS FROM WASTEWATERS.

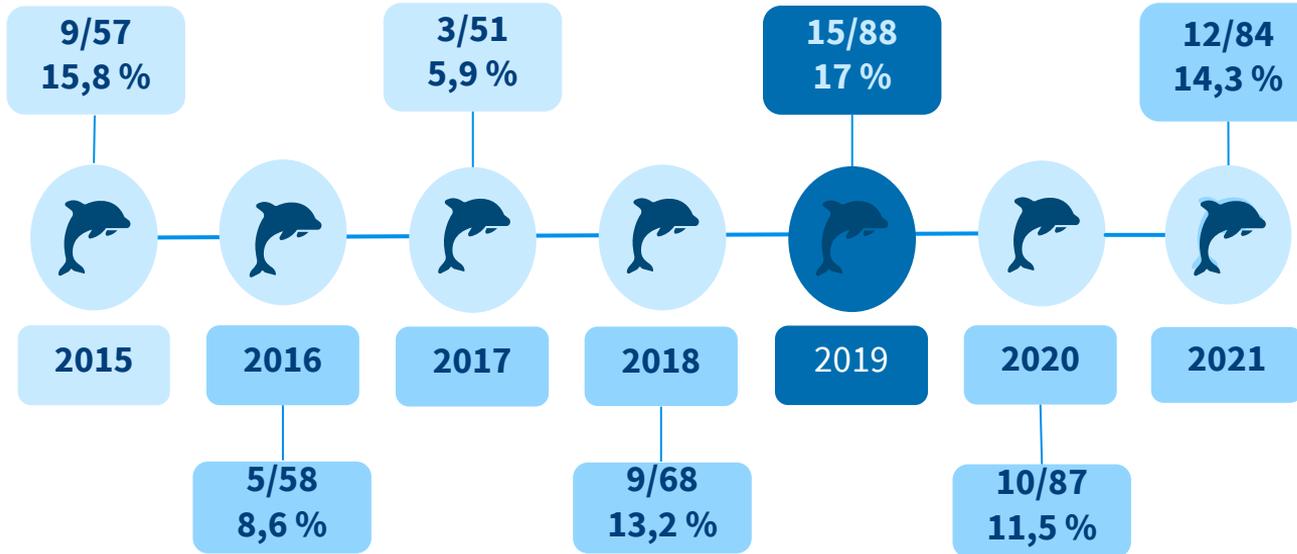
Climate change plays an
important role:

rainfalls, storms, floods
landslides increase the risk
of developing disease

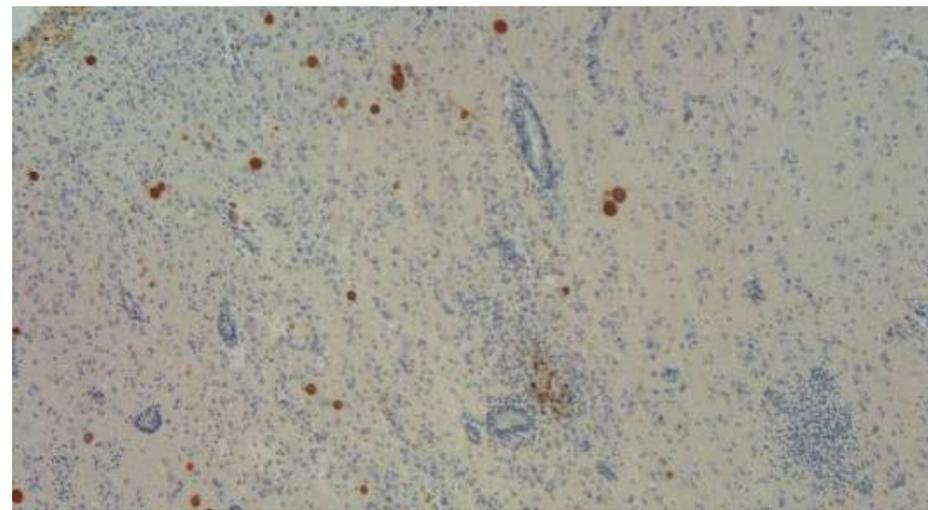
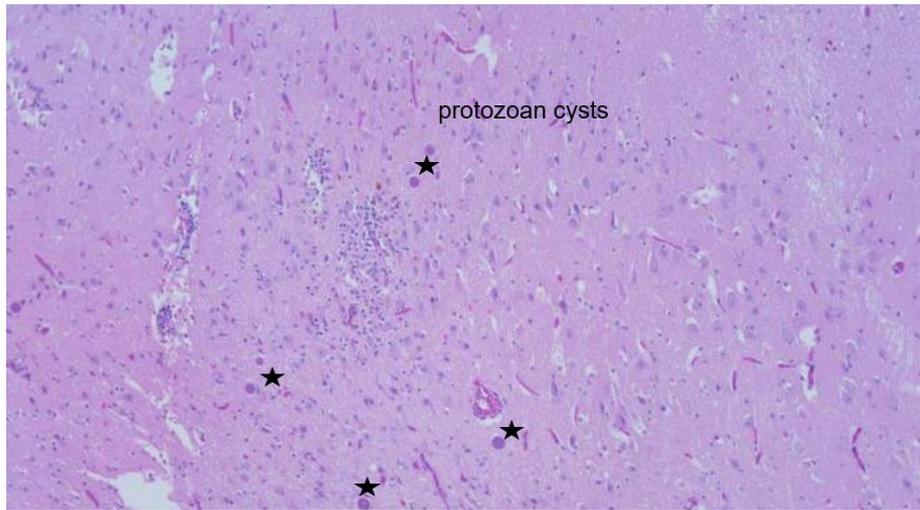
Emerging pathogens in the Mediterranean from land to sea



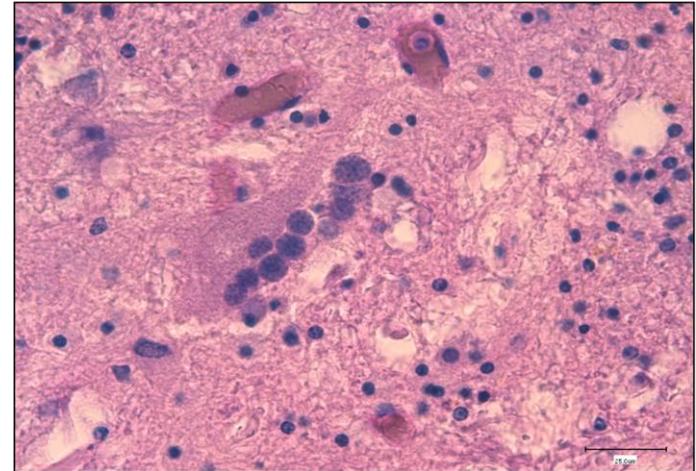
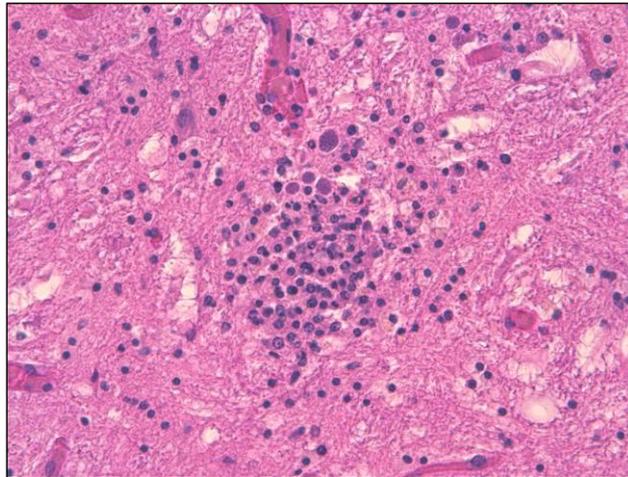
Toxoplasma gondii



Map of positive cases, positive animals stranded particularly in the Pelagos Sanctuary, south Tyrrhenian sea and Adriatic sea.

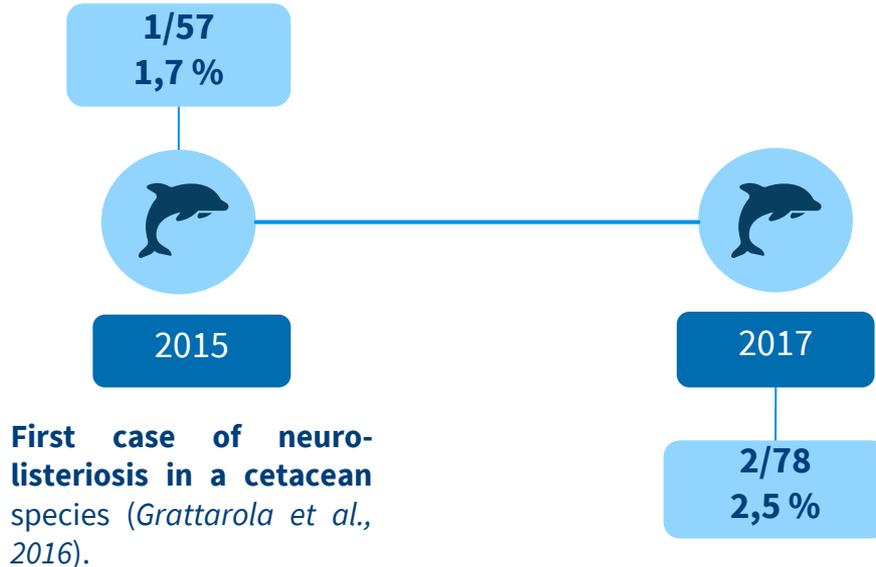


Toxoplasma gondii



Pintore et al., 2018; Grattarola et al. 2016

Listeria monocytogenes

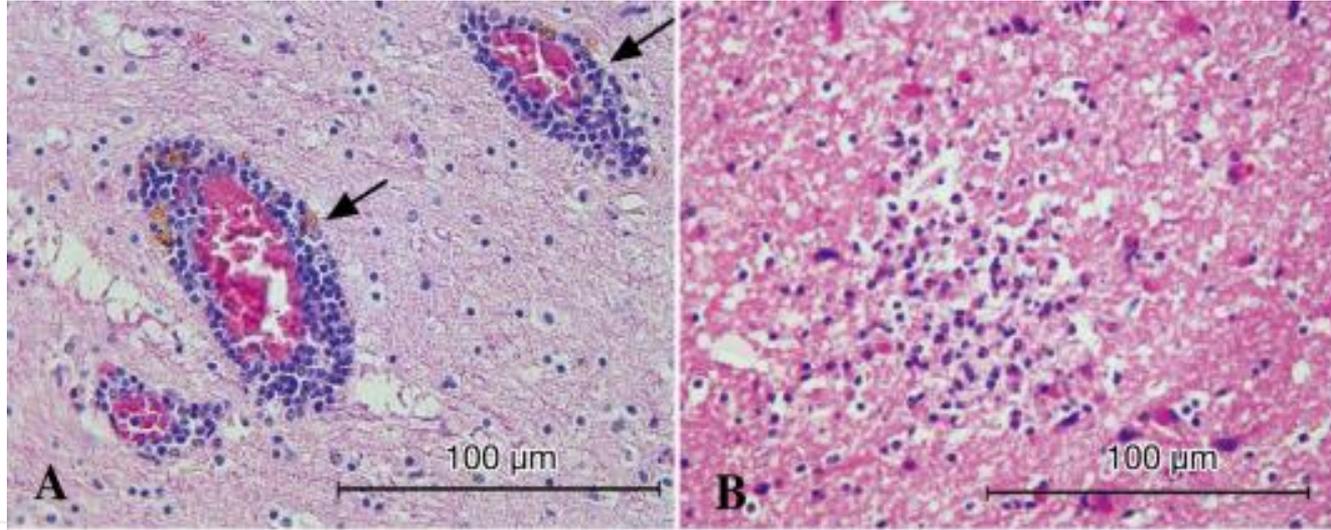


A. Map of positive cases, all animals stranded in the Pelagos Sanctuary along the Ligurian and Tuscan coastline.

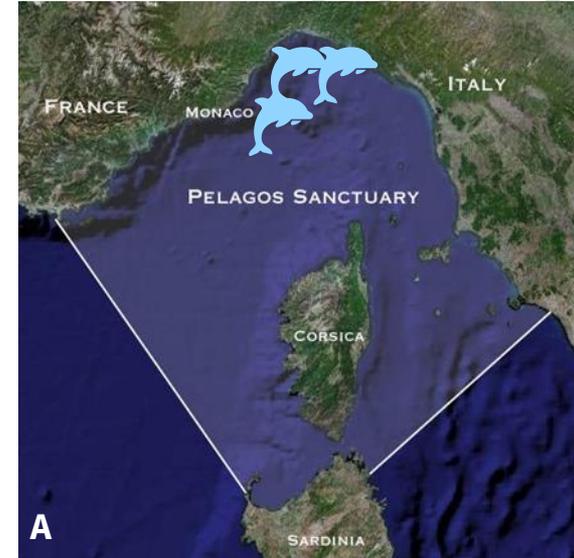
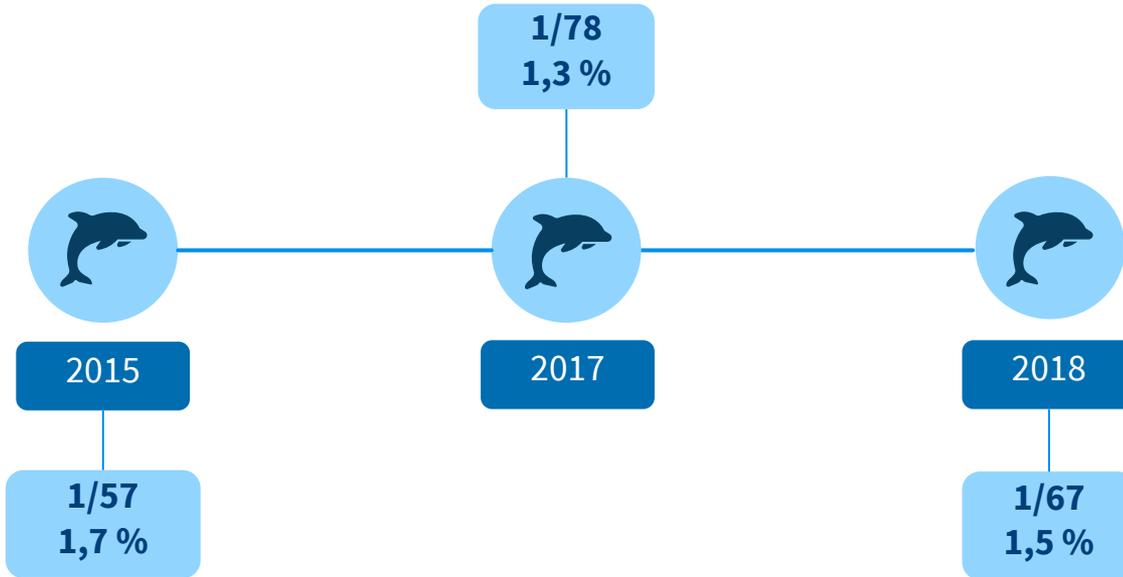


Meningoencephalitis and *Listeria monocytogenes*, *Toxoplasma gondii* and *Brucella* spp. coinfection in a dolphin in Italy

Carla Grattarola¹, Federica Giorda¹, Barbara Iulini¹, Maria Domenica Pintore¹,
Alessandra Pautasso¹, Simona Zoppi¹, Maria Goria¹, Angelo Romano¹,
Simone Peletto¹, Katia Varello¹, Fulvio Garibaldi², Giuliano Garofolo³,
Cristina Esmeralda Di Francesco⁴, Letizia Marsili⁵, Elena Bozzetta¹,
Giovanni Di Guardo⁴, Alessandro Dondo¹, Walter Mignone⁶, Cristina Casalone^{1,*}



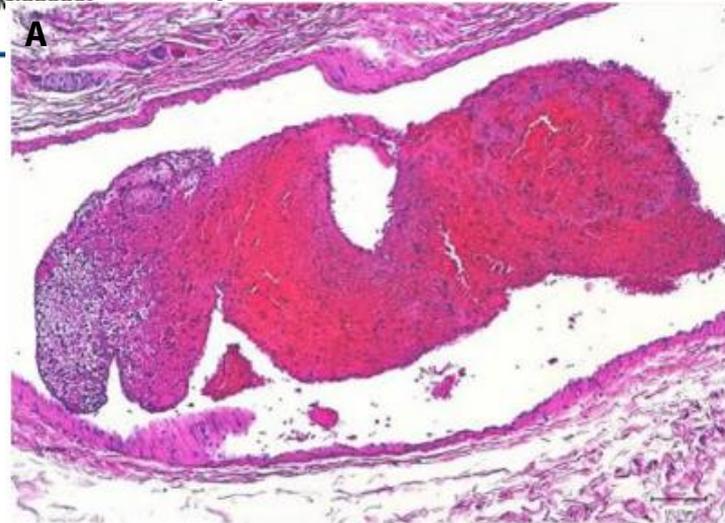
Salmonella 1, 4 [5], 12:i: (*Typhimurium monophasic variant*)



A. Map of positive cases, all animals stranded in the Pelagos Sanctuary along the Ligurian coastline.

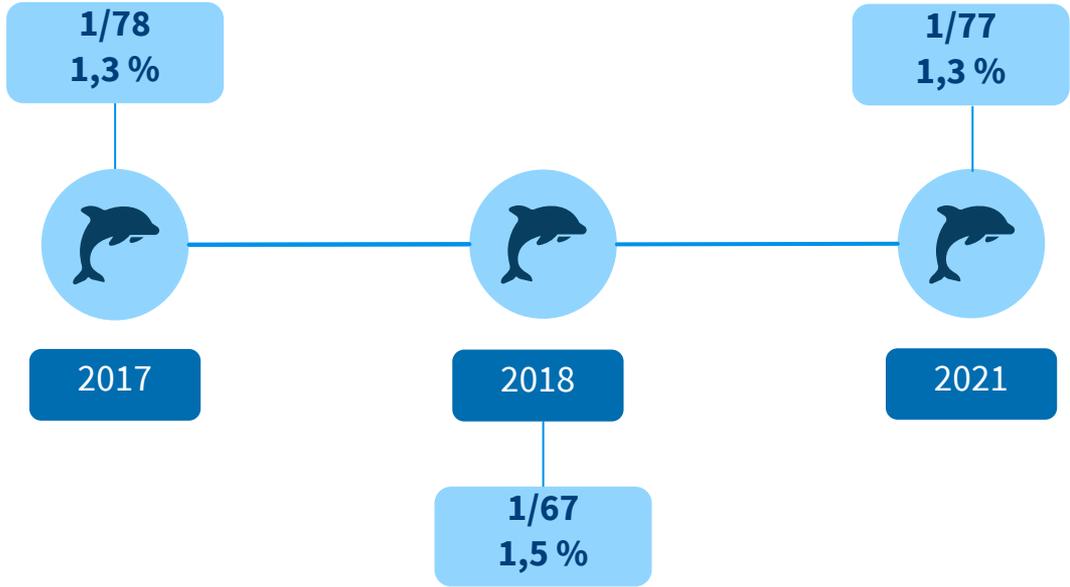
First report of *Salmonella* 1,4,[5],12:i:- in free-ranging striped dolphins (*Stenella coeruleoalba*), Italy

C. Grattarola¹, S. Gallina¹, F. Giorda^{1,2}, A. Pautasso¹, M. Ballardini¹, B. Iulini¹, K. Varello¹,
M. Gorla¹, S. Peletto¹, L. Masoero¹, L. Serracca¹, A. Romano¹, A. Dondo¹, S. Zoppi¹,
F. Garibaldi³, F. E. Scaglione⁴, L. Marsili⁵, G. Di Guardo⁶, A. A. Lettini⁷, W. M. ...¹
A. Fernandez² & C. Casalone¹



A. Striped dolphin, Intestinal mesentery. A large embolus is clearly shown inside the lumen of a blood vessel. 20x H&E.

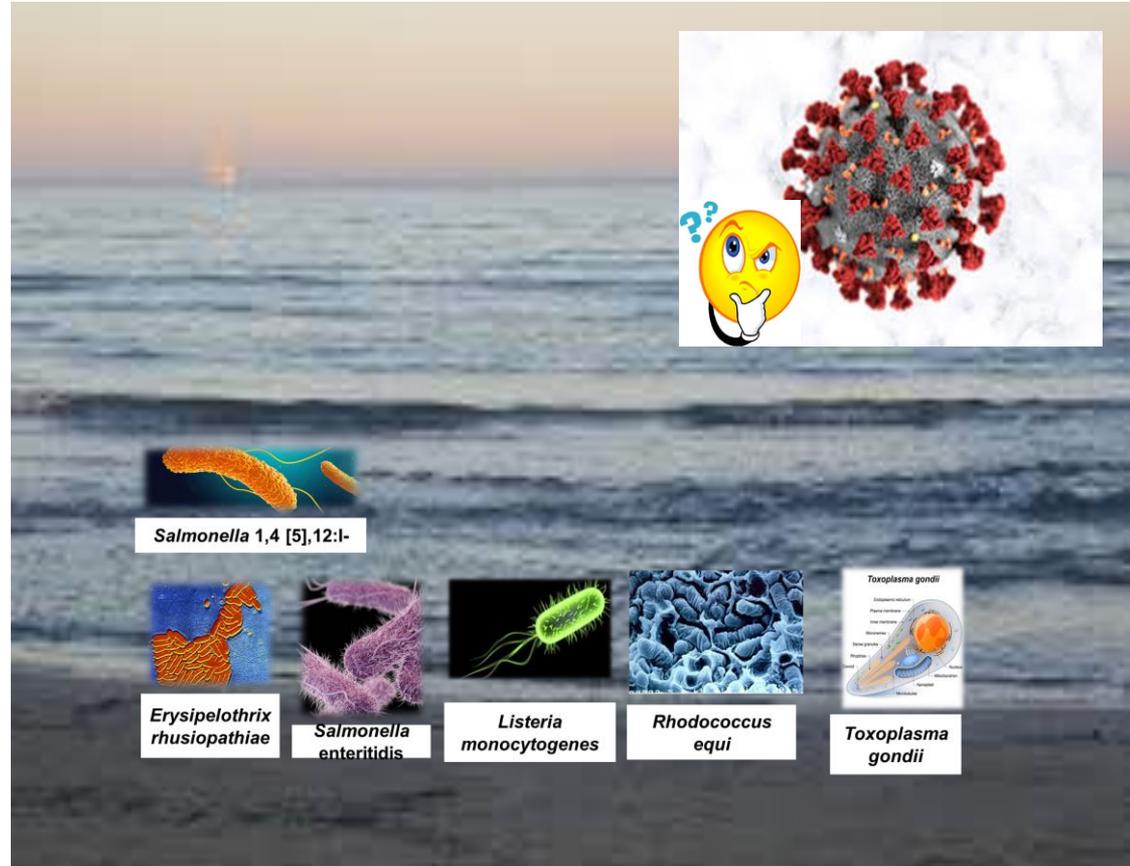
Erysipelotrix rhusiopathiae

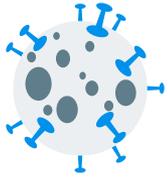


A. Map of positive cases. **B.** Bottlenose dolphin, Calabria 2017, multiple foci of skin necrosis.

THE ITALIAN SEAWATERS

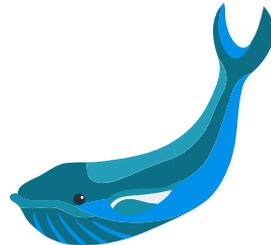
Infectious diseases
caused by agents
of terrestrial origin





Survey on the potential viral susceptibility in cetaceans stranded along the Italian coastline

- Analysis of the susceptibility of Mediterranean marine mammal species to SARS-CoV-2
- Identification of high-risk areas for SARS-CoV-2 viral spillover in Italy
- Evaluation of ACE-2 protein expression in lung tissue of cetaceans





Article
SARS-CoV-2, a Threat to Marine Mammals? A Study from Italian Seawaters

Tania Audino ¹, Carla Grattarola ¹, Cinzia Centelleghé ², Simone Peletto ¹, Federica Giorda ^{1,3}, Caterina Lucia Florio ¹, Maria Caramelli ¹, Elena Bozzetta ¹, Sandro Mazzariol ², Giovanni Di Guardo ⁴, Giancarlo Lauriano ^{5,*} and Cristina Casalone ^{1,*}

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² Department of Comparative Biomedicine and Food Science, University of Padua, Legnaro, 35020 Padua, Italy; cinzia.centelleghé@unipd.it (C.C.); sandro.mazzariol@unipd.it (S.M.)
³ Institute for Animal Health and Food Safety (IUSA), Veterinary School, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, 35416 Canary Islands, Spain
⁴ Faculty of Veterinary Medicine, University of Teramo, Strada Provinciale 18 Località Piano d'Aceto, 64100 Teramo, Italy; gdiuardo@unite.it
⁵ Italian National Institute for Environmental Protection and Research (ISPRA), via Vitaliano Brancati 60, 00144 Rome, Italy
* Correspondence: giancarlo.lauriano@isprambiente.it (G.L.); cristina.casalone@izsto.it (C.C.); Tel.: +39-06-50074762 (G.L.); +39-011-2686296 (C.C.)

 **check for updates**

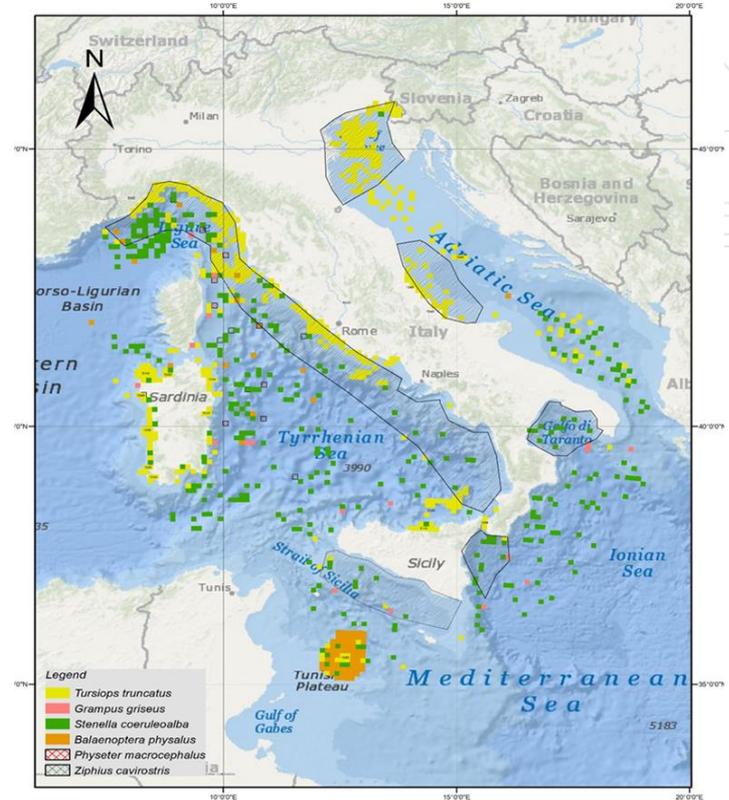
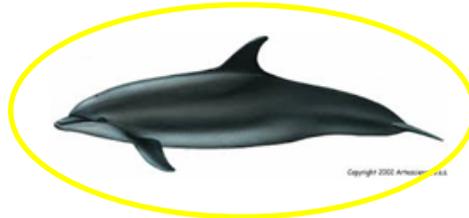
Citation: Audino, T.; Grattarola, C.; Centelleghé, C.; Peletto, S.; Giorda, F.; Florio, C.L.; Caramelli, M.; Bozzetta, E.; Mazzariol, S.; Di Guardo, G.; et al. SARS-CoV-2, a Threat to Marine Mammals? A Study from Italian Seawaters. *Animals* **2021**, *11*, 1663. <https://doi.org/10.3390/ani11061663>

Simple Summary: Growing concern exists that SARS-CoV-2, as has already been ascertained for its SARS-CoV and MERS-CoV “predecessors”, originated from an animal “reservoir”, thereafter spilling over into mankind, possibly anticipated by a viral “passage” into a secondary animal host. Within the dramatic SARS-CoV-2 pandemic context, hitherto characterized by over 110 million cases and almost 2,500,000 deaths on a global scale, several domestic and wild animal species have been reported as being susceptible to natural and/or experimental SARS-CoV-2 infection. In this respect, while some marine mammal species are deemed as potentially susceptible to SARS-CoV-2 infection on the basis of the sequence homology of their ACE-2 viral receptor with the human one, this study addresses this critical issue in stranded sea mammal specimens.



Analysis of the susceptibility of Mediterranean marine mammal species to SARS-Cov-2

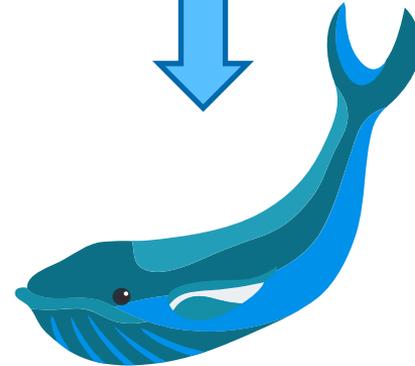
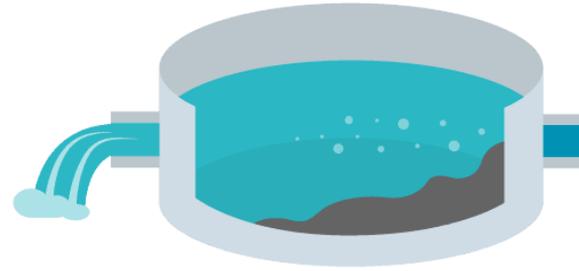
- Bottlenose Dolphin (yellow) and Striped Dolphin (green) are predicted to be potential highly susceptible to the virus
- In particular, in-shore species like Bottlenose dolphin risk of acquiring Sars-CoV2 appears to be greater than off-shore species



Identification of high-risk areas for SARS-Cov-2 viral spillover in Italy

Through the assessment of the potential viral infection level of water bodies entering the sea.

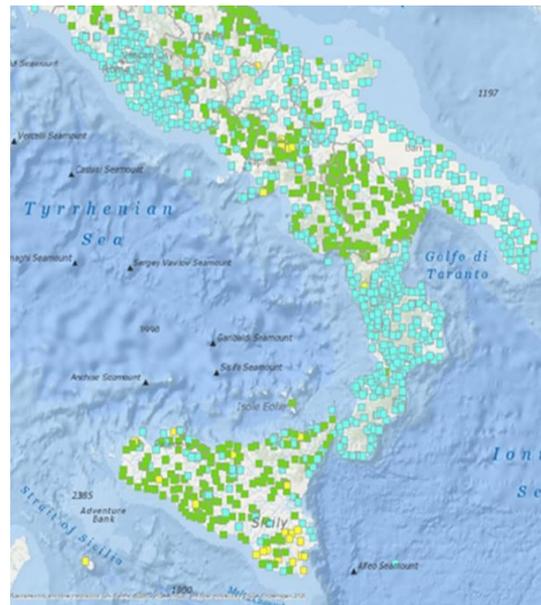
- **First step:** check of quality sewage treatment procedures and location of Italian wastewaters plants.
- **Second step:** check of coastal areas more exposed to rainfalls, storms, floods and landslides.





Identification of high-risk areas for SARS-Cov-2 viral spillover in Italy

- First step: check of quality sewage treatment procedures and location of Italian wastewaters plants.



Reference: **urban wastewater treatment maps on European Environmental Agency thematic page** (focus on Italy, UWWTS maps) (<https://www.eea.europa.eu/themes/water/european-waters/water-use-and-environmental-pressures/uwwtd>). Data reported in 2020

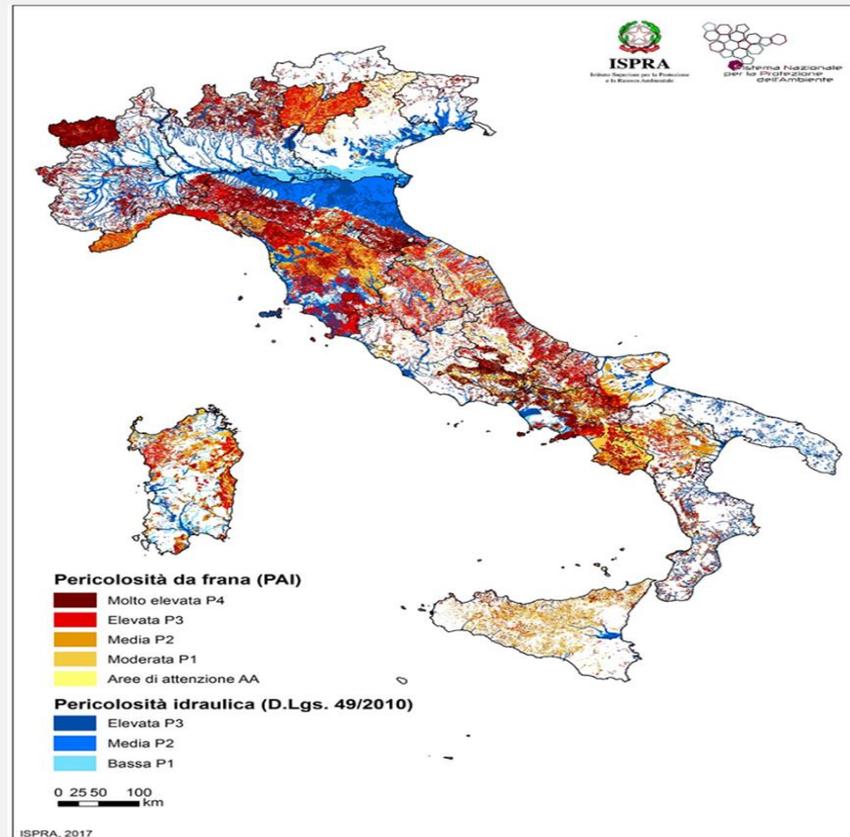


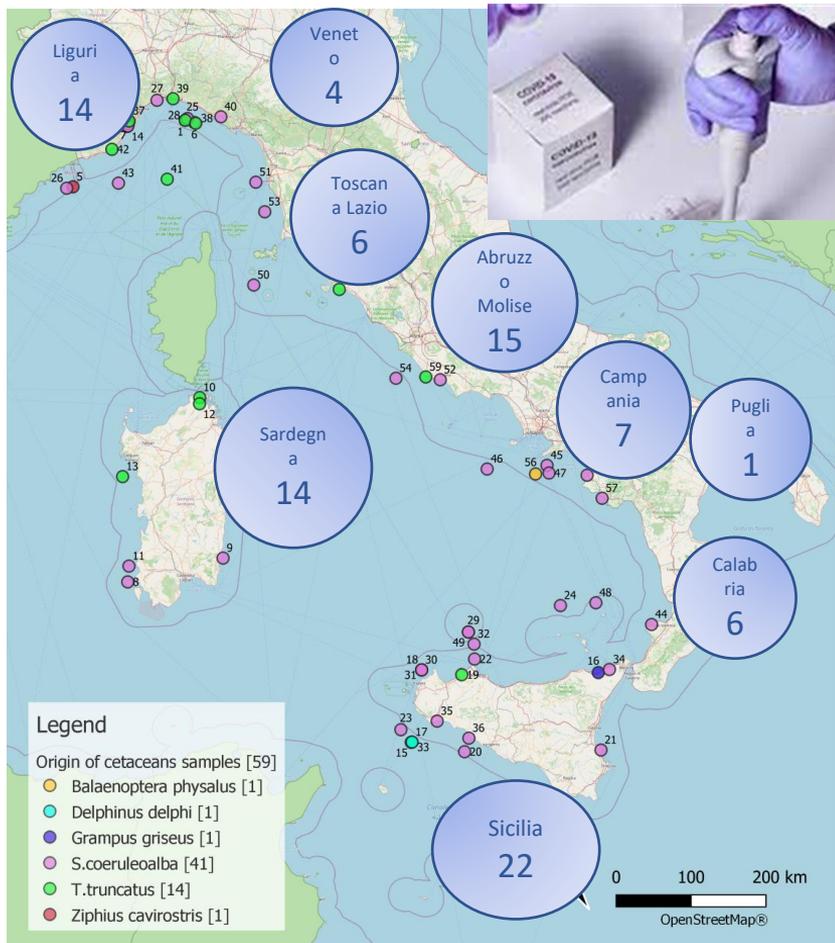
CReDiMa
GENOVA

Centro di Riferenza Nazionale per le
Indagini Diagnostiche sui Mammiferi marini spiaggiati

Identification of high-risk areas for SARS-Cov-2 viral spillover in Italy

II° step
check of coastal areas more exposed to rainfalls, storms, floods and landslides





Sars-Cov-2 PCR and IHC investigations on stranded cetaceans in 2020-2022



Article

Potential SARS-CoV-2 Susceptibility of Cetaceans Stranded along the Italian Coastline

Tania Audino ¹, Elena Berrone ¹, Carla Grattarola ¹, Federica Giorda ¹, Virginia Mattioda ¹, Walter Martelli ¹, Antonio Pintore ², Giuliana Terracciano ¹, Cristiano Cocumelli ³, Giuseppe Lucifora ⁴, Fabio Di Nocera ⁴, Gabriella Di Francesco ⁵, Ludovica Di Renzo ⁵, Silva Rubini ⁶, Stefano Gavaudan ⁷, Anna Toffan ⁸, Roberto Puleio ⁹, Dashzeveg Bold ¹⁰, Francesco Brunelli ¹¹, Maria Goria ¹, Antonio Petrella ¹¹, Maria Caramelli ¹, Cristiano Corona ¹, Sandro Mazzariol ¹², Juergen A. Richt ¹³ and Giovanni Di Guardo ¹³ and Cristina Casalone ^{13,14*}

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² Istituto Zooprofilattico Sperimentale della Sardegna, 07100 Sassari, Italy

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⁴ Istituto Zooprofilattico Sperimentale del Mezzogiorno, Portici, 80055 Napoli, Italy

⁵ Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise, 64100 Teramo, Italy

⁶ Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia-Romagna, 44124 Ferrara, Italy

⁷ Istituto Zooprofilattico Sperimentale dell'Umbria e delle Marche, 60131 Ancona, Italy

⁸ Istituto Zooprofilattico Sperimentale delle Venezie, 35020 Legnaro, Italy

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¹⁴ Scientific and technical office of REMESA Istituto Zooprofilattico Sperimentale della Sicilia, 90129 Palermo, Italy

* Correspondence: cristina.casalone@iszsto.it

Citation: Audino, T.; Berrone, E.; Grattarola, C.; Giorda, F.; Mattioda, V.; Martelli, W.; Pintore, A.; Terracciano, G.; Cocumelli, C.; Lucifora, G.; et al. Potential SARS-CoV-2 Susceptibility of Cetaceans Stranded along the Italian Coastline. *Pathogens* 2022, 11, 1096. <https://doi.org/10.3390/pathogens11101096>

Academic Editor: Jingfei Wang

Abstract: Due to marine mammals' demonstrated susceptibility to SARS-CoV-2, based upon the homology level of their angiotensin-converting enzyme 2 (ACE2) viral receptor with the human one, alongside the global SARS-CoV-2 occurrence and fecal contamination of the river and marine ecosystems, SARS-CoV-2 infection may be plausibly expected to occur also in cetaceans, with special emphasis on inshore species like bottlenose dolphins (*Tursiops truncatus*). Moreover, based

Despite the potential susceptibility of marine mammals, no SARS CoV-2 positivity was detected.

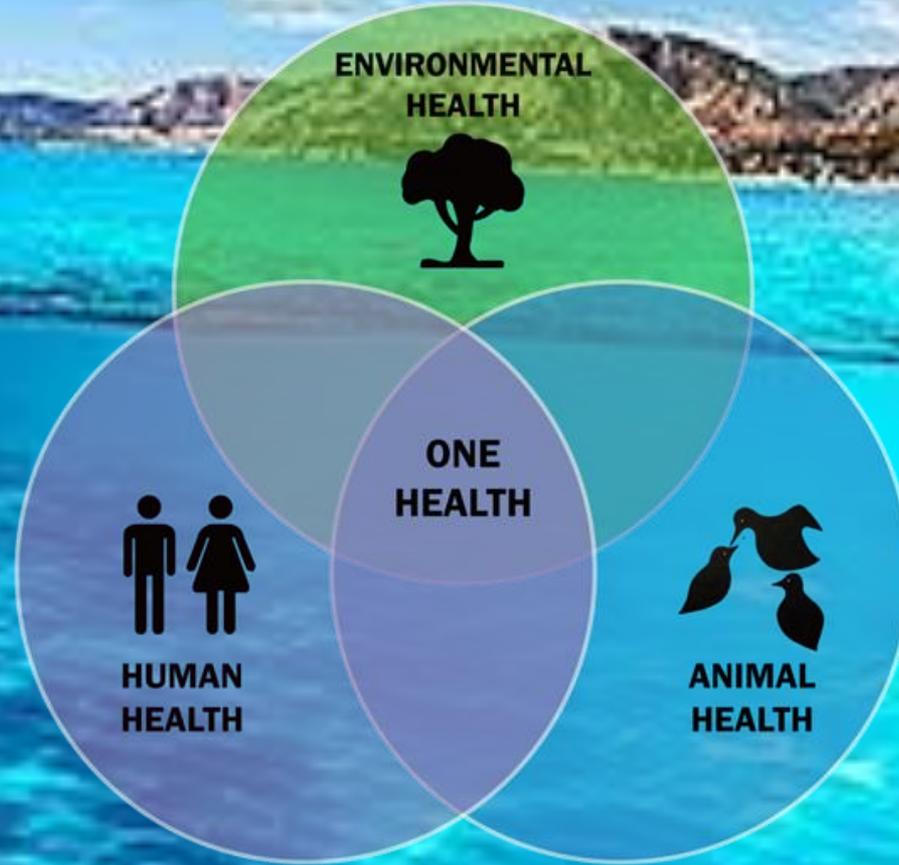
SO WHAT TO DO NOW?

**IMPROVE AND MONITOR WASTEWATER
PURIFICATION TREATMENTS**

**INCREASE SARS-COV-2 AND DIFFERENT PATHOGENS
SURVEILLANCE IN FREE-RANGING CETACEANS**

**DEVELOP EMERGENCY PROTOCOLS TO
FACE EPIDEMICS IN WILDLIFE**

And never as in this context we can talk about...



must work together for a common goal!

The Science We Need for the Ocean We Want



The United Nations
Decade of Ocean Science
for Sustainable Development
(2021-2030)



Once again,

the contribution of the
scientific community is
essential to fill the
knowledge gap between
climate change, human impact
and Marine Mammals
for the Health our sea

The Science We Need for the Ocean We Want



The United Nations
Decade of Ocean Science
for Sustainable Development
(2021-2030)



Once again,

the contribution of the scientific community is essential to fill the knowledge gap in the data on the interaction between climate change Human impact and Marine Mammals for the Health our sea

...but still, we call
governments and global
organizations to act for
the ocean we want!



Join the
movement
for the
Ocean
We Want

The United Nations
Decade of Ocean Science
for Sustainable Development
2021-2030

