14th PROCEEDINGS of the ICZEGAR

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27-30 JUNE 2019
THESSALONIKI, GREECE

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PROCEEDINGS

Climate change adaptive management for the protection of the loggerhead sea turtle in the Mediterranean Sea

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Ensuring effective conservation of marine biodiversity implies that all life cycle stages and related habitats should be protected. Climate change is likely to become the main cause of biodiversity decrease within the next years, with significant impacts on the marine ecosystems' structure and function, and the vulnerability of coastal areas. Particularly for long-range migratory species that depend on a variety of habitats such as sea turtles, climate change is expected to alter the species' ranges and phenology, posing a risk for the effectiveness of applied policies and management measures. The aim is to propose management actions for the long-term protection of the loggerhead sea turtle *Caretta caretta* population in the Mediterranean, suggesting important areas for the species' life cycle in both terrestrial and marine realms, accounting for the dynamics of ecological and climate change risks. Different scenarios were developed using MARXAN spatial prioritization software, and compared based on the present conditions and future impacts from climate change on the life cycle and preferences of sea turtles. The planning exercise attempts to make a substantial contribution towards the development of an integrative methodological framework for the protection of marine biodiversity, highlighting the risks of management actions when neglecting climate change effects. This research is carried out in the context of the project "Systematic conservation planning for biodiversity: developing integrated strategies in a changing planet" (MIS 5005001) under the call for proposals "Supporting researchers with emphasis on new researchers" (EDULLL 34). The project is co-financed by Greece and the European Union (European Social Fund- ESF) by the Operational Programme Human Resources Development, Education and Lifelong Learning 2014-2020.

Keywords: *Caretta caretta*, Systematic Conservation Planning, Marxan, management plan, vulnerability

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Ευρωπαϊκή Ένωση
European Social Fund

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ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

Integrated Conservation Planning (ICP)

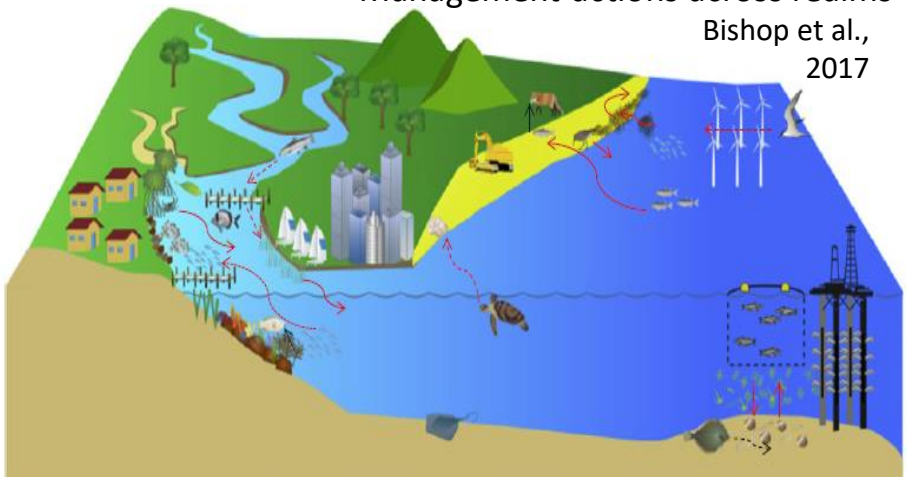
- Connectivity between land and sea have been largely neglected in conservation planning
- Conservation efforts focused in one realm

Thinking beyond the borders of a single-realm planning to secure areas most critical for the long-term protection of biodiversity is imperative

Multi-realm species (i.e. species using habitats in more than one realm during their daily or life cycle; Giakoumi et al., 2019)

Species depending on protection of various realms

Management actions across realms
Bishop et al., 2017



Integrated Conservation Planning (ICP)

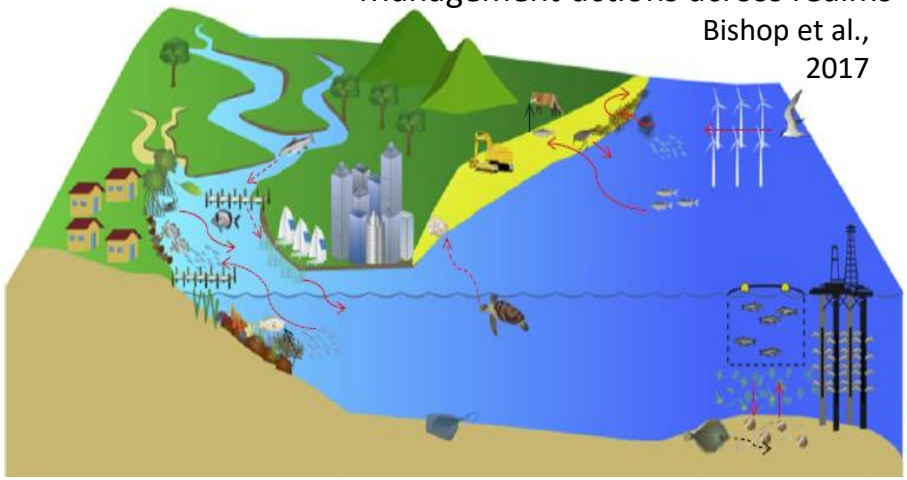
- Maintaining ecological connections among various realms is essential, particularly considering future alternations on species life cycles and habitat loss due to climate change

Climate change models: predict areas more resilient to climate change => prioritization of planning investment

Challenges in ICP in a changing planet…

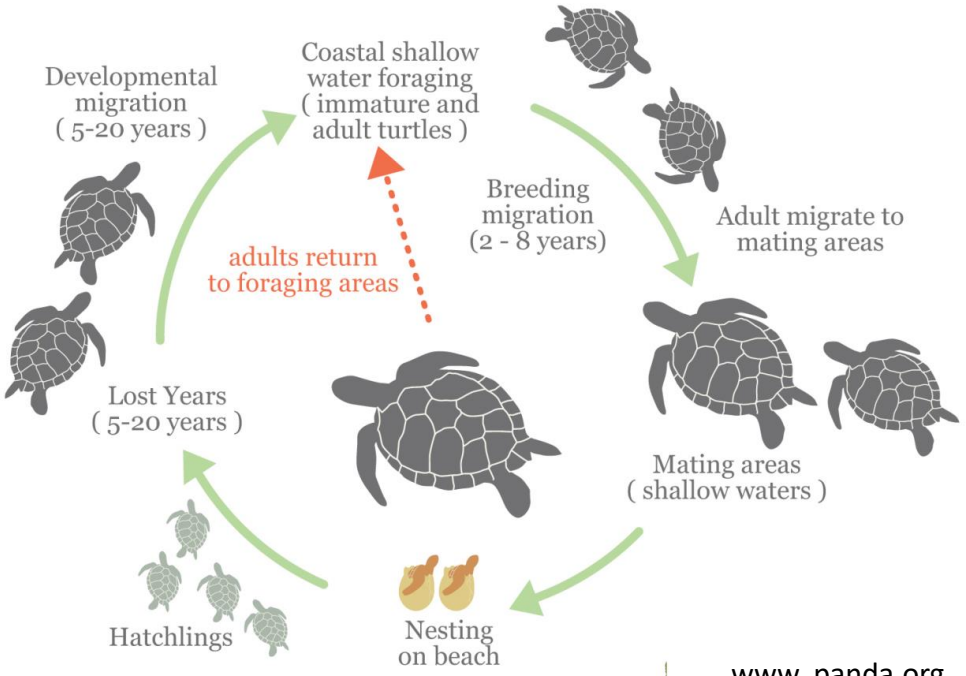
- Lack of understanding
-Lack of information
-Ecosystems' complexity
-Uncertainty for climate change effects

Management actions across realms
Bishop et al., 2017



Aim of planning exercise

Identify **priority areas in terrestrial and marine realms** for the **long-term protection of *Caretta caretta*** population in the Mediterranean, accounting for the **dynamics of ecological processes** and **climate change risks**

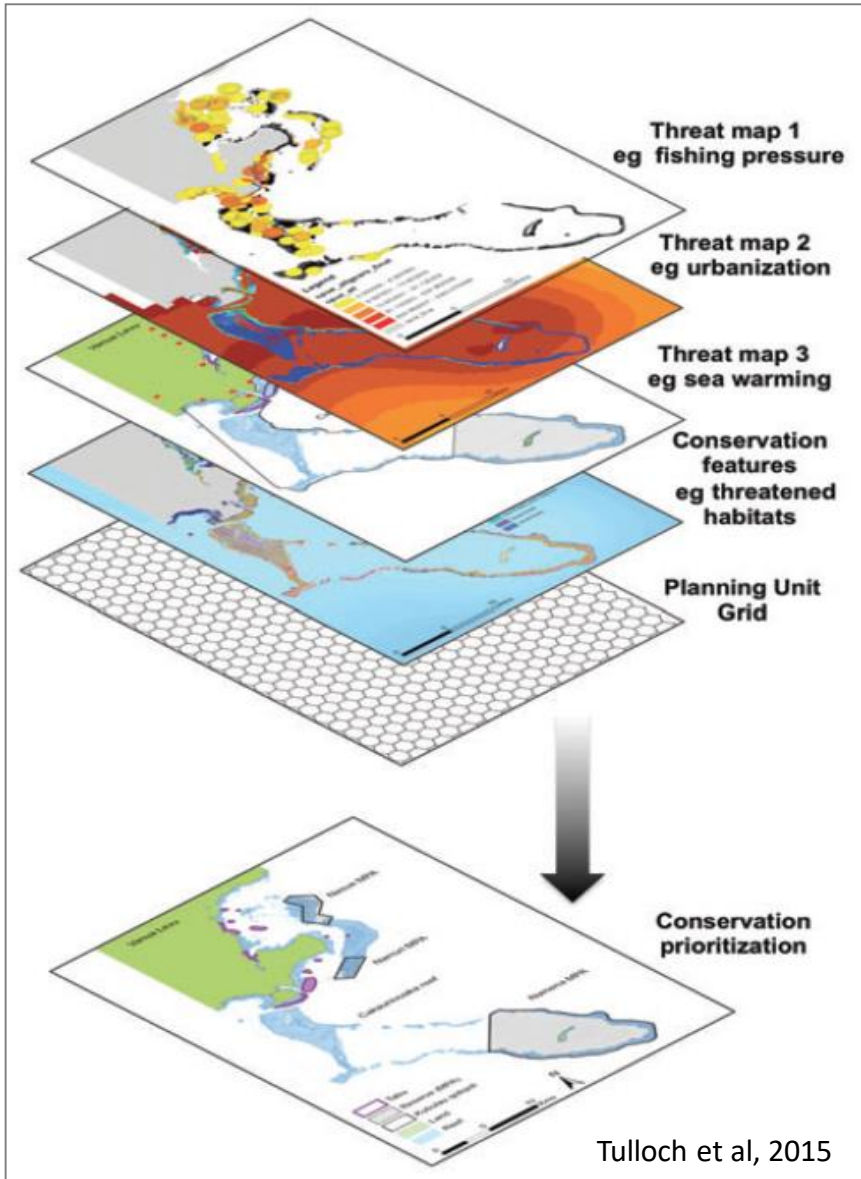


Life cycle of *C. caretta*

Systematic Conservation Planning

Marxan spatial prioritization software
(Ball et al., 2009)

- Spatial identification of **priority areas** for the protection of **multiple biodiversity features** (operational **targets**), **with the least possible cost**
- Ecosystem-based management approach
- Selection of priority areas based on **ecological principles** (*adequacy; representativeness; uniqueness; complementarity; efficiency)*



Tulloch et al, 2015

MARXAN conservation solutions

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

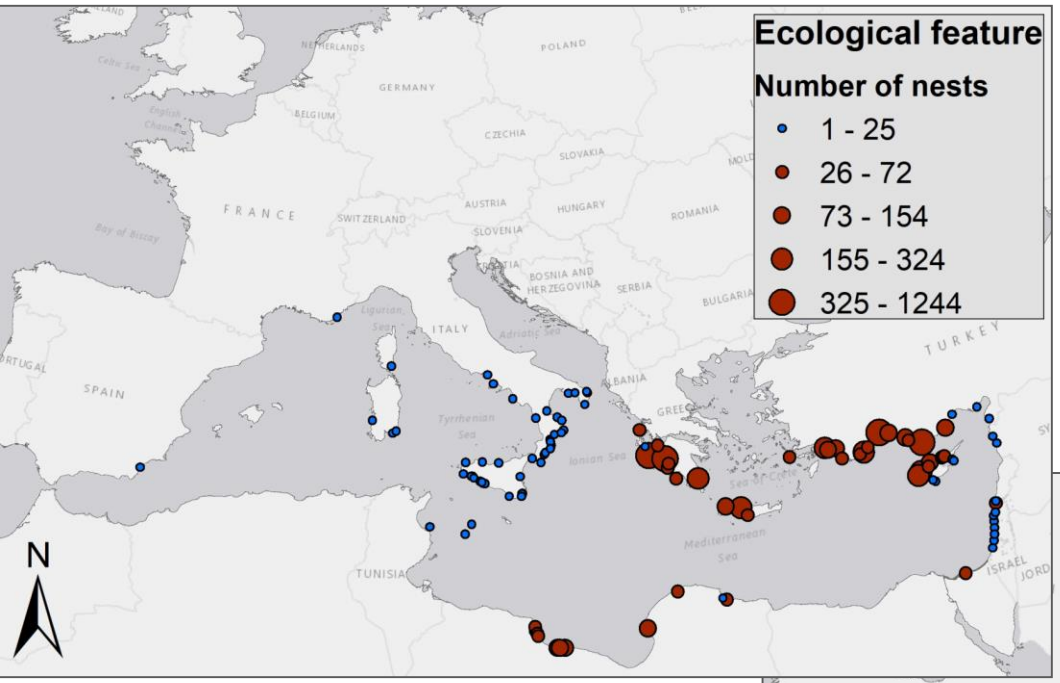
Study Area: Mediterranean Sea

Study area	Area (km^2)
Total area	3277000
Terrestrial part (10 km from coastline*)	582800
Marine part	2694200

** influence area of the shore, in order to capture the specific ecosystems and the urban areas that might generate pressure over the coast (Lavalle et al., 2011)*

Ecological features: Important habitats in life cycle of *Caretta caretta*

Nesting sites: present and future sites resilient to Climate Change

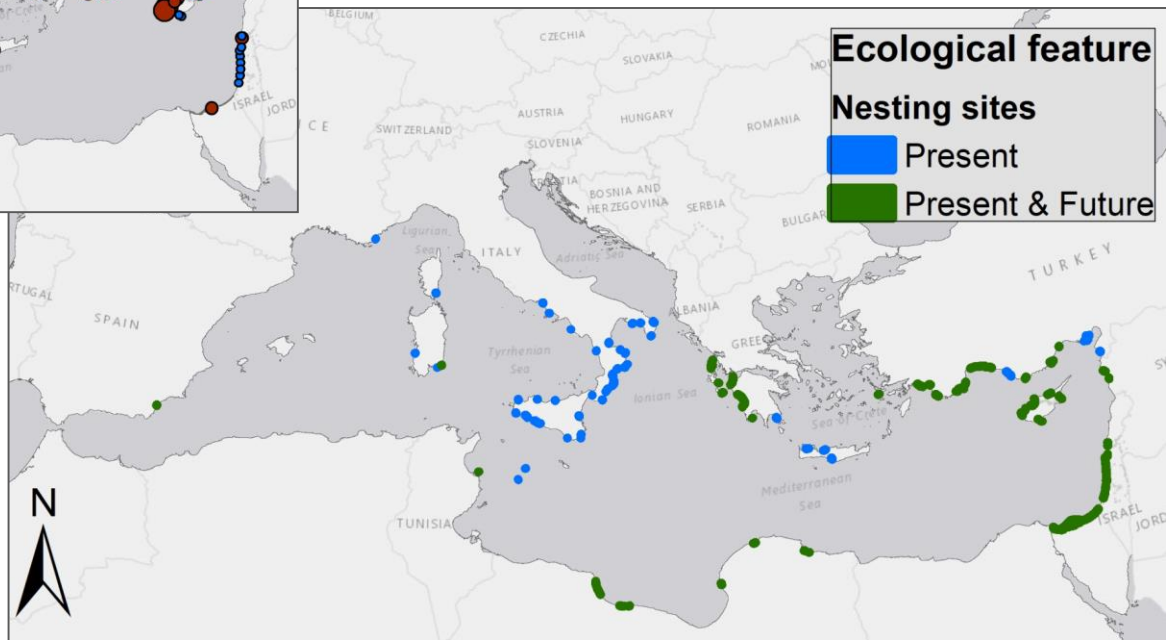


Red: Stable sites (53)

Blue: Sporadic sites (60, <25 nests)

Blue: Present sites (113)

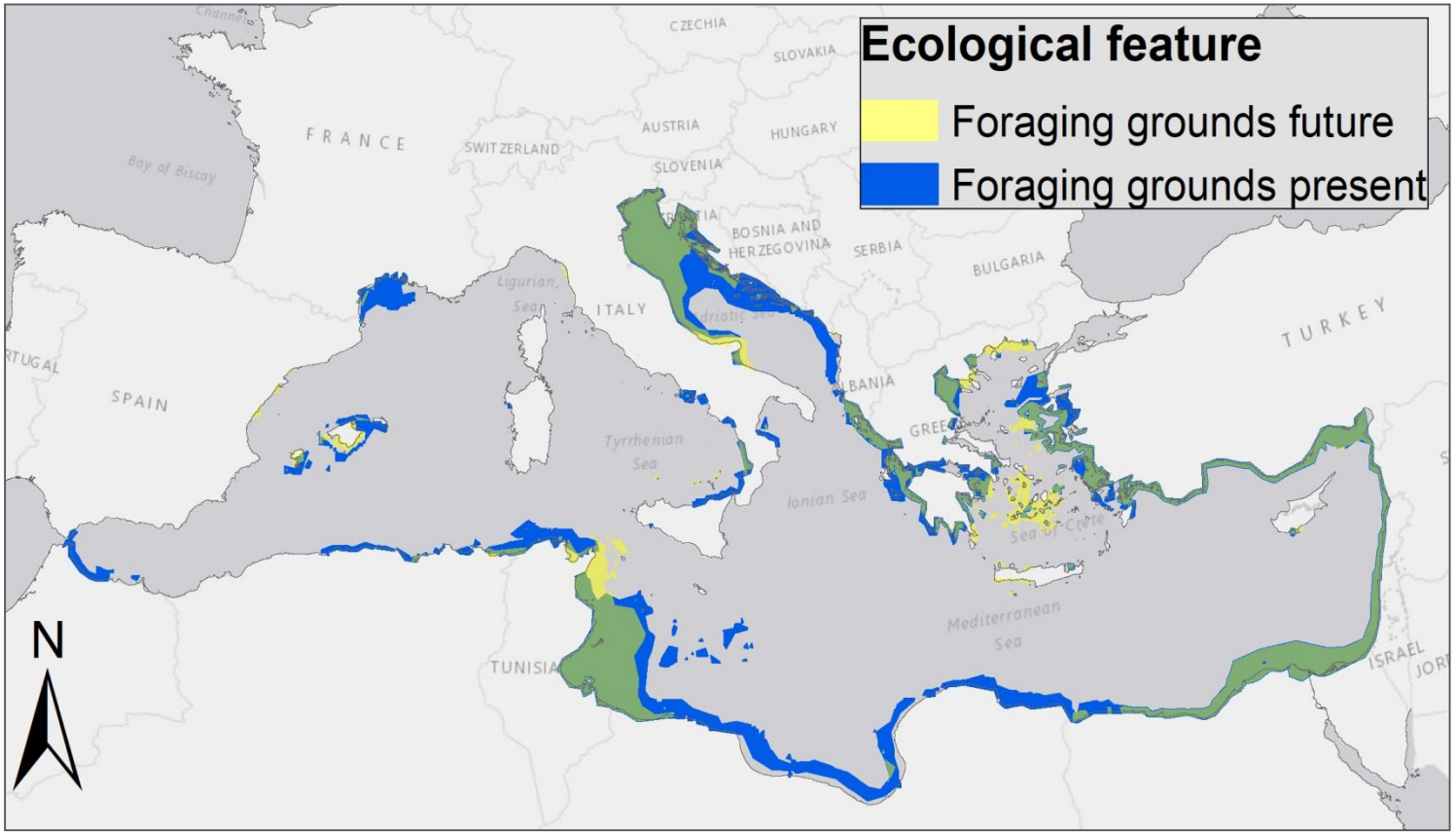
Green: Future sites (58)



Almpanidou et al., 2016. Ecological Indicators 71:551–556

Ecological features: Important habitats in life cycle of *Caretta caretta*

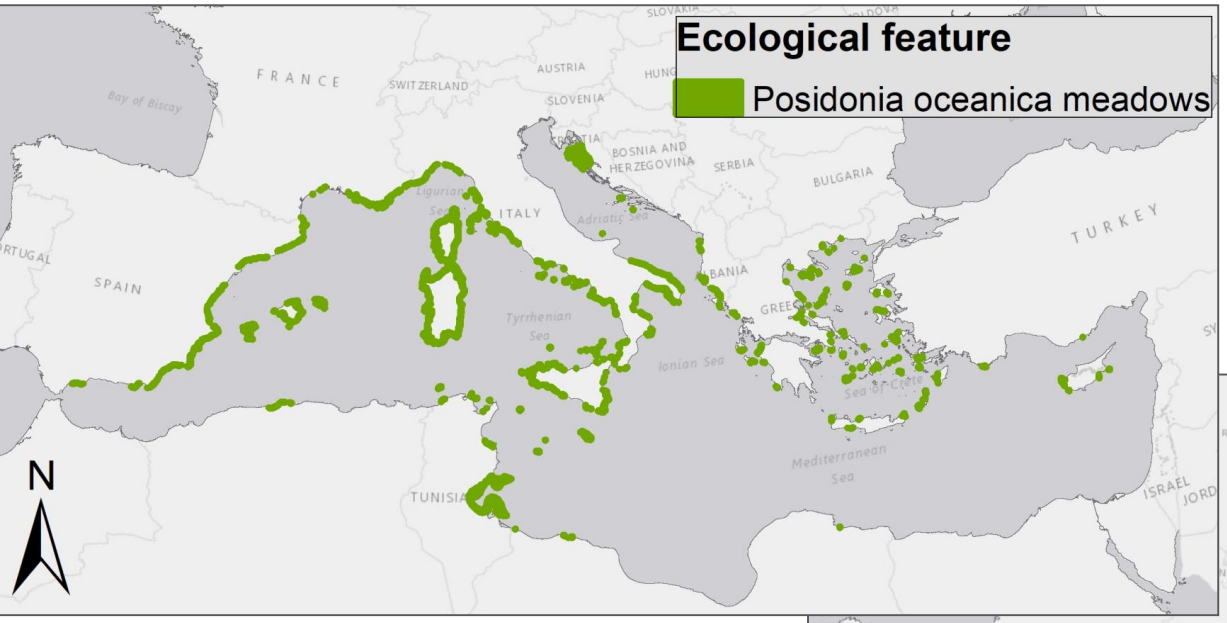
Foraging grounds (suitable areas for climate change)

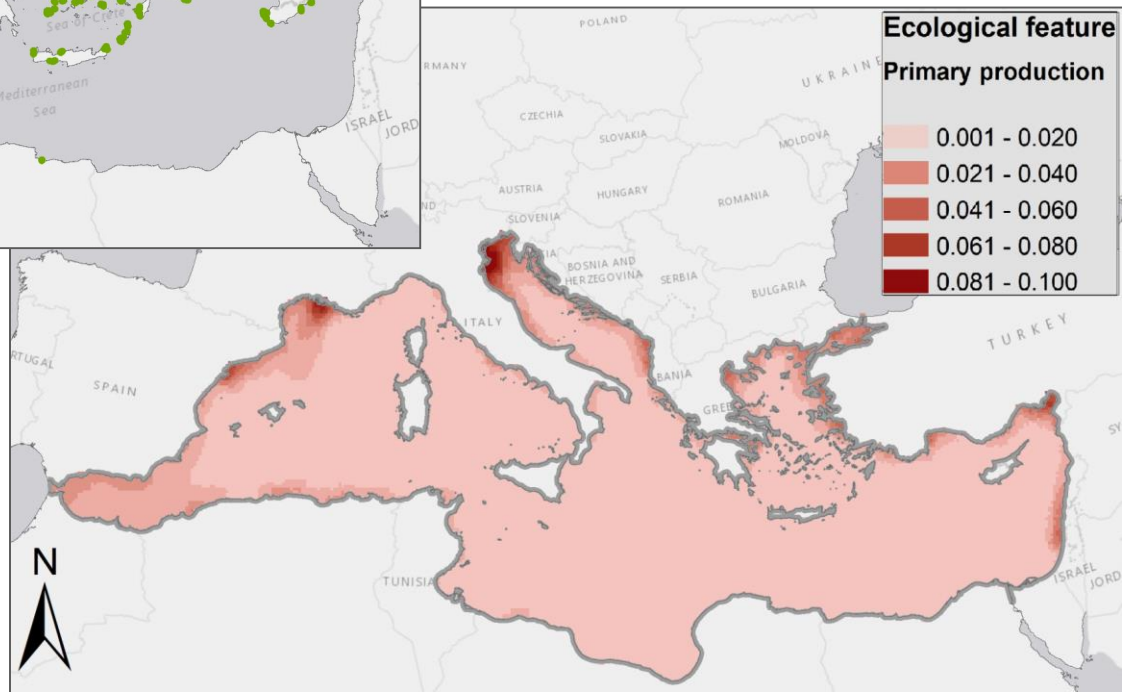


Almpanidou et al., in progr.

Ecological features: Important habitats in life cycle of *Caretta caretta*

Surrogates for foraging grounds: *Posidonia oceanica meadows* & Primary production





Belluscio et al., 2013; Tyberghein et al., 2012; Assis et al., 2017

Scenarios development

Conservation targets for ecological features

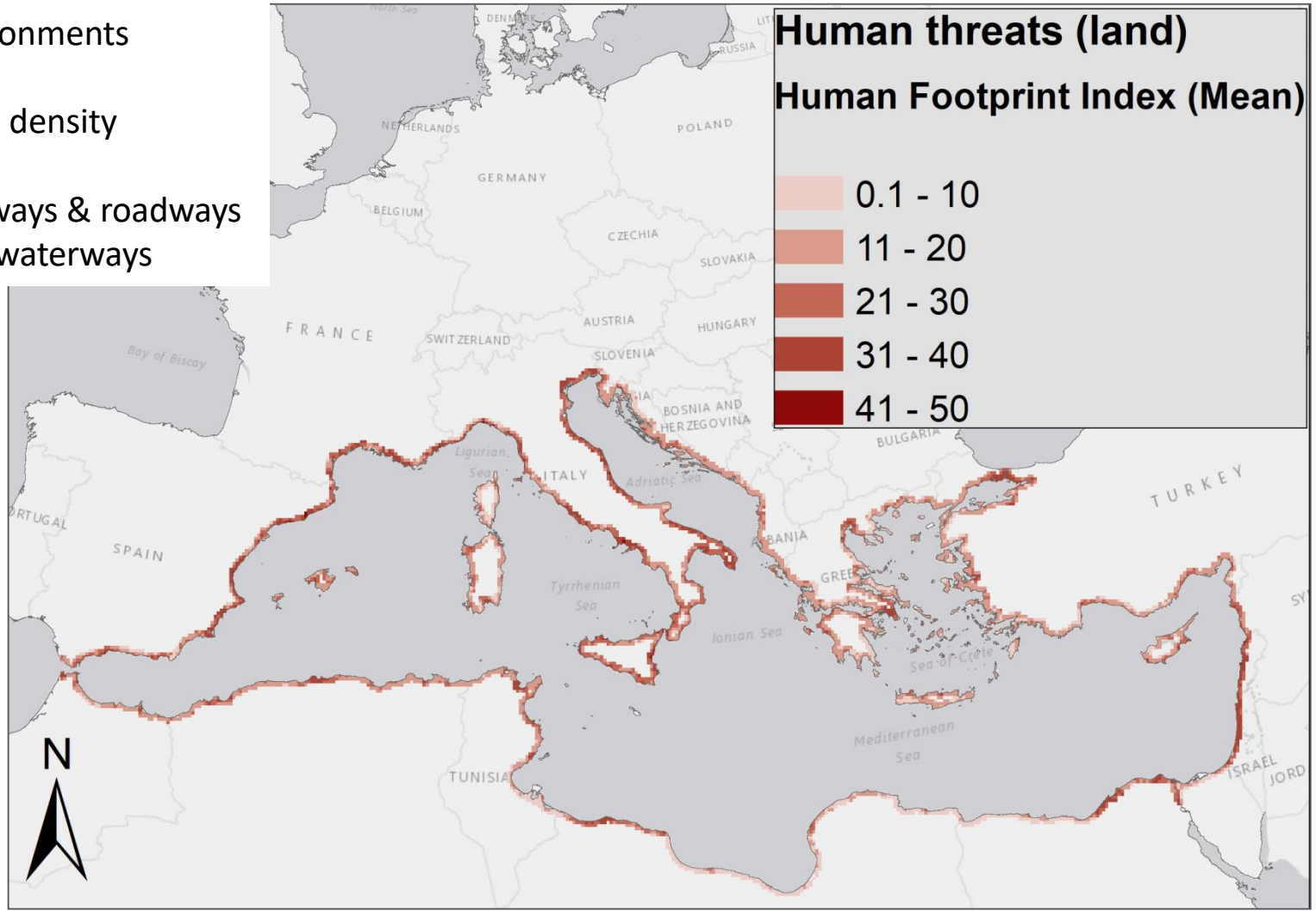
Feature	Present High	Future High	Mixed High
Posidonia oceanica **meadows**	60%	60%	60%
Primary production	40%	40%	40%
Nesting sites (present)	60%		60%
Nesting sites (future)		60%	60%
Foraging grounds (present)	40%		40%
Foraging grounds (future)		40%	40%

EU Recommendation on priority species & habitats (HD)

Human threats in life cycle of *Caretta caretta*: Terrestrial realm

Human Footprint Index on terrestrial realm

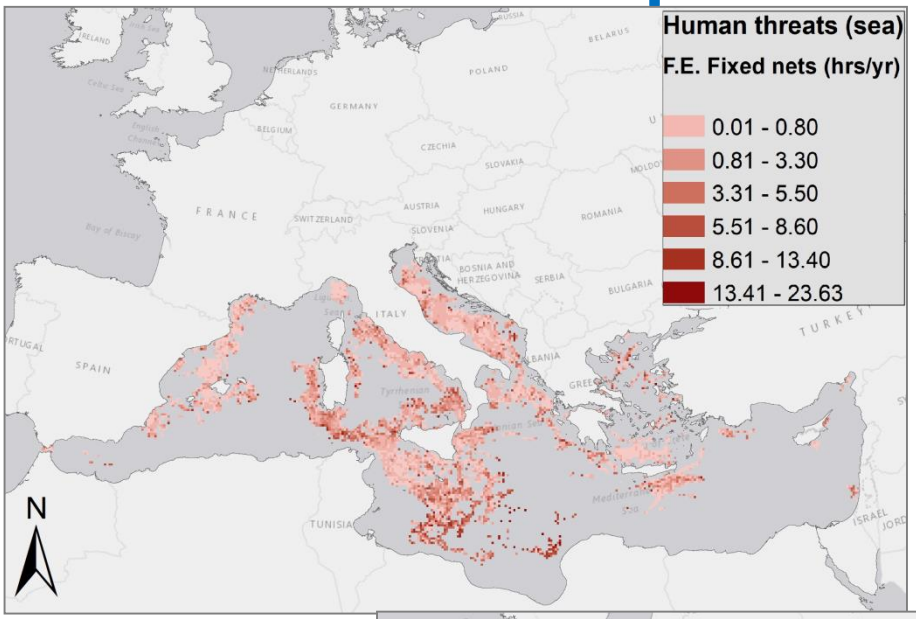
- ✓Build environments
- ✓Crop lands
- ✓Population density
- ✓Nightlights
- ✓Major railways & roadways
- ✓Navigable waterways

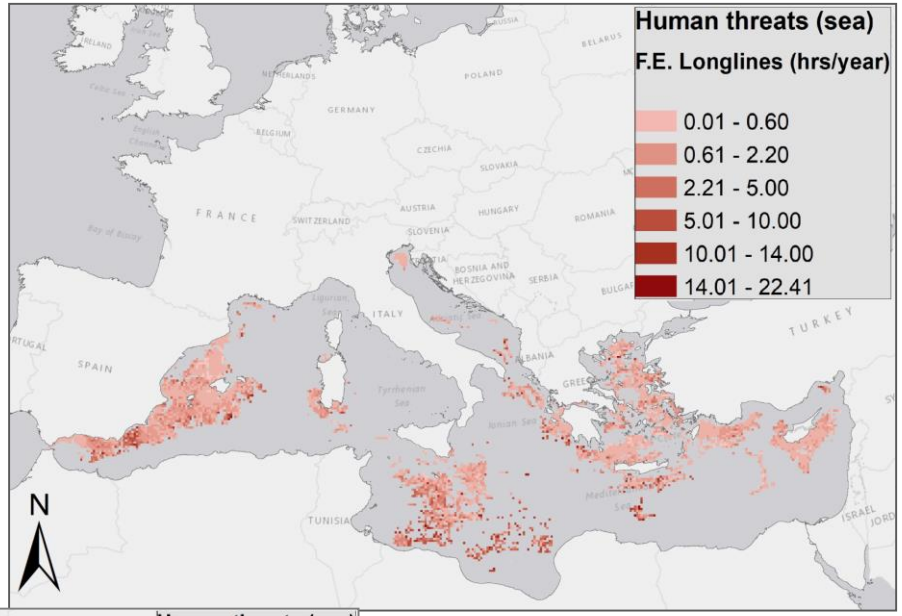


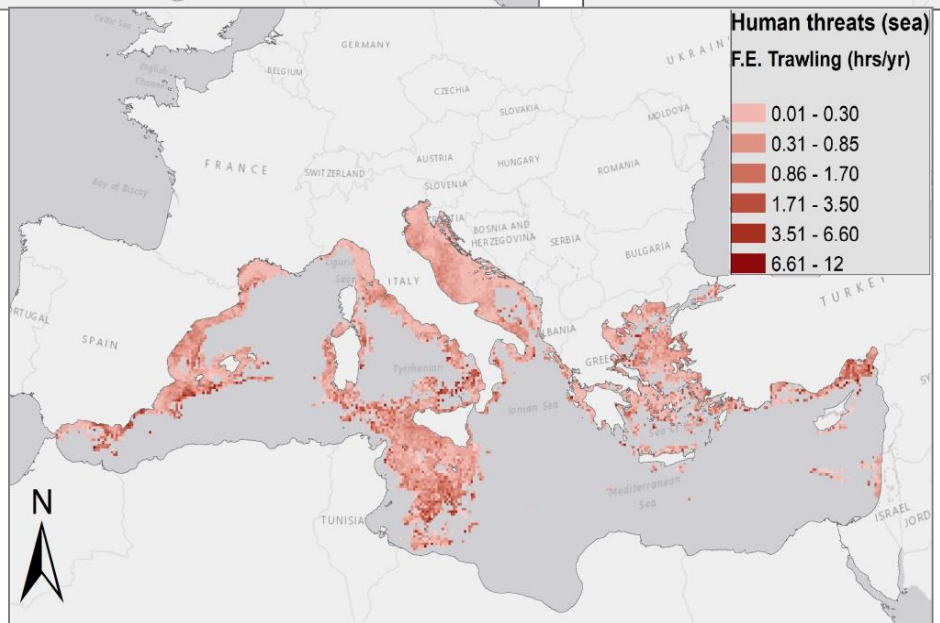
Venter et al., 2016. Sci. Data 3:160067

Human impact factor: Marine realm

Human Footprint Index on marine realm





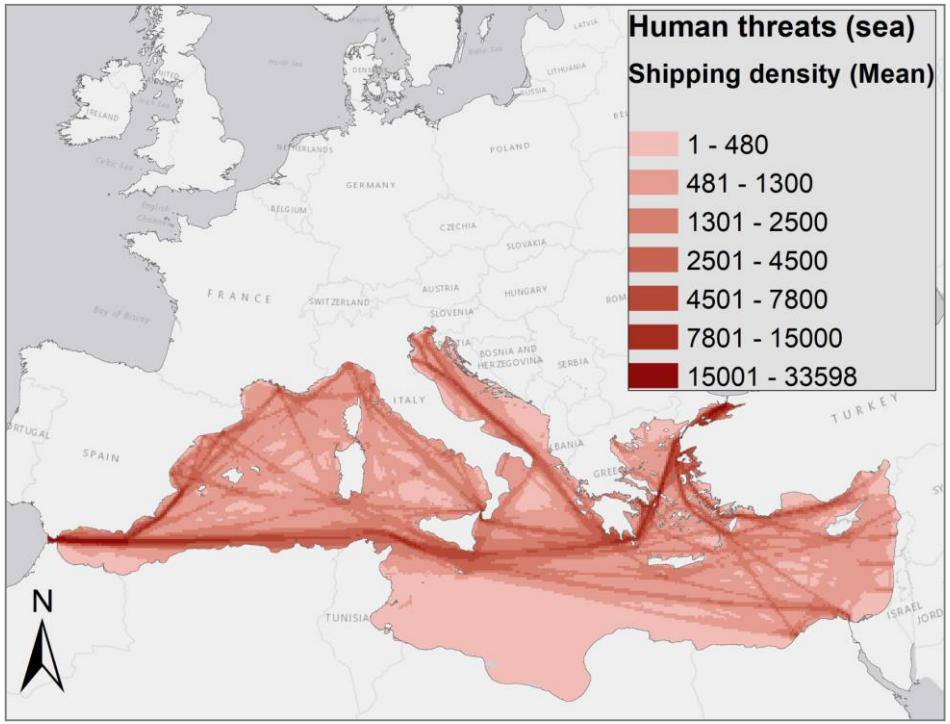


Fishing effort (2016): Mean values;
Global Fishing Watch

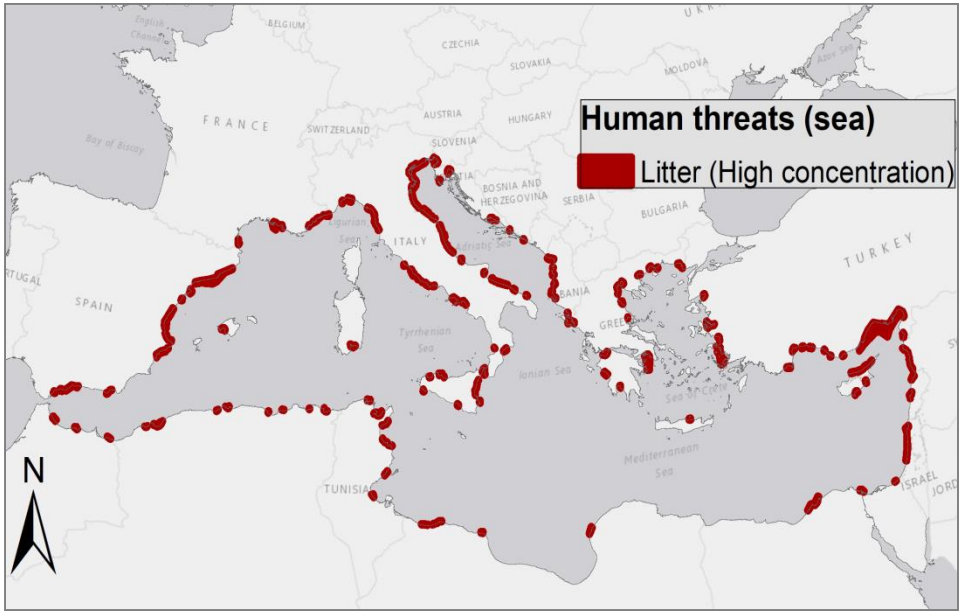
Human impact factor: Marine realm

Human Footprint Index on marine realm

Mean shipping density



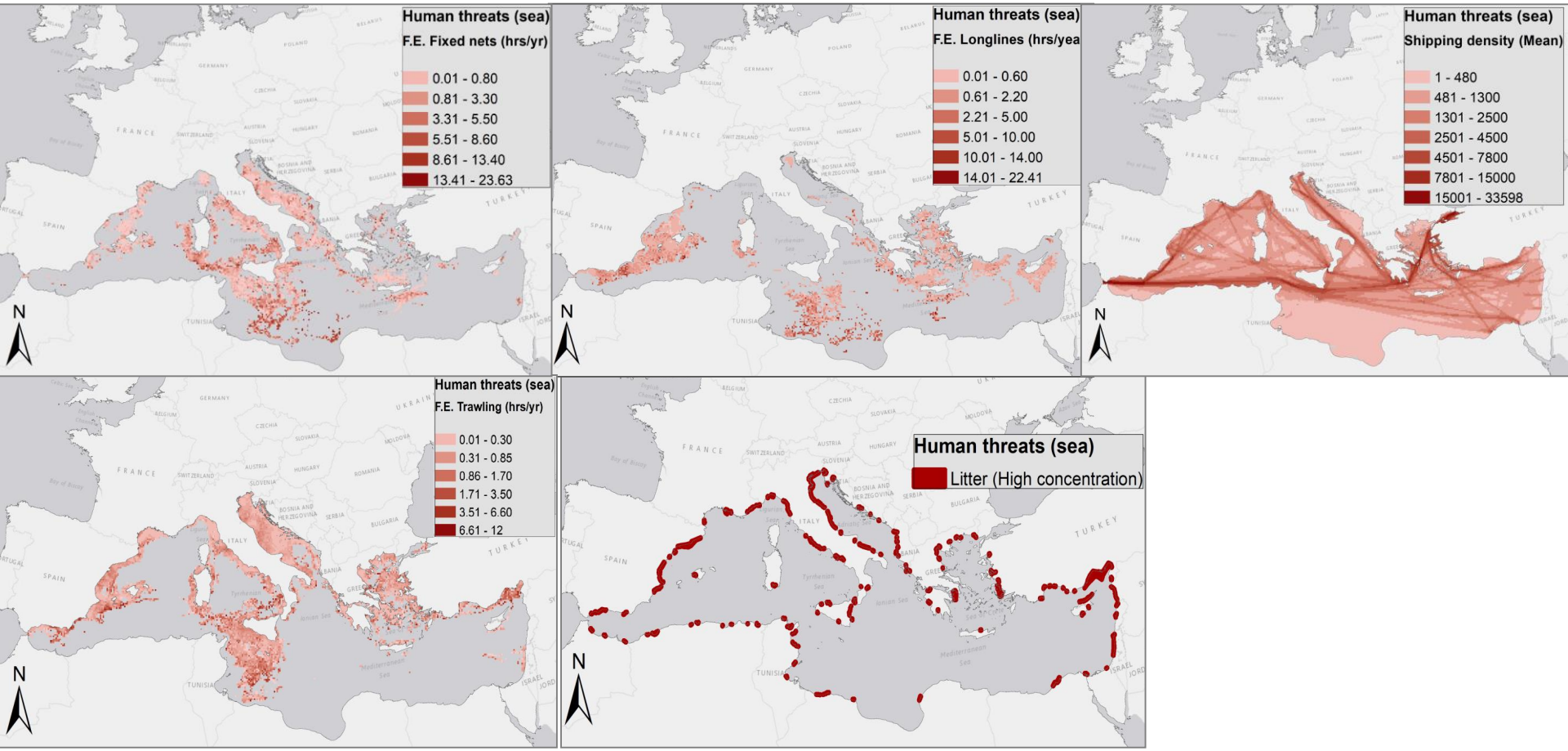
High concentration of surface marine litter



Micheli et al., 2013
Liubartseva et al. 2018

Human impact factor: Marine realm

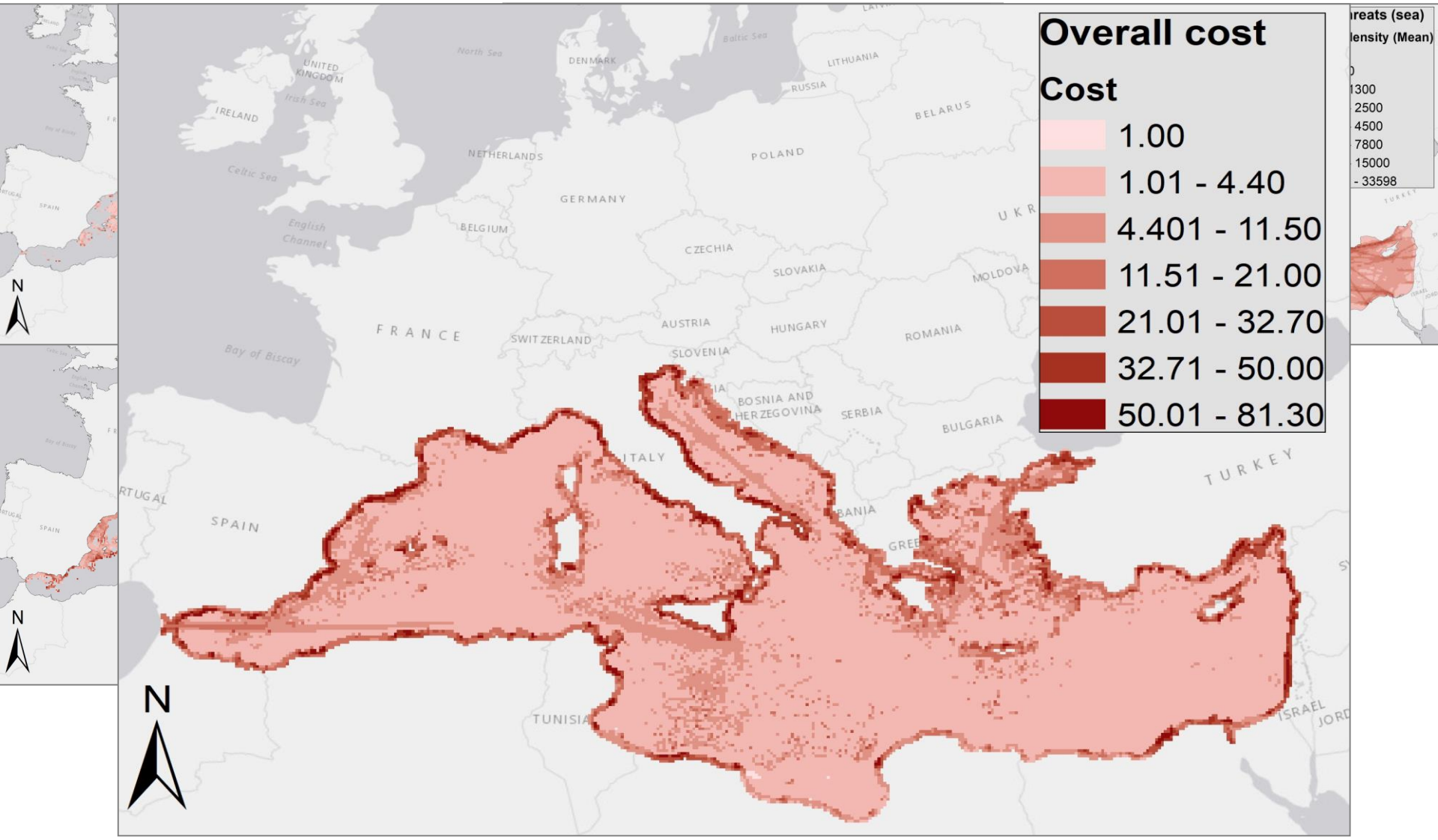
Human Footprint Index on marine realm



Pressure assessment on sea turtles: 11 sea turtle experts from the Mediterranean basin

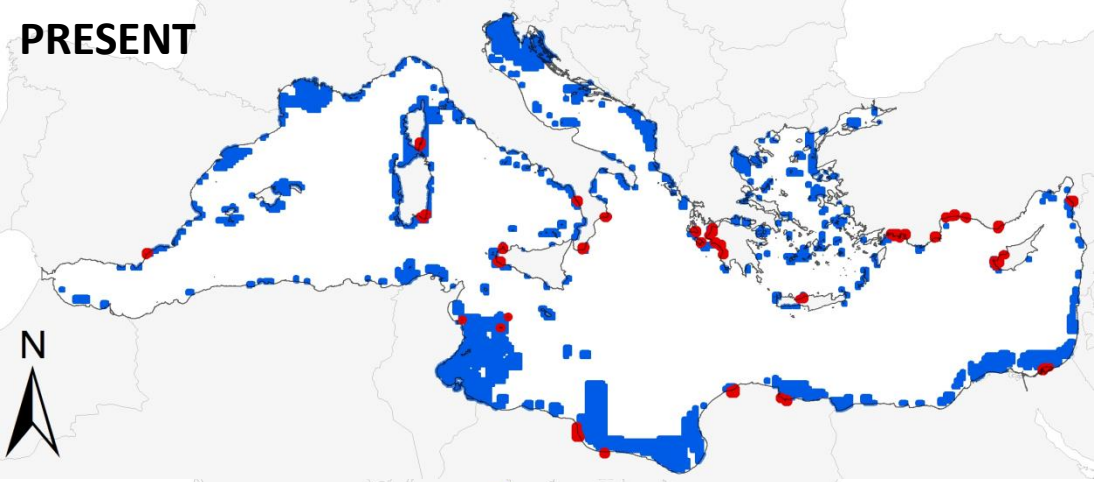
Human impact factor: Marine realm

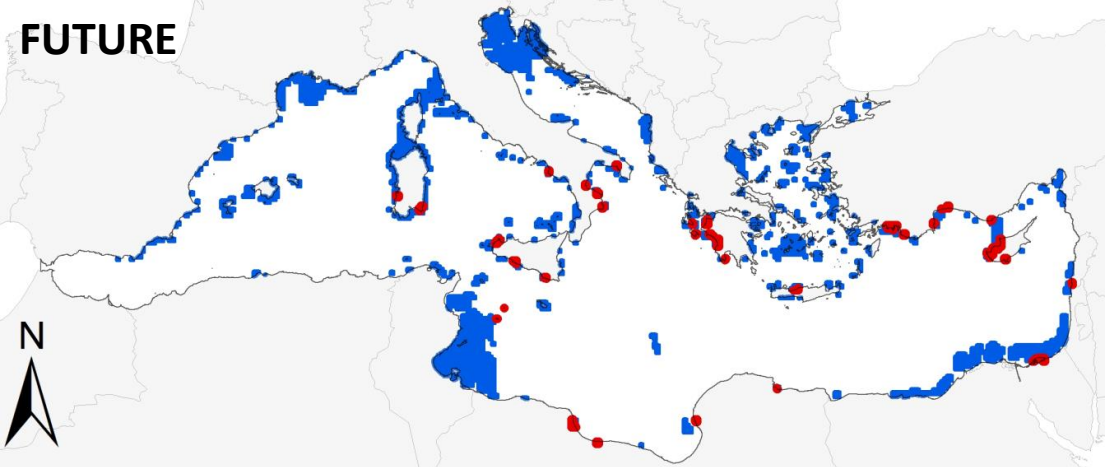
Human Footprint Index on marine realm

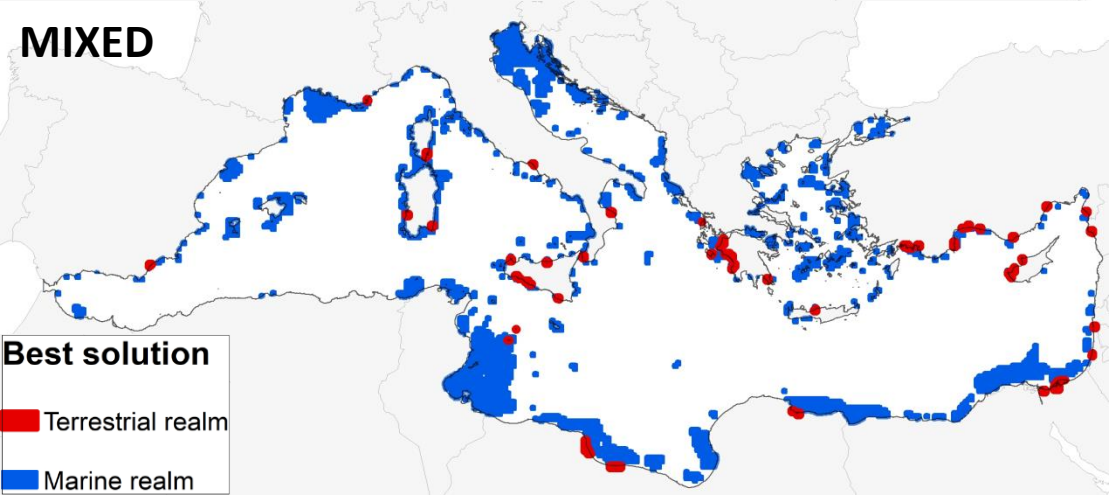


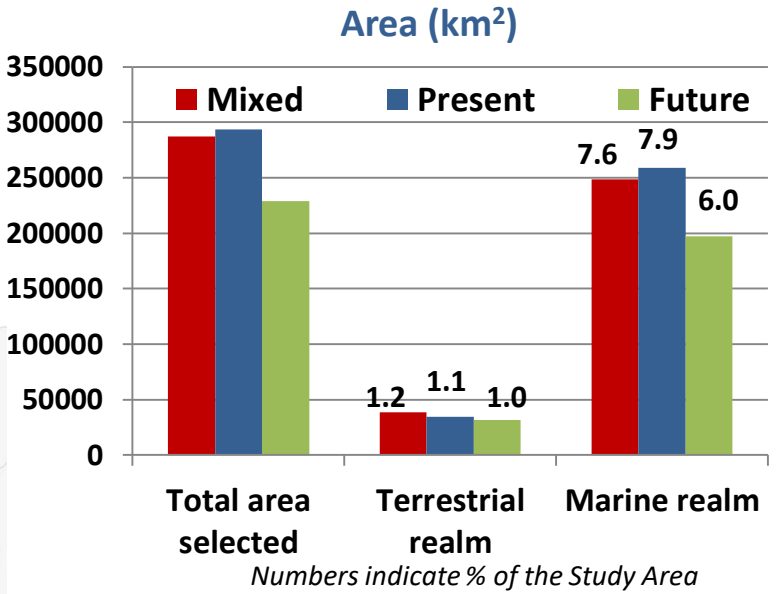
Scenarios - High targets

Preliminary results

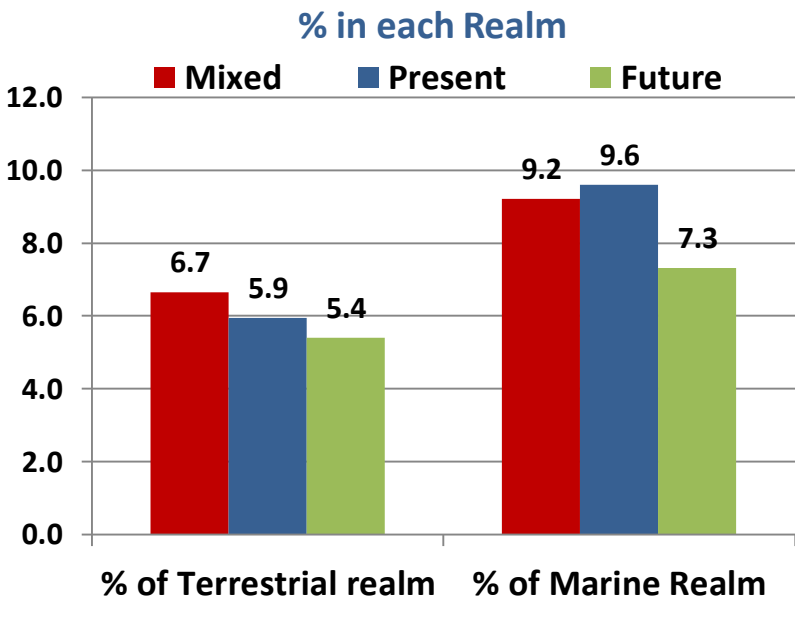






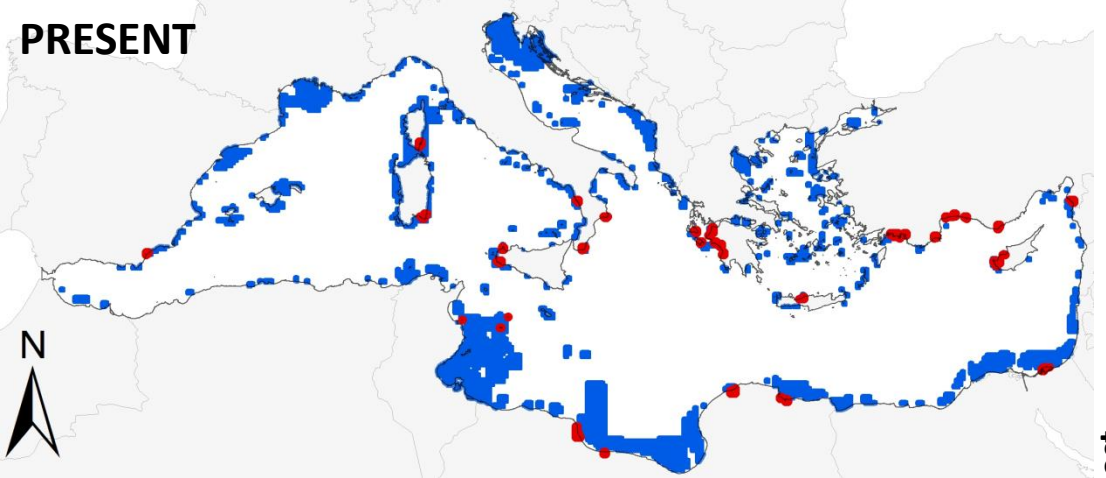


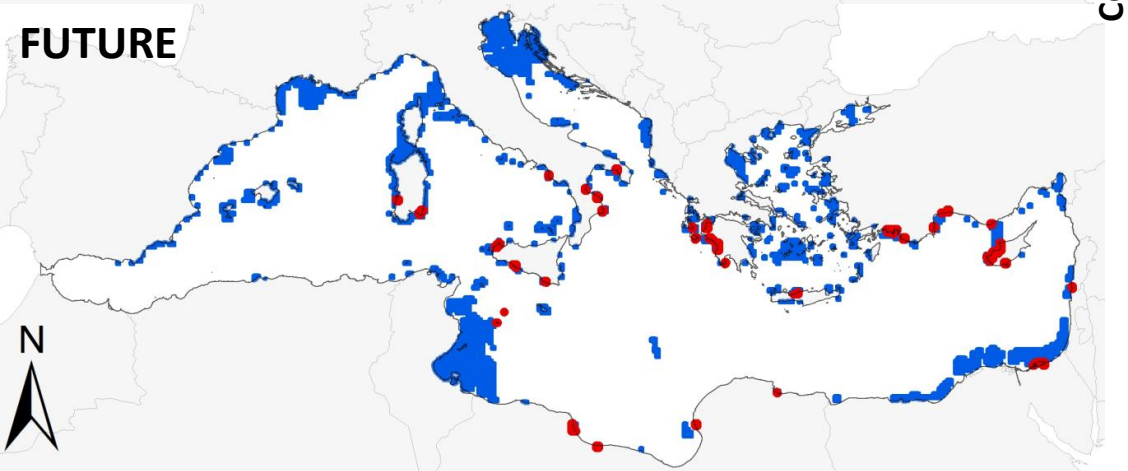
Numbers indicate % of the Study Area

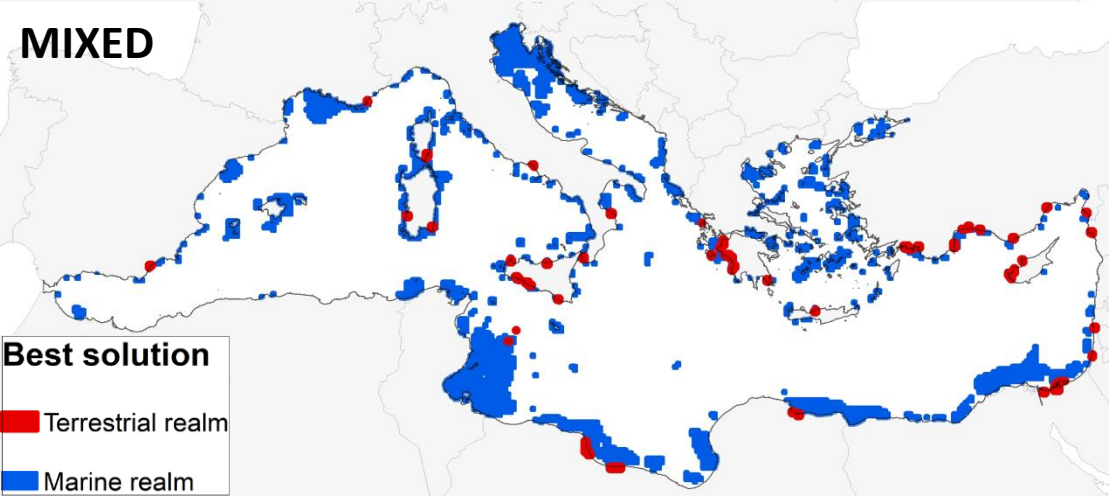


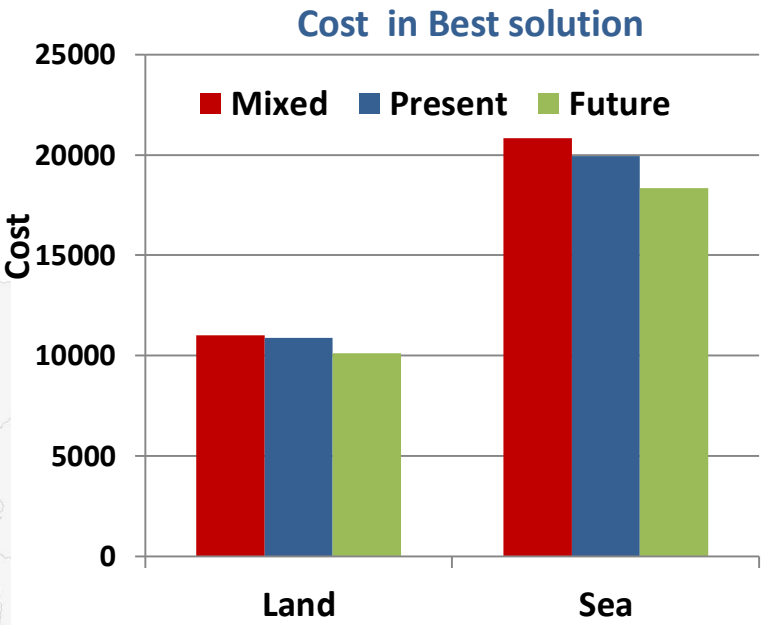
Scenarios - High targets

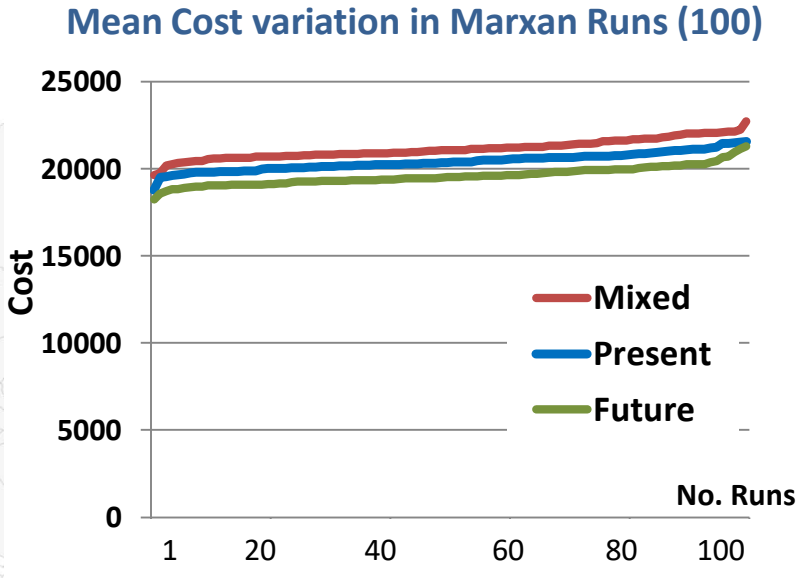
Preliminary results











Conclusions

- **Challenges in Integrated Planning**:

Lack of understanding	→	- Experts from the whole basin
Lack of information	→	- Modeling - Literature review - Expert judgment
Ecosystems' complexity	→	- Integration of marine & terrestrial realms
High **uncertainty** for climate change in "future" scenarios	→	**- Variety of conservation scenarios** **- thresholds** in **climate change** models

Conclusions

- **ICP provides a new perspective** in the protection of multi-realm species
- **Management** of **terrestrial environment** is **more "expensive"** than marine

Conservation approach	Scenario	Cost	Uncertainty	Risk of failure to reach long-term conservation targets
Not considering CC	PRESENT	MEDIUM	LOW	HIGH
Simple integration of CC	FUTURE	LOW	HIGH	MEDIUM
Integration of CC under a precautionary approach	MIXED	HIGH	MEDIUM	LOW

- **Conservation actions in the proposed areas** could potentially include:

- Land: Seasonal control of tourism & recreational activity, nightlights, fishing from land and beach cleaning

- Sea: Permanent control of shipping & fishing activity, litter removal

Conclusions

- **Methodology applicable:**

✓ Species distributed patchily & their survival depends on dispersal

✓ Wide ranging species requiring more space & survival depends on their ability to move between realms

✓ Sources of threats to biodiversity in one realm can influence conservation status in other realms

✓ Climate change – species' range alternation

WWF, 2018

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