

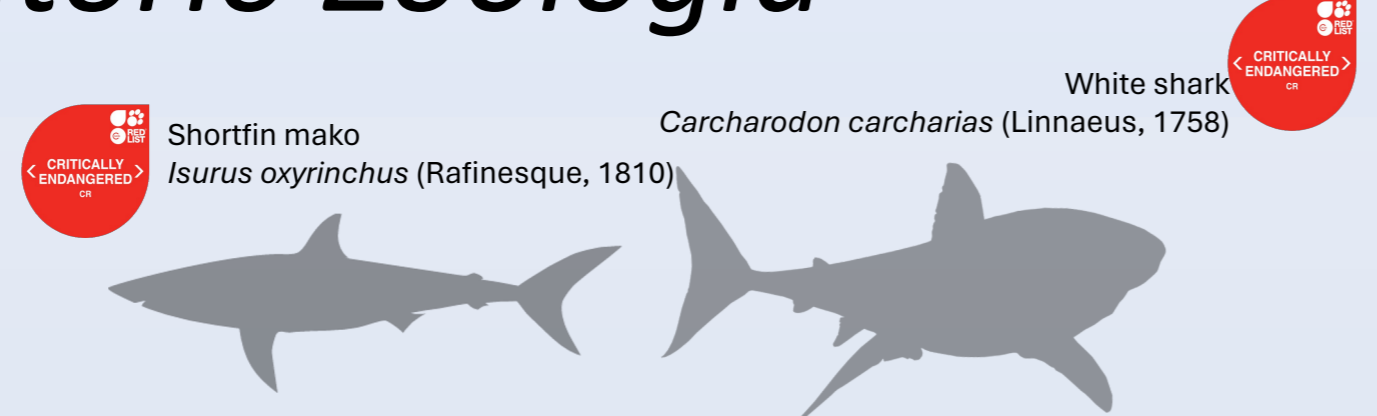
Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente, Ciclo XXXVIII

Large marine predators in the Mediterranean Sea. A losing game or there is still room for their recovery?

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Introduction

Some large marine predators in the Mediterranean Sea are as charismatic as endangered, like the **shortfin mako** or the **white shark**.

They are considered "Critically Endangered" by the IUCN [1], but there is a big gap of regional information on basic ecology and population structure.

Why is that?

They are rare and elusive species, and moreover studying them is very difficult, because they mainly inhabit the **offshore pelagic environment**.

How can we overcome these challenges and get information about these species in our region?

Aims and working packages

This **PhD project** proposes a **framework** to study large marine predators in the Mediterranean Sea, integrating data science, citizen science and new fieldwork approaches.

- WP1:** Shortfin mako spatio-temporal trends of abundance in the Mediterranean Sea
- WP2:** Population structure of the shortfin mako in the Mediterranean Sea
- WP3:** Ecological niche modelling
- WP4:** Application of a highly integrated approach to study pelagic predators in the field

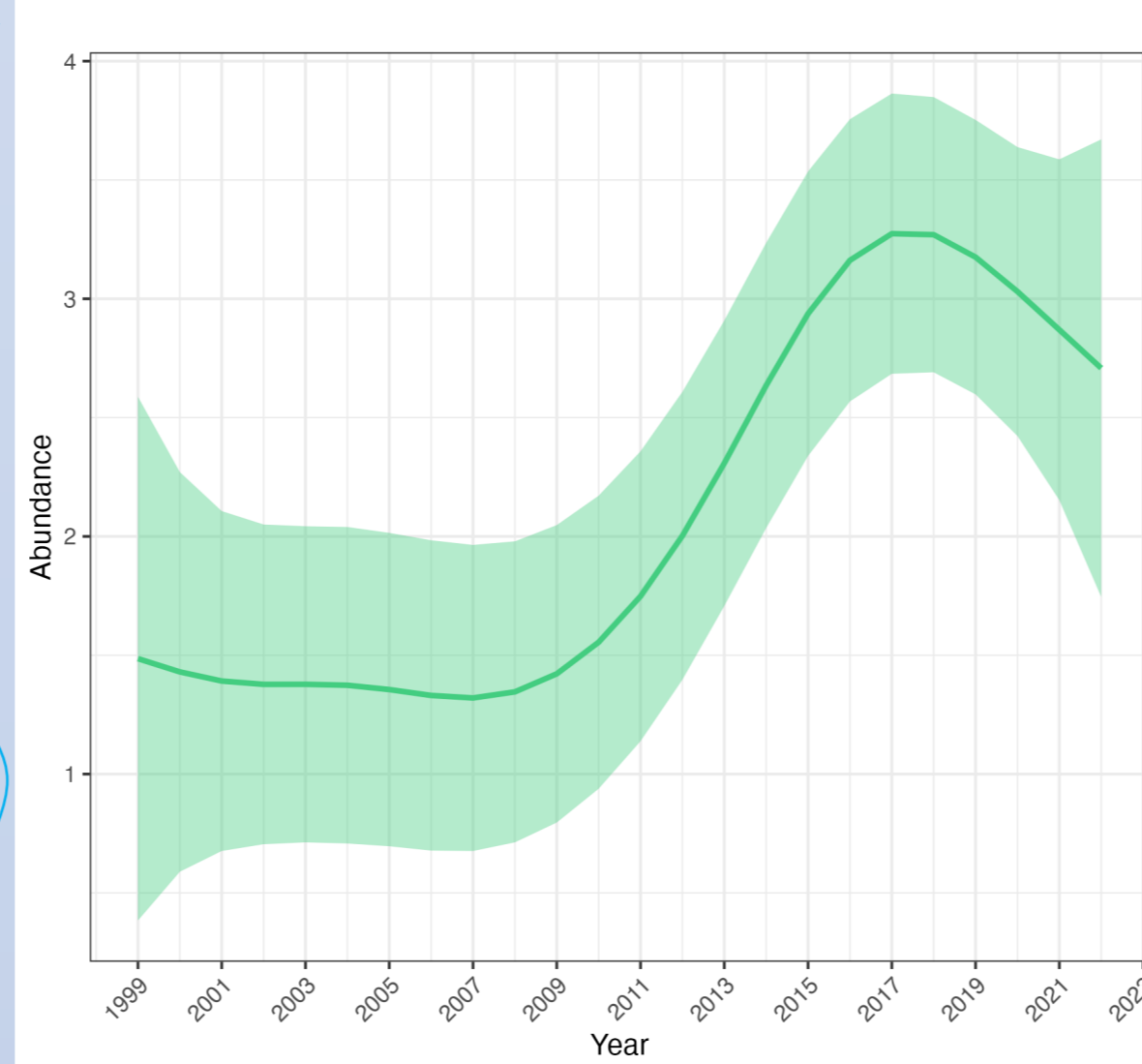
WP1

Can you find me?

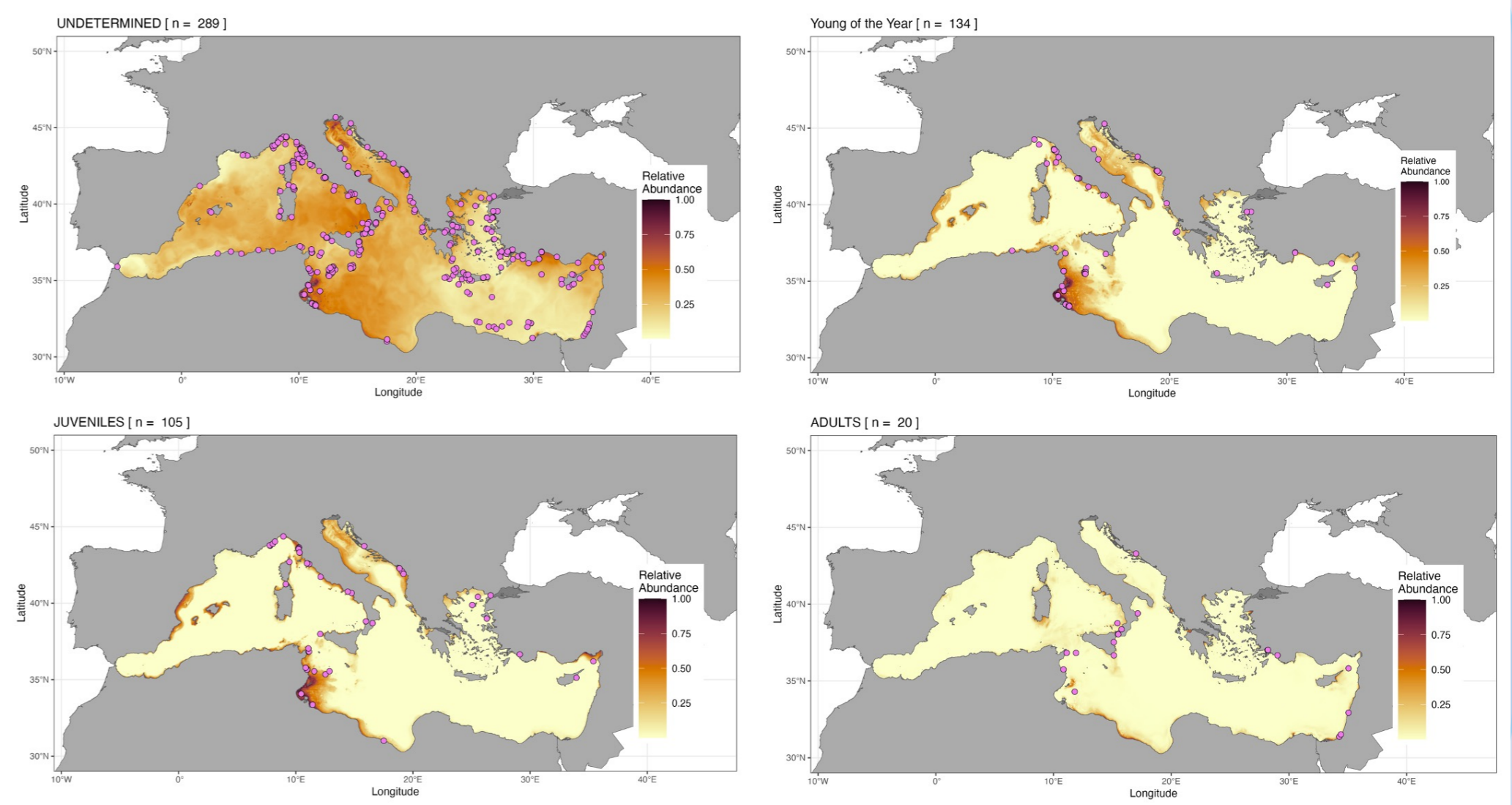
- **Area-based** protection is a cornerstone for halting the loss of biodiversity, identifying key sites or seascapes of importance for biodiversity or target species [2]
- Information mostly comes from opportunistic sightings, which if well standardized can represent a **powerful data source** to keep track of elusive species' distribution [3]

- We synthesized occurrences from diverse sources
- Generalized Additive Models (GAM) were used to estimate a standardized abundance trend between 1999 and 2022;
- Log-Gaussian Cox Process (LGCP) were fitted to the occurrence locations to extract high-resolution abundance patterns, as a function of the different life-stages and environmental parameters.

GAM Temporal trend of occurrences



LGCP Prediction of spatial distribution according to age classes (raster) with the known occurrences (pink dots)



WP2

- Genetic approaches have improved our knowledge of population connectivity, migration, and the extent of philopatric behavior in determining observed population genetic discontinuities. Overall, genetic tools have broadened our understanding of contemporary and historical processes driving shark population genetic structure.
- The shortfin mako is a highly migratory species: this feature usually leads to genetic homogeneity, but for this species studies on mitochondrial DNA showed a global population structure, except in the Mediterranean Sea [4]. Further analyses could assist in resolving genetic population structure of this endangered apex predator in the region, as well as help management and conservation.

Collect tissue samples from different sectors

Extract DNA

Sequence

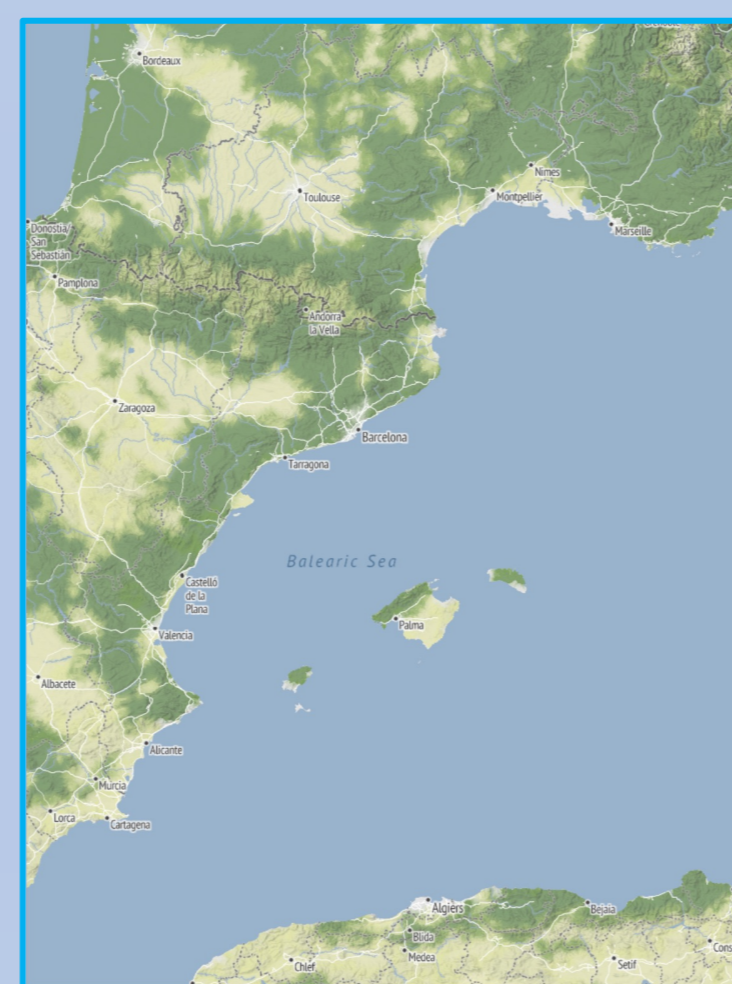
Bioinformatics



WP3

WORK IN PROGRESS

- Reconstruct occurrences of shortfin mako from available historical databases of longlining fishing catches in the Balearic Sea
- Literature synthesis
- Perform Ecological Niche Modeling on shortfin mako and explore habitat segregation between two large lamnids in the Mediterranean Sea



WP4

White Shark Chase: a multi-annual (2021, 2022 and 2023) research program where an international team of researchers is tracking the last White Sharks in the Mediterranean Sea

- Methodologies:
- eDNA
 - Pelagic Baited Remote Underwater Video
 - Deep water Baited Remote Underwater Video
 - Satellite tags

We detected white sharks at four sites [5] from eDNA samples. Mid- and deep-water baited video detected 42 species of bony fishes, elasmobranchs, marine mammals (bottlenose dolphins), and reptiles (loggerhead turtles)



Career development plan

	First year	Second year	Third year
WP1- Spatiotemporal pattern of Shortfin mako in the Mediterranean Sea	Task 1.1 Review on Mako Task 1.2 Distribution models - Mako	Task 2.1 Molecular approaches and tissue sample analyses Task 2.2 Engage with ocean users from core regions	Task 2.1 Molecular approaches and tissue sample analyses
WP2- Population genetics of Shortfin mako population in the Mediterranean Sea and new molecular tools to explore their distribution		Task 2.3 eDNA sampling and processing	
WP3- Ecological segregation between large predators, case study on shortfin mako and white shark in the Mediterranean Sea		Task 3.1 Ecological niche modeling Task 3.2 Habitat segregation for White Shark and Shortfin Mako	
WP4- Case study on white shark in the Mediterranean Sea: integrated approach to study elusive predators	Task 4.1 WSC- Field expedition and sample collection	Task 4.1 WSC- Field expedition and sample collection	Task 4.1 WSC- Field expedition and sample collection
Dissertation			Writing thesis and dissertation

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[5] Jenrette, J.; Jenrette, J.; Truelove, K.; Moro, S.; Dunn, N.; Chapple, T.; Gallagher, A.; Gambardella, C.; Schallert, R.; Shea, B.; Curnick, D.; Block, B.; & Ferretti, F. (2023). Detecting Mediterranean White Sharks with Environmental DNA. *Oceanography*. <https://doi.org/10.5670/oceanog.2023.s1.28>

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