PROGETTO DI RICERCA e PIANO DELLE ATTIVITA'

TITOLO DEL PROGETTO DI RICERCA:

Integrated approaches to ecosystemic diversity: genetics, ecology and advanced modelling applied to elasmobranchs

TUTOR:

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BASE DI PARTENZA SCIENTIFICA ed OBIETTIVI

The Mediterranean Sea is a hot spot of biodiversity for chondrichthyan species hosting over 80 species (Serena et al., 2020), but it is also one of the world's regions facing the highest risk of extinction: more than half of the evaluated species are under threat, with almost a third of them fished close to the level of extinction. Indeed, the biodiversity of Mediterranean elasmobranchs is currently and heavily threatened by multiple anthropogenic activities, including habitat loss and fragmentation, accidental catch by commercial and recreational fishery (Carpentieri et al., 2021; Dulvy et al., 2021) and climate change (Coulon et al., 2024). Limited information on the conservation status of elasmobranchs is currently available, although much effort has been addressed at the local scale. Therefore, elasmobranch management is a challenging task, since it requires key information on life history traits and ecological knowledge of the species. These challenges are currently taken up by the ongoing project LIFE PROMETHEUS "PROMoting Elasmobranchs conservation THrough by-catch reduction, Ecotourism and alternative sUStainable fisheries" (LIFE23 NAT/IT/101148295). In particular the Work Package 3 is conceived to implement Preparatory actions for elasmobranchs conservation and development of tool for support decision makers. Within Task3.1, the identification, monitoring and protection of Essential Fish Habitats- EFH, such as nursery areas, feeding grounds and reproductive aggregation sites, is the core aim, since it is of outmost importance for the comprehensive conservation of the species at all life cycle stages (Chapman et al., 2015) and need to be monitored. Thus, understanding the use of space by elasmobranch species represents a priority for their conservation. As a first step in this direction, the evaluation of species philopatry (i.e., the return to the same site to give birth), connectivity and genetic population structure over long temporal scales may represent a key trait for population recovery.

Secondly, in order to develop long-term monitoring plans of species, and indirectly EFHs, an effective and non-invasive tool such as the environmental DNA will be implemented (Boussarie et al., 2018), and further applied in the framework of the foreseen monitoring activity to assess the recovery and conservation of the target species (Work Package 6).

ARTICOLAZIONE DEL PROGETTO

The PhD candidate will be improving the state of knowledge on elasmobranchs in the Mediterranean Sea by:

- **Compiling available information for the identification of EFHs for elasmobranchs**: In synergy with the several other research groups involved in the collection of baseline information, the PhD student will contribute to reconstruct and summarise how elasmobranchs use the space for parturition, aggregation for mating and nursery areas.
- **Sampling.** The PhD student will be contributing at the collection of individual samples from different Mediterranean areas thanks to the collaboration with ongoing scientific surveys (e.g., MEDITS surveys), and in close collaboration with other research groups as well as fishermen. Sampling will be targeting areas where new-born, juvenile individuals and adults have been previously recorded (also based on retrieved knowledge on EFHs)) to unravel the relationship existing among target areas in terms of habitat use for mating and reproduction. Samples will be collected on dead specimens, while non-lethal approaches (biopsies, mucous collection) will be used on alive animals that will be released. In the same sampling sites, the PhD student will be also participating in the collection of water samples for eDNA analysis using the most advanced, standardized, and automated protocols under proper conditions.
- **Genetic analysis.** The use of space and the persistence of EFH will be assessed through genetic analyses aimed at evaluating connectivity among different EFH and the occurrence of behaviours, like philopatry that should be deeply considered for an effective spatially explicit management (Therkildsen et al., 2013; Chapman et al., 2015; Cristofari et al., 2016, 2018). Connectivity and philopatric behaviours will be evaluated using available cost-effective technologies (from mitochondrial/nuclear DNA to reduced representation-based genome-wide markers, such as the double digest restriction-site associated DNA data; Peterson et al., 2012 or low coverage whole genome sequencing; Lou et al. 2021). This will allow the screening of different genes to hundreds to thousands of loci, and the accurate estimate of demographic parameters even on small sample size (Winternitz & Wares, 2013; Nazareno et al., 2017). On the other hand, total eDNA will be extracted using the most advanced, standardized, and automated protocols under proper conditions. Subsequently, the extracted material will be utilized for library preparation according to the chosen NGS sequencing platform.
- **Advanced bioinformatics and modelling.** After sequencing by service companies, well-established and routinely applied bioinformatic pipelines will be used to estimate population connectivity and philopatry of the targeted species. For what concerns the eDNA analysis, the raw

reads obtained will be analysed following a shared bioinformatic pipeline (e.g., OBITools metabarcoding open-source pipeline, Boyer et al., 2016). In addition, the PhD student will be integrating multiple available data sources (e.g., data produced by other research teams working on Expert Knowledge, tagging, Baited Underwater Video – BUV) with biotic/abiotic factors and other information concerning the mapped EFHs in order to design advanced predictive ecological models of species migration in relation to different life stages.

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