

FULL FINAL REPORT

Research activities carried out by the OceanWebs team on board of the Yersin, 24-26

August 2017

- José Pedro Granadeiro - [Professor at Faculty of Science, University of Lisbon](#)
- Paulo Catry - [Senior researcher at MARE, ISPA - Instituto Universitário](#)
- João Morgado - masters student at [Faculty of Science, University of Lisbon](#),
- Luis Berimbau - student at [University of Madeira](#), volunteer of Museu da Baleia, Madeira
- Inês Cunha research assistant at Museu da Baleia, within [Project OceanWebs](#)

The Project OceanWebs

Large marine predators are widely recognized as key elements in the marine environment, delivering invaluable regulation services and many providing substantial economic revenue. Hence, their rapid and widespread decline by excessive harvesting or other human impacts is a matter of high economic and social relevance, gathering serious concerns in the scientific and political arenas alike. Therefore significant resources have been devoted to build ancillary data to feed functional ecosystem models. These models are strongly based on the knowledge of relevant ecological processes and provide vital guidance to management for the sustainable and ecosystem-based exploitation of commercially significant taxa and/or the conservation of threatened species. However, in many areas such process-oriented approach is hampered by limited knowledge on such basic topics as diet, energy fluxes and distribution of predators and of their prey.

This is also true for the deep-ocean regions surrounding the archipelago of Madeira, including the Selvagens. In the project OceanWebs we are undertaking the first comprehensive and integrated attempt to unveil the structure and functioning of these offshore pelagic ecosystems. Our broad-scoped team aims at investigating and modelling the trophic links (and ecological derivatives) involving the marine megafauna occurring in this vast oceanic region. The taxonomic coverage of this project includes above and underwater predators: pelagic seabirds (shearwaters and petrels), tunas, billfishes (targeted by commercial or big game fisheries), sea turtles and marine

mammals. We use these charismatic taxa to provide detailed data on the distribution and ecological significance of prey, mostly fish and squid, but also crustaceans and jellyfish. The geographical scope of the project includes the huge ranges of well-studied breeding seabirds, notably Cory's Shearwater (CS) which forages over an area over 1.5million km².

The location of major aggregations of seabird taxa in this region is still unknown. We are complementing our extensive database on CS trips with new tracking data for most other pelagic seabird (Bulwer's Petrel, Deserta Petrel, Little Shearwater, and White-Faced Storm Petrel), using bird-born GPS and geolocators. We employ recent spatially-explicit techniques to produce predictive distributional models, using remote-sensed oceanographic variables.

The diet of seabirds tracked with GPS as well as that of tunas and billfishes captured at known locations are used to assess the distribution and ecological role of different forage taxa in these subtropical ecosystems. We are combining conventional methods with DNA-barcoding to describe diet of predators to high taxonomic detail, using stomach samples of live, stranded and harvested animals. Research on trophic ecology and feeding habits of predator and prey is furthered by using mixing models and community metrics derived from stable isotopic analysis of predator and prey tissues. Our heterogeneous predator assemblage represents a powerful asset to sample marine prey over wide horizontal (inshore-offshore), and vertical (epi-vs mesopelagic) gradients, in distinct water masses and bathymetric landscapes.

Evidence suggests that even remote oceanic environments are not safeguarded from pollution due to global water and air circulation of several pollutants, most showing bio-accumulation and trophic amplification, like potential toxic trace elements. Levels of biota contamination in this region are poorly documented, a situation in need of remedy given that some species are used for human consumption. Our multi-species study represents an ideal setup to document and interpret geographic patterns in trace elements (Hg and other contaminants) distribution, and to identify factors and processes contributing to enrichment in different taxa.

Innovative aspects of the OceanWebs project include: 1) delivery of an integrated overview of distribution and abundance of charismatic megafauna and their prey in subtropical ocean water, and identification of key ecological and oceanographic features driving space partitioning; 2) collection of novel dietary data from predators and development of complementary methods to enhance current understanding of offshore oceanic trophic webs (concerning e.g. the role of poorly known species from the mesopelagic compartment); 3) using geographically-tagged information on the diet of predators to depict the spatial distribution, abundance and ecological role of prey; 4) combining distribution, dietary and biomarker data to formally represent and model community structure, functioning and sensitivity, with relevance for societal challenges such as an ecosystem-based fisheries management and the designation of Marine Protected Areas in the wide ocean.

The Yersin cruise

Taking advantage of the presence of the Yersin in Madeira, and its kind availability to assist local research projects, a team composed by 5 researchers and assistants carried out observations and sampling in 24-26 August 2017. Researchers are linked to Faculdade de Ciências da Universidade de Lisboa, ISPA – Instituto Universitário and Museu da Baleia, Funchal.

The very short duration of the cruise (just over 48 hours) and the need to deploy time in activities other than those of the OceanWebs project meant that only a few very simple objectives could be pursued.

First, we wanted to collect plankton samples for stable isotope analyses, and future modelling of the food-web. There was not enough time for a systematic sampling protocol, and that was not our aim. A plankton net was used, in vertical trawls from 100m to the surface (Figure 1). Five trawls were carried out, all at night time and 3 other surface samples were collected from the stern of Yersin, while the vessel was on an anchor during the night. Samples were stored frozen for posterior identification and for Carbon and Nitrogen isotope analyses.



Figure 1. Approximate location of sampling stations for plankton. Overall, 8 samples were obtained with the plankton net.

Second, we wanted to try to capture squid, again for isotope analyses. Squid were attracted by the Yersin lights after dark, and captured using lures on a line. Three individual squid were caught and stored for later identification (Figure 2). Further, 7 individual chub mackerel *Scomber colias* were also captured, and they will be used to complement more extensive sampling for dietary studies using conventional analyses of stomach contents plus stable isotopes. Chub mackerel *Scomber colias* are an extremely important fish in the sub-tropical Northeast Atlantic. They are present along continental shelves in Northwest Africa and Southwest Europe, but also above seamounts and around oceanic islands in the deep open sea. They are mostly planktivorous, but can grow to a considerable size (ca 30-40 cm), and hence they provide a link between low trophic levels and higher predators, such as whales, dolphins, tuna and some seabirds. For example, in what concerns Cory's shearwaters, mackerel is the single most important prey type, for birds nesting in the Madeira region. Within the OceanWebs project, we are trying to understand the importance of chub mackerel for predators, but also its role and trophic position in the food webs of the Madeira region. The samples

now collected will enlarge our large collection of specimens used for gut content analysis, and for isotope analysis.

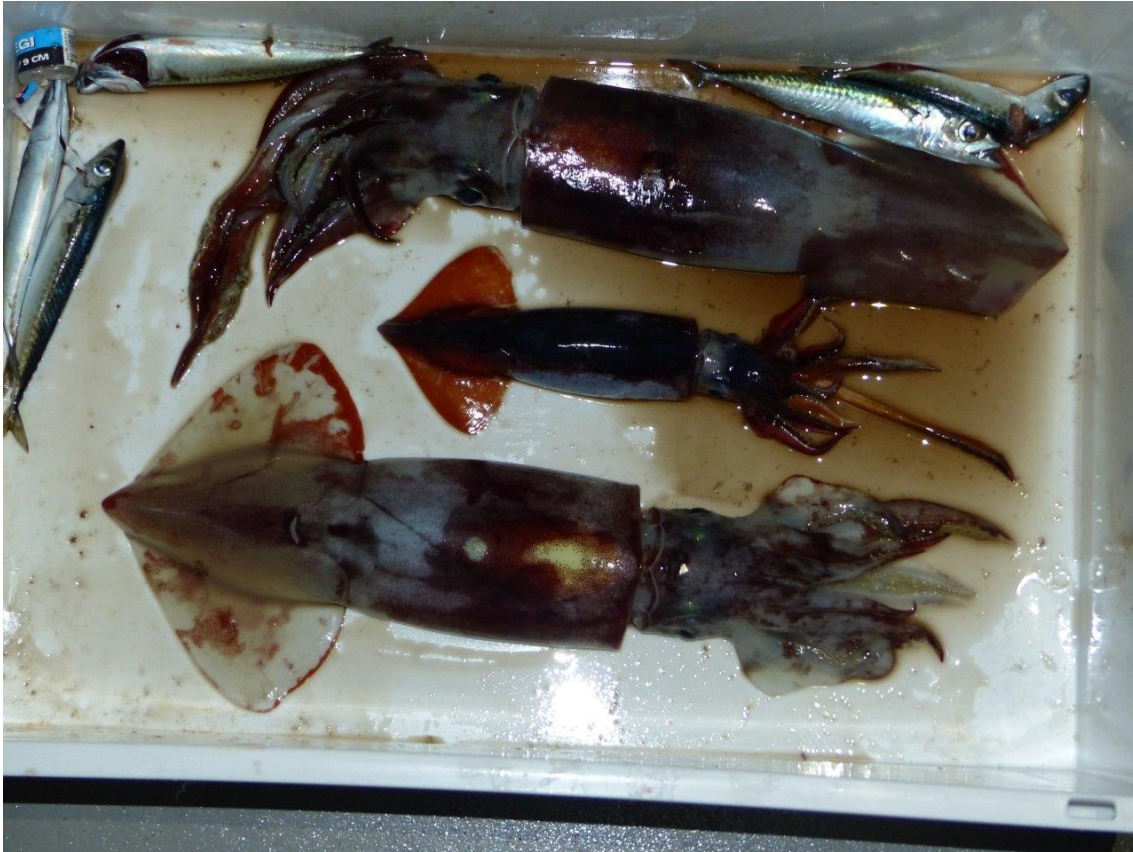


Figure 2. Some mackerel (*Scomber colias*) and squid (tentatively identified as *Sthenoteuthis pteropus*) specimens collected at night.

Third, considerable effort was spent looking for aggregations of cetaceans and birds, feeding in interaction, preying on shoals of small pelagics. The objective of the exercise was to assess which prey-species are caught during these interactions. Many groups of cetaceans were located, and observers assessed them from the ship and from smaller vessels, plus from underwater during snorkelling, but on no occasion were the cetaceans found to be actively feeding. A greater sampling effort will be needed to further advance this study. During the Yersin survey (see Figure 3 for approximate location of Yersin transect), we made underwater observations of 5 groups of spotted dolphins *Stenella frontalis*, 1 group of bottlenosed dolphins *Tursiops truncatus*, and 2 groups of short-finned pilot whales *Globicephala macrorhynchus*. We also entered the water at a location of ca 1500m bathymetric contour to inspect a floating wood log, which we

expected to work as a “natural” FAD (fish aggregating device). Despite its reduced size (2 m long and only ca 14 cm wide), this log had two pilot fish *Naucrates ductor*, plus 5 *Pseudocaranx dentex* and one *Seriola* spp associating with it. Such floating objects are privileged feeding sites for Cory’s shearwaters, and in particular pilot fish are a very important dietary item for these seabirds in the Madeira region.



Figure 3. Approximate location of transects for detection of seabird-marine mammal interactions.

An unintended product of this cruise, was the observation that many (at least 9) Bulwer’s petrels *Bulweria bulwerii* were attracted and fell on the ship while moored of Deserta Grande (Figure 4), with moderate onboard illumination (underwater lights were on to attract squid, but birds kept being attracted even after lights were switched off). One bird was injured. This occurred on a clear night, without moon and without cloud. This illustrates how illuminated vessels are a hazard for small petrels, particularly (but not only) near nesting colonies. Light pollution has a clear impact on small petrels, and the Yersin and other vessels should take great care to reduce as much as possible un-

needed external illumination whenever possible. This should be a permanent part of the sailing and mooring protocols.



Figure 4. Bulwer's petrels *Bulweria bulwerii* (and other petrels) are attracted to light during the night and get disoriented and often collide with ships sailing with strong light. Strong nocturnal lights represent a hazard to small petrels.