Pelagic fish assemblages in Cape Verde as sampled by mid-water Baited Remote Underwater Video Systems

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1 Introduction

Identifying drivers of distribution patterns in pelagic fish and sharks is fundamental to the effective conservation of the pelagic realm. Many pelagic species aggregate around physical features such as island slopes and seamounts[1] and around persistent oceanographic features such as fronts and upwellings[1]. These features are therefore preferentially targeted by fisheries activities, and are often vulnerable to depletion.

Our understanding of pelagic fish and shark assemblages is relatively limited due to challenges in sampling heterogeneously distributed species, which are of low overall density[2]. The use of non-destructive sampling techniques for monitoring pelagic fish assemblages is paramount to conservation and adequate management strategies of Marine Protected Areas (MPAs), where extractive activities and samples is restricted.

Cape Verde is a large group of islands in the tropical North Atlantic off the West Coast of Africa with an Economic Exclusive Area territory of 800,561 km^2, most of which is open-ocean. Reconstructed fisheries records in the archipelago have shown that a total of 758, 500 t have been caught from 1950 to 2010, with pelagic catches dominated by mackerel scad (*Decapterus macarellus,* 32%) and yellow fin tuna (*Thynnus albacares*)[3]. Although the sustainability of the fisheries are increasing[4], concerns have been raised regarding low spatial coverage of existing environmental monitoring in Cape Verde[3]. In order to address this we conducted a scientific survey to establish new fishery independent survey methodologies for pelagic fish population in Cape Verde. The aim was to improve spatial coverage of existing pelagic monitoring regimes, in order to improve fisheries sustainability.

<u>Objectives</u>

The Monaco Exploration Yersin Expedition (www.monacoexplorations.org) enables the study of ecological patterns across large spatial scale in the circumtropical belt, under varying environmental conditions. Further, the global expedition enables exploration of the structure of pelagic assemblages across different management regimes, including across regimes where all forms of exploitation are prohibited or human activity and pressures are relatively limited. These sites, including Cape Verde, are important to global biodiversity and are considered reference sites against which environmental and management impact can be assessed. Studying these areas will help us to identify components of the pelagic assemblage and evaluate their response to different management approaches. In the next Yersin destinations, this video recording based approach will be applied as a validation method for the use of environmental DNA (eDNA). The latter aims to detect species presence in a site solely from sampled water, where DNA is present from shredded cells, faeces, etc. and is later amplified and sequenced to identify the species present at the time of sampling[5]. Both techniques are non-invasive for targeted fauna, and represent a complementary approach to get the most accurate picture of species assemblages.

2. Method

Mid-water BRUVS designed to survey pelagic fish and sharks[6,7] (Fig. 1) were deployed in drifting 'longline' configuration of 5 rigs, where each rig is deployed 200 m from each nearest neighbour. The rigs are suspended at 10m depth by large surface floats and left to drift for 2 hours. The bait canister containing a mixture of pelagic fishes, mostly bonito, was suspended from the bait arm at a standardised distance of 1.5 m from the cameras.

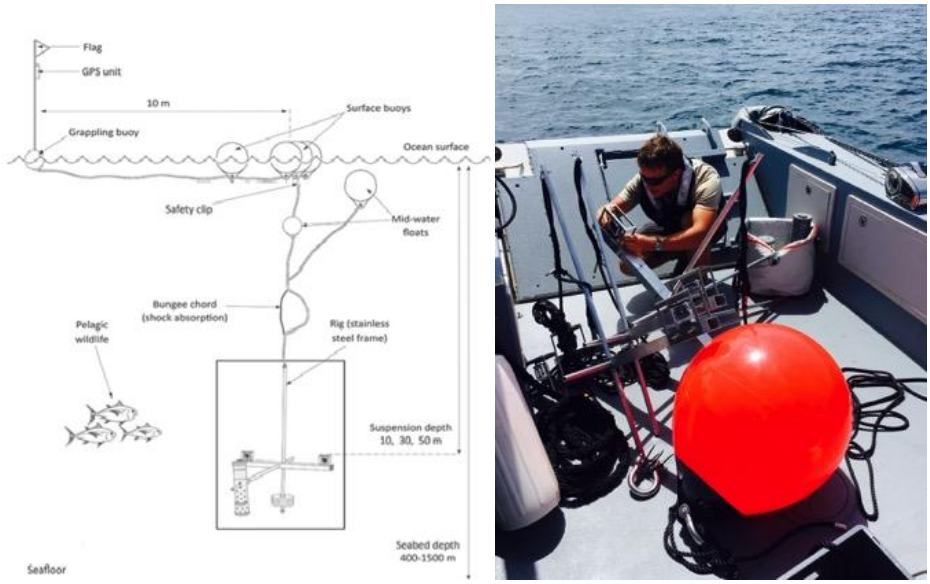

Fig. 1. Mid-water BRUV rig suspended in the open water (left pane), and preparation of the BRUVS on the Yersin Munson with a single surface buoy (right pane).

The stereo video system consists of a pair of GoPro video cameras in stereo configuration on a stainless steel frame. The rigs were deployed using the Yersin tenders, either the Munson or the ribs. The Munson was better suited in this task, due to the presence of a pothauler-type winch and the larger deck space. The longlines were fitted with a 'MIP' type satellite buoy, which enables the Yersin bridge to track them remotely.

3. Preliminary results

The mid-water BRUVS were deployed at three locations: outside the harbour of Sal Rei, on the southern coast (Sul) and on Joao Valente seamount bank. A total of 47 mid-water BRUV deployments were completed during the expedition (Table 1, Fig. 2).

Table 1. Mid-water BRUV efforts during the Cape Verde Monaco Exploration expedition.

Location	LAT	LONG	SEABED DEPTH (m)	#LONGLINES	#BRUVS
Sal Rei	16.15	-22.95	10-40	1	3
Sul	15.92	-22.94	100-250	5	24
Joao Valente	15.79	-23.15	10-200	4	20

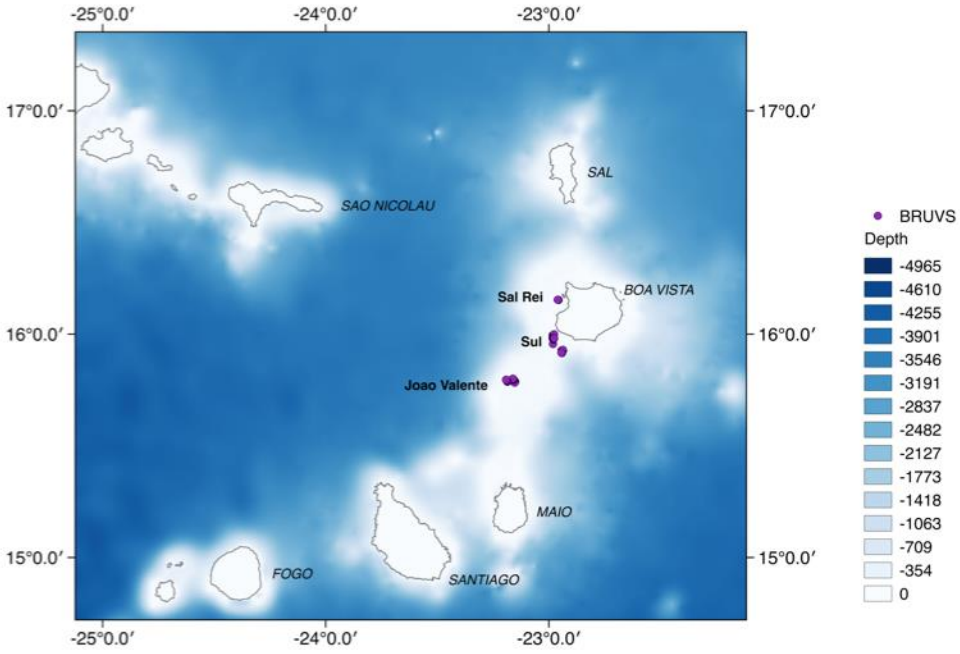

Fig. 2 Cape Verde and mid-water BRUVS sampling location in the three main sites: Sal Rei (n =3), Sul (n = 24), and Joao Valente (n = 20).

Preliminary viewing of mid-water BRUVS video footage have revealed records of pelagic predators and of low trophic level fish which are known to be targeted by fisheries both globally and regionally in Cape Verde, such as scalloped

hammerhead sharks (*Carcharhinus falciformis*), wahoo (*Acanthocybium solandri*) and mackerel scads (*Decapterus macarellus,* Fig. 3, Table 2).

4. Further analysis

All video imagery derived from the mid-water BRUVS will be processed using standard image analysis software (EventMeasure or VidSync) to (i) generate estimates of species richness, relative abundance per species and length for each sample, and to (ii) estimate demographic metrics using the individual body length and to (iii) evaluate behaviour (e.g., time of first arrival and individual behavioural responses).

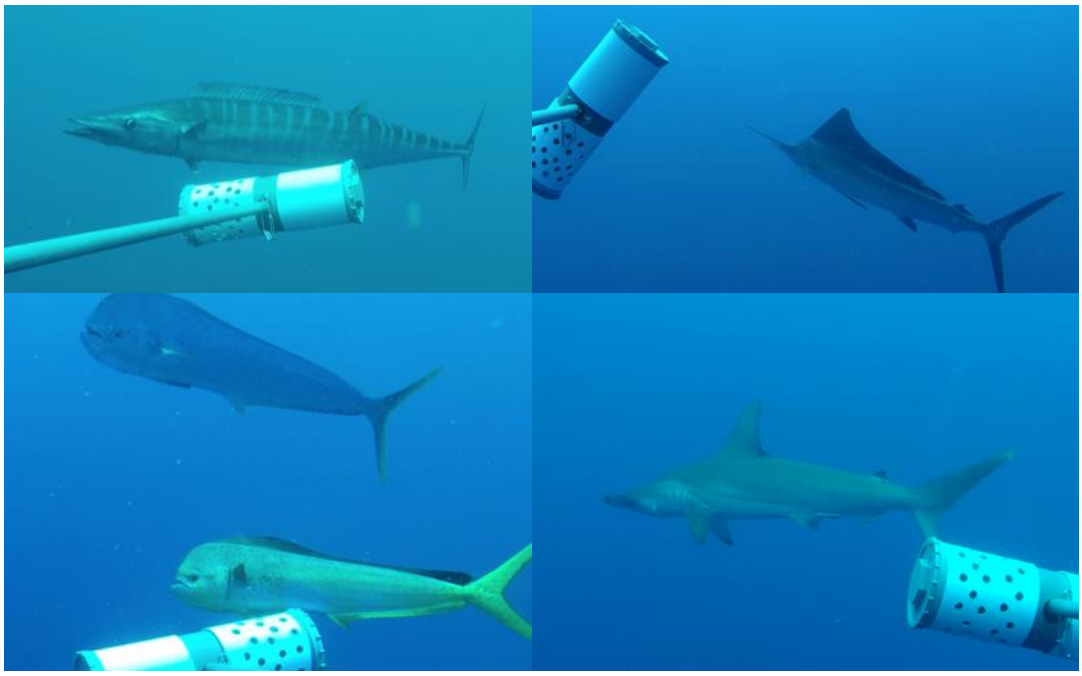

Fig. 3 Example of predators observed on the mid-water BRUVS in Cape Verde. Wahoo (top left, *Acanthocybium solandri*), sailfish (top right, *Istiophorus* sp), mahi mahi (bottom left, *Coryphaena hippurus*), and a scalloped hammerhead shark (bottom right, *Sphyrna lewini*).

Species richness is estimated as the sum of unique species observed on each BRUVS. The relative abundance will be quantified as MaxN, the maximum number of animals of a given species observed in a given frame of video [8]. This measure avoids double counts and has been shown to be robust through space and time[9].
A PhD project that focuses on the mid-water BRUVs derived from Monaco Exploration Yersin expedition has been approved by the National Environment Research Council. We expect further mid-water BRUVS sampling onboard the Yersin to be the focus of this project: https://london-nerc-dtp.org/2017/10/10/where-are-the-last-strongholds-of-marine-predators-in-the-pelagic-realm/.

5. Recommendation

Following conversation with the ship's Master, we make the following recommendation in order to facilitate and improve future scientific activities.

1) That a dedicated bait-freezer is fitted near the lazarette. This would be a major improvement from the current arrangement of storing bait in ice boxes on the crane deck: These boxes had to be topped up with ice cubes from the galley in order to be kept cool.
2) That a winch system capable of recovering monofilament is fitted on the Munson, in order to improve the deployment and recovery of the BRUVS longlines. The current systems of storing 800 m of 12 mm polypropylene line in boxes is heavy and requires a lot of storage space. Monofilament longline requires much less storage space and would enable us to deployment 2 or more longlines simultaneously and thus enable us to sample more effectively.
3) That a second MIP buoy be made available, in order to fit on the 2nd longline.
4) That bait provision is anticipated for future BRUVS mission. In order to ensure replicability with BRUVS deployment occurring prior to Monaco exploration (or simultaneously elsewhere) we request standardised bait (Clupeidae, sardines). Sardines are oily and of low trophic level, and widely available. We typically require 1.5 kg of sardines per deployment (7.5 kg per longline).

Table 2 Total species records derived from a preliminary analysis of the video footage

Species	Total Max*N*
Sphyrna lewini	1
Remora sp	1
Caranx crysos	12
Syngnathinae	2
Monacanthidae	2
Istiophorus sp	2
Coryphaenoides sp	10
Acanthocybium solandri	13
Stenella longirostris	13
Canthidermis sufflamen	17
Acanthurus monroviae	32
Trachurus trecae	25
Auxis thazard	45
Decapterus macarellus	301

6. Acknowledgement

We are deeply grateful to the Master, Chief and hardworking crew of the MV Yersin. The vessel's overall attitude and flexibility allowed us to sample beyond aspirational targets. The Monaco Explorations programme is a considerable asset for marine research and conservation and we are very grateful for their on-going support.

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