Passive acoustic survey for cetaceans of the Sargasso Sea, May 2024

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Background:

The Sargasso Sea is a 4.16 million km^2 area of the Atlantic Ocean depth ranging from the shallow coral reefs of Bermuda to the abyssal plains at 5,000 m (Ardron *et al.*, 2011; Huffard *et al.*, 2014; Lafolley *et al.*, 2011). The Sargasso Sea has no land borders, but rather is bordered on the west and northwest by the Gulf Stream, on the south by the North Atlantic equatorial current, on the east by the Canary Current, and bisected by the subtropical convergence zone. The Sargasso Sea biota is dominated by the presence of two entirely pelagic species of the seaweed *Sargassum* – *S. natans* and *S. fluitans* – and is thought to have rich, and in some cases unique, biodiversity. The region represents a breeding ground for turtles (loggerhead *Caretta caretta*; green *Chelonia mydas*; Kemp's ridley *Lepidochelys kempi*; and hawksbill *Eretmochelys imbricata*), endangered eels (the European eel *Anguilla anguilla* and the American eel *Anguilla rostrata*) and many pelagic fish species (Ardron *et al.*, 2011). Lafolley *et al.* (2011) states that 30 cetacean species spend some portion of their lives in the Sargasso Sea. Sperm whales are known to occur throughout the Sargasso Sea and surveys suggest that their occurrence may be influenced by oceanographic processes interacting with bathymetric features such as seamounts (Antunes, 2009; Wong & Whitehead, 2014). Humpback whales are known to migrate across the Sargasso Sea and their presence in Bermudan waters, which lie halfway between feeding and breeding grounds, has been documented since the 17th century (Stevenson, 2011, Stone *et al.*, 1987).

Threats to the Sargasso Sea ecosystem include the varying impacts related to poor fisheries management, shipping and shipping related impacts and pollution, including that from plastics (Laffoley *et al.*, 2011). Currently, the Sargasso Sea is loosely protected under the non-binding statement, the 2014 Hamilton Declaration on Collaboration for the Conservation of the Sargasso Sea (Sargasso Sea Commission, 2014). In 2012, a core area of the Sargasso Sea was described by the Convention on Biological Diversity (CBD) as an Ecologically or Biologically Significant Marine Area (EBSA) (Roe *et al.*, 2022). The region is a candidate for stronger protection under the newly agreed United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement) (United Nations, 2024). Legally binding protection would require multiple streams of data to establish a baseline and to document changes over time, in order to provide greater information on dynamic community composition and structure at the population level. In this study, we used a towed hydrophone array deployed from the stern of the *MY Arctic Sunrise* to conduct a passive acoustic survey during periods when the ship was not engaged in other activities such as collecting eDNA samples or campaign work. We were able to collect a continuous recording during the night and have analysed these data to illuminate which cetacean species were acoustically detected during the transit.

Methods:

Acoustic data were collected from the *MY Arctic Sunrise* during hours of darkness using a hydrophone array comprising four hydrophone elements (Vanishing Point, UK). The hydrophone array was towed behind the vessel with a 350 m Kevlar-strengthened cable. Two elements formed a medium frequency pair spaced 3 m apart (Benthos AQ4 elements and Magrec HP02 preamplifiers, nominal frequency range 50 Hz to 40 kHz), and two formed the high frequency pair spaced 50 cm apart (Magrec HP03 hydrophone and preamplifiers units, nominal frequency range 1 kHz to 200 kHz). Each hydrophone element was connected to a four-channel data acquisition card (St Andrews Instrumentation, UK) where analogue gain and filtering were applied (Medium frequency pair: 10 Hz high pass filter and 6 dB of gain. High frequency pair: 2,000 Hz high pass filter and 12 dB of gain). All four channels were digitally sampled at 500 kHz and written to 16 bit lossless '.wav' files using PAMGuard (Gillespie *et al.*, 2008; www.pamguard.org).

Acoustic .wav files were re-processed offline within PAMGuard viewer mode to detect marine mammal vocalisations. Offline processing followed the methods outlined in Webber *et al.* (2022), with the off a humpback whale deep learning model (Allen *et al.*, 2021) in an effort to increase the likelihood of detecting baleen whale vocalisations along with the whistle and moan detector. The deep learning model was implemented within the PAMGuard deep learning module on down sampled recordings (4000 Hz) with a window and hop length of 16000 and 8000 samples respectively. A minimum prediction threshold of 0.7 was applied to any humpback whale classifications which would be later manually audited.

Results:

Approximately 31 hrs of acoustic recordings were collected between the 2nd and the 5th of May 2024, and approximately four hours on the 10th of May 2024. A total of eight acoustic encounters were recorded during the survey (Table 1 – Figure 1). Of these, six were delphinid encounters, which could not be attributed to species level. The remaining two acoustic detections were of sperm whale groups, with approximately four and two individuals respectively. During the sperm whale encounter on the 4th of May, 7R and 9R codas (Gero *et al.*, 2016) were detected (Figure 2). Further analysis may be required to quantify fully the different types of codas and numbers detected. None of the acoustic detections could be localised from the track line due to the lack of GPS data recorded during the survey. Positions of acoustic detections were estimated by interpolating between GPS positions recorded within the ship's logbook approximately every two hours. No narrow band high frequency (NBHF) clicks were acoustically detected during the survey. The humpback whale deep learning model also did not detect any humpback whale vocalisations during the survey.

Table 1. Summary of acoustic detections onboard the M/V Arctic Sunrise between the 2nd and 10th of May 2024.

Common name	**Date**	**Time (UTC)**	**nClicks**	**Whistle frequencies kHz (lower – mid – upper)**
Unidentified dolphin	2nd May 2024	23:57	178	NA
Unidentified dolphin	3rd May 2024	02:46	216	13 .1 – 15.2 – 18.2
Unidentified dolphin	3rd May 2024	09:50	NA	9.4 – 11.0 – 12.6
Sperm whale group (approx. 4 individuals)	4th May 2024	01:20	1684	NA
Unidentified dolphin	4th May 2024	04:38	423	9.8 – 11.8 – 18.2
Unidentified dolphin	4th May 2024	09:07	2758	3.8 – 11.9 – 18.2
Unidentified dolphin	5th May 2024	14:40	NA	7.9 – 12.8 – 18.0
Sperm whale group (approx. 2 individuals)	10th May 2024	15:32	1087	NA

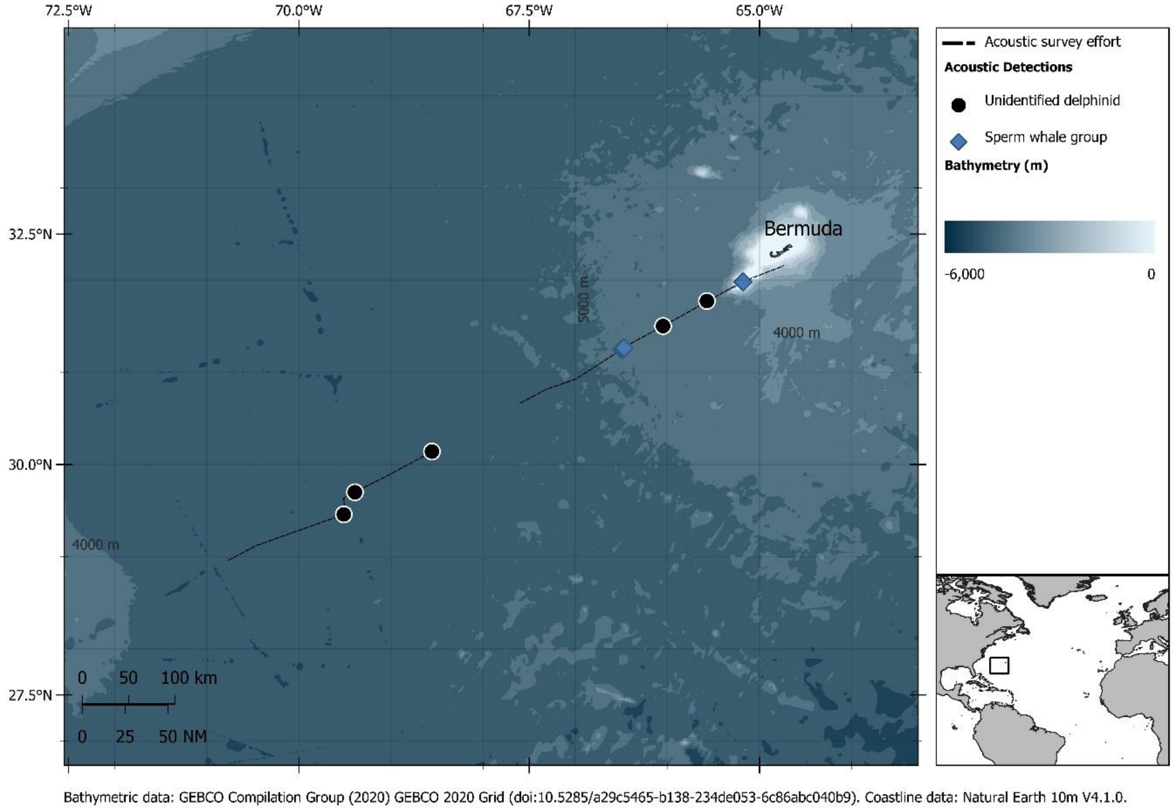

Figure 1. Acoustic detections recorded from *MY Arctic Sunrise* during surveys within the Sargasso Sea between the 2nd and 5th of May and for four hours on the 10th of May 2024. Acoustic survey effort is shown by the dotted black line.

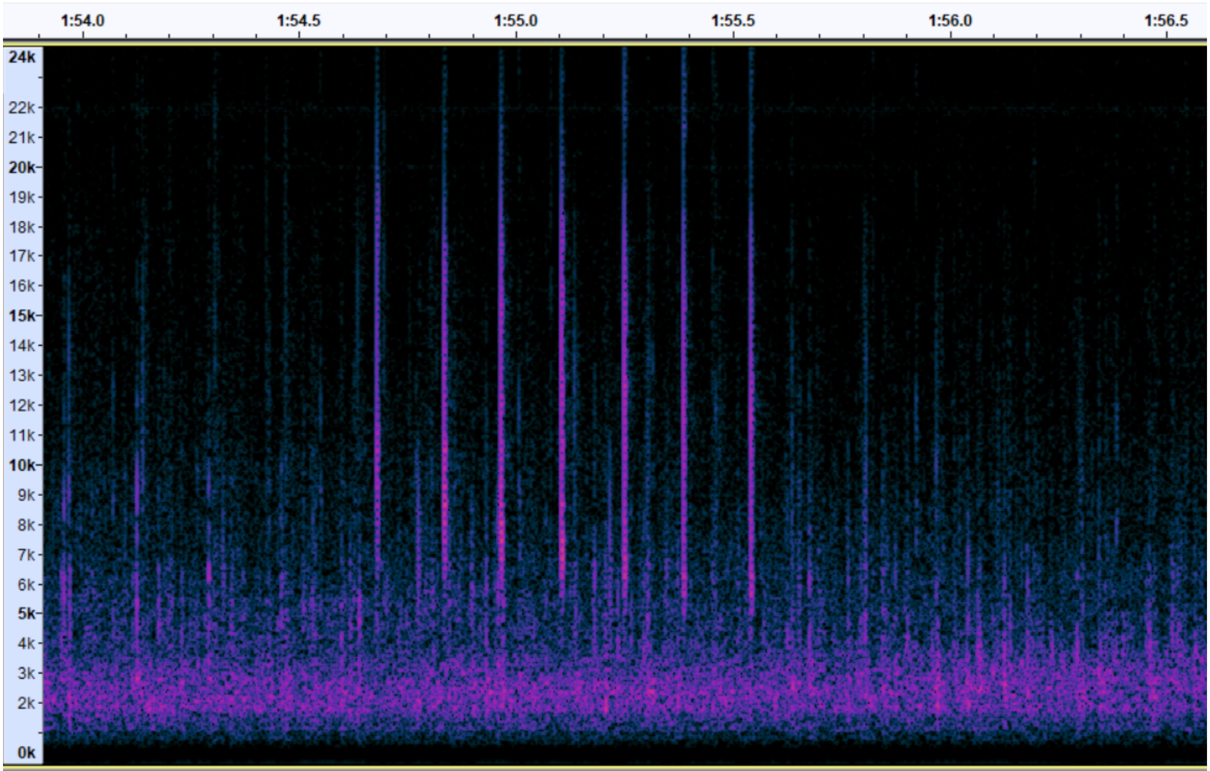

Figure 2: Example of a 7R coda recorded during a sperm whale acoustic encounter on the 4th May 2024 onboard the *MY Arctic Sunrise*.

Discussion:

This survey provides preliminary data on cetaceans detected acoustically during the short transit of the Greenpeace Vessel *MY Arctic Sunrise* across the Sargasso Sea in early May 2024, based on a total of 31 hrs of recordings. The only species to be identified to species level were sperm whales, with two separate acoustic encounters with approximately four whales (4th May 2024) and two whales (10th May 2024) respectively. On the 4th May 2024, two different codas were recorded – 7R and 9R – which are clicks with regular inter-click intervals (as opposed to those with longer gaps between clicks). These 'regular' class codas of varying lengths of click repetitions have been recorded previously in the Sargasso Sea (Antunes, 2009) and Dominica (Gero *et al.*, 2016) and Azores (Antunes, 2009). According to Antunes (2009) 93% of codas from the Sargasso Sea had coda repertoires of between four and 10 click 'regular' codas. Gero *et al.* (2016), recorded whales using 'regular' (7R, 9R) class codas in Dominica and named these whales EC2 clan. EC2 were seen less frequently than other clans, namely EC1, and the authors suggest that the EC2 clan likely has a core range elsewhere and make occasional incursions into Dominican waters. It is plausible that the whales acoustically encountered on the 4th May 2024 were members of the EC2 clan, though this could only be verified through further survey work. Other acoustic encounters could not be identified to species level and have, therefore, been reported as unidentified dolphins.

Our results highlight the utility of operating a towed hydrophone from vessels on transit, or 'platforms of opportunity', particularly in deep ocean areas where data on the offshore distributions of cetaceans are limited. We hope that, by making these data freely available online through the OBIS-SEAMAP repository (https://seamap.env.duke.edu/), we can contribute to the database on species relying on Sargasso Sea habitats.

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