Detection of Longman's beaked whale during an opportunistic passive acoustic survey across the Indian Ocean, 2024

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Background:

Cetacean diversity in the offshore waters of the Indian Ocean is poorly understood (Balance & Pitman, 1998; Kiszka *et al.*, 2009; Webber *et al.*, 2023). Published articles and reports indicate that over 50 cetacean species can be found across the wider Indian Ocean, but many of these are confined to the colder southern hemisphere waters (Anderson, 2014). Less is known on the distributions of species in warmer waters, though there are concerns regarding the level of bycatch incurred as a result of industrial fisheries (Escalle *et al.*, 2015; Anderson *et al.,* 2020; Kiszka *et al*., 2009). Opportunistic visual or acoustic surveys are one way in which stakeholders can help to address this knowledge gap.

In March 2024, Greenpeace International deployed the SY Rainbow Warrior as part of a series of campaign activities within the Indian Ocean. The transits between campaign and other science support locations – Sri Lanka, Seychelles and Saya de Malha Bank – provided an opportunity for data collection on cetaceans.

Methods:

Acoustic data were collected from the *SY Rainbow Warrior* during a portion of the vessel's transit between Sri Lanka and the Seychelles (13th and 17th of March 2024) and on its return (25th and 28th April 2024) across international waters. A hydrophone array comprising four hydrophone elements (Vanishing Point, UK) 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, with data written to 16 bit lossless '.wav' files using PAMGuard (Gillespie *et al.*, 2009 – pamguard.org).

Acoustic .wav files were re-processed offline within PAMGuard viewer mode to detect marine mammal vocalisations. Offline processing broadly followed the methods outlined in Webber *et al.* (2022), with the addition of a humpback whale deep learning model (Allen *et al.*, 2021) and the whistle and moan detector in an effort to increase the likelihood of detecting baleen whale vocalisations. 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 167 hrs of acoustic recordings were collected between the 13th and 17th of March 2024 between the 25th and 28th April 2024. A total of 48 acoustic encounters were recorded across the two transits (Table 1). Of these, 23 were detected during the first transit west (Figure 1), with the remaining 25 in the second transit east.

All but one acoustic detection were from oceanic delphinids, which could not be attributed to species level. The remaining acoustic detection was from a group of beaked whales, detected in waters approximately 3800 m deep, relatively close to the slopes of the Saya de Malha bank (Figure 1). Click characteristics (Figure 2), namely the mean peak frequency of 24.1 kHz (± 4.6), a mean centre frequency of 24.0 kHz (±4.8), and mean ICI of 0.411 (± 174), suggest this group may have been Longman's beaked whales (*Indopacetus pacificus*) based on similarities with existing descriptions of Longman's beaked whale echolocation clicks (Rankin *et al.*, 2011; Baumann-Pickering *et al.*, 2013). Other beaked whale species known to inhabit the Indian Ocean with reported click characteristics are as follows: goose-beaked whales, (*Ziphius cavirostris*), dense-beaked whales (*Mesoplodon densirostris*), True's beaked whales (*Mesoplodon mirus*), and Deraniyagala's beaked whales (*Mesoplodon hotaula*) (Macleod *et al.*, 2006; Rosso *et al.*, 2020; Baumann-Pickering *et al.*, 2013; DeAngelis *et al.*, 2018; Dong *et al.*, 2024). However, none of these species match the click characteristics detected in the Greenpeace survey. Ginkgo-toothed beaked whales (*Mesoplodon ginkgodens*) and Gray's beaked whales (*Mesoplodon grayi*) have also been recorded in the Indian Ocean (Rosso *et al.*, 2020; Ellis and Mead, 2017), but currently there are no descriptions of their echolocation clicks.

None of the acoustic detections on the second transit (east) could be localised due to the lack of GPS data recorded during this transit. No narrow band high frequency (NBHF) clicks were acoustically detected during either of the transits. Neither the whistle and moan detector, nor the humpback whale deep learning model, detected any baleen whale vocalisations during the transits.

Table 1 – Summary of acoustic detections onboard the S/V Rainbow Warrior during the two transits within the Indian ocean between the 13th and 17th of March 2024 and between the 25th and 28th April 2024. Number of echolocation clicks and some whistle frequency metrics are reported.

Species Group	Date time (UTC)	Number of clicks	Latitude (DD)	Longitude (DD)	Whistle frequencies kHz (lower – mid – upper)
Unidentified delphinid	13/03/2024 11:01	219	-3.220	68.714	12.6 ,13 ,18.6
Unidentified delphinid	13/03/2024 13:44	-	-3.500	68.633	13.2 ,13.8 ,19.9
Unidentified delphinid	13/03/2024 15:01	1287	-3.629	68.566	-
Unidentified delphinid	13/03/2024 16:09	2776	-3.720	68.475	12.2 ,12.5 ,16.6
Unidentified delphinid	13/03/2024 17:42	5031	-3.878	68.379	12.8 ,13.3 ,22.8
Unidentified delphinid	13/03/2024 20:51	3227	-4.145	68.200	11.6 ,12.1 ,20.1
Unidentified delphinid	14/03/2024 04:42	1076	-4.737	67.732	12.3 ,12.9 ,23.9
Unidentified delphinid	14/03/2024 12:27	1569	-5.289	67.278	12.4 ,12.8 ,21.8
Unidentified delphinid	15/03/2024 03:12	-	-6.761	66.670	7.4 ,8.1 ,9.8
Unidentified delphinid	15/03/2024 05:48	921	-6.981	66.497	-
Unidentified delphinid	15/03/2024 10:22	1273	-7.333	66.094	11.5 ,12.4 ,16.4
Unidentified delphinid	15/03/2024 13:04	-	-7.465	65.902	10.4 ,11.2 ,23.9
Unidentified delphinid	15/03/2024 17:51	282	-7.870	65.526	-
Unidentified delphinid	15/03/2024 18:34	6112	-7.913	65.374	-
Unidentified delphinid	15/03/2024 19:23	3721	-8.057	65.438	-
Unidentified delphinid	15/03/2024 21:32	12399	-8.279	65.302	9.3 ,9.9 ,21.1
Unidentified delphinid	16/03/2024 01:05	1039	-8.689	65.067	-
Unidentified delphinid	16/03/2024 15:02	393	-9.766	64.607	-
Unidentified delphinid	16/03/2024 19:00	3137	-9.852	64.215	-
Beaked whale	16/03/2024 21:47	302	-9.796	63.947	-
Unidentified delphinid	16/03/2024 22:27	516	-9.758	63.890	-
Unidentified delphinid	16/03/2024 23:33	1126	-9.729	63.774	12.1 ,12.6 ,21.8
Unidentified delphinid	17/03/2024 01:47	-	-9.683	63.515	11.8 ,12.5 ,21.2

Species Group	Date time (UTC)	Number of clicks	Latitude (DD)	Longitude (DD)	Whistle frequencies kHz (lower – mid – upper)
Unidentified delphinid	25/04/2024 10:26	-			9.6 ,10.8 ,15.4
Unidentified delphinid	25/04/2024 11:07	-			12 ,12.6 ,14.4
Unidentified delphinid	25/04/2024 19:32	758			,-
Unidentified delphinid	25/04/2024 20:26	11384			12 ,12.6 ,20.9
Unidentified delphinid	25/04/2024 21:09	4417			11.1 ,11.6 ,20.2
Unidentified delphinid	25/04/2024 23:24	-			10.5 ,11 ,22.8
Unidentified delphinid	26/04/2024 01:02	7182			10.2 ,10.8 ,23.9
Unidentified delphinid	26/04/2024 07:09	146			13.2 ,13.6 ,17.4
Unidentified delphinid	26/04/2024 10:01	2061			14.6 ,15.4 ,23.9
Unidentified delphinid	26/04/2024 12:52	3587			14.3 ,15.5 ,22.2
Unidentified delphinid	26/04/2024 15:04	1469			-
Unidentified delphinid	26/04/2024 16:13	1491			-
Unidentified delphinid	26/04/2024 16:38	4398			11.7 ,13 ,23.9
Unidentified delphinid	26/04/2024 19:34	4102			10.7 ,12.1 ,20.6
Unidentified delphinid	26/04/2024 22:55	1671			-
Unidentified delphinid	27/04/2024 07:58	-			15.7 ,16.7 ,23.4
Unidentified delphinid	27/04/2024 12:06	177			12.8 ,13.5 ,23.9
Unidentified delphinid	27/04/2024 13:19	-			9.1 ,9.5 ,14.1
Unidentified delphinid	27/04/2024 14:22	1014			-
Unidentified delphinid	27/04/2024 16:17	3668			8.4 ,9 ,19.7
Unidentified delphinid	27/04/2024 18:50	3113			-
Unidentified delphinid	27/04/2024 21:23	-			12.4 ,13.6 ,22.4
Unidentified delphinid	27/04/2024 22:10	651			-
Unidentified delphinid	27/04/2024 23:47	999			-
Unidentified delphinid	28/04/2024 05:13	-			14.8 ,15.1 ,18.4

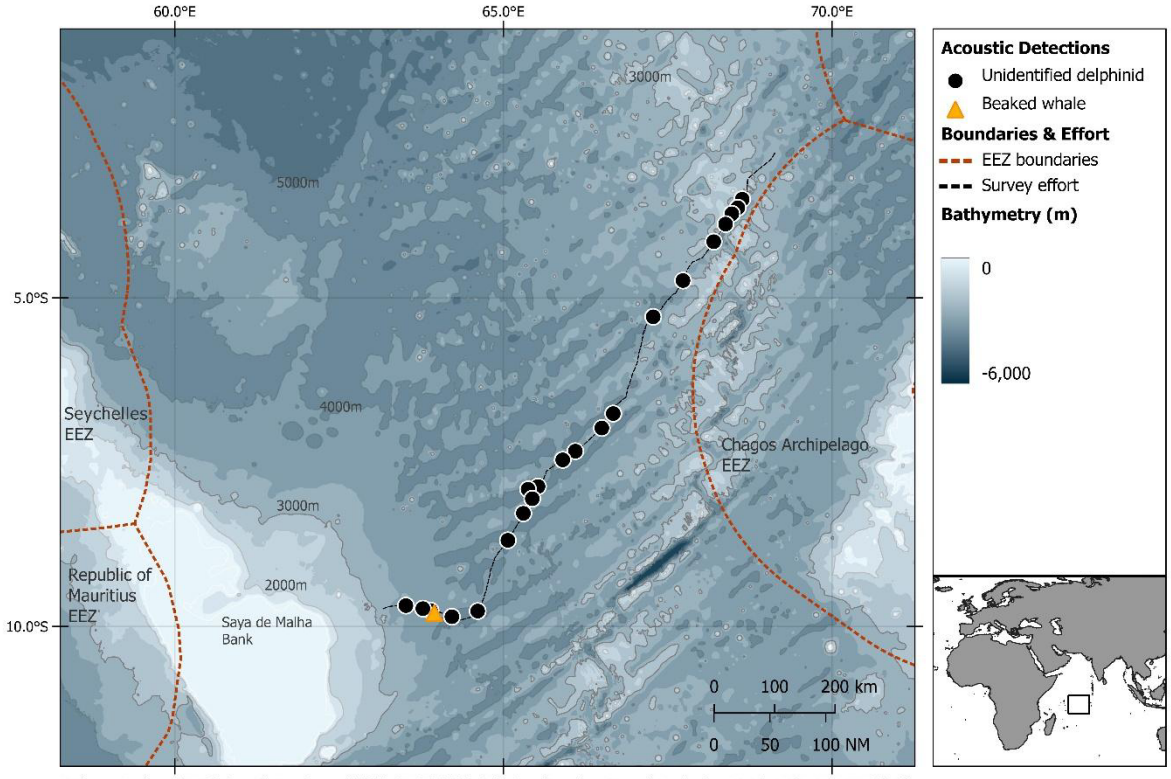

Figure 1 – Acoustic detections from the *SY Rainbow Warrior* during a portion of the transit from Sri Lanka and the Seychelles between 13th and 17th of March 2024. All but one acoustic detection were of oceanic delphinids that could not be identified to species level. The remaining detection was a group of beaked whales (orange triangle) likely to be Longman's beaked whales based on click characteristics. Bathymetric data from GEBCO Compilation Group (2020) GEBCO 2020 Grid. Coastline data: Natural Earth 10m V4.1.0.

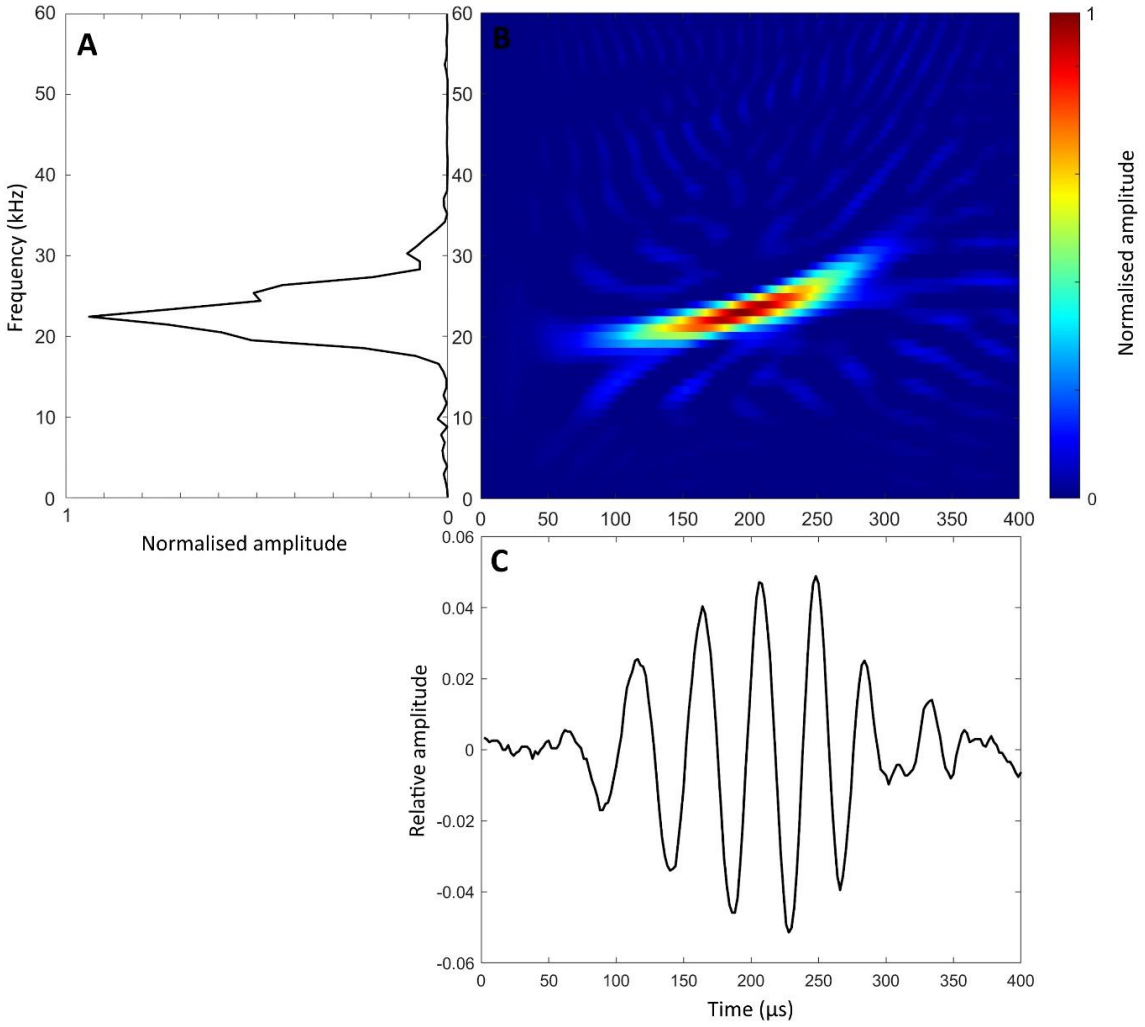

Figure 2 – An example echolocation click from the beaked whale detection on the 16th March 2024 at 3800 m water depth. The peak click frequency here 22.5 kHz (mean 24.1 kHz) can be seen in plot A. The characteristic upsweep in the Wigner-Ville distribution can be seen in plot B. Plot C shows the click waveform, with a click length of approximately 250 µs.

Discussion:

We report the findings of a short preliminary survey carried out opportunistically during transits across the Indian Ocean. The vessel *SY Rainbow Warrior* is a valuable platform for acoustic data collection given the utility and sensitivity of the towed hydrophone array system onboard. The majority of acoustic detections in this case were oceanic delphinids which could not be identified to species level in the absence of visual data. Nonetheless the data indicate that these waters provide important habitat for delphinid cetaceans.

One acoustic detection of a group of beaked whales, to the east of Saya de Malha Bank, is most likely Longman's beaked whale, based on click characteristics that match with those described by Shannon et al. (2011) with a mean peak frequency of 24.1 kHz. The detection near Saya de Malha is consistent with the findings of Anderson et al. (2006), which suggested that Longman's beaked whales are distributed in the warm offshore waters (> 27 °C) of the Western Indian Ocean,

particularly over or adjacent to deep slopes (250 m to 2000+ m water depth). The water depth for the Longman's detection in our survey was 3800 m, and this is consistent with findings of both Anderson et al. (2006) and other recorded sightings such as Afsal et al. (2009) (Bay of Bengal, 3500 m water depth), Martin & Wood (2016) (Kenya, 3707 m water depth).

Our report highlights the utility of integrating passive acoustic monitoring where possible during the long transits of vessels necessary to engage in other work. The *SY Rainbow Warrior* was able to follow an efficient transit route and speed in addition to collecting data on offshore cetaceans with minimal additional effort beyond downstream analysis. We hope that other organisations and institutions can in future follow such data collection protocols in order to help fill similar data gaps in relation to the distribution of offshore cetaceans.

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