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Identifying critical habitats of melon-headed whales *(Peponocephala electra)* in Mauritian waters using a multi-source approach: implications for conservation management

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ABSTRACT

The melon-headed whale (*Peponocephala electra*) is one of the species of cetacean most associated with mass strandings. Such events have repeatedly occurred in the same location on the east coast of Mauritius in the western Indian Ocean, but the cause remains unknown. Conducted after a mass stranding in 2020, this study aimed to provide insights to help prevent similar events in the future. During field work carried out in 2021 pods of over 100–200 individuals were observed in the target area at a median distance of 11.3 km from the shore and at a median depth of 176 m. In almost half of observations (44%), they exhibited resting behaviours. Mark–recapture analysis based on photo-identification revealed 272 unique individuals, 18% of which were resighted across one to five sampling periods. Although the dataset did not allow for the determination of social structure, the recurrent associated individuals across sampling periods suggests the reuse of the study area and indicates site fidelity. Consistent with local ecological knowledge and observations of resident populations in other island regions, these ecological and behavioural patterns support the hypothesis that the eastern waters of Mauritius could be a critical habitat for *Peponocephala electra*, potentially hosting resident groups. Six other cetacean species were recorded within the study area, indicating broader conservation importance of the region. To help prevent future strandings and based on the most probable contributing factors, we provide recommendations to reduce anthropogenic pressure and incorporate identified critical habitats into marine spatial planning.

1. Introduction

Mass strandings of marine mammals have complex and unpredictable patterns. However, some locations, particularly those associated with areas of higher productivity, are hotspots for such events (Hamilton, 2018). The root causes of recurring events in such locations may be various natural factors, such as the coastal configuration and geomorphology of the site favouring stranding, e.g. sandy, flat slopes and mudflats, as well as weather and oceanic processes, e.g. tides, currents, storms and tectonic events (Hamilton, 2018; Moore et al., 2017). Nevertheless, scientists more often point to anthropogenic causes of mass strandings, such as sound effects from military sonar, seismic echo sounders, and fisheries interaction (Aragones et al., 2024; Moore et al., 2017; Ortiz-Wolford et al., 2021; Yuan et al., 2025). In these cases, repeated cetacean strandings may indicate spatial overlap between areas of frequent or consistent species presence and zones of human activity that pose threats. Although the causes of specific events are usually investigated after the event, identifying critical cetacean habitats adjacent to areas with repetitive strandings can provide a proactive basis for conservation to reduce mortality. Notable example from Scotland demonstrates how spatiotemporal analysis of stranding data can identify key reproductive areas for harbour porpoises, informing management recommendations for seasonal mitigation of anthropogenic threats during the spring and summer months (Lennon et al., 2025).

Areas of consistent species presence—especially where individuals exhibit site fidelity—may represent critical habitats, essential for long-term population persistence. Following Morán-Ordóñez et al., 2025, a critical habitat is defined as an area supporting key ecological functions (e.g., foraging, reproduction, social cohesion), whose loss would significantly impair species conservation. In this context, site fidelity—the tendency of individuals or groups to return to previously occupied locations—can be interpreted as an adaptive behavioral

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strategy, emerging when high habitat quality, predictable resource availability, and elevated costs of dispersal outweigh the potential benefits of exploring alternative areas (Switzer, 1993). Consistent presence of cetaceans in specific marine regions can also shape ecosystem dynamics, influencing trophic interactions and nutrient cycling (Roman et al., 2014), particularly in social, long-lived species with limited home ranges (Gilbert et al., 2023). Therefore, identifying habitats that are functionally irreplaceable—not merely frequently used—is essential for effective conservation.

Marine spatial planning (MSP) is a key tool for integrating such ecological insights into ocean governance. As a process for allocating marine space among competing uses, MSP enables the protection of Ecologically or Biologically Significant Marine Areas (EBSAs) by balancing conservation with sustainable development (Dunn et al., 2014; Ehler & Douvere, 2009). For example, Harris et al. (2022) demonstrate in South Africa how evidence-based MSP, combined with stakeholder engagement and adaptive governance, can effectively manage EBSAs in developing-world contexts. Thus, MSP provides a practical framework for translating behavioral ecology into actionable conservation, ensuring that areas of high ecological value are safeguarded from escalating anthropogenic pressures. By incorporating data on species distribution, site fidelity, and habitat quality in MSP can support the implementation of measures to mitigate human impacts and help to prevent new strandings.

Over 95% of mass strandings globally are associated with 6 species of cetaceans, one of which is melon-headed whale (*Peponocephala electra)* (Hamilton, 2018). This species is recognised as being particularly sensitive to noise pollution (Wang et al., 2021). Globally, there has been an increasing trend in melon-headed whale strandings (Aragones et al., 2024; Hamilton, 2018; Ofori-Danson et al., 2022) frequently linked to anthropogenic stressors such as naval sonar, high intensity underwater noise, and vessel traffic (Aschettino et al., 2012; Erbe et al., 2019; Ofori-Danson et al., 2022; Wang et al., 2021). They are occasionally caught accidentally in tuna purse seine nets and in drift nets fisheries (Ilangakoon, 1997; Jeyabaskaran and Vivekanandan, 2013). Further, their highly social nature suggests that disturbances make them particularly prone to mass strandings and is likely to have wider consequences for group dynamics and population viability (Baird et al., 2015).

Melon-headed whales (MHW) are small odontocetes that are commonly found in deep tropical and subtropical offshore waters with a depth range of 300 to 2,000 m in areas associated with steep bathymetry and submarine canyons (Brownell Jr et al., 2009). Data from locations such as Hawaii and French Polynesia show the presence of the island-specific populations that exhibit long-term site fidelity and limited dispersal (Aschettino et al., 2012; McClung, 2017; Perryman and Danil, 2018). They are an incredibly social species with matrilineal social structure and normally seen in the aggregations of several hundred individuals (Amano et al., 2014; Brownell Jr et al., 2009; Perryman and Danil, 2018). This species rests throughout the morning, socialises in the afternoon and forages at night for squid, fish, and cuttlefish (Baumann-Pickering et al., 2015). In the Western Indian Ocean (WIO), MHW sightings have been recorded mainly off oceanic islands such as Comoros, Madagascar, Mayotte, Reunion, Seychelles and Mauritius (Kalashnikova et al., 2025), though systematic studies remain limited.

One of the top WIO countries in terms of stranded cetaceans is Mauritius due to mass strandings of MHW. (Plön et al., 2023). In the last 20 years, two major mass stranding events have occurred in Mauritius, the first one in 2005 and then in 2020. Both events occurred on the eastern coast of Mauritius, at the Grand Sable Lagoon, and involved the same species: melon-headed whales. Collectively, the events involved at least 275 individuals – 75 in 2005 and about 200 in 2020, of which 87 died (35 and 52 respectively). Details of the 2005 stranding event are limited and the cause of evet is unknown; only the location, the number of individuals involved, and a brief description of the operation to herd surviving animals back into the open ocean are documented (Mauritian Marine Conservation Society, unpublished data). In 2020, the case was well documented, a necropsy of the animals was carried out and photographs of dorsal fins of survivors were collected for subsequent analysis and photo-identification (Plön et al., 2020). The dead animals showed signs of decompression sickness and rostrum fractures in some, while the survivors had numerous abrasions and cuts all over their bodies (Fig. 1). The cause of the 2020 event remained undetermined, but most likely occurred offshore and was related to anthropogenic impacts through noise disturbance or bycatch (Plön et al., 2020).

Therefore, melon-headed whales, with their reliance on steep bathymetric features, site fidelity, predictable diel behaviour, social cohesion, represent a species for which the concept of critical habitat is highly relevant. It is important to emphasize the considerable intra-specific ecological variation observed in this predominantly offshore species, when certain sub-populations demonstrate island-associated specialisation and consistently occupy restricted home ranges (Aschettino et al., 2012). Similar resident, island specialised groups have been documented in other odontocetes, including killer whales, false killer whales, and sperm whales (Barteneva-Vitry et al., 2025; Vachon et al., 2022). The determination and conservation of such discrete population units is essential for maintaining both the genetic and cultural diversity at the population and species levels (Vachon et al., 2022).

Repeated mass strandings on the east coast of Mauritius suggest a spatial overlap between core habitat use and human-induced threats. Protecting these areas is crucial not only for the species' survival but also for maintaining broader ecosystem integrity of Mauritius. Although a formal, nationwide Marine Spatial Planning (MSP) framework has not yet been fully implemented in Mauritius, foundational steps have been taken through national coastal zone management initiatives and regional collaborations under the Nairobi Convention (Mcateer et al., 2022; Ramessur, 2015; UNEP, 2021). These efforts provide a viable platform for integrating scientific findings into future MSP processes. This study is therefore timely and essential: it generates critical data on habitat use and residency patterns of melon-headed whales, directly informing evidence-based conservation planning and helping to prevent future strandings through targeted spatial management.

Following the reoccurrence of stranding this study was conducted during 2021. Its aim was to fill key knowledge gaps that are essential for informing local conservation and MSP efforts. The specific objectives were: (1) explore adjacent waters off the east coast of Mauritius to identify critical habitat for MHW; (2) examine the residency of the population; (3) develop recommendations to prevent possible strandings in the future for inclusion in the MSP of Mauritius.

2. Methods

2.1. Study design

The selection of the survey area was based on relative proximity to the stranding area and testimonies from local fishermen regarding the occurrence of MHW in adjacent waters. In addition, the knowledge from the scientific literature on habitat preferences of this species in relation to local marine topography associated with foraging grounds was taken in account.

The team of local non-governmental organisation (NGO) Marine Megafauna Conservation Organisation (MMCO) arrived on site at the onset of the 2020 mass stranding event for investigation. Given that this was the second event of the same species in the same location — following a similar event in 2005 — as part of the investigation, interviews were conducted with local fishers, particularly those with offshore experience, to assess their familiarity with the species. Along the eastern coast of Mauritius, fishing effort is predominantly directed toward the inner lagoon, with comparatively little offshore activity, as persistent south-east trade winds produce rough sea conditions in this region (Appadoo et al., 2022). Consequently, encounters with pelagic species are relatively rare. During the interviews, while some residents expressed uncertainty about whether the stranded animals were

Fig. 1. Injuries on the bodies of surviving melon-headed whales during the stranding event at Grand Sable Lagoon on the east coast of Mauritius in September 2020. Photo credit: Hugues Vitry.

dolphins or whales, one fisherman in his forties reported long-standing familiarity with these animals, which he referred to as "*marsouins*". He stated that he had regularly observed large groups—often exceeding 100 individuals—in offshore waters since beginning his fishing career over two decades earlier. His account was corroborated by similar observations from another experienced offshore fisher.

In French, the term "*marsouin*" typically refers to porpoises (*Phocoenidae*), but historically it has also been used for small cetaceans with blunt snout (Littré, 1872). However, no porpoise species are known to occur in the waters around Mauritius or elsewhere in the tropical Indian Ocean (Jefferson et al., 2011). The described morphological and behavioural traits — particularly the relatively small size, bulbous head, and offshore, gregarious behaviour — are consistent with MHW or other small cetacean with similar head anatomy like a pygmy killer whale *(Feresa attenuata)*, for example, which are often confused with MHW (Castro, 2004). However, repeated, localized sightings over more than two decades can suggest the potential existence of a critical habitat for the species in the region.

Building on fisher testimonies, bathymetric analysis was used to refine the study site. A zone northeast of Grand Sable Lagoon, 10–15 km offshore, was selected where depths increase sharply from ~100 m to over 2000 m within 5 km, distinguishing it from the generally more gradual eastern shelf. This steep drop is consistent with known habitat preferences of melon-headed whales and indicates potential prey-rich areas (Moors-Murphy, 2014), providing a clear rationale for choosing this location as the focal study site.

The field survey was conducted within the framework of the 'Whales of Mauritius' project, which was implemented by MMCO. The project aimed to obtain up-to-date data on species diversity and the spatial and temporal distribution of cetaceans in Mauritius with identification of critical habitats. It also aimed to map ecologically sensitive areas for marine mammals and to assess the anthropogenic pressure, in order to improve conservation management. The project comprised four 10-day expeditions around Mauritius over a period from 01 March 2021 to 01 March 2022: two in the summer season (November–April) and two in the winter season (May–October). Although the east coast was entirely surveyed during the expeditions, weather conditions permitting, at least two days per expedition were devoted to searching the focal area of the MHW study.

2.2. Field methods

Surveys were conducted by boat during daylight hours (7:00–16:00), and with state conditions of Beaufort 4 or less. The research vessel followed a cruising speed of 7 – 10 knots during transit and reduced speed to 7–8 knots when cetaceans were encountered. A minimum of two trained cetacean observers were on board during each expedition. Visual observations were conducted from the vessel's highest vantage point using the naked eye and binoculars to monitor a 180° sector. Approximately every 30 min when weather conditions permit acoustic search was conducted using hydrophone SS03 −10 Sea-Phone 'Cetacean Research Technology". When the animals were in sight, encounters were documented with photo equipment. For most small cetaceans, the posterior edge of the dorsal fin is the most identifying feature. Data for photo-identification were collected using commonly used procedures (Wiirsig and Jefferson, 1990). Photographs were taken from a boat, by one or two observers, using SLR digital cameras with 70–300 mm telephoto lenses, allowing rapid adjustments to take pictures of individuals at different distances from the boat. All individuals were photographed with particular attention to dorsal fins, irrespective of any distinguishing features, with the aim of photographing as many individuals as possible. Additional recorded data included date, time, GPS location, sea conditions, the best size of the pod and presence of other species of cetaceans. Data on behaviour was recorded as well: traveling (swimming towards a specific direction) and bow-riding Infront of boat; stationary and resting (not moving, logging − swimming in place with their heads emerging above the water's surface), avoidance (movement to avoid sailing vessels), feeding (food-seeking activity) (Pranatami et al., 2023).

2.3. Photo-identification and catalogue compilation

After the completion of each expedition, dorsal fin photos were sorted within each encounter, taking into account focus, dorsal fin angle, visibility due to splashes, waves or other individuals. Only the best photos of each individual that met the criteria of 'excellent' or 'good' were included in the catalogue. Each individual was given an identification name containing the first letters of the species scientific name *Peponocephala electra*, the year and month of the first encounter, and a serial number in the following format Pe-YYMM-NNNN. When melon-headed whales were encountered in mixed groups with Fraser dolphins, if the species of individual could be distinguished, the Fraser's dolphin *(Lagenodelphis hosei)* was assigned the number Lh-YYYMM-NNNN, and if the species could not be distinguished, the individual was assigned the ID name Pe-Lh-YYMM-NNNN. The selected images were then manually compared (matched) one by one and previously unidentified individuals were catalogued. Only data on individuals from *Peponocephala electra* catalogue were used for further analysis.

In the same way, photographs of individuals from the stranding event collected on 20 September 2020, when about 150 surviving individuals remained for several days in the lagoon until they voluntarily left the site, were processed and added to the catalogue.

2.4. Data analysis

The existence of MHW's critical habitat was determined based on the presence/absence basis of animals in the study area and behavior. To profile the MHW's habitat, encounters were analysed for bathymetry, distance from the coast and slope. Bathymetry data with a 1 km of resolution were obtained from the General Bathymetric Chart of the Oceans (GEBCO, https://www.gebco.net). The coastlines were obtained from the MapCruzin society (https://mapcruzin.com/). Distance to-coast, slope and isobaths were derived from the bathymetry data using tools of QGIS v. 3.24.0-Tisler. Isobaths were sub-divided into bathymetric strata: oceanic shelf (<200 m), slope (from 200 to 2,000 m) and oceanic (>2,000 m) strata, like Laran et al., 2017.

Created ID catalogue of MHW served as a foundation for assessing site fidelity and re-sighting frequencies over the survey period. The capture-recapture analyses were carried out using the software SOCPROG ver. 2.10 for MATLAB 2023b (Whitehead, 2009). Given the small number of sampling periods in this study ($n < 15$, Whitehead, 2001), it was not possible to produce statistically adequate estimates of social differentiation and association indices for hierarchical cluster analysis (Cairns and Schwager, 1987). However, a simple matrix of occurrences was constructed to get an insight into the fidelity of the MHW groups to the study site. This was done taking into account the high sociality of MHW and based on the assumption that if individual is recorded as part of a particular group, then in the case of recapture it can be assumed that this individual is recaptured as part of the same group. Each observation day (group) was labelled (A–H).

3. Results

3.1. Melon-headed whale encounters in study area

The hypothetical melon-headed whale (MHW) habitat area was surveyed 9 times over 40 days of fieldwork, twice during each of the first three expeditions and three times during the fourth expedition. Observations were made in all seasons and at different times of the day (morning and afternoon). The presence of MHW in study area was recorded in 9 out of 9 observations/sampling periods, i.e., 100% of the target area survey days (Table 1, Fig. 2). Weather conditions averaged Beaufort 3 (min 2, max 4), which sometimes limited the data collection for photo-ID.

The median distance from shore at sighting locations was 11,257 m, ranging from 9,221 to 15,835 m. These areas were characterised by median depths of 176 m (min 68 m, max 470 m) and median seafloor slope 10% (min 3%, max 20%). Most sightings (6 out of 9) occurred between 10,000 m and 13,000 m offshore at depths ranging from 100 m to 300 m, particularly in areas with slopes of 5–20%, suggesting a preferred habitat zone within these parameters (Fig. 3).

MHW pods observed consistently consisted of over 100–200 individuals, structured into small sub-groups of 2 to 20 individuals, most often in the range of 6–12, and included calves. A variety of behaviours were documented, including both active behaviours (traveling, bow-riding) – in 8 from 9 observations and passive states (not moving, logging) – in 4 from 9 observations; no avoidance behaviour was recorded. The results show a high frequency of sightings of MHW in the same area and that sightings were not dependent on season or time of day, indicating that this region may be an important habitat for this species in eastern Mauritius.

In five of nine sightings, MHW whales were associated with other species: four times with Fraser's Dolphins *(Lagenodelphis hosei)* in groups more than 100 individuals and one time with 2 individuals of humpback whales (*Megaptera novaeangliae*). Additionally, bird aggregations, large predatory fish, and the presence of other few cetacean species recorded during the surveys, including an encounter of single Blainville's beaked whale *(Mesoplodon densirostris)*, a group of three common bottlenose dolphins *(Tursiops truncatus)*, two pantropical spotted dolphins *(Stenella attenuata),* and two encounters of groups of more than 30 spinner dolphins *(Stenella longirostris)*, reinforcing the ecological richness and

Table 1
Field efforts and melon-headed whale observations during survey in 2021.

N of Exp.	Season	Date	Weather condition (Beaufort scale)	Fact of presence of MHW in study area (presence – 1, absence – 0)	Estimated size of the pod	Time of the day (morning/ afternoon)	Number of photos made	Number of photos suitable for identification
1	summer	06/03/2021	4	1	>200	afternoon	740	28
		08/03/2021	3	1	>100	afternoon	1,017	32
2	winter	10/08/2021	4	1	>100	morning	1,784	71
		11/08/2021	4	1	>100	morning	128	–
3	winter	07/10/2021	2	1	>100	afternoon	2,095	75
		08/10/2021	2	1	>100	morning	1,513	22
4	summer	05/12/2021	4	1	>200	afternoon	1,544	56
		09/12/2021	3	1	>200	afternoon	2,017	59
		10/12/2021	3	1	>150	morning	1,229	35
Total				**9**			**12,067**	**378**

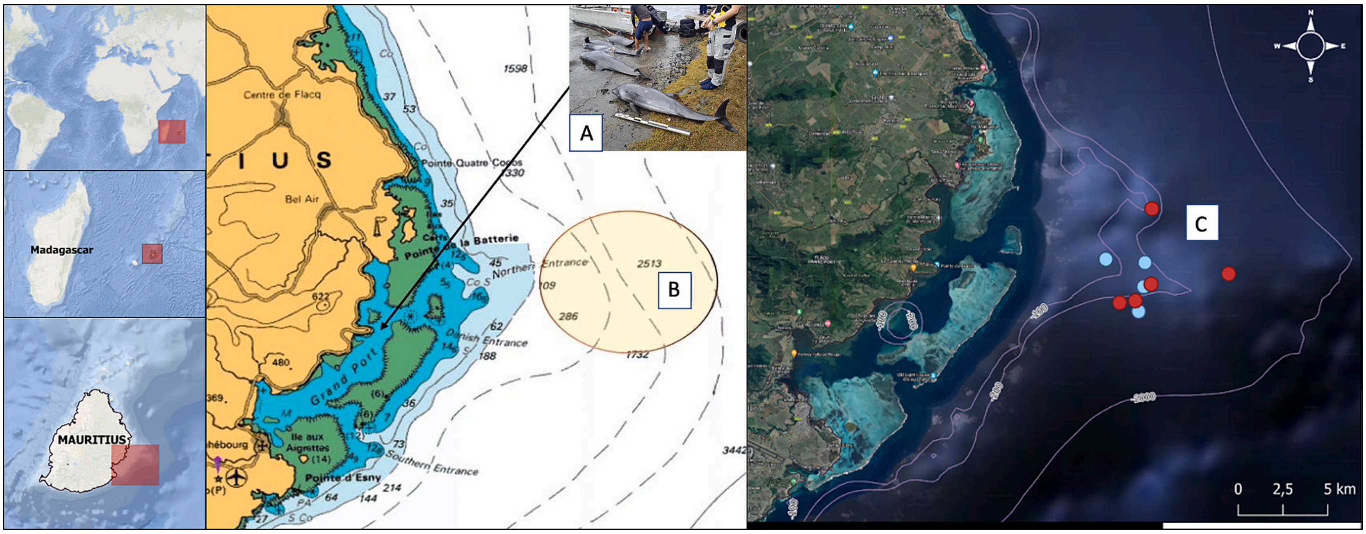


Fig. 2. The area of mass strandings of MHW on the eastern coast of Mauritius (A), hypothetical melon-headed whale habitat area – target study area (B); actual area where melon-headed whales were encountered during this study (C) – blue dots encounters in winter and red dots – in summer (each dot represents one encounter). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

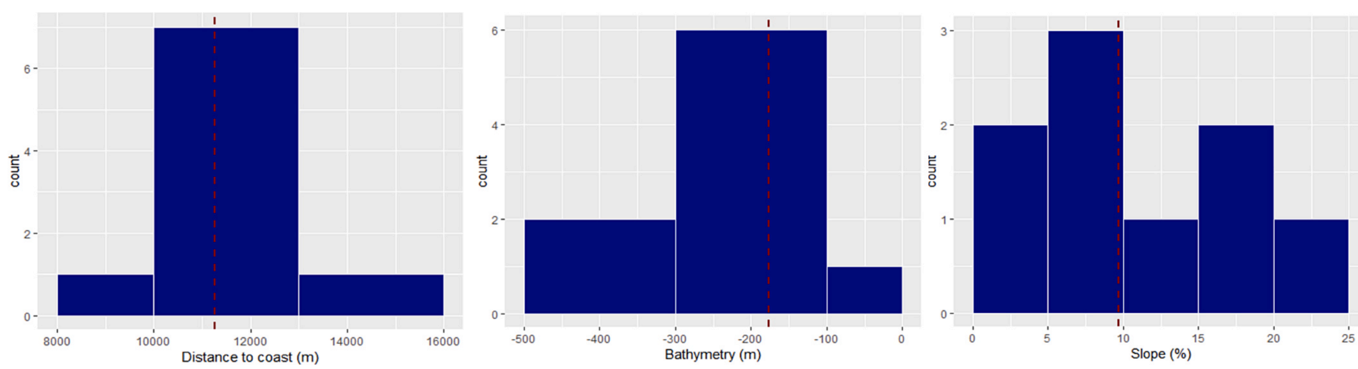
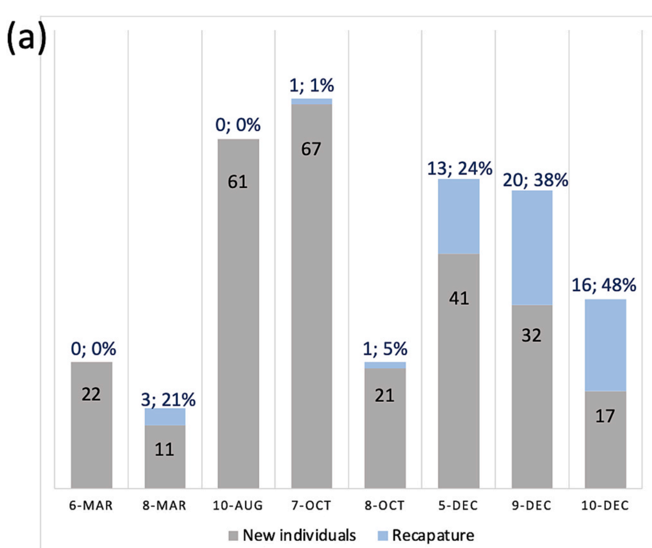


Fig. 3. Ecological characteristics of melon-headed whales' encounter sites: distance to the coast, bathymetry and slope.

potential trophic importance of the sites. It should be noted here that, apart from MHW, no other cetaceans that could be close to the description of "*marsouin*" were found in the study area, which may confirm that the fishermen in their testimonies meant exactly MHW.



(b)

Date / Group	Date of encounter of individuals from the corresponding potential group and the number of individuals - captured for the first time (gray) and recaptured (blue) 6-Mar	8-Mar	10-Aug	7-Oct	8-Oct	5-Dec	9-Dec	10-Dec	Number of recaptured by group	Recapture rate by group
A	22	3					1	1	5	0.23
B		11							3	0.21
C			61	1		5	6	2	14	0.23
D				67	1	7	8	5	22	0.32
E					21	1	2	2	6	0.27
F						41	3		16	0.30
G							32	6	26	0.50
H								17	16	0.48
Total number of identified individuals by day	22	14	61	68	22	54	52	33		

Fig. 4. Captures and recaptures of melon-headed whales individuals in sampling periods with proportion of recaptured individuals (a); the matrix of encounters of potential groups with the number of captured and recaptured individuals and recapture rate on the corresponding sampling periods during the study in 2021.

3.2. Patterns of habitat use

Photographic data were collected from 8 out of the 9 sampling days; no usable images were obtained on August 11, 2021, due to adverse weather conditions. From 378 photographs suitable for analysis, 326 identifications were made, corresponding to 272 unique *Peponocephala electra* individuals. On average, 40.75 individuals were identified per sampling period (min 14, max 68). The average proportion of individuals identified per day was 0.15. The capture-recapture analysis showed that the majority of individuals (n = 223) were captured in only one sampling period and 46 in two sampling periods; 2 individuals were captured three times and one within 5 sampling periods. The proportion of recaptures rises with increasing number of surveys, reaching 48% in the last day of observation (Fig. 4).

At least one individual from each of the potential groups was recaptured on other observation days. As shown in Fig. 3, individuals from six Groups C–H were associated with four to six of the other groups. Group B individuals were observed only with Group A; however, it should be noted that this particular day yielded the lowest number of identifications (14, compared to an average of 41). Individuals of Group A, in addition to Group B, were also associated with Groups G and H. Overall, all eight groups showed evidence of intermixing and may represent several interacting groups or a single population unit. The recurrence of associated individuals across all sampling periods demonstrates reuse of the study area and can suggest site fidelity.

3.3. Survivors of 2020 stranding

Using the photographs of individuals that survived the August–September 2020 stranding events, it was found out that there are 40 unique individuals. When these were compared with the 2021 survey catalogue of 272 individuals, no matches were found, suggesting that survivors' group may not be using or using the survey area rarely.

4. Discussion

4.1. Evidence for critical habitat

Despite the limited number of field efforts, which nevertheless were conducted at various times of the year and day, *Peponocephala electra* was observed with 100% detection success in the target region. Although MHWs are primarily an oceanic species, the observations in this study are consistent with those reported in other island systems such as Hawaii and French Polynesia (Aschettino et al., 2012; McClung, 2017; Perryman and Danil, 2018), where MHWs demonstrate a high degree of fidelity to specific insular areas and similar behaviour patterns. Perryman and Danil (2018) noted that melon-headed whales were frequently observed along coastlines exposed to trade winds, which enhance upwelling and productivity on windward shores. This mirrors the situation in Mauritius, where MHWs were found exclusively along the wind-exposed eastern coast (Perryman and Danil, 2018).

Although no direct feeding observations were recorded in this study, the frequent presence of predatory fish schools and seabird aggregations in the same areas may potentially indicate prey availability (Moors-Murphy, 2014). In addition, as in other island regions, these insular areas were repeatedly used for both active (traveling, milling) and passive (resting, logging) behaviours (Aschettino et al., 2012; Perryman and Danil, 2018), highlighting their role in social and resting activities (Brownell Jr et al., 2009).

Frequent, and possibly continuous, use of the area for foraging, resting and socialising—i.e. for maintaining key ecological functions—meets the criteria for designating the study area as critical habitat for melon-headed whales, both from ecological and behavioural perspectives (Morán-Ordóñez et al., 2025). The target region therefore likely represents a functionally irreplaceable part of the species' range in Mauritius, the loss or degradation of which would substantially compromise the species' conservation status. Interestingly, despite extensive survey effort and the development of whale-watching activities along the western coast, only a single sighting of MHW's pod (~150 individuals) has ever been documented in the south-west in 2009 (Barteneva et al., 2022; Webster et al., 2020), further underscoring the eastern coast as the critical habitat for MHWs in Mauritius. Aschettino et al. (2012) suggested that long-term sighting records in Hawaii likely reflect the persistence of a resident population for at least few decades. Here it is interesting to return to the testimonies of fishermen on the east coast of Mauritius during the 2020 stranding. As described in the Methods, fishers refered to MHWs as *marsouin* (porpoise), although true porpoises do not occur in Mauritian waters (Jefferson et al., 2011) and no other bulbous-headed cetaceans were found in the area, so misidentification is unlikely to have occurred. This terminology likely dates back to the French colonisation of Mauritius in the 18th century, when Breton sailors—who formed the majority of arrivals at that time (Morbihan, 2025)—encountered unfamiliar cetaceans with bulbous heads and analogized them to porpoises from their native French Mediterranean coasts (Gervais, 1865). The persistence of this terminology among local fishers provides cautious evidence that melon-headed whales may have been regularly present in Mauritian waters for at least the past three centuries.

In a broader context, it should be pointed out that six other species of cetaceans *(Lagenodelphis hosei, Megaptera novaeangliae, Mesoplodon densirostris, Tursiops truncatus, Stenella attenuata* and *Stenella longirostris)* were recorded during the study, emphasizing the rich biodiversity of the target study area and demonstrating its importance not only for *Peponocephala electra* but as a marine mammal habitat. Notably, Fraser's dolphins *(Lagenodelphis hosei)* were recorded for the first time in Mauritius in this study, although they appear to be common in the region. Their apparent absence may also be linked to the limited research effort in this region. This species is frequently associated with areas characterized by high cetacean abundance and diversity (Bernier et al., 2025). Although it remains one of the least studied cetaceans, observations from the Lesser Antilles suggest the possibility of population residency (Bernier et al., 2025). A similar possibility cannot be excluded for Mauritius and warrants further investigation.

4.2. Residency of melon-headed whales off Mauritius

Some odontocete species, such as the sperm whale, false killer whale and melon-headed whale, which are generally regarded as oceanic, exhibit ecological diversity within certain population units. These may range from wide-ranging pelagic nomads to regional residents with home ranges spanning up to hundreds km, as well as island specialists—permanent residents of restricted habitats in the shelf waters of oceanic islands (Barteneva-Vitry et al., 2025).

In this study, melon-headed whales frequently used relatively shallow nearshore waters, likely reflecting distinct foraging niches and social behaviours, consistent with island-specialist populations reported from Hawaii and French Polynesia (Aschettino et al., 2012). While the main population of MHWs off the Hawaiian Islands covers a habitat of at least 600 km^2 at a median depth of over 1,800 m, a small resident population uses exclusively the shallower waters off the island of Hawaii, at a median distance of 9.4 km from the shore and at a median depth of 381 m (Aschettino et al., 2012). Quite comparable, melon-headed whales off Mauritius in this study were most frequently sighted at a median distance of 11.3 km from the shore and at median depths of 176 m.

MHWs are known to live in large stable social groups, and reports suggest that their social structure is organised matrilineally (Amano et al., 2014). Such structuring drives population subdivision through restricted inter-group mixing and limited dispersal (Aschettino et al., 2012; Miyazaki, 1998). Although the data set of this study did not allow for a precise determination of the social structure, the recurrence of associated individuals across all sampling periods indicates the fidelity of at least one or few population units.

Studies in Japan and French Polynesia have identified some but very little overlap between groups that frequent different offshore areas, suggesting that localised habitat preferences and social organisation may be widespread traits in this species (Amano et al., 2014; Brownell Jr et al., 2009). The number of identified individuals, i.e., slightly less than 300 individuals in Mauritian waters as well as low proportion of identified individuals per sampling period, may indicate that a large proportion of individuals have not yet been captured. Hence, several groups with overlapping habitats may be present off eastern Mauritius, including groups with different habitat specialisations, both island-specific and regional residents with a wider range of habitats (Barteneva-Vitry et al., 2025), like in Hawaii. The absence of even a single recapture of the 40 individuals identified in 2020 among the 272 individuals identified during this study may indicate possible the occasional presence of non-resident, pelagic groups in Mauritian waters, either as rare visitors or under exceptional circumstances. For example, such visits could involve offshore groups approaching island shelf waters in response to external stressors. A striking illustration is the mass stranding of melon-headed whales in Hanalei Bay, Hawaii—an area where the species had not previously been recorded—likely triggered by naval sonar activity nearly 50 km from the stranding site (Perryman and Danil, 2018; Southall et al., 2006).

All of the foregoing points support the possible existence of a locally structured population with at least some groups constantly present in the study area. This population could be discrete from other populations in the broader western Indian Ocean and around neighbouring territories such as Réunion, Madagascar, and the Seychelles (Kalashnikova et al., 2025; Kiszka et al., 2009a). However, the overlap of the ranges of groups with broader range cannot be ruled out. A longer-term study is needed, both within a year period and over several years to assess population structure and fidelity patterns with greater confidence. Collaborative regional studies, including neighbouring territories such as Réunion, Madagascar, and the Seychelles, could further enhance the understanding of broader population dynamics in the western Indian Ocean and help determine whether the Mauritian whales are an isolated population or a sub-population of the larger area.

4.3. Conservation implications

The results of this study carry important implications for management in two key aspects: the discovery of a critical habitat for marine mammals off the east coast of Mauritius, and the detection of a presumed resident population of melon-headed whales.

Identifying and protecting critical habitats – such as key foraging or nursery grounds or travel corridors – is essential for the continued survival of marine megafauna (Hooker and Gerber, 2004). Mauritian waters are increasingly subjected to a range of human activities, including disturbances from the fishing industries, increased marine tourism and commercial shipping (Barteneva et al., 2022). Many of these anthropogenic pressures spatially coincide with key cetaceans' habitats, posing several potential threats. Given these risks, there is a great need to integrate the knowledge of critical marine mammal's habitat use into MSP processes in Mauritius. Efforts should prioritise the identification and protection of key habitats through the implementation of Marine Protected Areas (MPAs), spatial regulation of high impact activities, and long-term monitoring of cetaceans presence and behaviour (Spalding et al., 2013). Considering the potential presence of pelagic population units in Mauritian waters, conservation measures should also be applied throughout the Exclusive Economic Zone (EEZ).

Melon-headed whales are listed as "Least Concern" on the IUCN Red List of Threatened Species (Kiszka and Brownell Jr, 2019) with an unknown global population trend. The high susceptibility of this species to mass strandings is disturbing factor, especially considering that it is expected that anthropogenic stressors in the ocean environment, including seabed exploration and increased fishing effort, will cause an increasing number of strandings (Moore et al., 2017). Mass strandings of MHWs have occurred in other regions with similar environmental features, often attributed to a combination of social cohesion and anthropogenic factors such as naval sonar and shipping noise (Aschettino et al., 2012; Brownell Jr et al., 2009; Erbe et al., 2019). The 2020 mass stranding event in Mauritius, highlights the vulnerability of this species to such events. If resident pods are present, repeated mass stranding events in this area could have disproportionate population consequences, particularly given the species' strong social bonds and slow reproductive rate (Amano et al., 2014; Perryman and Danil, 2018). The measures to mitigate anthropogenic impacts is vital, especially those related to the potential causes of stranding, namely noise pollution and bycatch (Plön et al., 2020).

It is recognized that anthropogenic noise pollution, including naval sonar, seismic surveys, and offshore construction, has an impact on marine mammals (Erbe et al., 2019; Southall et al., 2019; Wang et al., 2021). The effects are directly dependent on the source and its nature (amplitude, frequency and timing of exposure) and can be in the form of direct tissue injury leading to auditory damage; behavioural responses and stress, which can lead to serious injury and even death; disruption of communication between individuals and the food extraction process (Nelms et al., 2021). For example, the use of military sonar has been found to be a cause of mortality in various cetacean species, including MHW, around the world (Southall et al., 2013, 2006). In Mauritius, planned offshore wind development on the east coast, driven by the persistence of south-east trade winds (GovMU, 2022), together with hydrocarbon exploration projects in the EEZ (GovMU, n.d.), represent potential future sources of underwater noise within and adjacent to the proposed critical habitat. The presence of such planned projects highlights the existence of tangible anthropogenic threats to melon-headed whales and other cetaceans in Mauritian waters and must be considered in conservation planning. To reduce the potential impact of anthropogenic noise pollution in critical cetacean habitats, the following measures are recommended: establishing areas to be avoided by vessels and setting exclusion zones for naval or seismic activities. Where it is necessary to conduct exercises involving acoustic sources in critical habitats and surrounding areas, clear protocols must be established and applied, using the precautionary approach and another best practices (NATO, 2006; Southall et al., 2019), including the mandatory involvement of certified marine mammal observers.

Bycatch is one of the most pressing but poorly documented threats in Southwest Indian Ocean in general, and in Mauritian waters in particular (Kiszka et al., 2009b). Given the size of Mauritius's Exclusive Economic Zone (EEZ) and the presence of both legal and unmonitored illegal fishing operations, it is likely that bycatch does occur, but goes unreported (Kiszka et al., 2009b). MHW are known to be occasionally caught accidentally in tuna purse seine nets and in drift nets fisheries (Aragones et al., 2024; Southall et al., 2006) both of which are used in Mauritian waters. To address this, conservation measures must include forcing commercial vessels fishing in Mauritius waters to use the latest global best practices to reduce bycatch, as well as mandatory reporting of actual bycatch of marine animals, including having cameras on board to record the catch; the prohibition of fishing or particular fishing methods that pose as threats to marine mammals in critical cetacean habitats, especially in the eastern part of Mauritius in the melon-headed whale habitat; determination of the habitat ranges of the MHW population in the eastern waters of the Mauritian EEZ and establishing no-take zones for commercial fishing.

4.4. Limitation of the study

This study represents a step toward understanding melon-headed whale ecology in Mauritius, however, some limitations remain. Unlike long-term research in other regions, such in Hawaii (Aschettino et al., 2012), this work is constrained by a reliance on short-term observations and opportunistic data. The absence of recaptures from the 2020 stranding group may be due to true absence, dispersal, or simply limited sampling effort, and further effort is needed to distinguish among these possibilities. As such, while the data suggests residency, definitive confirmation requires additional and more sustained research.

5. Conclusion

This study provides the first dedicated assessment of melon-headed whales in Mauritian waters, aimed at evaluating site fidelity, habitat use, and potential critical habitats. Despite limited survey effort, groups were consistently observed along the eastern coast, and photo-identification of 272 unique individuals, including repeated associations, indicates the presence of a locally structured population. Together with ecological and behavioural patterns, these findings support the designation of the eastern coast as a critical habitat. Evidence from habitat preferences, stranding records, and fishermen's testimonies further demonstrates the value of complementary sources for identifying such areas. The occurrence of transient pelagic groups highlights the need for conservation measures extending across the Exclusive Economic Zone. Overall, these results inform evidence-based conservation planning, and, together with recommendations, offer a pathway to effective habitat protection and reduced risk of future strandings.

CRediT authorship contribution statement

Svetlana Barteneva-Vitry: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Hugues Vitry:** Writing – review & editing, Project administration, Investigation, Funding acquisition, Conceptualization. **Jessica Shaw:** Writing – review & editing, Writing – original draft.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authorisations

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Data availability

The data that supports the findings of this study are available from the corresponding author on reasonable request.

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