

**Final report of the Independent Scientific Review
Panel investigating potential contributing factors
to a 2008 mass stranding of melon-headed whales
(*Peponocephala electra*) in Antsohihy,
Madagascar**

Panel Members and Report Authors*:

Brandon L. Southall, Ph.D.

Teri Rowles, D.V.M., Ph.D.

Frances Gulland, Vet. MB., Ph.D., MRCVS

Robin W. Baird, Ph.D.

Paul D. Jepson, DVM, Ph.D., Dip.ECZM

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* Dr. Douglas Nowacek participated in initial planning calls of the ISRP and provided initial technical review of the report

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Executive summary

A highly unusual event involving the long-term displacement and mass stranding of approximately 100 melon-headed whales (*Peponocephala electra*) occurred in May-June 2008 in the Loza Lagoon system in northwest Madagascar. This typically open-ocean cetacean species had never previously nor since been reported in this shallow tidal estuarine system, nor in any other in Madagascar, although previous strandings of this species in embayments have been documented. A coordinated effort was organized for response to live animals, and to collect information through physical samples from stranded animals and a structured interview process. This mass stranding response involved local officials and citizens, conservation organizations, oil and gas exploration companies working in the area, and international marine mammal experts. Despite the remote location of the stranding event and the challenging logistics of operations, field efforts were mounted within days and a significant amount of information about the stranding event was collected.

After several years, a formalized process for investigating the known facts associated with this event was established through a partnership among many of the organizations involved in the mass stranding response effort, the International Whaling Commission (IWC), and U.S. federal agencies with relevant expertise and interest in the event; this process was undertaken in direct communication with the government of Madagascar. An Independent Scientific Review Panel (ISRP) reviewed all available information provided by responders and those analysing the events. Following a face-face meeting of the ISRP with information providers, all potential primary or secondary contributing factors to this atypical mass stranding were considered relative to all available information given to the ISRP.

The extent to which causality may be unequivocally determined here is limited by: (1) the remote and harsh conditions of the stranding area; (2) the time required to mount the stranding response and investigation; (3) the time that has passed since the event; (4) the fact that the location and behavioral state of the animals just prior to the first known observations of them within the lagoon system is unknown; and (5) limited information on the type and nature of behavioral responses of melon-headed whales to multi-beam echosounders.

There is no unequivocal and easily identifiable single cause of this event, such as those that have been implicated in previous marine mammal mortalities (*e.g.*, entanglement, vessel strike, identified disease) or mass stranding events (*e.g.*, weather, extreme tidal events, predator presence, anthropogenic noise). Based on information provided to the ISRP these animals apparently entered the bay on 30 May 2008 following some initial triggering event, following which at least 75 mortalities resulted over the following weeks, ultimately as a result of multiple secondary factors (*e.g.*, emaciation, dehydration, sun exposure) related to their being

out of their normal habitat for such an extended period. In such a stranding scenario where the initial response may be behavioral, but the ultimate cause of mortality relates to being out of typical habitat (of which there are a growing number of examples discussed in the report), there may not be clear forensic evidence of causality. Assessing such situations inherently requires some subjective assessment by experts of the weight of the evidence regarding the temporal and spatial association with some potential disturbance and the stranding event, as well as a science-based approach to systematically consider all possible primary or secondary contributing factors (as in Southall *et al.*, 2006; Jepson *et al.*, 2013; Wright *et al.*, 2013).

While aspects of this event will remain unknown, the ISRP systematically excluded or deemed highly unlikely nearly all potential reasons for the animals leaving their typical pelagic habitat and entering the Loza Lagoon (an extremely atypical area for this species). This included the use of seismic airguns in an offshore seismic survey several days after the whales were already in the lagoon system, which was originally speculated to have played some role but in the view of the ISRP clearly did not. The exception was a high-power 12 kHz multi-beam echosounder system (MBES) operated intermittently by a survey vessel moving in a directed manner down the shelf-break the day before the event, to an area ~65 km offshore from the first known stranding location. The ISRP deemed this MBES use to be the most plausible and likely behavioral trigger for the animals initially entering the lagoon system. This conclusion is based on:

- (1) Very close temporal and spatial association and directed movement of the MBES survey with the stranding event. The MBES vessel moved in a directed manner transmitting sounds that would have been clearly audible over many hundreds of square kilometers of melon-headed whale deep-water habitat areas (and extending into some shallower waters along the shelf break) from 0544 until 1230 local time on 29 May and then intermittently in a concentrated offshore area (located ~65 km from the mouth of the lagoon) between 1456 and 1931 on 29 May; these preceded the first known stranding during the day of 30 May and sighting of live animals within the lagoon at 2300 on 30 May.
- (2) The unusual nature of this type of stranding event coupled with previous documented apparent behavioral sensitivity in this pelagic species (albeit to other sound types - discussed in more detail below).
- (3) The fact that all other possible factors considered were determined by the ISRP to be unlikely causes for the initial behavioral response of animals entering the lagoon system.

This is the first known such marine mammal mass stranding event closely associated with relatively high-frequency mapping sonar systems. However, this alone is not a compelling reason to exclude the potential that the MBES played a role in this event. Earlier such events may have been undetected because detailed inquiries were not

conducted, given assumptions that high frequency systems were unlikely to have such effects because of relatively greater sound propagation loss at high frequencies. It is important to note the relatively lower output frequency, higher output power, and complex nature (100+ directional but overlapping sound beams) of the MBES used here relative to most conventional lower-power and often much higher-frequency fish-finding or shallow-water bathymetric mapping systems. Similar MBES systems to the 12 kHz source used in this case are in fact commonly used in hydrographic surveys around the world over large areas without such events being previously documented. In fact, a very similar MBES system was apparently used in a survey in the general area (and particularly the Mahajanga harbor area to the south) for some period during April and early-mid May 2008. This in fact could have played some contributing factor by sensitizing animals in the vicinity to such sources, but information on where and how this system was used was unavailable despite efforts to obtain it.

There may well be a very low probability that the operation of such sources will induce marine mammal strandings - animals may simply avoid them or even ignore them most of the time. In this case, environmental, social, or some other confluence of factors (*e.g.*, shoreward-directed surface currents and elevated chlorophyll levels in the area preceding the stranding) may have meant that this group of whales was oriented relative to the directional movement of the transmitting vessel in such a way that an avoidance response caused animals to move into an unfamiliar and unsafe out-of-habitat area. It is important to note that, especially for odontocete cetaceans that hear well in the 10-100 kHz range where ambient noise is typically quite low, high-power active sonars operating in this range may in fact be more easily audible and have potential effects over larger areas than lower-frequency systems that have more typically been considered in terms of anthropogenic noise threats. The potential for behavioral responses and indirect injury or mortality from the use of similar MBES systems should be considered in future environmental assessments, operational planning, and regulatory decisions.