

MADAGASCAR MELON-HEADED WHALE MASS STRANDING EVENT ANTSOHIHY, MADAGASCAR MAY-JUNE 2008

FINAL REPORT PART I

SITE DESCRIPTION AND MASS STRANDING TIMELINE



Compiled by
The Wildlife Conservation Society
The International Fund for Animal Welfare

Madagascar Melon-headed whale (*Peponocephala electra*)

Mass Stranding Event of May/June 2008

Final Report—Part I

Site Description and Mass Stranding Timeline

Wildlife Conservation Society

and

International Fund for Animal Welfare

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BACKGROUND

On the 31st of May¹ 2008 a large group of melon-headed whales (*Peponocephala electra*) was reported to be deep within the Loza Bay mangrove system in northwest Madagascar. Melon-headed whales are typically found in pelagic waters and often occur near the continental edge (Jefferson & Barros, 1997; Brownell et al. 2009). Their presence within the shallow and largely closed lagoon system was thus exceptional; inhabitants of Loza Bay had never before encountered the species (nor a species like it) and had never witnessed a large group of whales or dolphins in such an apparent state of distress. The event was truly unusual.

The first reports of the stranding were posted on internet blogs by residents of Antsohihy and travelers passing through. Radio, television and newspapers from the Sofia² region picked up the story and national and international coverage followed. Despite some correlation between web-based and traditional media accounts it is clear that many important details of the first few days were muddled through hearsay and rumour. There was no technical lead for managing the stranding event until the Government of Madagascar asked the Wildlife Conservation Society (WCS) to assist; WCS staff arrived at the site early on June 6th. In the intervening period valuable diagnostic and circumstantial information was lost.

Efforts to help whales in the Loza Lagoon began at the Antsohihy dock on May the 31st 2008. Many credible eyewitness accounts corroborate this date. However the events leading up to the arrival of the whales at Antsohihy are less clear. Many eye-witnesses described the animals as tired, stressed and 'behaving strangely.' The first deaths from Antsohihy were reported on June 2nd but interviews recorded later by the strandings team suggest that whales were dying in Analalava as early as the 30th of May. Whales continued to die in the Loza lagoon for weeks afterwards. Accurate counts of total group size and total deaths will never be known, estimates from

villagers varied widely; members of the stranding response team believed the number to be upwards of 100, but not more the 200. It is unlikely that all animals were seen; the channel system of the lagoon is complex and many whales would have been lost during the first few days of the event.

Although occurrence was suspected (e.g. De Boer et al. 2002; Kiszka et al. 2007), melon-headed whales were not confirmed in the waters of Madagascar until 2007 despite many years of marine and coastal research at multiple sites. A WCS research team documented a live sighting of 50-70 individuals off Anakao in the southwest of Madagascar on 25th July 2007 and a stranding of at least 15 individuals (see Part II) was reported in the vicinity of Nosy Hara in December 2007.

Identified information needs

A variety of data gaps exist and relate not only to the timing of the stranding event but also its cause. There are many potential causes for strandings and a general description of these is provided in Part II of our report. The lack of an organized response during the first few days of the event at Antsohihy was critical, and consequently presents a challenge to conclusively determining cause. An attempt to assessing why this stranding occurred required a research effort across multiple investigative fronts by a Mass Stranding Response Team (MSRT - see Part II). A key information requirement was establishment of an accurate timeline of events during the first few days of the stranding. This document provides a description of how this information was collected and attempts to resolve a credible timeline of events.

Note on nomenclature

English common names of many species can be confusing, including the sometimes arbitrary use of 'whale' and 'dolphin'. *P. electra* is an oceanic cetacean of the family Delphinidae and the sub-order Odontoceti (toothed whales) (Jefferson & Barros, 1997). They are referred to as *P. electra* or 'whales' throughout this text.

¹Research described herein indicates they entered the lagoon on the 30th but first reports were from the 31st, when they were already deep within the system

²Sofia is one of 22 regions of Madagascar. Antsohihy is its administrative center.

Physical Environment

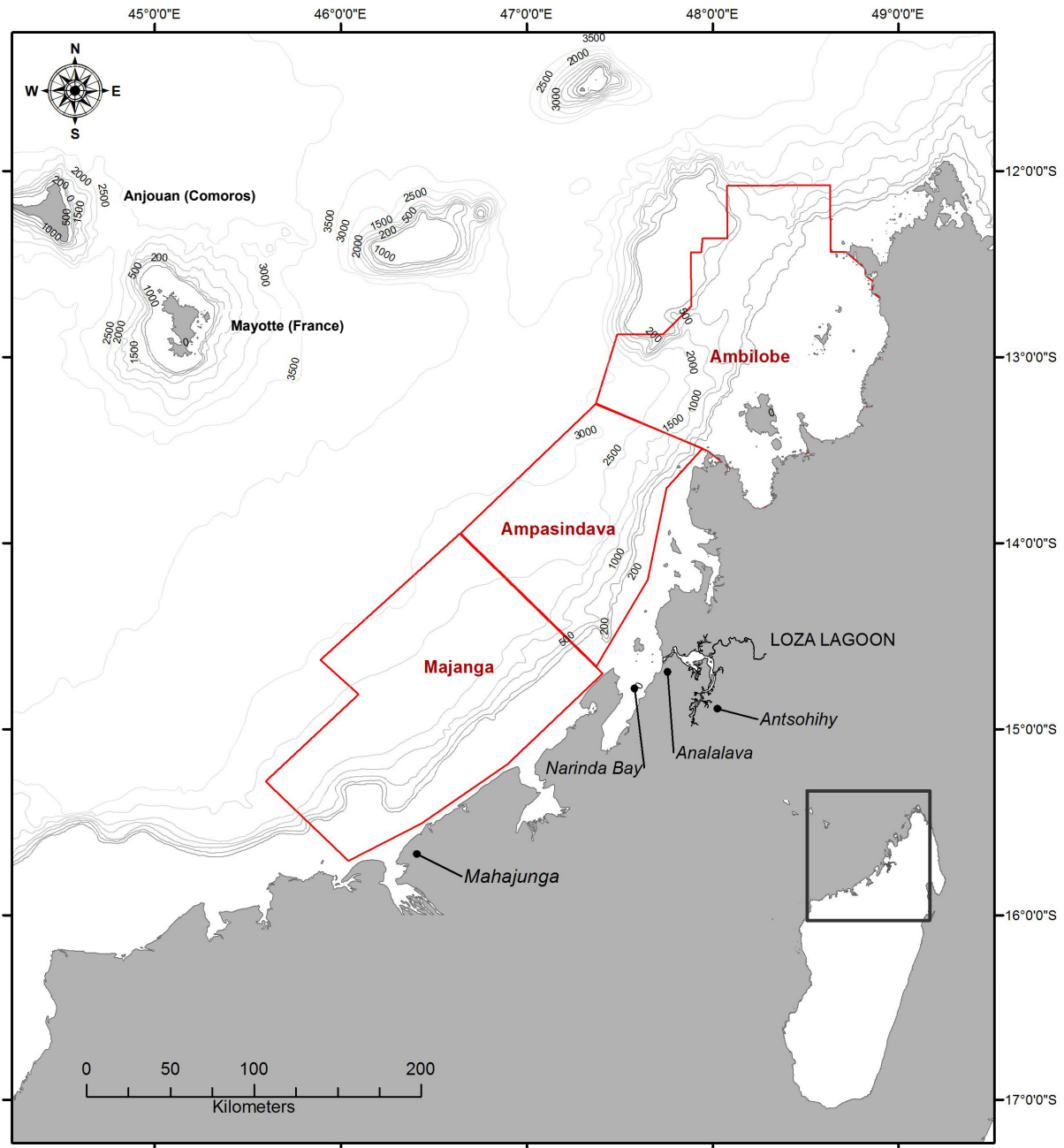


Figure 1: The location of Loza Lagoon, Madagascar. Water depths associated with suitable habitats for melon headed whales are close to the entrance of the lagoon. Red squares demarcate oil concessions, the names of each concession are also provided in red text.

The Loza lagoon system lies inland of the Baie de Narinda (*Helodranon'ny Narinda*) in the Sofia region of northwest Madagascar. The coastal near-shore is generally shallow, and characterized by wide expanses of sand interspersed with rocky reef. Sandy beaches are common on exposed coasts and are frequently separated from one another by rocky



Figure 2: looking out to sea across the Loza Lagoon entrance channel

cliffs and headlands. In sheltered, near-shore areas sandy substrates transition to shingle beaches. Mud flats are prevalent in low energy areas. Mangroves are common in most sheltered areas.

The Loza lagoon is accessed from the sea at the village of Analalava by a single V-shaped channel that is 670 m wide at its narrowest point (see figure 2). The channel is deep (30 m) in comparison to adjacent waters and connects the open ocean to the largest expanse of water in the lagoon system, known locally as *Matsaboribe* or the *Grand Lac* (hereafter as Grand Lac). The Grand Lac is large (w/h of 14 km * 6 km), with a surface area (on a spring tide) of over 100 km². Inland it is connected to a multitude of tributaries and mangrove creeks that are at times highly bifurcated. The entire Loza system exceeds 200 km² with a periphery of over 600 km. The lagoon is fed by three freshwater rivers, the *Doroa*, *Tsinjomorona* and *Maevarano* but remains largely estuarine with brackish waters extending into the creeks south of Antsohihy. Waters are typically

very turbid, with much suspended sediment. The entire system is strongly tidal and tidal ranges can be significant, exceeding three meters during springtides and typically reverse twice each day. There is a massive exchange of tidal water through the Analalava inlet and currents there are occasionally very strong, exceeding seven knots (~13 km/h). Local fishers and transport vessels generally avoid navigating this channel during tidal peaks. The most direct navigable distance between Analalava and Antsohihy is ~65 km.

Near the lagoon mouth mangroves are sparse, growing on shingle beaches. They become more expansive and abundant with increasing distance inshore of the inlet. The densest mangroves fringe a complicated tangle of blind and connecting creeks between Malaoko and Antsohihy. These creeks are known locally as *kingas* and most are named. At low tide wide expanses of intertidal mudflat are exposed. The mud is thick, glutinous, anoxic and pervasive. The higher banks are covered by dense, dry deciduous forest which is



Tim Collins (WCS)

Figure 3: Coastal approaches and sandy beaches; looking from open water into the *Baie de Narinda*. Note the rocky intertidal and nearshore. The Loza lagoon can just be seen as a sliver in the far distance.

mostly degraded, with savanna on adjacent hills which have not yet eroded.



Tim Collins (WCS)

Weather conditions throughout the stranding response period were very changeable. Conditions on the narrower mangrove channels were generally calm, with currents an occasional issue for navigation and herding. On larger channels and the wide expanse of the Grand Lac conditions were extremely changeable and at times limiting. The months of June, July and August are well known for a brisk Notherly breeze known locally as the *Varatraza*. When combined with a flood tide the larger channels and Grand Lac become treacherous for small boats. Steep, short interval waves develop and passage becomes uncomfortable and dangerous. These conditions were to limit searches for whales on the Grand Lac and were a significant consideration during transits between Antsohihy and Analalava.

Figure 4: Mangroves near to Anjango

Human Environment

There are many small villages and fishing camps dotted at regular intervals around the lagoon and mangrove system. Villages vary in size from large, multiple family settlements to small, seasonal or temporary camps. Antsohihy and to a much lesser extent Analalava are the only true 'urban' areas. An effort was made to map villages during the stranding response and subsequent interviews (see figure on page 10).

The principal livelihoods of the majority of inhabitants in Loza lagoon are fishing, farming and charcoal making (using mangrove wood). There are a variety of fisheries, with the majority of fishers setting small-mesh gillnets across the mouths of tidal creeks or casting for shrimp and crab. Hook and line fisheries are rare and fishers and their families are generally very poor. Occasional directed takes of dolphins, known generically as *fesotra* or *feso*, were described by some fishers interviewed during the stranding event. Fishers were aware of laws forbidding capture and were thus reluctant to discuss them. Broader mesh gillnets are used for captures, which are apparently uncommon. The targeted species are most likely to be the bottlenose dolphin (*Tursiops aduncus*) or the Indo-pacific humpback dolphin (*Sousa chinensis*); the latter were encountered on several occasions during the stranding response.

The transport and communications infrastructure is very poorly developed in the area of the lagoon. A two lane tarmac road between Antsiranana (Diego Suárez) and Boriziny (Port-Bergé) passes through Antsohihy; all other roads between Antsohihy and the coast are rough tracks. Most travel between the lagoon and coastal villages is by water, with regular, small motorized ferries called *vedety* (French *vedette*=boat) making stops along the way. Lagoon fishers use small outrigger canoes called *lakana* (*pirogues*), propelled with paddles or small sails. At Analalava there are a few motorboats. Telecommunications are limited to mobile telephones that only function in areas close to the antennas at Antsohihy and Analalava.



Figure 5: Top Antsohihy dock. Bottom: A typical fishing village seen on the Lagoon

INFORMATION SOURCES

Internet based accounts

Many informal accounts of the stranding event were immediately available on internet websites, blogs and in popular media. These were routinely scanned by team members at the beginning of the stranding event and for a time they were the only source of information. Much of it was sensational but did include useful pieces of information. Images are a valuable example; witnesses took pictures using mobile telephones and small point-and-shoot digital cameras, including those taken by expatriate tourists passing through Antsohihy. Some images are repeated on different websites. Some of these pictures were located in their original format (including 35mm negatives) and are included in the library of images that document the event. In these instances the picture takers could also verify the picture date. Blog accounts also provided a useful means for correlating events that occurred during the initial few days. A review of websites and blogs was completed for timeline development.¹

Interviews

Interviews fall into two broad categories:

1. Interviews conducted during the course of stranding response. These include both formal (some standard questions, notes made) and informal approaches (conversations etc).
2. Interviews conducted during a dedicated two day campaign following the stranding response work. This utilized a formal strategy, with villages systematically targeted for information; some interviews were recorded (video and dictaphone), all pertinent responses were noted.

A team from the Direction de la Pêche et des Ressources Halieutiques (DPRH) also conducted interviews in Befotaka on June 6th 2008. These are not discussed here but should receive some follow up (internet blogs also refer to strandings here).

Interviews during the stranding response

Interviews during the course of the stranding response work were conducted either on an *ad hoc* basis or in response to a specific tip or information request. Few of the responses were formally recorded during the first ten days of work and a significant amount of information has thus been lost. Recognizing this, team members applied a more formal interview strategy from the 14th of June onwards, following a visit by MSRT team members to Analalava and Ampasindava.

Additional interviews were secured from volunteers on the stranding response team during the course of work, many of whom were at the Antsohihy port the morning the whales first appeared. Additional accounts were provided by a variety of lagoon residents and officials.

Dedicated interview campaign

A dedicated interview plan was approved by the Government of Madagascar *ad hoc* committee on June 20th 2008. These were designed to address information needs identified by the expert MSRT during a meeting on June 13th (items 2 & 3 on the list of recommendations). Specifically these were:

- Interview people along the coast, Grand Lac and the river to determine sighting locations and dates for live and dead animals that have occurred since the beginning of the event.
- Interview people in Analalava to determine dates when whales were observed entering and leaving the Loza Lagoon, and assess how many have been observed returning to the ocean.

The approved strategy required the hiring of local consultants with both interview experience and knowledge of local geography; these consultants lead the subsequent interview process. WCS field staff with an understanding of whale biology and the explicit information needs of the MSRT accompanied them.

¹It should be noted that most of the people involved in the stranding event were thoroughly occupied in the business of trying to rescue whales. Time available to the team to source images, footage and corollary data was short whilst the rescue attempt was in progress.

Candidates for the interviewing positions were sourced from the local Antsohihy area. The local ANGAP offices (l'Association Nationale pour la Gestion des Aires Protégées) helped facilitate this search. Three interviewers with suitable training and experience were hired (CV's available). These interviewers (*enquêteurs*) were given a thorough briefing on the required information needs.

Interview survey process

Major objectives

Several ideas and concerns were evaluated prior to the development of a standard list of questions. Questions that dealt directly with the stranding event were clearly required, but there was also a risk that an approach that was too direct would elicit biased, tempered or false responses. All interviewers had experience of survey design and although the results were not intended for robust statistical analysis, interviewers agreed that establishing a reliable timeline required some degree of independence among interviewees. Thus a means for limiting those responses that were untrue or strongly influenced by word of mouth was a priority. Thus questions were posed in general conversation and included both direct and indirect queries. This included asking after the health of inhabitants (sick whales may have been eaten), and whether the whales competed for lagoon fish. However an attempt was made to address five central topics:

- Did you hear about the Antsohihy whale stranding?
- Did strandings occur here and [if yes] do you remember when, where and how many?
- [If yes] Did any of the animals die and [if yes] how many and what was the species?
- [If yes] What happened to the dead whales?
- Were there any illnesses following the consumption of whale meat?

Targeted groups

Considerable thought was given to who should be questioned at each interview site given time

constraints. For instance a sole focus on fishers was likely to be problematic given anxieties associated with whale hunting. Moreover some potential interviewees may have travelled to and from Antsohihy during the weeks prior to the stranding event and therefore some care was needed to try and achieve a set of balanced responses. Key categories included;

- Administrative Chief
- Traditional Chief
- Fishers
- Women
- Herbalists and health workers
- Children

Larger villages are often lead by a combination of an administrative and a traditional chief. The administrative chief or *Chef de Fokontany* is an elected official and their mandate is to ensure the political, administrative and security of the village; visitors are required to pay them a visit on arrival. Traditional chiefs (*Sojabe*) ensure that village traditions are respected. Given time constraints most interviews were unannounced (chiefs are typically informed some time before). Making contact with these personalities on arrival at each site was a priority. Once the purpose of the visit was established interviewers were free to talk to villagers.

Only notebooks were used (no datasheets) and care was taken to limit obvious insignia (for instance clothing bearing the WCS logo). No payments or gifts were given for information. Interview teams were composed exclusively of Malagasy staff.

Survey Areas (see map overleaf)

Some triage was required. The lagoon is large and many people live in scattered small villages that are hard to access. Interviewing them all or even a representative portion was clearly an impossibility given time and resources available. A limited interview schedule was planned, informed by the

experience of the stranding response team over the prior two weeks of rescue work. The Loza lagoon and its tributaries were divided into four interview zones, encompassing villages from each major area of the system and the route whales would have swum. The passage of the whales from the inlet channel to the dock at Antsohihy is likely to have been reasonably direct, given the shape of the lagoon and arrangement of associated mudbanks and tributaries; options were limited despite the size of the system. The four interview areas are listed below—these numbers correspond to the red numbers on the map below.

Interview Area #1 (Main Stranding Location)

- Antsohihy

Interview Area #2 (Main Mangrove Channel)

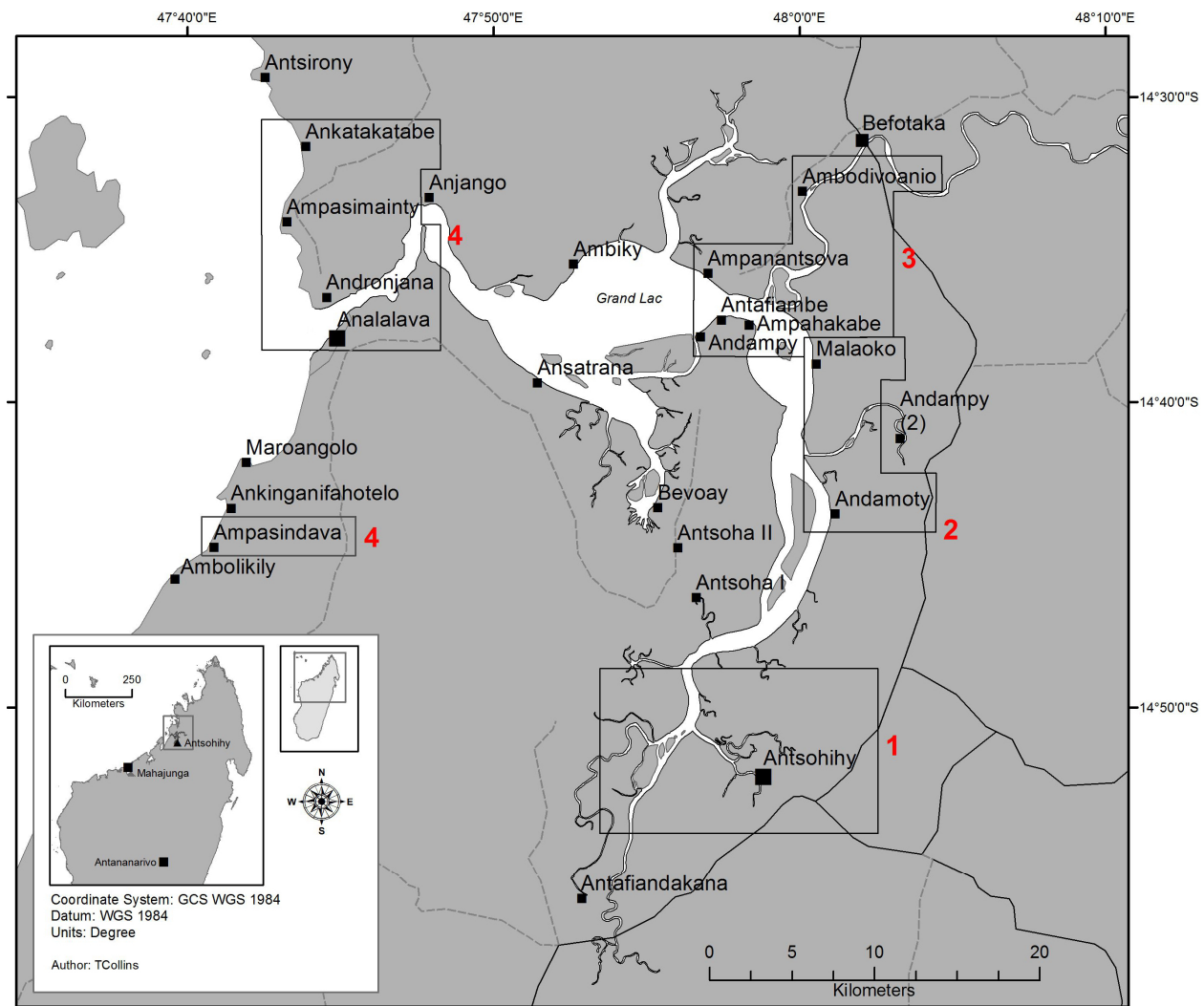
- Andamoty
- Malaoko

Interview Area #3 (Grand Lac)

- Ampahakabe
- Andampy
- Ambodivoanio
- Antafiambe
- Ampanantsovana

Interview Area #4 (Coastal Communities)

- Analalava
- Androjana
- Ankatakatabe
- Ampasimainty
- Ampasindava



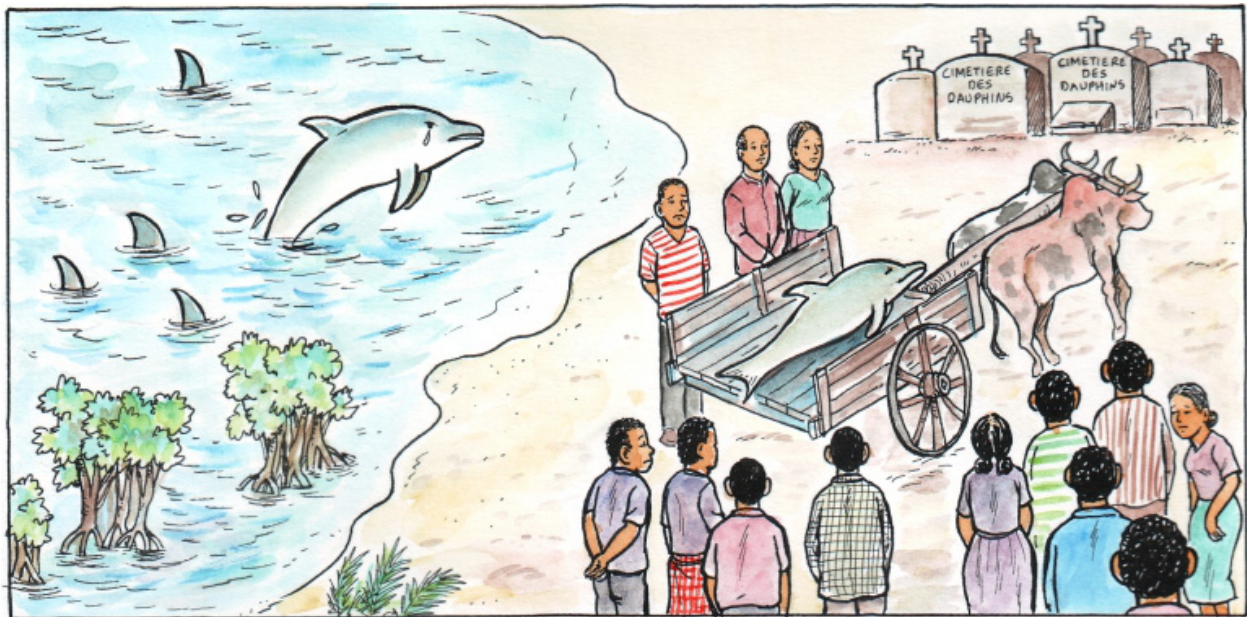
RESULTS

Website Information

Searches on several combinations of keywords (Antsohihy, échouage, stranding, Madagascar) yielded over 500 hits. Some of these sites used information provided by WCS and the Ad Hoc committee (mostly from initial on-site interviews) as well as independent information. Other sites provided important early detail (although much is repeated). Example links are provided below. Although local websites are likely to provide inaccurate information, a consistent thread could be found; firm identification of the 31st May 2008 as the first day whales appeared in Antsohihy, a piece of information verified in a communiqué issued by local officials. Websites also provided early images (Appendix C).

Below: Artwork from the website:

<http://www.madagascar-info.net/gztweb/gztantsohihy>



Selected websites with stranding information

<http://fanamby.wordpress.com/2008/06/>

<http://www.flickr.com/photos/75544836@N00/2552782089/>

<http://harinjaka.com/weblog/2008/06/>

<http://www.madagascar-info.net/gztweb/gztantsohihy>

An original communiqué from the Government of Madagascar (GOM) can also be sourced at:

<http://www.biodiv.be/madagascar/liens/divers/communique-du-gouvernement-relatif-aux-dauphins>

Interviews

Formal interviews were recorded in notebooks and these are available as part of the catalogue of information collected during the stranding event. Interview notes are in a mixture of Malagasy and French. Summary statistics and timeline provided below is a synthesis of information gathered from each survey area. This includes interviews recorded during both phases of work (strandings and formal interview campaign). Several interviews were recorded on a video or a digital voice recorder (with the interviewees consent). Filmed interviews were generally reserved for key personalities given a lack of spare media. These are also available in the library of images and film gathered during the event.

Under ideal circumstances interviews would have been given by single interviewees. Villagers were

excited (or made anxious) by a visit of new people which tended to preclude one-on-one interviews. Whenever possible, categories were assigned to interviewees (sojabe, fishers, farmers). In households livelihoods were frequently not established so broader categories were assigned (mother, father, teenager).

Interviewers reported a suspicion that some responses were biased (or tempered) by some villagers reluctant to share information in fear of reprimand. Other villagers were apparently frightened by the event, seeing it as a bad omen. Information was withheld and anxieties like this slowed the flow of information exchanges. Women were found to be more reticent; a stated regret of interview teams.

Interview Area #1 - Antsohihy

Interviews in Antsohihy spanned the entire stranding event. These interviewees were of most use in determining the date when whales first appeared at the dock in Antsohihy, and the circumstances surround the first few days of the rescue. However at least two interviewees in Antsohihy were actually from Analalava, and were able to provide accounts of whales leaving the lagoon later in the month of June (see Part II of this report for more details of these events).

A key personality during the early days of the stranding was Amirdine Amad, an Antsohihy merchant known locally as *Babaji*. Together with Philippe Robinet of the Hotel Biaina he provided much of the early energy and support for the rescue effort (provision of food to volunteers). He was present at the Antsohihy dock on the 31st of May and he provided an account of the events that transpired (recorded on video, June 24th). Like many residents of Antsohihy he first heard of the stranding on 31st of May. A dead whale had been reported from the old port and news quickly spread through town. Together with many other Antsohihy residents and authorities, he went to the new dock. Philippe Robinet and Roger

Andrianantenaina were using two privately owned boats to try and push whales back down the channel. The mayor made a public announcement forbidding the whales' harassment or consumption of their meat and also appealed to fishers to help with the herding effort. Amirdine Amad also played an important role during the whale rescue and helped to refloat 12 whales (his estimate).

Interview Area #2 - Malaoko & Andamoty

Interviews were conducted in Andamoty on June 21st 2008 and in Malaoko on June 22nd 2008. The village of Andamoty is of medium size (40 households). When visited most villagers were attending a burial but the team was able to meet the Chef de Fokontany and the *Quartier Mobile* (a team responsible for security). Respondents described seeing whales passing on the 31st of May in the morning. Estimates varied (100-400).

The village of Malaoko is inhabited by approximately 400 people. When visited many people were at work, but some interviews were given. Interviewees reported seeing many whales passing between Friday 30th May and Saturday 31st May 2008. The whales swam in the direction of Antsohihy on the 31st of May at approximately 09:00. Some respondents could not recall the date precisely but were sure that it was a Saturday (as was the 31st of May). Several interviewees describe the groups of whales as looking like 'wooden logs packed together' and 'covering the entire surface of the channel.' One respondent recalled seeing whales packed together like this between the Maevarano river and Malaoko. Estimates varied wildly (100-3000). A total of six whales that had stranded in the nearby *Antsinga kinga* had been eaten by villagers. Summary statistics for these sites is provided overleaf:

- Chef de Fokontany: 1
- Fishers (including divers): 8
- Mothers: 4
- Fathers: 2

Interview Area #3 – Grand Lac

Interviews were conducted in 4 villages of the Grand Lac area on June 21st 2008. These included Ampahakabe, Andampy, Ambodivoanio and Antafiambe. These villages are tiny and include a sum total of approximately 30 households. However 27 respondents were interviewed among the 4 villages. The team continued interviews at Ampanantsovana on 22nd June 2008. Ampanantsovana is also small (7 households). The team was able to interview 8 people, including the Chef de Fokontany, the *President de Pêcheur* (fishing collective) and the *Befotaka Conseiller Municipal Rural*. Two interviewees from Ampanantsovana described whales passing early in the morning at approximately 5:00am. Estimated group sizes varied but ranged to 500. Many small groups were seen and apparently 5 whales stranded on their shore. One interviewee claimed that the 5 dead animals had actually been killed, but this could not be substantiated

Several interviewees in Ampahakabe and Ampanantsovana described seeing whales pass in the direction of Antsohihy early on the morning (5:00am) of May 31st. The interviewees in Ampanantsovana also said that the whales moved towards Antsohihy at about 9:00am the same day. Sightings were also reported for the same morning by interviewees in the village of Ambodivoanio, which is 12 kilometres up the Maevarano river. No sightings for that day were reported by interviewees in Antafiambe and Andampy. One interviewee claimed that a whale had been captured and killed in the village of Ampahakabe. One interviewee at Antafiambe claimed to have seen the same species at sea off the coastal village of Mahajamba (north of Mahajanga). Summary statistics below:

- Chef de Fokontany: 1
- Fishers: 1
- Mothers: 14
- Fathers: 12
- Children: 6

Interview Area #4 – Analalava & coastal villages

A small team left Antsohihy by car on the 14th of June 2008 in order to investigate reports of 20 whales stranded on beaches at Ampasindava (south of Analalava). The visit was requested by the departing expert MSRT (see notes from meeting on the 13th of June). This team included Behamafaly Randriamanantsoa (WCS), a delegate from the office of Communication for the Region of Sofia (Jean de Dieu Razafindrakoto) and the Chef de Cantonnement for the Ministry of Environment, Water, Forests & Tourism (MEEFT) Antsohihy (Mr Jaosanta). The journey was difficult and they arrived late in the day at Analalava, planning to continue on to Ampasindava the next day. The opportunity was taken to chat with people around Analalava about the stranding event and some useful information was gathered, including accounts of strandings on the 30th of May 2008.

The most reliable interviewees for the Analalava strandings were questioned on June 15th 2008 by Bemahafaly Randriamanantsoa (WCS); these were *Mr Lava* (boat driver for *Mr Bruno Bobey*, Swiss owner of the Hotel Varatraza, Analalava, who was also interviewed) and *Madame Samina* (owner of the Hotel Malibu, Analalava). Fishers from Analalava described the same event but claimed that one animal was pushed back into the sea alive, and another was killed and eaten by former inmates of the prison at Nosy Lava. The interviewers conclusion was that at least two animals were butchered in the Analalava area on the 30th of May, but no firm evidence (remains or images) could be sourced to confirm the accounts. Additional interviewees included the Chef Fokontany and a nurse from the local clinic.

An account was provided by the marine gendarme Guy-Louis Sidonie, who is based at Analalava. He encountered ‘black’ whales whilst traversing the Loza Bay inlet from Anjanga (at the apex of the bend) to Analalava. He made this crossing on the 30th at 23:00 and described encountering a

tourbillion, a powerful eddy or whirlpool in the channel caused by tidal currents (see aerial image of these in Appendix C). He was forced to drive around the eddy and in doing so encountered approximately 20 whales at its edge. The species was unfamiliar to him and although the moon was in the last quarter (it would have been a sliver), the stars were bright and he claims he could see clearly. The whales were apparently very docile, and reminded him of television documentaries he had seen of dolphins in captivity. In fact they so docile (he used the French word *docile*) that he thought they may have escaped from an enclosure. He later worked with the stranding response team and could affirm that it was the same species he had encountered that night.

On the 15th of June 2008 the team continued by boat to Maroangolo and Ampasindava, with Mr Ambanindrazana from MEEFT in Analalava joining the group. The team members worked independently of one another in order to interview villagers more efficiently and to give each account some independence. Twelve households were interviewed (the village is comprised of 25). 90% of respondents had heard about the stranding at Antsohihy, and with one exception all villagers responded that no whales had stranded in Ampasindava. One interviewee described seeing a dolphin caught in a coastal fishing trap; it had a beak (thus a different species). The team left with the firm belief that the report of 20 whales was false. There is however another village called Ampasindava further south in Narinda Bay; this was not known to the interview team at the time.

On the 21st and 22nd of June 2008 interviews were conducted in the coastal villages of Andronjana, Ampasimainty and Ankatakatabe, to north of the Loza Lagoon inlet (comprised of ~80 households in total). Sixteen people were interviewed. These villages were considered ideal candidates for stranding information, particularly for clarifying the time when whales originally passed from the sea to the lagoon. Despite this, villagers in

Ankatakatabe and Ampasimainty had not observed whales at all. The stranding in Antsohihy was known to interviewees from Andronjana, but they learned of it from people returning from Antsohihy. Fishers from three of the villages who were active in near-coastal areas on the 30th had not seen whales. One interviewee reported that a live stranded whale was killed by Andronjana villagers on 1st June 2008. They had also heard mention of strandings in Ampasindava but in their account the number of whales was two; this account may have been confused with the strandings reported for Analalava. Notable also in interviews at Andronjana were accounts of ‘many’ whales being hunted by the village of Ankazomahitsy (a small hamlet within the inlet channel, near to Andronjana) and the dried meat being sold in Analalava; this account could not be verified. Summary statistics from these sites provided below:

- Chef de Fokontany: 2
- Fishers (divers): 2
- Hotel managers: 2
- Boat Pilots: 2
- Teenagers: 2
- Farmers: 3
- Health Workers: 1
- Sojabe: 2

STRANDING TIMELINE

The following is a synthesis of the information collected during interviews (formal and informal) and from web-based accounts.

30 May 2008

At Analalava (or in the area of Analalava) two stranded *P. electra* were found by fishers during the day and were subsequently butchered for food. Several accounts of this event were recorded independently even if the precise location could not be determined.

The marine gendarme Guy-Louis Sidonie, sighted whales in the entrance channel to the Loza Lagoon at 23:00 on the evening of the 30th of May.

Villagers from the coastal villages of Anjango (at the apex of the inlet), Andronjana, Ampasimainty and Ankatakatabe did not see whales passing, despite the account of Guy-Louis Sidonie. We surmised that most people were sleeping at this time of day, and thus were unlikely to see them.

31 May 2008

Two interviewees from Ampanantsovana (Grand Lac) described whales passing early in the morning at approximately 5:00am.

Whales were then seen at approximately 9:00am by many villagers at Malaoko and Andamoty (main mangrove channel). They describe seeing and hearing animals resting in the channel at night. Reports are varied but the general consensus is that there were many whales; they were tightly massed and swimming slowly. Estimated group sizes varied enormously (100 to 3000). These villages are slightly raised above the water (2-3 metres) above the channel and observers would have had a good view.

Whales were first observed at Antsohihy port on the same day. Estimates vary but they all exceed 100 individuals. There was no trained observer onsite but accounts describe docile animals, with some attempting to strand and behaving

‘strangely.’ Several key officials visited the port area on the 31st. These included:

- The *Chef de Region*
- The *Chef de District*
- The Mayor of Antsohihy
- The Commissar (of police)
- The Colonel of the *Gendarmerie*

In a videotaped interview (recorded on the 24th of June) Amirdeen Amad, a key volunteer active from the start of the event, states that the first deaths in the area of Antsohihy occurred on the 31st and that many officials were in attendance. A dead whale was first reported in the area of the old Antsohihy dock (time not specified). The first dead whale reported from the new dock was at approximately 18:00pm on the evening of the 31st.

The *Chef de Région* made an announcement on Sofia television requesting people not to kill whales in order to consume and sell the meat, voicing health concerns; marine gendarmes toured villages to ensure the message was delivered.

June 1 – June 6 2008

Efforts began on June 1st to push whales out of the Antsohihy port area by volunteers. These efforts continued until the 6th of June when WCS staff and Ministry officials arrived from Antananarivo.

A new announcement was made by Radio Andrea Madagascar-Antsohihy requesting that people not kill whales and they be ‘treated with respect.’ This announcement was repeated every day for the duration of the rescue effort. This information was provided by the staff of *United Christian Broadcasters Africa* (based in Antsohihy).

June 2 2008

Two adult whales were recorded dead at Antsohihy dock by Philippe Robinet. These were presumed to be the first deaths in the area of Antsohihy. Despite radio announcements meat from these animals was sold at the local market.

Deaths occur in greater numbers thereafter. (details available in Part II).

June 7 – June 9 2008

Efforts continued by volunteers to push whales out of the main channel.

June 10 – June 13 2008

Visit of the expert international MSRT.

June 14 – June 22 2008

Continued efforts to free whales from the Loza lagoon.

June 21 – June 22 2008

Interview surveys conducted across the Loza lagoon area.

June 23 – June 29 2008

No further attempts are made to free whales pending a decision on next steps by the

Government of Madagascar *ad hoc* committee

June 30 – July 10 2008

Monitoring phase of stranding response. A small WCS teams returned to Antsohihy to assess if whales were still in the Loza lagoon, and to collect museum specimens. The latter are now in the Iziko South African Museum (Cape Town).



DISCUSSION

The most direct navigable distance between Analalava and Antsohihy is approximately 65km. It would have taken time for a group of whales to swim from the lagoon entrance to Antsohihy, particularly if some individuals were ill or stressed. Even if positive accounts of whales from coastal villages were few, it is clear that in order for whales to arrive in Antsohihy on the 31st they would have entered the Loza lagoon some time beforehand. Using the times and locations of observations, we estimate that the whales in the lagoon were traveling at speeds (on average) between 3 kph and 5 kph, a reasonable swimming speed for a slow travelling pod. Using these figures they would have passed Analalava sometime between 20:10 and 21:20 on May 30th. The derivation of these times is provided in Appendix B.

Many of the villages around the Loza system are beyond mobile phone coverage and many of the inhabitants live in very basic conditions. This differs markedly from the relatively prosperous town of Antsohihy or other areas of Madagascar. For the interview process this was both a blessing and a curse; in many instances villagers were able to provide independent accounts of what they did or did not see, as they were unlikely to have read or seen news reports, or routinely shared information with other people. Fixing firm dates to their observations was more problematic; villagers do not habitually use calendars. The single notable public holiday falls on the 26th of June (Independence Day). Some villagers own cellular phones and some had been engaged in a more memorable activity (e.g. travelling on the lagoon in a *vedette*) so the dates provided were more reliable and a fair degree of confidence could be given to their recollections. Many interviewees spoke in more general and vague terms, referring to moon phases, weekends (church services) or weeks past rather than specific dates and times. No extrapolation was attempted for these accounts.

Many interviewees were able to firmly identify the species they had seen during the 30th and 31st of May. Fishers for example are notoriously unreliable in this regard (globally) so WCS biologists on survey teams were keen to stress this point in particular. Fishers routinely see cetaceans in the lagoon, but in the majority of cases are likely to be humpback dolphins. Bottlenose dolphins may on occasion venture into the system as well, but none were sighted during the work. The habitat requirements of humpback dolphins are precise and although they are known to overlap with other species, the special circumstances of Loza lagoon suggest that this would be rare in this context. Moreover many fishers were able to describe a diagnostic feature of the humpback dolphin, namely the fleshy mound under the dorsal fin. Humpback dolphins are also notably different from *P. electra*. The colour is markedly different (one is dark grey or black, the other is light grey) and their behaviour within the lagoon system during the stranding period was also different. Many fishers were given to describing the *P. electra* as the helicopter whale, with reference to their bulbous foreheads which were apparently reminiscent of the cockpits of some helicopters. Events described in construction of the timeline use accounts where observers were certain of the species.

Some interviewees, particularly in Antsohihy and Analalava, described geotechnical survey work offshore of the Narinda Bay area, later verified by Exxon Mobil. We understand that these operations were generally coincident with the stranding event. We also understand that when Exxon first learned of the stranding event, they immediately ceased survey operations that were being conducted in the immediate area. We subsequently learned more details of the survey from the Environmental Impact Assessment (EIA) submitted to the *Office National pour l'Environnement à Madagascar* (ONE) on March 15th 2008 (available from ONE at their website one@pnae.mg or <http://www.pnae.mg>). The

environmental permit was issued on the 28th of May 2008 (n°30/08/MEEFT/ONE/DG/PE).

Quoting from the Exxon EIA (2008):

“ExxonMobil Exploration and Production (Northern Madagascar) Limited (EMEP (NM)L), plans to carry out a high resolution 2D seismic survey over prospective drilling locations of the Sifaka Prospect, take sea floor and water samples in the prospect area for an Environmental Baseline Study, conduct a multi-beam bathymetry study and survey the upper slope to identify shallow water features in the Ampasindava Block, offshore Madagascar. The work will be conducted in May to June, 2008 for a period of approximately 30 days.”

The seismic survey was “utilizing an air gun source” and planned to be conducted “in the southwest part of the Ampasindava block... approximately 35 km northwest of Nosy Lava” and it was “anticipated [that] the vessel will not come closer than 15 km to the Madagascar coast, remaining in water depths exceeding 200 meters.” In addition to the seismic survey, two forms of bathymetry mapping using sonar sources were planned. A side-scan sonar survey using “a fish towed behind the vessel close to the seabed” which was to be conducted “along the upper edge of the slope measuring the water depths as shallow as 30 meters” and “for the most part remain more than 10 kilometers from the Madagascar mainland.” In addition a “multi-beam echo-sounder bathymetry survey” was conducted, with the “echo-sounder...mounted to the hull of the vessel and...operated simultaneously [with the seismic survey operation] to supplement the seismic and side scan sonar bathymetry data.”

The EIA provides some detail for operations and sound sources used. Air guns sound level output was expected to be between 190-200 dB re: 1μPa and predominant energy in the frequency range of 10-300 Hz; side scan sonar (EG&G model 260TH Recorder and Model 272-T tow fish) operated at 100kHz and/or 500kHz, with no source level provided; and the multi-beam echo-sounder (SIMRAD EM1002, mounted to hull) specified with a sound pressure level of 235 dB re: 1μPa and peak frequency of 12 kHz. It is noted in Figure 5.1 of the EIA, that the side scanning sonar bathymetry survey would be conducted along the shelf edge and shelf break immediately offshore of Nosy Lava and the Loza Lagoon system.

The EIA notes the likely presence of *P. electra* in the Ampasindava block, described in Table 5.4 as occurring in all three of the sub-divided regions (Mid-channel, Offshore and Coastal) in “substantial numbers”. The EIA also acknowledges that “key potential impacts with respect to underwater noise” include:

- Pathological effects (lethal or sub-lethal injuries): potential injury or fatality of marine fauna from exposure to significant noise levels.
- Behavioral disturbance leading to behavioral changes or displacement.

The EIA makes particular reference to mitigation of impacts from the seismic survey air-gun source, specifically the use of soft starts to allow mobile cetaceans in the area to move away from the operation. It is stated that the frequencies of the air gun source are lower than the predominant sensitivity of odontocetes in the area. However it is also stated that, “With respect to the high frequency noise of the echo sounder and side-scan sonar, they will be inaudible to most whales but will be audible by dolphins.”

It is also stated that a dedicated Marine Mammal Observer (MMO) would be aboard the survey vessel, whose role was:

- To provide advice on the application of the JNCC Guidelines;
- To monitor adherence to the Guidelines during air-gun operations;
- To keep watch for cetaceans during daylight hours;
- To record and report sightings of marine mammals and turtles;
- To keep records of fishing activity observed.

There is no mention of mitigation measures applied during the side-scanning sonar survey or mitigation procedures during the night.

With the above mentioned information, it is reasonable to carefully consider the hypothesis that this stranding of melon-headed whales may have occurred as a result of a flight response from a loud acoustic source, such as the seismic survey operations, or more likely and more plausibly, the side-scan sonar survey that was planned for the near-shore waters on the shelf edge and shelf break immediately offshore of Nosy Lava, Narinda Bay and the Loza Lagoon system. If the pod of *P. electra* responded behaviorally with a flight response away from the sound source, they may have crossed unfamiliar shallow waters and entered the Loza Lagoon. As became clear during the stranding response efforts, they then became disoriented and apparently unable to escape given the complexity of the lagoon system, the narrowness of the single lagoon opening, and their unfamiliarity with such an environment. In order to evaluate this hypothesis, it will be necessary to ascertain

- if the vessel(s) was operating and using a sound source in areas that encompassed potential *P.*

electra habitat;

- if the vessel(s) was operating in the vicinity of the event to allow such a scenario (i.e., offshore the Loza Lagoon system);
- if the vessel(s) was operating at a time that is congruent with the timeline of the stranding event (i.e., sometime prior to the estimated time of entry into the lagoon derived in this report);
- if there were any other potential factors such as the depth of the tow fish (which could place the source below cetacean groups, exacerbating the effects of the noise source).

Additional data must be obtained to determine the likelihood that these activities may have induced or contributed to this stranding event. The timeline presented here is incomplete without this and other data (environmental data, other activities offshore etc), and limits assessment of why the event occurred.

RECOMMENDATIONS

Given published concerns for the effects of sound on *P. electra* and other cetaceans (e.g. Cox *et al.* 2006) and the similarity of this event to other *P. electra* mass stranding events (Fromm *et al.* 2006; Southall *et al.* 2006; Brownell *et al.* 2006; Ligon *et al.* 2007; Brownell *et al.* 2009) the timeline established here should be compared to a detailed operational timeline of Exxon exploration activity.

At minimum this should include:

- A precise log of all sonar mapping activity, ideally to hourly or sub-hourly resolution;
- A precise GPS track of the vessel (or all vessels involved) during sonar surveys at the highest temporal resolution available;
- A precise log of all seismic survey activity, ideally to hourly or sub-hourly resolution;
- Precise GPS track of the vessel (or all vessels involved) during seismic survey activity at the highest temporal resolution available.
- Bathymetric depths at which the side scanning sonar survey was conducted (as determined by the survey)
- Depth of the side-scanning sonar tow-fish during the operation
- Details on the operating source level and frequency of the side-scanning sonar tow-fish

Comprehensive sound mapping should be conducted to assess sound exposure levels produced by the surveying vessel, and this can then be considered in reference to published travel speeds for *P. electra*, and the stranding locations and timing as described by Southall *et al.* (2006).

If a MMO was aboard the vessel, all data and notes recorded by the MMO should be reviewed for the period during both the sonar mapping

activity and the seismic survey activity. Coincident sightings (or not) would add important resolution to the mass stranding assessment.

Before further exploration operations are conducted in this region and elsewhere in the waters of Madagascar, we recommend that further baseline data is gathered on sensitive species of cetaceans, particularly in areas where exploration and production activities are planned.

Specific recommendations for future events in Madagascar include:

- Emergency funding should be made available to support travel, accommodation and fact finding.
- Assuring that at least 1 trained observer can arrive at the site as quickly as possible to facilitate initial data collection, coordination of activities, logistics & accurate communications.
- Development of a national stranding response plan, including contact details for within-country, regional and international expertise.
- Collection of baseline stranding data through the establishment of an ongoing stranding response program to document live and dead strandings along the coast of Madagascar, specifically: date & location of strandings, species, sex, length. Any additional samples and data, such as evaluation for signs of human interaction, and biological samples is preferred.
- Development of links (partnerships) to other institutions with more stranding experience.
- Developing greater national & regional capacity for stranding response. During this event national response was mixed. Some institutions and individuals offered immediate assistance; others declined, provided no response, or were only interested in receiving information. The variance stems from a poor understanding of the significance of the mass stranding event
- Supplementary training for stranding response personnel and provision of suitable materials.
- Supplementary training for veterinary personnel and provision of suitable materials.
- Interviewers discovered that some Loza communities were frightened by the stranding event (it was very unusual). This was a handicap during the rescues. Education and outreach efforts should be implemented.

Many data collecting opportunities were lost early in this event. A simple chronology of events could have been collected by a small team with simple training and access to emergency funding. It was clear to many observers, including authors of simple internet blogs, that this was an unusual event and that it needed attention. Future events will need a more immediate response, and should be documented from the outset.

APPENDIX A - Catalog of Interview Information

Localité	Personne interviewée	Pièce justificative
Ampasindava	Pêcheurs (4)	Vidéo
	Agriculteur (1)	Vidéo
	Mère de famille (1)	
Marangolo	Pêcheurs (2)	
Analalava	Mr Bruno, Gerant de l'Hotel VARATRAZA, Analalava	
	Mme Samina, Gerante de l'Hotel Malibu, Analalava	
	Mr Lava, Pilote de bateau NY ONJA	
	Chef Fokontany Analalava centre	Cahier de note de l'enquêteur
	Mr Gervais, Infirmier Analalava	Cahier de note de l'enquêteur
	Mr Louis Sidonie	Vidéo
Androjoano	Sojabe et son fils	Cahier de note de l'enquêteur
Ankakatabe	Sojabe	Cahier de note de l'enquêteur
	Chef Fokontany	Cahier de note de l'enquêteur
	Plongeurs (2)	Cahier de note de l'enquêteur
	Agriculteurs (3)	Cahier de note de l'enquêteur
	Jeune garçon (1)	Cahier de note de l'enquêteur
Ampasimainty	Sojabe (1)	Cahier de note de l'enquêteur
Grand Lac, Ampahakabe	Père de famille (1), Mère de famille (3), jeunes garçons (2)	Cahier de note de l'enquêteur
Grand Lac, Andampy	André II, père de famille et deux autres père de famille, mère de famille (1)	Cahier de note de l'enquêteur
	Mme Ninie Clare, mère de famille	Photo, Cahier de note de l'enquêteur
Grand Lac, Ambodivany	Mère de famille (2)	Cahier de note de l'enquêteur
	Jeunes garçons (3)	Photo, Cahier de note de l'enquêteur
	Pères de famille (4)	Photo, Cahier de note de l'enquêteur
Grand Lac, Antafiambe	Père de famille (1), mère de famille (3)	Photo, Cahier de note de l'enquêteur
	Lemisy, président de pêcheur, pères de famille (2)	Photo, Cahier de note de l'enquêteur
Grand Lac, Ampagnantsovana	Mère de famille (1)	Photo, Cahier de note de l'enquêteur
	Mr Tsiresy Edmond, Conseiller Communal de CR Befotaka, Père de famille (1), Mère de famille (2), jeune fille (1), jeune garçon (1), vieille femme (1)	Photo (Tsiresy Edmond), Cahier de note de l'enquêteur
Andamoty	Quartier mobile	Cahier de note de l'enquêteur
	Groupe de 8 personnes et quelques femmes	Cahier de note de l'enquêteur
Malaoko	Ex-Chef Fokontany	Cahier de note de l'enquêteur
	Pères de famille (2)	Cahier de note de l'enquêteur
	Mère de famille	Cahier de note de l'enquêteur
Antsohihy	Mr Christian	Vidéo
	Mr Amerdine	Vidéo
	Mr Zafera Eugène, docteur vétérinaire	Vidéo

APPENDIX B - Derivation of travel time and swimming speed

	Analalava	Anjango	Ampanantsovana	Andamoty	Antsohihy
<i>minimum speed est</i>	5/30/2008 20:10	5/30/2008 23:00	5/31/2008 5:00	5/31/2008 9:00	5/31/2008 16:00
<i>average speed est</i>	5/30/2008 20:36				
<i>maximum speed est</i>	5/30/2008 21:24				
Kilometres from entry	0	8	25	45	65
hours			6	4	7
km trav			17	20	20
km/hr			12.83	35.00	28.6
hours				10	11
km trav				37	40
km/hr				3.70	3.64
hours					17
km trav					57
km/hr					3.35

In the above table, estimated swim speeds are calculated for all pair-wise combinations of villages, using the estimated travel distances and approximate arrival times of whales based upon interviews. The minimum (#1) and maximum (#3) derived speeds were estimated from these, along with an overall average (#2, using the distance and times from Anjango and Antsohihy).

Red Box = Derived arrival times at Analalava based on minimum, average and maximum estimated swim speeds

To derive speed between villages:*Step 1*

Calculate distance between 2 villages. In our example this is distance between Anjango and Ampanantsovana (17 km).

Step 2

Swimming speed is then calculated by dividing this distance by time. This difference is based *verbatim* on interviewees recollections of when they first saw melon-headed whales. Thus time seen at Ampanantsovana (5/31/2008 5:00:00 AM) minus time seen at Anjango* (5/30/2008 11:00:00 PM) = 6 hours

Thus: $\frac{17}{6} = 2.83\text{km/h}$

* Anjango sighting reported by the Gendarme Guy-Louis Sidonie (see page 14)

To derive time of arrival at Analalava:*Step 1*

Calculate distance between Anjango and Analalava (8 km)

Step 2

Calculate travel time between these 2 sites by dividing 8km by a known swimming speed, in this example we use the minimum calculated swim speed (2.83 km/h). This is then converted to hours by dividing by 24.

$$\text{Time} = \frac{8}{2.83} / 24$$

Step 3

Derive arrival time at Analalava by subtracting the derived travel time (02:49:00) from time first seen at Anjango (5/30/2008 11:00:00 PM).

APPENDIX C - Images

Tourbillions (eddies) in the channel connecting Loza Lagoon to the open sea. The powerful eddies and currents routinely found in this channel during peak tides are given great respect by local boatmen.



Tim Collins (WCS)

Marine Gendarmes based at Analalava provided great support during the stranding response. In the foreground is Guy-Louise Sidonie



Tim Collins (WCS)



Fanamby's Weblog (beta)

Fanamby: ONG malagasy, qui relève le défi d'un aménagement concerté des espaces terrestres & marins, en partenariat et aux services des femmes et des hommes pour la conservation durable de la biodiversité.



Dernières nouvelles sur l'échouage de Dauphins d'Electre à Antsohihy depuis le samedi 31 mai (2008):



Sur le terrain, la situation n'a pas changée. Les animaux désorientés se perdent dans les canaux de mangroves et se font piéger dans la vase lors des marées descendantes. La soixantaine d'individus encore à proximité du port d'Antsohihy reste en situation critique, mais une partie de la population peut encore être sauvée, selon les informations du spécialiste de WCS, M. BEMAHAFALY, ce qui nécessitera des moyens logistiques importants.

6
06
2008

QUI SOMMES-NOUS ?

FANAMBY, signifiant « DEFI » en malgache, est une Organisation Non Gouvernementale oeuvrant dans le domaine de l'Environnement, créée en 1997, par un groupe de scientifiques et d'experts en conservation et développement malgache.

LIENS

Fanamby Facebook Cause
Fanamby's Website (en)
Fanamby's Website (fr)
JAMA, le festival - Marathon à Menabe
Office du Tourisme de Menabe

Top: During the first few days of the stranding event carcasses were collected by villagers for consumption. Below: Initial reports of the stranding were circulated on the internet (<http://fanamby.wordpress.com/2008/06/06/dernieres-nouvelles-sur-echouage-dauphins-electre-antsohihy/>)

The first corpses of stranded whales were either sold in market or examined by the local veterinarian Dr Zafera (seen here with blue gloves). Once an order forbidding consumption was issued carcasses from the Antsohihy dock area were buried locally.



Early days of the stranding at Antsohihy. Top left and right: many Antsohihy locals visited the dock area during early days of the stranding. They were also able to confirm the May 31st stranding date. Below left: Amirdeen Amad, an Antsohihy merchant whose early efforts fueled the stranding response. Below right: Phillipe Robinet (left), owner of the Hotel Biaina with his brother Teddy (right) - the brothers worked to save whales throughout the stranding response



Interviews at Analalava



A wide selection of people were interviewed, although women were harder to engage. Here two women provide an account.



Surfacing humpback dolphins. The dorsal fin is diagnostic, but swimming behavior is also very distinctive, with the beak often rising steeply from the water before the forehead hits the surface. The uniform grey color is also typical of this species in the Indian Ocean. (Jefferson & Karczmarski 2001).



Y. Razafindrakoto (WCS)

Surfacing melon-headed whale in the Loza Lagoon; note the distinctive dorsal fin, bulbous forehead and coloration



Tim Collins (WCS)

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MADAGASCAR MELON-HEADED WHALE MASS STRANDING EVENT ANTSOHIHY, MADAGASCAR MAY-JUNE 2008

FINAL REPORT PART II

STRANDING RESPONSE AND HEALTH ASSESSMENT



Compiled by
The Wildlife Conservation Society
The International Fund for Animal Welfare

Madagascar Melon-headed whale (*Peponocephala electra*)

Mass Stranding Event of May/June 2008

Final Report—Part II

Stranding Response and Health Assessment

Wildlife Conservation Society

and

International Fund for Animal Welfare

September 2009



Mass Stranding Response Team

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Antsohihy Volunteers

- Philippe Robinet
- Amirdine Amad (Babaji)
- Roger Andrianantenaina
- Christian Eloi Randrianantenaina
- Fitariha (second name not provided)
- Teddy Robinet
- Sergio Andriamanantena
- Tsiory Romeo Andriamanantena
- Odilon Jean Robuste
- Marc Angelo Rabesandratana
- Ducaud Ndrianjara
- Razafy Pierre Maharavo
- Erick Raheriniaina
- Haja Frederic Andrianomenjanahary
- John Rakotondramarina
- Donnat Flemis Rajaozaka
- Jean François Zafilaza Totomandiny
- Joseph Bartelot Hery Rasolonjatovo
- Joseph Sogastien
- Zafison Ralainiriko
- Roland (second name not provided)
- Dieudonné Salimo Mohamad
- Sidonie Guy Louis
- Fabrice Saniard Francois
- Norbert Razafindraibe
- Jean Pierre Jaonasy
- Nono (second name not provided)

Additional Stakeholders

- Chef de Région de Sofia
- Chef District
- Mayor of Antsohihy
- Chefs Fokontany (Elected village chiefs)
- Ministry of the Defense with the participation of the Gendarmerie Nationale, 2^{eme} CCGT
- Ministry of Environment, Water, Forests & Tourism
- Ministry of Agriculture, Fisheries & Livestock
- Ministère de la Justice et des Gardes des Sceaux
- The National Center for Oceanographic Research

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BACKGROUND

Mass Stranding Events and Prevention Efforts

Mass strandings of cetaceans have occurred around the world for hundreds of years. In many regions these were viewed as opportunities to harvest blubber for oil and meat for food and this is still the case in some areas of the world today. However, there has been a global shift in many cultures to protect and conserve marine mammals. Early efforts by scientists to investigate these events were based on the belief that mass stranded animals came ashore because they were ill; however, these investigations revealed that in many cases, the majority of animals were healthy. As a result, when mass strandings occur, or when groups of dolphins or whales are found out of their normal habitat (such as in rivers), attempts are made to rescue and return them to the safety of deeper, offshore water. Unfortunately, the effects of stranding are often so great that many animals do not survive. Although supportive care and in-depth health assessments have improved the survival rate for mass stranded cetaceans in some areas, the best survival rates can be achieved by preventing the stranding from occurring.

Prevention and Herding Methods

In 2002, the Cape Cod Stranding Network (CCSN), now a project of the International Fund for Animal Welfare (IFAW), began the first coordinated efforts to prevent dolphins and whales from mass stranding. A herding protocol was developed to drive animals into deeper water whenever they are observed close to shore. The Mass Stranding Prevention Program developed at CCSN/IFAW is similar to herding methods used

with cattle on land. A combination of herding movements made by vessels (and associated engine noise) and the deployment of acoustic deterrents (pingers) is used to drive the animals away from shore. Pingers, originally designed to reduce incidental bycatch of marine mammals in fishing nets, are small devices that emit a high frequency pinging noise that is aversive to marine mammals. The strength and frequency of the sound is designed to initiate an avoidance response away from the source of the sound. At the time of this stranding the CCSN/IFAW Mass Stranding Prevention Program employed two different models of pingers: the Dukane Netmark™ 1000, and the Aquatec Aquamark™ 200. Each model is slightly different and suited to differing hearing ranges of the species that most frequently mass strand (See Table 1).

The herding protocol requires a minimum of three vessels (two in smaller creeks) working in conjunction with one another. The vessels navigate between the animals and shore (or the upriver side), forming a semi-circle or “U” shape, all the time moving seawards. This motion of the vessels slowly drives the animals toward open water. It is essential that vessels communicate with one another to ensure that no animals slip between the boats.

Pingers are activated automatically when introduced into saltwater. The behavior of the animals is monitored consistently to determine the effects of the herding motion and the acoustic deterrents. Pingers are introduced and removed based on these observations. When effective,

zModel	Frequency	Pulse Width	Pulse Rate	Esonification Coverage	Acoustic Output
Dukane Netmark™ 1000	10 kHz Broadband	300 ms	4 sec	100 m	130dB min. re 1µ Pa @ 1m
Aquatec Aquamark™ 200	Variable (wideband frequency modulated waveforms, 5kHz – 160kHz)	200-300 ms/ea	Variable	100m	145 dB re 1µPa @ 1m

Table 1. Description of Pingers

these prevention efforts cause the animals to form a cohesive group and move away from the vessels into deeper waters. In some circumstances, pingers are not effective, with the animals showing no response. In other instances, animals become stressed and agitated by the sound, fracturing into multiple smaller groups, in which case the use of the pingers is discontinued. Often it is most effective to combine the herding motion of the vessels with the introduction and periodic removal of the pingers. These changes are often the best means to keep the animals consistently moving in the correct direction and avoiding habituation to the noise sources.

Previous Results from CCSN/IFAW Mass Stranding Prevention Program

The Mass Stranding Prevention Protocol has been quite successful in Cape Cod with several species. Given advanced warning of animals close to shore, there is a 74% success rate in preventing common dolphins from stranding and a 96% success rate with Atlantic white-sided dolphins (Moore, manuscript in prep). To date CCSN have had no success in preventing pilot whales from mass stranding. These varying degrees of success are due to a combination of factors; the behavior of the particular species, the size of the group involved (number of animals), and the hearing range of the species. Additionally, the more socially cohesive a species is, the better the chances of herding. Similarly, the larger the group of animals, the stronger those group tendencies will be, making herding and acoustic deterrents more effective.

***Peponocephala electra*: Description and Mass Stranding History**

Peponocephala electra (*P. electra*), commonly referred to as the melon-headed whale, is a long, slender odontocete that is found worldwide in tropical and sub-tropical waters mainly between 20° N and 20° S (Reeves *et al* 2002; Southall *et al* 2004; Wynne and Schwartz, 1999). Adults grow to approximately 2.7m in length and are approximately 0.8m in length at birth (Wynne and

Schwartz, 1999). *P. electra* are quite gregarious and are typically observed in large aggregations (groups can range up to 1,500 individuals) in deep-pelagic waters (Wynne & Schwartz, 1999). Their primary prey is mesopelagic squid, which are present in deep waters (1,500 m) (Southall *et al.* 2004). It is believed that this species forms socially cohesive schools, with many smaller coordinated sub-groups making up the whole (Reeves *et al.* 2002). Worldwide stranding records indicate that these animals more commonly mass strand (typically >100 individuals) than single strand (Reeves *et al.* 2002; Southall *et al.* 2004, Brownell *et al.* 2006). Brownell *et al.* (2006) report that approximately 29 separate mass stranding events of *P. electra* have occurred throughout the world from 1841 to April 2006, with some of these events involving more than 200 individual animals stranding in one single event (range 3 to 240, mean 79). Approximately 45% (13) of the total number of mass strandings occurred in Japan and Australia. Almost 48% (14) of the MSEs occurred in the last 10 years and 58 % (7) of these were in Japan (Brownell *et al.* 2006).

Note on nomenclature

English common names of many species can be confusing, particularly with the sometimes arbitrary use of 'whale' and 'dolphin'. *P. electra* are oceanic marine mammals of the family Delphinidae and the sub-order Odontoceti (toothed whales) and will be referred to as *P. electra* or whales throughout this text.

Strandings in Madagascar

There is no formal stranding network or stranding response system in Madagascar but strandings are occasionally reported in local media. Humpback whales and sub-Antarctic fur seals are the species most often recorded as strandings (Garrigue & Graham 1996; Randriamahazo & Razafindrakoto 2001; Razafindrakoto *et al.* 2005; Razafindrakoto *et al.* 2006, WCS unpublished data). However a 2001 marine mammal research expedition to the southern region of Cape Saint Marie provided evidence that cetacean strandings were more common in Madagascar than previously thought. For instance interviews with fishermen revealed that a large group of unidentified dolphins had beached at Lavanono in 2000 (Randriamahazo & Razafindrakoto 2001). Most recently, a stranding of 15 animals occurred in Nosy Hara in the northern region of Madagascar in 2007. The event was reported by the newspaper “Les Nouvelles” and photographs confirmed that stranded animals were *P. electra*. This stranding apparently occurred in two phases: the first report was of a group of stranded whales the week of November 20th and the second stranding occurred at the same site the first week of December 2007; there was no investigation.

Top: Scan of mass stranding article from the newspaper *Les Nouvelles*. Bottom: Image provided to WCS of the 2007 Nosy Hara stranding event

NOSY HARA
Mort inexpiquée de 15 dauphins

Quinze dauphins, ayant déjà atteint l'âge adulte, ont été trouvés morts à Nosy Hara-Antsirananana II. Les responsables sont actuellement en train d'élucider l'origine de ce drame.

Sur la plage de Nosy Hara.

Vendredi, les pêcheurs font la découverte. Poussés par les vagues, 15 dauphins, mesurant près de 2 mètres chacun, échoués sur la plage d'Ampasindava, dans l'archipel de Nosy Hara à Antsirananana II. Immédiatement, les pêcheurs préviennent les responsables de l'Angap. Des spécialistes, entre autres, des agents du service provincial de l'environnement et des vétérinaires se sont déplacés sur les lieux, examinant cinq des mammifères. Ils s'aperçoivent qu'ils sont déjà morts. Par ailleurs, les pêcheurs affirment que le reste de la bande est également décédé.

Mort par empoisonnement

C'est la première fois qu'un tel accident est survenu après 2005, l'année à laquelle l'Angap a pris en main la gestion de cet endroit qui, d'ici peu, deviendra probablement une aire protégée marine.

Selon Ignace, responsable du volet technique de l'Angap, deux hypothèses sont envisageables quant à l'origine de ce drame.

«Il est fort possible que cette mort soit due aux algues microscopiques. Il faut savoir que les dauphins sont des animaux carnivores et mangent des petits poissons qui se nourrissent des algues. Ainsi, si le taux de concentration des algues dans ces poissons est élevé, ça pourrait être mortel pour les dauphins. La deuxième hypothèse est la pollution marine. Ils ont peut-être consommé des substances toxiques», a-t-il expliqué.

En effet, des bateaux passent régulièrement près du littoral de Nosy Hara. Ces navires déversent des produits nuisibles pour les espèces endémiques dont ce littoral regorge. L'hypothèse d'intoxication n'est donc pas à écarter.

Afin de déterminer la cause de cette mort, les spécialistes ont procédé à des prélèvements. Les échantillons ont été envoyés à l'Institut Pasteur d'Antananarivo pour les analyses d'usage. En attendant le résultat de cette analyse, les responsables de l'Angap ont décidé d'enterrer les bêtes afin d'éviter le risque d'intoxication.

Un autre désastre écologique s'est déjà produit vers la mi-novembre. 265 dauphins sur un groupe d'environ 400 ont été trouvés morts sur l'île capverdienne de Boa Vista pour des raisons inconnues. Jusqu'à présent, la biologiste Ivone Delgado déclare ne pas avoir, dans l'immédiat, d'explication plausible à ce désastre écologique. Les dauphins sont des animaux mammifères cétacés appartenant à la famille Delphinidae. Ils vivent en petits ou moyens groupes et peuvent constituer des groupes de plus de 500 individus.

Mparany et Pasy R.



STRANDINGS RESPONSE

Situation Description

A timeline of events and a full description of the stranding location are provided in Part I of this report. *P. electra* were first seen massing at the Antsohihy dock on the 31st of May 2008. By all accounts the event was chaotic, with many Antsohihy residents attempting to swim with animals until ordered off by the Mayor of Antsohihy, Victor Rakotoarivony. Several animals were seen attempting to beach and some observers thought that the animals were behaving ‘strangely’. Initial estimates of group size exceeded 100 animals, though this number is likely very imprecise and an underestimation given the scale of the mangrove system (animals may have swum into many of the smaller creeks or *kingas*) and the absence of a skilled observer.

Event Response

The event response, which lasted from the 1st of June to 10th July, comprised five distinct phases:

Preliminary response: 1 June – 8 June

Expert MSRT response: 9 June – 13 June

Post-Expert MSRT: 14 June—20 June

Village Interviews: 21 June—22 June

Biological monitoring: 30 June - 10 July

Preliminary Response Efforts (1 June – 8 June)

Interview accounts (see part I) indicate that at least one if not two animals died in the area of the Antsohihy dock on May 31st. An attempt was made to drive the whales towards the Grand Lac on 1st June, 2008. This was initiated by Antsohihy residents Amirdine Amad, an Antsohihy merchant and Philippe Robinet, the proprietor of the Hotel Biaina. The effort utilized two privately owned motorized boats and a small fleet of paddled fishing pirogues; they had little success. The whales remained in the vicinity of the dock area for the next few days despite daily attempts to push them back towards the Grand Lac.

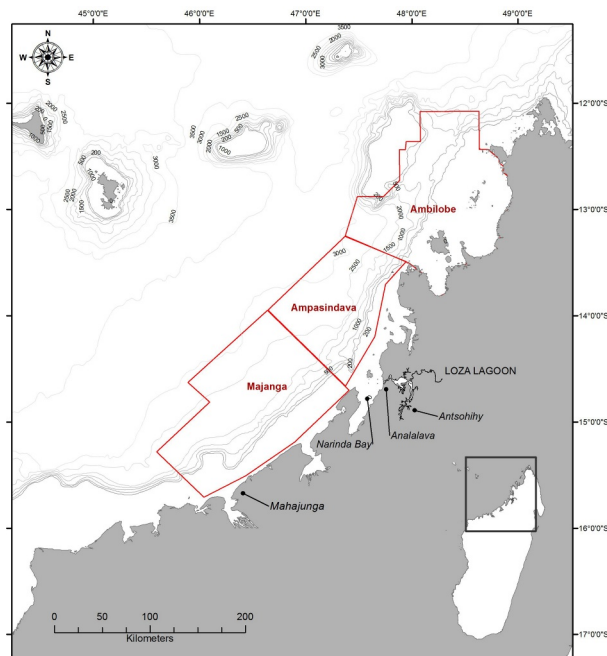


Figure 1: Location of Loza Lagoon.

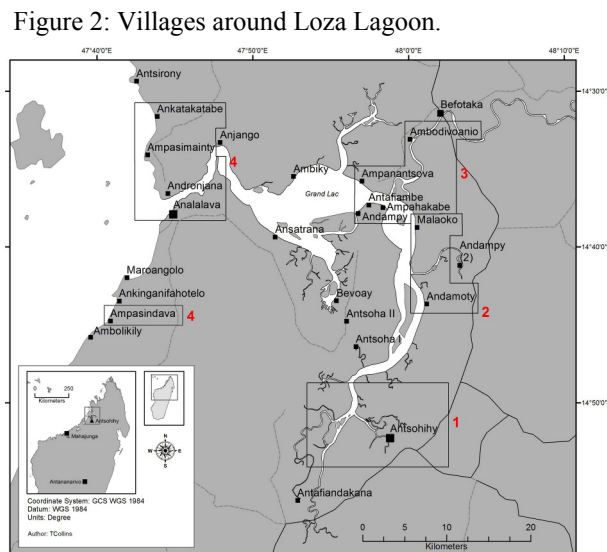


Figure 2: Villages around Loza Lagoon.

Additional deaths were recorded (two adults) on June 2nd. One of these animals was necropsied and sampled on June 3rd by Dr. Eugène Zafera, a state veterinarian based in Antsohihy. On June 3rd a further 9 adults and 2 calves were recovered dead.

Concerns were raised about the sale of whale meat in local markets given uncertainties about the cause of death. A burial site outside of Antsohihy was identified and prisoners from the local jail were put to work interring recovered carcasses. A public awareness campaign using local media (radio and TV) was also initiated on the 2nd of June with the primary objectives of informing the local population that the whales were a protected species and that the meat should not be eaten.

Between the 2nd and 6th of June 2008, the same small team of volunteers and fishermen spent many hours each day recovering whales that had become trapped in thick mud deep within mangrove channels and mangrove forests. Using lifting straps, whales were lifted bodily into a motor boat and were then released amongst groups swimming more freely in larger channels. Whales continued to die throughout this period (see figure 3).

Wildlife Conservation Society (WCS) staff members were made aware of the situation in Antsohihy on June 3rd 2008. Responses included an immediate push to get WCS personnel to the site and to seek additional international support. WCS marine scientist Behamafaly Randriamanantsoa was able to leave Antananarivo on the 4th June at 14:00pm in the company of officials from the National Fisheries Department using a ministry vehicle. Their immediate goal was to verify and report on events at the site. The car arrived in Antsohihy during the early hours of June 6th. Randriamanantsoa immediately set about organizing boats and personnel to help with a more organized response effort and with the approval of the Government of Madagascar WCS took control of the rescue effort until the arrival of an international mass stranding response team



Above: Dr Zafera inspected the first whales to strand at Antsohihy Dock

(MSRT). Most of the expert MSRT members were notified of the event and the need for assistance on the 6th of June 2008. These team members departed the US and Argentina on the 7th of June, arriving in Antananarivo, Madagascar on the 8th of June 2008. The full team arrived in Antsohihy via charter plane (Mission Aviation Fellowship - MAF) on the 9th of June. WCS staff and a WCS vehicle were sent from Toliara; their arrival at Antsohihy coincided with the arrival of the expert MSRT. For the duration of stranding response efforts, housing, food, water, supplies and other logistic support were provided by WCS and the hotel Biaina.

Expert MSRT Response (9 June – 13 June)

- The MSRT began their response based upon data provided by the Malagasy government (national, regional, and local) and initial aerial survey results. This included the following information:
- 100 – 200 whales were trapped in a river in northwest Madagascar
- At least 50 of these whales had already stranded and were dead, at least 23 were buried
- 8-10 strandings were being reported each day
- Animals were reported to be many kilometers inside the estuary although precise figures were not provided. These animals were possibly split into 4 sub-groups
- The dead were described as mostly female, with 2 neonates, but the method of determining sex was not verified so these results may not be accurate.
- Tidal fluctuations of approximately 3 metres and dense mangroves were hampering rescue efforts

The MSRT members developed a response plan designed to achieve two main goals:

1. To rescue as many animals as possible and release them into open water/ocean
2. To collect as much data as possible from both live and dead animals (performing ante-mortem and post-mortem examination sample collection) in an attempt to determine the cause of the stranding

To best achieve these goals, the MSRT divided into three sub-teams:

Team 1: Live Animal Rescue, Herding and Stranding Prevention Team

- to address live animal rescue

Team 2: Live Animal Health Assessment and Treatment Team

- to perform health assessments and treatment of live-stranded animals
- to collect diagnostic samples, perform tests and interpret test results in live stranded animals

Team 3: Post-mortem Examination Team

- to collect samples, perform diagnostic tests and interpret results in deceased animals

Team 1: Live Animal Rescue, Herding, and Stranding Prevention Team

Plan and Daily Activities

Based on prior response and prevention efforts within the US and the information available, the Live Animal Rescue, Herding, and Stranding Prevention Team established the following plan:

- Utilize as many boats as possible (at least three) departing from the port just before high tide
- Use standard herding protocols (described above) in conjunction with the falling tide to push the whales toward the open ocean
- Attempt to herd animals at least to the far (ocean) side of the Grand Lac
- Collect detailed data (GPS positions, behavioral observations, time, *etc.*) for all efforts
- Collect all fresh/moderately decomposed carcasses and transport to Team 3 for post-mortem examination
- Document and record basic data (species, length, sex, location, *etc.*) and samples (skin and teeth) for all carcasses not collected for post-mortem examination (sometimes referred to as 'Level A' data)

Resources

Although three is the minimum number of vessels required for herding and prevention efforts, it was not always possible to obtain three working vessels. On 10 and 11 of June, only two vessels were available: A WCS charter (21 ft charter

fishing vessel – “*Caranguea*” captained by Fabrice Saniard) and a local Gendarme powerboat (19ft Yamaha “*Moronda*” captained by Guy-Louis Sidonie). The fiberglass pirogue “*Vintsy*” had engine problems and did not function on two days. An 18ft rigid hulled inflatable boat (RHIB - “*Jano IV*”, captained by Norbert Razafindraibe) from the Centre de Surveillance de Pêche (CSP), was available and utilized in conjunction with the other three vessels between 12 and 18 June 2008. A further challenge was acquiring the necessary fuel and Andrianarivelo and Razafindrakoto worked persistently to successfully procure fuel each day. A second challenge was a lack of functional VHF radio equipment. Only one vessel (the “*Caranguea*”) was equipped with a working radio. The IFAW team brought three handheld VHF radios; however these were of limited long-term usefulness as they failed to recharge. Radio communications between boats were only possible on one day, 12 June 2008, when the CSP and a media consultant each provided the use of their radios for coordinating herding efforts and communication between Team 1 and Team 3 was not possible any day during the expert MSRT response.

Personnel

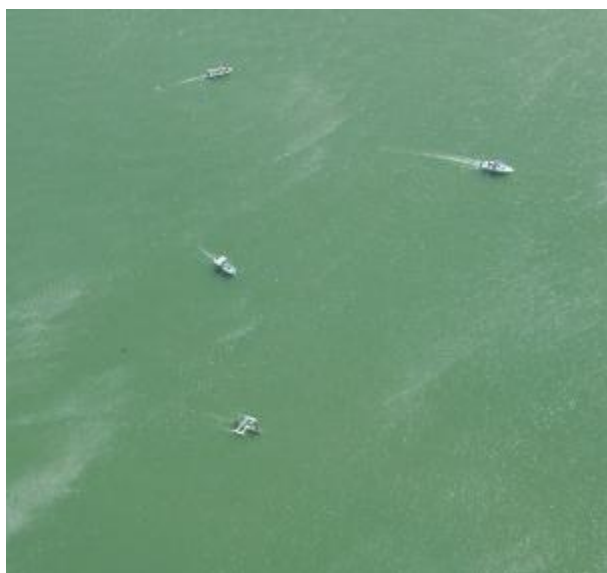
Each day from 10-12 June 2008, MSRT members Moore, Harry, Calle, McClave and Andrianarivelo planned departure from the dock at the port in Antsohihy to coincide with peak high tide. Andrianarivelo served as the chief logistics officer, procuring all vessels, gear, and supplies needed each day. The personnel resources utilized each day were streamlined over the course of the field work to optimize efforts (limiting the number of individuals on the vessels for safety and speed issues). The five MSRT members formed the core response team each day, in conjunction with the vessel captains and crew during this period. On 10th June, the response team and boat crews left the dock with numerous other volunteers who assisted in early stranding response efforts. These individuals provided local knowledge of the river system and descriptions of past efforts and their



Boats herding dolphins; the scale of the task is clear

results. On 11 June, Yvette Razafindrakoto (WCS), arrived in Antsohihy to assist with logistical support.

IFAW staff members, Moore and Harry, were deployed on separate vessels each day to maximize use of personnel experienced in mass stranding prevention, herding and the use of pingers. This enabled them to train captains in effective herding practices and in safe operation of



vessels around free-swimming marine mammals. Additionally, this arrangement allowed them to provide guidance and training in the deployment of pingers, maximizing their effectiveness.

On three of the days (10-12 June) live animal rescue and mass stranding prevention efforts were undertaken by the expert MSRT. Efforts were documented by recording GPS waypoints (latitude and longitude) for significant observations or actions taken by the team (leaving the port, observing animals, specific behaviors, pingers deployed and removed, *etc.*).

Team 2: Live Animal Health Assessment and Treatment Team

Plan and Daily Activities

Based on prior response and efforts within the US and the information available, Team 2 established the following plan:

- Provide supportive care and assess the health of all live stranded whales with the goal of releasing in open water as many as possible.
- Collect and process blood samples and morphometric data from all live stranded animals.
- Transfer of samples collected during this period (including securing all necessary permits) to WCS, New York, United States (WCS NY), for infectious disease serologic testing.

Resources

The necessary medication, supplies and laboratory equipment for treating and sampling live stranded whales was brought with the team from WCS NY. After blood sample processing, the serum and plasma were frozen in a freezer made available by Philippe Robinet.

Personnel

Calle and Uhart responded to a live stranded whale on the 9th of June. They provided treatment and obtained a blood sample. The sample was

processed by McClave, aliquoted into cryovials and frozen for transport to WCS NY for analysis for exposure to cetacean infectious diseases.

Other

Blood samples collected and processed by the team were transferred to WCS NY for further examination and testing; all appropriate permits were submitted and approved.

Team 3: Post-mortem Examination Team

Plan and Daily Activities

Based on prior response experience and the information available, Team 3 established the following plan:

- Perform gross necropsy examination on dead animals recovered by MSRT Teams 1 or 2 or by the general public
- Collect tissues for routine light microscopic examination and ancillary diagnostic procedures
- Perform post-procedure site clean-up and carcass disposal
- Prepare gross necropsy reports including morphometric data and abnormal findings
- Transfer samples collected during this period (including securing all necessary permits) to WCS NY for light microscopic (histologic) and ancillary diagnostic testing

Resources

The necessary equipment for necropsying was brought with the teams from WCS NY and Woods Hole. The team were also allocated a boat.

Site Selection and Necropsy Procedures

Analalava was initially identified as the site for performing gross necropsy procedures on dead *P. electra*. The primary factor influencing this decision was anticipation that the majority of dead animals would be transported to Team 3 by Team 1 and transfer of these animals at Analalava would be most efficient because in herding live animals to the open ocean Team 1 would pass by

Analalava. The MSRT was also told that travel from the Antsohihy dock to Analalava would take approximately two hours, which seemed to be an acceptable amount of time for animal transport between the herding team (Team 1) to the necropsy team (Team 3) while the team was still in the river system moving animals.

On June 10 two *P. electra* carcasses (MAD308-Pe002, MAD308-Pe003) and the head (MAD308-Pe001) of a third *P. electra* were transferred using the *Jano IV* to Analalava (an additional carcass MAD308-Pe004, collected near the village of Antafiampatsa was present on the dock at Antsohihy but was considered markedly autolyzed and was not transferred or necropsied). The two transferred carcasses had been stored out-of-doors in ambient conditions at the Antsohihy dock; the head was collected from a freezer in the hotel of Philippe Robinet. The original stranding dates and locations of these three animals were not provided to the necropsy team. The carcasses were not permitted onboard by the captain so they were towed with ropes to Analalava. The head was transported in an ice-box stored on-board. The boat trip to Analalava took approximately 6 hours rather than 2-2.5 hours the MSRT initially

anticipated, travel being slowed not only by the weight and drag of the towed whales but by another boat that was also in tow.

Upon arrival at Analalava, Team 3 submitted a request for permission to transport the animals to the beach for necropsy through a member of the crew. It is the understanding of Team 3 that the request was made to the Mayor of Analalava and that he granted approval (members of Team 3 were not present at this meeting). Animals and gear were subsequently transported to the beach by boat crew, MSRT members, and members of the general public. Necropsies of the carcasses and tissue collection were begun on the beach just inland from the tide-line. Due to fading light and the incoming tide, a decision was made to complete the external and cavitory examinations and tissue collection at the tide-line and to remove the heads for completion of dissection and tissue collection further up the beach away from the incoming tide. The remains of the two carcasses were removed by members of the general public and buried (site not known by MSRT) upon completion of the external exam and cavitory tissue collection and the 3 heads were moved for dissection and tissue collection further up the

Below: The coastal town of Analalava



beach. Dissection and tissue collection from the heads was not completed on June 10th due to loss of natural light. The heads were subsequently stored on ice with a plan to complete the dissection on June 11th.

However, on the evening of June 10th Team 3 recognized several problems that made it clear that all subsequent necropsy procedures should be conducted in Antsohihy.

- The trip between Analalava and Antsohihy was more time consuming than anticipated. This meant that critical resources would be lost from herding attempts if deceased animals were transported by Team 1 to Team 3 in Analalava.
- Team 1 never caught up to or passed Team 3 despite Team 3's slow progress. It was concluded that Team 1 was moving very slowly and perhaps not making much progress in herding whales to the sea, a factor that would limit the delivery of any subsequent animals to Team 3.
- Team 3 had lost all communication with the other MSRT teams (mobile telephones were being used initially but there was no signal in Analalava) and a coordinated response required an awareness of all of the activities of each team. The decision was therefore made to return to the port at Antsohihy as early as possible on June 11th.

On June 11th Team 3 returned to Antsohihy dock by boat. The three heads had been stored overnight on ice and dissection and tissue collection was completed adjacent to a warehouse at the port of Antsohihy. Tissue remains were buried (site described to MSRT as cemetery) by members of the public. Team 1 returned to the Antsohihy dock late the same day with a dead *P. electra* (MAD108-Pe003). The carcass was moved to the necropsy location and was stored under ice overnight. A complete necropsy with tissue collection was performed on June 12th. The carcass was removed for burial (same procedure

as for heads) upon completion of the necropsy procedure.

As Team 3 was preparing to depart from Antsohihy on June 13th, they learned that necropsy and tissue collection had been performed on two *P. electra* (MAD308-Pe005, MAD308-Pe006) by Eugène Zafera, DVM prior to their arrival. WCS Madagascar staff were tasked with coordinating transfer of the samples collected by Dr. Zafera, including securing all appropriate permits, to WCS NY for light microscopic examination.

Personnel

MSRT members McAloose, Uhart, Ketten and Andrianarimisa formed the core of Team 3. McAloose, Uhart and Ketten performed necropsy, dissection and tissue collection. Aristide Andrianarimisa served as the chief logistics officer June 10th-12th. Yvette Razafindrakoto joined the team on June 11th, 12th, providing logistical support to Andrianarimisa and assistance (note-taking, photography) during the necropsy procedures. The five MSRT members formed the core response team each day and coordinated activities with the vessel captains and crew during this period.

Other

Samples collected by MSRT Team 3 were transferred to the WCS, NY for further examination/testing; all appropriate permits were submitted and approved. Samples from two additional animals (collected by local Malagasy veterinarian Dr. Eugène Zafera prior to MSRT arrival) were also shipped to the United States and received by one member of the MSRT (McAloose) for further examination/testing; all appropriate permits were submitted and approved.

Post expert MSRT Response (14 June – 22 June)

After the international MSRT members departed Madagascar on 13 June 2008, the mass stranding rescue was lead by WCS Madagascar Program staff; the core team was composed by Behamafaly Randriamanantsoa, Aristide Andrianarimisa, Yvette Razafindrakoto, Norbert Andrianarivelo and the volunteers of Antsohihy. WCS Ocean Giants scientist Tim Collins joined the team in a supervisory role on 16 June 2008. The team was tasked with continued efforts to herd whales out to sea as well as to further investigate incidents surrounding the event, including establishment of a timeline to the event through an interview campaign (see Part 1 of this report).

Aerial surveys (9 June – 16 June)

Four aerial surveys were conducted between the of 9th June and 16th of June with these objectives:

- To assess overall *P. electra* distribution within the lagoon system
- To more thoroughly survey coastal beaches north and south of the Loza Lagoon mouth
- To locate possible capture channels in the area where animals were frequently seen

All surveys were flown using a chartered Cessna Caravan aircraft (MAF) at altitudes of between 550-750 ft. and maximum speed of 130kts. These remained consistent throughout the surveys.

Biological Monitoring (June 30 – July 10)

Following the larger scale MSRT rescue effort the *Ad Hoc* SOS committee recommended that WCS personnel conduct some additional biological monitoring to determine the fate of the presumed few whales remaining in the Loza Lagoon system. A combined approach using boat surveys and shore based observations from lagoon villages was put into place. A 19ft fiberglass boat (Argos

type) with two engines was hired from Analalava for the duration of the monitoring period and was used for logistics between the selected villages and for observation transects between Antsohihy and Analalava. The boat based team comprised five people including WCS coordinator Norbert Andrianarivelo. Four villages situated at appropriate intervals on the periphery of the lagoon were chosen as land based observation points. These villages were:

- Ankihibato (village close to Antsohihy)
- Andamoty (village on main mangrove channel close to the entrance of the Grand Lac)
- Ampahakabe (on the Grand Lac)
- Antafiabaky (close to Analalava)

Three observers from Antsohihy and five villagers were recruited for this effort.

SUMMARY OF RESULTS

Initial response

The initial local response to the stranding deserves special commendation. Despite having no prior experience and extremely limited resources many people offered help and their time. Subsequent interviews with Phillipe Robinet and Amirdine Amad were compelling in this regard. Their personal observations were that although their efforts were successful in preventing some deaths, the efficacy of their response was limited by a lack of suitable resources and a lack of trained personnel. The arrival of WCS Scientist Behamafaly Randriamanantsoa apparently had a galvanizing affect on the team and subsequent rescue efforts were conducted with more hope, organization, and success.

Events and results varied each day, and are described in detail in Appendices D and E. Between May 31 and June 9 at least 52 dead

whales were recorded (see Figure 3 below). An unspecified number of live animals were pulled from the mangrove mud banks and returned to the water.

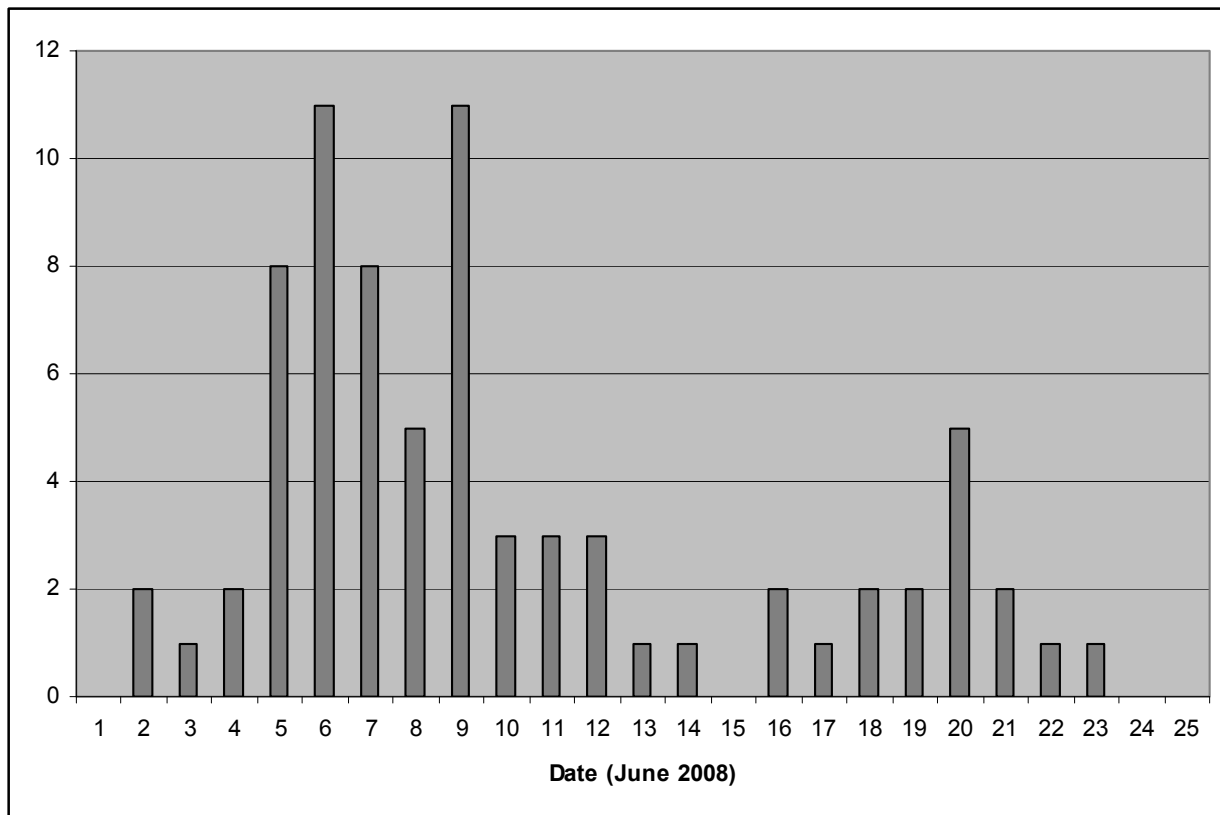
Expert MSRT Results:

Prior to arrival, the expert MSRT anticipated encountering 50-150 live animals based on various reports. However the initial aerial survey on 9 June documented only 25-40 individuals in the estuary system.

Team 1: Live Animal Rescue, Herding and Stranding Prevention Team

As detailed above, Team 1 encountered from 10-30 animals each day while attempting to herd animals to open water (10 June: 15-25, 11 June: 10-17, 12 June: 20-30). Although the team did not successfully herd any animals out to sea, efforts were successful in moving some of the

Figure 3: Mortalities recorded on a daily basis by the MSRT



animals into or close to the Grand Lac on the first two attempts. Of the 10-30 whales observed over the course of each day, approximately 19-24 (total) were herded into or close to the Grand Lac (10 June: 12-15, 11 June: 7-9). On the final herding attempt on 12 June 2008, 15-22 whales were herded approximately 7 km from the port toward the Grand Lac

In general the whales responded well to herding and pinger deployment. This was especially true on the first day, when the group of animals was moved the farthest distance towards the Grand Lac. Over the three days, the team observed that the pingers seemed to become less effective as each day progressed and less effective each successive day. Many of the animals appeared to swim normally, exhibiting strong swimming, changing speed and “normal” surfacing and respiration intervals. Several occurrences of repeated breaching were also observed within these groups. Each day, one or more sub-groups of animals appeared to become lethargic, swimming more slowly and in a less directed manner. These animals often changed direction, swimming up river, passing behind the herding boats. At first, the team attempted to double back behind the animals and drive them forward toward the main group. This was rarely successful. In order to achieve the greatest success, the team opted to leave these groups behind in order to continue pushing the larger group toward the Grand Lac, thus attempting to save a greater number of animals. The larger groups of whales, exhibiting more “normal” behavior were believed to be the “healthiest” whales remaining in the estuary and thus the best candidates for herding.

Marine mammals can be elusive and in this particular situation the many mangrove creeks and turbid waters further complicated the ability to observe and document whales from the vessels and from the air. The team documented the size of each group as a range and/or best estimate. At the end of each day the data were reviewed and a final figure agreed. Based on data collected during the

herding efforts, the team estimated that 11-29 animals were left in the mangrove system. The final aerial survey conducted on 13 June confirmed this number, with approximately 25 whales observed. Observed live whales appeared to be in reasonably good body condition. A small number of animals, possibly juveniles, appeared slightly thin, with a small indentation at the neck, but did not appear emaciated. Only one animal (MAD208-Pe001) was observed with superficial external lesions; it live stranded on 9 June, was released and probably re-sighted on 11 June.

During the herding efforts, the team responded to one previously reported dead whale and encountered two additional dead whales floating in the river. Basic data were collected from two of the dead animals; both were males greater than 250cm in length (adults reach approximately 270cm). The third carcass (MAD01-Pe003) was collected and transferred on June 11 to Team 2 for necropsy; post-mortem examination occurred on June 12.

In addition to *P. electra*, the team observed a small group of Indo-Pacific humpback dolphin (*Sousa chinensis*) during herding efforts on 13 June 2008. The sighting was not considered out of the ordinary in this region.

Team 2: Live Animal Health Assessment and Treatment Team

While preparing to meet with local officials after our arrival on 9 June, a report was received that a live *P. electra* had been brought to the port due to weakness and skin trauma to the right side of the head and neck. Calle and Uhart responded immediately. Sex determination was not attempted due to the animal's struggles. The approximate length was 200cm. The animal was lethargic, emaciated, flatulent, had superficial skin abrasions and lacerations along the right side of the melon, head, and body wall. A blood sample was obtained and emergency treatments consisting of 100 mg dexamethsone and 1000 mg of enrofloxacin were administered (See Appendix F).

The skin lesions were examined and determined to be relatively superficial. The animal responded to treatment and was then released and swam strongly away from the dock. On 12 June a whale with a similar pattern of skin lesions was sighted swimming strongly within a larger group. It appeared to be the same animal, but could not be confirmed.

Serum samples were transported to the US and submitted to the Oklahoma Animal Disease Diagnostic Laboratory for cetacean infectious disease serology. Both *Brucella* and *Morbilivirus* serologic results were positive, indicating previous exposure to these or related organisms (see Appendix G). With only a single animal sampled, and only a single sample obtained from this one individual without any other diagnostic samples available, it can not be determined if this represents a recent infection or an incidental finding indicating previous exposure. It is also not possible to determine from this result if there is any relationship to the mass stranding.

Team 3: Post-mortem Examination Team

See Appendixes H and I for complete Post-mortem Pathology Reports and Images and Post-

mortem Ancillary Diagnostic Test Reports, respectively

Gross Post-mortem Examination, Histology and Ancillary Diagnostic Results

General

The MSRT Team 3 was presented with and performed gross post-mortem necropsy examination and tissue collection from June 10-12 on three male *P. electra* carcasses (MAD308-Pe002, MAD308-Pe003, MAD108-Pe003) and dissected and collected tissue from the head of one *P. electra* (MAD308-Pe001). For detailed final gross necropsy reports for MAD308-Pe002, MAD308-Pe003 and MAD108-Pe003, a preliminary gross necropsy report for MAD308-Pe001, photos and post-mortem ancillary diagnostic test results see Appendixes H and I. Gross necropsy reports for the two animals necropsied by Dr. Zafera were not made available to the MSRT so are not incorporated into the necropsy report and results in this report; results of histologic examination of collected tissue samples are included.

Note: Gross necropsy notes related to the head (MAD308-Pe001) and descriptions of the ear bones for all of the carcasses were not

Right: MRST Team 2 members Calle and Uhart and members of local community responding to live stranded *P. electra*. Note severe skin lesions on dorsum.



incorporated into the necropsy reports or this report as they were not made available by the prosecutor by the time of completion of this MMSE-2 report. .

Tissues in each of the three carcasses, the head and tissue submitted by Dr. Zafera were moderately to severely autolyzed. Autolysis presented grossly in several ways including tissue discoloration, crepitus, dissolution of blubber with manual handling, and increased fragility. Histologically, tissue architecture and cellular detail was considered good to poor (often dependent on tissue type). Tissues from all animals contained bacteria that were multifocally associated with gas formation consistent with gross evidence of crepitus.

Each of the three carcasses was considered subjectively to be in moderately thin body condition, based on observed blubber thickness. The stomach of MAD108-Pe003 contained the flaccid carcass of an intact puffer fish and the skeleton of a second puffer fish. This whale's intestinal tract was empty as were the stomach and intestinal tract of MAD308-Pe002. The stomach of MAD308-Pe003 appeared empty (per manual palpation); the small intestine contained scant pasty contents. Hepatic lipidosis was present in all three animals, suggestive of peripheral mobilization of fat due to failure of recent feeding.

MAD308-Pe002 had mild multifocal pneumonia. The pattern and type of inflammation was suggestive of a disease process that had developed several days to perhaps a week prior to death; temporally, these findings were consistent with development during the mass stranding event.

Other Histologic Findings

Mild inflammation of the tongue and skin were seen in MAD308-Pe001 and MAD08-Pe003, respectively. Minimal multifocal edema and hemorrhage were seen in MAD308-Pe001 and tracheal hemorrhage was seen in MAD108-Pe003. All of these findings were considered incidental.

Parasites

The ear canals in each of the three carcasses and the head contained nematode parasites (*Stenurus* sp.) and trematode eggs (*Nasitrema* sp.). The presence of the parasites was associated with soft tissue inflammation in two of the whales (MAD308-Pe003, MAD108-Pe003). Few encysted larval cestodes (*Monorygma* sp.) were present in the caudal abdominal soft tissues in two of the carcasses (MAD308-Pe003, MAD108-Pe003) necropsied by the MSRT and one carcass necropsied by Dr. Zafera (N2008-0818). Skeletal muscle from one animal (N2008-0818) contained rare intramyofibrillar protozoa confirmed as *Sarcocyst* sp. with immunohistochemical staining. The encysted Cestodes and protozoa were interesting but were considered to be incidental.

Morbillivirus screening

Immunohistochemical staining was performed on tissue from all 4 animals: brain (MAD308-Pe001), lung (MAD308-002, MAD08-Pe003) or brain and lung (MAD108-Pe003). Results of tissue testing in each animal at these sites was negative.

Note: In the Athens Diagnostic Laboratory test results (see Appendix I) case N2008-0626-D is incorrectly identified as N2008-0625-D.

Toxicology screening

Brain, liver, kidney and stomach contents (puffer fish) from MAD108-Pe003 were evaluated for tetrodotoxin. Fish liver and whale kidney samples were positive; whale brain and liver samples were negative. Tetrodotoxin was extracted from tissues ("liver" from puffer fish, kidney from the whale) with acetonitrile:phosphate. The extract was centrifuged and washed with methylene chloride. The aqueous layer was cleaned-up using a STRATA X-C solid phase extraction cartridge, concentrated and analyzed using a triple quadrupole linear ion trap mass spectrometer (LC-MS/MS). Product ion spectra of the tetrodotoxin in the sample were compared to those in the analytical standard.

Ear scans

Ear imaging (scanning) and evaluation was performed at the Woods Hole Oceanographic Institute by MSRT member Ketten (dketten@whoi.edu; 1-508-289-3582). CDs of the ear scan images for all examined animals (MAD308-Pe001, MAD308-Pe002, MAD308-Pe003, MAD108-Pe003) were made available to the MSRT. The CDs of the ear scans include the software necessary for viewing the images and are available as a resource for potential future evaluation (e.g. external review by independent expert). Dr. Darlene Ketten's ear scan analysis and report were not available at time of completion of this report MMSE-2, but were reported directly to the ISRP from Dr. Ketten (cited as KET-1 in ISRP report). Additionally, the ISRP contacted Dr. Sophie Dennison (BVM& S; Dipl ACVR) and requested an additional independent review of the ear scans. Her report was also reported directly to the ISRP.

The authors believe it is essential to have all CT scans of the ears read by a board certified radiologist familiar with marine mammals. (The team suggests Sophie Dennison and can provide contact information). These data may prove important in better understanding what may have caused this stranding event. The authors wish to review these data if/when they are obtained. If time allows, the authors will incorporate relevant information into a revised report for the ISRP prior to their meeting. If that is not feasible, the new results will be summarized as to relevance to the event and added as an addendum to the report in its current state.

Post-expert MSRT

The local team operated between the evening of 13 and 22 June 2008. The same four boats were used during the period of 13 to 18 June 2008. WCS staff members were present in each boat except the Vintsy; Razafindrakoto worked in "Moronda", Andrianarivelo and Collins in "Caranguea" and Andrianarimisa was in Jano IV until 17 June 2008. Despite the cyclical pattern to

daily efforts the team was clearly motivated to save the remaining individuals and the continuing deaths were a major topic of discussion.

On the evening of 13 June they were told that a group of four individuals had become trapped in the shallow waters surrounding the old Antsohihy dock. The animals were captured (in the dark) and placed in boats to be released in deeper waters. The method was considered effective and over the following few days a total of 18 whales were moved using this method from within the mangroves into the main channel and as far as Analalava. Three groups of 1, 4 and 5 individuals were taken directly to the sea on the 15, 18 and 20 June 2008. All of the animals were seen to swim seawards.

On the 17 June several proactive options were ventured including directed capture of remaining groups using nets, boats and pingers and removing the captured animals directly to the Grand Lac or even put to sea. The most favored proposal was to push whales into a narrow mangrove channel on a low tide (spring tides were due on the 17th) in order to beach them; the captured animals would then be taken in all capable boats out to sea. The team agreed to one more day of the standard methodology in order to allow discussion of the idea with the expert MSRT.

Sightings of *P. electra* in the vicinity of Antsohihy port decreased over the course of the stranding event. The smallest groups of whales observed during the 13 – 22 June time period ranged between 1-5 individuals and the largest group observed comprised 8-15 individuals. Except for whales which were stuck in the mud in the deeper mangroves, most of the daily sightings were made in the portion of the river between Andamoty and Malaoko villages. This suggests that at least one group was remaining in the area and their daily movement ranged between Andamoty and Malaoko. Over time, the whales either became habituated to the pingers or the pingers themselves lost capability as the whales no longer responded

to the herding technique. Despite this, the team was able to continue moving observed groups towards Malaoko and Grand Lac by gently herding them with the boats.

This team also observed a large group (7-12) of Indo-Pacific humpback dolphin in a branch of the Ambinanibe Kinga on 17 June.

Aerial Surveys

June 9 2008

MSRT members conducted an opportunistic survey from the charter plane (Cessna Caravan) on their initial approach into Antsohihy. Objectives included sighting whales in the lagoon system and establishing an estimate of the number of trapped whales.

June 13 2008

Prior to departure members of the MSRT response team Charles Harry (IFAW), Kate McClave (WCS), Yvette Razafindrakoto, and other local representatives conducted an opportunistic aerial survey in order to locate remaining groups in the lagoon-estuary system and the area of Analalava. During the survey, when animals were observed, the GPS position and time were recorded. Survey effort began at 10:10 and finished at 11:10. The goal was to fly directly to the entrance of the open ocean and work backwards along the river system toward the Antsohihy dock. Two *P. electra* were observed in the channel leading to the open ocean; at 1047 hrs, four animals were observed 8 km from the dock; at 1050 hrs, eight animals were sighted 5.5 km from the port and at 1057 hrs, 11 animals were sighted approximately 1.5 km from the port. These last two groups, totaling 19 individuals, were exhibiting milling behavior with irregular circling and did not appear to be swimming in directed manner. The first two groups sighted exhibited much more defined, coordinated swimming toward the open ocean.

All groups sighted maintained a cohesive group structure. The survey effort ended at approximately 1110 hrs with a total of 25 whales observed.

June 16 2008

WCS scientists Collins and Randriamanantsoa, together with Isaia Raymond (ANGAP) flew a two hour survey flight with a Cessna Caravan, covering approximately 300 km. Objectives including locating groups within the lagoon and searches of beaches to the north of Analalava. Take off was at 12:53 and the flight covered approximately 300 km. Two groups of five and one whales were sighted in the main channel close to the Grand Lac. An attempt was also made to survey oceanic beaches on the inner coast of Narinda Bay (the bay within which the entrance to Loza bay is located) for additional strandings but time was short and the decision was made to complete additional surveys the following day.

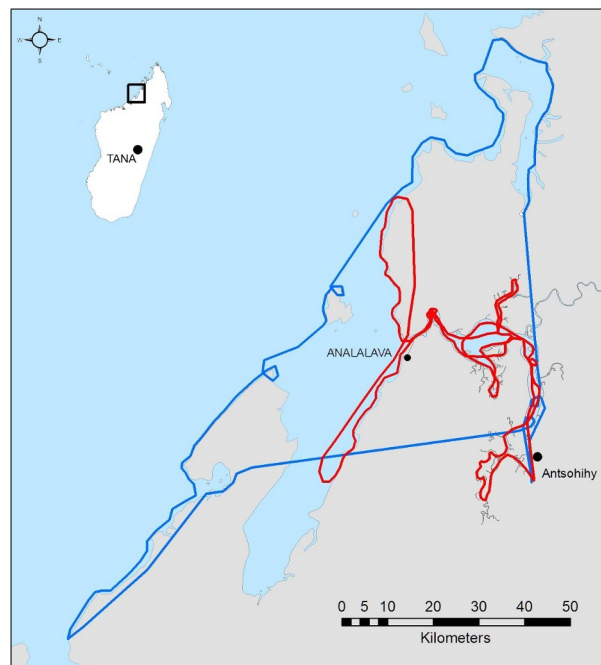


Figure 4: Tracks of aerial surveys flown by Tim Collins on June 16th (Red) and June 17th (Blue)

June 17 2008

An aerial survey was conducted by Collins and Randriamanantsoa (WCS), Mr Mananjary of DRDR, an officer with the Armée Populaire de l'Etat Major and the Commandant of the airport of Antsohihy. The objectives were to search beaches on the coast for additional strandings, to locate whales and to identify channels suitable for corralling and capturing dolphins. Take off time was at 10:47. Capture channels were located during the first 10 minutes of flight in areas where animals were frequently seen (Andamoty, Malaoko). Seven channels were waypointed for discussion with boat teams. From here the team flew to the southernmost survey point, defined on an *ad hoc* basis by the control zone of Mahajanga Airport to the south. This point was approximately 100 km to the south of the entrance to the Loza lagoon. Surveys also included the offshore islet of Nosy Lava and an additional 80 km of beach further north. All surveys were flown at a height of 750 feet and a minimum speed of 130kts for a total of over 500km survey effort. Open water passages were flown at 2500 feet for safety (Figure 4). No stranded animals were located but 4 live whales were sighted in the area of Andamoty.

Biological Monitoring

Ten days (June 30 – July 10) of shore based observation and three transects between Antsohihy and Analalava were completed. No *P. electra* were observed by the team during the boat transects. However a group of 12-18 Indo-Pacific humpback dolphins was observed on the 30th of June at Ambariakandraka, a small village between Andamoty and the Grand Lac. No whales were sighted from the shore based observation stations. However, in addition to conducting shore based searches observers at the selected villages asked local fishermen and passengers on local ferry boats if they had seen any whales. Sightings and interview results from each village are provided below:

Ankhibato

- July 2nd 2008: Observation of a group of approximately 20 humpback dolphins (this group was followed by observers in a pirogue to better estimate group size).
- July 3rd 2008: a fisher named Zarahita described a sighting of humpback dolphins numbering approximately 30 individuals.
- There were no observations of whales throughout the 10 day observation period

Andamoty

- No observations

Ampahakabe (Grand lac)

- A single sighting of a group of humpback dolphins was reported. No date provided.

Antafiabaky (Analalava)

Several reports were received of whales swimming out to sea from Analalava. One of these was provided by a commercial fisher.

- June 24th 2008: at around 16:00pm a group of 8 individuals was seen at high tide by Mr Misiny at Anorimbato (close to the bend in the entrance channel).
- June 28th 2008: a sighting was made between Anorimbato and Analalava on a dropping tide by Mr Bruno Bobey (Hotel Varatraza in Analalava) at ~17:30pm of 4 individuals swimming in the direction of Analalava ().
- July 2nd 2008: a carcass was reported by a fisher in the area of Antafiabaky. The carcass was in an advanced state of decomposition.
- July 6th 2008: Norbert Andrianarivelo was able to confirm that the carcass described above was a *P. electra*.

DISCUSSION

The Expert Mass Stranding Response Team arrived on site 9 days after the initial sighting of *P. electra* near the small harbour of Antsohihy. Thus, the animals that were still alive upon their arrival (approximately 25-40) had likely been out of habitat in an unfavorable estuarine environment (brackish, turbid, shallow and minimal natural prey availability) for an extended period of time. One would expect these animals to be stressed and begin to exhibit compromised health.

The goals for the Mass Stranding Response Team were to rescue as many animals as possible and release them into open water/ocean, and to collect as much data as possible from both live and dead animals in order to try to ascertain the cause for the stranding event. These goals included 1). Responding to any whales that stranded alive to perform health assessment, provide care and collect ante-mortem diagnostic samples, 2). To use herding and acoustic deterrents to prevent additional animals from stranding and to herd animals out of the estuary and out to sea into the Mozambique Channel and 3). To perform post-mortem examinations and diagnostics on deceased animals. In all cases, the team collected as much data as possible to help better understand the health of the animals and any possible causes for this event.

For the Live Animal Rescue, Herding and Stranding Prevention Team (Team 1) the greatest success was achieved on Day 1 (10 June 2008) when herding efforts were first initiated. This was likely due to the novel effect of herding with boats and pingers. Through visual observations of swimming behavior during these efforts, Team 1 was of the opinion that the healthiest or least physiologically stressed individuals were able to reach a more favorable environment, Grand Lac, putting them much closer to the channel leading toward the open ocean.

Each day Team 1 observed animals that fell into two distinct behavioral categories. There were animals that exhibited strong, directed, purposeful

swimming and there were animals that were noticeably stressed (swimming more slowly, slightly lethargic, milling). Furthermore, it appeared that the combined herding efforts (herding motion of the vessels and deployment of the pingers) became less effective each day, suggesting that the animals were either habituating to the herding and sounds produced by the pingers, and/or their condition was deteriorating to the point that they could not be herded. A combination of these factors was likely at play, since some animals continued to appear “normal” and respond to the efforts, while others appeared to be deteriorating and less responsive.

Team 1 continued vigilant herding efforts, but it appeared that on each successive day there were more unhealthy animals, thus the total distance the animals were herded decreased each day. Team 1 hypothesizes that as the tide turned and rose through the night, the weaker animals were being pushed from where herding efforts discontinued back toward the port of Antsohihy. This was most evident on Day 3 (12 June 2008) when a large group (approximately 20-30) was encountered closer to the port than on the previous two days. Again, herding efforts remained strong, but were even less effective than the previous day.

Overall, Team 1 had moderate success. Every available resource was utilized to drive the animals toward open water. Approximately 19-24 whales were successfully herded into or close to Grand Lac. At least four animals were observed moving from the channel out of Grand Lac towards the sea, thus the team believes that those whales successfully herded into Grand Lac had a reasonable likelihood of finding their way back to sea. Only one animal stranded alive during this period and was successfully treated and released (see Team 2 discussion below).

The *P. electra* that remained in the river system at the end of the MSRT efforts were most likely too weak to react towards consistent herding efforts. These animals were most likely the same

individuals that had not responded well to herding efforts and had been left behind each day, representing, presumably, a less fit group for which long-term survivorship remains questionable. The response team members agreed that without further intervention, these animals would remain in the river system with their health status continuing to deteriorate.

The single live stranded whale that Team 2 treated on 9 June with a single time with antibiotics and steroids appeared to improve after the treatment. It was very weak when examined, and after treatment it became stronger and swam away normally. It is not known to have stranded again, and an animal with similar skin lesions was observed on 12 June swimming strongly and normally within a group of other whales. Although it could not be determined if this was the same animal, no other animals (alive or dead) with similar skin wounds was observed for the duration of the period the team was on site.

The infectious disease results of the blood sample collected by Team 2 from the single live stranded whale indicated that this animal was exposed to both *Morbillivirus* and *Brucella*. It is also possible that these results indicate cross reaction to similar or related organisms. Both of these infections are common in cetaceans throughout the world, and although *Morbillivirus* infections can be associated with mass strandings, it was not possible in this case to determine if it played any role in this stranding event. Additional blood samples from other whales from this stranding event would be required to determine the significance of these findings.

In reviewing the post-mortem findings of Team 3, it is important to consider the presence and absence of pathologic changes/disease as both are significant. It is also important to consider context and limitations in order to correctly interpret data and develop appropriate conclusions. Post-mortem results must therefore

be interpreted in light of all of the data that is collected and available during the stranding event. The most significant limitation for Team 3 in this stranding and mass mortality event was the arrival of the MSRT several days after the event began. It was estimated that the greatest number of mortalities, from 50-100, occurred prior to our arrival and that expertise and resources to guide a coordinated effort for large-scale sample collection early in the stranding event were not available. Valuable information that would have added to a more complete description of pathological changes than we have been able to compile from 6 animals (3 carcasses, 1 head, limited samples from 2 additional animals) examined by the MSRT was therefore certainly lost. Despite these limitations, the local community is certainly to be commended as their concern for the animals was great and many contributed to efforts to aid in saving animals and investigate their deaths. For example, Dr. Eugène Zafera provided his assistance and collected samples from two animals, but he did not have the resources to continue his efforts.

The two most significant and consistent post-mortem findings in examined animals were poor body condition and parasites in the ear canals. Loss of condition was significant and likely a contributing factor in the death of 3 of 4 animals examined by the MSRT (could not be assessed on the 4th animal as we only received the head). Based on the time-course of events, these animals had been out of their environment without access to normal prey items for approximately a week prior to death. Loss of weight and condition was therefore not a surprising finding, given the distance of the animals from the open ocean and their normal prey items (potentially) coupled with increased metabolic and physiologic demands related to the stranding event and efforts to return to the ocean. Only one animal had any evidence of recent feeding (MAD108-Pe0003). This animal had ingested puffer fish, which is not a normal prey item of *P. electra*. In this case it is presumed that the whale ate the fish because it

was hungry and its normal prey items were not available. Puffer fish can contain the potent neurotoxin tetrodotoxin (anhydrotetrodotoxin 4-epitetrodotoxin). This toxin blocks voltage-gated sodium channels in nerves, effectively blocking neurotransmission. Effects of the toxin vary by species and dose and typically develop relatively rapidly after ingestion (30 minutes to several hours). Mild intoxication can include numbness, salivation, weakness, incoordination while more severe effects include paralysis, bronchospasm, coma, hypotension and death. Toxin was identified in the liver of the ingested puffer fish as well as the kidney of the whale. Given the time course of event and distance of the whale from the open ocean, it was concluded that the whale ingested the puffer fish while in the mangrove river system. Ingestion and intoxication did not play a role in the mass stranding event but may have contributed to the death of this individual.

Both *Stenurus* sp. parasites and *Nasitrema* sp. parasite eggs were present in the ears and around the ear bones of 4/4 animals examined by the MSRT. Parasite load was considered to be low but was associated with mild inflammation in 2/4 animals. *Stenurus* have been described in the air sinuses and ear canals and *Nasitrema* have been described in the air sinuses and around the ear bones in *P. electra* (reviewed by Jefferson and Barros1997) The significance of this finding in the individuals examined by the MSRT and the relationship of the infection to the stranding event was undetermined. There is debate in the scientific community about the significance of ear parasites in individual animal strandings and stranding events. (Dailey and Walker, 1978; discussed in Morimitsu *et al* 1986). In some reported cases, parasite migration and the presence of parasites and eggs have been associated with necrosis and inflammation of the brain, cranial nerves and ears, and it has been suggested that tissue damage might result in disoriented behavior and stranding. In 2/2 brains examined by the MSRT there was no gross or histologic evidence of parasites or eggs. Parasites

were however present in 4/4 of the ears. If parasites were involved in the stranding, a possible scenario might be that one or several animals could have become disoriented and lead others away from the ocean and into the estuary. Whether this occurred or not is not known. During the period of observation by the MSRT live animals being herded through the estuary system towards the ocean were reportedly swimming normally in a coordinated and directed manner; those that fell behind were thought to be weak but were not described as swimming abnormally. If parasites were present in the live swimming animals, they did not appear to be causing clinically apparent behavioral changes in observed whales. The few encysted larval cestodes (*Monorygma* sp.) present in the abdominal soft tissues were incidental findings.

Viral, bacterial, fungal or significant protozoal disease, each of which could potentially cause morbidity or mortality resulting in stranding, was not found in examined animals based on light microscopic (histologic) examination and immunohistochemical staining. Morbillivirus infection has caused strandings and death in cetaceans and pinnipeds worldwide. Samples from each of the four *P. electra* collected by Team 3 were negative for morbillivirus with immunohistochemical staining. In general, typical histologic lesions consistent with viral infection include (not limited to) non-suppurative encephalitis, pneumonia and intestinal or hepatic necrosis and/or inflammation in the presence or absence of viral inclusions. Bacterial and fungal infection (single or clusters of organisms) can occur in the absence (acute infection) or presence (acute-chronic) of edema, inflammation or tissue necrosis. Lesions consistent with an infectious process, including bacterial (such as *Brucella*), fungal, or viral infection, were not seen, which may lend credibility to other possible causes, including a behavioural response. Animals examined by the MSRT were not clinically affected and did not die as a result of viral, bacterial, fungal or protozoal disease. A similar

conclusion could not be established in samples from Dr. Zafera due to the limited number and external location of the samples (MRST received only skin, skeletal muscle, blubber, nerve). Due to our low sample size, viral, bacterial, fungal or protozoal disease cannot be ruled out as a cause or contributing factor in the stranding event based on their absence in the examined animals.

lesions reflective of the underlying reason/s for the mass stranding.

Acoustic trauma due to anthropogenic factors including high-intensity sonar has been implicated or associated with several marine mammal mass stranding events, and it is known that a seismic survey exploration operation was occurring in the area coincident with the Madagascar *P. electra* stranding event. Gross or histologic evidence of acoustic trauma includes hemorrhage and/or necrosis in the brain, internal organs or in the tissues around or in the ears, or by the formation of 'gas bubbles' in blood vessels. These changes were not identified in the brains or internal tissues of examined animals. Detailed examination (via imaging/scans) of the ear bones to identify lesions, including what can occur with acoustic trauma, was performed. However, final results and conclusions from the scanned ear bones have not been made available by the referral laboratory at WHOI. The role that acoustic trauma or other ear-related disease may have played in the stranding event is, therefore, currently undetermined. Should lesions be present, these data have the potential to provide additional insight into the underlying cause for the stranding event. That said, it is important to note that the absence of lesions in examined animals will not exclude acoustic trauma as a possible contributing factor in the stranding event since:

1. animals that were initially or immediately impacted by the underlying cause of the stranding event and would contain the most reflective lesions were not available for examination.
2. those that were available died several days after the initiating event and may not contain

CONCLUSIONS

The goals established for this mass stranding response were met to the extent feasible. Timely care, sample collection, health assessment and treatment were provided to the one live stranded animal encountered during the international team's response. The prevention of further strandings was attempted systematically with some success. Rescue attempts after the international team departed showed continued effort to adapt to the situation at hand, resulting in even greater success with some of the animals. Given ambient air and water temperatures and the remote locations of the carcasses found, collecting fresh samples was difficult if not impossible. Although the extent of decomposition was great, as many samples as possible were collected and disseminated for analysis. Given the small sample sizes (1 live, 3-5 dead specimens), it is difficult to draw any conclusions from the results of analyses. However, in every stranding event all possible causes must be considered. Both natural (disease, parasites, harmful algal blooms etc.) and anthropogenic (industrial and military sound sources, chemical spills, fishery interaction, vessel interactions etc.) factors should be incorporated into comprehensive analyses.

Of particular interest in this case, and a growing global concern, is the effect of ocean noise on marine mammals. As reported in the first part of this report we learned that surveys (seismic and sonar) commissioned by ExxonMobil, were taking place in near-shore waters directly offshore of the stranding location. Compilation of data regarding activities such as this can occur during the event, but more often occurs after the event. This cannot be undertaken by the stranding response teams, as they are both fully engaged in the response itself, and also need to maintain objectivity in examining the animals they encounter.

As post-event sample and data analyses take place, environmental and other data, such as the activities described above, should be incorporated for a truly comprehensive analysis. The degree of postmortem decomposition and autolysis inhibited

opportunities to conclusively identify or eliminate possible causes for this stranding event through biological sampling. Other sources of data may thus be instrumental in understanding this event (and may prevent it happening again). Although physical evidence may not support or refute a given hypothesis (pending reports of ear scans, histology and gross exams from Dr. Ketten), all possible causes for the event must be examined. In some instances, mass stranding investigations have yielded strong evidence to suggest a likely cause (e.g. Cox *et al.* 2006; Brownell *et al.* 2009). One such cause for events similar to this one (involving deep-diving, pelagic species stranding in an uncommon location) is the presence of an anthropogenic sound source that is often proximal in both time and space. Even in fresh carcasses, acoustic trauma and/or the physical effects of the behavioral changes caused by an acoustic source can be difficult to document. However, the circumstantial evidence of industrial or military activity in an area prior to, or during stranding events has been used to suggest a causal relationship. Cox *et al.* (2006), Southall *et al.* (2006) and Jepson *et al.* (2005; 2009) have all made connections between anthropogenic noise sources and mass stranding events.

Given these past cases and the anecdotally reported industrial seismic activity underway just offshore from this stranding site in the time period prior to the event, additional data must be obtained to determine the likelihood that these activities may have induced or contributed to this stranding event. Descriptions of these activities, levels and types of sounds produced, and exact locations must be obtained from ExxonMobil in order to determine the potential effects on these animals. Comprehensive sound mapping should be examined in reference to average travel speeds associated with *P. electra* and the stranding locations and timing as described by Southall *et al.* (2006).

In conclusion, the efforts undertaken by the mass stranding response team were an exercise in

patience, communication, unintended/unexpected situations, and adaptability. Ultimately a cause for the stranding event was not determined. The team was successful at assessing the issues and devising a plan with defined roles in order to execute response strategies. The plan was modified each day based on observations, lessons learned, brainstorming ideas, and available resources. Logistics (acquiring the optimal number of herding vessels) and communication (radio communication between the vessels) were a struggle, often dictating that the plan be modified to accommodate the circumstances. Furthermore, the unanticipated magnitude of the stranding location also confounded the situation. Prior to this event, efforts undertaken by CCSN/IFAW to herd groups of dolphins or whales took place in relatively enclosed creeks or estuaries (< 3.5km

wide and 5.6km long). Herding animals in very wide water bodies requires many more vessels (though not necessarily any more pingers) in order to establish a “wall” of motion behind the animals to drive them toward open water. The large width within this estuary (max. 7.4km) and length to open water (65.9km) presented an incredible challenge. With only two or three vessels available each day, it was not unanticipated that the team struggled to move the animals through the wider portions of the estuary. Compounding that problem was the lack of radio communications between the boats on two of the days. When herding animals communication is essential to coordinate movements and maximize effectiveness.



Three *P. electra* captured simultaneously on the 20th of June for transport by boat to the sea.

RECOMMENDATIONS

Recommendations for further analysis of this event:

- Data regarding industrial, military and other anthropogenic activity in the region before and during the event must be examined;
- Data regarding the examination of ears/ear bones from the necropsied carcasses and head must be obtained from Dr. Ketten as agreed upon prior to team deployment to the site (raw data and analytical notes). Without these data, this report is incomplete.

Recommendations for moving forward:

- The absence of historic stranding data in Madagascar (and the region in general) makes it difficult to place this event in context. A stranding response program should be initiated in a systematic and consistent manner. Collecting even the most basic data, recording the date of stranding, species, sex, length, location (lat/long) of each stranded animal would provide baseline data that would allow the government of Madagascar and citizens to recognize anomalous events.
- Establish a reporting system to document strandings on either a regional or national basis
- Legislation should be in place (if not already) to ensure observers are present on industrial vessels whose activity may impact protected species such as marine mammals.
- Partnerships with existing stranding response organizations can play a key role in supporting the development of a new network, often with little to no cost to the new network. Support can include sharing of protocols, data sheets and data management techniques as well as training.
- All dead animals should be marked or tagged in some way once examined in order to reduce the likelihood of double-counting an animal. Various means of tagging and marking can be explored (plastic livestock tags, biodegradable flagging tape, paint sticks, etc.)
- If possible, live animals that are released or relocated and released should be marked in some way (paint sticks, or properly attached radio tags) to attempt to identify animals that may re-strand or be re-sighted swimming on another occasion.

Recommendations for future responses in estuarine systems:

- Perform an aerial survey before attempting to move whales to determine their number and location.
- A minimum of 3-5 vessels are necessary to effectively herd animals (preferably five in the widest areas of rivers/channels).
- Each boat must have the ability to communicate with others via radio (or other means) in order to coordinate boat actions. The choice of radio system should be well considered.
- One individual should be identified as the leader to coordinate boat movement and the deployment and removal of pingers based on animal movement and behavior.
- Single frequency and variable frequency pingers should be available (or borrowed from a predefined source) and maintained for readiness.
- Herding efforts can be undertaken at any time (they are not tide dependent), and their efficacy should be evaluated on a case by case basis.
- All live stranded animals should be evaluated, triaged, treated, and samples collected before attempting to return the animal to the water system.
- All dead animals should be recorded with a GPS position and then removed from the tidal zone or secured in some fashion to prevent carcasses from drifting to new locations where they may be confused for new deaths.
- A minimum of basic, 'Level A' data (See Appendix J) should be collected from dead animals that are too decomposed for complete necropsy.

- All samples and data sheets should be labeled with a field number for each individual animal and organized for future analyses.
- Whenever possible, a full necropsy with tissue sampling should be completed on dead animals, even in advancing states of decomposition.
- Alternative response protocols should be discussed and, if deemed plausible and safe, protocols should be developed (*e.g.*: capture and transport/release). It should be noted that since 2008, the IFAW MMRR team has undertaken aggressive relocation and release efforts with great success. Protocols based on the experiences of other networks, such as IFAW MMRR, should be adapted to suit local species, rescue resources, personnel experience, and logistical constraints. This should be an option explored for each mass stranding event.

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APPENDIX A - IMAGES

Select images are included here. Additional images are available from WCS and IFAW.



Tim Collins (WCS)



Tim Collins (WCS)



Tim Collins (WCS)

Top: Loza Lagoon habitats are varied, with areas of open water, mangroves and complex sandbanks. Below: Aerial surveys provide an excellent overview and areas searched included the lagoon and oceanfront beaches.



Yvette Razafindrakoto (WCS)



Yvette Razafindrakoto (WCS)



Yvette Razafindrakoto (WCS)



Yvette Razafindrakoto (WCS)



Tim Collins (WCS)

Top: the *Caranguea*, a boat hired from Nosy Be for the stranding response effort. Below: the *Maronda*, a boat provided by the Gendarmerie at Analalava, together with its willing and enthusiastic crew



Tim Collins (WCS)



Tim Collins (WCS)

Top: Volunteers wade through knee high mud to reach a stranded whale. Note the extreme tidal variation. Below: more stranded whales are gently restrained before being transferred to boats for transit to open ocean waters



Top: a stranded but still living whale in the care of an Antsohihy volunteer. Below: volunteers prepare to lift a whale in the *Maronda*, for transfer to open waters.



Tim Collins (WCS)



Tim Collins (WCS)



Tim Collins (WCS)

Top: Gendarmes coax an exhausted whale to a waiting boat. Below: whales onboard the *Caranguea* during transfer to open water. Whales were treated with enormous respect by crews and responded well when released.



Tim Collins (WCS)



Sal Cerchio (WCS)

Top: Melon headed whales in the Loza Lagoon system, alien habitat for an oceanic species accustomed to diving deep. Below: free swimming melon-headed whales in Malagasy waters—here at Toliara, site of a WCS study

APPENDIX B

Available Images

- WCS/WHOI— ear scan images for all examined animals (MAD308-Pe001, MAD308-Pe002, MAD308-Pe003, MAD108-Pe003).
- WCS-194 images from gross necropsy procedures (MAD308-Pe001, MAD308-Pe002, MAD308-Pe003, MAD108-Pe003).
- WCS—1694 images of the stranding response effort, aerial survey, biological monitoring effort and meetings
- IFAW—61 images of the stranding response effort
- IFAW (Independent documentation specialist)—18 Images
- Incidental Images—images compiled by MSRT from Antsohihy residents and observers (20)

Available Video

- WCS—Incidental video compiled between June 6 and June 22 (2 hours)
- IFAW (Independent documentation specialist) – Professional video of stranding response teams between June 9 and June 13 (4 hours)
- Radio France International—Incidental video recorded by Gregoire Pourtier between June 16 and June 18 (1 hour)

APPENDIX C - Daily results during the rescue effort

1 June 2008

An attempt was made to drive the whales towards the Grand Lac by Antsohihy volunteers on 1 June. The effort utilized two privately owned motorized boats and a small fleet of local fishing pirogues. This initial effort apparently met with little success and the whales remained in the vicinity of the dock area for the subsequent few days despite repeated attempts to push them back towards the Grand Lac.

2 June - 6 June 2008

Between the 2nd and 6th of June 2008, the same small team of volunteers and fishers spent many hours each day recovering whales that had become trapped in thick mud deep within mangrove channels and amongst mangrove trunks. Using lifting straps, whales were lifted bodily into the only available motor boat and were then released amongst free swimming groups. Whales continued to die (see page 35).

WCS staff members were made aware of the situation in Antsohihy on June 3 2008. WCS scientist Bemahafaly Randriamanantsoa left Antananarivo on 4 June at 14:00pm in the company of officials from the National Fisheries Department using a ministry vehicle. The car arrived in Antsohihy during the early hours of June 6. Most of the expert MSRT members were notified of the event and the need for assistance on 6 June 2008. Randriamanantsoa immediately set about organizing boats and personnel to help with a more organized response effort and with the approval of the Government of Madagascar WCS took control of the rescue effort until the arrival of the expert MSRT. WCS staff and a WCS vehicle were dispatched from Toliara; their arrival at Antsohihy coincided with the arrival of the expert MSRT.

8 June 2008

The international expert team members departed the US and Argentina, arrived in Antananarivo, 8 June 2008 and stayed in the capital for one night.

9 June 2008

The expert MSRT transferred to Antsohihy via a chartered Cessna Caravan (Mission Aviation Fellowship - MAF) and conducted an aerial survey of the estuary from Antsohihy to Analalava. Several groups of animals were observed for a total range of 25-40 whales observed. The animals appeared to be either milling or swimming when observed. Varying lengths of animals were observed, suggesting a range of age classes from juvenile to adult. Animals were dispersed throughout the survey area, from the port in Antsohihy to the Grand Lac. (Note: as the opportunity to complete the survey was unexpected, the field gear necessary to record full data (GPS) was not available to the team as it was stowed for travel. Thus, there are no waypoints for these sightings.) Water color varied from black to light brown depending on the suspended sediment and visibility below the surface was minimal to non-existent. The width of the river/estuary varies greatly along the length (reaching almost 7.4 km at the widest point). The approximate distance from the port in Antsohihy to Analalava (sea) is approximately 65.9 km.

While preparing to meet with local officials after our arrival, a report was received that one live melon-headed whale had been brought to the port due to weakness and skin trauma to the right side of the head and neck. Drs. Paul Calle and Marcia Uhart responded immediately. Sex determination was not attempted due to the animal's struggles. The approximate length was 200cm. The animal was lethargic, emaciated, flatulent, had superficial skin abrasions and lacerations along the right side of the melon, head, and body wall. A blood sample was obtained and emergency treatments performed (See Annex F). The observed lesions were examined and determined to be superficial. The animal responded to treatment, was released and swam strongly away from the port.

10 June 2008

Early in the morning the team received word that

a group of nine whales had been observed not far from (seaward of) the port. After encountering some logistical challenges in the form of engine malfunction and lack of fuel, the team departed the dock at 1107hrs. The first group of animals (5) was observed at 1153hrs. At this time, the team began coordinated herding efforts to push the animals further north, out of the estuary and out to sea. There were no radios working this day, thus no clear communication possible between herding vessels. This proved to be a significant challenge in attempting to coordinate our movements to most effectively herd the animals. Over the course of the day, two boats and both models of pingers were used to herd a total of 15-25 whales toward open water. During the herding efforts, at 1351hrs, a sub-group of melon-headed whales began to slow their progress forward, swimming slower and appearing lethargic. One animal appeared to be surfacing oddly and listing to the right. After attempting to herd these animals, the two boat teams joined to discuss options and it was decided to leave the smaller group of approximately five animals in order to concentrate herding efforts on the larger group. The larger group was swimming in a strong, directed manner. These whales were herded further down the river and left near the opening to the Grand Lac at 1534hrs in order to allow the vessels to return safely to the port before dark (navigation on the river is dangerous after dark). As we expected, based on past experiences, herding with only two boats in such a large, open body of water was quite difficult and tedious. However, the combined use of coordinated boat maneuvering and pinger deployment was relatively effective on the first day as it appeared that 12-15 whales were successfully herded into Grand Lac.

One dead animal had been removed from the river several days earlier and placed in a hut along the bank. The team collected basic data and genetics and aging samples, and photos.

11 June 2008

The MSRT Live Animal Team departed the port at 1039 hrs (prior to peak high tide) with the goal of being in position to herd animals seaward just

as the tide began to fall (CCSN/IFAW data and logic suggest that pushing animals with the tide is more effective than against the tide). The Necropsy team (returning from Analalava) reported a group of 2-5 whales seen at 0824 hrs, with associated GPS coordinates. The team again used two boats to herd approximately 10-17 animals toward Grand Lac. One animal was observed with the same pattern of skin trauma that was documented by Drs. Calle and Uhart during the response to the live stranded animal that was treated and released at the Antsohihy port on 9 June. The animal was observed swimming strongly with a larger group of whales. It appeared to be the same whales, but without closer observation and better photography equipment, this could not be confirmed.

During the course of herding efforts, a sub-group again appeared more lethargic and less responsive to both herding and pinger deployment. After several attempts to round up these animals and keep them with the larger group, it was decided to abandon the small group of three animals in order to herd the larger, “healthier” animals toward Grand Lac. We left the larger group (7-9 animals) just south of Malaoko (Annex E).

Two dead animals were found during the survey. Basic data and two samples were collected from one decomposed carcass (MAD108-002Pe, See Annex A). The second carcass was less decomposed, thus it was collected and transported to Antsohihy for necropsy (MAD108-003Pe, See Necropsy Team Report).

On the evening of 11 June, four whales were observed by local individuals leaving the Grand Lac and entering the sea at approximately 1700hrs.

12 June 2008

Two boats departed Antsohihy at 1010hrs in search of the first group of whales, which was encountered at 1017hrs very close to the port. This was the largest group, 20-30 individuals, encountered at one time. The third boat ((RHIB) from the CSP) joined the herding efforts and Harry was shifted to that boat. In addition to a

third vessel, the team also acquired communication abilities with the help of the CSP and documentation specialist Alistair Sinclair. Each provided a radio for use, allowing the three vessels to communicate with one another. With the additional vessel and added communications capabilities, the team successfully pushed a subgroup of 12-22 animals approximately 7km to a point where the river widens (near the second island).

At 13:33hrs, the team observed another species, a small group of Indo-Pacific humpback dolphins (*Sousa chinensis*) moving up the river. The animals were very elusive and difficult to document. Local residents on board noted that it was not unusual to see these animals in the river.

13 June 2008

Members of the response team Charles Harry, Kate McClave and other local WCS representatives performed an aerial survey on their last day in the area to get a final assessment of overall melon-headed whale distribution within the river system. Once in the air, the goal was to fly directly to the entrance of the open ocean and work backwards along the river system toward the port of Antsohihy. During the survey, when animals were observed, a GPS waypoint was recorded which included time at sighting.

Survey effort began at 1010 hrs. with an altitude of 550 ft. and air speed of 110 kts. which remained consistent throughout the survey. At 1024 hrs. two melon-headed whales were observed beyond Grand Lac in the channel leading to the open ocean. At 1047 hrs. four animals were observed 8 km from the port. At 1050 hrs. eight animals were sighted 5.5 km from the port and at 1057 hrs. 11 animals were sighted approximately 1.5 km from the port. These last two groups, totaling 19 individuals, were exhibiting milling behavior with irregular circling and did not appear to be swimming in directed manner. The first two groups sighted exhibited much more defined, coordinated swimming toward the open ocean. All groups sighted maintained a cohesive group structure. The survey effort ended at approximately 1110 hrs. with a

total of 25 melon-headed whales observed.

14 June 2008

The boat teams (4 boats) left the dock at 09:07 hrs. The teams immediately recovered 2 whales in mangrove channels close to Antsohihy Port. These were returned to main channel but in closer proximity to Grand Lac. Boats then searched for larger group suspected to be in the main channel. This group was located and contained an estimated 10 individuals. Attempts were made to herd this group using pingers towards Grand Lac. These efforts continued until late afternoon when boats returned to the dock at Antsohihy.

An additional team left Antsohihy by car in order to investigate reports of 20 whales stranded on beaches at Ampasindava, a village to the south of Analalava. The report was filed by Mr Bruno, the owner of the Hotel Varatraza at Analalava. The team included personnel from WCS, a delegate from the office of Communication for the Region of Sofia and the Chef de Cantonnement for MEEFT. The road was poor and they arrived at Analalava in the afternoon where they hired a boat in order to continue to Ampasindava the following day. That evening they were able to talk informally to residents of Analalava about the stranding event.

15 June 2008

Boat teams left the dock at 09:50 hrs. One of the boats recovered a single whale from deep in the mangroves and opted to take it in the fast RHIB to the open ocean at Analalava. This team also chanced upon a small group of 5 individuals in the vicinity of the lagoon mouth. The captured individual was released in the vicinity of this group and was seen to join them. The remaining boats continued to herd animals located in the main channel just south of the two largest islands. An additional 2 animals were reported dead and moved to areas above the high tide limit. No necropsies were conducted.

The team at Analalava continued by boat to the coastal village of Ampasindava to conduct interviews with villagers. Twelve households were interviewed in a village comprising a

maximum of 25 houses. 90% of interviewees had heard about the stranding at Antsohihy but assured the interviewers that no whales had stranded at Ampasindava. The teams left with the firm belief that the report was false.

16 June 2008

The boat teams (4 boats) left the dock at 09:00 with the overall intent of returning to the main channel in order to continue efforts to herd remaining animals into the Grand Lac. Prior to this the teams conducted an initial search of mangrove channels to collect any animals that might be recoverable (alive). None were found. One group of 12-15 whales was located at Andamoty and appeared to be comprised of closely bonded individuals suggesting that at least one group was remaining in this area. The pingers were put to use but only two continued to function properly. In addition to these animals the teams suspected that an additional 10-15 animals remained distributed in the deeper mangrove channels. These animals were weaker and more dispersed (smaller groups). However boat teams focused on pushing the group in the main channel towards the Grand Lac. Two more dead animals were discovered during the day and were pulled above the high tide limit. No necropsies were performed.

WCS scientist Tim Collins arrived in Antsohihy in a chartered MAF aircraft. He and Behamafaly Randriamanantsoa, together with Isaia Raymond (ANGAP) flew a two hour survey flight.

The response team met at the Hotel Biaina in Antsohihy between 18:30 and 20:00 hrs to discuss options.

17 June 2008

Teams left the dock at 08:28hrs (4 boats) and began with a slightly modified strategy. The two fastest boats (RHIB and Caranguea) searched the mangrove channels for stranded animals and the two slower boats moved directly to the area where animals were most frequently seen. No animals were found by the search teams and only one individual was located and pushed in the main channel. Five additional dead animals were

located and pulled above the high tide line. None were necropsied. The smallest boat Vintsy was sent on to investigate a mangrove channel on the northern edge of the Grand Lac with the team spending the night in a village.

A second aerial survey was also flown, take off time at 10:47 hrs. The team included WCS personnel, Mr Mananjary of DRDR, an officer with the Armee Populaire de l'Etat Major and the Commandant of the airport of Antsohihy. The team departed with three major objectives in mind.

- To locate possible 'capture channels' in the area where animals were frequently seen
- To more thoroughly survey coastal beaches north and south of the Loza Lagoon mouth.
- To locate additional groups of whales.

The first objective was completed during the first 10 minutes of flight and entrances to 7 potential 'capture channels' were waypointed for discussion with boat teams. From here the aerial team flew directly to the southernmost survey point, defined on an ad hoc basis by the control zone of Mahajanga Airport to the south. This point was approximately 100 km to the south of the entrance to the Loza lagoon. Surveys also included the offshore islet of Nosy Lava and an additional 80 km of beach further north. All surveys were flown at a height of 750 feet and a minimum speed of 130kts for a total of over 500km survey effort. Open water passages were flown at 2500 feet for safety. No stranded animals were located but live animals were sighted in the area of Andamoty (group of 4).

The WCS team met that evening with Dr Eugene Zafera to transfer tissues samples. He expressed a keen interest in further helping the effort but had limited supplies. Collins also completed a conference call with members of the expert MSRT to discuss options to save live animals. Following extensive discussion the decision was made to attempt removal of stranded animals directly to the sea offshore of Analalava. This option was considered the better of two options; alternatives being continued pushing with a diminishing likelihood of animals returning of their own

accord and/or death. The team also received reports of whales swimming through the mouth of the Loza lagoon towards the sea. The report came from the Mayor of Analalava who sighted 4 groups from a ferry at 11:30am (rising tide) and the groups were small (<10).

18 June 2008

The team left the dock at 09:00hrs (4 boats) and located a group of 4 whales deep inside a mangrove channel. Using 3 boats the animals were gently herded into shallow water (tide very low). Within 30 minutes all four were secured by team members in waist high water and guided to holding positions on the muddy banks of the channel (photos available). These animals were lifted into the boats; two on the Caranguea and one into each of the other two boats. Animals were cushioned using foam-filled life jackets and other padding; towels were placed over their dorsal surfaces and water poured consistently over skin surfaces. The transit to the sea took approx. 1.5 hrs. At-sea conditions were rough and boats ventured to 3km. Three animals were released together and were seen to swim seawards. The fourth animal was transferred from the Moronda to the Caranguea in calmer waters as the crew were unhappy with sea conditions. This animal was freed in the location of the other releases; it swam laboriously, breathing frequently. Time forced the team back to Analalava where interviews revealed that 4 whales had left the lagoon at 17:00hrs on the 11th of June. The boats returned to Antsohihy after dark with team members exhausted but happier. Two dead whales were sighted but were not moved. A group of 5 live animals was also sighted. The CSP RHIB also returned to Mahajanga for service.

19 June 2008

Teams left the dock at 10:10 with crews' very tired (3 boats). They began by asking local fishers if they had seen whales in any of the kingas. None had been seen but fishers directed teams to a fresh carcass. Later in the day 6 live individuals were located in the central channel leading to Antsohihy and began an attempt to push them towards the Grand Lac. These whales appeared very reluctant to be herded. The teams were able

to push them a few hundred meters at a time before the whales turned and swam back towards Antsohihy. These efforts continued for 3 hours before the group split. The team attempted to push the section of the group swimming in the direction of the grand Lac but the effort failed. Two whales appeared to be trying to catch fish (feeding rushes). Teams stopped at this point (14:30hrs) and returned to Antsohihy to prepare for another capture the next day.

A plan for interview surveys was also resolved by Collins and Randriamanantsoa (WCS) in coordination with Herilala Randriamahazo (WCS). The decision was made to hire qualified professionals from within the Sofia region to conduct these interviews. They would be accompanied by WCS Malagasy staff who had interview skills, but also backgrounds in biology.

20 June 2008

Live response teams left the dock at 08:28hrs (4 boats). A new boat was hired to replace the CSP RHIB. Conversations with fishers revealed that no live whales had been seen in the immediate port area since 14 June. Teams searched channels closer to the Grand Lac, splitting up in order to cover more ground. It should be noted again that there was no mobile phone coverage over much of the lagoon system and the teams efforts were immensely hampered by the lack of suitable radio equipment. The boats were able to converge on a group of 9 in extremely shallow water (low spring tides). Although teams were reluctant to separate individuals in this group they were only able to place 5 whales into three boats. Weather on the Grand Lac was calm and these individuals were moved quickly through the inlet channel to the open ocean and released together. Respiratory patterns appeared to be normal, all appeared to be swimming strongly. An additional death (stranded in mangroves) was reported. No necropsy attempted.

Collins and Randriamanantsoa finalized the interview survey preparations. Four interviewers with suitable training and experience were interviewed and hired (CVs available). These interviewers were given a briefing on the

information needs of the MSRT (see points 2 and 3 on the list of recommendations provided by the expert MSRT). The lagoon and coastal area was divided into 4 sectors and interviews assigned to each. The ad hoc committee approved this plan on Friday evening (communicated by Randriamahazo).

21 June 2008

Boat teams left the dock at 08:54hrs (4 boats) with a plan to search for whales and to drop interview teams in villages. This strategy removed one of the boats from the search operations for two days given that one interview team would be based overnight at Analalava. An additional interview team was dropped at Befotaka for the night by car. Two search boats encountered 3 individuals and attempted to push them into a shallower water to capture them. The whales swam strongly into deeper water and crews opted to leave them. Two remaining interview teams were recovered by boat and brought to Antsohihy to continue elsewhere the next day.

22 June 2008

Boat teams left the dock at 08:30hrs. Two boats focused on finding and capturing whales. The team estimated at this stage that fewer than 10 remained in the channel system. Whales were encountered at the top of the main channel at the southern end of the Grand Lac. This group was estimated to include 8 or 9 individuals, loosely dispersed in pairs and single animals. One juvenile appeared to be much weaker, stopping often at the surface in a logging position. Others were swimming strongly and approached boats. The location did not favour the teams adopted capture method and the decision was made to leave them in the hope that once in the Grand Lac they would sense the direction of the sea. Interview teams were dropped or moved to new locations by boat or car. All team members returned to Antsohihy that evening.

Following this day of work WCS staff agreed that the remaining whales appeared to be moving towards the Grand Lac of their own accord. A decision was taken to give the teams a break, given a general state of exhaustion and fatigue. To

this end WCS and the Hotel Biaina hosted a small party for team members that evening.

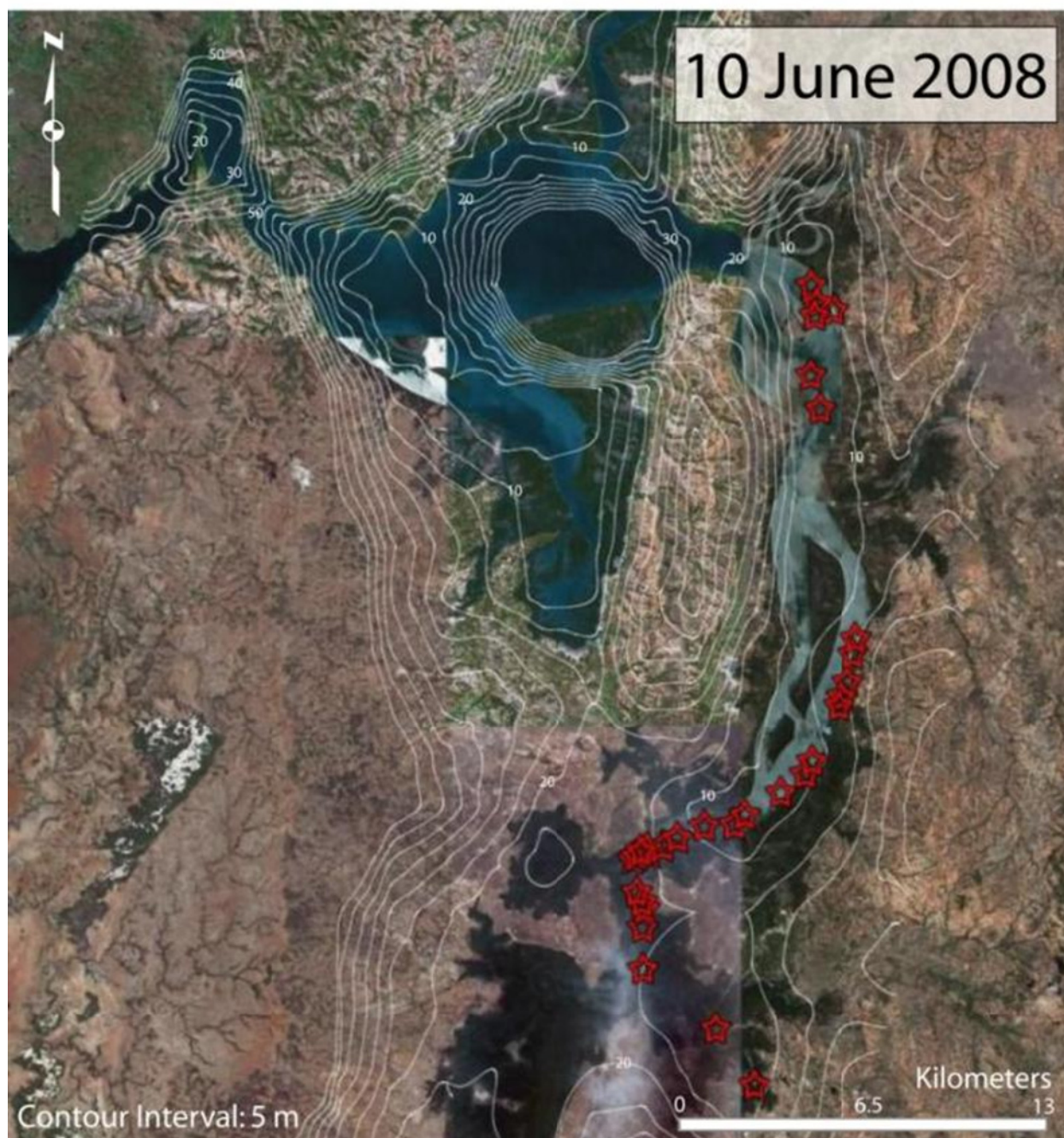
23 June 2008

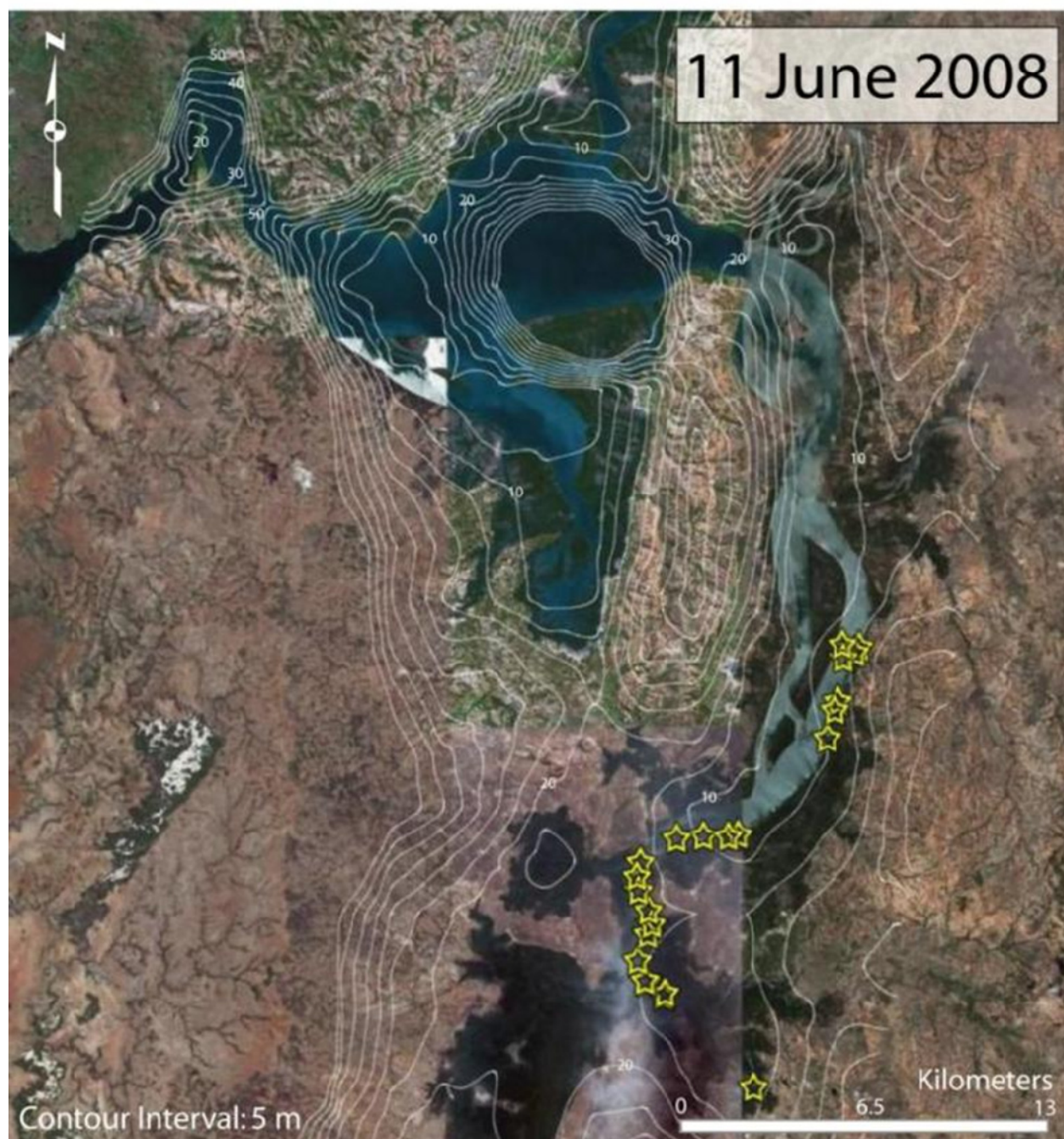
The chartered boat Caranguea returned to Nosy Be on this day. WCS staff spent the day resolving accounts, updating key personalities around town and interviewing others for their memory of

24 – 29 June 2008

No further small boat work was conducted during this period. Diminishing returns and rising costs suggested that a continued effort would be ineffective. WCS staff returned to Antananarivo on the 24-25 June to recover and regroup. Plans for the subsequent phase of monitoring were also determined in collaboration with the Ad Hoc committee.

APPENDIX D - Maps depicting MSRT herding efforts from 10-13 June









APPENDIX E - Daily Totals for sighted live, dead and 'pushed' whales

Date	Live	Pushed	Recovered	Dead	Area of dead	Source of information
2008-05-29						
2008-05-30				2	Analalava	Analalava, Hotel Malibu, Mr Lava
2008-05-31	100+		0	1	Port	Phillipe Robinet, Amirdine
2008-06-01	100+		0	2	Port	Phillipe Robinet, Amirdine
2008-06-02	100+		0	8	Port	Phillipe Robinet, Amirdine
2008-06-03			0	11		Phillipe Robinet, Amirdine
2008-06-04			12	8		Phillipe Robinet, Amirdine
2008-06-05	60		0	5		Phillipe Robinet, Amirdine
2008-06-06	60			11		Phillipe Robinet, Amirdine
2008-06-07		65		3		Behamafaly, Norbert, Yvette (WCS)
2008-06-08	4			3		Behamafaly, Norbert, Yvette (WCS)
2008-06-09	15			3		Behamafaly, Norbert, Yvette (WCS)
2008-06-10			4	1		Behamafaly, Norbert, Yvette (WCS)
2008-06-11		15	0	1		Behamafaly, Norbert, Yvette (WCS)
2008-06-12	30	0	0	0		Behamafaly, Norbert, Yvette (WCS)
2008-06-13	25		4	2	Port	Behamafaly, Norbert, Yvette (WCS)
2008-06-14		8	2	1	Port	Behamafaly, Norbert, Yvette (WCS)
2008-06-15		10	1	2		Behamafaly, Norbert, Yvette (WCS)
2008-06-16		15	2	2		Behamafaly, Norbert, Yvette (WCS)
2008-06-17	6	1	0	5	Andamouty	Behamafaly, Norbert, Yvette (WCS)
2008-06-18	7	3	4	2		Behamafaly, Norbert, Yvette (WCS)
2008-06-19	6	4	0	1		Behamafaly, Norbert, Yvette (WCS)
2008-06-20	9	5	5	1		Behamafaly, Norbert, Yvette (WCS)
2008-06-21	2	0	0	0		Behamafaly, Norbert, Yvette (WCS)
2008-06-22	9	5	0	0		Behamafaly, Norbert, Yvette (WCS)
				131	75	

Pushed whales are those herded by the mass stranding response teams using boats

Recovered whales are those that were rescued alive from the mangrove mud and put back into the water

APPENDIX F - Stranding Data Sheets

The strandings datasheets have been omitted from the public version of this document. They can be made available on request.

APPENDIX G - Serology Results

The Serology Results have been omitted from the public version of this document. They can be made available on request.

APPENDIX H - Post Mortem Pathology Reports

The Post Mortem Pathology Reports have been omitted from the public version of this document. They can be made available on request.

APPENDIX H - Tissue Collection List

Sample Collection: Mellon Headed Whales; Madagascar; June 9-13, 2008)											
		MAD308-Pe001 N2008-0623	MAD308-Pe002 N2008-0624	MAD308-Pe003 N2008-0625	MAD308-Pe004	MAD308-Pe005 N2008-0817	MAD3-8-Pe006 N2008-0818	MAD108-Pe003 N2008-0626	MAD108-001Pe	MAD108-002Pe	MAD208-001Pe
Formalin-tissue	adrenal gland		X	X				X			
	artery (elastic)							X			
	blubber		X	X		X		X			
	bone							X			
	bone marrow							X			
	brain	X						X			
	diaphragm							X			
	ears	X	X	X				X			
	esophagus							X			
	eye	X	X	X				X			
	heart		X	X				X			
	kidney		X	X				X			
	large intestine		X	X				X			
	liver		X	X				X			
	lung		X	X				X			
	lymph node (gastric)							X			
	lymph node (hilar)							X			
	lymph node (mesenteric)							X			
	lymph node							X			
	nerve						X	X			
	pancreas							X			
	parasites	X	X	X				X			
	parathyroid gland							X			
	penis							X			
	pituitary gland	X						X			
	skeletal muscle	X		X		X	X	X			
	skin	X	X	X		X		X			
	small intestine		X	X				X			
	spinal cord							X			
	spleen			X							
	stomach		X	X				X			
	testis		X	X				X			
	thymus							X			
	thyroid gland							X			
	tongue	X	X					X			
	trachea							X			
	urinary bladder							X			
Frozen	blood on paper	X	X	X				X			
	blubber (thorax)							X			
	brain							X			

Continued from previous page

Sample Collection: Mellon Headed Whales; Madagascar; June 9-13, 2008)											
		MAD308-Pe001 N2008-0623	MAD308-Pe002 N2008-0624	MAD308-Pe003 N2008-0625	MAD308-Pe004	MAD308-Pe005 N2008-0817	MAD3-8-Pe006 N2008-0818	MAD108-Pe003 N2008-0626	MAD108-001Pe	MAD108-002Pe	MAD208-001Pe
	kidney							X			
	liver							X			
	serum										X
	skeletal muscle	X	X	X				X			
	skin	X	X	X				X	X	X	
	spleen							X			
	stomach contents							X			
	teeth	X	X	X				X	X	X	
Alcohol	parasite-nematode	X	X	X				X			
	parasite-cestode							X			

APPENDIX H - Images

Select images are included here. Additional images are available from WCS and IFAW

Analalava 10 June, 2008: Members of local community assisting in movement of carcass for post-mortem examination.



MAD308-Pe001: MSRT Team 3 member Ketten performing tissue dissection and sample collection.



MAD308-Pe002: MSRT Team 3 members Uhart and McAloose performing gross examination and tissue collection.



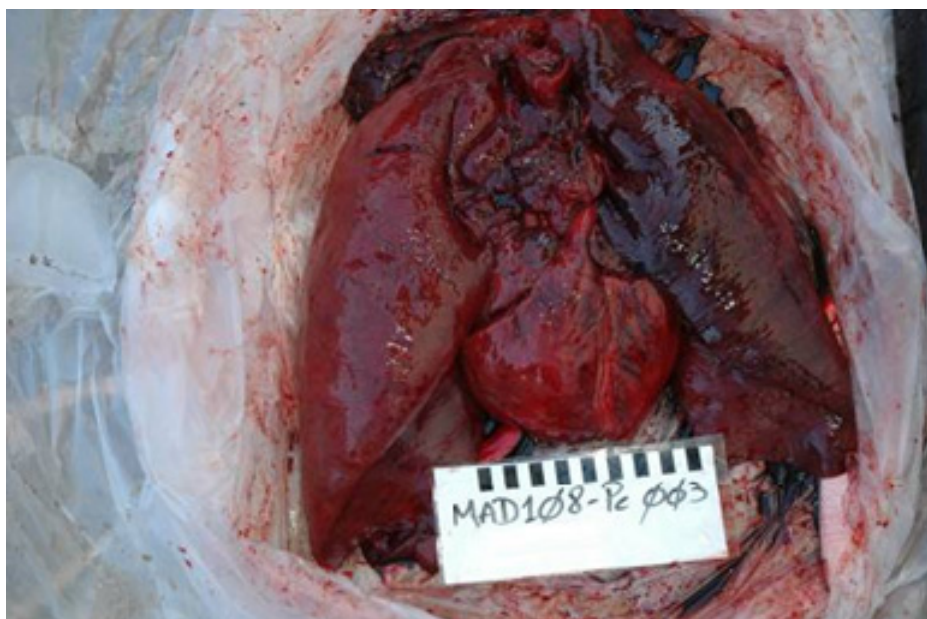
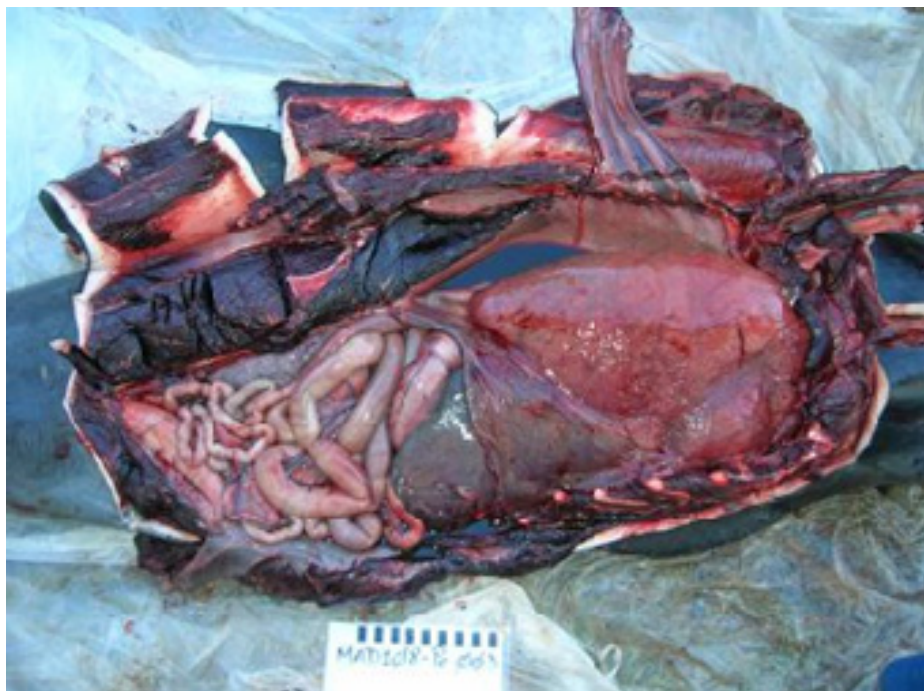
MAD308-Pe002: MSRT Team 3 members Uhart and McAloose performing gross examination and tissue collection.



MAD308-Pe003: Ear bones with metazoan parasites (*Stenurus* sp.)



MAD108-Pe003: Gross post-mortem examination.



MAD108-Pe003: Stomach contents
– puffer fish and puffer fish skeleton.



Fish



Skeleton

MAD108-Pe003: Caudal abdominal
encysted parasites
(*Monorygma grimaldii*).



MAD108-Pe003: Brain in situ



MAD108-Pe003: Dorsal surface



MAD108-Pe003: Ventral surface



MAD108-Pe003: Transverse section through the diencephalon.



APPENDIX G - Post Mortem Ancillary Diagnostic Reports

The Post Mortem Ancillary Diagnostic Reports for Parasitology, Immunology and Toxicology have been omitted from the public version of this report. They can be made available on request.

**IFAW Marine Mammal Rescue and Research
Cetacean Data Record**

Field #: IFAW _____
 Accession #: _____
 Species: _____
 Condition Code: 1 2 3 4 5
 Sex: M F CBD
 Length: _____
 Weight: _____
 Human Interaction: Y N CBD
 Carcass: Fresh Frozen
 Field Notes: _____

Date of Death: _____
 Date of Recovery: _____
 Date of Necropsy/Exam: _____
 Observers: _____
 Location: _____
 Lat/Long: _____ N/ _____ W
 Photos: Y N Roll #: _____
 Video: Y N Tape #: _____
 Necropsy: Y N; Location: _____
 Tag color: _____ Tag#: _____

Morphometrics: Left / Right Measurer: _____ Units: _____

Straight Line (taken from tip of upper jaw to...)

1 (total: to fluke notch)	.
2 (apex of melon)	.
3 (gape of mouth)	.
4 (center of blowhole)	.
5 (center of eye)	.
6 (ant. insert pec.)	.
7 (ant. insert d. fin)	.
8 (d. fin tip)	.
9 (umbilicus)	.
10 (center of genital slit)	.
11 (anus)	.
12 (fluke notch to anus)*	.

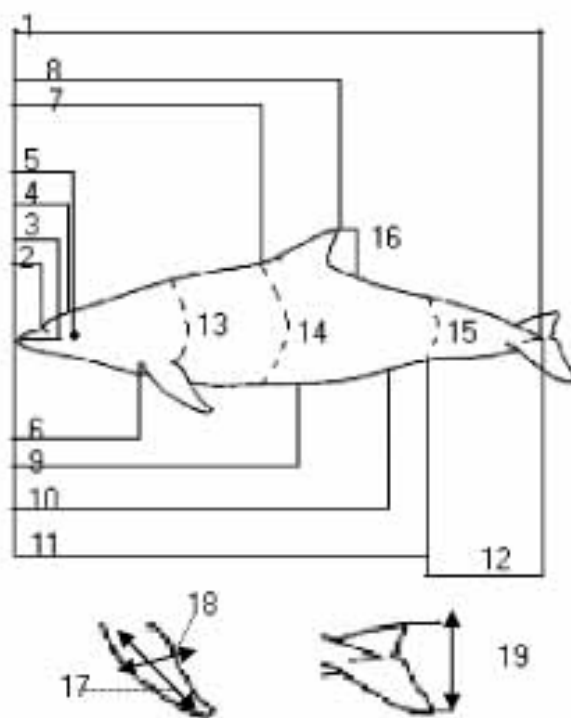
*Starting at fluke notch to anus

Girths

13 (axilla)	.
14 (ant. insert d. fin)	.
15 (anus)	.

Appendages

16 (d. fin height)	.
17 (pec. fin ant. length)	.
18 (pec. fin max width)	.
19 (fluke width)	.



Blubber Thickness (mm)

13-Dor	.
13-Lat	.
13-Vent	.

Emaciated: Yes / No / CBD

Tooth Counts: LL: _____ UL: _____ LR: _____ UR: _____

External Exam:

(lesions, scars, parasites, etc.)

Collecting data from stranded cetaceans:

1. For all cetacean strandings collect: GPS location, photograph of the left side of the animal (when possible), and all data for front page of this data sheet.
2. Condition Code: (1)= alive, (2)= fresh dead/ known time of death, (3)= moderate decomposition, (4)= advanced decomposition, (5)= mummified or skeletal remains.
3. Under field notes comment on the circumstances of the stranding, anything notable about the location, conditions, etc.
4. Terms: CBD= Cannot Be Determined, NE= Not Examined
5. Roll # and Tape #: indicate the ID numbers for the roll of film or video tape being used (e.g.: CCSN00-V1)
6. Follow the diagram to collect the measurements.
7. Fresh animals, (Codes 2, and early 3), will be collected for necropsy in the lab. When conditions (weather, mass stranding, location, size) do not permit transport to the lab, some animals will be necropsied in the field. Utilize the back portion of this sheet as appropriate for field necropsies and abbreviated necropsies.

Internal Exam:**Lungs** (describe condition, contents, etc.):**Stomach:** Were there contents? If so, were they collected?**Parasites** (phyllobothrium, monorygma, campula, nematodes, etc) Note organs affected and degree:**Reproductive tract:**

Left gonad: (LxWxD) _____ Weight: _____

Right gonad: (LxWxD) _____ Weight: _____

Males: seminal fluid in epididymes: copious / present / absent

Females (notch left ovary when sampling):

Uterine horn diameter: Left _____ Right _____

Lactating: Y N Pregnant: Y N

Fetus: straight length: _____ Weight: _____ Sex: Male / Female

Samples:

Life History
skin (genetics)
teeth
stomach
gonads
skeleton
Contaminants
blubber
muscle
liver
kidney
brain
Histopathology
Biotox
Brucella
Morbilli
OHHI

Comments:**Other Samples:****Datasheets:**

- ☐ NMFS Level A Form
☐ Human Interaction
☐ Necropsy Report
☐ Phone Log