Ecology, Status, Fisheries Interactions and Conservation of Coastal Indo-Pacific Humpback and Bottlenose Dolphins on the West Coast of Madagascar

Year 2 Final Report to
The Marine Mammal Commission
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Young Indo-Pacific bottlenose dolphins, *Tursiops aduncus*

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Introduction

Coastal dolphins in western Madagascar are threatened by both direct hunting and by-catch in artisanal fisheries. The Wildlife Conservation Society's (WCS) Ocean Giants Program has been conducting field research and conservation work on coastal dolphins in the Southwest of Madagascar since 2004 and in the Northwest of Madagascar since 2008. Work is directed to investigate the current and potential extent of these interactions through basic research on dolphin behavior, ecology, and population structure of two species, Indo-Pacific humpback dolphins (*Sousa chinensis*) and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), as well as on-the-ground interviews with local fishermen throughout the region. The valuable information produced by this research is being used to develop threat mitigation initiatives and support policy and management development at local and regional levels.

This yearly report to the Marine Mammal Commission (MMC) describes activities conducted during Year 2 of our three-year project described in the grant agreement, covering the period from July 1, 2012 to June 30, 2013. The MMC funds for this multi-funder project were primarily spent in Year 2, completing the MMC grant period. The project activities scheduled for this year were completed, and can be divided into three major components. First, in the Northwest region, boat-based field surveys were completed to define priority habitat and assess conservation status of coastal dolphins around the islands of Nosy Iranja and Nosy Be during November and December 2012. Second, in the Northwest region, interview surveys of fishers in the island of Nosy Iranja and on the Ampasindava Peninsula were completed in October 2012, aimed at assessing marine mammal by-catch and hunting. Third, in the Southwest region, community engagement work to reduce dolphin hunting and by-catch in villages on the coast north of Toliara, continued from last years work.

Defining Priority Habitat and Population Status: Field Research Surveys in the Northwest

Goal 1: Assess status, distribution and habitat preference for populations of Indo-Pacific humpback and Indo-Pacific bottlenose dolphins in the Northwest of Madagascar.

Coastal dolphins and other large marine vertebrates, including seabirds and marine turtles, were assessed in the Nosy Be and Nosy Iranja/Ampasindava regions on the Northwest coast of Madagascar (Figure 1) during November and December 2012. Over the past two years, WCS has led on the identification and management of two new marine protected areas (MPA) in this region, the Ankivonjy and Ankarea MPAs. During 2012, we surveyed the Ankivonjy MPA, covering 196,659ha approximately 50km Southwest of Nosy Be and encompassing the island of Nosy Iranja and the Ampasindava Peninsula (Figure 1). The objective was to gain a better understanding of the diversity, distribution and relative abundance of cetaceans and particularly coastal dolphins, expanding our regional geographic coverage to Nosy Iranja and the Ampasindava Peninsula, and adding another season of data to the more extensive effort that has focused on the Nosy Be region since 2007. Similar work was conducted in 2011 and reported in the Year 1 Final report to the MMC for work in the Nosy Mitsio archipelago, the site of the Ankarea MPA covering 173,690ha approximately 50km northeast of Nosy Be, also supported by research and management by WCS. During our Year 2 activities, we have successfully completed the first large marine vertebrate surveys for these two new MPAs.

Boat surveys in the Ankivonjy MPA where conducted from Nosy Iranja during a 19-day expedition between 8 and 26 November 2012, from an 8m outboard boat, with 3 observers. Boat surveys were also conducted in the Nosy Be region during a 17-day expedition from 29 November to 15 December 2012, adding a sixth year of data to the assessment of coastal dolphins and representing WCS's fourth substantive field season in this region. This report describes the details of the work conducted in 2012, and places results in context of all data collected since 2007 in Nosy Be and in 2011 in Nosy Mitsio to present the most thorough regional understanding of cetacean occurrence and coastal dolphin status to date.

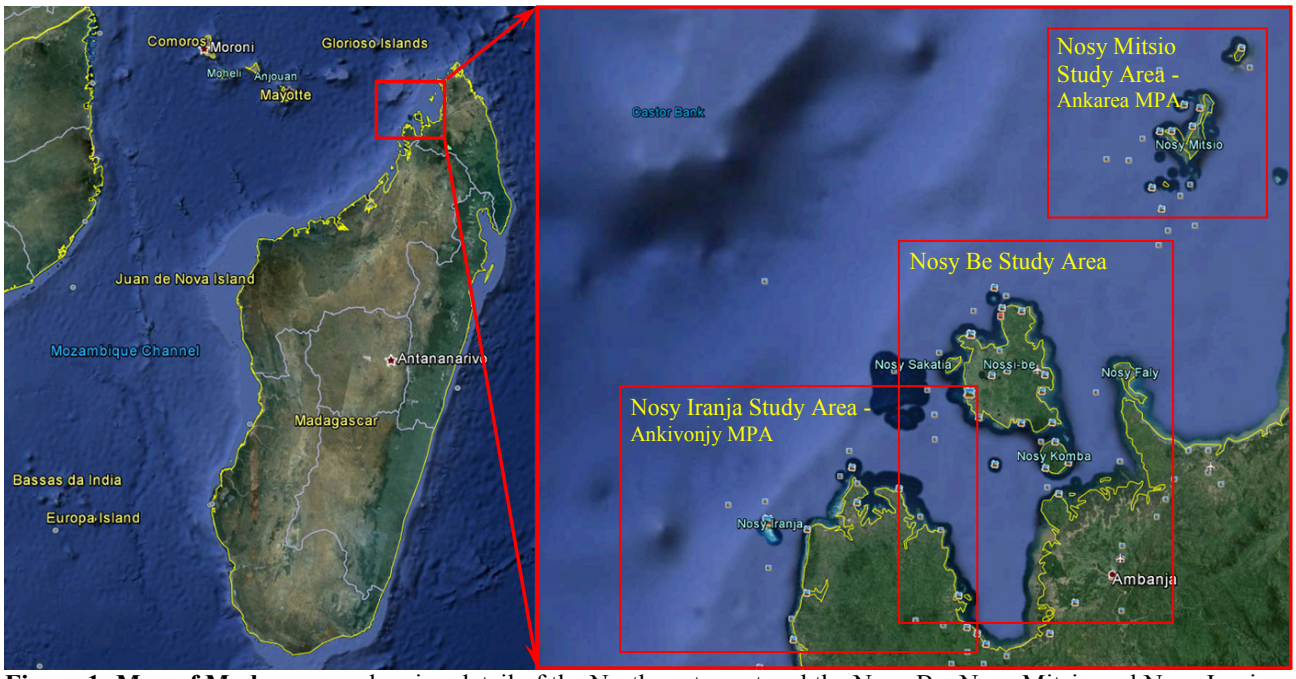

Figure 1: Map of Madagascar, showing detail of the Northwest coast and the Nosy Be, Nosy Mitsio and Nosy Iranja study areas.

General Methodology

To survey along the coastal zone, strip transects were employed to effectively cover shallow-water habitat; this method has proven, in our experience, to be more appropriate than standardized box or saw-tooth line-transects that crossed the bathymetric gradient and spent a majority of effort in open water, consequently yielding very low encounter rates for the shallow-water coastal dolphins and proving highly inefficient. For deeper water surveys, saw-tooth transects were conducted crossing the bathymetric gradient in order to maximize habitat coverage. Handheld GPS receivers were used to log positions and save a complete track of daily boat movements, and precise records of effort were made throughout the day, so as to calculate standardized sighting per unit effort (SPUE) measures. When groups of cetaceans were encountered, a standardized data collection routine was initiated: species were identified, and individual identification photographs obtained of each identifying feature (right dorsal fin, left dorsal fin for dolphins, plus tail flukes for humpback whales) from each individual using digital SLR cameras fitted with zoom lenses (70-200mm). Once photographs were obtained, skin biopsies of individuals were collected whenever possible, using a standard globally accepted protocol that has consistently been shown to cause no harm to dolphins or whales. During this procedure, a biopsy dart is delivered to the flank of the animal using either a lightweight crossbow (50lb pull prod used for dolphins, 150lb prod used for whales) or a compressed CO_2 rifle equipped with an adjustable pressure valve. The dart is designed to penetrate the epidermis and retain a small plug of skin, rebound off the animal, and float in the water for retrieval by the biopsy vessel.

Effort Summary

Effort is reported in terms of the actual daily boat tracks (Figures 2 and 3), kilometers of track line, as well as total hours spent on the water and searching two broad categories of habitat (Table 1). Working time on the boat was stratified by eight distinct effort categories including: (1) transiting without searching, (2) searching in coastal waters (generally shallower than 10m), (3) searching in open waters (generally but not always greater than 10m), (4) approaching pods of cetaceans after initially sighting them, (5) working with pods after joining them for photographic identification, (6) biopsy, (7) acoustic recording, and (8) on break when not motoring.

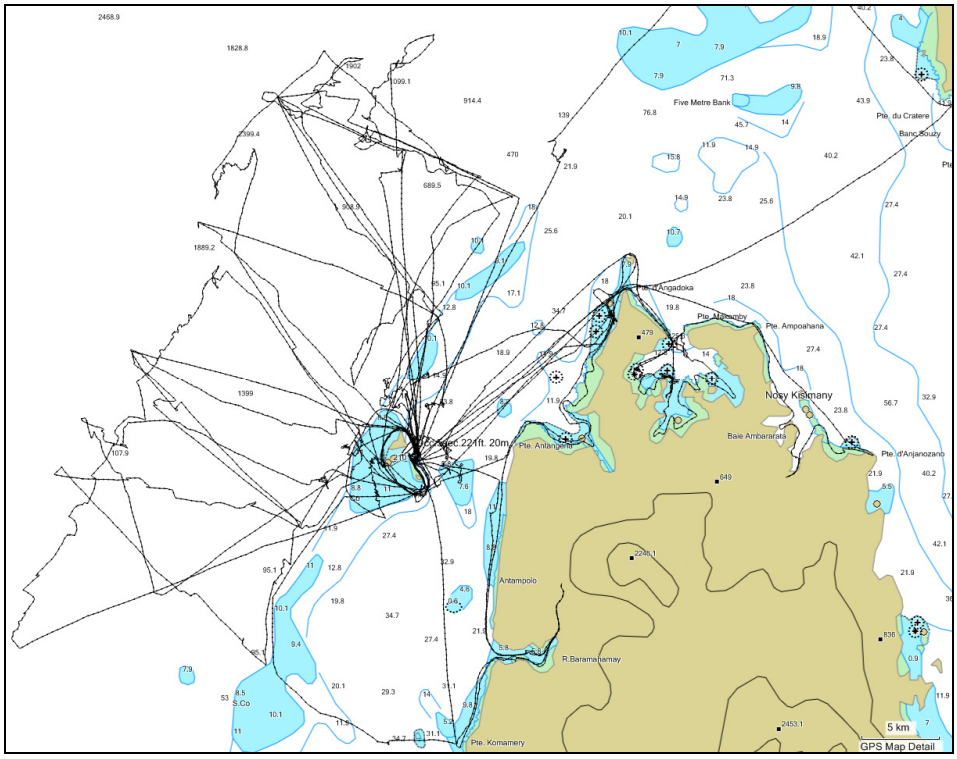

Figure 2: Effort in the Nosy Iranja study area, November 2012.
Dashed lines indicate complete boat tracks from all boat days.

During 2012 in the Ankivonjy MPA, effort was focused in all coastal waters around Nosy Iranja, as well as offshore past the shelf break, and along an extensive portion of the mainland coast of the Ampasindava peninsula (Figure 2). During 16 days on the water, 132.0 hours of surveys were conducted on a total of 1,561km of track line, and search effort totaled 62.4hr subdivided into 22.9hr in coastal search and 39.5hr in open/deep water search (Table 1). The total effort off Nosy Iranja was roughly equivalent to a single average season on Nosy Be (e.g., 2009) (Table 1). We deliberately focused a portion of effort on the near coastal shallow waters around Nosy Iranja and the Ampasindava peninsula, in order to maximize encounters with *Sousa chinensis* and *Tursiops aduncus*. Previous work in Madagascar indicated that *S. chinensis* is almost exclusively distributed very close to coasts and barrier reefs in shallow water. Conversely, for deep water surveys to the west of Nosy Iranja, saw-tooth transect lines were followed from the shelf break to the 2000m depth contour, crossing the bathymetric gradient in order to evenly cover different depths. The split between coastal and open water search time was more equivalent off Nosy Iranja compared to previous work around Nosy Be, due to the offshore nature of Nosy Iranja and our effort to cover deep water past the shelf break to the west of the island (Figure 2).

In the Nosy Be region, during 2012, we had 15 days on the water, and conducted 118.2hr of surveys for a total of 1,384km of track line (Table 1). Total search effort was 71.6hr, subdivided into 39.9hr in coastal waters and 31.7hr in open waters (Table 1). This added a sixth year working in the Nosy Be region, with the overall total for 2007-2012 being 88 days of boat time, covering 7,607km of track line in 679.4hr (Table 1). The year 2007 was a short pilot season of one week, and the 2010 season was also a single-week short visit after a more extensive field effort elsewhere on Madagascar; therefore the substantive sample years for the project were 2008, 2009, 2011 and 2012 (Table 1). Seasonally, all effort prior to 2012 occurred in the austral winter/spring months of July to October, with a concentration of effort in September; the 2012 season represented our first effort during the austral spring/summer (Table 2). In all years, effort encompassed all coastal waters around Nosy Be and the surrounding islands of Nosy Komba (small round island south of

Nosy Be), Nosy Faly (long island east of Nosy Be and close to mainland) and the Madagascar mainland (Figure 3). We deliberately chose to focus effort on the near coastal shallow waters, as opposed to standardized random transect crossing the depth contours, in order to maximize encounters with *Sousa chinensis* and *Tursiops aduncus*. A concerted attempt was made to spread effort throughout the region within the safe working range of our boat, focusing on different areas on consecutive days; unavoidably the areas near our bases (north Nosy Komba in 2008-2010 and 2012, Hellville in south Nosy Be in 2007 and 2011) received greater effort, whereas the areas to the far north and south received proportionally less due to time to transit and daily change in weather conditions.

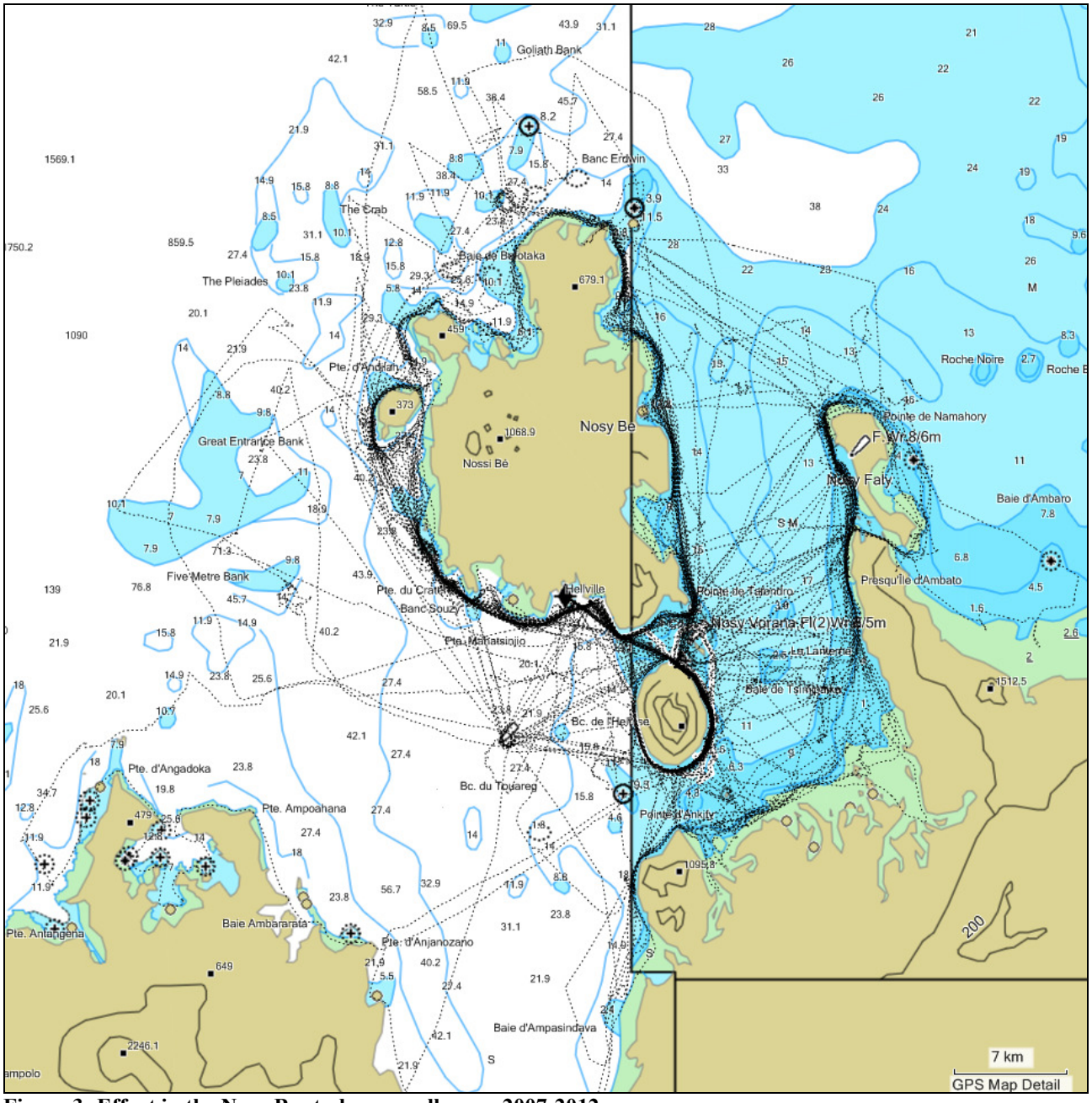

Figure 3: Effort in the Nosy Be study area, all years 2007-2012.
Dashed lines indicate complete boat tracks from all boat days.

Table 1: Distribution of effort by year in Nosy Be, Nosy Mitsio and Nosy Iranja.

	Nosy Be							Nosy Mitsio	Nosy Iranja	Grand
Effort type	2007	2008	2009	2010	2011	2012	Total	2011	2012	Total
Boat Days	6	21	17	5	24	15	88	17	17	122
Total km	517	1772	1502	340	2092	1384	7607	1336	1561	10,504
Total hours	49.8	160.1	135.2	31.3	184.7	118.2	679.4	112.6	132.0	924.1
Search effort:										
Coastal	18.3	66.9	47.1	13.1	65.1	39.9	250.5	41.4	22.9	314.9
Open Water	11.1	17.2	17.8	1.6	23.3	31.7	102.7	35.2	39.5	177.4
Total	29.5	84.0	64.9	14.8	88.4	71.6	353.2	76.6	62.4	492.3

Table 2: Distribution of effort by month in Nosy Be, Nosy Mitsio and Nosy Iranja.

	Nosy Be							Nosy Mitsio	Nosy Iranja	Grand
Month	2007	2008	2009	2010	2011	2012	Total	2011	2012	Total
July					74.8		74.8	52.3		127.1
August			16.6		109.9		126.5			126.5
September	6.6	160.1	118.6				285.3			285.3
October	43.2			31.3			74.6			74.6
November						12.5	12.5	60.4	132.0	204.8
December						105.8	105.8			105.8

Cetacean Sightings

Nosy Iranja Region. During surveys off Nosy Iranja, nine species of cetaceans were sighted in 33 groups, including two Mysticete species and seven Odontocete species (Table 3 & 4, Figure 4). This represents by far the highest species diversity observed during our work in the northwest of Madagascar, and is particularly noteworthy given the relatively short period of survey effort (16 days).

Baleen Whales. Most notably for Mysticetes, a pair of blues whales (*Balaenoptera musculus*) was sighted in deep offshore waters, which represents the best-documented observation of this endangered species in Madagascar. The pair was encountered in approximately 1,800m depth water (Figure 4), and was moving South-Southwest along the depth contour. The survey boat followed the group for over 3 hours covering approximately 30km, during which time photographic identifications, a biopsy of one animal, and sloughed skin potentially from the other were obtained. Only one individual confirmed biopsy was obtained due to the difficulty of approaching the group for sampling. Besides this blue whale sighting, there were two brief sightings of an unidentified *Balaenoptera* sp., at least one of which was likely to be another distant blue whale. There were three humpback whale (*Megaptera novaeangliae*) groups sighted, all mother-calf pairs, which is noteworthy since it was particularly late in the breeding season.

Table 3: Encounters with groups of cetaceans in Nosy Be and Nosy Mitsio.
Values represent the number of groups encountered while surveying; mixed species groups (see Table 5) are counted twice, once for each species, but only once in total groups encountered*, therefore columns do not necessarily sum to the total. For total number of species, encounters that were not identified to the species level (e.g., *Tursiops* sp.) were only included if there were no other encounters with a species of the same genus.

	Nosy Be						Nosy Mitsio	Nosy Iranja	
Species	2007	2008	2009	2010	2011	2012	2011	2012	Totals
Megaptera novaeangliae	0	**5**	**6**	0	**3**	0	**3**	**3**	**20**
Balaenoptera edeni/brydei	0	0	0	0	**2**	**1**	0	0	**3**
Balaenoptera musculus	0	0	0	0	0	0	0	**1**	**1**
Balaenoptera sp.	0	0	0	0	0	0	0	**2**	**2**
Sousa chinensis	**9**	**35**	**18**	**5**	**40**	**19**	**2**	**10**	**138**
Tursiops aduncus	**2**	**8**	**4**	**1**	**10**	**1**	0	**3**	**29**
Tursiops truncatus, inshore	0	**1**	**4**	**1**	**1**	0	0	0	**7**
Tursiops truncatus, offshore	0	0	0	0	0	0	0	**1**	**1**
Tursiops sp.	0	**3**	0	0	**2**	**3**	**5**	0	**13**
Stenella longirostris	0	0	0	0	0	0	0	**12**	**12**
Stenella attenuata	0	0	0	0	0	0	0	**5**	**5**
Stenella sp.	0	0	0	0	0	**1**	0	0	**1**
Globicephala macrorhynchus	0	0	0	0	0	0	0	**3**	**3**
Ziphiidae sp.	0	0	0	0	0	0	0	**1**	**1**
Total number different species	**2**	**4**	**4**	**3**	**5**	**4**	**3**	**9**	**11**
Total number encounters*	**10**	**48**	**29**	**5**	**54**	**25**	**10**	**33**	**214**

Table 4: Numbers of individuals encountered in Nosy Be and Nosy Mitsio.
Values represent the summation of number of individuals in all groups encountered, and does not infer number of different individuals (i.e., not corrected for re-sights between different encounters).

	Nosy Be						Nosy Mitsio	Nosy Iranja	
Species	2007	2008	2009	2010	2011	2012	2011	2012	Totals
Megaptera novaeangliae	0	**11**	**13**	0	**6**	0	**5**	**6**	**41**
Balaenoptera brydei	0	0	0	0	**3**	**3**	0	0	**6**
Balaenoptera musculus	0	0	0	0	0	0	0	**2**	**2**
Balaenoptera sp.	0	0	0	0	0	0	0	**2**	**2**
Sousa chinensis	**44**	**163**	**103**	**25**	**267**	**138**	**2**	**65**	**807**
Tursiops aduncus	**5**	**46**	**27**	**7**	**48**	**4**	0	**21**	**158**
Tursiops truncatus, inshore	0	**5**	**48**	**8**	**5**	0	0	0	**66**
Tursiops truncatus, offshore	0	0	0	0	0	0	0	**5**	**5**
Tursiops sp.	0	**28**	0	0	**5**	**37**	**17**	0	**87**
Stenella longirostris	0	0	0	0	0	0	0	**2368**	**2368**
Stenella attenuata	0	0	0	0	0	0	0	**940**	**940**
Stenella sp.	0	0	0	0	0	**10**	0	0	**10**
Globicephala macrorhynchus	0	0	0	0	0	0	0	**90**	**90**
Ziphiidae sp.	0	0	0	0	0	0	0	**5**	**5**
Summation of all groups	**49**	**253**	**191**	**40**	**334**	**192**	**24**	**3504**	**4587**

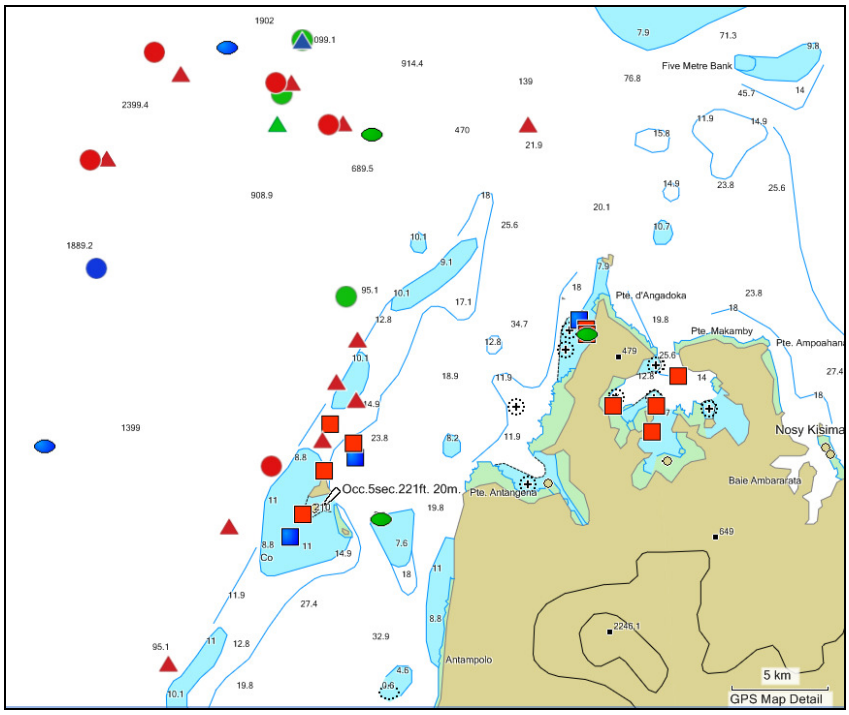

Figure 4: Cetacean sightings in the Nosy Iranja study area, November 2012.
Sighted species include *Sousa chinensis* (red squares), *Tursiops aduncus* (blue squares), *Tursiops truncatus* offshore form (blue triangle), *Stenella longirostis* (red triangles), *Stenella attenuata* (red circles), *Globicephala macrorhynchus* (green circles), Ziphiidae sp. (green triangle), *Balaenoptera musculus* (blue circle), *Balaenoptera* sp. (blue ovals), and *Megaptera novaeangliae* (green ovals).

Toothed Whales and Dolphins. Among oceanic Odontocetes, we observed 16 groups of five species (Table 3 & 4, Figure 4), including 1 group of an unidentified beaked whale Ziphiidae species (possibly *Ziphius cavirostris*), 3 groups of short-finned pilot whales (*Globicephala macrorhyncus*), 1 group of large offshore-form common bottlenose dolphins (*Tursiops truncatus*), 12 groups of spinner dolphins (*Stenella longirostris*), and 5 groups of spotted dolphins (*Stenella attenuata*). Spinner dolphins were the most frequently encountered cetacean (Table 3 & 4), exhibiting a generally bimodal distribution pattern; groups were encountered either in the shallow area just inside the shelf break in 20-100m depth, or further offshore in deep water greater than 1000m (Figure 4). In the later cases, spinner dolphins were most often associated with spotted dolphins in large mixed-species groups in excess of 500 individuals, and on at least one occasion greater than 1000 individuals, and thus difficult to estimate. Groups of *Stenella* (both species) were rarely less than 200 individuals, with a mean of 215 for *S. longirostris* and 188 for *S. attenuata* (likely underestimated) (Table 6). Groups of *Globicephala* were estimated at 30 to 40 individuals, and typically subdivided into several subgroups of 8-15 individuals, containing adult males, females, juveniles and calves. A group of the large offshore form of *Tursiops truncatus* was sighted once in association with a group of pilot whales; this is the first sighting of this species in the Northwest region and was dramatically different in size and morphology from the smaller *Tursiops* that we tentatively identify as the inshore form of *T. truncatus*, and the coastal *T. aduncus* (see below).

Along the shallow coastal waters of Nosy Iranja, and the extensive coastline of Ampasindava, we sighted 11 groups of coastal dolphins, including 10 groups of Indo-Pacific humpback dolphins, *Sousa chinensis* and 3 groups of Indo-Pacific bottlenose dolphins, *Tursiops aduncus* (associated in a mixed species group on two occasions) (Table 3, 4 & 5, Figure 4). It appeared that at least two different social groups of *S. chinensis* were encountered on multiple occasions, one that was repeatedly seen around the shallow waters of Nosy Iranja, and another in and around the Baie de Russe (Figure 4). Both were found with relatively large group

sizes, at times in excess of 10 individuals. Encounter rates for *S. chinensis* and *T. aduncus* groups were calculated as Sightings Per Unit Effort (SPUE) using the total effort spent searching in coastal waters, for each year individually, across all years, and for each month summed across years (Tables 7 & 8). The encounter rate for *S. chinensis* (0.44 sightings/hr) was similar to that documented in the Nosy Be region (0.50 sightings/hr), both of which were dramatically more than that documented on Nosy Mitsio (0.05 sightings/hr) (Table 7). The encounter rate for *T. aduncus* (0.13 sightings/hr) was also on the order of that documented on Nosy Be for *T. aduncus* (0.10 sightings/hr) and markedly greater than that for the inshore form of *T. truncatus* (0.02 sightings/hr) (Table 7).

Table 5: Encounters of mixed species groups, indicating species associating with *Sousa chinensis*.

	Nosy Be						Nosy Mitsio	Nosy Iranja	
Species	2007	2008	2009	2010	2011	2012	2011	2012	Totals
Tursiops aduncus	**1**	**3**	**2**	**1**	**4**	0	0	**2**	**13**
Tursiops truncatus, inshore	0	0	**1**	**1**	0	0	0	0	**2**
Tursiops sp.	0	**1**	0	0	0	0	0	0	**1**
	1	**4**	**3**	**2**	**4**	0	0	**2**	**16**

Nosy Be Region. During surveys in the Nosy be region we sighted five species of cetaceans, including Indo-Pacific humpback dolphins, *Sousa chinensis*, Indo-Pacific bottlenose dolphins, *Tursiops aduncus*, a larger form of *Tursiops* that we tentatively consider to be common bottlenose dolphins, *Tursiops truncatus*, one unidentified *Stenella* sp., and Bryde's whales, *Balaenoptera edeni/brydei* (Table 3 & 4, Figure 5 & 6).

Indo-Pacific Humpback Dolphins. *S. chinensis* was the most frequently sighted cetacean by four-fold, with 126 encounters of groups over the 6 years around Nosy Be, 19 of which were in 2012 (Table 3). On occasion *S. chinensis* was sighted in association with another species (Table 5), with 16 encounters of mixed species groups. Mixed groups were documented with both species of *Tursiops*, but much more commonly with *T. aduncus* (Table 5). During these encounters, individuals of the two species were clearly associating, typically forming integrated subgroups of 1 or 2 members of each species, as opposed to subgroups of entirely the same species segregated from each other. In some instances it appeared that multiple *Tursiops* were pursuing or chasing a single *S. chinensis*, but this was not the exclusive case and on at least one occasion it was clear that the reverse was occurring. When considering numbers of individuals encountered, the predominance of *S. chinensis* in the region is also clear, with 742 individual sightings in Nosy Be (807 for all regions) being approximately five-fold greater than that for *T. aduncus* with 137 individual sightings in Nosy Be and 158 over all (Table 4). There were many re-sightings of individuals across encounters, and since these numbers represent the summation of group size for all encounters, the numbers presented in Table 4 are probably much larger than the true population abundance. Mark-recapture using photographic identification will be used to estimate population abundance, but given the geographic distribution of sightings, and size of groups, we expect the abundance within the study site to be close to 100 individuals or more. Average group size was 5.9 (s.d. +/- 4.2) individuals across the entire six years (Table 6), with a maximum group size of 22 individuals encountered in 2011, and a total of 22 groups with greater than 10 individuals across all years.

As expected from the number of sightings, *S. chinensis* had the highest encounter rates for any species, with 0.50 groups sighted per hour of search time across all years (Table 7). In 2012, encounter rate around Nosy Be (0.48 sightings/hr) was near the median for all years. The highest encounter rates were in 2011 (0.61 sightings/hr), and the months of July and August (0.64 and 0.62 sightings/hr) (Tables 7 & 8); however, year and month are conflated, since all July effort and the majority of August effort occurred in 2011 (table 2), so it is difficult to distinguish if this is a seasonal effect or due to some variation across years without further sampling. Moreover, it is yet to be determined if this variation in SPUE is real or a product of variation in

spatial coverage from year to year, coupled with a heterogeneous distribution pattern (see below). Compared to other species, the SPUE for *S. chinensis* was four to five times greater than the next most frequently encountered species, *T. aduncus*, for all years and months (Tables 7 & 8).

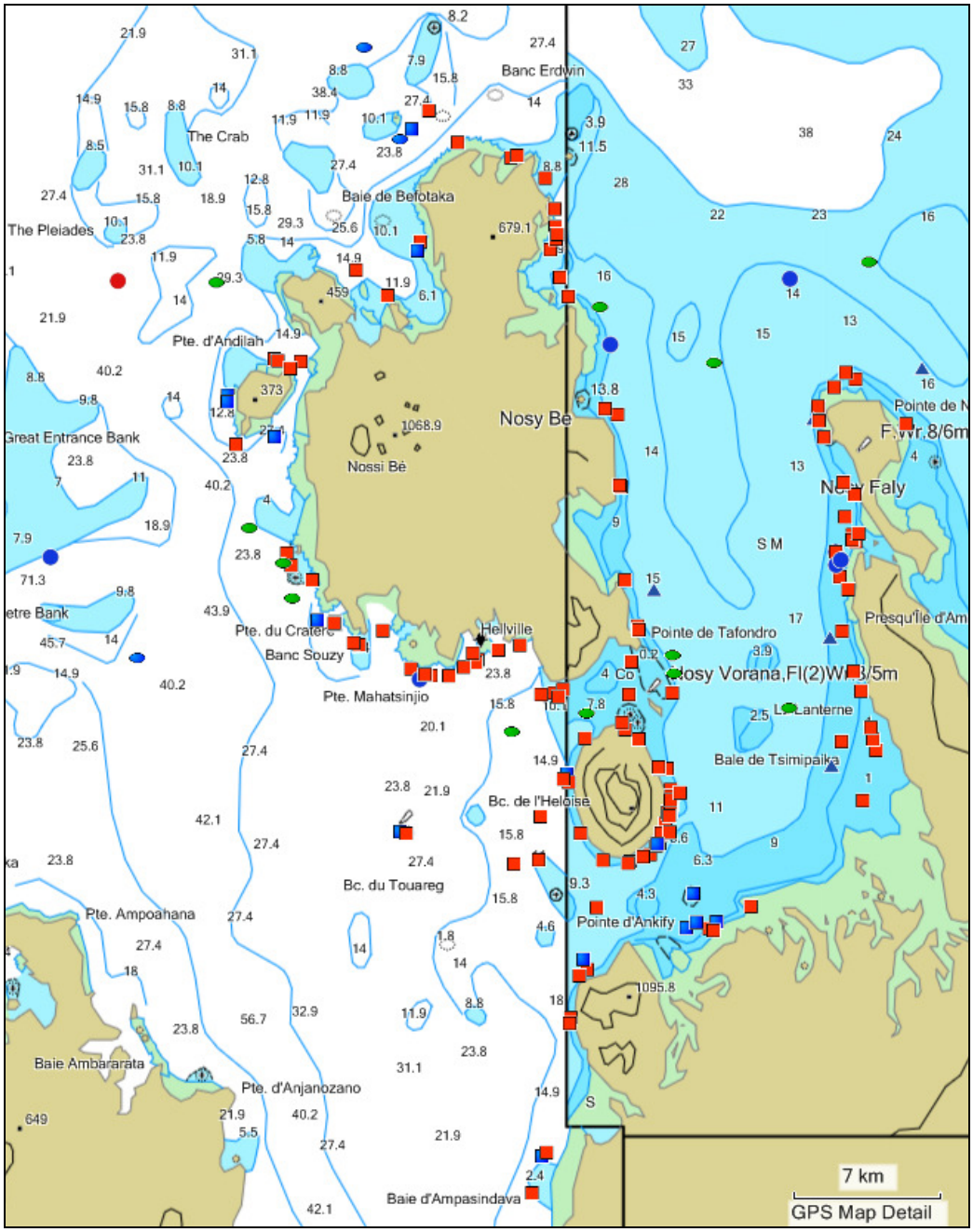

Figure 5: Sightings in the Nosy Be study area, all years 2007-2012.
Species include *Sousa chinensis* (red squares), *Tursiops aduncus* (blue squares), *Tursiops truncatus*, inshore form (blue triangles), undetermined *Tursiops* sp. (blue circles), *Stenella* sp. (red circles), *Megaptera novaeangliae* (green ovals), and *Balaenoptera brydei/edeni* (blue ovals).

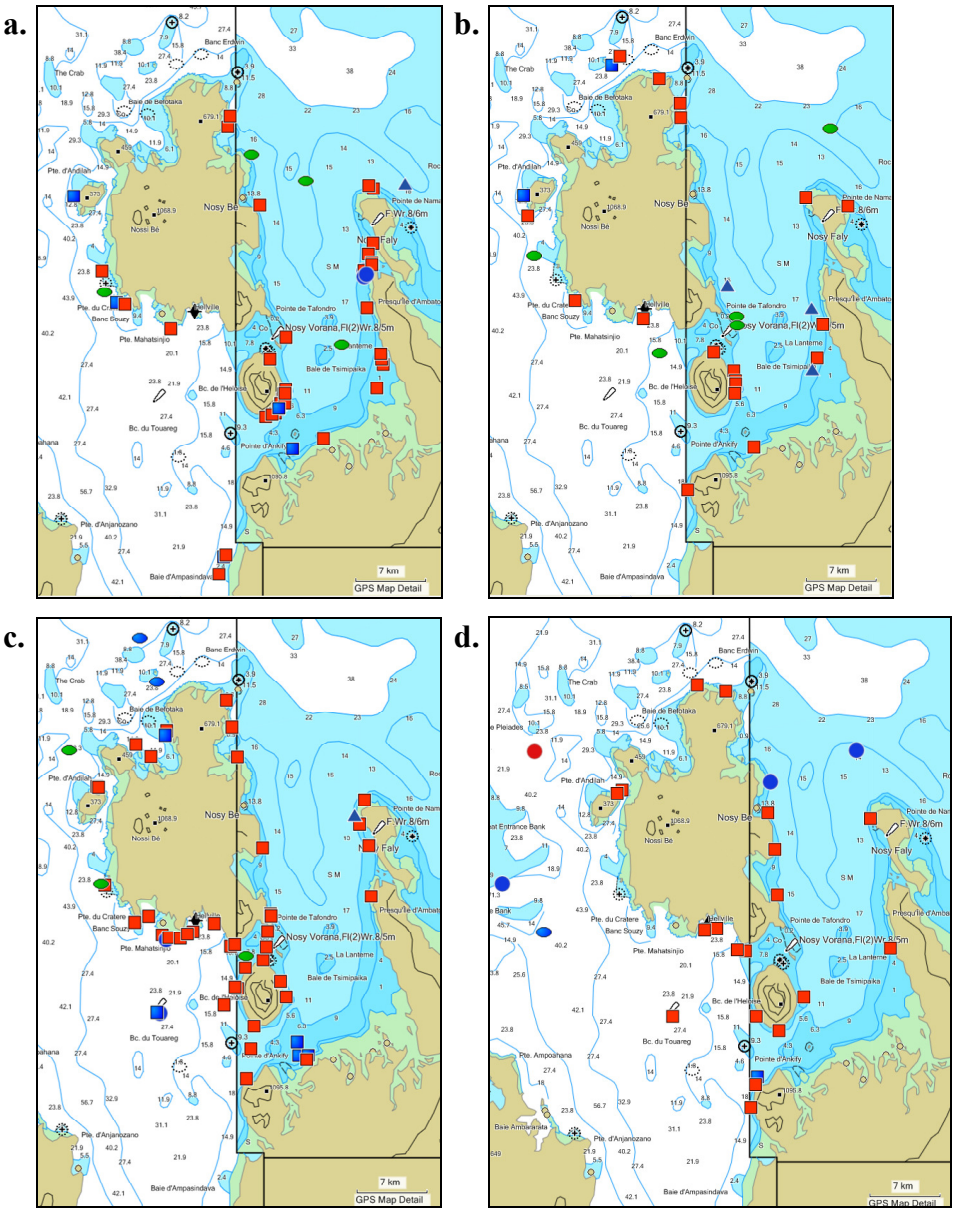

Figure 6: Sightings in the Nosy Be study area during the four main sampling years.
Sightings are shown separately for (a) 2008, (b) 2009, (c) 2011 and (d) 2012. Species include *Sousa chinensis* (red squares), *Tursiops aduncus* (blue squares), *Tursiops truncatus*, inshore form (blue triangles), undetermined *Tursiops* sp. (blue circles), *Stenella* sp. (red circles), *Megaptera novaeangliae* (green ovals), and *Balaenoptera brydei/edeni* (blue ovals).

Table 6: Group size of encountered cetaceans off Nosy Be and Nosy Mitsio.
Values represent means of "best" estimates of group size across all encountered pods of each species. During sightings, group size is recorded as minimum, best and maximum estimates, all of which being equivalent when size is confidently determined.

	Nosy Be							Nosy Mitsio	Nosy Iranja
Species	2007	2008	2009	2010	2011	2012	Overall	2011	2012
Megaptera novaeangliae		2.2	2.2		2.0		2.1	1.7	2.0
Balaenoptera edeni/brydei					1.5	3.0	2.0		
Balaenoptera musculus									2.0
Sousa chinensis	4.9	4.7	5.7	5.0	6.7	7.3	5.9	1.0	6.5
Tursiops aduncus	2.5	5.8	6.8	7.0	4.8	4.0	5.3		7.0
Tursiops truncatus, inshore		5.0	12.0	8.0	5.0		9.4		
Tursiops truncatus, offshore									5.0
Tursiops sp.		9.3			2.5	12.3	8.8	3.4	
Stenella longirostris									215.3
Stenella attenuate									188.0
Globicephala macrorhynchus									30.0
Ziphiidae sp.									5.0

Table 7: Group encounter rates for coastal dolphins by year.
In order to calculate an encounter rate for *S. chinensis* and *T. aduncus*, the total number of groups encountered was divided by the total effort searching in coastal waters. For *T. truncatus* (inshore form), the total effort searching in coastal and open water was used, since this species was encountered in both habitats; the same is done for *Tursiops* sp., as these sightings are possibly (and in the case of Nosy Mitsio, very likely) to be *T. truncatus*.

	Nosy Be							Nosy Mitsio	Nosy Iranja
Species	2007	2008	2009	2010	2011	2012	Overall	2011	2012
Sousa chinensis	0.49	0.52	0.38	0.38	0.61	0.48	0.50	0.05	0.44
Tursiops aduncus	0.11	0.12	0.08	0.08	0.15	0.03	0.10	0.00	0.13
Tursiops truncatus	0.00	0.01	0.06	0.07	0.01	0.00	0.02	0.00	0.00
Tursiops sp.	0.00	0.04	0.00	0.00	0.02	0.04	0.02	0.07	0.00

Table 8: Group encounter rates for dolphins and humpback whales by month.
Encounter rates are calculated as in Table 7, with all encounters and effort being summed across all years for each month. Rates for humpback whales, *M. novaeangliae*, are calculated using all search effort as with *T. truncatus*.

Species	July	Aug	Sept	Oct	Nov	Dec
Sousa chinensis	0.64	0.62	0.44	0.49	0.61	0.36
Tursiops aduncus	0.17	0.12	0.11	0.10	0.11	0.03
Tursiops truncatus	0.00	0.02	0.03	0.02	0.00	0.00
Megaptera novaeangliae	0.03	0.05	0.07	0.00	0.04	0.00

Distribution of *S. chinensis* around the Nosy Be region was heterogeneous, with several areas appearing to be favored by dolphins (Figure 5 & 6). Areas with more frequent sightings included the east of the study region along the coast of Nosy Faly and the Grand Terre (mainland of Madagascar), the northeast coast of Nosy Be, the east coast of Nosy Komba, and the southwest coast of Nosy Be. Other areas, while having relatively similar effort, such as the mid and southeast coasts and mid west coast of Nosy Be (Figure 4), had far fewer encounters (Figure 5). This pattern of geographic distribution was consistent across the four main sampling

years (2008, 2009, 2011 and 2012; Figure 6) and the 2012 data set further reinforced the previously discerned patterns, albeit with a smaller sample due to least effort among the four years (Table 1). There were several cases noted of individuals being re-sighted across encounters and years within the same general area, suggesting there might be site fidelity within the high sighting probability areas and restricted individual ranges. These hypotheses of heterogeneous distribution and site fidelity will be tested by spatially modeling encounter probability and assessing photographic recapture within vs. between areas of high sighting probability. The spatial assessment of effort and sighting probability will also be used to assess whether the variation in SPUE across years/months (Tables 7 & 8) is real or a product of variation in coverage (see above).

To date, our biopsy effort has yielded 29 biopsies of *S. chinensis* individuals, which is somewhat less than originally anticipated, but 2012 yielding an improvement over previous years with 9 collected samples (5 in the Ankivonjy MPA, and 4 in the Nosy Be region). Our first two years of attempting biopsy (2008 and 2009) was done with a low power 50lb draw crossbow and bolts equipped with a small biopsy tip. It was found that *S. chinensis* never bow ride the boat and are very difficult to approach within a close distance (20m) to allow efficient biopsy collection. We succeeded in collecting only 9 biopsies during the two years. Therefore, we began to use a pressurized CO_2 rifle (Dan-Inject JM SP25), to increase precision and hopefully effectiveness at greater range. We tested it during the short expedition in 2010 (collecting 1 biopsy) and fully implemented it in 2011 (collecting 10 biopsies). Given the two-fold difference in number of individual encounters, 267 in 2011 vs. 138 in 2012, the 9 samples collected in 2012 represent a near two-fold increase in effectiveness, which we attribute to an improved dart design with higher sample retention, and increasingly improved technique.

Bottlenose Dolphins. Two distinct forms of *Tursiops* species were encountered in the inshore waters around Nosy Be, the more frequently encountered being *T. aduncus*, as indicated by its smaller size, more delicate body shape, long rostrum and presence of belly spots documented on several occasions during leaps. There were a total of 26 sightings of groups of *T. aduncus*, during the six years, with 2011 again being the year with the most sightings (10 groups, Table 3). During 2012, only one group was positively identified as *T. aduncus* in the Nosy Be region; however, there were 3 groups encountered, all without the PI (SC) on board the boat, that were designated as undetermined *Tursiops* sp. (Table 3). The other form of *Tursiops* species sighted was clearly more robust, moderately larger in length, tended to travel in larger groups with greater activity and faster travel speeds, and have an apparent lack of spots on the belly; we therefore believe this to likely be an inshore or small form of *T. truncatus*. There were a total of 7 sightings of inshore *T. truncatus*, with the most occurring during 2009. In addition there were 8 sightings in which the species ID was not confidently determined, primarily due to brevity of the encounter, or lack of experienced staff (SC) on board the boat (Table 3). Average group size was markedly larger for inshore *T. truncatus*, 9.4 (s.d. +/- 7.4) individuals, as compared to *T. aduncus* 5.3 (s.d. +/- 2.6) individuals (Table 6).

The two *Tursiops* species appear to have distinctly different distributions, with *T. truncatus* sighted only to the east of Nosy Be, and *T. aduncus* sighting only to the west and south of Nosy Be (Figures 5 & 6). In addition to this dichotomy, *T. aduncus* may have a heterogeneous distribution similar to *S. chinensis*, preferring certain areas, such as the south of Nosy Komba and the mid West coast of Nosy Be (Figures 5 & 6); however, the current number of sightings is likely too few to test this or be confident. Encounter rate was much greater for *T. aduncus* (0.10 sightings/hr over the six years) at five-fold the rate for inshore *T. truncatus* (0.02 sightings/hr; Tables 7 & 8), however still much lower than for *S. chinensis* as noted above. There was no obvious variation in encounter rate across months for either species (Table 8). A total of 14 biopsies were collected for *T. aduncus*, 11 for inshore *T. truncatus*, and 8 for undetermined *Tursiops* sp., which will be used to investigate species identity and distinction, as well as assess population structure around Madagascar with samples collected in other regions, such as Nosy Mitso, Nosy Iranja, Belo Sur Mer (central west coast), Anakao (southwest coast), and Antongil Bay (northeast coast).

Baleen whales. Humpback whales were encountered relatively infrequently prior to 2012, despite the surveys covering the peak months of the breeding season in Madagascar. There were no humpback whales

sighted around Nosy Be in 2012, however this is not unexpected since the effort was almost entirely in December, after which we expect most of the population to have departed on migration. There were a total of 14 sightings of humpback whales across the five previous years (Table 3) for a total of 30 individuals (Table 4). Groups were composed of primarily single whales and pairs, with one mother-calf pair and one competitive group of four individuals; thus average group size was relatively small at 2.1 (s.d. +/- 0.9) individuals. Monthly rates of encounter were low, ranging from 0.3 to 0.7 sightings/hr from July to September, no sightings in October or December, and an encounter rate of 0.4 in November resulting from the 3 groups sighted off Nosy Iranja (Table 8).

The first sightings of Bryde's whales were made during 2011, with 2 separate groups encountered on the same day off the north coast of Nosy Be (Table 3, Figure 4). One of the sightings in 2011 was a mother-calf pair, of which the mother was successfully biopsied and excellent photographic documentation of both individuals were obtained. The second sighting occurred within 2 hours of the mother-calf sighting and consisted of a single surfacing of a lone adult whale. During 2012, the area to the west of Nosy Be was surveyed based upon the general location of several tourist reports of Bryde's whales. On one day a loose aggregation of 3 animals were sighted and biopsy samples were successfully collected for all 3 individuals. Due to the generally unresolved nature of Bryde's whale systematics, it is unclear whether these would be *Balaenoptera edeni brydei* or *Balaenoptera edeni edeni*.

Discussion

Research activities for the second year for the project were successfully carried out and produced valuable results. Survey results suggest that coastal dolphin species utilize the shallow water areas around the Nosy Be region, Nosy Iranja / Ampasindava Peninsula (Ankivonjy MPA) and the Nosy Mitsio island group (Ankarea MPA) as important habitat. The encounter rate and apparent abundance of *S. chinensis* were similar between the Nosy Be region and the recently surveyed coastal/shallow water areas of the Ankivonjy MPA, both of which were dramatically greater than for the Nosy Mitsio island group or any other region assessed by our team, including the southwest and central west coasts surveyed for other projects. The Nosy Be region and coastal areas of Ankivonjy MPA also appear to be important for *T. aduncus*, whereas the Nosy Mitsio region may be more important for the inshore form of *T. truncatus* (assuming the *Tursiops* form observed in Nosy Mitsio proves to be inshore *T. truncatus* as suspected). This may be related to differences in bathymetry regimes or the distance from the coast on Nosy Mitso. However, Nosy Iranja is a similar distance from the coastline and clearly provides valuable habitat for both *S. chinensis* and *T. aduncus*, so other factors are likely at work. By-catch and potentially directed takes, as described below in the interview results, and documented directly during our surveys, is clearly an important conservation concern.

Over the coming years, the effort and observational data will be integrated into a comprehensive dataset on coastal dolphins covering the Nosy Be region, Nosy Mitsio island group, and the Nosy Iranja region. Sighting per unit of effort data will be applied in a GIS framework with environmental variables to assess the relative encounter frequencies of species throughout the larger region, and inform definition of critical habitat. Individual photographic identification data for *S. chinensis* and (given a large enough sample) *T. aduncus* will be used to estimate population abundance, define movements of individuals and inform population structure. A manuscript on photographic identification data from 2007-2010, that was originally targeted for completion in 2012, was postponed last year; given the 2012 data collected in Nosy Iranja, we will work towards integrating the entire six year dataset before deciding the publication format (likely towards the end of the study period in 2014).

The collection of biopsy samples has been challenging from the onset of the project. Encountered dolphins, irrespective of species, have proven to be moderately to highly evasive and do not bow ride. Collection of biopsy samples has been difficult and slow and, consequently, the resolution of our current sample to define fine scale population genetic structure may be limited. However, our 2012 efficiency in collecting biopsies was improved from previous years, so we believe continued biopsy collection in coming years will at least partially alleviate the sample size constraint.

Of particular importance from this past year's work is the discovery of high species diversity in the Ankivonjy MPA region. This is likely due to the great diversity of habitat that is encompassed within the bounds of the MPA, including coastal zones, mangroves, coral reefs, shelf slope and deep water, similar to southwest region of Anakao / St. Augustine Bay, where we have documented 15 species of cetaceans since 2004. In comparison, the exclusively shallow water habitat of Nosy Be, Nosy Mistio and Antongil Bay (in the northeast) have all relatively low species diversity. Moreover, the finding in Ankivonjy MPA of species of high conservation relevance (e.g., blue whales and beaked whales) underscores the importance of this habitat and sensitivity to anthropogenic impacts. This region is currently being developed by the Oil and Gas industry, with exploration for petroleum reserves planned in the Ambolobe and Ampasindava blocks by Sterling Energy PLC during 2013 to 2018; these blocks entirely overlap with the Ankivonjy and Ankarea MPAs (Figure 7). The work conducted under this study has already been used in conservation efforts to protect this habitat, by expanding the proposed boundaries of the Ankivonjy MPA to include the deep-water habitat in which blue whales, beaked whales and oceanic delphinids were sighted. In coming years, our work will focus on this region, with specific aim to developing a strong baseline dataset with which to influence government policy and industry practices in the region.

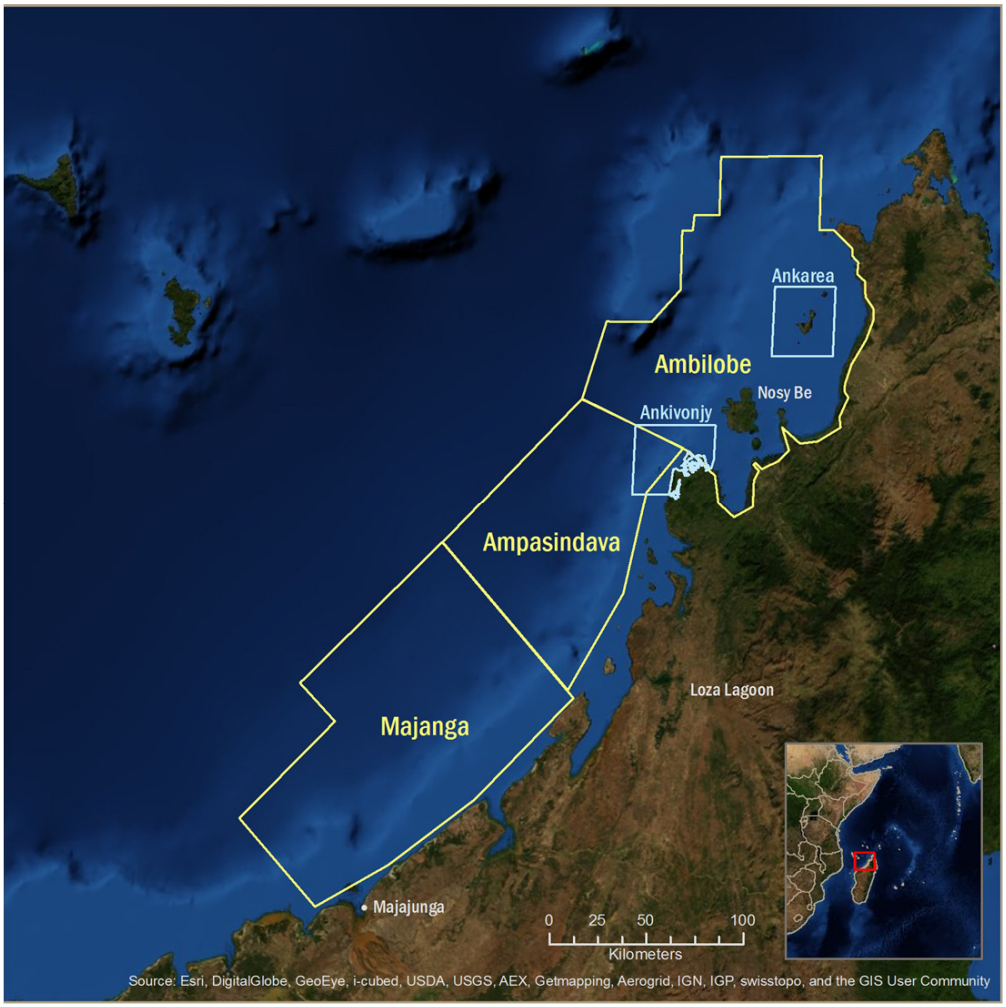

Figure 7: Location of Oil and Gas Concession Lease Blocks Ambilobe, Ampasindava and Majanga
Active petroleum exploration is occurring during 2013-2017. Also indicated are the boundaries of the Ankarea and Ankivonjy MPAs, and Loza Lagoon the site of the 2008 mass stranding of melon-headed whales that has been recently associated with exploration activities in the Ampasindava block.

Assessing By-catch and Hunting: Interview surveys in the Northwest

Goal 2: Assess the extent of artisanal fisheries interactions with coastal dolphin populations in the Northwest of Madagascar, for both incidental by-catch and directed hunting.

WCS has developed a program of interview surveys to assess local communities' perceptions of and interactions with coastal dolphins. These activities provide a better understanding of artisanal fisheries interactions, focusing on coastal dolphin hunting and by-catch, and ultimately led to our discoveries and conservation work on unsustainable hunting in the Southwest of Madagascar. Our initial interview surveys in the Northwest (2008-2009) indicated some by-catch in the Nosy Be region varying in magnitude among villages and fishing practices, and also a low level of directed hunting restricted to a few closely related villages. Socio-economic interview surveys during 2011-2013 are intended to encompass adjacent island groups (Nosy Mitsio and Nosy Iranja study areas) to assess fisheries interactions in the larger region, both in terms of spatial variation in the magnitude of impacts on coastal dolphins from by-catch, and geographic scope and level of intensity of directed hunting if found. Additionally we collect local knowledge on cetacean species encountered by fishers; this knowledge complements results from boat-based surveys because fishers work daily throughout the year and can thus provide a broad picture of dolphin distribution and sightings of rarer species. Surveys in the Nosy Mitsio region (Ankarea MPA) were completed in 2011, indicating by-catch, particularly of *Tursiops* sp. and dugong, but no apparent hunting. Below we report on surveys conducted on Nosy Iranja and the Ampasindava peninsula (Ankivonjy MPA).

Interview Methodology

Interview surveys targeted fishers in coastal villages and were aimed at collecting information about the occurrence, hunting and by-catch of all marine mammals, with a focus on collecting data on the prevalence of previously documented coastal dolphin hunting and by-catch. Since hunting of marine mammals is illegal in Madagascar, and this is wildly known among west coast communities that practice dolphin hunting in particular, the collection of data regarding hunting and by-catch of marine mammals is a very sensitive topic. Therefore, several protocols were followed that aimed at creating a relaxed atmosphere and gaining the confidence of interviewees. The interview team leader (NA) has extensive experience conducting interviews with fishers in Madagascar and has been working with coastal communities since 1999. Interviews were conducted by an all-Malagasy team, always including one member from the general region, and when possible a local fisher or mariner from the area that was known among the targeted villages. The absence of westerners/foreigners (or Vazaha in Malagasy), and the presence of a known local individual, allowed the interviewees to feel at ease, allaying suspicions and encouraging honest responses. The use of forms or creating hardcopy documentation in the presence of fishers was avoided. Instead the interviews involved an informal, standardized set of questions that are delivered in a casual verbal manner that has been developed for this purpose. Interview sessions (each of which is considered a sample) took the form of interviews with single individuals, or focus groups, where a group of related fishers were interviewed. Questions were designed to gather (a) village/population information, including number of fishers, gender and age breakdown, backgrounds and types of activities practiced; (b) individual information, including age, family size, areas fished and types of gear used; (c) information on marine mammals in the area, including species found (using a visual guide with French, English, and Malagasy names), frequency of encounter, and areas observed; and (d) information on by-catch and hunting, including: whether marine mammals were ever incidentally entangled in gear; when caught as by-catch, how often they were consumed or released; whether there was active hunting for marine mammals, and if so, how frequently it occurred, how many individuals were taken, and what was done with the meat (distributed locally or sold at markets).

Due to the rapid nature of the survey missions and often short time available at any given village, it was not possible to make a standardized random sampling of all households in a village. Instead, an opportunistic approach was used, approaching individual fishers as they returned from sea, or organizing a focus group in a similar manner (approaching groups of fishers that were already gathered). Age of the interviewees was

estimated within decadal categories by the interviewers, and data was collected regarding the type of fishing they engaged in and the gear used. During an interview, a fisher was asked to report any observations that he/she, or the group, knew of involving marine mammals, including whales, dolphins and dugongs, and was presented with a detailed full-color visual guide developed by WCS that contains highly detailed illustrations meant to be used for field identification. Reports were categorized as one of four different event types: hunting, by-catch, stranding, or live sighting. For hunting and by-catch events, the type of fishing gear was recorded along with if and how the meat was used (i.e., consumed, sold). The number of individual marine mammals in each event was recorded, along with the timing of the event by the year of occurrence. In cases where the fisher could not remember the exact year, the interviewers approximated the year by associating the event with some landmark in the life of the fisher (e.g., marriage, birth of a child, etc.).

Table 9: Description of villages in Ankivonjy MPA that were sampled and interviews conducted in 2012.
The estimated population (Est Pop) and estimated number and percentage of fishers (Est #Fishers and %Pop Fishers) were provided by an elder or mayor in each village. Interviews are defined as each separate session (Tot #Interv) irrespective of number of individuals; Single Interv indicate number of single person sessions, and Focus Grps indicate number of sessions with focus groups of 2 or more people; Tot Individ is the summation of all people present in all sessions, and %Fish Interv is the percentage of the estimated number of fishers represented by Tot Individ.

	Village Stats			Interview Stats				
Village	Est Pop	Est # Fishers	%Pop Fishers	Tot #Interv	Single Interv	Focus Grps	Tot Individ	%Fish. Interv
Nosy Iranja								
Nosy Iranja Be	200	15	8%	9	8	1	10	67%
Ampasindava Peninsula								
Marotogny	1214	120	10%	11	8	3	16	13%
Amporaha GT	1200	50	4%	12	6	6	19	38%
Mangirankiragna	218	49	22%	8	5	3	15	60%
Ampohagna	80	10	13%	7	5	2	10	70%
Ankilobato	30	3	10%	2	0	2	5	67%
Ampasimena GT	21	5	24%	3	2	1	4	80%
Ankisimany	10	8	80%	1	0	1	5	63%
Ampasimireho	10	4	40%	1	0	1	4	100%
Ankivonjy MPA	2983	264	9%	54	34	20	88	33%

Ankivonjy MPA Interview Results

During late October 2012, WCS's Malagasy team worked on Nosy Iranja and the Ampansindava Peninsula to conduct interviews of fishers in 9 villages in Ankivonjy MPA (Table 9). The reported population of the 9 villages was 2863 people of which 247 are fishers (9%). Interviews were conducted with 93 fishers during 54 interview sessions, 20 of which were focus groups consisting of 2 to 9 fishers. Interviewees reported sighting 15 species of marine mammals based upon a visual guide to species in Madagascar, including four Mysticete species, 10 Odontocete species and the dugong (Table 10). Frequency of reporting Mysticetes, based upon the percentage of interview sessions (not individuals), was 93% for humpback whales, 15% for right whales (*Eubalaena australis*), 7% for Brydes whales (*Balaenoptera edeni/brydei*) and 6% for blue whales (*Balaenoptera musculus*). There were four commonly reported Odontocetes, with 67% for *Tursiops* sp., 48% for *Stenella* sp., 37% for *S. chinensis*, and 22% for sperm whales (*Physeter macrocephalus*); an additional six Odontocete species were reported in 6% or fewer interviews. Dugongs (*Dugong dugong*) were widely reported in 67% of interviews (Table 10). Incidental by-catch in the gillnet "jarifa" targeting sharks was reported in 50% of interview sessions, with 9 *Tursiops* between 1990-2008, 4 *Stenella* sp. for a similar

period (both possibly underestimated), and 19 dugongs between 1980-2003. Most notably, although no dolphin hunting was reported, dugong hunting was reported as recently as 2012, with 51 reported hunted primarily between 1980 and 2007, but going back to the 1970's. Strandings were also reported for 12 humpback whales, 2 sperm whales, 4 *Tursiops*, 3 *Stenella* sp. and 5 dugongs (and it is noteworthy that no mass strandings were reported).

Table 10: Reports of marine mammals during interview surveys in Ankivonjy MPA.
For each species, the overall percentage of interview sessions in Ankvonjy MPA that reported the species is presented, irrespective of type of report ("Reported"), as well as the percentage that reported the species as Hunted, By-catch, Live and Stranded. In addition the total numbers of individuals reported hunted, by-caught or stranded is presented in (). The percentage of sessions in the Nosy Mitsio interviews that reported each species is also presented for comparison.

	Ankivonjy MPA					Nosy Mitsio
Species	Reported	Hunted	By-catch	Live	Stranded	Reported
Balaenoptera musculus	6%			6%		
Megaptera novaeangliae	93%			87%	31% (12)*	90%
Balaenoptera edeni/brydei	7%			7%		
Eubalaena australis	15%			15%		2%
Physeter macrocephalus	22%			11%	13% (2)	
Kogia simus	2%			2%		
Sousa chinensis	37%			37%		46%
Tursiops sp.	67%		15% (9)	63%	7% (4)	93%
Stenella sp.	48%		6% (4)	44%	4% (3)	12%
Delphinus delphis[1]	6%			6%		
Orcinus orca	4%			4%		
Grampus griseus	4%			4%		
"Blackfish"[2]	2%			2%		
Beaked whale[3]	4%			4%		
Dugong dugon	67%	24% (51)	30% (19)	28%	6% (5)	51%

[1] Due to lack of confirmed records of *D. delphis* in Madagascar, this is possibly a misidentification (of *Stenella* sp.?);
[2] Reported by fisher as *Feresa attenuata*, but unlikely to be accurate to species, so reported in table as simply "Blackfish";
[3] Reported by fisher as *Mesoplodon densirostris*, but unlikely to be accurate to species, so reported in table simply as Beaked whale.
* Strandings of humpback whales were reported in 18 interviews, however 12 strandings represent a conservative minimum for different events, taking into consideration reported years and location.

Discussion and Larger Context

The species diversity (15 species) reported in the Ankivonjy MPA interviews is notably higher than that reported in the Nosy Mitsio interviews (6 species), and appears congruent with that indicated in the region by our preliminary boat surveys (see section above). Among coastal dolphins, both *Tursiops* sp. and *S. chinensis* were commonly reported; that *Tursiops* sp. were reported twice as frequently is somewhat at odds with our boat survey results, in which *S. chinensis* were much more frequently sighted. Nearly 50% of interviews reported *Stenella* sp., which is distinctly different from other regions, but not surprising given that spinner dolphins were our most commonly sighted dolphin in the Ankivonjy MPA. Interview reports of blue whales and beaked whales were corroborated by our direct observations of these species in our boat surveys; similarly, one interviewee reported pygmy killer whale, *Feresa attenuata,* and although we did not sight this species, our multiple sightings of pilot whales suggest that a report of a blackfish species is also valid. For most other species reported, there are also corroborating evidence from other sources suggesting the validity

of the interview results. Therefore we deem that the traditional knowledge of species diversity gathered through the interviews is a valuable addition to our understanding of the region, and predicts that our directly observed species diversity will continue to climb with increased effort in coming years.

The reports of dugong, which are very rare and likely highly endangered in Madagascar waters, are of great conservation significance. Dugongs were reported in a majority of interviews in both Nosy Mitsio and Ankivonjy MPA. In the Nosy Mitsio interviews, all sightings and by-catch of dugongs occurred prior to 2001, primarily in the 1990's, suggesting that the dugong population of this area is extremely impacted and possibly extirpated. In the Ankivonjy MPA interviews, dugongs were reported in an even larger proportion (two thirds of interviews), more recently with reports as recent as 2012, and unlike in Nosy Mitso, nearly 25% of interviews reported actively hunting dugong. This is critically important information, suggesting that there is an extant population of dugongs that continues to utilize the habitats of Ankivonjy MPA, and moreover is potentially seriously endangered by continued hunting and by-catch. The information from interviews in Nosy Mitsio and Ankivonjy MPA along with our interview work in other parts of the west coast (Table 11), has recently been used to set priority target areas for a GEF funded Convention on Migratory Species project aimed at conserving dugongs and seagrass habitat in Madagascar. This project will commence in 2014, with the involvement of WCS, and institute conservation research and habitat protection for dugongs in the country.

Table 11: Description of all west coast locations that have been sampled and interviews that have been conducted since 2008.

Villages indicates the number of separate villages that were visited at each location; the estimated population (Est Pop) and estimated number and percentage of fishers (Est #Fishers and %Pop Fishers) are the summations for all indicated villages, as estimated by an elder or mayor in each village. Interviews are defined as each separate session (Tot #Interv) irrespective of number of individuals; Single Interv indicate number of single person sessions, and Focus Grps indicate the number of sessions with focus groups of 2 or more people; Tot Individ is the summation of all people present in all sessions, and %Fish Interv is the percentage of the estimated number of fishers represented by Tot Individ.

	Location Stats				Interview Stats				
Location	Villages	Est Pop	Est # Fishers	%Pop Fishers	Tot #Interv	Single Interv	Focus Grps	Tot Individ	%Fisher Interv
Nosy Mitsio	18	547	142	26%	41	31	10	57	40%
Nosy Be/Komba	8	14170	656	5%	24	14	10	140	21%
Nosy Faly/GT	5	2979	1055	35%	12	2	10	137	13%
Ankivonjy MPA	9	2983	264	9%	54	34	20	88	33%
Mahajanga	4	2300	1390	60%	13	4	9	27	2%
Barren Islands	3	60	60	100%	5	0	5	20	33%
Ambozaka	1	2040	1800	88%	3	0	3	12	1%
Morondava	2	8980	1700	19%	4	0	4	13	1%
Belo sur Mer	3	5187	3440	66%	30	17	13	107	3%
Morombe	2	9144	2220	24%	6	1	5	20	1%
Bevato	1	437	300	69%	9	3	6	37	12%
Andavadoake	4	1392	668	48%	27	13	14	56	8%
Bevohitse	3	475	251	53%	24	14	10	57	23%
Ifaty	4	11540	3730	32%	12	7	5	29	1%
Totals	67				264	140	124	800	

Interview results from these past two years will be used as WCS develops a management strategy for the Ankivonjy and Ankarea MPAs, working with the local communities to protect and manage the total 370,349ha that the two MPAs encompass. Indications of by-catch of coastal dolphins, particularly *Tursiops* sp. in Nosy Mitsio and to a lesser extent in Ankivonjy MPA emphasize the need to educate the communities

on dolphin conservation and introduce measures to mitigate the by-catch (e.g., through gear modification). More critically, the information gathered on dugongs in both regions suggest that immediate action is needed to conserve this threatened species, and will direct conservation priorities in the near future. These results will also be incorporated into a larger interview survey effort covering an extensive portion of the west coast of Madagascar (Table 11). In the Northwest of Madagascar, in addition to the Nosy Mitsio effort, interviews were conducted during 2008 and 2009 at the islands of Nosy Be and Nosy Komba (8 villages), and the island of Nosy Faly and the nearby "Grande Terre" (the main land of Madagascar, or GT; 5 villages). In the Southwest and central West coast of Madagascar, 13 locations were surveyed during 2010, including, from South to North, Ifaty (4 villages), Bevohitse (3 villages), Andavadoake (4 villages), Bevato (1 village), Morombe (2 villages), Belo sur Mer (3 villages), Morondava (2 villages), Ambozaka (1 village), the Barren Islands (3 villages) and Mahajanga (4 villages). Together with field research on priority habitat and population status, this information will support the development of management policy at the community and government levels within and beyond the MPAs and, at a wider scope, will inform conservation measures and policy actions through the region.

Reducing Hunting of Coastal Dolphins: Community Workshops in the Southwest

Goal 3: Respond to identified threats in the Southwest of Madagascar through a series of community workshops and outreach measures in a community of villages recently identified as conducting dolphin hunting.

Background, initial workshop in Befandefa and the community-led Action Plan

WCS's conservation approach on the West coast of Madagascar engages communities directly, using a methodology developed through work in the Anakao region to facilitate community-based solutions to mitigate impact on dolphin populations. Activities to assess status of coastal cetaceans and mitigate hunting in Southwest Madagascar commenced in 2004, after drive hunts on pods of coastal dolphins (including *Stenella longirostris*, *Tursiops aduncus*, and *Sousa chinensis*) were first identified in the region.

Workshops and sustained community engagement activities conducted since 2007 have lead to the development of an education and awareness raising program in the local villages, the community-based Anakao Association for the Protection of Whales and Dolphins (the FMTF, consisting entirely of traditional Vezo fishers from three villages), and traditional laws (Dina in Malagasy) on cetacean conservation. Wider range surveys conducted in 2010 revealed that the dolphin hunting tradition is geographically widespread but localized to a few specific Vezo communities, primarily in the Southwest, with a particularly high incidence of hunting reported north of Toliara in the Befandefa communities around the villages of Andavadoaka, Bevato and Behovitse.

During the first year of the project, an initial workshop in the Befandefa region with fisher associations, Vezo members from the Anakao FMTF, non-profit conservation NGOs in Madagascar, and national-level institutions, resulted in a validated action plan, with clear responsibilities, timeline, vision and objectives for conservation of marine mammals (Annex I). This action plan charts the process to the eventual formation of a local association(s) like FMTF (or expansion of the FMTF as a regional association), the creation of local Dina, and development of livelihood alternatives to dolphin hunting. Since July of 2012 WCS has developed an MOU with the British NGO Blue Ventures, active in the Andavadoaka commune and working with the traditional fishers association, Velondriake, to move forward on the action plan.

Activities on the second year of the project built on the solid work conducted in the Vezo villages of the Befandefa region during the first year. Several missions to the Befandefa region were conducted between July 2012 and July 2013 to create new local associations for the protection of marine mammals, select committee members and create an overall organizational structure for the associations, conduct training for key committee members, and conduct general awareness raising activities in the communities at large.

Follow up meetings to initial Befandefa workshop and Action Plan implementation

Creation of new associations for the protection of marine mammals

In the later half of 2012, we worked in the Befandefa commune with objectives of (i) meeting with local communities, key informants and local authorities (heads of villages, Mayors, elders) to discuss the implementation of the marine mammal protection strategy plan in all fisher villages around the commune of Befandefa; and (ii) plan conjointly with the existing local associations (Manjaboake, Velondriake) for the creation of a new association(s) for the protection of marine mammals.

Four separate meetings were conducted respectively in the communities Bevohitse, Tampolove, Andavadoaka and Belavenoke. The latter three communities represent three separate districts within the existing fisher association, Velondriake, South, central and North, respectively. Participants came from each of the villages in the commune, and in all cases the decision was made to create a new association,

representing an important milestone and movement forward in the process of developing community-led conservation of marine mammals. Each association was given a locally significant name:

1. In Bevohitse, 11 people from 5 villages participated in the meeting. After discussion, the participants created a new association called RAZABENDRIAKE (from the traditional Malagasy beliefs on whales: RAZA=ancestor; BE=big and RIAKE=sea).
2. In Tampolove, the South district of the Velondriake zone, 22 people from 9 villages participated in the meeting. The participants decided as well to create a new association, called SOAMITAHY (based on a traditional belief that whales bring good luck to the fishermen by getting more fish, etc.).
3. In Andavadoaka, the central district of the Velondriake zone, 18 people from 5 villages attended the meeting. They also decided to create an association, named KOMBIMAMI, Komity Miaro ny Biby Mampinono Miharisoa, (meaning the committee that protects marine mammals well).
4. In Belavenoke, the North district of the Velondriake zone, 22 people from 11 villages participated in the discussions and decided to create a new association named FANEVANDRIAKE (meaning the best things in the water).

Selection of leaders for the new associations and awareness raising campaign

The objectives of this mission in early 2013 were to (i) identify the representatives for each village, and to select leaders and officials for each new association (President, Secretary, Treasurer, etc.), as well as (ii) commence an extensive awareness-raising campaign focused on the importance of protecting whales, dolphins and dugongs. To accomplish these two objectives, activities were organized in two consecutive steps: meetings for the creation of committees, and awareness raising campaign in the fisher villages along the coast in the commune of Befandefa.

Meetings for the creation of committees

A meeting was organized for each of the new four associations, three in February 2013 and a fourth was delayed until the following May due to the passing of cyclone Haruna. Representatives were invited to participate and put forward their candidates to be elected and included in the committee. Each committee was conformed of twelve people, to cover the positions of President, Vice-President, Secretary and Adjunct Secretary, Treasurer and Adjunct Treasurer, two auditors and four advisors. The list of representatives for each of the new committees can be found on tables 1-4 of Annex II. The details for the awareness raising campaign to be conducted in the region were also presented and discussed at these meetings.

Awareness raising campaign

The following villages were reached out to through the awareness raising efforts: Ambohibao, Bevohitse, Antsepoke, Akitambagna, Tsimivolo, Tampolove, Akindranoke, Befandefa, Ambalorao, Ampasilava, Andavadoaka, Antsatsamoroy, Belavenoke, and Ambatomilo (the former ten during the mission in February 2013, and the last two delayed until May due to the passing of cyclone Haruna).

The ceremony at each village included the official opening by the chief of the Fokontany (community leader above the mayoral level), an introduction by the WCS representative (NA) explaining the action plan defined during the workshop in Andavadoaka in 2012 and the objectives of the creation of the each association, and the official presentation of the committee members of the new committees. During the ceremonies, images of marine mammals were projected and accompanied by two FMTF songs and the launching of a new competition for songs and theatrical animation on the protection of the marine mammals. The FMTF President (Mr. Yalaude Jean René Lahiniriko) participated in all four ceremonies, sharing the FMTF experience in Anakao and explaining marine mammal conservation issues in the region. He emphasized the critical status of whales and dolphins in the area after being hunted for a long time, and the importance of the elaboration of the Dina to protect them.

Creation of a Central Committee for associations and training of members of the management committees

In May 2013, all committee members of the four new associations created in commune met in Andavadoaka to: (i) create a platform uniting the four associations, or central committee for the protection of marine mammals in the commune; (ii) train all members on general knowledge of marine mammals and national laws; and (iii) to discuss together their tasks.

Creation of the Central Committee

Out of 48 members of the four associations, 43 were present in the meeting. Through a secret vote, 14 people were elected as leader members of the central committee, named Komity Foibe MIaro ny BIby Mampinono Andriake or KFMIBIMA FANEVASOA. The names and positions of the central committee members can be found on Annex III. The organization chart showing the relationships and hierarchy among the different levels is presented in Figure 8.

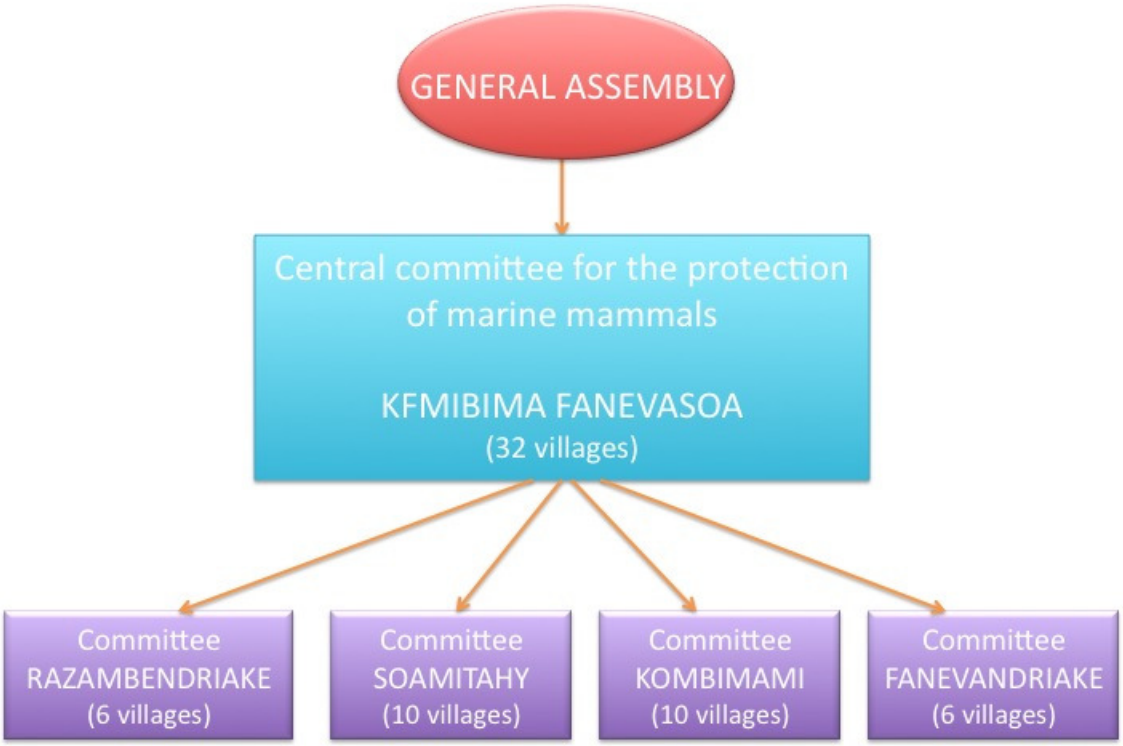

Figure 8: Organization chart for the new associations in the commune of Befandefa.
Relationships are shown for the general assembly, the central committee and the 4 regional committees for the protection of the marine mammals.

Training of committee members

The training efforts were oriented to educate all members of the associations on basic biology and conservation issues of marine mammals, as well as on national laws protecting them. A training session was organized around the workshop that brought together all members of regional committees in Andavadoaka. During this educational effort, trainees received explanations on basic knowledge of cetaceans and general differences with fish, and broad issues affecting their conservation. Additionally, participants were informed on the Malagasy laws currently in force forbidding the hunting of marine mammals and received copies of these. With this training, including knowledge on marine mammals and their national laws, committee members are now prepared to transmit this important information and to advocate for these animals in their

communities, which are affecting marine mammal populations through both direct hunting and by-catch. Finally, data sheets to collect information on hunting, by-catch, and strandings were distributed to all participants, who received basic training on how to register the information (see Annex IV).

Progress towards creation of Dina

Dina are traditional laws governing various aspects of social behavior in local Malagasy communities. Drawn up and ratified by stakeholders in local villages, these social conventions are powerful tools for altering behavior patterns and practices in a conservation context, and typically are more reliably enforceable and abided by than national or regional laws and jurisdiction. The training session provided a space for the formulation of questions related to the Dina of the commune of Befandefa on direct hunting and by-catch. Due to the lack of articles especially stipulating the protection of marine mammals in existing traditional laws, it was decided that additional Dina specifically dedicated to the protection would be ensured subsequently in the commune. The President of FMTF explained the process developed in Anakao and used as example some of the articles from the FMTF Dina related to the questions asked by the participants. This is a very encouraging development, with the elaboration of the new Dina expected for 2014.

Tasks for the members of the committees

Being members of management committees for the protection of the marine mammals and having some knowledge on the Malagasy laws, all participants have committed to continue and to ensure the sensitization of the communities of every village where they live in to the importance of the protection of the marine mammals. CDs with the FMTF songs were distributed to all members to reinforce their awareness raising efforts. They are also responsible for promoting local participation in the song and theatrical animation competition concerning the protection of the marine mammals launched in February 2013. Members of all associations will be contributing to the annual monitoring of marine mammal mortality by filling the data sheets provided.

Conclusion

Project activities scheduled for Year 2 were successfully completed, covering the three major components of this project: (1) Defining priority habitat and population status: research field surveys in the Northwest; (2) Assessing by-catch and hunting: interview surveys in the Northwest; and (3) Reducing hunting of coastal dolphins: community engagement in the Southwest. Information gathered from Components 1 and 2 in the Northwest Ankivonjy MPA was broadly complementary and reinforcing, indicating high species diversity, presence of several species of conservation concern, and important habitat for coastal dolphins as documented previously in the Nosy Be region. Results of interview surveys in the Ankivonjy MPA on by-catch of marine mammals and hunting of dugongs will be instrumental in directing priorities in the development of the MPA management plan and the GEF-funded CMS dugong conservation project.

These concurrent activities of the first two components in the Northwest are part of a larger model that ultimately leads to direct conservation action at the community level. Component 3 exemplifies the advanced stage of this same model as demonstrated in the Southwest communities, where prior field research and interview work identified the need for conservation efforts and guided actions. Following our initial workshops on the importance of marine mammal conservation in the Befandefa commune, the now engaged communities began the implementation of the previously established action plan. This involved the important milestone of creating specific local associations and committees for the protection of marine mammals, and the initiation of activities to be overseen by these associations, including education and awareness raising of local fishers and creation of specific Dina (traditional law) for protection of marine mammals. Progress in these communities is moving at a rapid pace and represents promising success. A simple anecdote demonstrates the potential of this progress: Mr. Oezime Marcel, a fisherman advisor of the Fanevandriake Association, reported that on May 8, 2013, a live dugong was captured accidentally in his net in the village of Bevato situated to the North of Andavadoaka; although this village was indicated by our interviews as having among the highest incidence of dolphin and dugong hunting in the region, this entrapped dugong was released due to the existence of the recently created association for the protection of the marine mammals in the commune. We predict that this action foretells the larger conservation impact that our program will have in the region, as the community-based structures and management spread and take hold.

Annex I: Summary table of final Action Plan for conservation of marine mammals in the Andavadoaka region.
Created and endorsed by all participants in the workshop conducted in February 2012.

VISION	OBJECTIVES	CONSTRAINTS	ACTIVITIES	RESPONSIBILITIES	PERIOD
Marine mammals are protected and provide the basis for development of sustainable ecotourism, making the Southwest Region a conservation leader in Madagascar, and preserving marine heritage for future generations.	To protect marine mammals from extinction through the cessation of hunting by the communes of Anakao, Soalara Sud, St. Augustin, Manombo and Befandefa by 2015.	1. Lack of funding to support the awareness raising campaign.	Fundraising.	Partners (WCS, BV), Velondriake* (Andavadoake), Manjaboaka* (Bevohitse), Soariaka* (Salary Nord) committees	Commencing in 2012 Meetings - Once/month for Committee. - Twice/year for partners
		2. Lack of knowledge and awareness on the importance of protecting marine mammals.	Develop and implement awareness-raising program in local communities, using tools such as posters, panels, t-shirts, allegoric songs, radio, videos, news papers, festival, environmental education, meetings with all communities, recitation, theater, etc.		
		3. Lack of knowledge and enforcement of national laws.	Develop, ratify and implement local traditional laws, or Dina, throughout the communes.	Fokontany, villages, police, judiciary.	2014 for all partners
	To promote development of whale and dolphin watching ecotourism, with approximately a 30 % increase in the number of tourists by 2013.	1. Lack of advertisement of marine mammals in the Region.	Inform tourists of the existence of marine mammals in region through media.	All local associations.	Commencing in 2012
			Create and install information panels in each village.	Partners (WCS, BV).	2013
		2. Tourists lack information on the present structure concerning tourism activities.	Providing tourists with information on tourism infrastructure (hotel operators to be included as part of the management committee).	Management Committee.	Once a month
		3. Lack of local Guides knowledgeable in marine mammals.	Creating and training local guides with expertise on marine mammals.	WCS, Blue Ventures, Velondriake, IHSM.	2013
		4. Lack of adequate equipment to conduct tourism activities.	Fund raising to purchase a whale watching boat for each community.	BV, WCS, Government, local associations.	2013
		5. Roads in poor condition.	Requesting funding for road reparations.	Community	2013
		6. Poor security.	- Improving public safety, - Monthly control by responsible security (Policeman and Gendarme, etc.)	Fokontany, community, Gendarmes, judiciary, Military.	2013

* Fishermen Associations in the Andavadoaka region

Annex II: List of committee members in each of the four new community associations for the conservation of dolphins, whales, and dugongs.

Table 1: List of members of the Razabendriake Committee

	POSITION	NAME	VILLAGE
01	President	VEVE Edmond	Antsepoke
02	Vice President	DEVANCE	Ambohitsabo
03	Secretary	ZANVIRON Mokatsy Vally	Beangolo
04	Adjunct Secretary	MANIMPA Forest Anistophane	Antsepoke
05	Treasurer	ZIRISIA Marcellin	Ambatomilo
06	Adjunct Treasurer	NESTOR Felix	Ambohitsabo
07	First Auditor	SEZAN Felix	Ambohitsabo
08	Second Auditor	PIERROT	Ambatomilo
09	Advisor	VICTOR dit MIADA	Beangolo
10	Advisor	ZAVARY	Antsepoke
11	Advisor	ROXE Milimo	Ambatomilo
12	Advisor	MICHELRaelson	Pandrivotse

Table 2: List of members of the Soamitahy Committee

	POSITION	NAME	VILLAGE
01	President	FANOMEZA Naie	Vatoavo
02	Vice President	CELESTIN	Lamboara
03	Secretary	BRUNO Bensemin	Agnolignoly
04	Adjunct Secretary	ZATAO Jean Theodore	Akitambagna
05	Treasurer	RICHARD Badouraly	Tampolove
06	Adjunct Treasurer	RENE Kata	Agnolignoly
07	First Auditor	REDOKO Dieu Donné	Akindranoke
08	Second Auditor	GERMAIN	Befandefa
09	Advisor	MAMONO	Befandefa
10	Advisor	TOVONDRAINY	Lamboara
11	Advisor	JISPIN	Tsimivolo
12	Advisor	RANDRIAMANANTENA	Tampolove

Table 3: List of members of the Kombimami Committee

	POSITION	NAME	VILLAGE
01	President	DANTESSE Takantera	Andavadoaka
02	Vice President	HERIZISTRE	Andavadoaka
03	Secretary	VOHALY Clovis dit Marcelin	Andavadoaka
04	Adjunct Secretary	LAZA Ziriel	Ankilimalinike
05	Treasurer	RAIVOSOA Bino	Ankilimalinike
06	Adjunct Treasurer	ZAFIANAKE	Ambalorao
07	First Auditor	SILIVY	Antsatsamoroy
08	Second Auditor	Jean Rosy Roger	Ampasilava
09	Advisor	COSITA	Nosy Mitata
10	Advisor	RADAFINELY Eugene	Andavadoake
11	Advisor	MAHATOKINAVY Jules Freddy	Ambalorao
12	Advisor	OSWAED Norbert	Ampasilava

Table 4: List of members of the Fanevandriake Committee

	POSITION	NAME	VILLAGE
01	President	ZAFIANANY Julien	Belavenoke
02	Vice President	NDIRO Arisony	Bevato
03	Secretary	ZAFIMASO Rosina (TARA)	Belavenoke
04	Adjunct Secretary	ANDRIANANDRASANA Alain José	Belavenoke
05	Treasurer	LALA Juliette	Antsatsamandika
06	Adjunct Treasurer	MISOSA Ingazy	Bevato
07	First Auditor	BOSCO Jean	Ambolimoky
08	Second Auditor	MAMPITOHY Tokila	Antsatsamandika
09	Advisor	OEZIME Marcel	Bevato
10	Advisor	MERDINASY Elson	Belavenoka
11	Advisor	ROLLAND Marcelin	Ambolimoke
12	Advisor	ODILON	Antsatsamandika

Annex III: List of members in the central committee of KFMIBIMA Fanevasoa.

Table 5: List of members in the central committee of KFMIBIMA Fanevasoa.

	POSITION	NAME	VILLAGE
01	President	DANTESSE Takantera	Andavadoake
02	Vice President 1	NAIE Fanomeza	Vatoavo
03	Vice President 2	ZAFIANANY Julien	Belavenoke
04	Vice President 3	RASOLONDRIANY Veve Edmond	Antsepoke
05	Secretary	VOLAHY Clovis dit Marcelin	Andavadoake
06	Adjunct Secretary	BRUNO Bensemin	Agnolignoly
07	Treasurer	RENE Kata	Agnolignoly
08	Adjunct Treasurer	RAIVOSOA Bino	Ambalorao
09	First Auditor	ZAROSY Roger	Ampasilava
10	Second Auditor	TOMBOKARADY Germain	Befandefa
11	Advisor	TOVONDRAINY	Lamboara
12	Advisor	RADAFINELY Eugene	Andavadoake
13	Advisor	MERIDINASY Elson	Belavenoke
14	Advisor	MILIMO Roxe	Ambatomilo

Annex IV: Data sheet for collection of information on hunting, by-catch, and strandings.

Table 6: Data sheet collection of events of hunting, by-catch, and stranding.

Date	Marine mammal species	Number	Location	Reason (hunting, by-catch, stranding)	Decision taken by the association

Name of the data collector: