A rapid assessment of the impacts of the Montara oil leak on birds, cetaceans and marine reptiles

James E.M. Watson, Liana N. Joseph and Alexander W.T. Watson

A report commissioned by the Department of the Environment, Water, Heritage and the Arts (DEWHA). Final version completed October 23rd 2009.

Recommended citation: Watson, J.E.M., Joseph, L.N. and Watson, A.W.T. 2009. *A rapid assessment of the impacts of the Montara field oil leak on birds, cetaceans and marine reptiles.* Prepared on behalf of the Department of the Environment, Water, Heritage and the Arts by the Spatial Ecology Laboratory, University of Queensland, Brisbane.

EXECUTIVE SUMMARY

- On 24th September 2009, Dr James Watson of the University of Queensland was commissioned by the Department of the Environment, Water, Heritage and the Arts (DEWHA) to lead a rapid survey of the 'megafauna' (defined as cetaceans, birds and marine reptiles, i.e. turtles and sea snakes) in the Montara oil spill region. He solicited the help of Dr Liana Joseph (University of Queensland) and Dr Alexander Watson to conduct these tasks.
- The rapid survey, conducted on board the boat *Sea Sprint*, departed Darwin in the evening of Friday 25th September and returned the morning of Sunday 4th October.
- Five days of transects (incorporating 279 10-minute strip transects) were conducted at sea, covering a distance of 668.5 nautical miles (1,238 km) and a total survey area of 99,040 ha. In these surveys, a total of 124 (44%) 10-minute strip transects were in waters that were visibly affected by oil.
- The surveys at sea revealed a high level of diversity and abundance of birds (number of individuals (NI) = 2801, number of species (NS) =23), cetaceans (NI= 462, NS= 4), turtles (NI=25, NS=2) and sea snakes (NI=62, NS=4), in the region of the Montara oil spill.
- A further three days of land-based surveys were conducted on the three permanent islands (East, Middle and West Islands) of Ashmore Reef. The surveys on land found 35 bird species of which 10 species were in a stage of breeding.
- The presence of one dying Common Noddy (*Anous stolidus*) and one dead Horned Sea Snake (*Acalyptophis peronii*) floating in oil affected waters indicates that some species are negatively affected by the oil spill. The Noddy died within 12 hours of its capture. A further 17 adult dead birds found on the islands of Ashmore Reef appeared to have died of unknown causes, with at least four having large amounts of oil residue on parts of their body. These birds are undergoing toxicological testing to establish cause of death.
- During the surveys at sea, five seabird species were found only in transects where oil was not observed. These species may be avoiding the oil slick region when feeding. However, a number of bird, cetacean and sea snake species were found in higher numbers in oil affected waters than in non oil affected waters. Our observations

suggest that response to the oil slick is species-specific and the presence of oil in the water is affecting some species' behaviour.

- We believe that the only way to ascertain the true impacts of the Montara oil spill on the region's biodiversity is to conduct a systematic, long-term monitoring effort. This effort should include long term monitoring on all seabird and turtle breeding islands in the region as well as permanent transects along the reef itself to ascertain the impacts of the oil slick on fish and sea snake populations. Further long term monitoring at sea is also needed to ascertain if the oil spill has affected species behavior and population dynamics for both species breeding in the region and migratory species visiting the region. Toxicological studies of all 'megafauna' species (birds, mammals and reptiles) as well as fish are recommended to assess if toxic chemicals are present in the tissue of the animals.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

BACKGROUND

On Friday 21st August 2009, during activity being undertaken by the West Atlas drilling rig, an oil release was observed from the Montara Well. The source of the oil leak is approximately 57 nautical miles from Cartier Island Marine Reserve and 80 nautical miles from Ashmore Reef National Nature Reserve (a declared RAMSAR Wetland of International Significance). Other sensitive habitats in the region include the Hibernia Reef and the Jabiru Shoals. Oil seeping from the Montara Well is a light crude oil with an 11% wax content.

On 24th September 2009, Dr James Watson of the University of Queensland, was commissioned by the Department of the Environment, Water, Heritage and the Arts (DEWHA) to lead a rapid survey of the 'megafauna' (defined as cetaceans, birds and marine reptiles, i.e. turtles and sea snakes) in the Montara oil spill region. Two colleagues (Dr Liana Joseph, also from University of Queensland and Dr Alexander Watson) volunteered to assist with these surveys. The survey started on 25th September 2009 and ended on 4th October, on board *Sea sprint*.

Specifically, the research team was asked by DEHWA to address the following questions:

1. What species are currently in the region of the Montara oil spill?
2. What behavior are species in the region of the Montara oil spill exhibiting?
3. What identifiable physical impacts, if any, has the Montara oil spill had on species in the region?
4. What identifiable behavioral impacts, if any, has the Montara oil spill had on species in the region?

METHODOLOGY

Survey design

Two different types of surveys were conducted in the period: (i) five days of surveys at sea between the Montara Oil Well and Ashmore Reef (which included two days of heading to and from Ashmore Reef from Darwin) and (ii) three days of land-based surveys of the three permanent islands (that is, islands that are exposed at high tide) at Ashmore Reef.

The survey design was influenced by a number of logistic and temporal issues. The captain of *Sea Sprint* was tasked to transfer a WA Department of Environment and Conservation Wildlife Response Officer to the customs vessel (located at Ashmore Reef) on Sunday 27/09/2009, and return to pick him up on Friday 2/10/2009. As such, the *Sea Sprint* had to be at these locations on these dates. The WA DEC officer needed the *Sea Sprint* to remain in the area so that he could use the zodiac from *Sea Sprint* to assess the effects of the oil spill on nesting seabirds in the region. Therefore more time was spent at Ashmore Reef than was initially planned.

Survey design at sea

Surveys at sea were conducted on five days (26/9/2009, 29/9/2009, 30/9/2009, 1/10/2009, 3/10/2009), using a strip transect methodology. Strip transects were chosen as they are the most commonly used and most trusted rapid survey methodology for surveying for birds, cetaceans and turtles at sea (Hyrenbach *et al*., 2007). When using strip transects, observers aim to detect every species within the survey strip, and estimate relative abundance by dividing the number of individuals sighted by the area of ocean surface surveyed. Ultimately, the width of the survey strip represents a compromise between the desire to cover as much surface area as possible and the ability to detect every individual within the area surveyed (Becker *et al.* 1997). Ten minute periods with a width of 400 m each side was deemed a good compromise for the strip transects, considering the weather conditions we had, the speed of the boat and the density of the birds we expected to find in the tropical waters off north-western Western Australia (Hyrenbach *et al*., 2007).

Two full days of the strip transects were conducted while going to and from Ashmore Reef from Darwin Port (the first day and last of the survey period; see Figure 1). For the three

other days, day-long transects were conducted along a grid. These transects were conducted between Ashmore Reef and the Montara Oil Well (Figure 1). As the exact location of the oil spill was unknown, we conducted straight line transects running west to east, for approximately 20 miles before heading north for 5-10 miles and then returning for twenty miles in a east to west direction. We followed this systematic pattern for three days. Our assumption was that the oil slick was randomly distributed to the north of the Montara Well because of the prevailing wind conditions and use of dispersants. Before disembarking from Darwin we were told that the oil resulting from the spill ranged from long lines of thick yellow, waxy oil (up to 5m wide) to a thin film covering large areas. We felt this survey design gave us the best opportunity to compare areas affected by oil with areas that were not.

In our surveys, the 10-minute strip transects were continuous and operated all day (from approximately first light at 0630 to last light, 1800 hrs local time). Approximately 47 hours of strip-transects, comprising 279 10-minute 'strips', were conducted on the five days of surveys, covering a distance of 668.5 nautical miles (1238 km). A total of 99,040 ha of sea were surveyed given the 800 m width of each strip survey.

All seabirds, cetaceans and reptiles sighted within 400 m of either side of the vessel from 90° from the bow on both sides of the ship were identified to the lowest taxonomic level possible, with the horizontal distance estimated by eye. Behaviour (e.g., sitting, flying [for birds only], feeding) of each individual was recorded for each sighting. Animals that followed the vessel were recorded when they were first encountered, and ignored thereafter.

Surveys were always conducted with paired observers (as recommended by Spear et al. 2004), with each scanning one side of the transect line from directly ahead to 90° abeam. The search pattern included equal effort through the 90° arc and out to 400 m from the transect line (Figure 2). All three observers were experienced seabird and cetacean observers and had some experience surveying turtles at sea. It must be noted that none of the three researchers had sea snake experience and there is no sea snake guide for the Australia. We used Wilson & Swan (2003) to make preliminary identifications and then requested a sea snake expert to identify sea snakes from photographs once we returned to land). All surveyors used high quality optical equipment (Lieca and Saworski binoculars) to

identify species. Cetaceans and reptiles were recorded on a large-zoom telephoto camera (400mm) to help confirm identification.

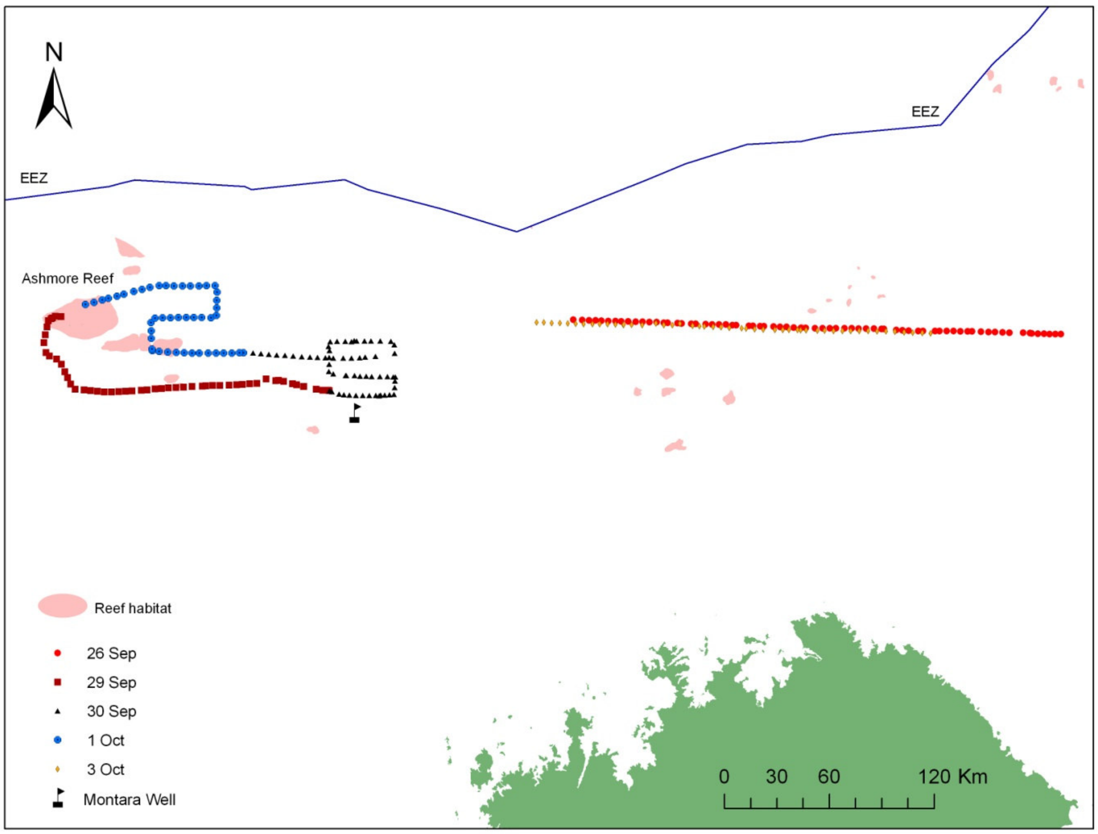

Figure 1: Locations of the five day-long transects conducted at sea between Ashmore Reef and Darwin, in the vicinity of the Montara Oil Well.

During each survey we collected environmental data on viewing conditions, and we had planned to restrict surveys to periods of low swell (<1.5 m) and low winds (Beaufort sea state ≤3), following Becker *et al*. (1997). The weather for the first three surveys was exceptional for surveying – clear blue skies, little wind, and seas > 0.5m in height. The weather for Thursday 1st was windy and seas were between 0.5-1m, with some gusts of rain in the afternoon. The weather for Saturday was clear blue skies, but 10-12 knots winds and seas to 1-1.5m. Despite the worsening conditions while we were at sea, observations were suitable for birds all five days and for cetaceans and reptiles for the first four days.

Afternoon and morning glare had some impact on data collection, especially in areas with high concentrations of oil.

Figure 2: Dr James Watson and Dr Alexander Watson conducting strip-transects for sea birds, cetaceans, turtles and sea snakes aboard the *Sea Sprint*. Note the slick of oil in the distance.

Data collection was straight forward: after each 10-minute period we logged any species of bird, mammal or reptile we had seen, our location and the percentage of oil encountered in the previous 10 minutes. After every hour we collected speed and depth from the ships computers. Data was entered every evening on a laptop computer.

Surveys of the three islands at Ashmore Reef

Three days were spent surveying the islands at Ashmore Reef on 27/09/2009, 28/09/2009 and 2/10/2009. West Island was surveyed on the first day (27/09/2009), East and West Islands the second day (28/09/2009), and Middle and West Islands on the third day (2/10/2009) of surveys. Middle and East islands were especially difficult to visit as approach

to both of these islands are tide dependent (i.e. it is only possible to visit these islands at high tide).

Surveying both Middle and East Islands consisted of separating the four members of the survey team into two groups who then circumnavigated each island in opposite directions (Figure 3). There was a minimal survey effort in the middle of these islands due to the large number of breeding birds and the sensitivity of young fledglings to human disturbance. All of West Island was surveyed as there are very few nesting seabirds on this island.

Figure 3: Dr Alexander Watson conducting bird surveys on Middle Island, Ashmore Reef.

<u>Analysis</u>

As discussed above, we divided the tracks into discrete survey bins, defined as uninterrupted ten-minute observation periods. We were then able to compare the presence, behaviour and abundance of birds, cetaceans and reptiles in areas that were affected by oil to those that were not. We also graphed the location of species identified in each of these 10-minute surveys.

RESULTS

Oil was found in 124 (44.4%) of the transect during our sea surveys. In 155 (55.5%) of the transect, no oil was observed. The oil was more prominent in transects directly north of the Montara Oil Well (Figure 4). Twenty (7.1%) transects had oil covering 100% of the transect area, while the average amount of area affected by oil in the 10-minute strip transects was 12% (see Figure 5 for a breakdown of proportion of oil per 10-minute transect and Figure 6 & Figure 7 for example images).

There was little variation in depth of the ocean floor among survey transects with 86% of transects being <300m in depth.

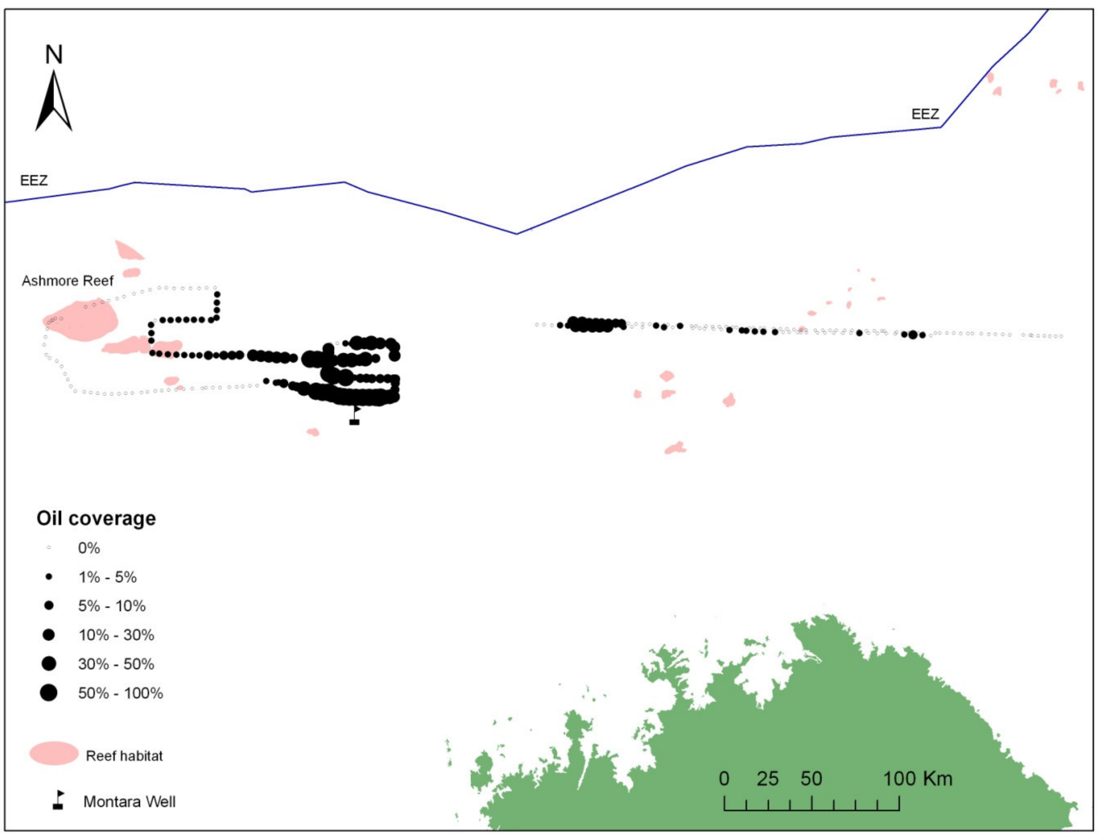

Figure 4: The proportion of oil located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The percentage refers to the amount of oil observed in each 10- minute transect.

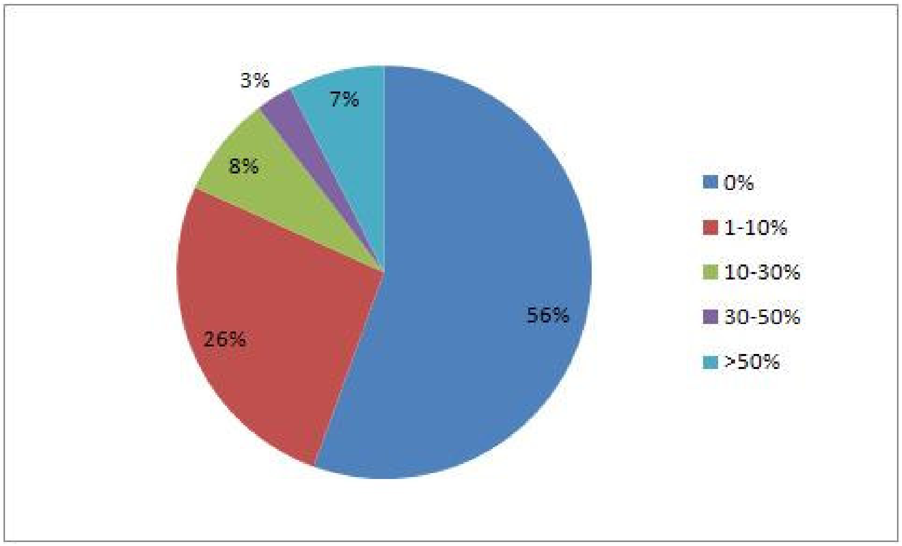

Figure 5: Proportion of transects that contain 0%, 1-10%, 10-30%, 30-50% and >50% surface-coverage of oil.

Figure 6: An example of a thin layer of oil on the surface on the water.

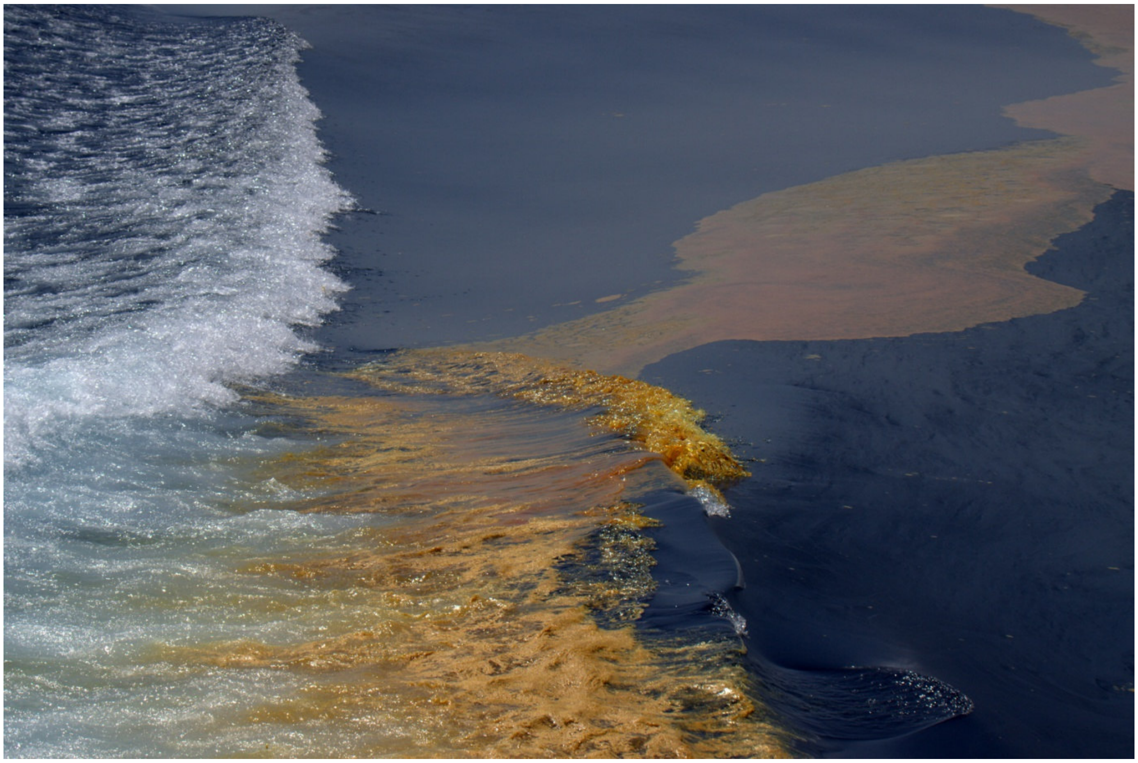

Figure 7: An example of thick layer of oil on the surface on the water.

What species are currently in the region of the Montara oil spill?

Birds

A total of 2801 individuals making up 23 species were observed in the strip transects conducted out to sea (Table 1; Figure 8). Twenty of these species were true seabirds. Three species (Rainbow Bee-eater *Merops ornatus*, Barn Swallow *Hirundo rustica*, Lesser Sand Plover *Charadrius mongolus*) that are land/shore birds were migrating when encountered along the transects.

The most common seabirds encountered were Common Noddy (*Anous stolidus*, Figure 9), Brown Booby *Sula leucogaster*, Bridled Tern *Onychoprion anaethetus* and Sooty Tern *Onychoprion fuscata* (Figure 10; note that many of the Bridled and Sooty terns could not be differentiated at sea, so many were placed in the class 'Bridled/sooty'). The Common Noddy was by far the most abundant species recorded, with 2178 individuals making up 77% of all bird observations.

A number of pelagic migratory species were also recorded frequently on the transects, including Wedge-tailed Shearwater *Ardenna pacifica*, Streaked Shearwater *Calonectris leucomelas*, Tahiti Petrel *Pseudobulweria rostrata*, Bulwer's Petrel *Bulweria bulwerii* and Matsudaira's Storm-Petrel *Hydrobates matsudairae*. Wedge-tailed Shearwaters are known to breed in small numbers at Ashmore Reef but the other *procellariformes* (the 'tube-noses') are summer visitors to these waters. Two species of *procellariformes* that are rarely recorded in Australian waters were also recorded in very small numbers (Jouanin's Petrel *Bulweria fallax* and Swinhoe's Storm-Petrel *Hydrobates monorhis*).

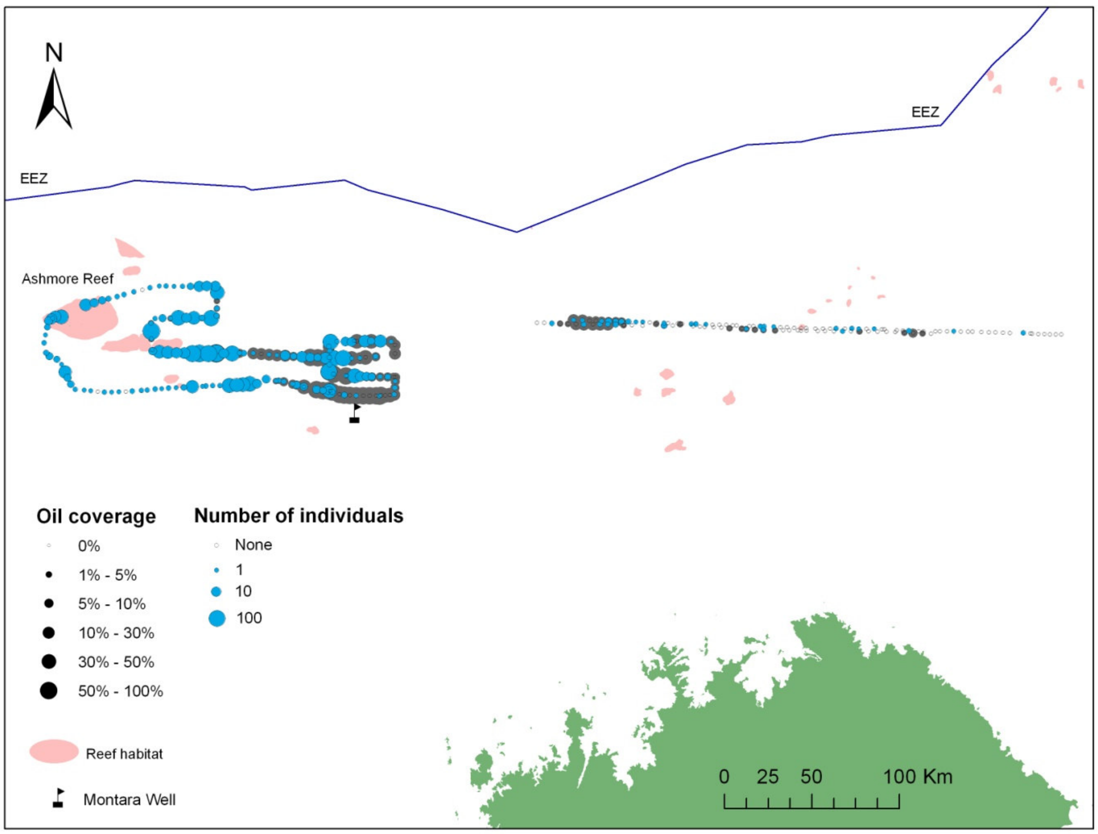

Figure 8: The number of birds located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The size of the circle is proportional to the number of birds encountered in each 10-minute transect while the oil coverage refers to the amount of oil coverage refers to the amount of oil observed in each 10-minute transect (see Figure 4 & Figure 5).

Our surveys showed that bird species were widely distributed throughout the region, with some hotspots of densities (Figure 8). These hotspots occurred close to reef and frequently, as discussed below, in areas where there was large amounts of oil on the surface of the water.

Table 1:Number of birds observed in 279 10-minute strip-transects conducted between 26/9/2009 - 3/10/2009.

Common Name	Scientific Name	Total number observed at sea	Total number (percentage) of transects species observed in	Total number (percentage) of oil affected transects species observed in	Total number (percentage) of non-oil affected transects species observed in
PROCELLARIFORMES					
Hydrobatidae					
Swinhoe's Storm-Petrel	*Hydrobates monorhis*	5	2 (1%)	0 (0%)	2 (1%)
Matsudaira's Storm-Petrel	*Hydrobates matsudairae*	16	8 (3%)	3 (2%)	5 (3%)
Oceanitidae					
Wilson's Storm-Petrel	*Oceanites oceanicus*	7	2 (1%)	0 (0%)	2 (1%)
Procellariidae					
Bulwer's Petrel	*Bulweria bulwerii*	35	28 (10%)	11 (9%)	17 (11%)
Jouanin's Petrel	*Bulweria fallax*	3	3 (1%)	1 (1%)	2 (1%)
Wedge-tailed Shearwater	*Ardenna pacifica*	15	14 (5%)	10 (8%)	4 (3%)
Streaked Shearwater	*Calonectris leucomelas*	15	8 (3%)	7 (6%)	1 (1%)
Tahiti Petrel	*Pseudobulweria rostrata*	2	2 (1%)	1 (1%)	1 (1%)
PHALACROCORACIFORMES					
Fregatidae					
Lesser Frigatebird	*Fregata ariel*	8	5 (2%)	4 (3%)	1 (1%)
Sulidae					
Masked Booby	*Sula dactylatra*	4	3 (1%)	0 (0%)	3 (2%)
Red-footed Booby	*Sula sula*	1	1 (0%)	0 (0%)	1 (1%)
Brown Booby	*Sula leucogaster*	183	53 (19%)	19 (15%)	34 (22%)
CHARADRIIFORMES					
Charadriidae					
Lesser Sand Plover	*Charadrius mongolus*	1	1 (0%)	0 (0%)	1 (1%)
Stercorariidae					
Pomarine Jaeger	*Stercorarius pomarinus*	1	1 (0%)	1 (1%)	0 (0%)
Laridae					
Common Noddy	*Anous stolidus*	2178	92 (33%)	64 (52%)	28 (18%)
Bridled Tern	*Onychoprion anaethetus*	14	8 (3%)	2 (2%)	6 (4%)
Sooty Tern	*Onychoprion fuscata*	6	5 (2%)	1 (1%)	4 (3%)
Bridled/sooty Tern	*Onychoprion spp.*	72	44 (16%)	23 (19%)	21 (14%)
Gull-billed Tern	*Gelochelidon nilotica*	1	1 (0%)	0 (0%)	1 (1%)
Caspian Tern	*Hydroprogne caspia*	1	1 (0%)	1 (1%)	0 (0%)
Lesser Crested Tern	*Thalasseus bengalensis*	2	2 (1%)	1 (1%)	1 (1%)
Crested Tern	*Thalasseus bergii*	7	7 (3%)	2 (2%)	5 (3%)
CORACIIFORMES					
Meropidae					
Rainbow Bee-eater	*Merops ornatus*	223	6 (2%)	2 (2%)	4 (3%)
PASSERIFORMES					
Hirundinidae					
Barn Swallow	*Hirundo rustica*	1	1 (0%)	1 (1%)	0 (0%)

A total of 35 species were found on the East, Middle and West Islands during the land-based surveys (see Table 2). Of these, 13 species were seabird and ten of these species were breeding. Many species were at the end of their breeding season (Common Noddy, Sooty Tern, Brown Booby, Masked Booby *Sula dactylatra*, Lesser Frigatebird *Fregata ariel* and Red-tailed Tropicbird *Phaethon rubricauda,* Figure 11) as the young were large and acquiring sub-adult plumage. The Red-footed Booby *Sula sula* (Figure 12) was still sitting on eggs on the nest, and White-tailed Tropicbirds *Phaethon lepturus* and Crested Terns *Thalasseus bergii* were displaying courtship behavior. Empty nest burrows were found in the middle of West Island; we were unsure of the species but they are possibly the burrows of Wedge-tailed Shearwaters.

Table 2: List of species found on the three permanent islands of Ashmore: West, Middle and East Islands.

		West Island		Middle Island		East island	
Common Name	**Scientific Name**	**estimated population**	**breeding?**	**estimated population**	**breeding?**	**estimated population**	**breeding?**
PHAETHONTIFORMES							
Phaethontidae							
Red-tailed Tropicbird	*Phaethon rubricauda*	1-10	yes, juveniles seen				
White-tailed Tropicbird	*Phaethon lepturus*	1-10	?, courtship display only	1-10	?, courtship display only		
APODIFORMES							
Apodidae							
Fork-tailed Swift	*Apus pacificus*	1-10					
Procellariidae							
Wedge-tailed Shearwater	*Ardenna pacifica*	?, empty nest burrows	?	?	?	?	?
PHALACROCORACIFORMES							
Fregatidae							
Lesser Frigatebird	*Fregata ariel*			100-1000	yes, juveniles seen	10-100	yes, juveniles seen
Great Frigatebird	*Fregata minor*			1-10	?		
Sulidae							
Masked Booby	*Sula dactylatra*			10-100	yes, juveniles seen	10-100	yes, juveniles seen
Red-footed Booby	*Sula sula*			10-100	yes, adults on nest	10-100	yes, adults on nest
Brown Booby	*Sula leucogaster*			>1000	yes, juveniles seen	>1000	yes, juveniles seen
CICONIIFORMES							
Ardeidae							
Eastern Reef Egret	*Egretta sacra*	100-1000	yes, juveniles seen	10-100	?	10-100	?
Nankeen Night heron	*Nycticorax caledonicus*	10-100	yes, juveniles seen				
GRUIFORMES							
Rallidae							
Buff-banded Rail	*Gallirallus philippensis*	10-100	?	10-100	?	10-100	?
CHARADRIIFORMES							
Charadriidae							
Lesser Sand Plover	*Charadrius mongolus*	10-100		2			
Greater Sand Plover	*Charadrius leschenaultii*	1-10					
Scolopacidae							
Red-necked Stint	*Calidris rufocollis*	1-10					
Common Sandpiper	*Actitis hypoleucos*	1-10					
Whimbrel	*Numenius phaeopus*	10-100					
Eastern Curlew	*Numenius madagascariensis*	10-100					
Grey-tailed Tattler	*Tringa brevipes*	10-100					
Ruddy Turnstone	*Arenaria interpres*	10-100		10-100		10-100	
Laridae							
Common Noddy	*Anous stolidus*	1-10	yes, juveniles seen	>1000	yes, juveniles seen	>1000	yes, juveniles seen
Sooty Tern	*Onychoprion fuscata*			10-100	yes, juveniles seen	10-100	yes, juveniles seen
Caspian Tern	*Hydroprogne caspia*	1					
Lesser Crested Tern	*Thalasseus bengalensis*	10		10-100	?, courtship display only		
Crested Tern	*Thalasseus bergii*						
Little Tern	*Sterna albeifrons*	4					
CUCULIFORMES							
Cuculidae							
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	2					
CORACIIFORMES							
Halcyonidae							
Sacred Kingfisher	*Todiramphus sanctus*	1-10					
Collared Kingfisher	*Todiramphus chloris*	1-10					
Meropidae							
Rainbow Bee-eater	*Merops ornatus*	10-100					
PASSERIFORMES							
Campephagidae							
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	3					
Monarchidae							
Magpie-lark	*Grallina cyanoleuca*	3					
Acrocephalidae							
Oriental Reed-Warbler	*Acrocephalus orientalis*	2					
Hirundinidae							
Barn Swallow	*Hirundo rustica*	2					

A summary of the number of each species on West, Middle and East islands can be found in Table 2. It was both beyond the scope and time of this study to accurately estimate the numbers of seabirds on the islands. Therefore, we grouped our estimates in order of magnitudes.

Surprisingly, a number of seabird species that nest (or were present) in large numbers on the one or more of the three islands at Ashmore Reef were not, or were rarely, recorded in the sea strip transects. These include both species of Tropicbird (none were recorded at sea) and Lesser Frigatebird and Little Terns *Sterna albeifrons*. We also encountered quite low numbers of Red-footed and Masked Booby relative to the numbers breeding on Ashmore Reef. There are a number of possible reasons for this. First, some of the species that are currently undertaking breeding may be highly restricted in terms of the area they cover, and as such it was unlikely they flew to the regions that we conducted our strip transects. There is some evidence to support this for Red-footed Booby and the Lesser Frigate bird (Jacquemet *et al*. 2005) as they do not travel far from the nest, unlike Sooty Tern (Jacquemet *et al*. 2008). Another possible reason is these species feed in the deeper waters located to the west of Ashmore Reef (which we did not survey). A final reason could be these species are deliberately avoiding the oil spill region, or those individuals that feed in the affected region have perished. However, due to the rapid nature of these surveys the reason(s) for these phenomena could not be ascertained.

Figure 9: A Common Noddy (*Anous stolidus*) on East Island, Ashmore.

Figure 10: A Juvenile Sooty Tern (*Onychoprion fuscata)* on Middle Island, Ashmore.

Figure 11: Red-tailed Tropicbird (*Phaethon rubricauda)* on West Island, Ashmore.

Figure 12: Red-footed Booby (*Sula sula*) on nest on Middle Island, Ashmore.

Cetaceans (whales, dolphins)

Cetaceans were seen on four of the five days surveying at sea, with none found on the last day (as discussed in the methodology, conditions for observing cetaceans and marine reptiles deteriorated on the last day making it unlikely that this was a true reflection of absence from the survey area). A total of approximately 462 individual cetaceans were observed in 33 (6%) 10-minute strip transects (Figure 13; Table 3). Four different species were positively identified: False Killer Whale *Pseudorca crassidens* (Figure 14), Common Bottlenose Dolphin *Tursiops truncates*, Pantropical Spotted Dolphin *Stenella attenuate* (Figure 15) and Long-snouted Spinner Dolphin *Stenella longirostris*. Twenty-four (5%) individuals could not be identified as they surfaced and then disappeared too quickly.

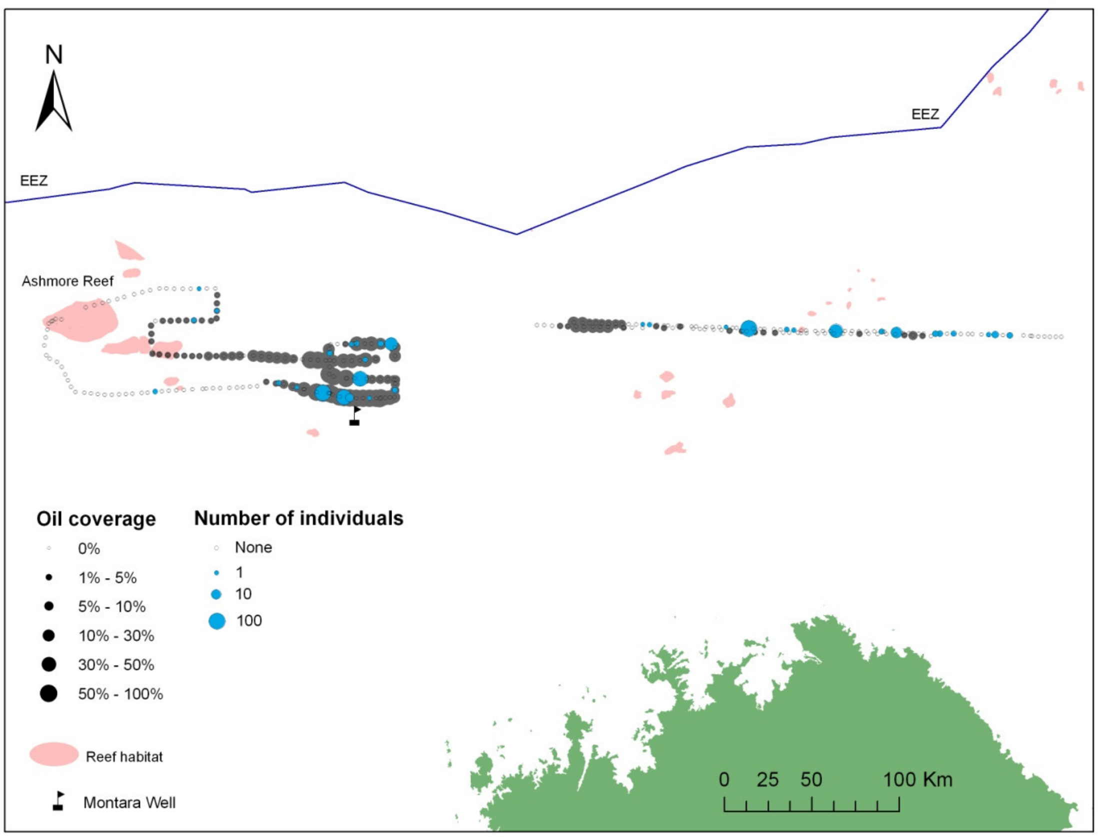

Figure 13: The number of cetaceans located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The size of the circle is proportional to the number of cetaceans encountered in each 10-minute transect while the oil coverage refers to the amount of oil observed in each 10-minute transect (see Figure 4 & Figure 5).

Table 3: The number of cetaceans observed in 10-mintue strip-transects.

Common Name	Scientific Name	Total number observed at sea	Total number (percentage) of transects species observed in	Total number (percentage) of oil affected transects species observed in	Total number (percentage) of non-oil affected transects species observed in
CETACEA					
Delphinidae					
False Killer Whale	*Pseudorca crassidens*	100	1 (0%)	1 (1%)	0 (0%)
Bottlenose Dolphin	*Tursiops truncatus*	158	17 (6%)	8 (6%)	9 (6%)
Pantropical Spotted Dolphin	*Stenella attenuata*	75	2 (1%)	2 (2%)	0 (0%)
Long-snouted Spinner Dolphin	*Stenella longirostris*	105	1 (0%)	0 (0%)	1 (1%)
Dolphin sp.		24	12 (4%)	5 (4%)	7 (5%)

Figure 14: False Killer Whales (*Pseudorca crassidens*) seen in transects near Montara Oil Well.

Figure 15: Pantropical Spotted Dolphin (*Stenella attenuata*) in transects near Montara Oil Well.

Reptiles

A total of 62 individual sea snakes in 38 (13.6%) of the strip transects during the sea survey (Figure 16, Table 4). Over two thirds of these individuals could not be accurately identified as they were either a long way away or disappeared before a photograph or a worthwhile observation could occur. We were able to confidently identify four species: Olive Sea Snake *Aipysurus laevis* (Figure 18), Horned Sea Snake *Acalyptophis peronii*, Spotted Sea Snake *Hydrophis (ornatus) ocellatus* (Figure 17), and Olive-headed Sea Snake *Disteira major*. The most commonly encountered species was the Spotted Sea Snake, encountered in 13 transects.

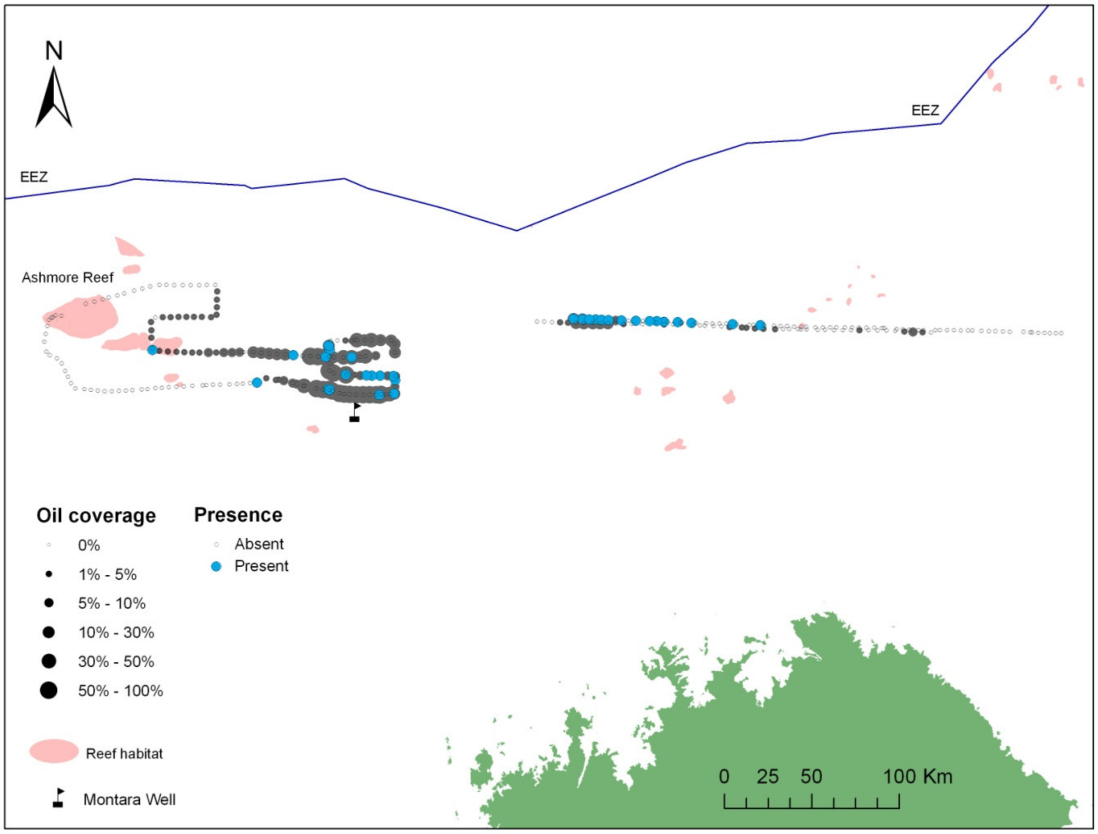

Figure 16: The number of sea snakes located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The size of the circle is proportional to the number of sea snakes encountered in each 10-minute transect while the oil coverage refers to the amount of oil observed in each 10-minute transect (see Figure 4 & Figure 5).

Table 4: The number of sea snakes observed in 10-mintue strip-transects.

Common Name	Scientific Name	Total number observed at sea	Total number (percentage) of transects species observed in	Total number (percentage) of oil affected transects species observed in	Total number (percentage) of non-oil affected transects species observed in
SQUAMATA					
Elapidae					
Olive sea snake	*Aipysurus laevis*	1	1 (0%)	0 (0%)	1 (1%)
Horned sea snake	*Acalyptophis peronii*	1	1 (0%)	1 (1%)	0 (0%)
Spotted sea snake	*Hydrophis (ornatus) ocellatus*	14	13 (5%)	10 (8%)	3 (2%)
Hydrophiidae					
Olive-headed sea snake	*Disteira major*	3	3 (1%)	1 (1%)	2 (1%)
unknown family					
unidentified species	-	43	20 (7%)	16 (13%)	4 (3%)

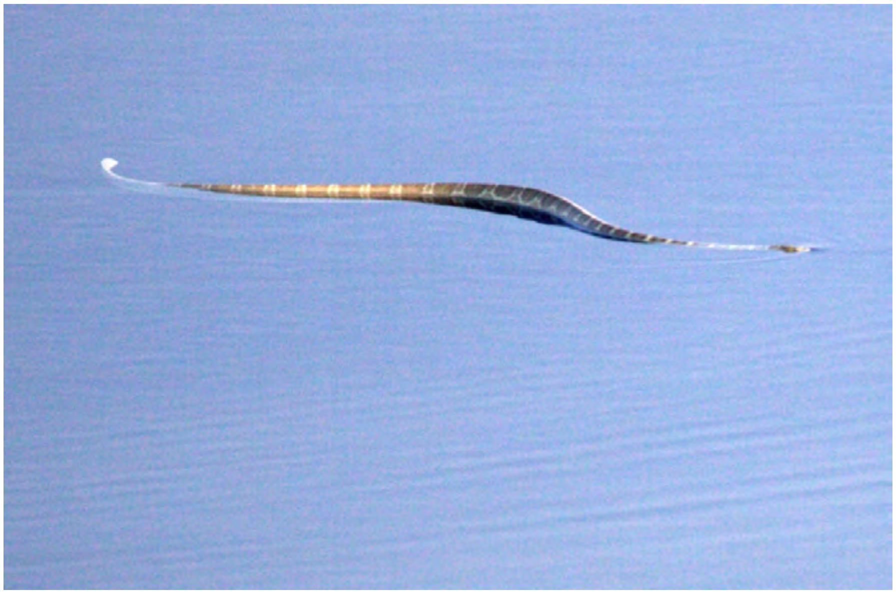

Figure 17: A Spotted sea snake (*Hydrophis (ornatus) ocellatus*) observed in transects near Montara Oil Well.

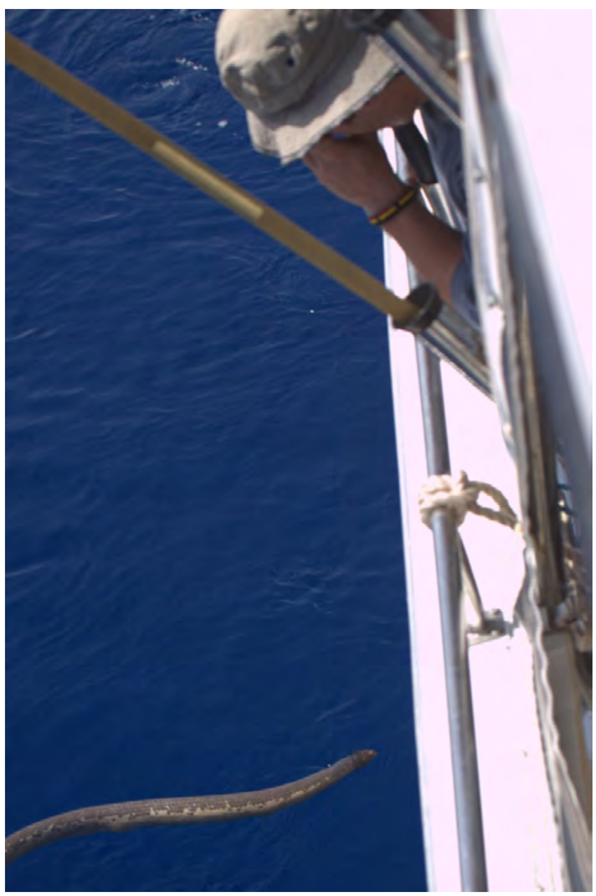

Figure 18: Dr Alexander Watson inspecting an Olive Sea snake (*Aipysurus laevis*) during surveys near the Montara Oil Well.

A total of 25 individual sea turtles were observed in 21 (8.9%) of the strip transects during the sea survey (Figure 19; Table 5). Over half (n=14, 56%) of these individuals could not be accurately identified as they were either a long way away or disappeared before a photograph or a worthwhile observation could occur. We were able to confidently identify Loggerhead Turtle *Caretta caretta* and Green Turtle *Chelonia mydas*.

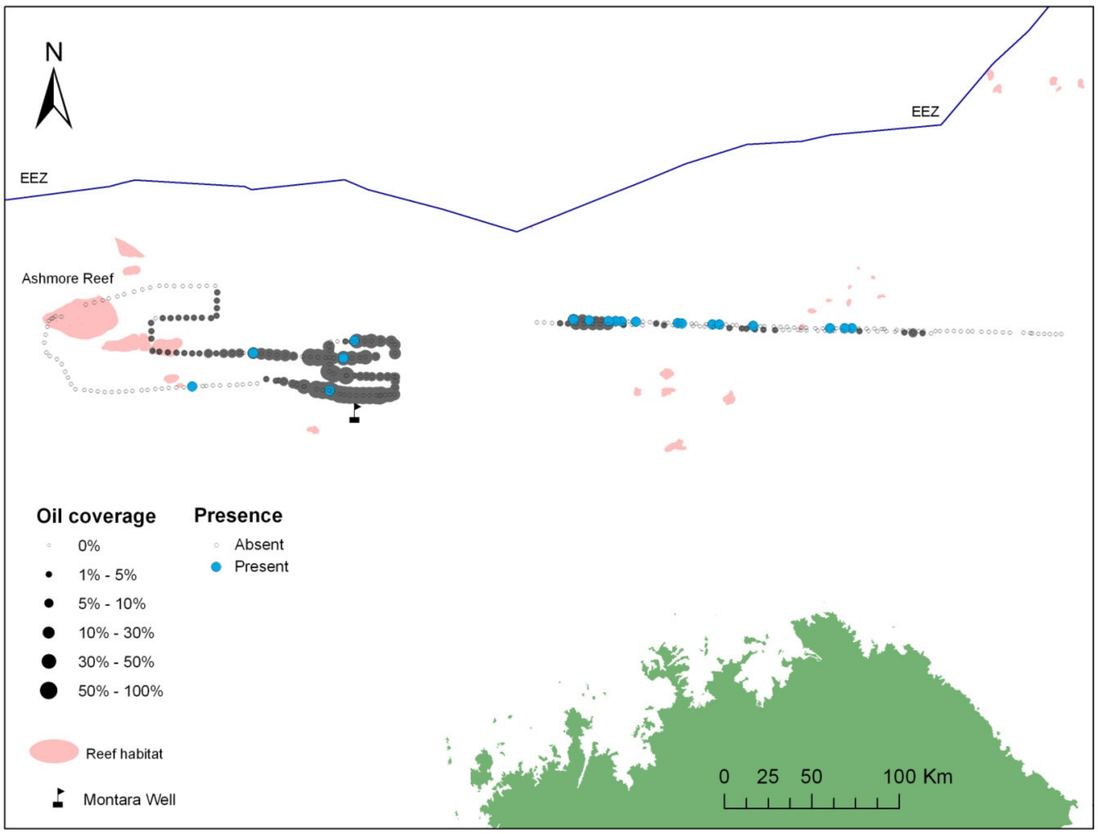

Figure 19: The number of sea turtles located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The size of the circle is proportional to the number of sea turtles encountered in each 10-minute transect while the oil coverage refers to the amount of oil observed in each 10-minute transect (see Figure 4 & Figure 5).

Table 5: The number of turtles observed in 10-mintue strip-transects.

	Common Name	Scientific Name	Total number observed at sea	Total number (percentage) of transects species observed in	Total number (percentage) of oil affected transects species observed in	Total number (percentage) of non-oil affected transects species observed in
TESTUDINES						
Cheloniidae						
	Loggerhead turtle	*Caretta caretta*	7	6 (2%)	4 (3%)	2 (1%)
	Green turtle	*Chelonia mydas*	4	4 (1%)	2 (2%)	2 (1%)
	unidentified species		14	11 (4%)	4 (3%)	7 (5%)

During our land-based surveys, we found Green Turtle tracks from the sea to the middle of the land on West Island and Hawksbill Turtle *Eretmochelys imbricata* tracks on both Middle and East Islands. We are unsure if they successfully laid eggs. We also saw numerous sea turtles in the lagoon, while going between islands and these were all identified as Green Turtles (Figure 20).

Figure 20: Green Turtle (*Chelonia mydas*) observed near West Island, Ashmore.

<u>What behavior are species in the region of the Montara oil spill exhibiting?</u>

Birds

At sea, there were more birds with increasing proximity to Ashmore reef (Figure 8). This is due to the close proximity to large numbers of nesting seabirds on the three islands. We found that once we were beyond 20-30 miles from Ashmore Reef the number of birds dropped to normal (low) levels common for tropical environments.

Importantly, the abundance of certain seabirds (e.g. Common Noddy, Wedge-tailed Shearwater, Streaked Shearwater, Lesser Frigatebird) was frequently high in oil affected waters (especially areas that had a lighter sheen of oil). A comparison of observations along the strip transects (between transects with oil compared to transects without oil) showed that the abundance of these bird species was higher in transects where oil was present (Table 1, Table 6; Figure 8). Figure 21 highlights this pattern for Common Noddy. We observed that this increase in bird activity corresponded with greater activity of larger fish (jumping and schooling) in the oil affected areas and we surmise that the presence of a light oil sheen may attract fish, which then attracts some species of bird. A commonly sighted phenomenon was large groups of Noddies flying around strips of oil and feeding in, and around, these patches of water (Figure 23).

Table 6: A comparison of the number of individuals found in transects with and without oil for seven of the most commonly encountered bird species. Note that all Sooty and Bridled Tern records were placed in one category 'Bridled/sooty Tern'.

	Total number (percentage) of birds in oil affected transects	Total number (percentage) of birds in non-oil affected transects
Bulwer's Petrel	13 (37%)	22 (63%)
Wedge-tailed Shearwater	10 (67%)	5 (33%)
Streaked Shearwater	13 (87%)	2 (13%)
Lesser Frigatebird	7 (88%)	1 (13%)
Brown Booby	55 (30%)	128 (70%)
Common Noddy	1931 (89%)	246 (11%)
Bridled/sooty Tern	41 (45%)	51 (55%)
Crested Tern	2 (29%)	5 (71%)

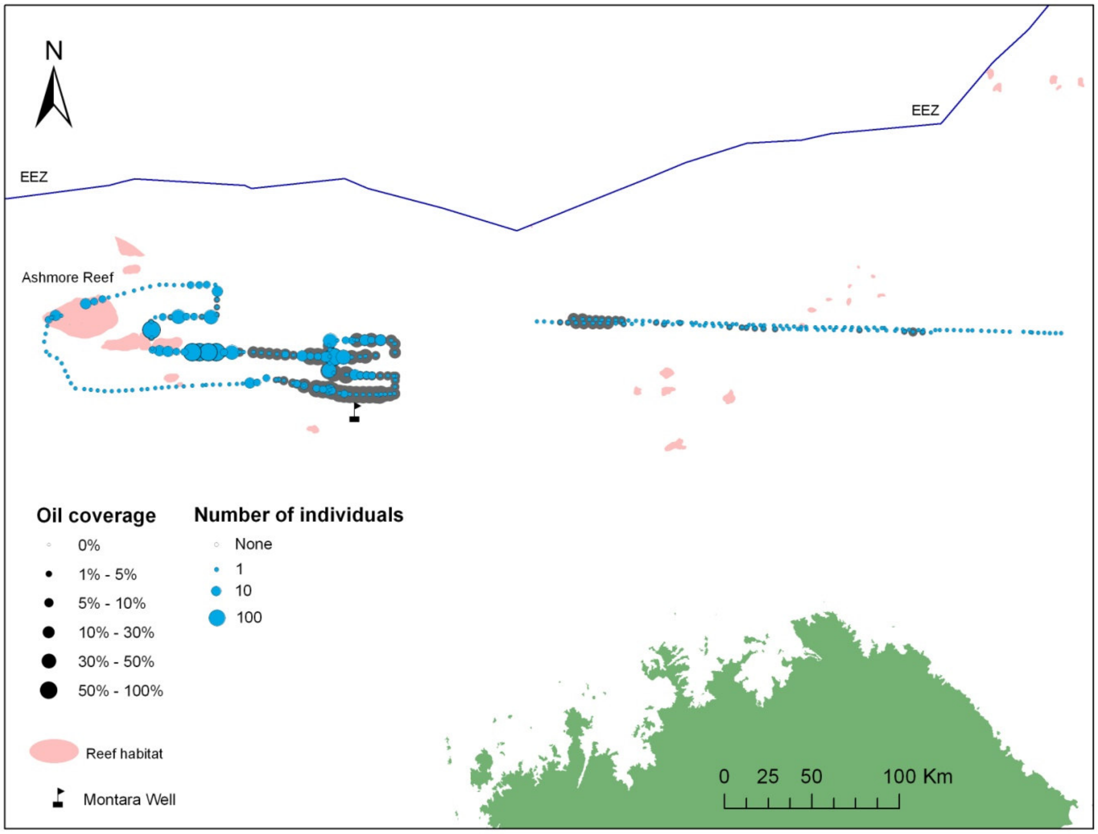

Figure 21: The number of Common Noddies (*Anous stolidus*) located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The size of the circle is proportional to the number of Common Noddies encountered in each 10-minute transect while the oil coverage refers to the amount of oil observed in each 10-minute transect (see Figure 4 & Figure 5).

Not all species responded in the same manner and there appeared to be species-specific responses to the oil. Five species were recorded at sea in non-oil affected areas and were not recorded in transects that contained oil records. Species including Brown Booby, Bulwer's Petrel and Crested Tern were recorded far less often in oil affected waters (Table 1, Table 6). Figure 22 highlights this pattern for the Brown Booby.

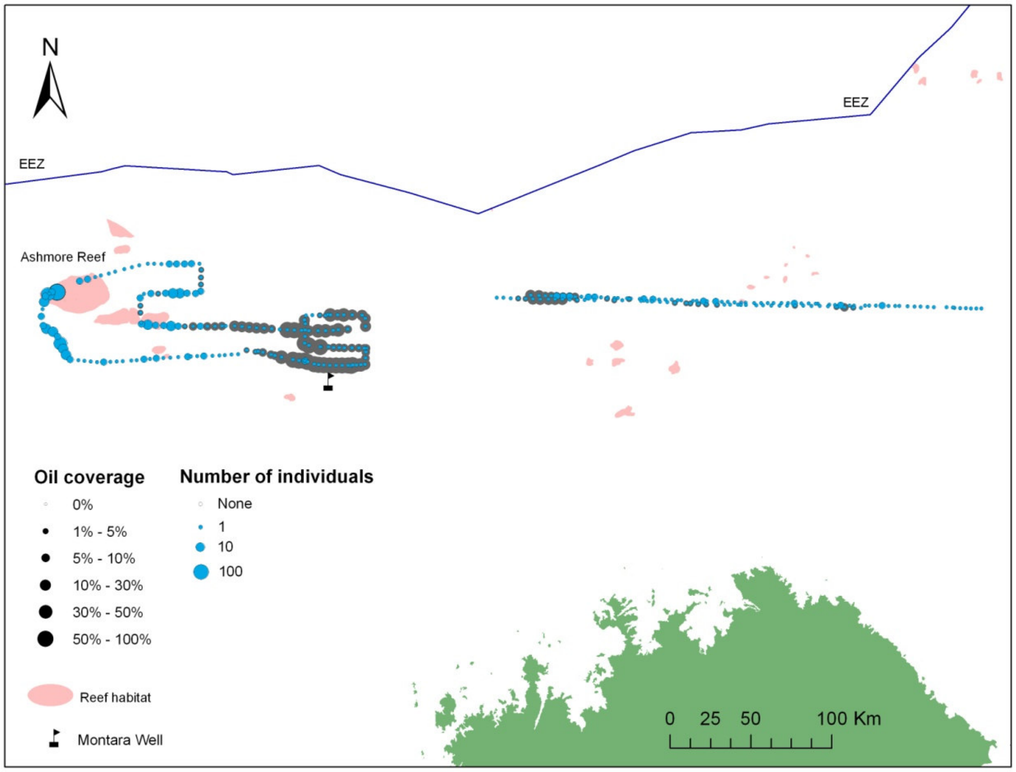

Figure 22: The number of Brown Boobies (*Sula leucogaster*) located in 279 10-minute strip transects conducted between 26/9/2009 - 3/10/2009. The size of the circle is proportional to the number of Brown Boobies encountered in each 10-minute transect while the oil coverage refers to the amount of oil observed in each 10-minute transect (see Figure 4 & Figure 5).

Figure 23: Fish jumping from water and Noddies fishing in oil affected water near the Montara Oil Well.

Cetaceans

We found cetaceans throughout the region, except in transects close to Ashmore Reef. As with the seabirds, we found that there were large numbers of sightings of cetaceans and of individual animals in areas that were affected by oil, especially near the Montara Oil Well. False Killer Whales and Spotted Pantropical Dolphins were found only in oil affected waters.

Reptiles

We found that sea snakes, like cetaceans, were not found close to Ashmore reef but were frequently encountered in the region of the Montara oil spill. This is unusual as some sea snakes are known to breed at Ashmore Reef at this time of year. Only one species (the Olive Sea Snake) was not recorded in oil affected waters, but it is very possible that they do utilise these waters as many of the unidentified sea snakes were found in oil affected waters. Importantly, when numbers were considered, they were found far more in areas that were affected by oil than areas that were not (Table 4).

Turtles were observed throughout the area, and both species that were identified were observed in oil affected areas. There also appeared to be seen more commonly in oil affected waters than non-oil affected waters, but this pattern was far less clear than with cetaceans and sea snakes (Table 5).

What identifiable physical impacts, if any, has the Montara oil spill had on species in the region?

It must be noted that it is hard to identify physical impacts of species in the region due to the limited time we had out there, and the fact we were not catching species and physically assessing their health. It is possible that species that are dying or dead and lying in oil affected water may not stay afloat for long periods of time, making it unlikely that we would find large numbers of dead animals.

This being said, during the sea surveys we found one very sick Common Noddy and one dead Horned Sea Snake in thick oil (Figure 24 & Figure 25). The Common Noddy was sitting in the oily water and there was oil covering its feathers. Upon capture we found it was malnourished and very cold. Despite following best-practice guidelines of wildlife care by

keeping it in a warm place, in the dark, the animal died within 12 hours of its capture. The sea snake was found dead floating in thick oil and was captured and frozen for testing.

Figure 24: Horned sea snake (*Acalyptophis peronii*) that was found dead in thick oil near the Montara Oil Well.

We also observed a number of other observations of lethargic sea snakes lying in thick oil (i.e. not moving much when approached, unable to dive) but chose not to capture them.

Our surveys of the three islands of Ashmore Reef found 17 dead adult birds, comprising two Brown Boobies, and 15 Common Noddies. While the presence of the dead birds is not uncommon on a large seabird breeding island, the fact these species were adults (and at least four had the look of being heavily contaminated with oil) means that we collected them so that toxicology analysis can be conducted to determine the cause of death, in accordance with the DEWHA Wildlife Response Plan.

Figure 25: Common Noddy (*Anous stolidus*) found in oil near the Montara Oil Well.

<u>What identifiable behavioral impacts, if any, has the Montara oil spill had on species in the region?</u>

As discussed in the previous section, species of all the four major taxa surveyed were found in oil affected areas. Behavioural responses appear to be species specific as five bird species were not found in oil affected areas, and a further three species that were found commonly in non affected waters were found at lower densities. These species may be actively avoiding the oil spill affected area but the nature of these rapid surveys meant that this finding could not be conclusively made without further long-term monitoring.

The results of our rapid surveys also show that that some bird, mammal, and sea snake species are found in large numbers in the oil affected areas, suggesting that these species may be attracted to the oil spill. This may be due to the presence of bait fish that are attracted to the oil, but this could not be ascertained for certain.

Discussion and some recommendations

These rapid surveys were able to reveal that many species from all four taxon groups surveyed (birds, cetaceans, sea snakes and turtles) were feeding, often in very large numbers, within the oil affected areas of the Montara Oil Well spill. Due to the nature of these rapid surveys, the lack of temporal and spatial data available about the oil slick when conducting these surveys, and the fact that the oil was translucent (and as such, hard to see on animals without handling them), it was impossible to ascertain how many individual species were adversely affected. However, the presence of dying birds and dead sea snakes suggest that there is an immediate risk to species utilizing the water that has been affected by the oil slick.

There is a significant risk that a change in conditions may push the slick towards breeding islands and reef communities that lie to the north, west and to the south of the rig. A change in conditions may also push the slick into deeper waters to the west and north of Ashmore Reef, which contains large numbers of endangered cetaceans and also a whole new suite of seabirds, turtle and sea snake communities.

It must be noted that the short duration of the sea survey and the time of the year definitely affected the number of species observed on the strip transects, especially migratory cetaceans and seabirds. A number of species (e.g. Hutton shearwaters *Puffinus huttoni*) were not found in our surveys but are expected to migrate to the region in the upcoming weeks. These species, and the number of other migratory species we did see, are likely to increase the overall density of birds in the region, over the coming months as their migration progresses. Moreover, as the breeding seasons ends on Ashmore Reef islands (and other islands in the region), more juvenile birds will be feeding throughout the region. As such, we believe that over the upcoming months the oil slick – if uncontained - may have an increasing impact on these species.

It also must be noted that very little is known about sea turtles and sea snake species in the region and that rapid surveys from ships at sea are probably not the best way of ascertaining their responses to the oil slick. This is because rapid surveys allows only brief, ‘chance’ observations of these reptiles (when they come to the surface to breath) and

therefore the chances of accurately ascertaining the impacts of the oil slick on these species is minimal. The northwestern shelf of Australia is an important biodiversity area of sea snakes as it contains more species of sea snakes than anywhere else on earth, so a special effort is needed to ascertain and mitigate the impacts of this oil slick on these species.

As a consequence of our findings, we recommend:

1. Monitoring needs to continue on all three islands of Ashmore Reef as they have breeding seabirds and turtles that appear to utilize the waters where the oil spill is currently. We believe that this should be extended to all islands in the region that contains breeding birds and turtles.
2. This monitoring procedure needs to not just focus on finding dead or dying oil birds but also focus on specific changes in populations of birds and turtles. Some oiled animals may not find their way back to the islands, and die at sea, and the numbers of these individuals can only be ascertained by thorough appropriate long term analyses of population size (and how they change post the oil slick). There is also a need to focus on breeding success of seabirds on these islands as the oil spill is likely to affect food supply to chicks over a longer time period. Monitoring of breeding success and population densities will need to be species specific and be repeatable, so that different teams on these Islands can conduct the same monitoring assessment over time. We believe that five years is a minimum time-frame for this type of monitoring as it will allow for a long term assessment of the impact of the oil spill, i.e. to ascertain if populations change post the oil spill and to see if they return to normal (pre-oil spill) numbers.
3. Further monitoring at sea is also needed to ascertain if the oil spill has affected species behavior and population dynamics for both species breeding in the region and migratory species visiting the region.
4. Monitoring the changes in how birds, cetaceans and reptiles are behaving in areas that have the oil slick needs to be done in a staged, systematic manner. We recommend that a boat-based line transect survey is conducted once a month for the first year and twice a year for, at least, the following four years (i.e. summer and winter) to assess the impact of the oil on marine mammals, seabirds and reptile

species. The first year monthly surveys will help ascertain an accurate baseline for species in the region and the surveys for the next four years will ascertain if there are long term changes to this baseline. We believe that four years is a minimum time period to assess long term changes in behavior and population numbers due to the oil slick. Using the same logic of the rapid survey, parallel transects should be positioned throughout, and 5km, beyond the region of the oil spill. However, we recommend the use of satellite imagery of the location of the slick, and the density of the slick, to guide the placing of these transects. Species identification, number of individuals and number of calves (for cetaceans) should be recorded for each species observed in the transects. For all species, information about breeding success (e.g. calving success for cetaceans or number of juvenile birds for seabirds) and population number can be compared with expectations of expects, previous studies in the region and studies of the species in other regions to determine if the oil spill is impacting these species.

5. To ensure that the most is made of the time out at sea, at least three observers need to be on the survey boat at any time allowing two observers working at any one time. As already mentioned, maps and grid references of the current location of the oil slick would enhance the success of these transect design, as will the use of an oil sampler on board the vessel.
6. We recommend that long-term monitoring of nesting turtles in the region be conducted during the breeding season to assess the numbers, clutch sizes and sex of hatchlings of nesting turtles. We believe that a five year period is a minimum for this type of monitoring to accurately ascertain the long term effects of the oil spill on breeding behavior and breeding success by these species.
7. The DEC people stationed at Ashmore Reef are experts at caring for sick animals and have been trained in identifying oil affected wildlife; however, they are unlikely to be experts at monitoring or identification of seabirds. As such, it is recommended that experts are also stationed with the DEC crew to assist in the monitoring efforts.
8. We recommend that long-term monitoring of sea snakes be conducted to assess the impact of oil on this important population. Information about population numbers and behaviour is required to determine if populations of sea snakes are responding to oil in the region. To assess the long term trends of snake density and reproductive

success due to the oil spill, we recommend that a minimum of 20 permanent monitoring stations are established, where three replicates of 500m-transects are conducted along the reef crest every month for the first year, and twice a year (summer and winter) for the next four years. This design will allow for an accurate baseline to be ascertained and also allow for an accurate long term assessment of the effects of the oil spill on sea snakes in the region. Transects should be positioned along the reef crest around Ashmore and Cartier Reefs. Information about sea snake identity, density and observations of pairing and mating should be recorded. In-depth studies to determine reproductive success and the sex-ratio of the offspring are also recommended.

9. Toxicological studies of all species (birds, mammals and reptiles) are recommended to assess if toxic chemicals are present in the tissue of the animals. In addition, the impacts of the oil on reef fishes and corals in the Ashmore and Cartier Reefs should be assessed.

References

Becker, B. H., S. R. Beissinger, and H. R. Carter. 1997. At-sea density monitoring of Marbled Murrelets in central California: methodological considerations. Condor **99**:743–755.

Hyrenbach, K. D., M. F. Henry, K. H. Morgan, D. W. Welch, and W. J. Sydeman. 2007. Optimizing the width of strip transects for seabird surveys from vessels of opportunity Marine Ornithology **35**:29-38.

Jaquemet, S., M. Le Corre, F. Marsac, M. Potier, and H. Weimerskirch. 2005. Foraging habitats of the seabird community of Europa Island (Mozambique Channel). Marine Biology **147**:573-582.

Jaquemet, S., M. Potier, Y. Cherel, J. Kojadinovic, P. Bustamante, P. Richard, T. Catry, J. Ramos, and M. Le Corre. 2008. Comparative foraging ecology and ecological niche of a superabundant tropical seabird: the sooty tern Sterna fuscata in the southwest Indian Ocean. Marine Biology **155**:505-520.

Spear, L. B., D. G. Ainley, B. D. Hardesty, S. N. G. Howell, and S. W. Webb. 2004. Reducing biases affecting at-sea surveys of seabirds: use of multiple observer teams. Marine Ornithology **32**:147-157.

Wilson, S., and G. Swan 2003. A complete guide to reptiles in Australia. Reed New Holland, Sydney.

Acknowledgements

It was a pleasure to work with Dave Patmore, Glen Ewers and Micheal Deering from DEWHA and Brad Daw from WA DECC, during the research and writing phases of this report. It was also a pleasure to work with Mark Farris, Neville Gill and Glen Cowling on the *Sea Sprint*. We thank Richard Fuller for his assistance in developing the maps in this report.