Aerial surveys of marine mammals and other fauna around Aruba, Curaçao and Bonaire, November 2013

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Summary

In November 2013 aerial surveys were conducted for the first time in the Exclusive Economic Zone of Aruba, Curaçao and Bonaire to evaluate aerial surveys as a tool for marine mammal surveys in these waters, and to assess the distribution and abundance of marine mammals. A secondary aim of these surveys was to collect data on the occurrence of other megafauna (e.g. sharks, rays, turtles) and seabirds. Marine mammals were assessed using distance sampling methods; for other species a strip transect method was applied.

Four marine mammal species were sighted, all of them cetaceans: Humpback Whale, Atlantic/Pantropical Spotted Dolphin, Bottlenose Dolphin and Rough-toothed Dolphin. The total number of individuals seen was 107. Numbers of sightings were too low to calculate densities and abundance estimates for any of the species recorded.

In addition to the marine mammals, sharks, rays, turtles and seabirds were recorded. Noteworthy observations include the first record of a (living) Basking shark and records of seabirds that are scarcely documented in these waters: Red-billed Tropicbird and either Great Skua or South Polar Skua. The number of sightings for these groups were too low to calculate densities and abundance estimates for any of the species recorded.

This survey was commissioned by the Dutch Ministry of Economic Affairs (EZ), and World Wildlife Fund The Netherlands.

1. Introduction

In 2008, the Specially Protected Areas and Wildlife (SPAW) Protocol of the Convention for the protection and development of the marine environment of the Wider Caribbean (Cartagena Convention), adopted an Action Plan for the Conservation of Marine Mammals (MMAP) in the Wider Caribbean region. The main objective of the MMAP is to assist participating governments in the region in their efforts to develop and improve marine mammal conservation policies and practices. On 10 October 2010, within the Kingdom of The Netherlands, Saba, Sint Eustatius and Bonaire became special municipalities, while Aruba, Curaçao and Sint Maarten are constituent countries within the Kingdom. The ultimate responsibility for the sustainable management and conservation of the marine biodiversity in the EEZ of Saba, Sint Eustatius and Bonaire, as well as the territorial waters of these islands, now lies with the Ministry of Economic Affairs of the Netherlands (EZ). In preparation for this expanded responsibility this ministry has been developing a management plan for the EEZ of the so-called Dutch Caribbean Islands in consultation with all six islands (Meesters et al., 2010).
In accordance with existing marine mammal sanctuaries in the Caribbean of the Dominican Republic and France (AGOA), and also with the USA Stellwagen Bank Sanctuary off New England, comprising the main summering grounds of humpback whales that migrate to the Caribbean in winter), the Dutch government is in the process of designating a whale sanctuary (see Debrot et al., 2011) in the waters of the Windward Islands, Sint Maarten, Saba and Sint Eustatius. The establishment of a marine mammal sanctuary has since been listed as a key priority in the current Caribbean Nature Policy Plan (MinEZ, 2013). Future considerations of protected areas for marine mammals in the waters of the Leeward Islands Aruba, Curaçao and Bonaire, are up to the respective islands to decide.
Future considerations of protected areas for marine mammals most likely will also include the waters of the Leeward Islands Aruba, Curaçao and Bonaire.

In the Wider Caribbean Region 34 marine mammal species (31 cetaceans, 2 pinnipeds and 1 manatee) have been documented (Ward et al., 2001). For many of these species, the waters of the region serve as primary habitat for critical activities that include feeding, mating and calving. Data concerning the abundance, distribution, biology, life history and behaviour of most marine mammals in the Caribbean Sea remain sparse. The International Whaling Commission stressed the need for more and better quality data for the Caribbean recently (IWC, 2012).
There are several possible approaches to assessing the occurrence, abundance and distribution of cetaceans. A first overview of species occurrence in an area is usually obtained by collecting so-called opportunistic strandings and sightings data. As a next step, dedicated surveys of marine mammals at sea can be conducted. Opportunistic data are available for the Dutch Windward and Leeward islands (Debrot et al., 1998; 2011; 2013; Luksenburg, 2013). Dedicated surveys of marine mammals to obtain systematically collected data were missing. In November 2013, aerial surveys were conducted in e EEZ of Aruba, Curaçao and Bonaire. Aims of these surveys were threefold: evaluate the use of aerial surveys as a tool for marine mammal surveys in these waters, collect data on abundance and distribution of marine mammals and collect data on occurrence and distribution of other so-called charismatic megafauna (e.g sharks, rays, turtles) and seabirds.

2. Assignment

This report presents the results of an aerial survey of the EEZ of Aruba, Curacao and Bonaire using line transect distance sampling and strip transect methods as described in the original assignment from the Dutch Ministry of Economic Affairs (EZ).

3. Materials and Methods

Study area, and survey design

The study area included the Exclusive Economic Zone (EEZ) of the Leeward Islands Aruba, Curaçao and Bonaire, also known as the Leeward or ABC Islands (Figure 1, ca 71,000 km^2). The waters of these islands are down-stream from seasonal upwelling areas off Venezuela that support the largest fishery of the Caribbean.

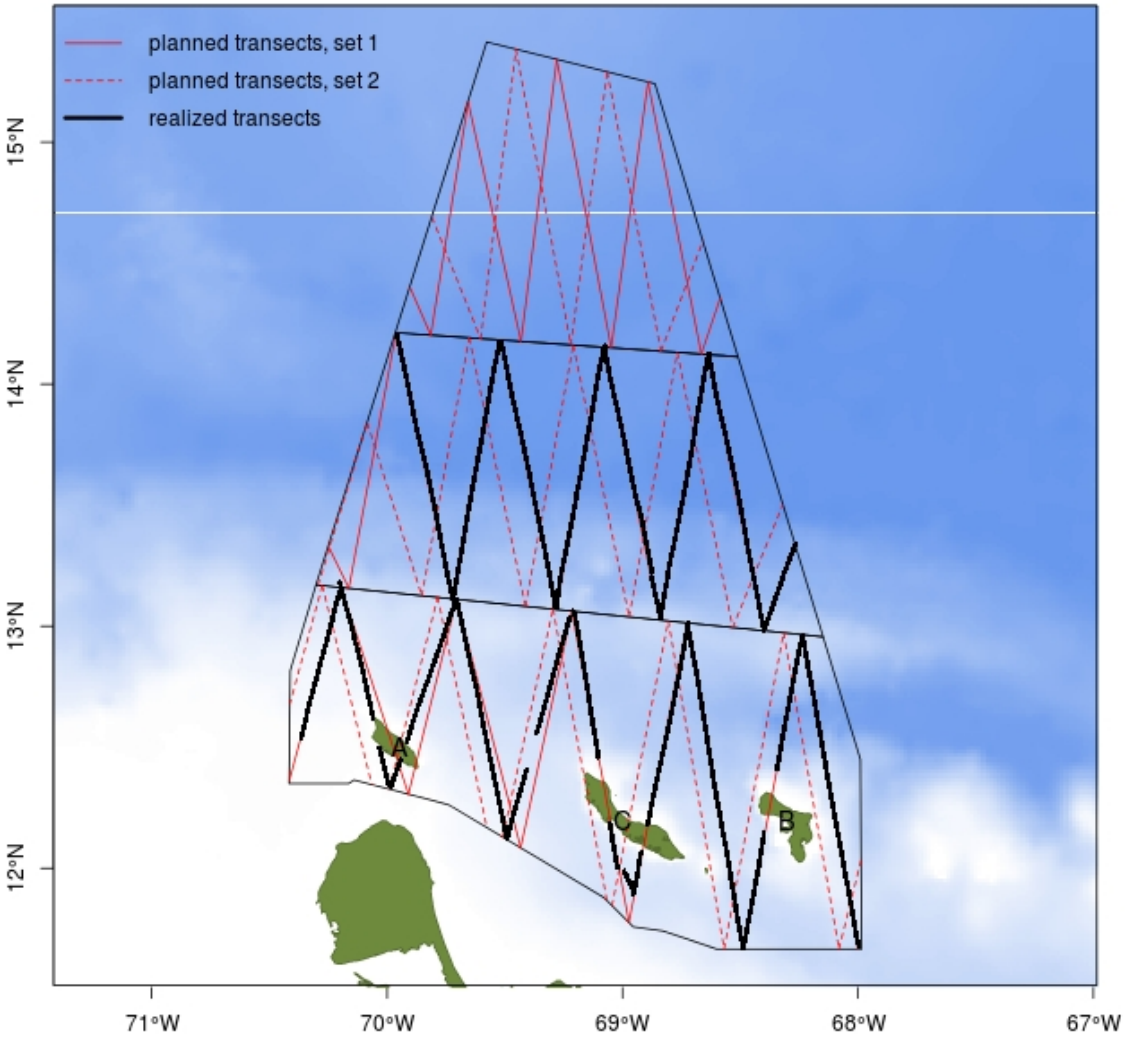

Figure 1. Study area, survey design and effort of the survey in the EEZ of Aruba (A), Curaçao (C) and Bonaire (B) in November 2013.

The survey design was created using DISTANCE 5.0 (Thomas et al. 2010) and comprised three strata (North, Middle and South) within the study area (Figure 1). To provide equal coverage probability within each stratum two sets of zigzag track lines were designed. The transect lines covering in total 5913 km run more or less perpendicular to water depth gradients in a roughly north-south direction over most of the area, as (distance) sampling theory dictates that transect direction should not parallel physical or

biological features (Buckland et al. 2001). Flights were operated from Hato airfield on Curaçao. One set of track lines (set 1) was surveyed in each stratum Middle and South, covering 3,900 km of survey effort (Table 4).

The aircraft used was a high-winged two-engine Partenavia 68, equipped with bubble windows, flying at an altitude of ca. 183 m (600 feet) with a speed of ca. 186 km/h (ca. 100 knots). Every four seconds the aircraft's position and time (to the nearest second) was recorded automatically onto a laptop computer connected to a GPS. Surveys were conducted by a team of three people. Details on environmental conditions were entered by one person (the navigator or data recorder) at the beginning of each transect and whenever conditions changed. Observations were made by two dedicated observers located at the bubble windows on the left and right sides of the aircraft.

Line transect distance sampling and strip transect counts

Data collection differed per species group. Since marine mammals were the primary target of the survey, data on marine mammals were collected according to line transect distance sampling methods. For each observation of marine mammals the observers noted species, declination angle (measured with an inclinometer from the aircraft abeam to the group), group size, presence of calves, behaviour (Table 1), swimming direction, cue, and reaction to the survey plane. These data were entered in real time by the navigator. The perpendicular distances from transect to the sightings were later calculated from aircraft altitude and declination angle. Environmental data included sea state (Beaufort scale), turbidity, cloud cover (in octaves), glare and subjective sighting conditions (Table 2). These sighting conditions represent each observer's subjective view of the likelihood that the observer would see a dolphin within the primary search area (≤ 300 m) should one be present, and could differ between left and right.

For the other species data were collected according to strip transect methods; only species, group size, and strip band (0-50, 50-100, 100-200, 200-300, > 300m) were recorded. To facilitate determining the strip bands the angles corresponding to the borders of these bands were marked on the bubble windows.

Surveys were conducted in weather conditions safe for visual flying operations (no fog, low clouds or rain, visibility >3 km, no military activity etc.) and suitable for dolphin surveys (Beaufort sea state equal or less than 4). Surveys were conducted by experienced observers Steve Geelhoed and Hans Verdaat. Nicole Janinhoff was navigator.

Table 1. Behavioural codes and description for marine mammals.

Behaviour	Description
Swimming	directional swimming
Slow swimming	slow directional swimming
Fast swimming	fast directional swimming or porpoising
Milling	milling, non-directional swimming
Resting	resting/logging: not moving at the surface
Feeding	feeding
Head-up	spy hop of seals vertically in the water column
Other	other behaviour, noted down in comments

Table 2. Description of subjective sighting conditions.

Sighting condition	Description
Good (G)	Observer's assessment that the likelihood of seeing a dolphin, should one occur within the search strip, is good. Normally, good subjective conditions will require a sea state of two or less and clear water.
Moderate (M)	Observer's assessment that the likelihood of seeing a dolphin, should one occur within the search area, is moderate.
Poor (P)	Observer's assessment that it is unlikely to see a dolphin, should one occur within the search strip.
Exceptional (X)	Observer off effort due to adverse circumstances

4. Results

Weather conditions and survey effort

Surveys were conducted in moderate to good sighting conditions, with some periods of excellent conditions. Some periods with poor conditions occurred when visibility was limited by glare. These conditions were usually limited to one side of the plane, with the exception of the most western transect of stratum Middle. The survey was aborted due to strong glare on both sides of the plane. All in all almost 4000 km was surveyed.

Table 3. Survey dates and surveyed strata in the EEZ of Aruba, Curaçao and Bonaire.

Survey date	Surveyed stratum
7 November	Stratum Middle (west) and South (centre)
9 November	Stratum Middle (east) and South (centre)
10 November	Stratum South (east and west)
11 November	Stratum South (west)

Table 4. Total survey effort (surveyed distance km) per sighting condition for each observer.

Sighting condition	left	right	total	perc
Good	11.8	45.8	57.6	1.5
Moderate	1356.1	1761.9	3118	78.9
Poor	580.1	161.2	741.3	18.8
Not possible to observe	27.3	6.2	33.5	0.8
	1975.3	1975.1	3950.4	100

General results

In total 89 sightings of 272 individuals of four marine mammal and sixteen other species (groups) were collected on-effort. Apart from marine mammals (Figure 2) the following species groups were observed: birds, sunfish, sharks, rays and turtles.

Marine mammals

In total, four sightings of four marine mammal species totalling 107 individuals were made (**Error! Not a valid bookmark self-reference.**), corresponding to 0.001 sightings/km effort (Table 7). The distribution of these sightings is shown in Figure 2. The observed number of sightings of these species were too low to calculate densities and abundance estimates.

Table 5. On-effort number of sightings and individuals of marine mammals in in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

	No sightings	No ind
Humpback Whale	1	3
Bottlenose Dolphin	1	6
Atlantic/Pantropical Spotted Dolphin	1	60
Rough-toothed Dolphin	1	38
	4	107

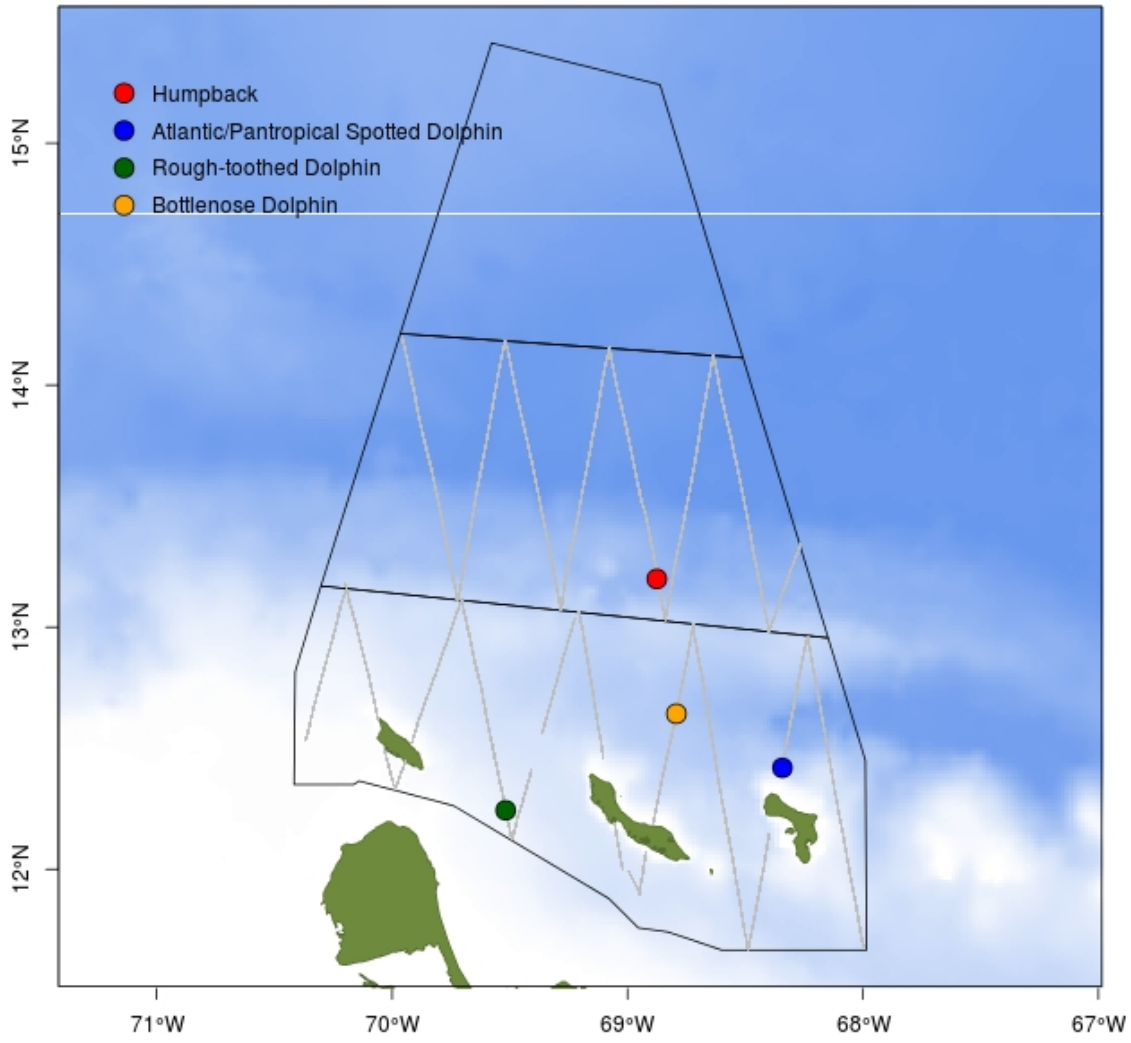

Figure 2. Sightings of marine mammal species in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

Humpback Whales *Megaptera novaeangliae* were recorded in stratum Middle on 9 November. Identification to species level was straightforward, since the rounded head and long pectoral flippers were clearly visible. A group of three individuals of which one was about three quarter of the size of the other animals was seen swimming in an easterly direction 5-10 m below the surface. Humpback whale is one of the most abundant (baleen) whales in the Caribbean Sea (Ward et al., 2001).

Atlantic/Pantropical Spotted Dolphins *Stenella frontalis/attenuata* were recorded north of Bonaire on 10 November. A group of ca 60 individuals was seen, partly within partly outside the primary search area. The animals were identified as spotted dolphins by their small size and 'average' dolphin shape, the presence of different coloured animals from different sizes, varying from (smaller) uniform dark grey coloured animals to bigger animals with dark grey upper-sides and lighter coloured flanks. Two species of 'spotted' dolphins occur in the study area: Atlantic Spotted and Pantropical Spotted Dolphins (Ward et al., 2001). Identification to species level is only possible when good views of adults can be attained. Both species acquire spots when ageing and a dark upper-side and contrasting underside. Adults of Atlantic and Pantropical Spotted Dolphins have a three-toned colouration and two-toned colouration

respectively. Despite circling back to clinch the identification it was neither possible to identify the animals to species level nor to make photographs of the animals.

Rough-toothed Dolphins *Steno bredaensis* were observed between Aruba and Curaçao near the border with Venezuela on 10 November. A group of 38 individuals was observed swimming parallel to the track line. Identification as Rough-toothed Dolphin was based on the overall bulkier and stockier appearance than Bottlenose Dolphin. Their flippers were positioned more caudal than in Bottlenose Dolphin. The overall brownish-grey colouration of the animals differed from the greyish colouration of Bottlenose Dolphin.

Bottlenose Dolphins *Tursiops truncatus* were seen north of Curaçao, in the northern half of stratum South. On 9 November a group of six equally sized individuals was seen swimming towards the track line. The animals were seen in frontal view and identified as Bottlenose Dolphin based on the size (2-3 m), stocky build, short beak and apparently uniform greyish colouration.

Birds

In total 85 sightings of 11 taxa totalling 165 individual birds were collected (Table 6), corresponding to 0.022 sightings/km effort (Table 7).

Table 6. Number of sightings and individuals of birds in in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

	No sightings	No ind
Tropicbirds	22	25
Shearwaters	10	11
Boobies	3	5
Terns and noddies	39	106
Other	11	18
	85	165

Tropicbirds were the second-most abundant birds during the surveys. The combination of overall white plumage, large size, tapering body, wing shape (broad arm and pointed hand) and on some occasions long tail streamers made identification as tropicbird straightforward. Two tropicbird species occur in the study area: White-tailed Tropicbird *Phaethon lepturus* and Red-billed Tropicbird *P. aethereus* (Prins et al., 2009). Identification to species level was mainly based on the visibility of a dark carpal band on the upper wing: White-tailed Tropicbirds have this feature, Red-billed Tropicbird do not. The majority of the tropicbirds (64%, n =25) was identified to species level; all of these birds were Red-billed Tropicbirds. Tropicbirds were widespread and seen far offshore (Figure 3). Records of Red-billed Tropicbirds around the islands are scarce, with ten records in Bonaire and Curaçao (Prins et al., 2009). The occurrence of this species in Aruban waters has only recently been documented (Luksenburg & Sangster, 2013).

Shearwaters were observed on ten occasions. All recorded individuals had dark upperparts and light underparts. Audubons Shearwater *Puffinus lherminieri* occurs regularly in the study area (Prins et al., 2009), whereas Manx Shearwater *P. puffinus* can be expected since they just east of the Caribbean during migration (Guilford et al., 2009). All shearwaters were tentatively identified as Audubon's Shearwater. The identification was based on a combination of small size, rounded wings and -on some individuals- a lighter patch on the upper wing. These features are indicative for Audubon's instead of Manx Shearwater (e.g. Howell, 2012). The distribution of shearwaters was restricted to the eastern part of the study area, with most observations between Bonaire and Venezuelan waters (Figure 3).

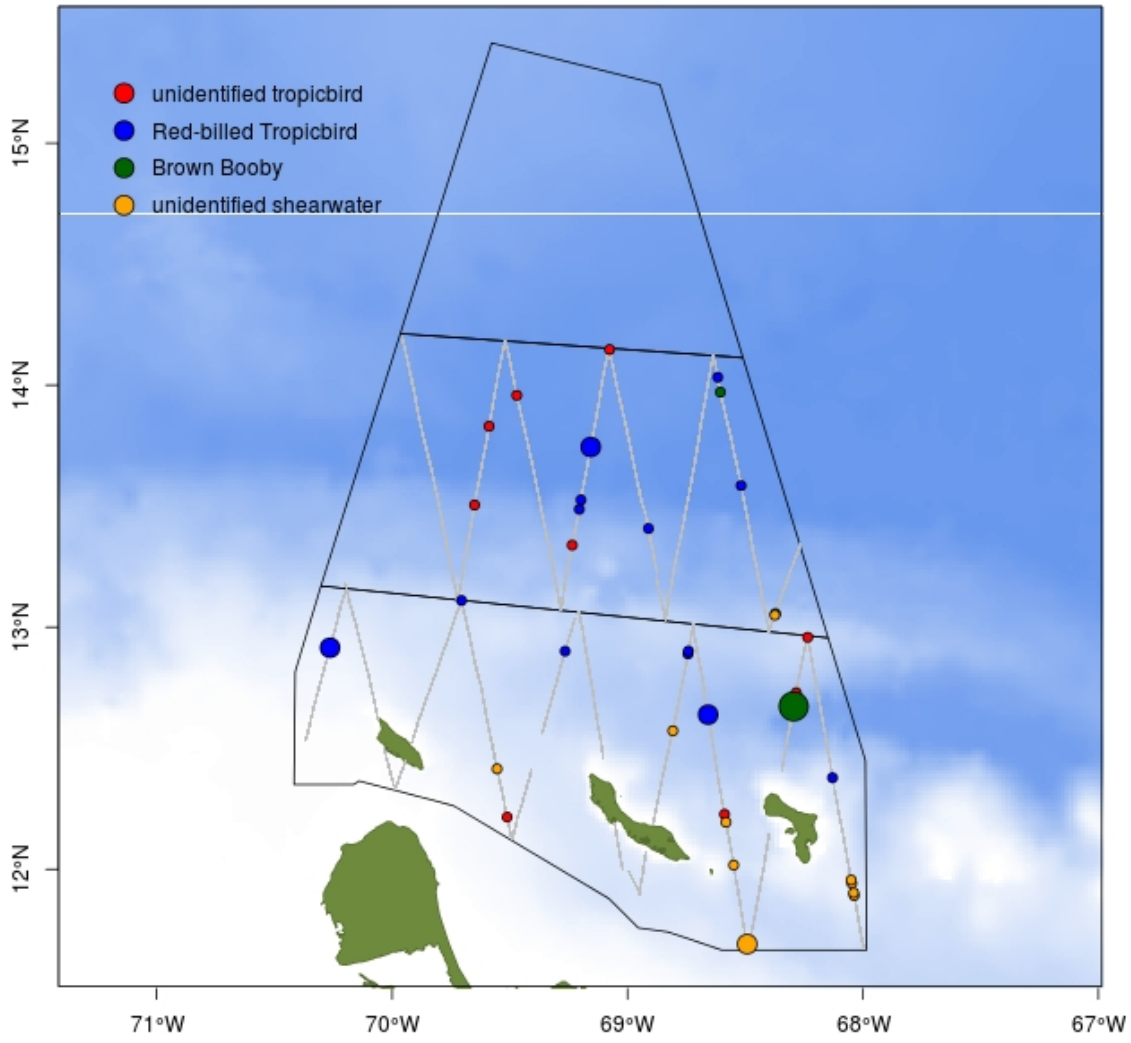

Figure 3. Sightings of tropicbirds, shearwaters and boobies in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

Boobies were seen on three occasions. Two Booby species that superficially look alike occur regularly in the study area: Brown Booby *Sula leucogaster* and Red-footed Booby *Sula sula* (Prins et al., 2009). Immature birds look superficially alike, but immature Brown Booby has white underparts, whereas immature Red-footed Booby has dark underparts. All boobies were identified as Brown Booby. In total 5 individuals were seen, all within a small area in the northeastern part of stratum South (Figure 3).

Terns and noddies were the most abundant birds during the survey. Three types of terns and one type of noddy were identified. The terns were divided in large and small light-winged and dark-winged types. Two large white-winged terns are known to occur in the study area: Royal Tern *Sterna maxima* or Cabott's Terns *S. acuflavidus.* (Prins et al., 2009). Our own observations on the islands of Bonaire and Curacao, 1-20 November, indicate that all large light-winged terns were Royal terns (n > 156). We have not seen other large light-winged terns than Royals. Both species' occurrence at sea, however, could differ from their occurrence on the islands. During the survey most (large) white-winged terns (n = 42) were seen in the northern part of stratum South and in the southern part of stratum Middle (Figure 4).

Apart from terns with light-coloured upperparts several dark-winged terns were seen. Most of these had whitish underparts and could be either Sooty Tern *Onychoprion fuscatus* or Bridled Tern *S. anaethetus* (Prins et al., 2009). Apart from subtle differences in head and tail colouration Sooty Tern basically has black and Bridled Tern blackish-brown upperparts. During the survey all dark-winged terns (n = 63) apparently had brownish upperparts, and were tentatively identified as Bridled Tern. The distribution of these birds was restricted to the eastern part of the study area, with a concentration in the northeast of stratum Middle (Figure 4).

One noddy was seen in stratum Middle (Figure 4). It is easily identified as a noddy by the overall dark colour and different structure than (dark-winged) terns. In the Caribbean both Brown Noddy *Anous stolidus* and Black Noddy *A.minutus* occur (Prins et al., 2009). They are difficult to identify to species level when not seen well, e.g. from an airplane.

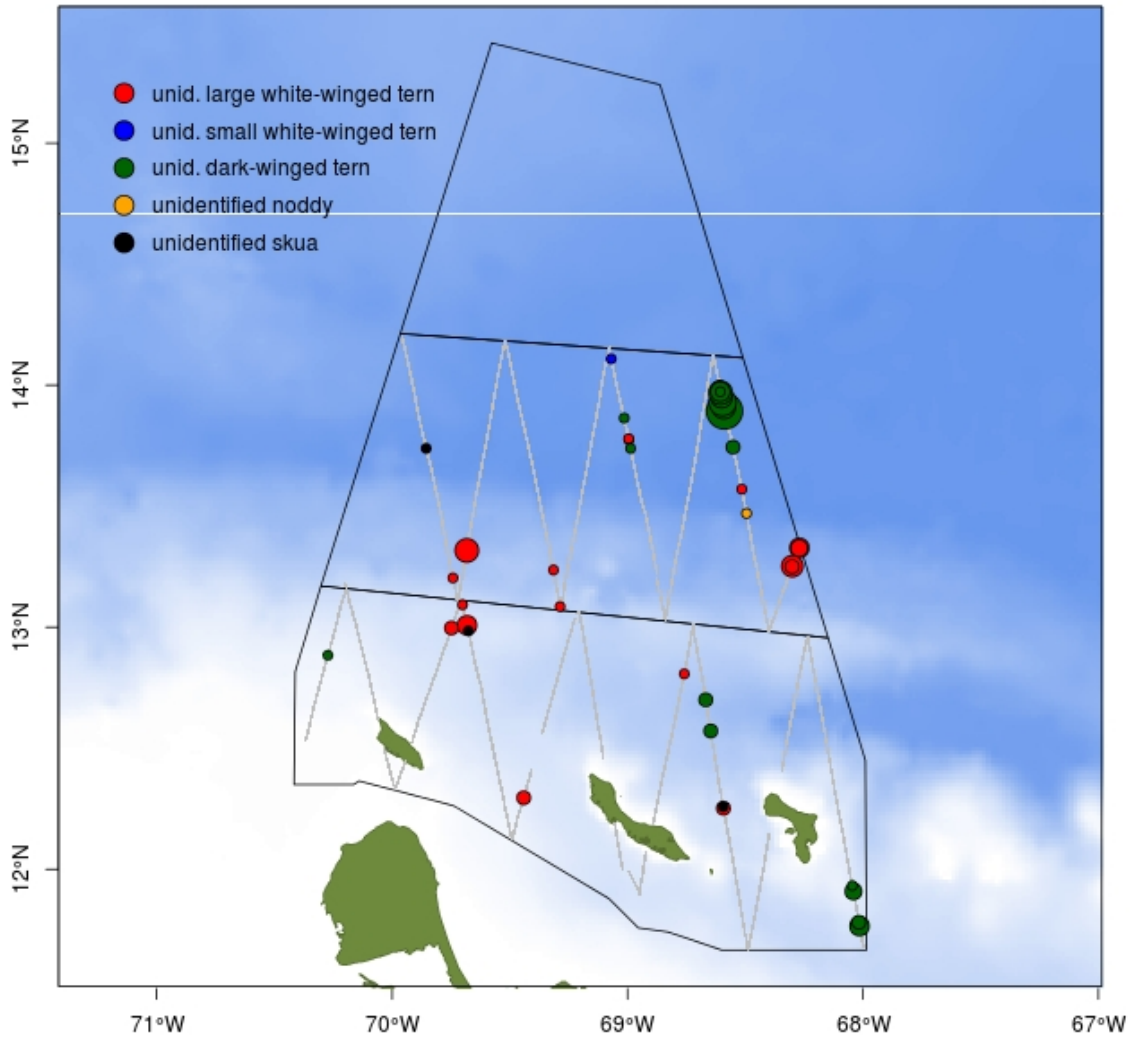

Figure 4. Sightings of skuas, terns and noddies in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

Other bird species

A group of three (American Great) white egrets was seen near Curaçao on 7 November. A flock of unidentified waders was seen on 10 November. Three unidentified skuas were seen in areas where other seabirds were relatively common (Figure 4). Skuas are difficult to identify to species level when not seen well, e.g. from an airplane. Two types could be distinguished during the survey: small skuas, i.c. either Arctic *Stercorarius parasiticus* or Pomarine Skua *S. pomarinus* and a great skua, either Great Skua *S.skua* or South Polar Skua *S.maccormicki*. The latter has only recently been documented around the islands (Luksenburg & Sangster, 2013).

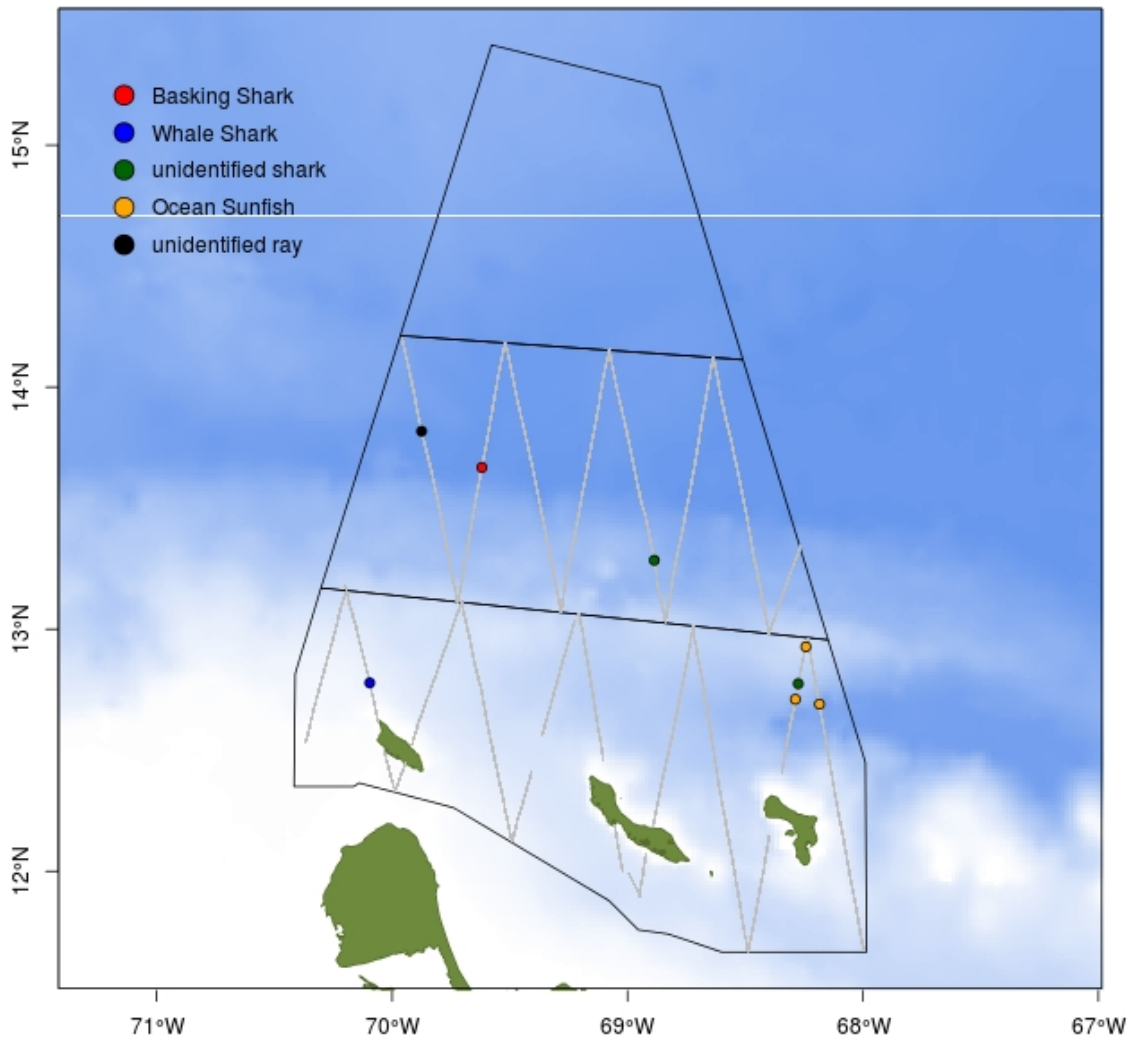

Figure 5. Sightings of sunfish, sharks and rays in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

Sunfish, sharks and rays

A handful of sightings of sunfish, sharks and rays was made (Table 7), corresponding to 0.001 sighting/km effort. Two sharks were identified to species level. A Basking Shark *Cetorhinus maximus* and a Whale Shark *Rhincodon typus* were both recorded on single occasions (Figure 5).
The Basking Shark was identified by it's typical head shape, uniform dark colouration and size (6-7 m) and was seen swimming in stratum Middle. The observation is remarkable. Until recently the distribution of Basking Sharks in winter was unknown. A recent tagging study (Skomal et al., 2009) in which 25 animals were tagged at Cape Cod USA, showed the first proof of migration to tropical regions. Most animals wintered off the southeast coast of USA, but two animals spent their winter in waters off the northeast coast of South America. During migration they moved rapidly past the Windward and Leeward Islands in late November and early December. The tagging data of the sharks showed that they were swimming 81% of the time at mesopelagic depths, invisible for human observers. The observation of a Basking Shark during the aerial surveys was the first sighting in this region and supports the results of Skomal et al. (2009). As far as we could assess, one record in the survey area has previously been documented: a stranding on Aruba in March 1973 (Carmabi 1974).

The Whale Shark was seen north-northwest of Aruba. Whale Shark is a common migratory species in the western Caribbean Sea, where feeding aggregations of up to several hundred individuals occur off the shelf edge south of Cuba and along the shelf edge off Honduras to Mexico in different seasons (Graham, 2007). Records in the eastern Caribbean Sea are sparsely documented. For Venezuelan waters Romero et al. (2000) documented 20 records in half a century, whereas Debrot et al. (2013b) documented 24 records in the Dutch Caribbean for the same period Of which 20 around the Leeward Islands. In the latter area observed numbers decline in the second half of the year with a minimum in November-Decmber. The Venezuelan records on the contrary show a distinct peak in October.

In total one single ray was seen: a huge ray ("flying carpet") with white 'tips' at the end of its wings was observed outside the counted strip by the navigator on 7 November. Rays of the *Mobula*-genus do not have white tips, whereas Giant Manta Ray *Manta birostris* and Reef Manta Ray *M. alfredi* show different amounts of white on their upperparts. Given the restricted amount of white on the observed ray, it was tentatively identified as Giant Manta Ray. On 10 November three single Ocean Sunfishes *Mola mola* were seen in the north eastern corner of stratum South.

Turtles

Turtles were seen on five occasions, corresponding to 0.001 sighting/km effort. The majority of turtles could not be identified to species level. The exception was a Leatherback *Dermochelys coriacea* on 9 November in the stratum Middle, seen by the navigator outside the counted strip. The unidentified turtles could have belonged to any of the three species that are known to nest on the islands: Loggerhead *Caretta caretta*, Hawksbill *Eretmochelys imbricata* and Green Turtle *Chelonia mydas*. Identification of these species is based on the shape and number of plates on the turtles' shield. Consequently identification to species level is impossible during aerial surveys. The distribution of these unidentified turtles showed no clear pattern (Figure 6).

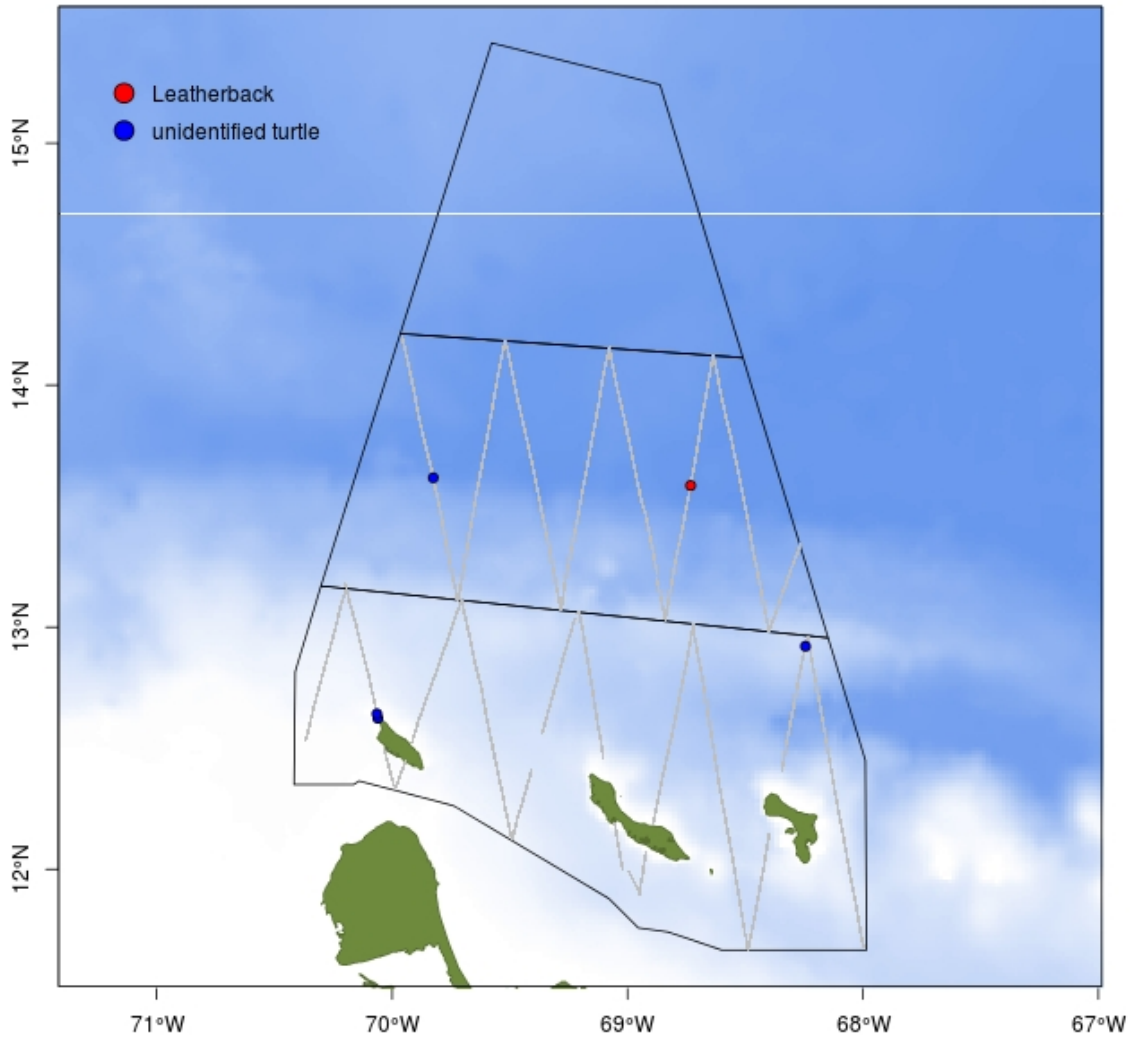

Figure 6. Sightings of turtles in the EEZ of Aruba, Curaçao and Bonaire in November 2013.

5. Comparison with other surveys

To put the results of the survey in perspective they are compared to the French REMMOA surveys (Ridoux et al., 2010). During the REMMOA project all French overseas territory was surveyed by plane. In the Caribbean the waters around the French Antilles were surveyed in February-March 2008 (8400 km of transect lines) and those around French Guiana in October 2008 (7300 km). Since the timing, area and methods of the surveys differ slightly only a rough comparison is feasible. Although the effort during our survey is relatively low, compared to the French surveys our sighting rates (sightings/km) for all groups seem lower but are in the same order of magnitude (Table 7), with the exception of cetaceans and sharks and rays around French Guiana where the sighting rates were twenty times higher. The reasons for the similarities and differences between the surveys are not clear, but could reflect geographical and seasonal differences.

Table 7. Comparison of the aerial survey around Aruba, Curaçao and Bonaire with REMMOA surveys in the French Antilles and in French Guiana (source Ridoux et al, 2010).

	This survey		**French Antilles**	**French Guiana**
Taxa	**sightings/km effort**	**animals/km effort**	**sightings/km effort**	**sightings/km effort**
Cetaceans	0.001	0.027	0.007	0.019
Birds	0.022	0.042	0.048	0.040
Turtles	0.001	0.001	0.003	0.005
sunfish/sharks/rays	0.001	0.001	0.001	0.020

6. Conclusions

The November survey in the EEZ of the ABC islands showed that aerial surveys are a useful and cost effective tool to collect data on abundance and distribution of marine mammals. Quantitative insight is critical for a true understanding of cetacean distribution and abundance in the region and for setting conservation and research priorities The density of marine mammals, and, with the survey's relatively little effort, the observed numbers were too low to calculate densities or abundance estimates. More effort in space and time is needed to collect enough data necessary for a robust picture of the abundance and distribution of marine mammals. The low density of marine mammals on the other hand allowed for simultaneously and systematically collecting data on other so-called charismatic megafauna (i.c. sunfish, sharks, rays, turtles) and birds during the survey without compromising the quality of the marine mammal survey.
The density of cetaceans and other species seems low, but the diversity in the area is high. The number of recorded species will likely increase if surveys will be conducted in other seasons and in the offshore habitats in the northern part of the area.

Acknowledgements

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7. Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 57846-2009-AQ-NLD-RvA). This certificate is valid until 15 December 2012. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

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The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Mardik Leopold
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