

# **Monitoring cetacean occurrence in coastal waters of the Caribbean Netherlands (Saba, St. Eustatius & Bonaire) using port sampling**

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## Summary

Knowledge on the density, distribution and occurrence of whales and dolphins in the Caribbean Netherlands is sparse. This knowledge is needed as basic input for conservation and management of cetaceans in the area. Especially in the long term, dedicated data is needed to provide a base-line for monitoring the effect of policy decisions, such as a proposed implementation of a whale sanctuary.

Until recently, knowledge was mainly based on strandings and opportunistic sightings of whales and dolphins. Dedicated data collection, such as obtained from designed aerial or shipboard surveys, will provide reliable and unbiased estimates of abundances and describe distribution patterns and habitat use. However, these types of studies are costly. To explore options on how to bridge the gap between costs (high-low) and data quality (high-low), we investigated a method that could potentially provide long term and cost effective, albeit low quality (in certain aspects), data. In this report we present the results obtained using a port sampling programme used to monitor the fisheries of Saba, St. Eustatius and Bonaire.

During port sampling fishermen were interviewed after returning to the harbour from a fishing trip. The fishermen described their fishing activities and in addition they reported any sightings of whales or dolphins. The study on Saba has included the recording of cetacean sightings since July 2012, the same method has been applied in St. Eustatius since November 2012 and on Bonaire since January 2014. In total 59 different fishing vessels participated in the study (9 Saba, 15 St. Eustatius and 35 Bonaire). The waters around each island were divided into sub-areas to provide data on where the fishing effort took place and where sightings were made. Effort was described as "fishing trips" per sub-area, per month and per island. A total of 1428 days at sea were monitored, with 1020 from Saba, 292 from St. Eustatius and 116 from Bonaire.

During the study a total of 42 whale sightings of 71 individuals was made, of these 36 (62 animals) were recorded in Saba, 2 (2 animals) in St. Eustatius and 4 (4 animals) in Bonaire. There were 93 dolphin sightings consisting of 1362 individual animals. Of these, from Saba there were 71 sightings (877 animals), from St Eustatius 3 sightings (144 animals) and from Bonaire 19 sightings (341 animals).

The relative density (sightings per "fishing trip") showed a pronounced difference in occurrence of cetaceans between islands. The highest relative density of dolphins was found in Bonaire with 0.16 dolphin sightings/fishing trip. The highest relative density of whales was found in Saba with 0.04 whales/fishing trip. Occurrence of whales and dolphins indicated seasonal patterns, in particular for Saba waters where the monitoring ran for several years and most whale and dolphin sightings were in March. The spatial distribution in the Saba study area indicated that dolphins occur regularly on the Saba Bank. In Bonaire the data indicated that an area on the west side of the island and close to shore (<1 km) with high fishing effort also had a high occurrence of cetacean sightings.

An evaluation of the method used indicated that the sampling methodology could be adapted to improve data quality. Most important hereby is a standardization of data collection and data storage between the islands. It also showed that the information provided by the fishermen is very useful in identifying areas of research needed to further investigate cetacean distributional patterns and habitat use around these three islands.

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## 1. Introduction

For the conservation of cetaceans in Dutch waters it is imperative that knowledge on their density, distribution and habitat use is available. Only then can adequate conservation measures be taken and their effectiveness monitored.

Unfortunately, designated monitoring of cetacean density and distribution, for example by using a vessel or an aircraft, is expensive. In the vicinity of the Caribbean Netherlands a number of dedicated surveys have taken place, such as aerial surveys conducted in November 2013 by IMARES in the exclusive economic zone of Aruba, Curaçao and Bonaire (Geelhoed et al. 2014), the REMMOA aerial surveys in French waters (Ridoux et al. 2010), AGOA surveys and some smaller scale boat surveys (e.g. Geelhoed & Verdaat 2012). However, to obtain information on seasonal changes in distribution one would need to repeat these types of surveys several times per year, which is costly. Because of the cost and lower priority given to such data collection in the past, most of the information currently available on cetacean occurrence in the Caribbean Netherlands is based on the collation of opportunistic sightings and strandings data (e.g. Debrot et al. 1998, 2013).

Opportunistic data can provide information that can help to plan designated surveys or other research work in a way that is most effective, e.g. in terms of time of survey and/or target areas. Opportunistic data can generally be collected in a cost-effective way and may provide long-term data that is otherwise difficult to obtain. The active participation of stakeholders in projects can increase the involvement of the local communities in conservation and management of their resources.

In this project we investigated the possibility of using established port sampling programmes for fisheries monitoring on Saba, St Eustatius and Bonaire, to obtain long-term, low-cost data on cetacean occurrence in the Dutch Caribbean. On the islands, a sample based fishery survey endorsed by FAO (Stamatopoulos, 2002) is used to collect basic data on catch, effort, species composition and length frequency. Short interviews (1-2 minutes) are conducted with the fishermen upon returning into the harbour. Although information collected was aimed to monitor fishing catch and effort, it was adapted to also include questions related to dolphin(s) or whale(s) sightings (location, species and number of individuals).

Aim of this study was threefold. Firstly, to evaluate the type of data and the data quality we could obtain from the port sampling, including consideration on the cost-effectiveness. Secondly, to advise on improvements of the port sampling programme to increase data quality. Thirdly, to present the information collected on cetacean occurrence in the Dutch Caribbean waters.

## 2. Materials and Methods

### 2.1 Study areas

#### 2.1.1 Saba

The study area consists of the waters around the island of Saba, with the largest part being covered by the Saba Bank (Figure 1). The Saba Bank is a large submarine atoll with a surface area of about 2000 km<sup>2</sup> and an average depth of 25m (Meesters et al. 1996; Hoetjes and Carpenter 2010). The study area was divided into 20 sub-areas (A1 to A5, ... D1 to D5).

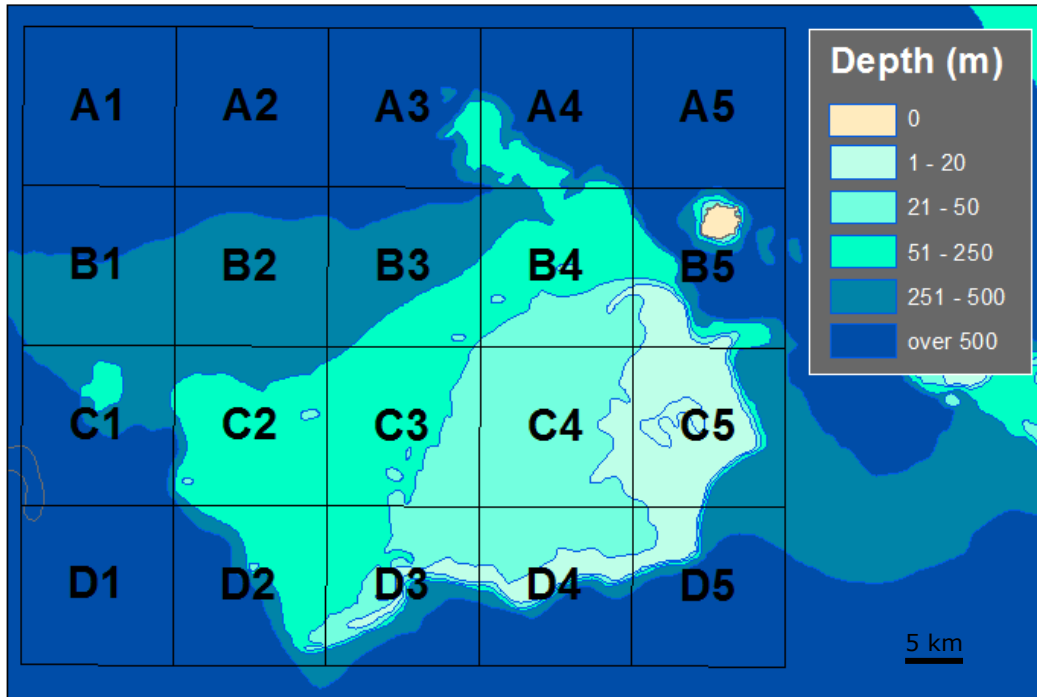


Figure 1: Overview of the study area with the 20 sub-areas used in the fishery monitoring scheme.

#### 2.1.2 St. Eustatius

The study area around St. Eustatius consists of the coastal waters used by the fishermen. The waters were separated into eight sub-areas (Figure 2). Fishing effort also occurred outside the described study area, in particular on Saba Bank (>20 km W of St. Eustatius) and close to a fish aggregation device (approximately 15 km W of St. Eustatius; at 17° 26.76'N, 063° 07.70'W).

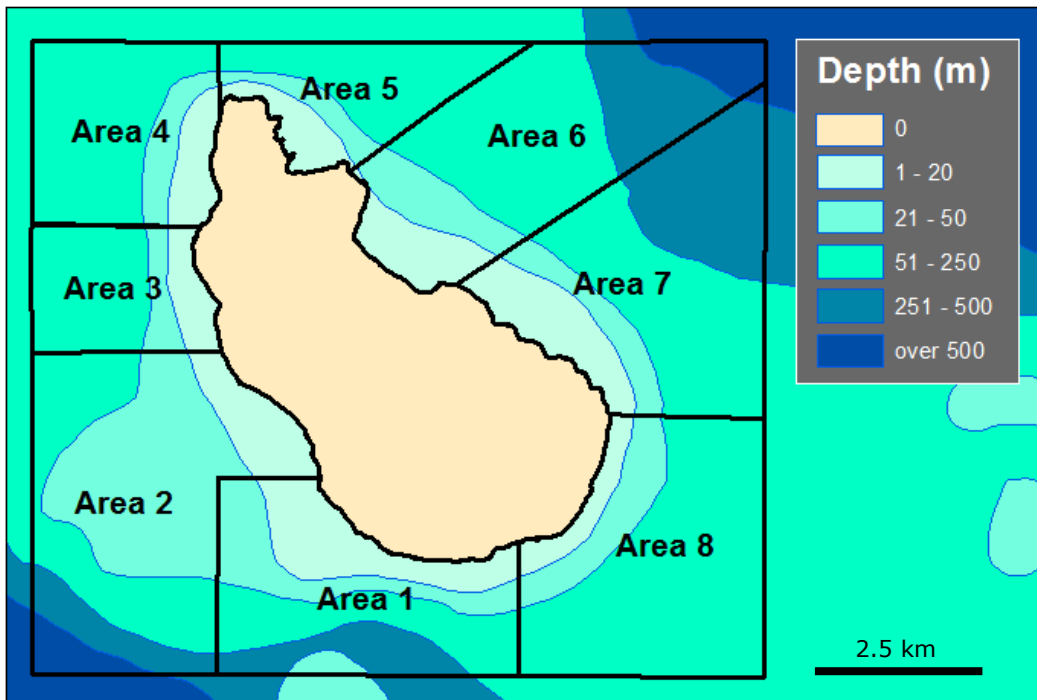


Figure 2: Study area around St. Eustatius in which fishing effort was monitored.

### 2.1.3 Bonaire

On Bonaire five sub-areas were defined in the waters around the island. Fishermen were asked to provide information not only on the sub-areas but also on the distance at which they were fishing from shore. Whereas most of the fishing activity in Saba and St. Eustatius is with fish traps targeting Caribbean spiny lobster or deep water snapper species, on Bonaire the majority of fishing is trolling for large pelagic species such as tunas, wahoo and dolphin fish. Areas 4 and 5 are on the “exposed” side of the island and are generally only fished by larger vessels (>8 m).

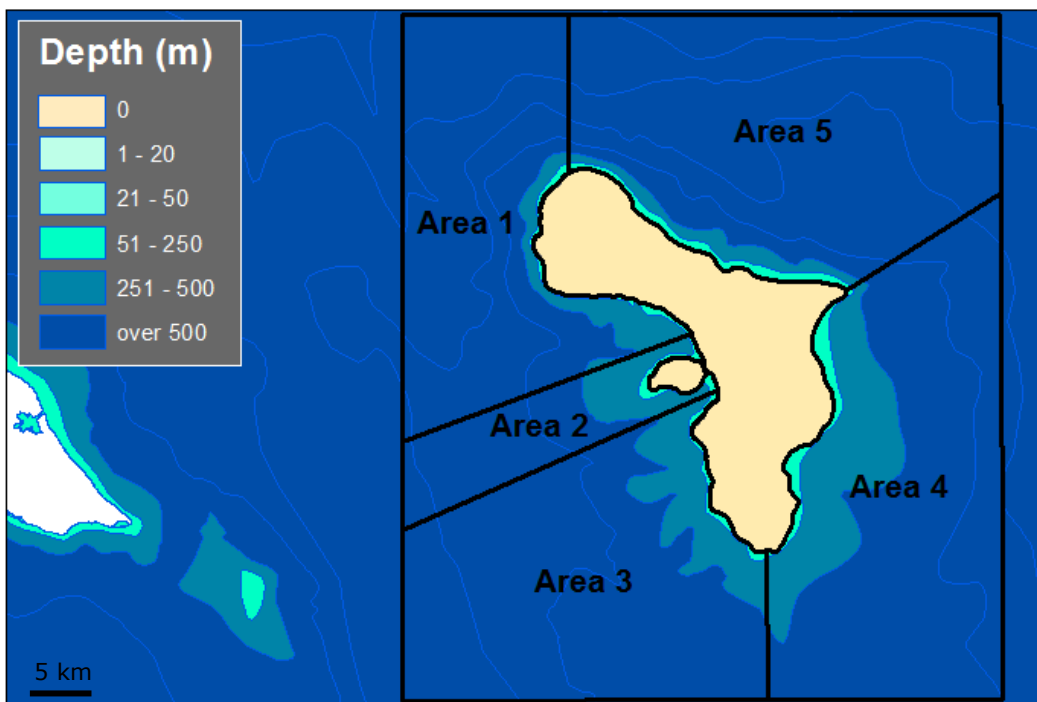


Figure 3: Study area around Bonaire in which fishing effort was monitored

## 2.2 Data collection

### 2.2.1 Port sampling

The FAO endorsed fishery survey method collects basic data on catch, effort, species composition and length frequency (Stamatopoulos, 2002). Rather than directly counting all catches, the total catch for each boat/gear category is estimated by using data on the number of boats, the activity level of the boats and the average catches per boat per day (Figure 4).

The fisheries survey consists of four components:

1. *Frame Survey*: A frame survey is a census-based approach to collate a list of homeports and boat/gear categories which will be used as the basis for the Active Days, Boat Activity and Landings surveys.
2. *Active Days Survey*: Active Day Surveys are conducted at the end of each month to determine the number of active fishing days for each strata in the survey design (e.g. home port, boat/gear category).
3. *Boat Activity Survey*: Boat Activity Surveys are conducted at homeports separately for each boat/gear category to determine how many boats are active on a given day.
4. *Landings Survey*: Landing Surveys are conducted to collect data on catch, effort, species composition and length frequency with a minor stratum, a calendar month and boat/gear category.

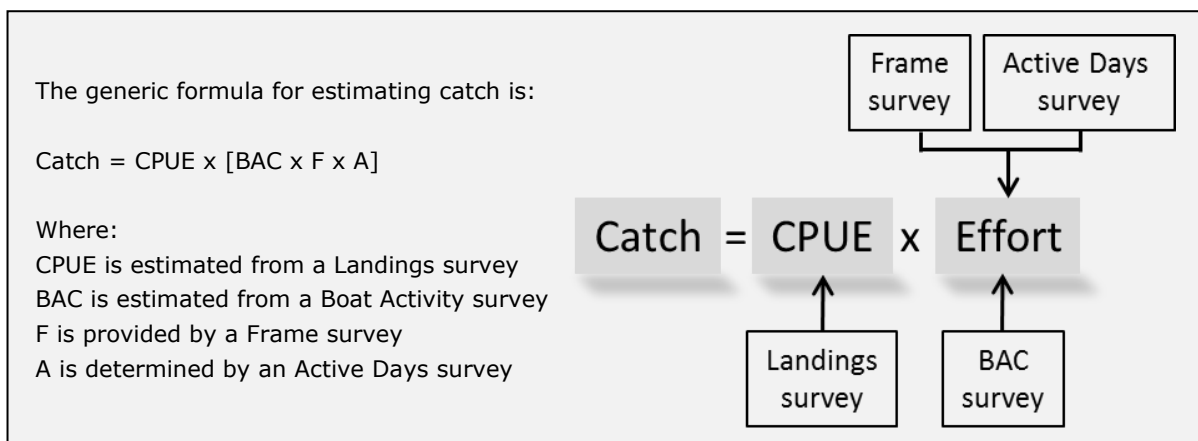


Figure 4: Schematic representation of a fisheries surveys in the Caribbean Netherlands

For this study only the landings surveys, which were conducted when the fishermen had returned into the harbour, were used. Information collected was aimed to monitor fishing catch and effort, but it also included the question if any dolphin(s) or whale(s) had been sighted and fishermen were asked to provide details on their sightings.

For the cetacean database derived from the port sampling the following information was included: date, boat name, fishing sub-area, sub-area of cetacean sightings, number of whale and/or dolphin sightings, number of whales and/or dolphins, group size, group composition (e.g. presence of calves), behaviour and species. When a range for group size was given, the mean of that range was used as a best estimate. Effort was calculated by using the frequency of visitations to each sub-area in which the observation was recorded. In some records this information was not available; in those cases sightings were assumed to be in the sub-area in which the main fishing effort occurred. The relative frequency of cetaceans was described as sightings per fishing days (or animals per fishing days). An example of the type of fishing vessels active in the three islands can be seen in Figure 5.





Figure 5. Examples of participating fishing vessels from Saba, St. Eustatius and Bonaire

At Saba the data collection period was 10 July 2012 to 10 November 2014. The fishing vessels leave from Fort Bay (Saba's only harbour in the Southwest of the island) to their fishing grounds. The number of fishing vessels operating from Saba was 8 in 2012 and 9 in 2013 and 2014. In 2012 the fishermen of Saba were given laminated field guides describing the most common cetacean species in the area to aid in the identification of sightings.

At St. Eustatius the data collection period was 12 November 2012 to 13 November 2014. Data in St. Eustatius was collected through logbooks or interviews. Approximately 90% of the logbook fill-ins were done while an interview was conducted. The number of total fishing vessels operating from St. Eustatius was 15.

At Bonaire the data collection period was 21 January 2014 to 28 October 2014. The number of fishing vessels operating and engaged in the sampling programme from Bonaire was 35.

### 2.3 Data analyses

To obtain a relative value for cetacean occurrence we calculated the mean number of sightings per effort as well as the mean number of animals per effort. This resulted as the frequency of occurrence indices of cetacean sightings per fishing day and cetacean numbers per fishing day (separately for dolphins and whales). For the distribution of sightings, this value (sightings per animals per day) was calculated per sub-area for the three islands. To look into the spatial distribution the number of times fishing occurred in a sub-area was used as a proxy for observation effort. Fishermen could fish in more than one fishing area per day.

The GIS analysis followed the steps of data collection, data formatting and classification. The main parameters for analysis were sightings/ animal numbers by days fishing.

The size of each sub-area ( $m^2$ ) was calculated using ArcGIS (ESRI Ocean World Ocean Reference, which included bathymetry data). The mid-point of each sub-area, indicating the middle of the fishing zone, was identified using the 'finding middle point' construction tool in ArcGIS. The number of sightings/ animal numbers by the effort (fishing days) were fused with the middle point of the each fishing zone.

### 3. Results

#### 3.1 Effort

##### 3.1.1 Saba

During the study period at Saba a total of 1020 fishing days were monitored using port sampling (Table 1). 2013 was the only year that was completely covered. Fishing effort varied greatly between months between 2 and 71 fishing days (overall average 35 per month).

Table 1: Monitored fishing days at Saba, presented by month, between 10 July 2012 and 10 November 2014, for which cetacean occurrence data were obtained.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
2012	-	-	-	-	-	-	32	46	71	65	43	4	<b>261</b>
2013	2	31	10	43	47	39	38	39	24	42	32	28	<b>375</b>
2014	26	41	34	39	29	43	40	28	49	31	24	-	<b>384</b>
Mean	14	36	22	41	38	41	36.7	37.7	48	46	33	16	
<b>total</b>	<b>28</b>	<b>72</b>	<b>44</b>	<b>82</b>	<b>76</b>	<b>82</b>	<b>110</b>	<b>113</b>	<b>144</b>	<b>138</b>	<b>99</b>	<b>32</b>	<b>1020</b>

##### 3.1.2 St. Eustatius

Over the 25 month sampling period at St. Eustatius, 292 fishing days were monitored (Table 2). Monitoring included between 0 and 31 fishing days per month (overall average 12 per month).

Table 2: Monitored fishing days at St. Eustatius, presented per month, between 12 November 2012 and 13 November 2014, for which cetacean occurrence data were obtained.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
2012	-	-	-	-	-	-	-	-	-	-	13	19	<b>32</b>
2013	15	14	10	7	12	11	2	9	11	11	13	10	<b>125</b>
2014	8	25	25	11	1	0	2	9	31	20	13	-	<b>135</b>
Mean	11.5	19.5	12.5	9	6.5	5.5	2	9	21	15.5	13	14.5	
<b>total</b>	<b>23</b>	<b>39</b>	<b>25</b>	<b>18</b>	<b>13</b>	<b>11</b>	<b>4</b>	<b>18</b>	<b>42</b>	<b>31</b>	<b>39</b>	<b>29</b>	<b>292</b>

##### 3.1.3 Bonaire

Over the 10 month sampling period at Bonaire, in 2014, 116 fishing days were monitored (Table 3). Monitoring included between 1 and 33 fishing days per month (overall average 12 per month). The main sampling effort was in the months March, April and May. Sampling effort was especially low (one or two fishing days) in February, July and August.

Table 3: Monitored fishing days at Bonaire, presented per month, between 21 January and 28 October 2014, for which cetacean occurrence data were obtained.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2014	10	1	33	23	21	8	2	2	8	8	-	-	<b>116</b>

The fishing activity of the 35 vessels sampled was not uniform (Figure 6). Seventeen vessels were sampled once only, while at the maximum a single vessel provided 22 fishing days.

In a similar way not all vessels were fishing in all areas (Figure 7). Most effort (53%) was in area 2, which was the smallest study area.

The vast majority of the sampled fishing trips from Bonaire were close to shore, 70% to <100 m and 1% to >1 km (Figure 8).

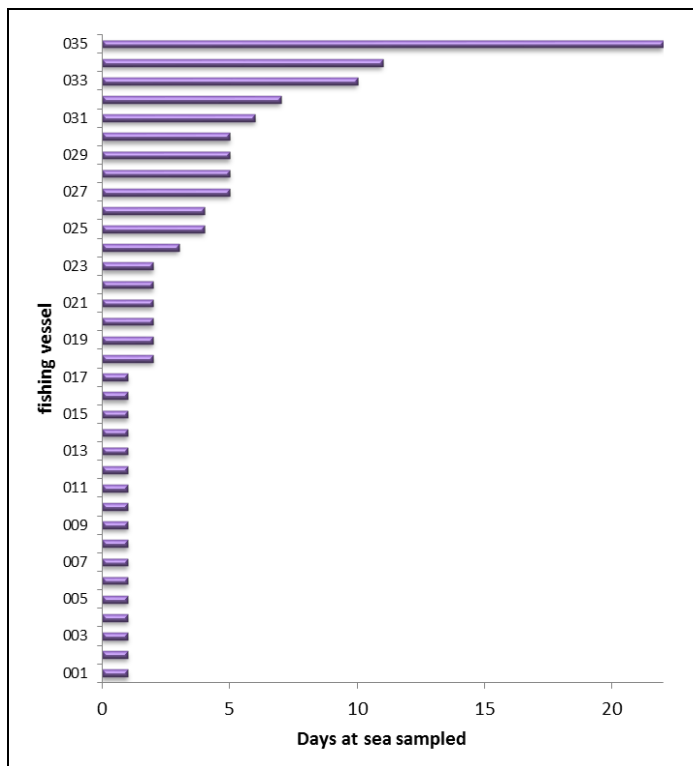


Figure 6: Number of fishing days sampled per fishing vessel on Bonaire.

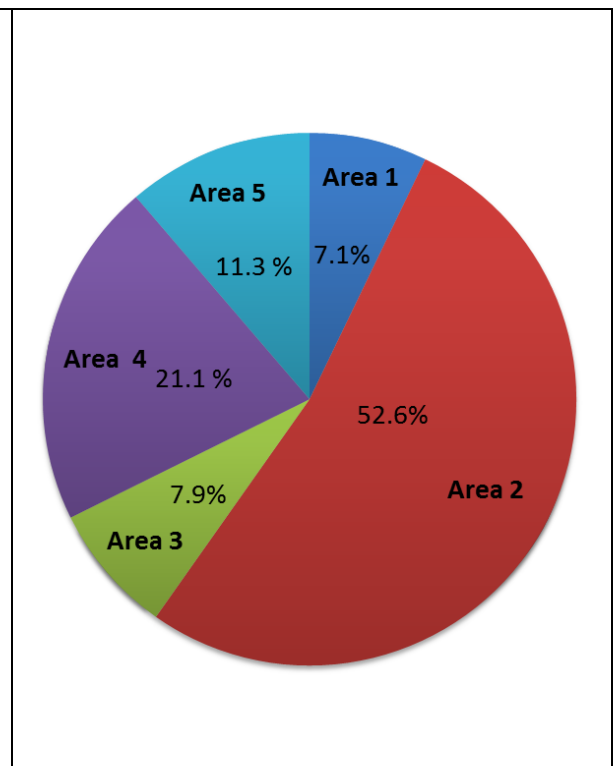


Figure 7: Effort (number of fishing days) per sub-area on Bonaire

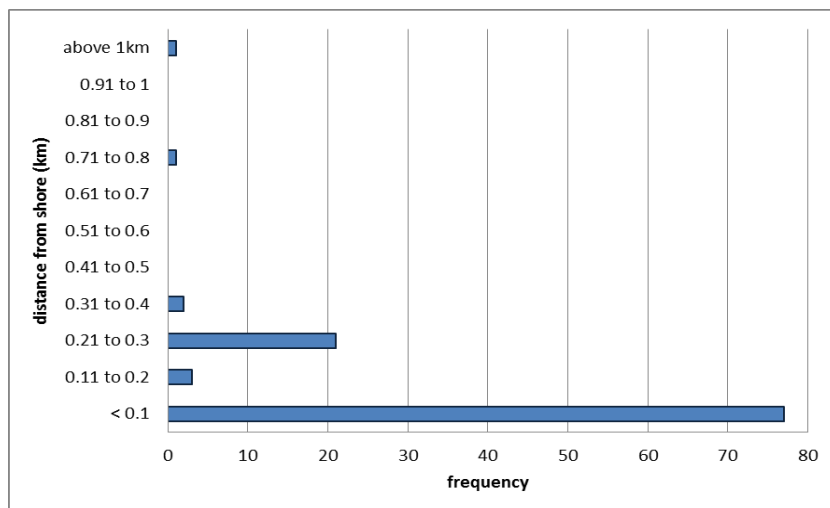


Figure 8: Frequency of fishing days in relation to distance to shore around Bonaire

### 3.2 Cetacean sightings

#### 3.2.1 Saba

A total of 107 sightings (939 animals) was made and categorized as either "dolphin" or "whale" (Table 4). For the 36 whale sightings (62 animals) 28% of the sightings were identified as humpback whales and 3% (one sighting of one animal) as a sperm whale. The remaining 69% were not identified to species.

Table 4: Overview of number of whale and dolphin sightings, numbers and mean group size recorded during the Saba port sampling 2012 to 2014.

	<i>sightings</i>	<i>numbers</i>	<i>mean group size</i>
humpback whale	10	13	1.3
sperm whale	1	1	1.0
non identified whale	25	48	1.9
<b>total whales</b>	<b>36</b>	<b>62</b>	
bottlenose dolphin	5	49	9.8
"like" bottlenose dolphin	2	6	3.0
"like" spinner dolphin	2	115	57.5
pilot whale	1	15	15.0
non identified dolphin	61	692	11.3
<b>total dolphins</b>	<b>71</b>	<b>877</b>	
<b>total whales &amp; dolphins</b>	<b>107</b>	<b>939</b>	

A total of 71 dolphin sightings with a total of 877 animals were recorded (Table 4). Of these sightings 8% were identified as bottlenose dolphins, 3% as "like" bottlenose, 3% as "like" spinner and 2% as pilot whales. The remaining 83% of the sightings were not identified on a species level.

The mean group size of all dolphin sightings was 12.4, but ranged up to 50 (Figure 9).

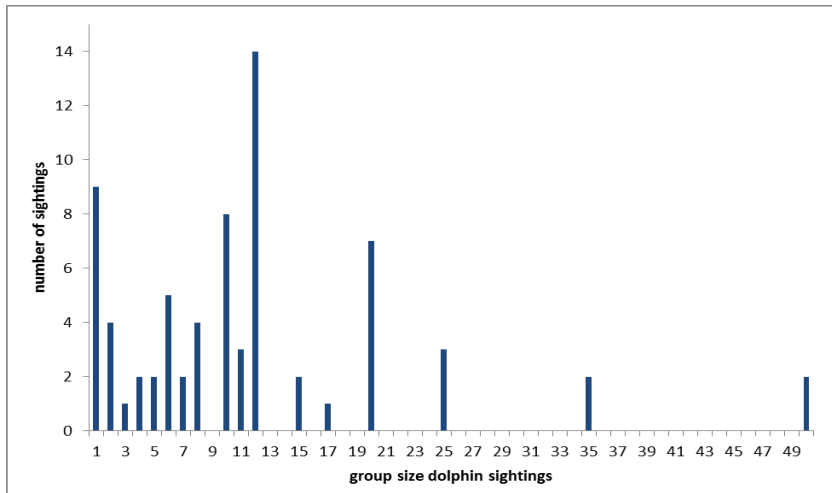


Figure 9: Distribution of group sizes for dolphin sightings made from Saba during the port sampling. Group sizes of 50 or above were pooled.

### 3.2.2 St. Eustatius

Only five sightings of cetaceans were reported by the fishermen from St. Eustatius (Table 5). Of these four were made outside the sub-areas, three around a Fish Aggregation Device 15 km west of the island, and one on Saba Bank >20 km to the west. The remaining sighting was in sub-area 3 and was of a group of about 100 unidentified dolphins.

Table 5: Overview of number of whale and dolphin sightings, numbers and mean group size recorded during the St. Eustatius port sampling 12<sup>th</sup> November 2012 to 13<sup>th</sup> November 2014.

	sightings	numbers
humpback whale	2	5
<b>total whales</b>	<b>2</b>	<b>5</b>
spinner dolphin	1	40
non identified dolphin	2	104
<b>total dolphins</b>	<b>3</b>	<b>144</b>
<b>total whales &amp; dolphins</b>	<b>5</b>	<b>149</b>

### 3.2.3 Bonaire

During the sampling period on Bonaire a total of 23 sightings of cetaceans was made, four of these were of unidentified whales, the remaining 19 of unidentified dolphins (Table 6). The mean group size of dolphins was 18 animals with the largest group size consisting of 45 animals (Figure 10).

Table 6: Overview of number of whale and dolphin sightings, numbers and mean group size recorded during the Bonaire port sampling 2014 (21<sup>st</sup> of January 2014 to 28<sup>th</sup> October 2014).

	sightings	numbers	mean group size
non identified whale	4	4	1
non identified dolphin	19	341	18
<b>total whales &amp; dolphins</b>	<b>23</b>	<b>345</b>	

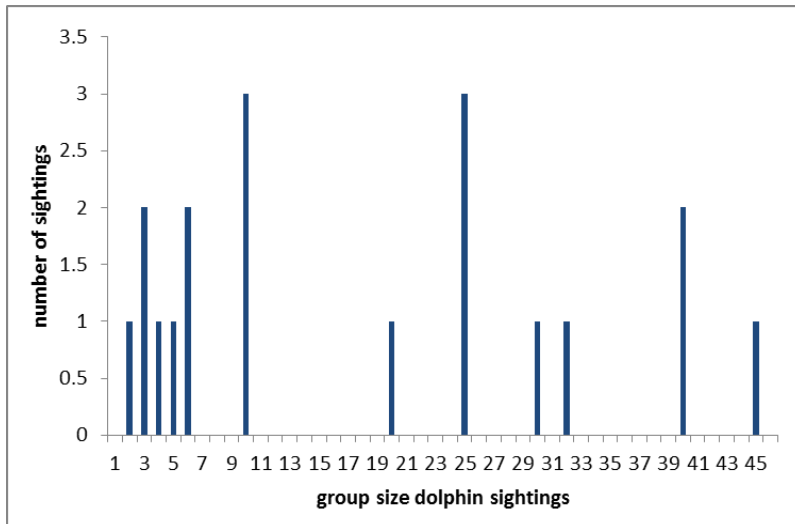


Figure 10: Distribution of group sizes for dolphin sightings made from Bonaire during the port sampling

### 3.3 Spatial distribution

For the representation of the spatial distribution of dolphins and whales, the sightings (not number of animals) per fishing effort (fishing day) per sub-area were calculated. For these maps all effort and all sightings were pooled across the period sampled at each island.

#### 3.3.1 Saba

Effort from Saba was predominantly over the Saba Bank to the west of the island, and up to extended out to 50 km from the island (Figure 11 & 12).

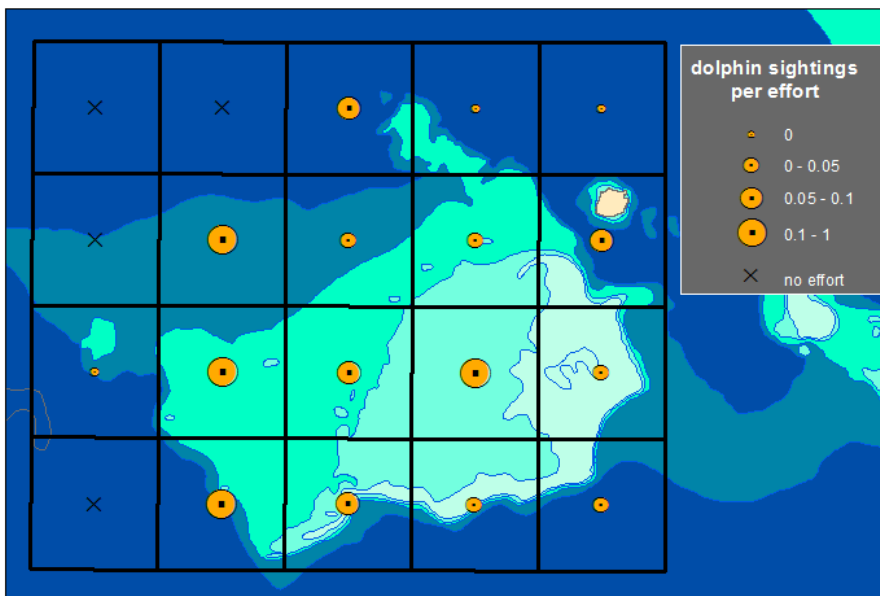


Figure 11: Distribution around Saba of dolphin sightings by sub-area per fishing day.

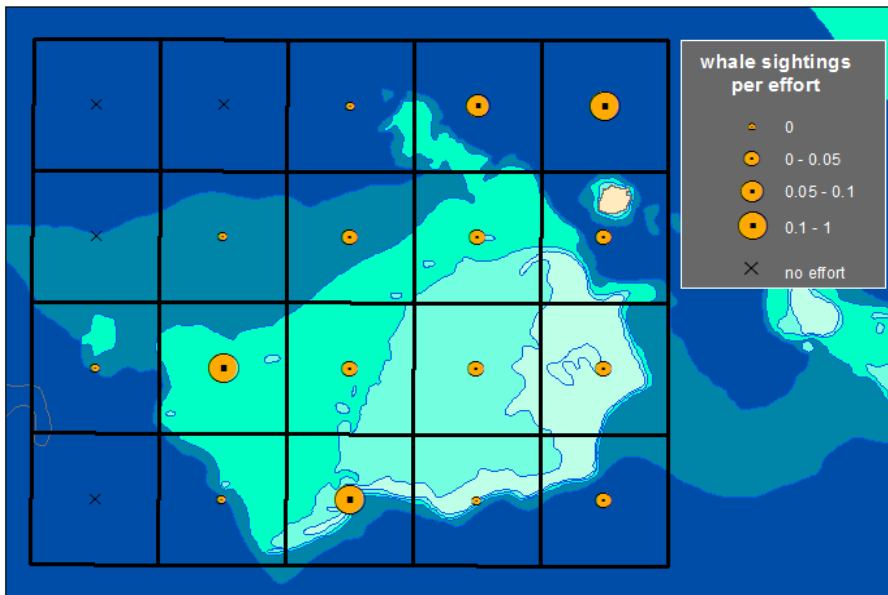


Figure 12: Distribution around Saba of whale sightings, by sub-area, per fishing day.

### 3.3.2 St. Eustatius

During the port sampling on St. Eustatius the one sighting of a group of 100 dolphins was sub-area 3, to the west of the island (Figure 13). Although fishing effort occurred in all areas, no other cetaceans were recorded.

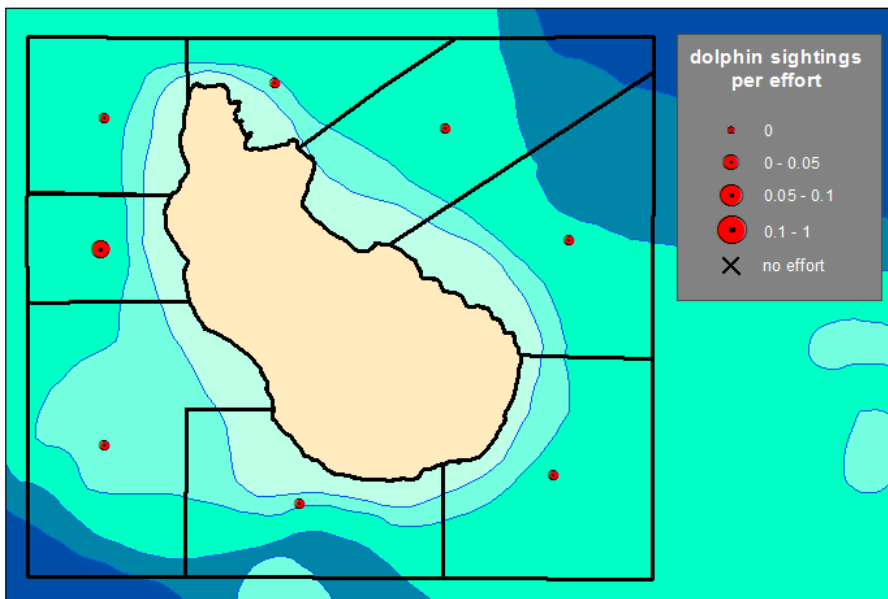


Figure 13. Distribution around St. Eustatius of all dolphin sightings, by sub-area, per fishing day

### 3.3.3 Bonaire

Figure 14 and 15 show an overview of dolphin and whale sightings per fishing day in the five sub-areas around Bonaire. Fishing effort occurred in all sub-areas and sightings were distributed uniformly around the island, except for a slight drop in dolphin sightings off the SW coast and slight increase in whale sightings off the SE coast.

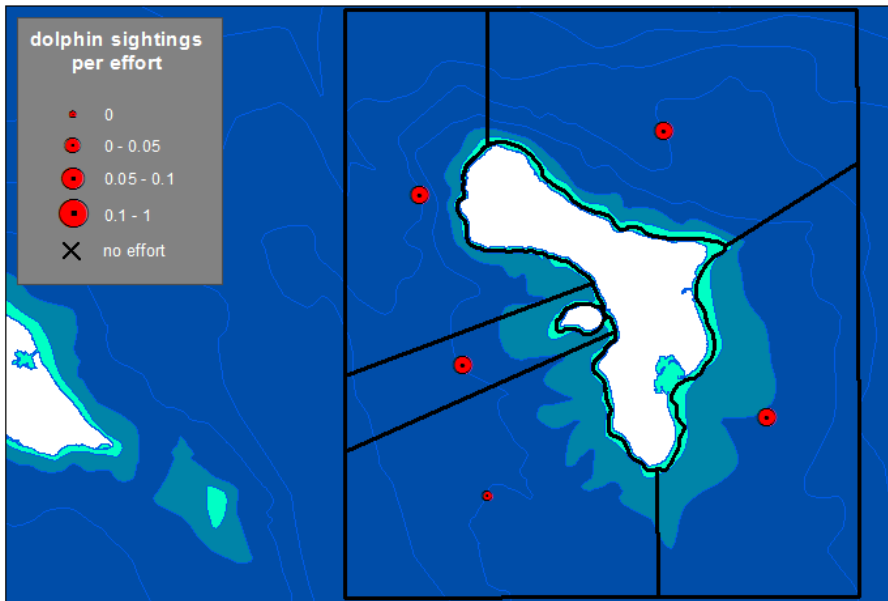


Figure 14. Distribution around Bonaire of all dolphin sightings, by sub-area, per fishing day.

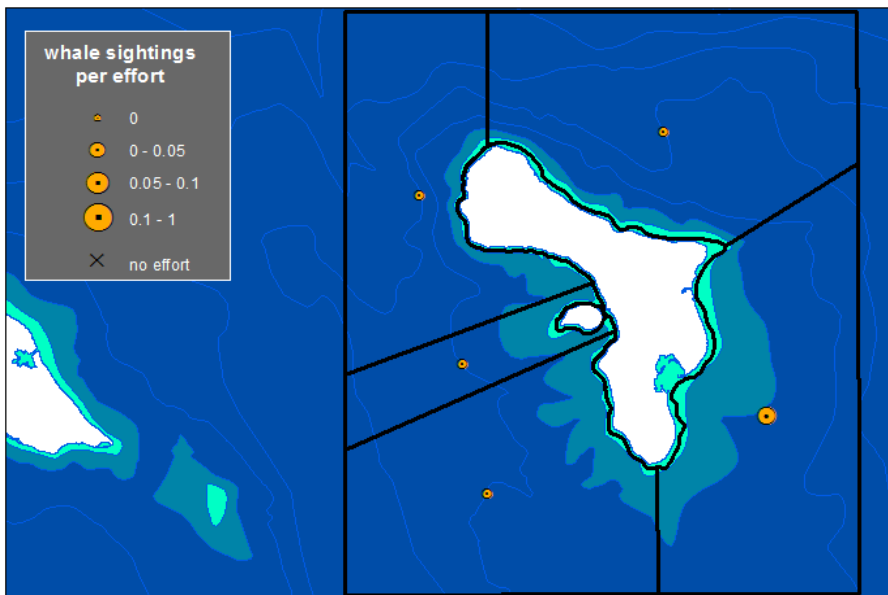


Figure 15: Distribution around Bonaire of all whale sightings, by sub-area, per fishing day

### 3.4 Seasonal changes

#### 3.4.1 Saba

Almost all sightings of whales were made in the early spring, with the highest numbers in March (Figure 16). For dolphins, sightings occurred every month, but most sightings were made in March and September. Effort of sampling was highest in the Autumn and lowest in the winter and early spring months. When looking at the relative occurrence, thus sightings per fishing day, dolphins occur in more or less the same density in all months except March (Figure 17).



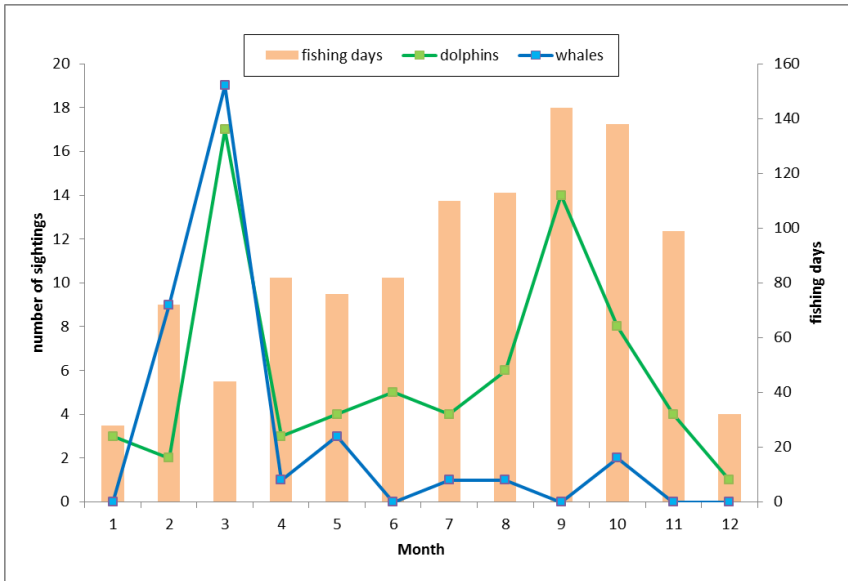


Figure 16: Number of whale and dolphin sightings recorded per month during the Saba port sampling (2012 to 2014). Effort of sampling is displayed as fishing days of sampled fishing vessels.

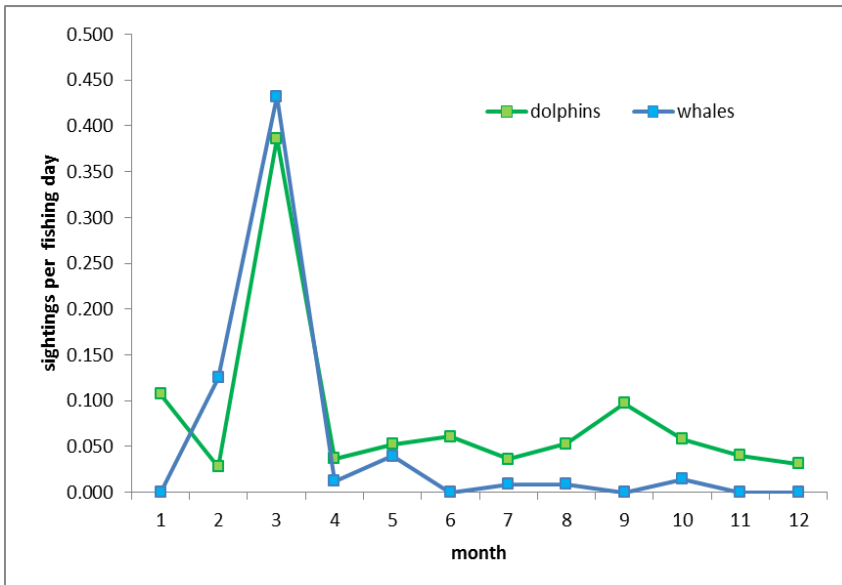


Figure 17: Number of whale and dolphin sightings per fishing day per month during the Saba port sampling (2012 to 2014).

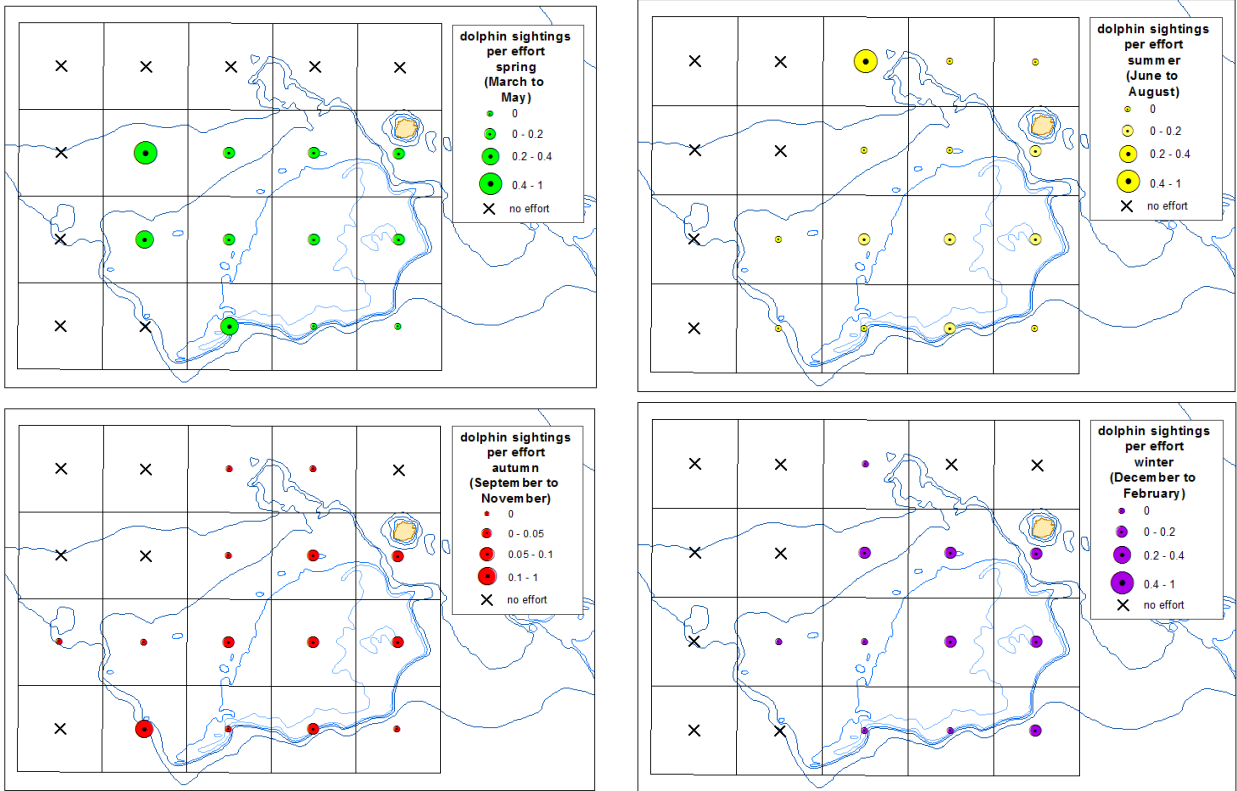


Figure 18: Seasonal distribution (spring, summer, autumn and winter) of dolphin sightings per fishing day around Saba as derived from the port sampling. All data combined from 10 July 2012 to 10 November 2014.

### 3.4.2 *St. Eustatius*

Despite high effort relative to the other islands, only five sightings of cetaceans were recorded during the *St. Eustatius* port sampling (of which four were made outside the study area shown in figure 2). The two humpback whale sightings were made in February and March, the three dolphin sightings were made in January and February (Figures 19 and 20).

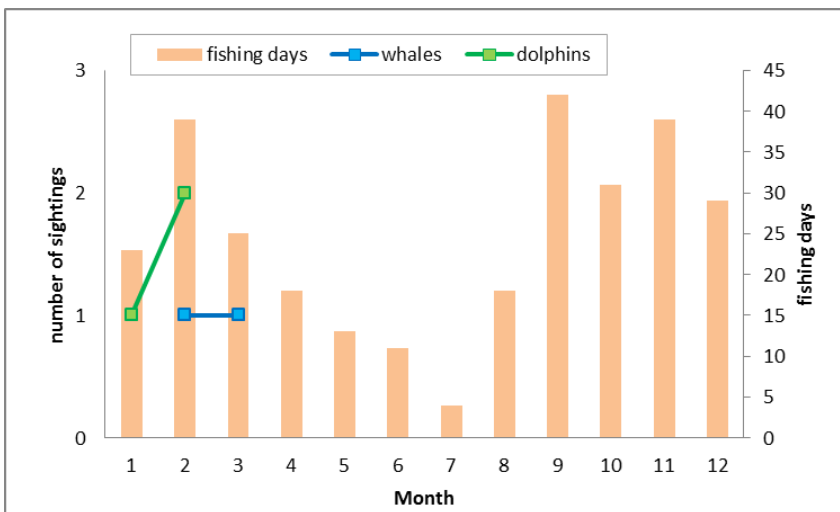


Figure 19: Number of whale and dolphin sightings recorded per month during the *St. Eustatius* port sampling (2012 to 2014). Effort of sampling is displayed as fishing days of sampled fishing vessels.

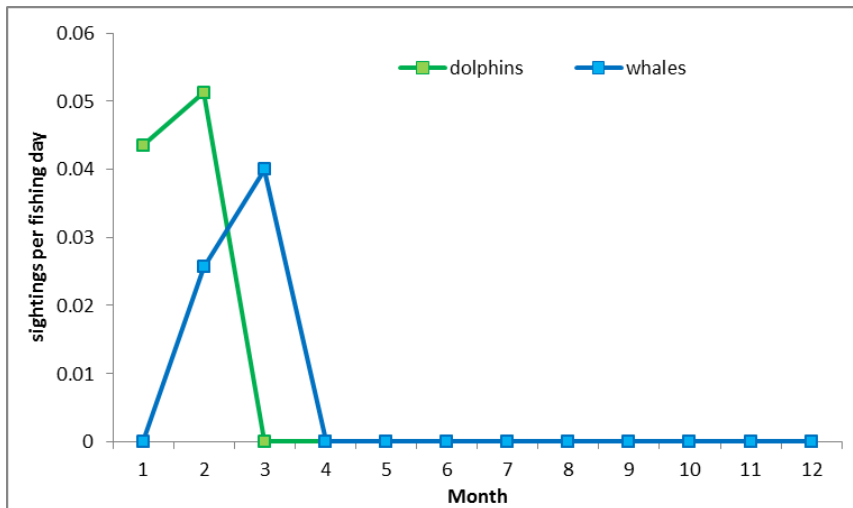


Figure 20: Number of whale and dolphin sightings per fishing day per month during the St. Eustatius port sampling (2012 to 2014).

### 3.4.3 Bonaire

On Bonaire cetaceans were registered commonly in the area (Figure 21 and 22). In the months July and August sampling effort was very low with only 2 vessels interviewed per month (figure 21).

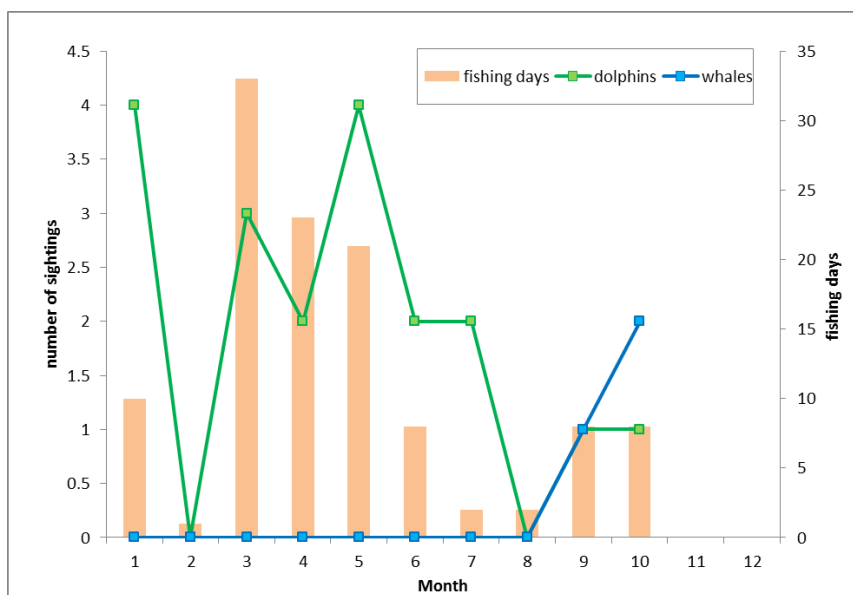


Figure 21: Number of whale and dolphin sightings recorded per month during the Bonaire port sampling (21 January to 28 October 2014). Effort of sampling is displayed as fishing days of sampled fishing vessels.

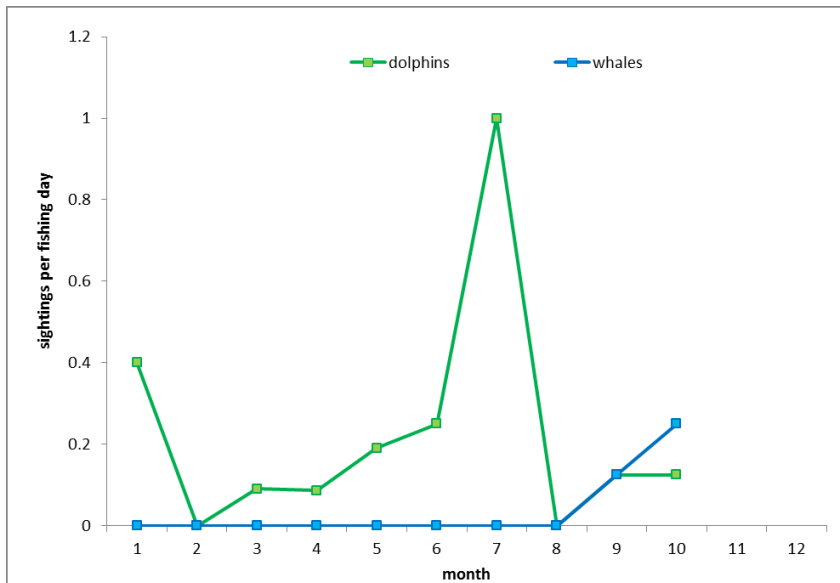


Figure 22: Number of whale and dolphin sightings per fishing day per month during the Bonaire port sampling (21 January to 28 October 2014)

### 3.4.4 Comparison between islands

The effort for the three islands differ with Saba having the monitoring for cetaceans in place for already 29 months (1020 fishing days), St. Eustatius for 25 months (292 fishing days) and Bonaire 10 months (116 fishing days). Even though the effort was lowest on Bonaire, a first comparison of the relative occurrence of cetacean sightings shows that at this island we find a much higher number of cetaceans registered than St. Eustatius (Figure 23). All islands have records of dolphins and/or whales, with (for now) the highest numbers of whales per effort seen in Saba.

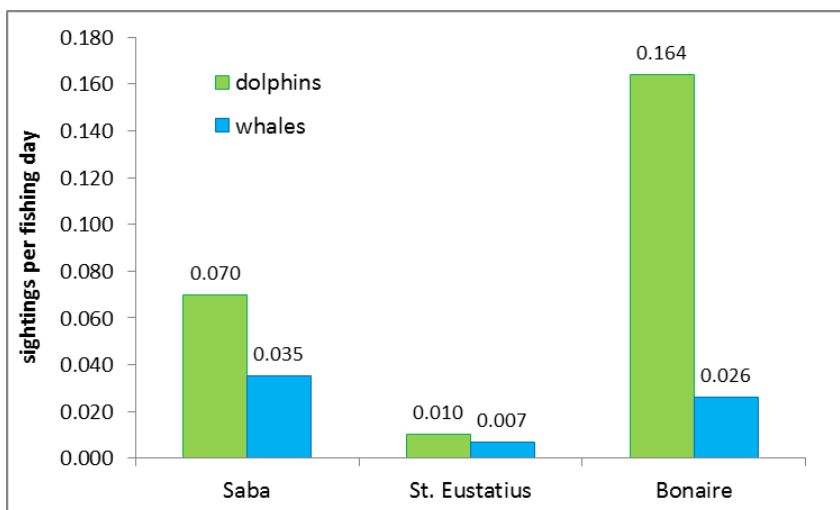


Figure 23: Comparison of relative occurrence of dolphins and whales (sightings per fishing day) between Saba, St. Eustatius and Bonaire.

## 4. Discussion

The results of this monitoring program provide interesting and new information even though the sampling scheme was brief with less than 3 years per site. For example, it is apparent that the relative density of dolphins in Bonaire's waters is markedly higher than the densities observed on the other two islands. Most of the sightings on Bonaire were made close to the coastline (<1 km) and in sub-area 2, partly because this is where most of the fishing effort is occurring. Considering that monitoring in that area has only been going on for 10 months it will be very interesting to evaluate if this is a "hot spot" throughout the year and between years or an artefact of fishing behaviours and/or sampling design.

Humpback whales are easy to identify. They show a range of conspicuous behaviours, such as breaching, which makes it possibly more easy to identify them. Of the 13 whale sightings for which species was identified, 12 were identified as humpback whales. It is likely that a significant proportion of the 29 sightings of unidentified whales were also humpbacks. The main occurrence of whale sightings was in the months January to March in the northern islands, and September and October in Bonaire, which fits with current knowledge on humpback whale migration patterns in the area (e.g. Swartz et al. 2003).

Seasonal occurrences of dolphins are apparent in the Saba data, which provides the longest time-series. Dolphins were recorded every month, but there was a marked increase in sightings in March, also coinciding with an increase of whales. It is not clear if and how the increase in whale and dolphin sightings is related. Assuming most of the whale sightings are humpbacks, we know that they come to the Caribbean to reproduce and during that time generally do not feed (e.g. Clapham 2000). The distribution of dolphins is most likely linked to prey availability. This pattern needs some further investigation on what underlying process is occurring here.

The spatial distribution of dolphin sightings by fishing vessels operating out of Saba shows that Saba Bank is widely used by the dolphins. The identification of bottlenose dolphins on the Saba Bank gives some credit to the hypothesis that there might be resident groups using this area, at least at certain times of the year. There have been a number of studies on bottlenose dolphins, primarily using photo-identification, in other areas of the Caribbean describing the movements and social structure of resident populations (e.g. Rogers et al. 2004, Kerr et al. 2005, Whaley et al. 2006, Roland 2014).

### Evaluation of the method

One of the aims of this study was to evaluate the quality of the data collected through port sampling and to identify where it can be improved. In this section current short comings are highlighted and a common data format for all islands is advised for the future (Appendix A).

#### **Effort**

Monitoring effort has neither been consistent over time nor between the areas. The number of surveyed fishing days through port interviews depends on a number of factors, including: 1. Availability of personnel conducting the interviews and 2. Availability of fishermen fishing to be interviewed. In principle the more vessels that can be sampled, the better. Taking into account the minimum number of sightings made per fishing trips and the number of vessels available per island, our advice is to:

- sample a minimum of 40 fishing trips per month on Saba
- sample a minimum of 20 fishing trips per month on St. Eustatius and on Bonaire

The three study areas differ in the size they cover. The Saba area is quite large, encompassing the Saba Bank. The study area in St. Eustatius is very small and only one sighting was recorded within the sampling map area. Additional sightings were made further offshore, but the current sampling map does not include these areas (Saba Bank and Fish Aggregation Device). The subareas used for the three islands are very different in size and in their use by fishermen.

It is important not to interpret the study areas as an actual representation of the space that is covered during fishing efforts. The use of sub-areas allows us to give some indication of effort. This makes the data comparable between days, months and years and gives a relative index of cetacean occurrence. On Bonaire most of the fishing effort is taking place very close to the coast and information on distance from shore for the fishing effort is provided, indicating that most effort of fishermen is close to the shore.

Our advice is to:

- include the distance to shore for both Bonaire and St. Eustatius in the sampling
- extend the sampling map for St. Eustatius to include the Saba Bank and the Fish Aggregation Device for fishing effort and sightings

For Bonaire most of the interviews were conducted with only a few fishermen. Ideally the sampling of the vessels for the interviews would be representative of all active fishermen.

It would be advisable to:

- for Bonaire, try to spread out sampling over a larger number of fishermen

### **Data quality of records**

#### ***Species identification:***

Species identification of cetaceans is not always straight forward. The port sampling at this time asks for making a decision if the sightings were "dolphins" or "whales". Humpback whales are probably the most easy to identify, especially when they show active surface behaviour. Also bottlenose dolphins seem to be recognizable, in particular when they are close to the vessel (e.g. even bow riding). It would be good to provide the programme with a clear definition on what species fall under the respective categories "dolphin" and "whale". The main factor here is size, which is not always easy to determine at sea.

Some fishermen provide additional information on the sighting which can sometimes indicate what species it is (e.g. typical jumping behaviour of spinner dolphins). In 2012 the fishermen of Saba were given laminated sheets to aid in the identification of cetacean species (Appendix B). One other way to potentially improve the quality of the species identification would be to obtain photographic records of the sightings.

Our advice is to:

- provide all fishermen with laminated guides for the most common cetacean species in the area
- encourage the fishermen during the interviews to include descriptive comments on the sightings

#### ***Group sizes:***

Group sizes are provided in different formats for the three islands. They are sometimes given as range and/or as a mean or best estimate. For the database one format is advisable, including a best estimate. For those cases where we only had a range we converted it to a mean. In the future it would be best to have a best estimate with a range (maximum – minimum) when reporting group size.

For the protocol on how to record group sizes it would also be important to provide the participants with a definition of what a group is (e.g. a group of animals engaged in the same behaviour and not more than 10 body lengths from each other).

Advice:

- provide the fishermen with clear definitions on what a group is
- give group sizes as best estimate, minimum and maximum

#### ***Group composition:***

When describing the sighting sometime information is given on the group composition, e.g. number of calves present in the group. This type of data can be very valuable. To ensure that the term "calf" is used consistently a training and/or guide on the definition of the different age and sex classes would be needed.

Advice:

- encourage fishermen to note if any smaller animals / calves are present within a sighting

### **Behaviour:**

Sometimes the behaviour of the observed animals is noted. The descriptions don't follow a standard language (e.g. "jump", "breach"). Any description of behaviour can be helpful, but to standardize this it would be necessary to provide the participants with a training and/or guide on cetacean behaviour.

Advice:

- consider some kind of training and/or include more information on behaviour of cetaceans in a printed guide for the fishermen

### **Costs**

Using the current questionnaire, the costs of data collection are very low. To answer the additional question on whale and dolphin sightings in the port sampling scheme does not take a lot of effort on the part of the interviewer or the participant.

The analyses costs are relatively low. The main effort at the moment is spent streamlining and checking the three databases. The standardization of the formats will aid in this.

For the future we would also advise:

- to use a standardized format for the data collection forms and the database

### **Outlook**

Little is known on the local distribution of cetaceans in these waters. The use of vessels that regularly occur in these waters provides year-round information that is not easily available. For Saba Bank the data has shown that dolphins are present all year round and the data indicates that there might be resident populations of bottlenose dolphins using the Saba Bank. This data could be used as a basis for more dedicated studies and it also leads to a number of potential research questions for the future (Table 7).

In the future it would be important to investigate if some of the participating fishing vessels would be interested to take on a more active role in the monitoring. There are some option to increasing the accuracy of the sightings and effort collections significantly, but they would include a higher engagement by the participating fishermen. They could for example use a Global Positioning System (GPS) to record the exact positions of the fishing trip, have a camera on board to take video or photos of sightings to aid in the species identification and go through a more intense training for the identification of species. This type of dedicated monitoring work would be associated with additional costs.

*Table 7: Overview of some potential research questions arising from the results of the port sampling, monitoring program*

Short title	description	methods
Distribution and habitat use	This study shows marked differences between the three study areas. Designated surveys covering the different habitats could allow the investigation in what kind of parameters influence the distribution and density of cetaceans. This would provide baseline data on cetacean distribution and their habitat use.	Designated surveys; habitat modelling
Residency of bottlenose dolphins in Saba and Bonaire waters	Some type of designated study, e.g. by using passive acoustic or designated surveys including photo-identification, and/or biopsy sampling could be used to determine if there are resident populations (in particular of bottlenose dolphins).	Photo identification; genetic fingerprinting
Investigation of potential "hot spot" Bonaire	The results indicate that the coastal area around Bonaire, in particular in the sample area 2, is home to a relatively high number of dolphins. It can be hypothesized that this area holds some resident population(s) and their close proximity to the coast and their probably predictable occurrence would make them an ideal study object for a targeted study.	Designated local surveys; photo-identification
Investigate the overlap of human use of the areas and indicated cetacean distribution	In some of the areas a potential overlap of high human use (e.g. fishery, shipping, tourism) and cetaceans can be assumed. Aim of this project would be to compile information on human use as well as cetacean distribution and to conduct a risk analyses.	Risk analyses

## 5. Conclusions

The results of the evaluation of the current monitoring program show that there are a number of straight forward adjustments that can be made to improve the data quality. Further training of the participants and interviewers of all three islands would make sure that the same definitions are used when describing sightings of cetaceans. Involvement of the fishermen not only in the data collection but also in the sharing of the results could help their commitment to report sightings.

For St. Eustatius with the apparently lower densities of cetaceans, it is important to increase the sampling effort. In general it would be good to have a minimum number of interviews conducted per month per island. The more consistent the effort per month is, the more useful the obtained information. When the data is entered it is necessary to introduce a standardized data format, so the data can be compiled in one database. Furthermore, a continuous data quality control is advisable to ensure that errors in the database can be detected and fixed as soon as possible.

One of the main advantages of this program is that the costs of data collection are low as it is taking advantage of the established data collection of the port sampling scheme. Furthermore, in particular once the data collection is streamlined, the analyses costs are fairly low if they are done at the level we are presenting here.

There are some further possible improvements in the data sampling. In theory fishermen could be provided with digital cameras and GPS systems to allow them to precisely record the positions of sightings and to help with the identification of species. However, the main question is in what way such type of added quality is possible to obtain, how much this would cost and if it is necessary for the aim of this study. The main priority of the fishermen is to fish and increasing the effort in recording cetacean sightings is not something they might be able or willing to do.

The results from this study are also useful to define research questions and conduct designated projects. They can also be linked further with ongoing work, such as sightings made from land (e.g. Saba) or from vessels. The data obtained could be used in combination with a passive acoustic listening device on Saba Bank (planned to be deployed). Table 7 provides some possible ideas that could be followed up.

Interviews of fishermen have been used to assess the occurrence of marine mammal intentional or unintentional catch (e.g. Ayissi and Jiofack 2014, Moore et al. 2010, Zerbini & Kotas 1998). This method has also been applied to determine the scope of cetacean depredation in longline fishery (e.g. TEC Inc. 2009). However, using this type of methodology is not common for recording the presence of cetaceans.

This study gives an indication of the kind of data that can be collected within the existing port sampling project, how the current program can be improved and also highlights the limitations of the results obtained. It shows that identification of cetaceans on a species level, in particular dolphins, is most likely still on a low confidence level. Although effort is not equal over the study area, by collecting sightings data in relation to fishing effort, first information on the spatial and temporal distribution of dolphins and whales can be obtained. This type of data can be used as a baseline for a long-term baseline as well as future (more dedicated) research work.

In summary, for regions with no dedicated survey efforts, a low number of stranding records and in general a low density of cetaceans, the use of port sampling provides valuable baseline data which can be used to design targeted research questions.



## **6. Quality Assurance**

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

## **Acknowledgements**

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## Justification

Report : C038/15  
Project Number : 4308601070, 4308601071, 4308601075

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

Approved: Dr. R.J. Kirkwood  
Researcher

Signature:



Date: 27 February 2015

Approved: Drs. F.C. Groenendijk  
Head of Maritime Department

Signature:



Date: 27 February 2015

## Appendix A. Proposed data collection format

dd/mm/yyyy	Day	Month	Year	Boat name	Trip_ID	Fishing area	Observed area	distance from shore (km)	best number	min number	max number	species	time	behaviour	Comments	
5/6/2015	5	6	2015	Bobby	222	B2	none									
10/7/2015	10	7	2015	Anna Maria	223	B5	B5	0.5	33	26	35	dolphins	6:00	jumping in the air		
12/7/2015	12	7	2015	Bobby	224	C4	none									
25/8/2015	25	8	2015	Lucky 7	225	C3	C3	5	5	5	5	bottlenose dolphins	14:00		one calf	
25/8/2015	25	8	2015	Lucky 7	225	C3	C3	3	2	2	2	humpback-whale	15:00			
25/8/2015	25	8	2015	Bridget	226	D3	none									
26/8/2015	26	8	2015	Anna Maria	227	A4	none									
29/8/2015	29	8	2015	Anna Maria	228	C5	none									
1/9/2015	1	9	2015	Bridget	229	D1, D2	D1	unknown	1	1	1	whale	unknown	breaching		
5/9/2015	5	9	2015	Bridget	230	B4	B4	0.2	3	3	4	whales	unknown		one group of whales	
...	.	.	.	...	.	.	.	.	.	.	.	...	.	.	...	...
...	.	.	.	...	.	.	.	.	.	.	.	...	.	.	...	...

## Appendix B. Cetacean guide

### Short ID sheet whales and dolphins Dutch Caribbean

#### Most common species:

Humpback whale – *Megaptera novaeangliae* - bultrug

Fin whale – *Balaenoptera physalus* – gewone vinvis

Minke whale – *Balaenoptera acutorostrata* - dwergvinvis

Sperm whale – *Physeter macrocephalus* - potvis

Short-finned pilot whale – *Globicephala macrorhynchus* – tropische griend

Bottlenose dolphin – *Tursiops truncatus* - tuimelaar

Spinner dolphin – *Stenella longirostris* – spinner dolfijn

Clymene dolphin – *Stenella clymene* – gehelmde dolfijn

Common dolphin – *Delphinus delphis* – gewone dolfijn

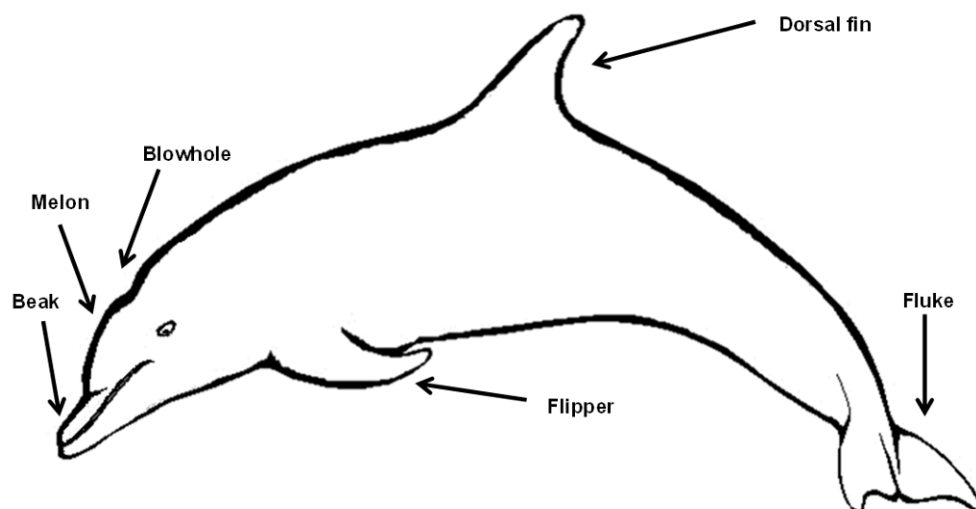
Atlantic spotted dolphin – *Stenella frontalis* – Atlantische gevlekte dolfijn

Pantropical spotted dolphin – *Stenella attenuata* – pan-tropische gevlekte dolfijn

#### What to note during a sighting:

- Position
- Species (if known)
  - Group size
  - Date and time

#### Topography of a dolphin:



More info: Meike Scheidat [meike.scheidat@wur.nl](mailto:meike.scheidat@wur.nl); Steve Geelhoed [steve.geelhoed@wur.nl](mailto:steve.geelhoed@wur.nl)

## Humpback Whale – *Megaptera novaeangliae*

large whale, mostly solitary or in pairs (mother-calf)

Length: ca. 16 m

- tail flukes serrated edge, varying black and white pattern on underside



- extremely long flippers (appr. 4m)



- blow rounded and bushy, still visible when dorsal fin emerges
  - small bump before the small dorsal fin
  - **tubercles on head** and lower jaw



## Fin Whale *Balaenoptera physalus*

large whale; length : ~24m



- **right lower jaw white**, V-shaped pattern (chevron) behind head
- tall, columnar blow, blowhole surface briefly before dorsal fin emerges
  - rarely shows tail before diving
  - sharp dorsal fin, often pointed or falcate
  - coloration: dark grey above, white/cream below

## Minke Whale *Balaenoptera acutorostrata*

small size whale; length: 9-11m



- **sharply pointed snout**; sharp ridge on the snout
  - V shaped head when seen from above
- falcate dorsal fin, appears simultaneously with the blowholes during surfacing
  - **white band** on flippers
  - no fluke up when diving, often arches the back
    - inconspicuous or no blow
- coloration: black or dark grey above; grey chevron behind head; white underneath





## Sperm Whale *Physeter macrocephalus*

large whale; length: 18m (male); 11m (female)

- typically solitary or small groups; normally in offshore deep water



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- single blowhole on left side of head, bushy blow angles forward and left from front of head
  - huge bumpy head; low dorsal fin without bump in front
  - wrinkled skin (like a plum), ridge on back with bumps
    - triangular flukes lifted high at start of dive



© Steve Geelhoed



## Short-finned pilot whale *Globicephala macrorhynchus*

small sized whale, length: 7m (male), 5m (female)

- typically in groups of more than 10; normally in deep water



© Steve Geelhoed



- exaggerated and **bulbous melon head**, with beak barely discernible or non-existent; robust body, with a deep tail stock.
- **dorsal fin is wide**, broad-based, falcate and set well forward on the body
  - the **flippers are long**, slender, and sickle-shaped
    - overall coloration dark (grey)
  - but a faint **grey “saddle patch”** may be visible behind the dorsal fin

## Bottlenose dolphin *Tursiops truncatus*

medium-sized to large dolphin, length: 2.5 to 4m

- typically groups: 10 or more (also bow riding but less often than spinner)



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© Steve Geelhoed

- **robust body**
- short to medium-length “**stubby**” beak
  - **distinct forehead above beak**
  - large falcate dorsal fin



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## Spinner dolphin *Stenella longirostris*

small to medium sized dolphin, length: 1.30m to 2.30m

- typically groups of 10 or more (also bow riding)
- they can be seen **spinning** high in the air



Z98-296659 [RM] © www.visualphotos.com

- **slender body** with an extremely **long and thin beak**
  - on top **dark grey cape**, light grey on the sides and white on the belly
- a dark band runs from the eye to the flipper, bordered above by a thin light line
  - the beak is tipped with black or grey
- the dorsal fin is basically triangular, slightly falcate to erect or canted forward

## Clymene dolphin (*Stenella clymene*)

small dolphin, length: 1.70 to 2m



- small but **rather stocky** and has a moderately long beak.
- dorsal fin is tall and nearly triangular to slightly falcate
  - white belly, light grey flanks and dark grey cape
- **black "moustache"** marking of variable extent at the top of the beak.
- very similar to the spinner dolphin, coloration looks vaguely like a grey Common dolphin

## Common dolphin (*Delphinus delphis*)

small dolphin, length 1.60m to 2m



- slender body with a **long beak** sharply demarcated from the melon
- the dorsal fin is high and moderately curved backwards, often with pale centre
  - unique (hourglass) pattern with a **pale yellow patch** on the side

## Atlantic spotted dolphin (*Stenella frontalis*)

small dolphin, length: 1.7 to 2.3m

- often in groups of animals with different ages



- overall impression of a small (spotted) Bottlenose dolphin
- moderately long, **stocky beak**, with a distinctive forehead above the beak
- the **dorsal fin is tall and falcate** and the flippers are curved backwards
  - juveniles are unspotted, older individuals acquire spots
  - very similar to the other dolphins occurring here

## Pantropical spotted dolphin (*Stenella attenuata*)

small dolphin, length: 1.6 to 2.6m



- **long beak** sharply demarcated from the melon, slender body, strongly backward curved fin and spotted body
  - the ventral spots fuse and fade to a medium grey
    - tip of the beak is white
  - details of coloration and spot intensity vary regionally
- the newborn calf is unspotted, older individuals acquire spots
- very similar to the Atlantic spotted dolphin and the other dolphins occurring here