

— THE — **SABA BANK**

CORAL-CROWNED
seamount

Biodiversity
HOTSPOT

EXPLORING
natural treasures

LARGEST
National Park
OF THE KINGDOM OF
the Netherlands

DCNA nature.org

Dutch Caribbean Nature Alliance
Safeguarding nature in the Dutch Caribbean



— THE — SABA BANK

- 3 Saba Bank Symposium
- 4 Geography and Reef Structure
- 5 Expeditions to the Saba Bank
- 9 Corals
- 11 Sponges, Algae, Cyanobacteria
- 13 Fish
- 16 Marine Mammals
- 18 Birds
- 19 Fisheries
- 23 Local Stressors
- 25 Conservation Activities
- 26 Management Recommendations
- 27 Members and Contact

Editor's Letter

Dutch Caribbean 2018

Until recently the Saba Bank remained a mysterious and largely unexplored off shore atoll falling mostly within the water of the Exclusive Economic Zone, some 5 km south of Saba.

Research directed towards the exploration of the Saba Bank was initiated by the Central Government of the Netherlands Antilles and came as a direct result of the fishing pressure on the Bank, particularly by foreign vessels, and the passing of fisheries legislation.

In 2010, after the constitutional change, the Saba Bank became the direct responsibility of the Netherlands. Since that time considerable resources have been spent on the Saba Bank including several research expeditions to assess the state of the fisheries, coral reef health and

shark population. A known biodiversity hotspot, the Saba Bank is of special interest to scientists because it has remained relatively pristine thanks to its remote location. But the Saba Bank is by no means immune to global and regional impacts including the effects of climate change.

DCNA is proud to present this Special Edition, which came about as a response to the Saba Bank Symposium, organized by Wageningen Marine Research, in Den Helder in December 2016. The Symposium brought together scientists working on the Saba Bank and provided the Dutch Government with a wealth of information as well as recommendations for the future wise management of this national treasure.

"We need to improve the resilience of the Saba Bank to cope with the effects of climate change and fisheries."

Wageningen University & Research
(Becking & Meesters, 2017)

Cover photo by: © Jennett Bremer & Kai Wulf
Editor's Letter photo by: © Kai Wulf

Saba Bank: Symposium

A Symposium dedicated to the Saba Bank was organized by Wageningen Marine Research in Den Helder in December 2016. The Symposium brought together researchers and conservationists from throughout the Kingdom to share their knowledge and to provide an overview of the current state of scientific knowledge about the Saba Bank.

A special BioNews edition (<http://www.dcnanature.org/bionews-2017-1/>) was created to capture the wealth of information presented at the Symposium.

Additionally a book was produced by Wageningen University, which can be downloaded here: <http://edepot.wur.nl/400225> (Bos et al., 2016).



Presentations given at the Saba Bank Symposium can be downloaded from the WUR website:

A special thanks to Wageningen University & Research who organised the Symposium.

- *Where does our interest in Saba Bank come from?* by Paul Hoetjes
- *State of the reefs: 3 expeditions to Saba Bank* by Erik Meesters
- *Fish and fisheries at Saba Bank* by Martin de Graaf
- *Importance of Saba Bank for local communities*, by Kai Wulf
- *Research by NIOZ on the Saba Bank*, by Fleur van Duyl
- *Coral diversity and historical collections of Saba Bank*, by Bert Hoeksema
- *Shark habitat use*, by Erwin Winter
- *Listening to the Bank: whales and dolphins*, by Dick de Haan



Photo by: © Kai Wulf



Photo by: © Stan Shea

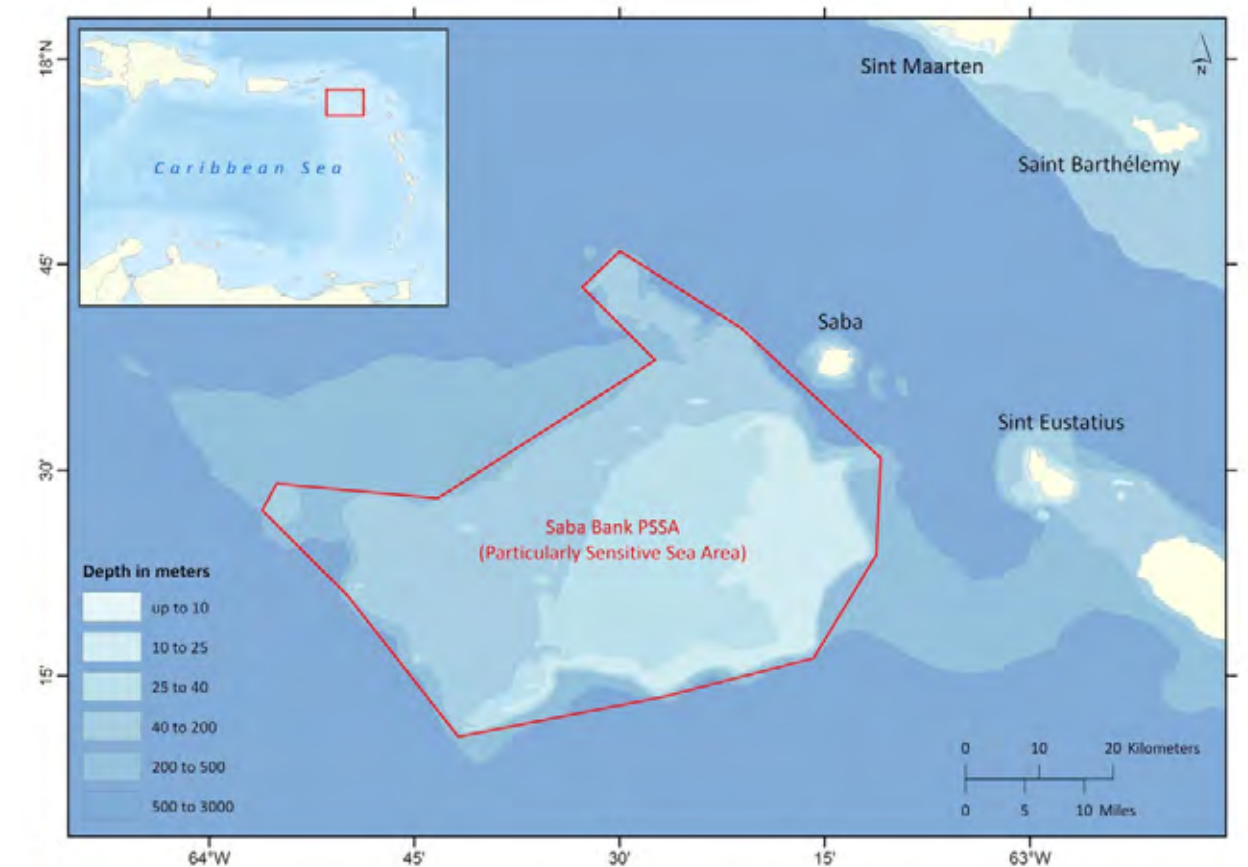
Geography and Reef Structure

The Saba Bank lies just 5 kilometers southwest of the island of Saba but extends almost 70km from the Saba coastline. It covers 268.000 hectares, an area roughly the size of the Dutch part of the Wadden Sea or, more evocatively, about the same size as Luxembourg. About one quarter of the Bank lies within Saban territorial waters (DCNA, 2017).

The Saba Bank is the second largest submerged carbonate platform of its kind and the largest in the Atlantic Ocean basin (Meesters et al., 2009). It was an island during the last glacial period until about 5,000 years ago (Van der Land 1977). There are reef crests, lagoon and beach formations, which probably formed during this and previous glaciations when the Bank was above sea level (DCNA, 2017).

This submerged carbonate platform rises from the sea floor and is crowned at the summit by a 150 km² expanse of growing coral reef (Meesters et al., 1996; DCNA, 2016). Most of the Bank lies at depths of 20 to 50 meters, but a considerable area to the east lies between 10 and 20 meters and has extensive reef development (Meesters et al., 1996). It reaches a plateau at a depth of about 15 m (Klomp and Kooistra, 2003). The western edge is deeper (50 m) and believed to be dominated by sand (Klomp and Kooistra, 2003).

Considered to be one of the world's marine biodiversity hotspots (Church and Allison, 2004), the Saba Bank is recognized under the Convention of Biological Diversity (CBD) as an Ecologically and Biologically Significant Area (EBSA). It forms a regionally unique and relatively pristine ecosystem characterized by high biological diversity and productivity (Meesters, 2013). The Bank is home to some of the richest diversity of marine life of the Dutch Caribbean (Bos et al., 2016) including sea turtles, migratory humpback whales (*Megaptera novaeangliae*) and more than 200 species of fish. It contains many different habitat types including coral reefs (patch reefs and spur and groove reefs with sandy channels), fields of calcareous algae, algal fields, sand plains, as well as limestone pavements overgrown with unique and diverse plant assemblages (Lundvall, 2008; Meesters, 2016; DCNA, 2017).



Map of the Saba Bank

Image by: © DCNA

Photo by: © Randall Ruiz

Expeditions to the Saba Bank

The first scientific expeditions to the Saba Bank took place in the 1970s with mixed results: one study concluded that the Saba Bank had minimal reef development but abundant crustose coralline algae and sponges (MacIntyre et al., 1975), while a study published soon after found that the Bank's two large windward reefs had abundant coral growth (Zonneveld, 1977). During an expedition with research vessel H.M.S. Luymes of the Royal Netherlands Navy in 1972, natural history specimens were collected that could serve as baseline material for future biodiversity studies (Van der Land, 1977; Hofker, 1980; Logan, 1990; Thacker et al., 2010; Hoeksema et al., 2011).

In the 1980s the reefs on the Saba Bank have experienced Caribbean-wide disease induced mass mortalities such as the die-off of the main urchin species in the Caribbean (*Diadema antillarum*) in 1983 (Aronson & Precht, 2001). In 2006, Scientists from Conservation International (CI), the Netherlands Antilles government and Smithsonian

Institution's Museum of Natural History carried out a two-week expedition to the Saba Bank. They uncovered a rich and healthy coral fauna, confirming Zonneveld's prior findings (1977). The Bank was recognized as a regionally unique area with relatively pristine ecosystems characterized by high biological diversity and productivity, as well as being a possible source of fish and coral larvae to downstream areas.

Research on the Saba Bank gained momentum when the Bank became the responsibility of the Netherlands in October 2010, and since then several research expeditions have taken place to assess the Bank's fish communities, coral reef health and shark population (Bos et al., 2016). As a known biodiversity hotspot, the Saba Bank is of special interest to scientists because it has remained relatively pristine thanks to its remote location, offering researchers the opportunity to study the effects of global change and reef resilience compared to other reefs in the region (Meesters et al., 2016; Bos et al., 2016).



Photo by: © Hans Leijnse

Please check the References and Publications in BioNews 1 to find an overview of the publications which are the result of these expeditions.

1968-1969

R/V Oregon, R/V Pillsbury, R/V eastward Caribbean Cruise E- 33D-70/71
Small samples of fish and possibly other organism have been collected by passing research vessels.

1999

AGRRA expedition
Less than two weeks after hurricane Lenny, the reefs of the Windward islands were surveyed using the Atlantic And Gulf Rapid Reef Assessment (AGRRA) with modifications to detect impacts by hurricane Lenny. Three sites on the Saba Bank were examined and stony coral cover of 11, 26 and 41% was reported, mainly *Montastraea annularis faveolata* (23%). Windward islands were largely influenced by hurricanes; around 1% of all the individually surveyed colonies were physically damaged and >23% was bleached with lowest percentage occurring on the Saba Bank (9%).

1972

CICAR Expedition

The first recorded expedition to the Saba Bank was in May and June of 1972 aboard the Dutch Royal Navy vessel, HMS Luymes. Collections of the benthos were made by hand using Dutch Naval divers. Twenty-five sites were sampled spanning the length and breadth of the Saba Bank. Collections included 37 species of stony corals.

2006

Conservation International expedition In January 2006, Conservation International financed a Rapid Assessment of the Saba Bank. Surveying 17 sites the expedition confirmed the high species richness on the bank and identified many species of fish, coral, sponges and macro-algae. On average researchers found one new species a day including two new species of goby, one new to science, and more than a dozen new species of macro algae as well as previously undocumented macro algal assemblages. As a result of this work Conservation International declared the Saba Bank a Biodiversity Hot Spot.



Photo by: © Hans Leijnse

1989

Corwith Cramer Cruise C-103

During this expedition a depth Recorder profile and sediment sample transect lines were completed.

2007

Royal Dutch Navy, MINA, Harte Research Institute, Conservation International (CI), and Saba Conservation Foundation

An expedition in October 2007 focused on octocorals as well as surveys of fish and conch. Two new species of gorgonian were discovered and for the first time monitoring included surveys for crustacean as well as some ROV deep water exploration. The expedition was used to ground truth a high-resolution bathymetric map based on 2006 survey data from the Dutch Hydrographic Service. Results from all expeditions so far plus a six month survey of fisheries, ship traffic and biodiversity out of Saba, formed the basis for the Saba Bank Special Marine Area Management Plan 2008 (Lundvall, 2008).

1996

Netherlands Antilles Department of Environment (MINA) survey

A first quick field survey of the Saba Bank was commissioned by the Netherlands Antilles Department of Nature and Environment in 1996. The expedition focused on the central and eastern part of the Saba Bank and surveyed approximately 1.8% of the total area. Researchers concluded that the Saba Bank is a regionally unique and relatively pristine ecosystem with high biodiversity and productivity. The survey noted a high abundance of apex predators, which are generally considered good indicators of a healthy ecosystem.

2010

CARIBSAT expedition, M.V. Caribbean Explorer

In November 2010, a team of eight scientists and conservation practitioners came together for a mapping expedition to the Saba Bank with the M.V. Caribbean Explorer. This was part of a joint project called CARIBSAT, between Martinique, Saba and Bonaire, to find ways to use satellite images to map the benthic communities and included data collected from 200 video camera drops. The expedition found that the health of the reefs of the Saba Bank had deteriorated since the first observations in 1972, 1996, and 2002. The general impression was that the Bank is still recovering from the 2005 bleaching disaster, but there is not enough data to exclude other reasons (e.g. overfishing, anchor damage, hurricanes).

Expeditions to the Saba Bank

2011

IMARES expedition aboard Caribbean Explorer

The October 2011 research expedition aimed to collect data on benthic and reef fish communities; sponges and nutritional sources of the sponge community; seabirds and marine mammals; water quality, water velocity and other physical parameters. A multidisciplinary team conducted video and visual surveys of the benthos, fish and sponges at ten sites, while sea birds and marine mammals were surveyed by means of on-board visual surveys and acoustic data loggers. The first passive acoustic monitoring sensor (noise logger) for marine mammals was placed on the Saba Bank. Water velocity and water quality were also measured on-board. During the expedition 8 sponge species were collected and 37 scleractinian coral species and 85 fish species were identified. Most frequently sighted seabirds were the Brown Booby and Magnificent Frigatebird.

2013

IMARES expedition

An international team of marine biologists collected data on benthic communities at 11 study sites, recording fish abundance and size, reef structural complexity, coral-algal interactions, water quality and connectivity. A preliminary comparison with data from 2011 showed a reduction in snappers, groupers, and grunts, whilst there were noticeably more sharks. Fewer algae were recorded on the bank, possibly indicating a healthier reef, though there appeared to be a gradient with algal cover increasing towards the island of Saba. The expedition was filmed by Mouissie Corporation and broadcast as part of a series on marine life for National Geographic.

2015

IMARES / NIOZ joint expedition aboard Caribbean Explorer

In October 2015 fourteen researchers visited 11 sites on the Saba Bank to continue benthic and fish monitoring as well as to look at productivity. Particular attention was paid to sponge communities. Other areas of the bank were also monitored using camera drops. Research teams diving at sites with a flat bottom, small low growing reefs and a substrate that was partly unconsolidated recorded 18 coral species one of which was new to science (*Meandrina danae*). Together with earlier expeditions this brings the total confirmed number of stony corals on the Saba Bank to around 40 species which includes four unattached, free living varieties of coral (coralliths). These were found by roving divers at a depth of 15-20 meters. One of the conclusions of this expedition was that the Saba Bank includes unique wave-swept habitats, which support free-living corals so far not reported from any other sites.

2016

NIOZ expedition aboard R.V. Pelagia

In August and September, a group of scientists from NIOZ, University of Wageningen and others surveyed 30 sites on the Saba Bank to investigate how environmental conditions are impacting coral reef ecosystem function on the Saba Bank. This work is part of an NWO funded project entitled "Caribbean Coral Reef Ecosystems - interactions of anthropogenic ocean acidification and eutrophication with bio-erosion by coral excavating sponges". Researchers want to gain a better understanding of the hydrography of the Saba Bank and to determine if net ecosystem calcification is occurring. In other words is the Saba Bank growing or eroding and which factors can explain these processes.

2016

DCNA Shark Tagging expedition aboard the Caribbean Explorer

In October 2016 as part of a three year long "Save our Sharks" project the Dutch Caribbean Nature Alliance ran a shark tagging expedition to the Saba Bank. Drum lines were used to catch a total of 22 sharks: sixteen Caribbean reefs sharks and six adult Tiger sharks (*Galeocerdo cuvier*). All were fitted with Passive Integrated Transponder (PIT) tags. Four of the tiger sharks were additionally fitted with SPOT satellite transmitting devices, which will be used to track the sharks movements for up to four years via the ARGOS satellite tracking system.

2016

Waitt Institute expedition aboard M.V Plan B

The Saba Bank was included in a Waitt Institute's research voyage to the Dutch Caribbean Windward Islands to collect standardized information on the status of the reefs. The surveys were conducted using GCRMN monitoring protocols in addition to new efforts in large-area reef imaging using photography and advanced image post-processing to create photomosaic images of the reefs.

Photo by: © Kai Wulf



Shark tagging expedition 2016

Expeditions to the Saba Bank

2016

WAITT Institute expedition aboard MV Plan B

Footage can be found at:
<https://drive.google.com/drive/folders/oBy3cTucxJgGFcEYyUi16OG4ycok?usp=sharing>
(Scripps Institution of Oceanography).

2018

National Initiative Changing Oceans (NICO) expedition (NWO-Science & NIOZ Sea Research)

The NICO expedition aimed to provide the Netherlands with a better understanding of changing seas and oceans (NIOZ, 2017). During the Northern Caribbean leg of the expedition, two research projects focused on the Saba Bank. The first project focused on the deep-sea habitats (100m and beyond) and their main goal was to determine the biodiversity of the deep slopes and describe how environmental conditions such as

turbulence, currents, mixing and food-supply influence live in the deep-sea. During the second project the researchers mapped the benthic habitats (from 10 until 100m depth) and investigated benthic-pelagic coupling of different benthic habitats with focus on net calcification, organic matter (bio) deposition/ mineralization and oxygen dynamics in the benthic boundary layer .

Photo by: © Hans Leijnse



Expeditions to the Saba Bank

Corals

Coral cover is the amount of bottom surface covered by live stony corals, contributing to the three-dimensional framework of the coral reef. The Saba Bank had a rich coral fauna and high coral cover in the 1990s and 2000s according to a number of studies. During a 1996 expedition on the Saba Bank, 28 hard coral species and 14 soft coral species were recorded and hard coral cover was estimated at 60 to 90% (Meesters et al., 1996). A decade later, scientists from Conservation International (CI), the Netherlands Antilles government and Smithsonian Institution's Museum of Natural History carried out a survey of the Bank and found the hard and soft coral fauna of the Bank to be very rich, abundant, diverse and representative of the Caribbean (Lundvall, 2008). Researchers counted 40 hard coral species and found a rich and abundant gorgonian fauna with 20 different species of soft coral documented. In 2015, a biodiversity assessment of the Bank recorded nearly 50 species of reef-building corals (Hoeksema et al., 2017).

However, there has been a significant decrease in coral cover in the last 15 to 20 years. Quantitative surveys carried out at 10 different locations as part of the 2011, 2013 and 2015 IMARES research expeditions revealed an important decline (Becking & Meesters, 2017), although coral cover remained stable between 2011 and 2015 (Becking

& Meesters, 2017). In 2011, living hard coral cover was only 8%, which is much lower than the coverages of 40-60% reported in 1996 (Bos et al., 2016). Some variety was found between sites, with the lowest coral cover found at "Tertre de Fleur" (2.6%) and the highest recorded on the southern edge of the Bank at "Gorgonian Delight" (15.5%) (Meesters, 2016). It is hard to pinpoint what caused this drastic decline, but a mix of events including climate change related impacts such as several bleaching events (1998 and 2005) are likely to blame (Meesters 2016; Becking & Meesters, 2017).

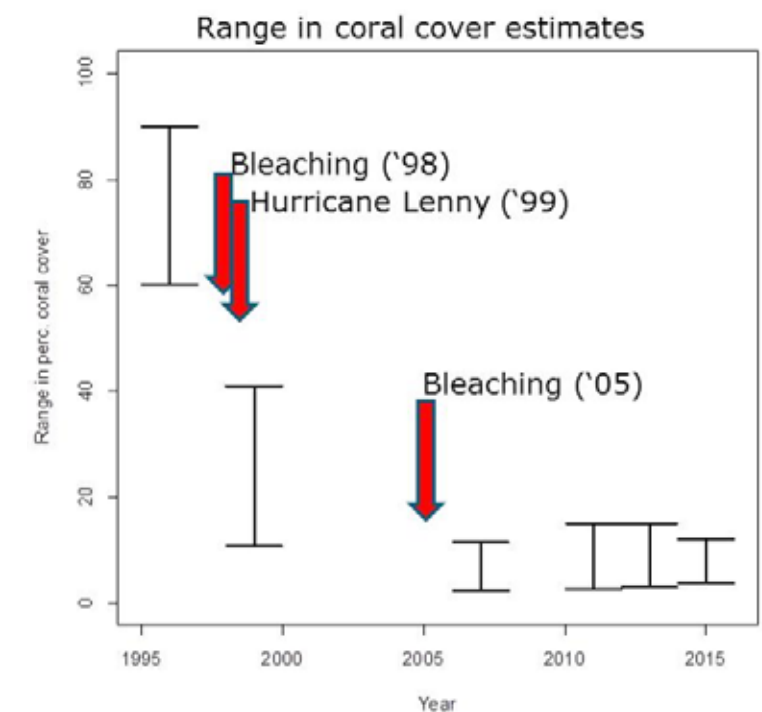
Beyond the stabilization of coral cover between 2011 and 2015, there are some encouraging signs regarding the Saba Bank's reef health. During NIOZ's 2016 research expedition, many new coral areas were discovered, as well as other habitats (Becking & Meesters, 2017). The 2011-2015 expeditions also found numerous small young coral colonies and little evidence of disease, which are good indicators for reef resilience (Becking & Meesters, 2017). Meesters et al. (1996) also described the virtual absence of diseases back in the 1990s (Meesters et al., 1996). Furthermore, it was discovered that the species-poor locality "Tertre de Fleur" harbours a unique assemblage of free-living corals, so-called coralliths, which is probably related to the special oceanographic conditions offered by the Saba Bank (Hoeksema et al., 2017).

Whilst just 9% of the Saba Bank's coral reefs were bleached in 1999 (Klomp & Kooistra, 2003), the 2005 Caribbean-wide bleaching event had devastating consequences for the Bank's reefs. It is estimated that over 50% of coral cover in the Caribbean was lost (Eakin et al., 2005), and while no accurate data for the Saba Bank is available, similar loss of coral cover was recorded on neighboring islands of Saba and St. Eustatius and many other islands in the northeastern Caribbean (Esteban & Kooistra, 2005). Anecdotal data such as comparison of before and after photographs of an identical spot on the Bank from 2003 and 2007 show an almost complete loss of coral cover (Lundvall, 2008; DCNA, 2017). A rapid assessment of stony corals in January 2006 found evidence of bleaching at 82% of the sites assessed with 43 colonies bleached (McKenna, 2010).

Bakker et al. (2016) assessed the role of the Saba Bank as a potential reservoir of diversity for the surrounding reefs by examining the population genetic structure, abundance and health status of two prominent benthic species, the coral *Montastraea cavernosa* and the sponge *Xestospongia muta*. Data indicates that there is genetic connectivity between populations on the Saba Bank and nearby Saba as well as multiple locations in the wider Caribbean, ranging in distance from 100s–1000s km (Bakker et al., 2016). "The combined results of apparent gene flow

among populations on Saba Bank and surrounding reefs, the high abundance and unique genetic diversity, indicate that Saba Bank could function as an important buffer for the region. Either as a natural source of larvae to replenish genetic diversity or as a storehouse of diversity that can be utilized if needed for restoration practices" (Bakker et al., 2016).

This chapter is based on a presentation given by **Erik Meesters (WUR)**
<https://www.wur.nl/en/download/Erik-Meesters-State-of-the-reefs-3-expeditions-toSaba-Bank.htm>



"The Saba Bank, the most pristine and largest coral reef area of the Dutch Caribbean."

Erik Meesters (Wageningen Marine Research)

Coral cover estimates for the Saba Bank from 1995 to 2015 (Meesters, 2016)

What have we learned from the past 5 years:

Reef status:

Compared to the 1990s, coral cover on Saba Bank is currently much lower. In 2011, 2013 and 2015 quantitative surveys were carried out on the Saba Bank on 10 locations. At each site 3 transects of 50 m were photographed (150m²). In 2011, living coral cover was only 8%, which is much lower than the coverages of 40-60% reported in 1996. The proximate causes for this dramatic decline remain uncertain but we suggest that bleaching and climate change are largely responsible for the lower cover of living corals on the bank. Climate change leads to warmer sea water and this causes periods when the sea water temperature is too high for corals leading to so called bleaching events, which often cause high coral mortality. In particular, the 2005 Caribbean bleaching event which decimated coral cover all over the north eastern Caribbean is important in this respect. On a positive note, between 2011 and 2015, there is no indication that coral cover has further declined. Encouraging indications for reef resilience were that there are many small young coral colonies and there are very little signs of coral disease. Furthermore, Saba Bank is not a 'sponge reef' and sponges are not becoming dominant over corals, as is the case in several disturbed eutrophic reefs in the Caribbean.

These findings seem to indicate that the Bank is relatively less disturbed. Even under the best circumstances, we have to add that restoration of coral reefs is a very slow process and might take several decades. Saba Bank will, however, not stay the same in the coming years, as it will continue to change due to climate change and this change must be considered in management plans. During the 2016 research expedition of NIOZ many new coral areas were discovered, as well as other habitats. At this moment knowledge is insufficient to set up a biologically sound benthic monitoring plan or management plan for the whole Bank – more basic knowledge of the bank is required.

Due to its high species and unique genetic diversity, the upstream position with respect to the wider western Atlantic, its large area of deeper reef, and relatively limited anthropogenic disturbance, Saba Bank serves as an important source population to the wider Caribbean. However, further research is necessary to establish to what extent and how it serves as a source and or sink for key species groups.

Wageningen University & Research
(Becking & Meesters, 2017)

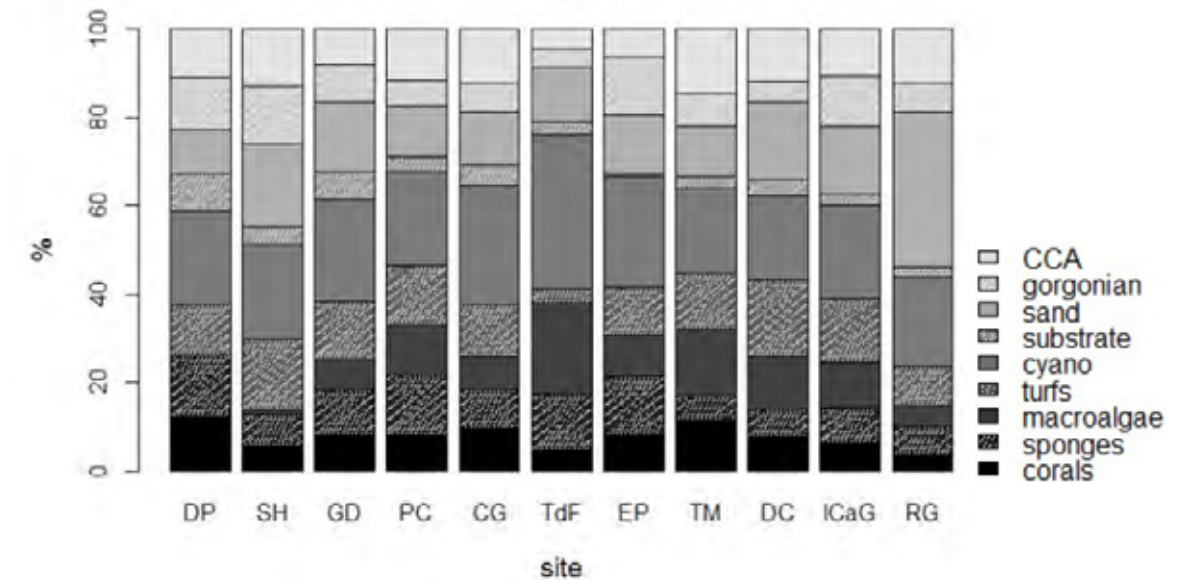


Photo by: © Hans Leijnse

Sponges, algae, cyanobacteria

Corals, sponges, macroalgae, turf algae and cyanobacteria are all naturally occurring components of the benthos which compete with each other for space. Macroalgae, turf algae and cyanobacteria appear to benefit from eutrophication (de Bakker et al., 2017). From 2012 to 2015 a shift was seen on the Saba Bank from turf algae to a cyanobacteria dominated system, possibly linked to increasing water temperatures and/or low grazing pressure on cyanobacteria (Wiltink, 2016). It is hypothesized that increased macroalgae, turf algae and cyanobacteria densities might be beneficial to sponges as they feed on the dissolved organic carbon they release (Wiltink, 2016; de Bakker et al., 2017). This, in combination with a reduction of spongivores due to overfishing, decreasing pH and climate changed induced increasing seawater temperatures, may give sponges a competitive advantage over reef building corals in the future (Wiltink, 2016; de Bakker et al., 2017). More disturbed eutrophic coral reefs in the Caribbean have changed into sponge-dominated reefs where corals abundance largely declined (Becking & Meesters, 2017). This is currently not the case on the Saba Bank where sponge cover is not considered to be high and does not appear to be increasing (Wiltink, 2016; Becking & Meesters, 2017).

Sponges are essential components of reef ecosystems (de Goeij et al., 2013). They filter small particulate material including pathogens from the water, provide habitat for many species and convert dissolved organic matter into food particles for other species (de Goeij et al., 2013; Bos et al., 2016). At least 131 species occur on the Saba Bank (Wiltink et al., 2017) and at present, "the cover and diversity of sponges indicates a resilient community" (de Bos et al., 2016). Sponge cover is generally slightly higher on the Bank than coral cover (Wiltink, 2016). One of the species that contributes most to total sponge cover is the Giant Barrel sponge (*Xestospongia muta*) and there seems connectivity between populations on the Saba Bank and Belize and the Bahamas (Wiltink, 2016; de Bakker et al., 2016). There is some concern about the health Giant Barrel sponges on the Saba Bank. A study by de Bakker et al. (2016) found the vast majority of the Giant barrel sponge (> 80%) showed signs of presumed bleaching in 2013 (although the densities and genetic diversity of *X. muta* on Saba Bank indicate a healthy population) (de Bakker et al., 2016). This is of concern as "a reduction in *X. muta* populations would likely cause a significant change in ecosystem functioning" (de Bakker et al., 2016).



Benthic cover on the Saba Bank in 2015. Mean cover values include: corals 7.82% +/- 1.26; sponges 9.62% +/- 1.48; macroalgae 9.01% +/- 2.64; turf algae 12.02% +/- 1.78; cyanobacteria 23.02% +/- 2.22 (Wiltink, 2016).



Photo by: © Hans Leijnse

During the 2006 Conservation International expedition, the Saba Bank was discovered to have an exceptionally high diversity of macroalgae (Conservation International, 2006). Littler et al. (2010), who carried out a marine macroalgal diversity assessment of the Bank during the expedition, not only found a high cover of algae (mainly *Dictyota* spp. and *Lobophora* spp.) on the reefs (Meesters, 2010) but also observed few filamentous and thin sheet forms indicative of stressed or physically disturbed environments (Littler et al., 2010). Acknowledged algae experts M. and D. Littler stated that the Saba Bank is without doubt the richest area in the Caribbean

for macroalgae (Littler et al., 2010). The following year, macroalgae were found to be the most conspicuous component of the Bank's benthic communities, most likely due to environmental conditions which favor the growth of many different types of macroalgae (Lundvall, 2008). In 2015 mean macroalgae cover was 9% which was lower than the dominant cyanobacteria cover of 23% (Wiltink, 2016). Macroalgae are a natural part of a reef community, but many studies have shown how harmful they can be to corals, inhibiting coral settlement and recruitment, slowing coral growth and making them more prone to disease (Jackson et al., 2014).



Photo by: © MMBockstael-Rubio

Sponges, algae, cyanobacteria

Fish

1. Teleosts

Despite the absence of shallow water nursery habitats, the Saba Bank ranks eighth in the Caribbean for fish species richness. A biodiversity-assessment survey carried out on the Saba Bank between 2006 and 2007 recorded a total of 270 fish species, raising expectations that the final count may exceed 400 species (Williams et al. 2010).

Fish density, however, has remained low over time. In 1996, researchers observed low fish densities on the Bank (Meesters et al., 1996). During the 2011 IMARES expedition, the visual surveys (UVC) demonstrated that fish abundance was quite low, varying between 23 and 100 fish per 100m² (van Beek & Meesters, 2014). The 2013 expedition did record a considerably higher fish abundance, varying between 51 and 175 fish per 100m² (van Beek & Meesters, 2014). However, the visual surveys in 2011, 2013 and 2015 indicate that the biomass of key herbivorous and commercial fish (snappers, groupers and grunts) families is low, “indicating possibly a poor status of these fish families” (van Beek & Meesters, 2013; Becking & Meesters, 2017).

“

A biodiversity-assessment survey carried out on the Saba Bank between 2006 and 2007 recorded a total of 270 fish species, raising expectations that the final count may exceed 400 species.

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What have we learned from the past 5 years:

Fish communities:

From surveys between 2011-2013 a reduction in snappers, groupers, and grunts has been observed, while there were noticeably more sharks. The visual surveys (UVC) in 2011, 2013 and 2015 demonstrated repeatedly that the biomass of key herbivorous fish families and key commercial fish families was low, indicating possibly a poor status of these fish families. Lionfish are present on the Bank, but their densities are lower compared to the neighbouring islands and no significant increase was seen between years 2011-2015 at 20-30m depth.

Wageningen University & Research
(Becking & Meesters, 2017)



Photo by: © Hans Leijnse

2. Elasmobranches

Researchers on early expeditions to the Saba Bank recorded seeing sharks on every dive. In today's world, where about a quarter of sharks and rays are considered globally endangered (Dulvy et al., 2014), this is very good news and has prompted the Netherlands to declare the Yarari Marine Mammal and Shark Sanctuary in Dutch Caribbean waters as well as developing a policy document to protect sharks ("Shark Protection Plan").

Monitoring sharks

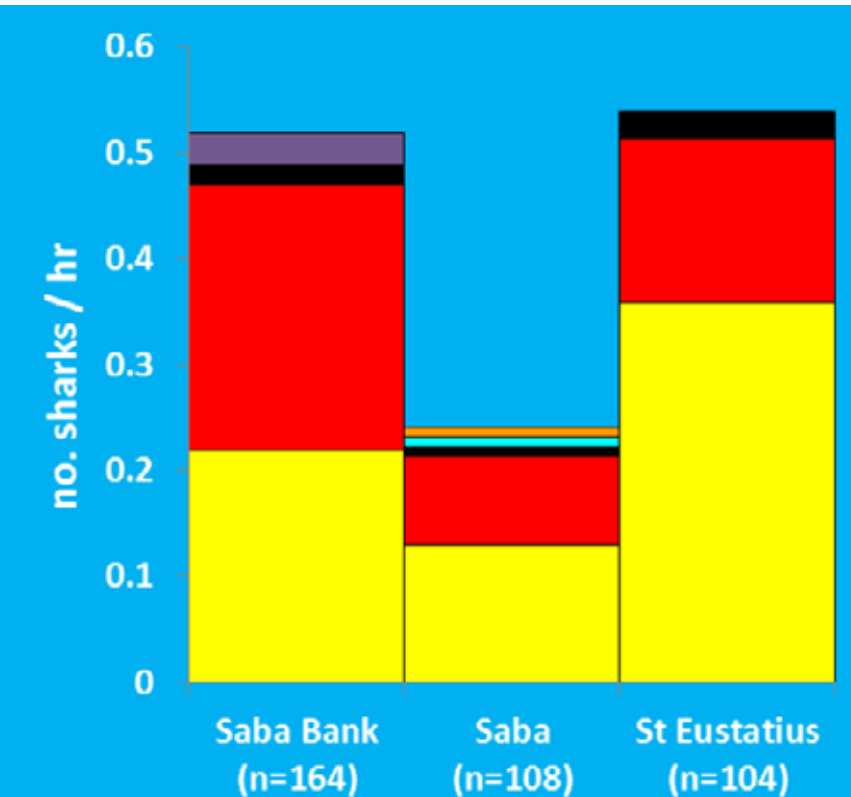
To find out more about sharks, a technique involving the use of simple, non-invasive, Baited Remote Underwater Videos (BRUVs), has been used to gather information on species composition and length frequency distribution. BRUVs have been deployed on Saba since 2013 and on the Saba Bank since 2014 across a variety of habitats in depths of 15 – 100m water for between 50min and 70 minutes per drop. This work has shown that sharks are most common along the shallow eastern and southern edge of the Saba Bank and that the most common species are Caribbean reef sharks (*Carcharhinus perezi*) and nurse sharks (*Ginglymostoma cirratum*). On average BRUV studies record 0.23 reef shark sightings per hour, which is higher than sightings at study sites on Belize and the Bahamas and 50% higher than around the adjacent island of Saba (Brooks et al., 2011, Bond et al., 2012; Stoffers, 2014, Winter, 2016). (See BioNews 30 for an in-depth article on the BRUV work in the Dutch Caribbean)

Fishing effort on the Saba Bank does not target sharks, but there is an unwanted by-catch of nurse sharks estimated at up to 900 sharks annually. These are caught in lobster traps and are not landed but discarded.

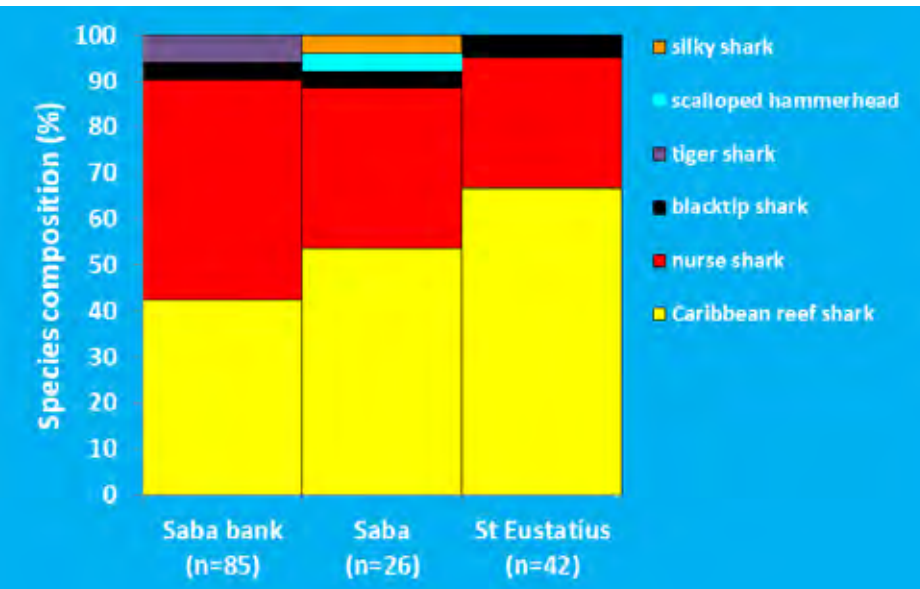
Without historical information on the Saba Bank or reference points from other locations in the Caribbean it is difficult to assess whether or not shark densities on the Saba Bank are "reasonable". GlobalFingerprint is a worldwide initiative, which aims to create reference points by using available BRUV data to assess reef shark abundance around the world. Researchers from the Wageningen Marine Research are also participating in this initiative.

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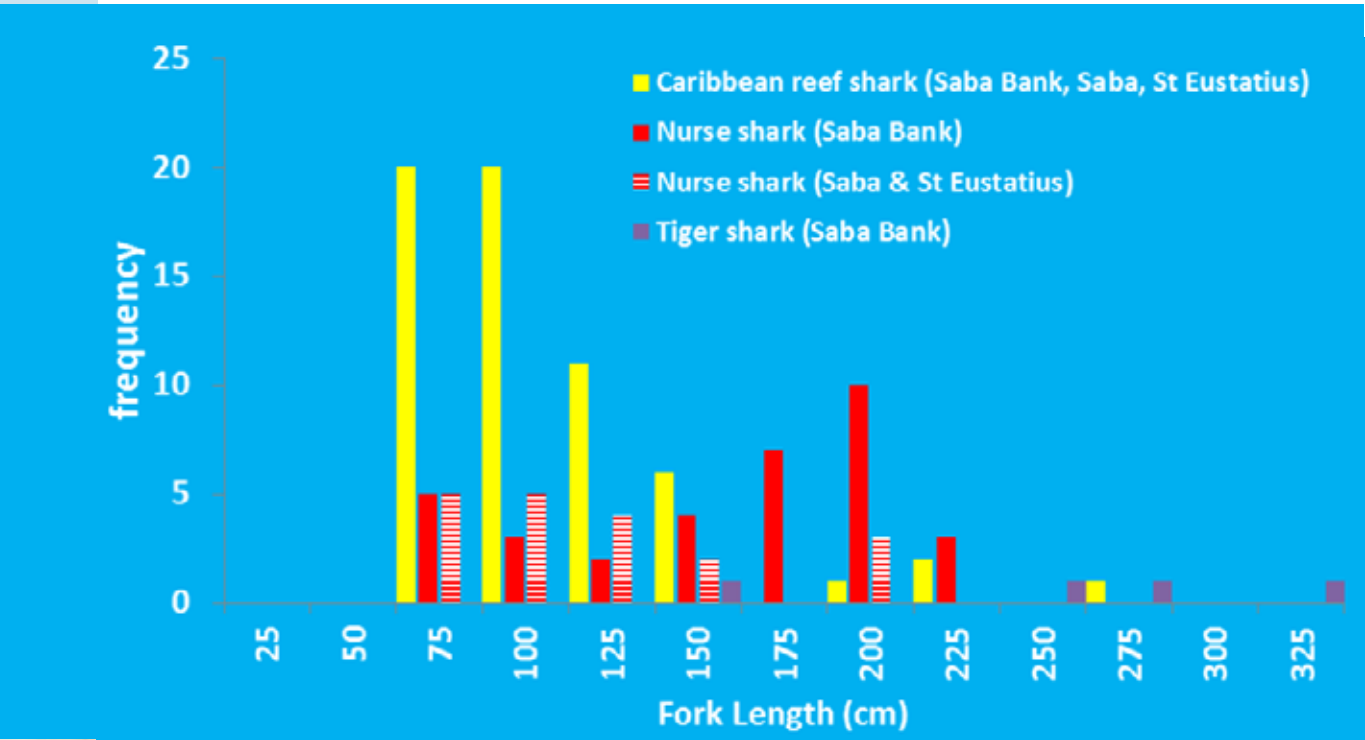
Species composition
of sharks on the Saba Bank, Saba
and St. Eustatius (BRUV results).
Mainly Caribbean Reef sharks
(*C. perezi*) and Nurse sharks
(*G. cirratum*) were recorded.
(n= no. sharks)



Number of sharks observed
per hour on the Saba Bank,
Saba and St. Eustatius
(BRUV results). This number
was about 50% higher on
the Saba Bank and St. Eustatius
than on Saba. (n=no. drops)



Length of sharks recorded around Saba, St. Eustatius and the Saba Bank (BRUV results). Mainly neonates (<0.8m), y-o-y (<1m) and juveniles (<1.5-2m) of Caribbean reef shark (*C. perez*i) were recorded. Mostly juveniles (<2m) of nurse shark (*G. cirratum*) on St Eustatius and Saba were filmed.



BRUV data from the Saba Bank compared to other areas.

Area	Species	Latin name	Shark hr ⁻¹
Saba Bank	Reef shark	<i>C. perez</i> i	0.23 (0.13 - 0.36)
Saba Bank	Nurse shark	<i>G. cirratum</i>	0.18 (0.08 - 0.25)
Bahamas (Brooks et al 2011)	Reef shark	<i>C. perez</i> i	0.08 (0 - 0.23)
Bahamas (Brooks et al 2011)	Nurse shark	<i>G. cirratum</i>	0.21 (0.12 - 0.35)
Belize (Bond et al. 2012)	Reef shark	<i>C. perez</i> i	0.16 (0.03 - 0.29)

Fish

Tracking shark movements

VEMCO acoustic telemetry equipment has been deployed to track shark movements. In total a network of 32 acoustic receivers has been set up, eight of them on the Saba Bank and the remainder on Saba, St. Eustatius and St. Maarten. Receivers have a detection ranger of 450-850m and a battery life of up to 4.5 years. Pilot studies on Saba started in 2014 and expanded to the Saba Bank in 2015. (See BioNews 30 for an in-depth article on the acoustic telemetry work on Saba)

So far 11 sharks caught on the Saba Bank have been fitted with acoustic transmitters and data collected so far from the individual movement patterns of two Caribbean reef sharks (*C. perez*i) seems to indicate that they may have

a relatively small home range. One 1.63m long male Caribbean reef shark (*C. perez*i) has been detected by acoustic receivers on the north, south and east of the Saba Bank.

The scientific data collected so far, does not show whether or not the Saba Bank is important for particular life stages of sharks, such as a mating ground or as a nursery area, but it does indicate that the Saba Bank supports healthy populations of Caribbean reef and nurse sharks. Local conservation efforts and the establishment of shark-protected areas may be a very good management option for this species.



What have we learned from the past 5 years:

Sharks

Caribbean reef sharks, nurse sharks and tiger sharks were observed during the 155 baited video (BRUV) deployments across the Saba Bank. The relative abundance of reef sharks on the Saba Bank appeared to be higher compared to similar standardised BRUV surveys in the wider Caribbean region. Saba Bank appears to have relatively healthy reef shark populations. Results further suggest that the Saba Bank is an important nursery and adult habitat for Caribbean Reef and Nurse Sharks (possibly also for the Tiger Shark). Individual movement patterns based on tracking data point to small home ranges of the Reef and Nurse sharks which show that reserves and marine parks offer good opportunities to protect these shark species.

Wageningen University & Research
(Becking & Meesters, 2017)

This chapter is based on the presentation by Erwin Winter’s (WUR) given at the Saba Bank Symposium <https://www.wur.nl/en/download/Erwin-Winter-Shark-Habitat-Use.htm>

Would you like to learn more about the sharks in the Dutch Caribbean? Follow the ‘Save Our Sharks’ online or on facebook (<http://saveoursharks.nl/en/homepage/>) + (<https://www.facebook.com/SaveOurSharksNL/?fref=ts>)

You can help save our sharks by signing the petition (<http://saveoursharks.nl/en/events/petition/>)

Marine Mammals

The Northern Caribbean is a well-known breeding and calving ground for North Atlantic humpback whales (*Megaptera novaeangliae*) and considerable research effort has focused on the largest aggregations of whales, off the Silver Bank, north of the Dominican Republic during their winter breeding and calving season.

Resident marine mammals in the Caribbean include bottlenose dolphin (*Tursiops*), spinner dolphin (*Stenella longirostris*), Atlantic spotted dolphin (*Stenella frontalis*), short-finned pilot whales (*Globicephala macrorhynchus*) and cuvier's beaked whales (*Ziphius cavirostris*). Seasonal visitor include humpback whales (*Megaptera novaeangliae*), common minke whales (*Balaenoptera acutorostrata*) and sperm whales (*Physeter macrocephalus*). Little is known about the seasonal migration and distribution of whales and dolphins in the Caribbean as a whole.

Ecotourism activities in the windward islands in the form of whale watching tours has encouraged many Caribbean islands that whales are more economically valuable to them alive than dead. And whilst humpback whale populations worldwide have shown some signs of recovery in recent years, concern remains about the status of marine mammal populations in the Caribbean.

The Dominican Republic and France were the first to establish marine mammal protected areas and in September 2015 the Dutch Caribbean Yarari Marine Mammal and Shark Sanctuary was declared by ministerial decree and which includes the territorial waters of Saba and the Saba Bank.

Marine mammal monitoring is generally conducted by aerial surveys and through sighting networks. More recently Passive Acoustic Monitoring (PAM) noise recorders have been deployed to detect whale soundings. The first MARU noise logger was placed in 2011 and from 2015 onwards more AMAR noise loggers have been deployed including loggers deployed by NOAA in Guadeloupe, St Martin and Aruba. Two PAM noise loggers were placed on the Saba Bank, one on the north eastern tip and the other on the south eastern part of the bank.

Noise loggers detect all ambient noise including noise of natural background, produced by tidal current and waves, anthropogenic noise from shipping, seismic operations and naval sonar. Shipping intensity is high in some parts of the Caribbean and this could interfere sound produced by marine mammals and fish. Humpback whales and Minke whales, in particular, have distinctive vocalizations. Male humpback whales "sing" and Minke whales produce calls or pulse trains.



Photo by: © Henkjan Kievit

From December 2011 to April 2012 the distinct continuous acoustic presence of Humpback whales was detected around the Saba Bank demonstrating consistent use of the Saba Bank during their winter breeding season. There was a general increase in song positive hours at the end of December, which peaked in February and tailed off towards the end of April. From February to April whale song was recorded 89% of the time.

The occasional presence of minke whales was also detected with most pulse trains were recorded from February through to April 2012. Acoustic loggers also picked up distinctive vocalizations by grouper, squirrelfish and damselfish.

This work not only highlights the feasibility of using passive acoustic monitoring to record the presence of marine mammals in otherwise remote and understudied areas but also opens the door to the tracking of migration routes and first estimates of marine mammal densities in the region.

This chapter is based on a presentation given by Dick de Haan (WUR) at the Saba bank symposium.

https://www.wur.nl/upload_mm/3/b/1/943f3a6e-8doa-45db-acfb-c632deae6do_g.de_Haan_SabaBankSymposium2016.pdf



Photo by: © Rudy van Gelderen

What have we learned from the past 5 years:

Marine mammals

There are at least 9 species that are regularly observed over the Saba Bank. Presence and temporal aspects of whale migration are being studied using passive acoustic monitoring as part of regional acoustic monitoring network together with the USA and France. Our results indicate intensive use by Humpback whales during the winter calving season as well as regular winter presence of the Minke whale.

Wageningen University & Research
(Becking & Meesters, 2017)

Marine Mammals

Birds

The Saba Bank is also an important foraging ground for many seabirds and conservative estimates indicate that ¼ million sea birds are dependent on the Saba Bank. This includes birds from Saba, St Eustatius and Dog Island, which alone supports 100,000 pairs of nesting seabirds including magnificent frigatebirds (*Fregata magnificens*), Tropicbirds (*Phaethontidae*), Sooty terns (*Onychoprion fuscatus*) and Masked boobies (*Sula dactylatra*), all of which are species whose global populations are in decline. An estimated 18% of the world population, the equivalent of 70% of the Caribbean population of Red-billed Tropicbirds, forage on the Saba Bank (Adrian Delnevo, personal communication, 23 February 2017).

“

An estimated 18% of the world population, the equivalent of 70% of the Caribbean population of Red-billed Tropicbirds, forage on the Saba Bank

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Photo by: © Kai Wulf



Photo by: © Miro Zumrik

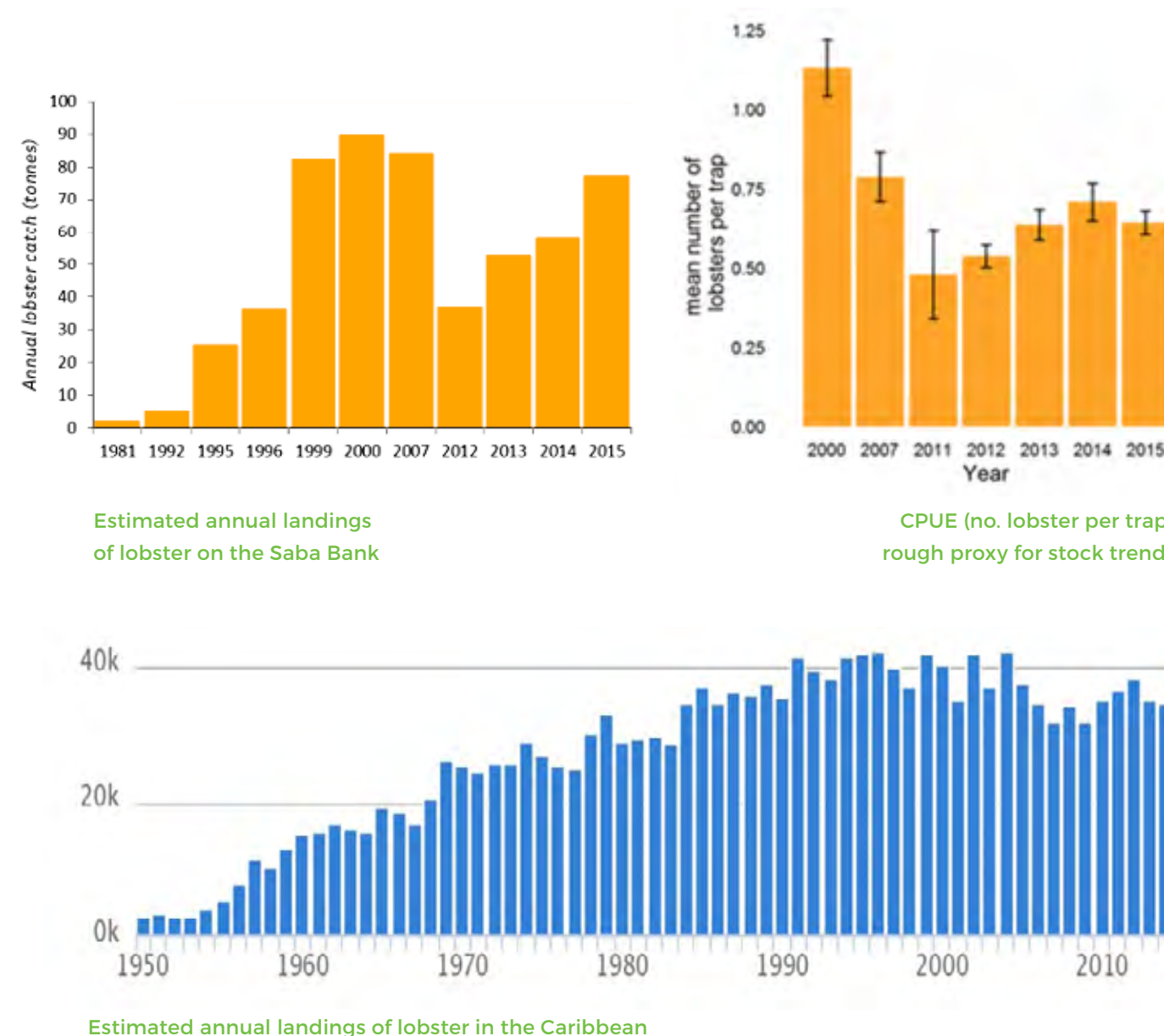
Fisheries



The Saba Bank supports a vibrant local fishing industry. Fishing effort focuses mainly on a trap fishery, targeting lobster and deep water red fish (snapper) (Dilrosun 2000, Toller 2008, van Gerwen 2013, Boonstra 2014), as well as bottom drop lining for red fish (snapper). Other common fishing activities include hand lining and trap fishing for red hind (grouper) as well as trolling for pelagic species.

Studies of fishing effort from 2000 – 2007 indicate that the fishery on the Saba Bank was relatively stable at that time, supporting 50 active fishermen from Saba and generating around Euro 1 million annually, or 8% of the total economic activity on the island of Saba (Dilrosun 2000, Toller and Lundvall 2008). Fishing currently accounts for an estimated US\$ 1.38 million income annually (Lely, 2014).

Fishing activities on the Saba Bank have been regulated since 1996 but it is only since 2012 that researchers from the Wageningen Marine Research institute have been involved with fishermen and Saba Bank Management Unit staff in the structural monitoring of fishing activities.



Lobster

Caribbean spiny lobsters (*Panulirus argus*) are caught on the Saba Bank using traps. Only ten Saba fishermen currently have licenses to fish for lobster on the Saba Bank and their annual catch (Fig. 1) is believed to account for approximately 0.1% of the total lobster landed in the Caribbean annually. In common with other places in the Caribbean, lobster catches from the Saba Bank declined after 2000. Despite the lower lobster stock abundance (expressed as CPUE), recent annual landings are comparable to the annual landing in 2000 due to an increase in the number of fishing trips.

Lobster throughout the Caribbean, are currently thought to be part of one metapopulation and the management of lobster stocks therefore requires international collaboration and co-ordination. The current recommended is to follow management proposals of Caribbean Regional Fisheries Mechanism (CRFM) (Headley, 2014).

Mixed reef fish

Whilst fishermen do not actively target reef fish, they are caught in lobster traps. Since 2000 the landings of mixed reef fish caught in lobster traps has remained rather stable. Assuming that the mixed fish are harvested from 100-400 km2 of coral reef on the Saba Bank, only 0.12-0.3 tonnes of reef fish are harvested per km2 of coral reef. This is significantly lower than the 2 tonnes per km2 of mixed reef fish harvested on Bonaire’s reefs (de Graaf et al, 2016).

In addition to reef fish, which are landed, a similar amount of mixed reef fish are discarded annually by fishermen.

Bycatch is a potentially important issue for the lobster fishery with an estimated 500-950 nurse sharks caught in lobster traps annually (de Graaf, personal communication). Under a recent agreement, signed in 2016, Saban fishermen have pledged to return trap caught sharks to the reef alive.

Ghost traps

On average 0.6 traps are lost per fishing trip. This amounts to between 400-600 lobster traps lost annually, which can trap sea life as ‘ghost traps’. Work is underway to refine the trap design to make them more sustainable. Current recommendations include increasing the mesh size to over 38mm and making sure traps are made with biodegradable material and include a biodegradable panel to prevent ghost fishing.

“The Saba bank is a unique area, invaluable for neighboring Saba, but also for the region as a whole as a source of coral, fish, lobster, and queen conch larvae. I’d say it is the richest biodiversity area of the entire Kingdom”

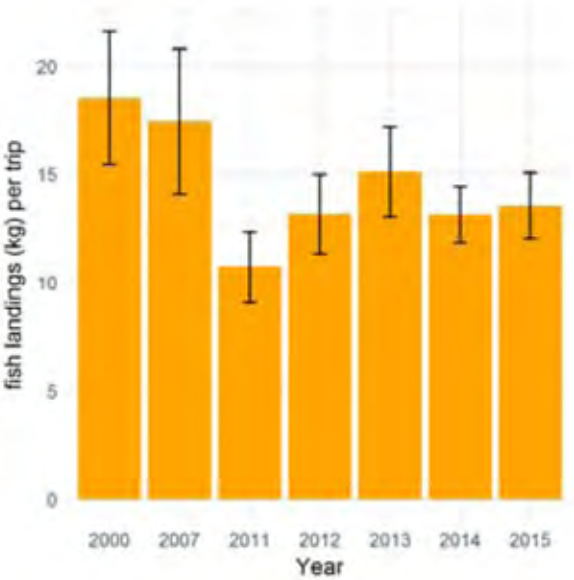
Paul Hoetjes (RCN)

Common name	Latin name	% Catch
White grunt	<i>Haemulon plumierii</i>	27
Red hind	<i>Epinephelus guttatus</i>	11
Cottonwick grunt	<i>Haemulon melaanurum</i>	8
Queen trigger fish	<i>Balistes vetula</i>	6
Doctorfish	<i>Acanthurus chirurgus</i>	6
Honeycomb cowfish	<i>Acanthostracion polygonia</i>	6
Spotted goatfish	<i>Pseudopeneus maculatus</i>	3
Coney	<i>Cephalopholis fulva</i>	3
Blue tang	<i>Acanthurus coeruleus</i>	3
	<i>Other</i>	24

Species composition of the landed mixed reef fish from lobster traps on the Saba Bank (van Gerwen 2013)

Common name	Latin name	% Catch
White grunt	<i>Haemulon melanurum</i>	27
Red hind	<i>Haemulon plumierii</i>	11
Cottonwick grunt	<i>Acanthostracion polygonia</i>	8
Queen trigger fish	<i>Acanthostracion quadricornis</i>	6
Doctorfish	<i>Acanthurus bahianus</i>	6
Honeycomb cowfish	<i>Cheatodon striatus</i>	6
Spotted goatfish	<i>Chilomycterus antillarum</i>	3
Coney	<i>Acanthurus chirurgus</i>	3
Blue tang	<i>Acanthurus coeruleus</i>	3
	<i>Other</i>	24

Species composition of the discarded mixed reef fish from the lobster traps on the Saba Bank (van Gerwen 2013).



Yearly mean landed catches of mixed reef fish (kg) per fishing trip (de Graaf et al., 2017)

Red fish

The red fish fishery targets mostly silk snapper (*Lutjanus vivanus*), blackfin snapper (*Lutjanus buccanella*) and vermilion snapper (*Rhomboplites aurorubens*), with silk snapper accounting for approximately ¾ of the total landings.

Since 2007, annual landings of red fish have remained relatively stable. The CPUE (kg per trap which is a proxy for the stock) has even showed a modest increase since 2011. A drop in red fish landings recorded in 2015 is the result of a decline in redfish fishing trips.

Despite evidence from landings that fish populations are stable, there is concern amongst local fishermen about the status of red fish populations. This has resulted in a local fishermen agreement, brokered by Saba fishermen themselves in 2016, which introduces a number of self-imposed restrictions aimed at protecting red

fish populations from over-exploitation. These measures include a 6 month closure for red fish beginning in April 2017. Once the site closure ends licensed fishermen have agreed to deploy only 25 traps and to use large mesh sizes. These restrictions are being regulated through the existing fishing license system, which does not extend to the EEZ (Exclusive Economic Zone). Fishermen also expressed the intention to set up a fishermen’s organisation.

Red hind

There is an emerging fishery on the Saba Bank for red hind (*Epinephelus guttatus*), which has developed over the past five years. Fishing activity focuses on red hind spawning aggregation sites. These fish group together at spawning aggregation sites annually to breed. Targeting spawning aggregation sites makes the red hind extremely vulnerable to overfishing and population collapse.

The danger of targeting spawning aggregations has been highlighted by work on Nassau groupers (*Epinephelus striatus*) for which more than 60% of spawning aggregation sites have been overfished to the point of collapse. Most of the remaining Nassau grouper aggregations are severely depleted (Whaylen 2007, Sadovy de Mitcheson 2008).

As a response to this, the first fisheries related closure of a fishing ground was introduced in December 2013 to protect known red hind spawning aggregations. Annually from December to February all fishing for red hind, whether by traps or lines, is now prohibited on the Moonfish Bank.

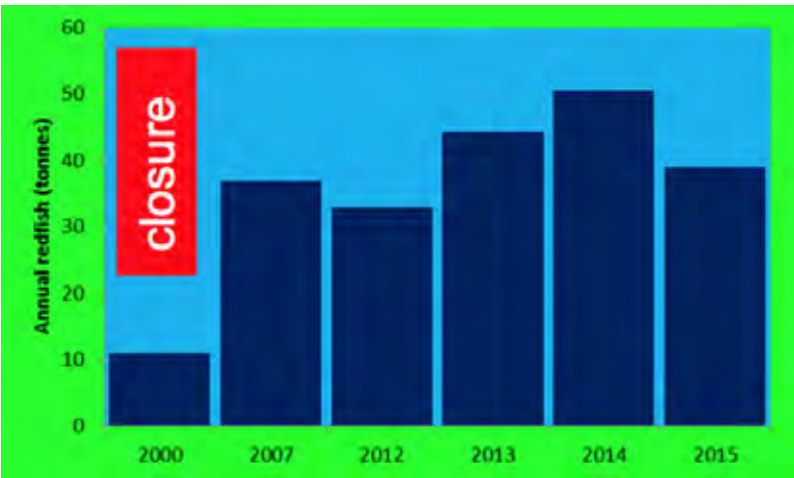
Conch

Whilst no local conch fishery exists, until 1996 Queen conch (*Strombus gigas*) were the target of intensive and unsustainable fishing

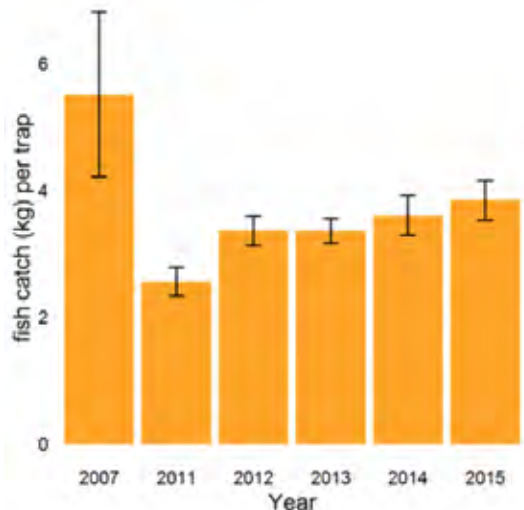
activities by foreign vessels on the Saba Bank. Recent monitoring indicates that Queen conch populations appear to be recovering (*Boman, unpublished results*). Their size at maturity is around 10mm lip thickness and their spawning season lasts from June to September (Boman et al, in preparation). This makes the Saba Bank not only an important potential source of larval recruitment for large areas downstream, but also, with good management, the Saba Bank could potentially support a sustainable local conch fishery.

This chapter is based on a presentation given by Martin de Graaf (WUR) at the Saba Bank Symposium.

<https://www.wur.nl/en/download/Martin-de-Graaf-Fish-and-fisheries-at-Saba-Bank.htm>



Estimated annual landings of the red fish trap fishery on the Saba Bank



CPUE (kg of red fish per trap, rough proxy for stock trend) (de Graaf et al., 2017).

Saba Bank 2016/ Chizzilala

Short documentary produced for broadcast on Saba local TV about the Saba Bank. Commissioned by the Ministry of Economic Affairs (EZ) of The Netherlands can be watched here:

<https://vimeo.com/195774102>

Photo by: © Hans Leijnse



What have we learned from the past 5 years:

Fisheries

Most fishermen are positive towards working on regulations and working together with management. During 2012-2015 the West-Indian spiny lobster stock remained stable and total annual landings increased yearly due to increasing effort (number of fishing trips). The peak and subsequent gradual decline in annual in lobster landings as witnessed in recent years, mirror catch trends for the wider Caribbean region. A potentially healthy sign is the consistently large size of harvested lobsters between 2000 and 2015. The rules and regulations of both the lobster and deep-water snapper trap fisheries will need to be updated in the near future to provide the responsible management authorities with the appropriate tools to ensure a sustainable fisheries.

Wageningen University & Research
(Becking & Meesters, 2017)

Local stressors

Unregulated fishing was a serious concern for the Saba Bank in the 1980s and 1990s, but since the mid-1990s fishing activities have become much more regulated. Management of the Saba Bank dates back to 1994 with the declaration of the Exclusive Fishery Zone in the Dutch Caribbean and the passing of a national fishery ordinance which made it illegal for foreign vessels to fish on the Bank without a license. This effectively ended most illegal, unreported and unregulated (IUU) fishing on the Saba Bank, with lobster and fin fisheries practiced only by local, licensed fishermen (DCNA, 2017). Since 2002, researchers from the Wageningen Marine Research institute have been involved with fishermen and SBMU staff in the structural monitoring of fishing activities (de Graaf et al., 2017) and there have been regular coast guard patrols (by plane) above the Saba Bank.

Saban fishermen have been actively involved in the regulation of fisheries on the Bank (Becking & Meesters, 2017). Recent concerns over the status of redfish populations led Saban fishermen to broker an agreement in 2016 that introduces a number of self-imposed restrictions aimed at protecting redfish populations from over-exploitation, such as a 6-month closure for redfish beginning in April 2017 (de Graaf et al., 2017). Once the closure ends, licensed fishermen will only deploy 25 traps per fisherman and use large mesh sizes. Another decision that was made with the support of local fishermen is the seasonal closure of the Moonfish Bank Spawning Aggregation Area. Since December 2013, fishing for red hind, whether by traps or

lines, is now prohibited on the Moonfish Bank from December to February (DCNA, 2017). This will help protect their spawning aggregation from being fished out.

Whilst fishermen do not actively target reef fish, some are caught as by-catch in lobster traps. Between 2012 and 2015 the landings of mixed reef fish caught in lobster traps increased from 6.6t to 13.6t, which appears low in comparison to other areas in the Caribbean (de Graaf et al., 2017). However, no conclusions can be made about differences in fishing pressure compared to other areas in the region. Therefore, besides landings, differences in observed fish biomass need to be taken into account. This has not yet been evaluated.

By-catch is a potentially important issue for the lobster fishery with nurse sharks being caught in about 60% of the trips using lobster traps (de Graaf et al., 2017). Under the redfish agreement above, signed in 2016, Saban fishermen have also pledged to release trap caught sharks to the reef alive (DCNA, 2017).

On average 0.6 traps are lost per fishing trip. This amounts to between 400-600 lobster traps lost annually, which can trap sea life as 'ghost traps'. Work is underway to refine the trap design to make them more sustainable. Current recommendations include increasing the mesh size to over 38mm and making sure traps are made with biodegradable material and include a biodegradable panel to prevent ghost fishing (De Graaf et al., 2017).

Photo by: © Hans Leijnse



“

Nurse sharks are caught in about 60% of trips using lobster traps.

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The rules and regulations of both the lobster and deep-water snapper trap fisheries will need to be updated in the near-future to provide the responsible management authorities with the appropriate tools to ensure their sustainability (Becking & Meesters, 2017). At this time it is unclear how the Bank's reef communities will fare and what impact fishing activity is having on the reefs.

Prior to the designation of the Saba Bank as the world's 13th Particularly Sensitive Sea Area (PSSA) by the International Maritime Organisation in 2012, ships and tankers were a significant threat to the Bank's reefs. Many freighters, tankers and cruise ships passed over the Bank, with reports of oil spills and the emptying of sewage tanks. Tankers frequently anchored on the shallow Saba Bank while waiting to unload at the St. Eustatius Oil Terminal to avoid anchoring fees in the territorial waters of nearby St. Eustatius, causing significant damage to the Bank's reefs as well as other benthic communities (Meesters et al., 1996). Before anchoring was prohibited in 2010, it was estimated that in 2009 a minimum of 24 vessels anchored on the Saba Bank for a total of 187 days (Resolution MEPC 226(64), 2012). This was an underestimation as the surveys only covered 40-60% of the Bank.

In 2008, Lundvall listed the four main threats to the Saba Bank as followed: overexploitation of fishery resources, impacts from tanker anchorage on benthic communities, impacts of tanker traffic on fishermen and traps and global climate change (Lundvall, 2008). The first three of these threats have been either removed or decreased as a result of active management. It is important to keep monitoring those threats and enforcement of regulations should be further improved. Even though the Saba Bank is not influenced by coastal processes because of its distance from land—its remoteness means that it has been spared many of the insidious anthropogenic effects such as eutrophication and increased sedimentation—global threats such as climate change appear to be on the increase. Extreme weather events in the Caribbean Region have become much more common and intense bleaching events have already taken their toll on the Bank's coral reef communities (Meesters et al., 2016). It is vital that future management plans for the protection of the Bank's reefs anticipate the potential negative impact of these threats as well as their ever-evolving nature and take the appropriate actions to increase the resilience of the Bank's reefs (Meesters et al. 2016).



Local stressors

Conservation Activities

A PSSA is an “*area that needs special protection through action by IMO because of its significance for recognized ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities*” (IMO, 2017). The Saba Bank was designated as a PSSA in 2012, and with the designation came the establishment of a new mandatory ‘no anchoring’ area for all ships and a new ‘area to be avoided’ (for ships of 300 gross tonnage or over). The Bank was declared a Nature Park in 2010 and came under the management of the Saba Conservation Foundation (SCF) in 2012. That same year (2012) the Saba Bank was also recognized as an area of regional importance by the Specially Protected Areas and Wildlife (SPAW) Protocol and in 2013 it was recognized as an Ecologically/Biologically Significant Marine Area (EBSA) by the Convention on Biological Diversity (CBD).

The “Save our Sharks” DCNA awareness project is being implemented from 2015-2018 (grant from National Postcode Lottery). In September 2015, thanks in major part to the efforts of Saba’s Commissioner Chris Johnson, facilitated by a regional meeting promoting shark protection organized by the PEW Trust, the Saba Bank became part of the Yarari Marine Mammal and Shark Sanctuary covering all waters of Saba and Bonaire. As part of a multi-year program funded by the Ministry of Economic Affairs (MinEZ), now the Dutch Ministry of Agriculture, Nature & Food Quality, the collaborating parties are working out the steps needed towards implementing marine mammal management and policy measures for the Yarari Sanctuary (Becking and Meesters, 2017).

The Saba Bank Management Unit (SBMU) was established by the MinEZ in 2012, in close co-operation with SCF and the Saba Island Government. The SBMU is responsible for

day-to-day management of the Saba Bank. It is staffed by two fulltime staff and its tasks consist of surveillance and reporting of shipping or fishing violations, facilitating and conducting scientific research on the Bank, monitoring of fish landings and liaising with local resource users (DCNA, 2017).

Recently the management of the Saba Bank National Park by SCF (SBMU) during the period 2012-2017 was evaluated. Thanks to the support of the MinEZ, SCF and the Island Government of Saba “*and to the work of the various agencies and resource users involved, the Saba Bank is to a large extent an effectively managed protected area, in a region where many marine protected areas are legally established but do not benefit from active management in the field. When measured against the goals and objectives of the Saba Bank Special Marine Area Management Plan, the impacts and outcomes of the management effort have been significant. However, at current level, the financial, human and technical resources available to the SBMU through the SCF are insufficient to allow it to perform all its tasks and functions effectively, and are not commensurate with the size, the ecological and economic value of the Saba Bank nor with the conservation and resource management mandates arising from the status of the area as a Nature Park, PSSA, EBSA and critical component of the Yarari Sanctuary. So far, the achievements of the SBMU were only possible thanks to the collaboration with the SCF, to the support provided by the SCF beyond the terms of the Agreement between the MinEZ and SCF, and to the SCF’s and the SBMU’s ability to work under challenging conditions. The two main planning instruments that have guided management, namely the Saba Bank Management Plan and the terms of reference for the management of the Saba Bank, have proven adequate, but now need updating.* (Renard & Hoogerduijn, 2017)”

To ensure a sustainable future for the Saba Bank it is important the SBMU continues its activities and its capacities are strengthened. Some wish list items for research include:

- Identification, description and a mapping of main ecological habitats
- Continued monitoring of reefs, fisheries, marine mammals and sharks
- Habitat restoration experiments (anchor damaged areas)
- Methods to reduce shark bycatch, and parrotfish bycatch in fisheries
- Development of methods for a targeted lionfish fishery
- Identify and protect other spawning aggregation areas



Photo by: © Hans Leijnse

Management recommendations

Wageningen University & Research
(Becking & Meesters, 2017)

- *Institutional responsibilities for policy and management activities need to be clearly defined: who needs to take leadership in what activity? What is the ultimate goal of the Dutch cabinet for the Saba Bank?*
- *Saba Bank Management Unit needs more capacity; currently only 2 people are employed in the unit; The current vessel is too small for unencumbered operations on the bank.*
- *Studies are needed to explore the impacts of climate change on the bank and what mitigation measures might be possible.*
- *A habitat map of Saba Bank is required that includes habitat identification, descriptions, and location, as well as the ecological significance for fisheries and/or coral reef resources. This baseline information is crucial to support management and monitoring.*
- *Ecosystem functioning and connectivity on the bank needs to be identified and assessed: how are coral reef areas, marine calcareous algal fields, marine algal fields, and other areas ecologically connected?*
- *Monitoring program (WOT). Continued monitoring of reefs, fisheries, marine mammals and sharks is necessary for sustainable use of the Bank's resources.*
- *The feasibility of zonation (of fisheries) needs to be determined including possibilities of closing a large portion of the bank (e.g. the part furthest away from Saba).*
- *Fisheries regulations need to be reviewed and amended.*
- *Quantitative fisheries management goals and objectives need to be formulated.*
- *Gear type and allowed quantity, needs to be linked to the fishing licenses.*
- *Research on methods to reduce shark bycatch is needed.*
- *Spawning aggregation areas for target species need to be identified for protection by seasonal closure.*
- *Escape hatches for undersized and bycatch species should become obligatory.*
- *The role of the Saba Bank for specific life stages of marine mammals, mating and calving and connectivity to adjacent reef systems still remains to be unravelled.*
- *Ship disturbance of whales needs to be studied by comparing noise logger data with vessel movements.*
- *Better data management is needed: data is getting lost (e.g. from navy) or not well preserved. Data coordination and sharing arrangements are needed to prevent further loss.*

The Saba Bank photo collection is available through the Image Collections of Wageningen University & Research:

<http://images.wur.nl/cdm/search/collection/coll18/searchterm/saba%20bank/order/nosort>

We would like to thank all researchers for sharing their pictures!

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Saba

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