

Status of Saba Bank's Reefs

The Saba Bank remained an unexplored and mysterious offshore submerged carbonate platform until very recently. Research on the Saba Bank was first initiated under the Central Government of the Netherlands Antilles due to fishing pressure on the Bank and after fishery legislation was first enacted. After the constitutional change in 2010 when the Saba Bank became the direct responsibility of the Netherlands, there was more attention for the Saba Bank and there have been several research expeditions to assess the state of the fisheries, coral reef health and shark population (Bos et al., 2016). A known biodiversity hotspot, the Saba Bank is of special interest to scientists because it has remained relatively pristine thanks to its remote location (DCNA, 2016; Bos et al., 2016). But the Saba Bank is by no means immune to global and regional impacts including the effects of climate change.

It is essential that action is taken to increase the resilience of the Saba Bank as much as possible in order to buffer the effects of climate change including the very real possibility of more, and more intense bleaching events and hurricanes as well as the insidious impact of ocean acidification.

1. 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

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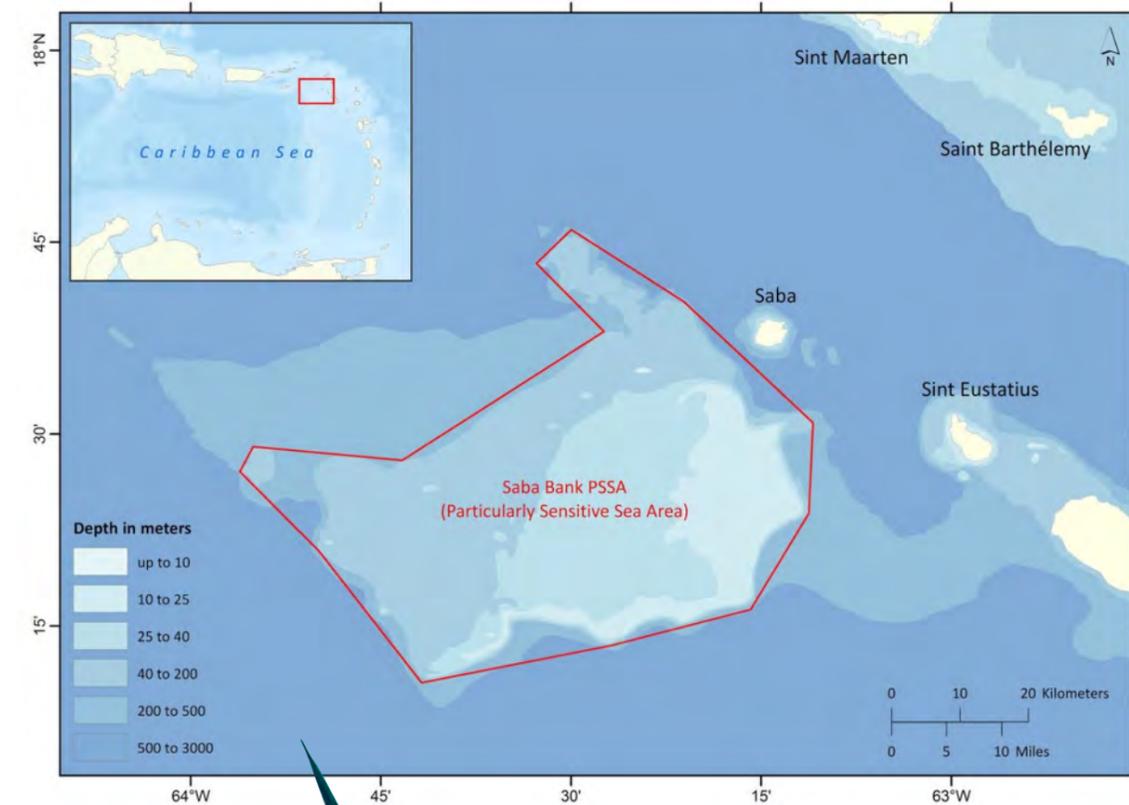


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2. Status of the reefs of the Saba Bank

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).

Three research expeditions conducted by Wageningen Marine Research (formerly IMARES) took place between 2011 and 2015 to gather data on the Bank's biodiversity, ecological functioning and ecosystem changes triggered by mounting environmental pressures. The 2015 expedition was a joint expedition with NIOZ (van Duyl, 2016). The data collected during these surveys will be invaluable to ensure the sustainable management of the Bank.

In November 2016 conservation management organizations from Saba, St. Eustatius and St. Maarten joined a research expedition organized by the Scripps Institute of Oceanography and the WAITT Foundation to conduct a rapid scientific assessment of the coral reefs in the windward Caribbean islands (Sandin et al., 2016). The Global Coral Reef Monitoring Network protocol for the Caribbean (GCRMN-Caribbean) was used to establish a regional perspective of coral reef health, surveying the fore-reef habitat at depths between 7 and 15 meters. In addition to GCRMN coral reef assessments, a selection of coral reef environments on the Saba Bank were mapped using 3D imagery. Photography and advanced image post-processing were used to create photomosaic images of large reef areas up to 100 square meters. These images provide a snapshot view of large-area coral reef communities and their compositions, enabling data collection of benthic communities. The results of these surveys have not yet been released but footage can be found at: <https://drive.google.com/drive/folders/oBy3cTucxJ9GFcEYyUi16OG4ycok?usp=sharing> (Scripps Institution of Oceanography). The goal is to repeat this assessment in two years so that changes in reef health can be gauged. In addition to local trends these assessments will allow for a comparison of coral reef health in the Dutch Caribbean region. Surveys by the Saba Conservation Foundation (SCF) using the same GCRMN protocol to assess the impact of the extreme hurricane season in 2017 are underway.

A Symposium dedicated to the Saba Bank was organized by the University of Wageningen 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).

Status of Saba Bank's Reefs

Table 1: Summary of major coral status surveys conducted on Saba Bank's coral reefs.
(Source: DCNA, 2017)

Studies	Time period	Survey Description	# Sites Surveyed
CICAR Expedition (Van der Land, 1977)	1972	The first recorded expedition to the Saba Bank. Collections of the benthos were made by hand by Dutch Naval divers.	25 by Scuba diving
Corwith Cramer Cruise C-103 (Joyce, 1989)	1989	During this expedition a depth Recorder profile and sediment sample transect lines were completed.	112
Netherlands Antilles Department of Environment (MINA) survey (Meesters, 1996)	1996	The expedition focused on the central and eastern part of the Saba Bank and surveyed approximately 1.8% of the total area.	-
AGRRA (Klomp & Kooistra, 2003)	1999	Post-hurricane (Lenny) rapid assessment of reefs including measures on coral cover and bleaching.	3
Conservation International expedition	2006	Rapid Assessment of the Saba Bank	17
Royal Dutch Navy, MINA, Harte Research Institute, Conservation International (CI), and SCF	2007	This survey focused on octocorals as well as surveys of fish and conch. For the first time monitoring included surveys for crustaceans as well as some ROV deep water exploration. Using multibeam sonar data from the Dutch Navy a high resolution (2 m) bathymetric GIS map was prepared	40 (5 zones)
CARIBSAT expedition, M.V. Caribbean Explorer	2010	A ground truthing expedition to the Saba Bank to find ways to use satellite images to map the benthic communities. Data were collected using video camera drops and underwater video transects at 7 places.	200

Studies	Time period	Survey Description	# Sites Surveyed
IMARES and NIOZ	2011, 2013, 2015	Three expeditions aimed to collect data on benthic and reef fish communities; connectivity; sponges and nutritional sources of the sponge community; seabirds and marine mammals; net coral reef calcification, water quality, water velocity and other physical parameters.	11
NIOZ and IMARES (NWO funded project entitled "Caribbean Coral Reef Ecosystems - interactions of anthropogenic ocean acidification and eutrophication with bio-erosion by coral excavating sponges")	2016	Researchers wanted to gain a better understanding of the hydrography of the Saba Bank and to determine if net ecosystem calcification is occurring. This expedition integrates ecological mapping (Spatial coverage of corals and other calcifying organisms), (carbonate) chemistry, net calcification, and physical oceanography.	61
Scripps Institute of Oceanography and the WAITT Foundation	2016	Coral reef assessments following the GCRMN protocol and a selection of 2 coral reef environments were mapped using 3D imagery.	3
GCRMN by SCF	Planned	Coral reef assessments following the GCRMN protocol after hurricanes Irma and Maria	Planned: 25
National Initiative Changing Oceans (NICO) expedition (NWO-Science & NIOZ)	Planned for 2018	The multidisciplinary scientific expedition aimed at providing the Netherlands with a better understanding of changing seas and oceans, crucial for climate stability and sustainable economic activities.	

Status of Saba Bank's Reefs

2.1 Benthic cover

Coral

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 the Bank and surrounding reefs, the high abundance and unique genetic diversity and the upstream position with respect to the wider Caribbean indicate that the 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; Becking & Meesters, 2017).

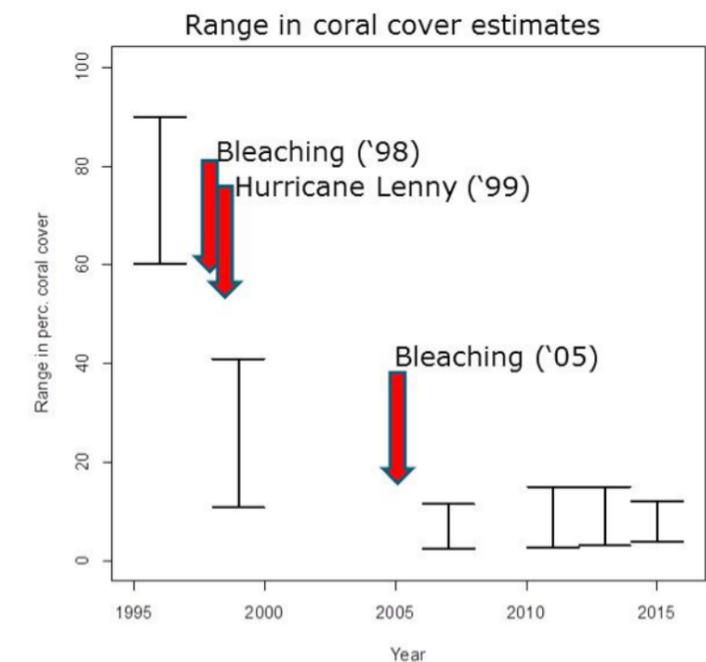


Figure 1: Coral cover estimates for the Saba Bank from 1995 to 2015 (Meesters, 2016)

Status of Saba Bank's Reefs

Macroalgae

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 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).

A gradient of increasing algal cover from the Bank towards the island of Saba was identified during the IMARES expeditions, although it is unlikely that this is linked to anthropogenic activities on the island (Van Beek & Meesters, 2014).

Sponges, turf algae, cyanobacteria

Corals, sponges, macroalgae, turf algae and cyanobacteria are all naturally occurring components of the benthos which compete with each other for space (Figure 2). 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 systems, 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 of 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).

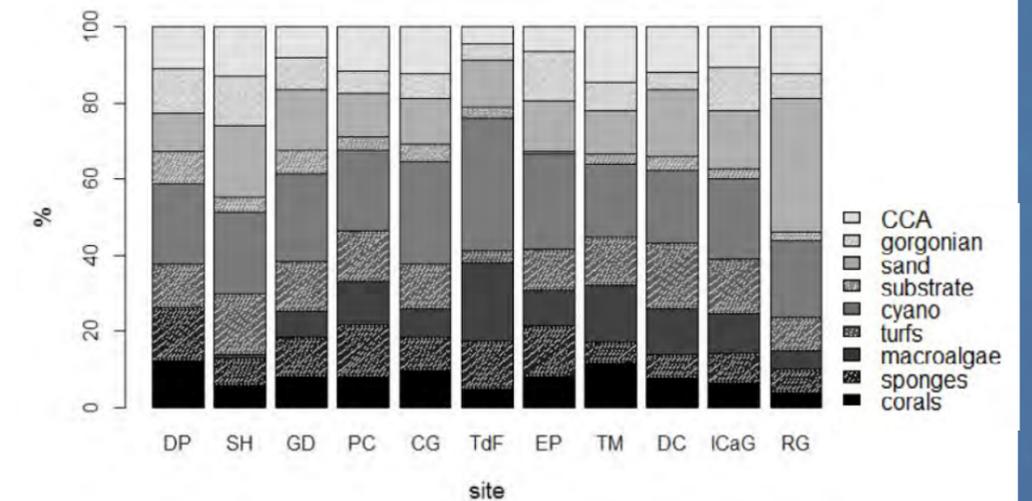


Figure 2: Benthic cover on the Saba Bank in 2015. Mean cover values include: corals 7.82% +/- 1.26; sponges 9.62% +/- 1.48; macroalgae 9.01% +/- 2.64; turf algae 12.02% +/- 1.78; cyanobacteria 23.02% +/- 2.22 (Wiltink, 2016).



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Status of Saba Bank's Reefs

2.2 Fish

The Saba Bank has a very diverse and rich fish fauna. 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).

The low density of commercial fish could have a serious economic impact for Saba as the Bank is a vital fisheries resource for the island, bringing the island an estimate annual revenue of US\$ 1.38 million (Lely, 2014). Fishing efforts focus mainly on a trap fishery, targeting lobster (*Panulirus argus*) and deep-water snappers (redfish) (Dilrosun 2000, Toller 2008, van Gerwen 2013, Boonstra 2014; de Graaf et al., 2017). The mixed reef fish landings are significantly lower than

mixed reef fish harvest in the region (de Graaf et al., 2017).

The Saba Bank has revealed itself as an important spawning ground for fish species, making the Bank an important natural resource for the surrounding region. "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" explains Paul Hoetjes (RCN). "I'd say it is the richest biodiversity area of the entire Kingdom" (DCNA, 2017). Spawning aggregations of red hind, queen triggerfish - locally called moonfish - and squirrelfish have been confirmed (Lundvall, 2008). Since December 2013, the spawning aggregation site on the Moon Fish Bank (northeastern corner of the Saba Bank) is closed to fisheries for three months each year to protect the populations of red hind (*Epinephelus guttatus*) and queen triggerfish (*Balistes vetula*) (Lundvall, 2008).

Recent work on the Bank has revealed that the Saba Bank has a healthy population of sharks. Since 2012, researchers from Wageningen Marine Research (IMARES), in partnership with local partners, have used simple, non-invasive stereo Baited Remote Underwater Videos (sBRUV) to gather baseline information on the size, diversity, species composition and abundance and of shark populations across different management zones in the Dutch Caribbean. To this date, 165 BRUVs have been deployed and initial results point to the Bank having a higher abundance

of sharks compared to similar BRUV surveys in the wider Caribbean region (Stoffers, 2014; Becking & Meesters, 2017). The two most common species on the Bank are the nurse shark (*Ginglymostoma cirratum*) and the Caribbean reef shark (*Carcharhinus perezii*). In 2013, BRUV deployments recorded an average of 0.23 reef shark sightings per hour - including a 3-meter long hammerhead - which is higher than sightings at study sites on Belize and the Bahamas (Brooks et al., 2011, Bond et al., 2012; Stoffers, 2014; Winter, 2016). For nurse sharks and Caribbean reef sharks also behavioural studies are carried out using acoustic telemetry (Winter et al., 2015). The 8 receivers that were placed on the Saba Bank are part of a larger network that covers the reefs of Saba, in St. Eustatius and St. Maarten. With this study individual movements and scale of home ranges can be assessed.

3. Condition of the reefs of the Saba Bank compared to other reefs within the Caribbean Region

The Saba Bank is home to some of the richest diversity of marine life of the Dutch Caribbean (Bos et al., 2016). Not only are there stoney coral reefs, but the Bank is particularly rich in gorgonians, benthic cyanobacteria and macroalgae, including algal assemblages never described before (Littler et al., 2010; Wiltink, 2016). The high species abundance on the Saba Bank prompted Conservation International to designate it an important "biodiversity hotspot" within the

Caribbean (Hoetjes, 2010). The abundance of shallow water gorgonians is 10-30% higher than at other sites in the Caribbean, with 43 recorded species and the discovery of a new species of *Pterogorgia* (Etnoyer et al., 2010). More gorgonian species remain to be discovered on the Bank, though richness is already higher than other study sites in the West Atlantic (Etnoyer et al., 2008). Sponge diversity on the other hand seems lower than in other Caribbean locations even though these studies are difficult to compare as they were done in different habitats (Thacker et al., 2010; Wiltink, 2016).

Despite the absence of shallow water nursery habitats, the Saba Bank ranks eighth in the Caribbean for fish species richness. Recent studies indicate that good genetic connectivity as well as genetic diversity comparable to other sites in the Caribbean mean that the Saba Bank is a likely source of fish and coral larvae and may serve an important ecological role, bolstering the resilience of reefs downstream (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).



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Status of Saba Bank's Reefs



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

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Status of Saba Bank's Reefs

4. Local stressors on the reefs of the Saba Bank

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).

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).

Status of Saba Bank's Reefs

5. 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 2015-2017 (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), 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).

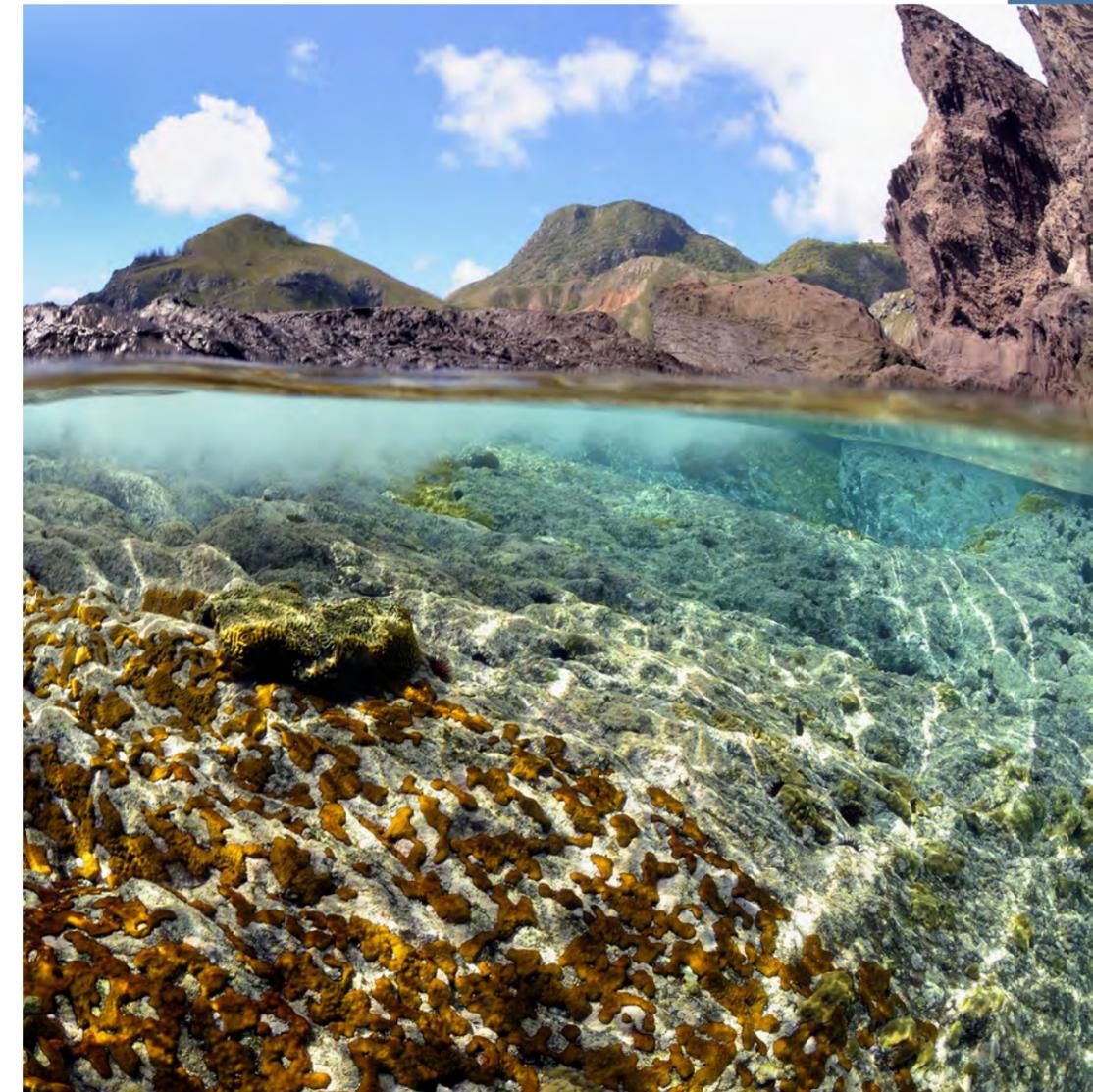


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Recently the management of the Saba Bank National Park by SCF (SBMU) during the period 2012-2017 was evaluated. Thanks to the support of the MinEZ, SCF and the Island Government of Saba "and to the work of the various agencies and resource users involved, 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)"



Video Saba Bank: <https://vimeo.com/195774102>

Status of Saba Bank's Reefs

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