Saba Bank Research

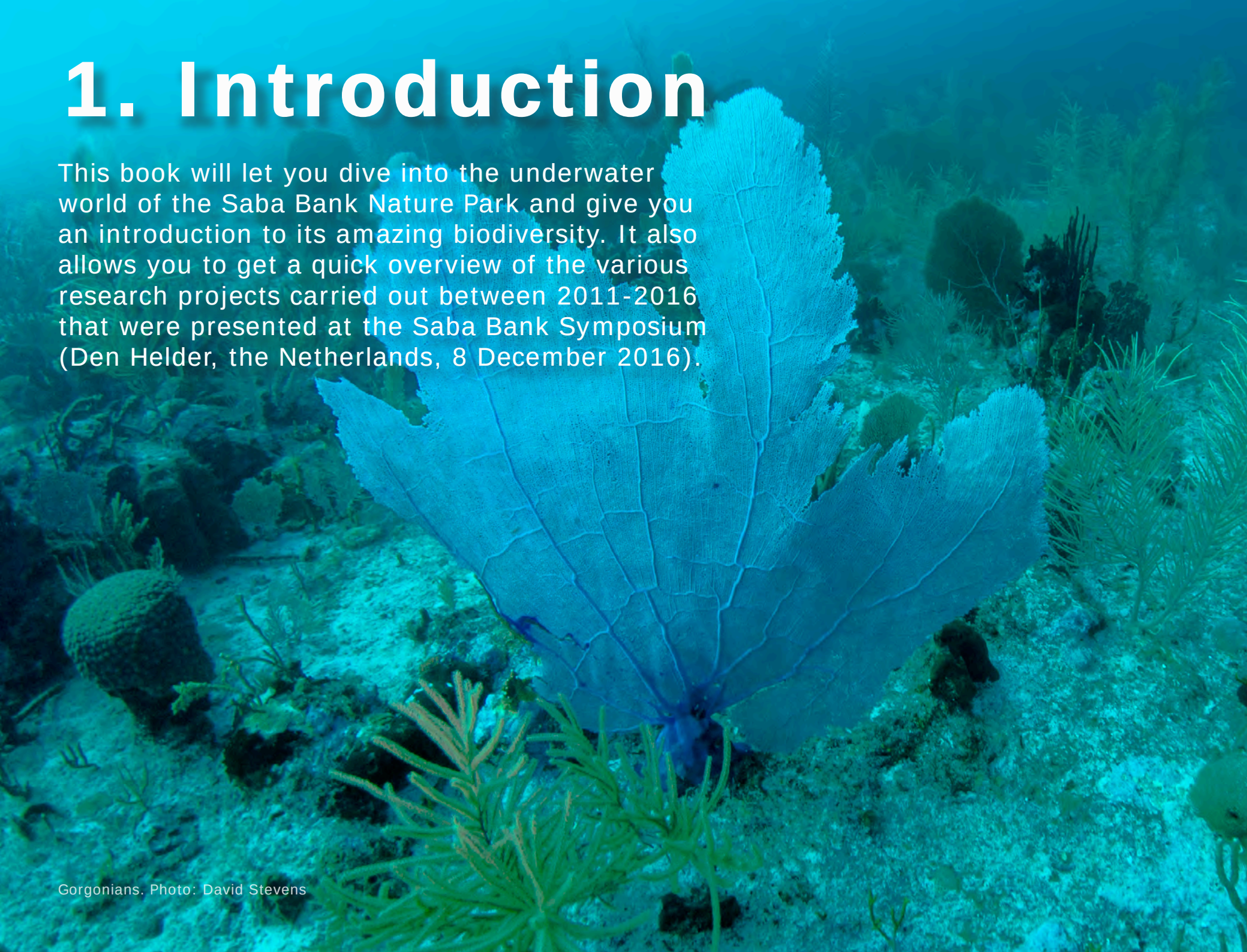
2011-2016

WAGENINGEN
UNIVERSITY & RESEARCH

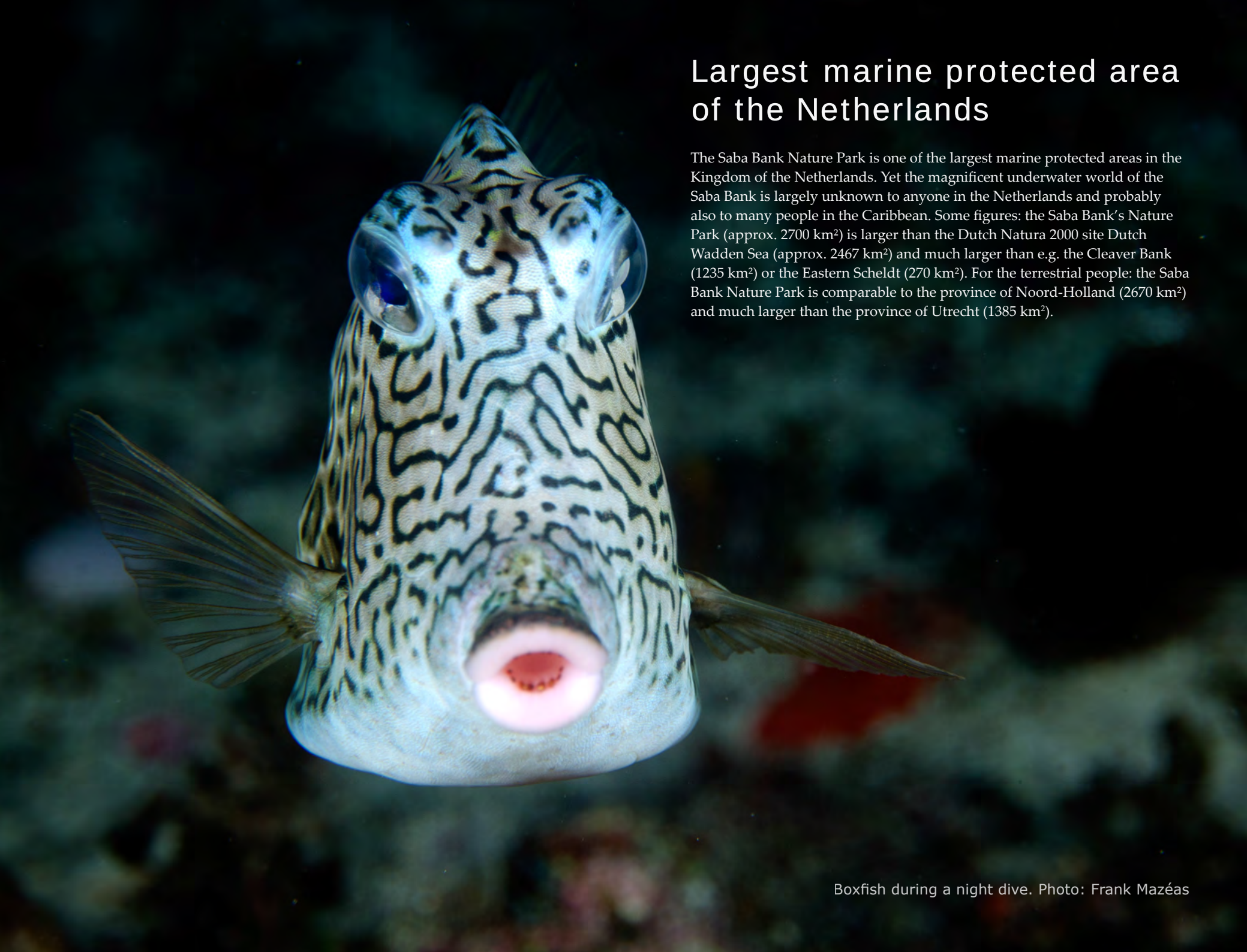
Buoy marking the dive site. Saba in the background.
Photo: David Stevens

1. Introduction

This book will let you dive into the underwater world of the Saba Bank Nature Park and give you an introduction to its amazing biodiversity. It also allows you to get a quick overview of the various research projects carried out between 2011-2016 that were presented at the Saba Bank Symposium (Den Helder, the Netherlands, 8 December 2016).



Gorgonians. Photo: David Stevens



Largest marine protected area of the Netherlands

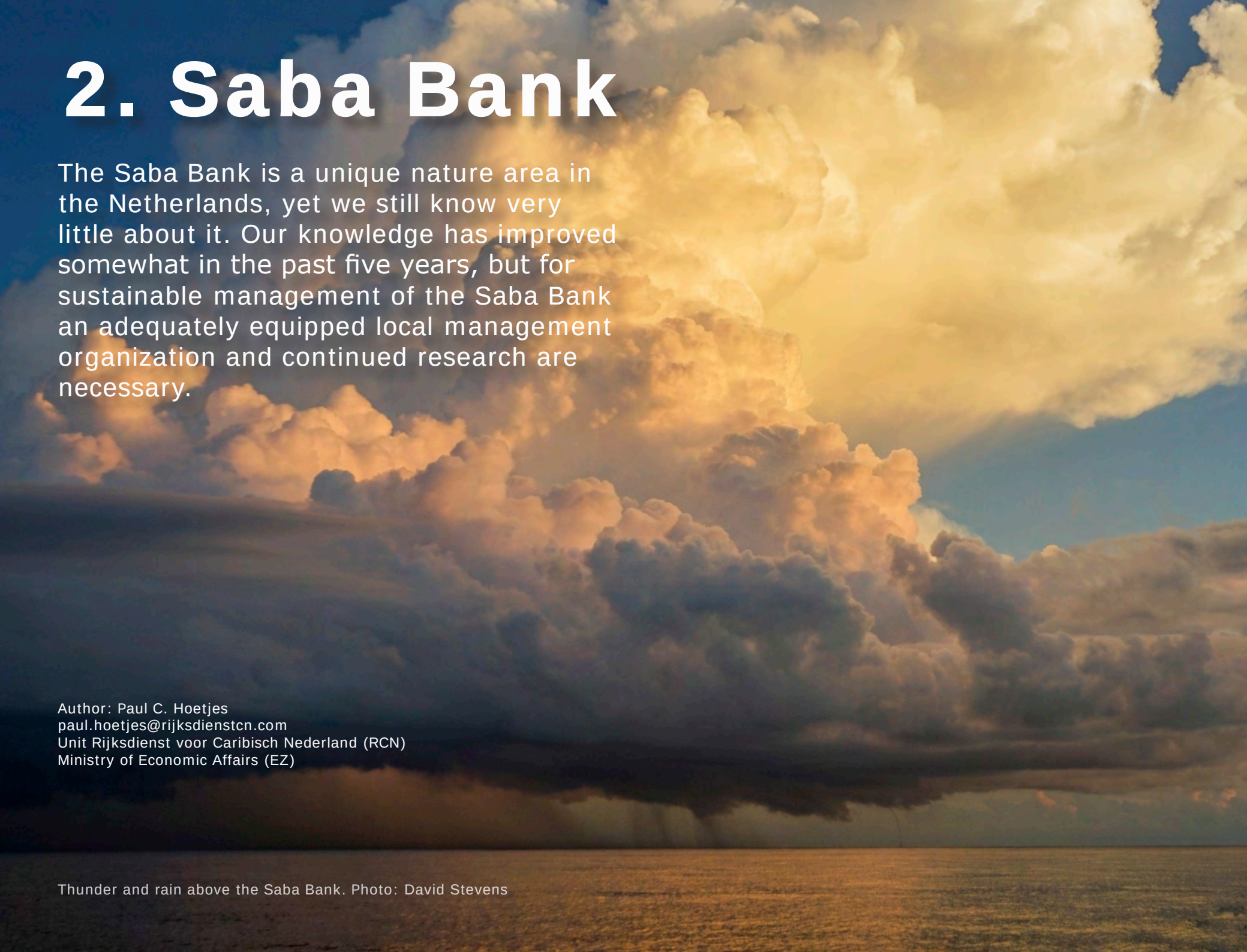
The Saba Bank Nature Park is one of the largest marine protected areas in the Kingdom of the Netherlands. Yet the magnificent underwater world of the Saba Bank is largely unknown to anyone in the Netherlands and probably also to many people in the Caribbean. Some figures: the Saba Bank's Nature Park (approx. 2700 km²) is larger than the Dutch Natura 2000 site Dutch Wadden Sea (approx. 2467 km²) and much larger than e.g. the Cleaver Bank (1235 km²) or the Eastern Scheldt (270 km²). For the terrestrial people: the Saba Bank Nature Park is comparable to the province of Noord-Holland (2670 km²) and much larger than the province of Utrecht (1385 km²).

Boxfish during a night dive. Photo: Frank Mazéas

2. Saba Bank

The Saba Bank is a unique nature area in the Netherlands, yet we still know very little about it. Our knowledge has improved somewhat in the past five years, but for sustainable management of the Saba Bank an adequately equipped local management organization and continued research are necessary.

Author: Paul C. Hoetjes
paul.hoetjes@rijksdienstcn.com
Unit Rijksdienst voor Caribisch Nederland (RCN)
Ministry of Economic Affairs (EZ)



Thunder and rain above the Saba Bank. Photo: David Stevens

Little attention until the mid-1990s

The Saba Bank, though important to the Saban people as a fisheries resource, generally attracted little attention until the mid-1990s. Geologists debated the exact nature of the Bank and noted extensive coral reefs. Also some seismic exploration for oil took place, but otherwise little was known about the bank. This changed when the Netherlands Antilles started regulating its fisheries and it was discovered that huge quantities of queen conch (*Lobatus gigas*), lobsters and groupers were being harvested from the Bank by foreign fishermen.

To protect these resources the government needed to know more about what was out there on the Bank. Surveys started in the nineties and as more became known the Saba Bank turned out to be increasingly interesting and valuable as a resource, not just for its fisheries, but for its rich biodiversity in general. Aside from some 80 km of coral reefs, an unparalleled diversity of macroalgae was found, rich gorgonian communities, and indications that it might also be an important area for whales and tiger sharks. Yet, because of its huge size, bigger than the Dutch part of the Waddenzee, and limited means, the knowledge gained was tantalizingly inadequate. It was enough however, to warrant a precautionary approach to the management of the fisheries and to justify protection of the area from anchoring.

Research 2011-2016

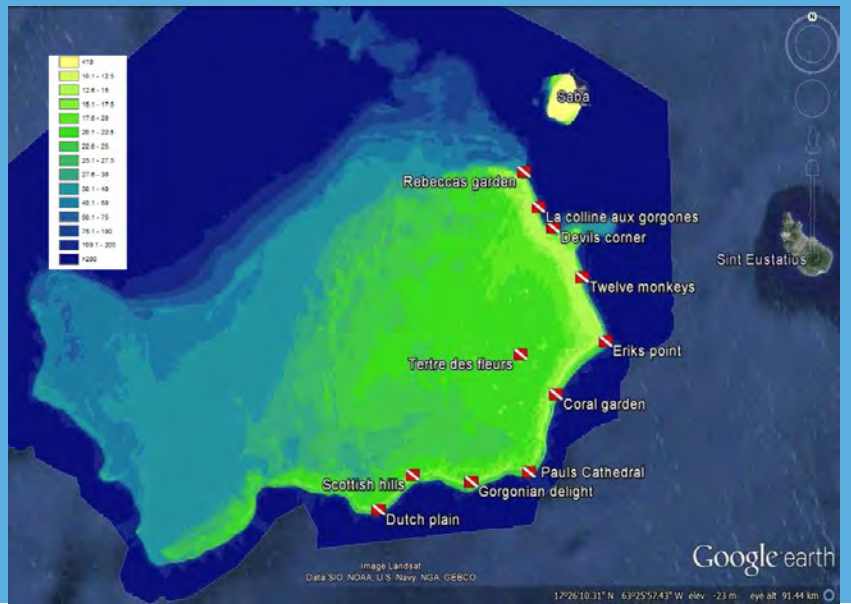
Research on the Saba Bank gained momentum when the Saba Bank came under direct responsibility of the Netherlands after 2010 when Bonaire, St. Eustatius and Saba joined the Netherlands as 'public entities'. Suddenly more financial means became available and scientific interest from Dutch knowledge institutions was aroused. The Saba Bank was recognized as a Nature Park as well as an area of exceptional regional importance. Much work was done to assess the fisheries and the health of the coral reef, with results recently becoming available. Research on marine mammals as well as sharks was started.

It was realized that the Saba Bank, separated by deep ocean from coastal influences, yet only a short distance from the island of Saba, is a very good place to study the effects of global change and the resilience of coral reefs.

Management of Saba Bank falls under the responsiblity of the Ministry of Economic Affairs and has been mandated by the Ministry to the Saba Conservation Foundation (SCF), which has formed the Saba Bank Management Unit for this task. The two person Management Unit is equipped with a small but seaworthy boat to go out to the Bank. This unit provides much indispensable support for the research on the Saba Bank, which it depends on for effective management. The unit also links with the fishermen on Saba, providing information and listening to their concerns to translate them to management or research questions.

Policy challenges

With the Saba Bank as a Nature Park and internationally recognized as an area of regional importance that needs to be protected because of its rich biodiversity, there is an obligation to continue research and monitoring as well as to strengthen the active management of the Saba Bank. Yet, funding for this is decreasing and the Netherlands appears to be turning away from biodiversity conservation in general in the islands of the Dutch Caribbean. The work is not done however. For sustainable management of the Saba Bank a strong management organization and a broad research program, each facilitating the other, is necessary.



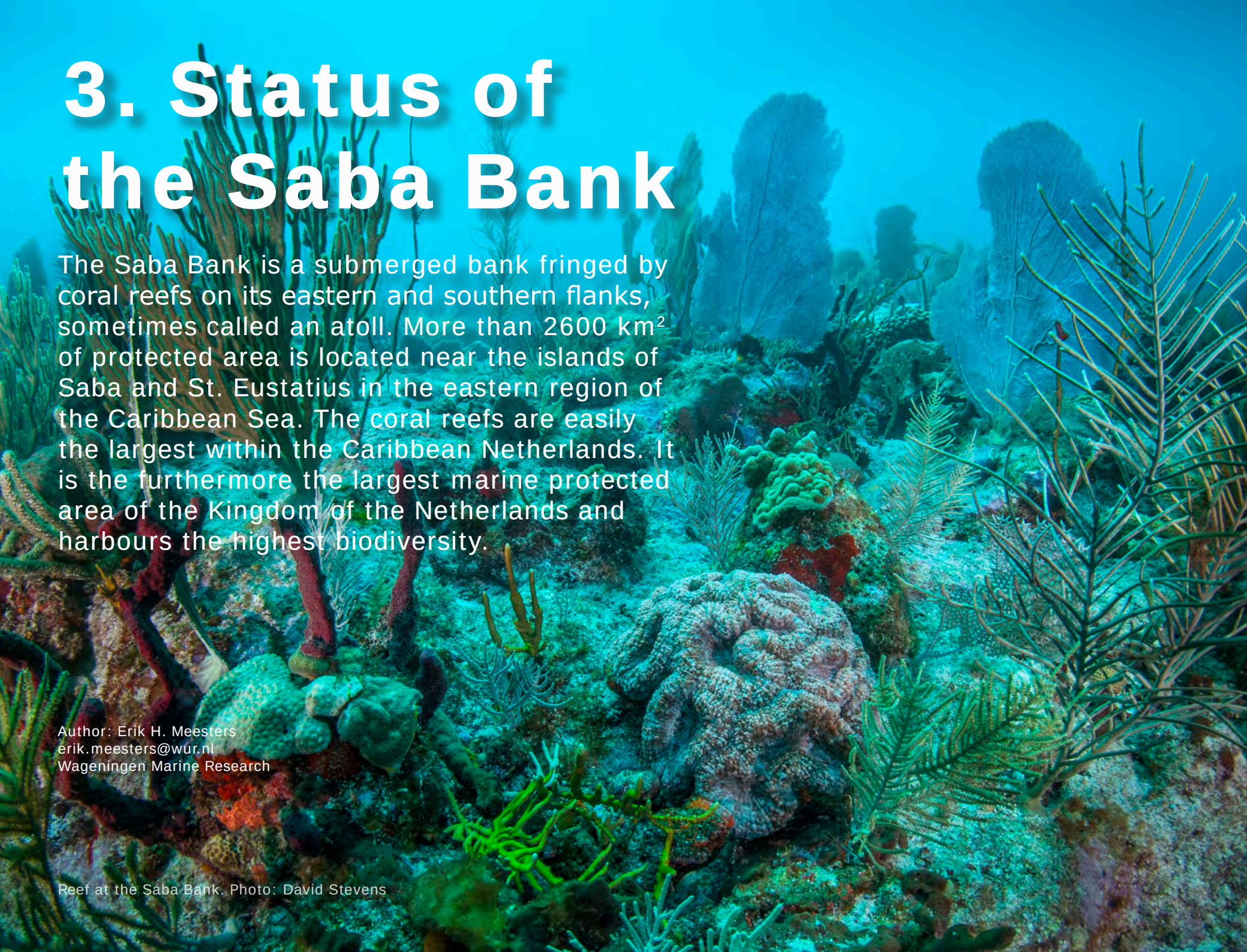
School of jacks. Photo: David Stevens

Spiny lobster with eggs. Photo: Martin de Graaf

3. Status of the Saba Bank

The Saba Bank is a submerged bank fringed by coral reefs on its eastern and southern flanks, sometimes called an atoll. More than 2600 km^2 of protected area is located near the islands of Saba and St. Eustatius in the eastern region of the Caribbean Sea. The coral reefs are easily the largest within the Caribbean Netherlands. It is the furthermore the largest marine protected area of the Kingdom of the Netherlands and harbours the highest biodiversity.

Author: Erik H. Meesters
erik.meesters@wur.nl
Wageningen Marine Research



Reef at the Saba Bank. Photo: David Stevens

The largest nature park in the Caribbean

The Saba Bank is the largest nature park in the Caribbean Sea and is recognized internationally as a exceptional area due to its rich diversity of marine animals and plants. Already in 1907 (Boeke, 1907) the Saba Bank was reported to be an important fishing area for fishermen from Saba who had been fishing here already for generations. In the 1970s and 1980s the bank was also fished by many other countries because of its large fish stocks. A first biological survey was carried out in 1972 which showed how rich the coral community was at many sampled places.

Protection against unlicenced fishing and anchoring

In 1996, after a new inventory of its biological richness (Meesters et al. 1996), legislation was put in place to regulate the unlicensed fishing by declaring an Exclusive Fishing Zone including the Saba Bank. In 2010, the Bank was designated as a natural reserve by the Dutch government and a protected area under the SPAW-protocol (Protocol Concerning Specially Protected Areas and Wildlife). Research showed that there were clear signs that anchoring by large tankers was causing immense damage to the bank's reefs. In 2012 the bank was declared a Particularly Sensitive Sea Area (PSSA) by the International Maritime Organization (IMO). This gave the Netherlands extended possibilities to regulate international shipping and anchoring. March 2013 the Saba-bank was recognized by the Convention on Biological Diversity (CBD) as an "Ecologically or Biologically Significant marine Area" (EBSA). This was an important recognition of the biological importance of the Saba Bank. Nowadays, still much remains unknown about the bank's biological treasures.

Aichi targets

The Aichi Biodiversity Targets were set under the Convention on Biological Diversity. Aichi Target 10 specifically mentions that "*the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning*", singling them out as one of the most important ecosystems for immediate action. The research described in this book provides the knowledge needed to adress this target.

The Saba Bank expeditions

Since 2011 three expeditions to the Saba Bank have been carried out to assess its condition and investigate ecological processes. These were funded by the Ministry of Economic Affairs with a contribution by the World Wide Fund Netherlands (WWF). The expeditions have contributed tremendously to our knowledge of the Saba Bank. A documentary on National Geographic helped to draw worldwide attention for the unique diversity on the Saba Bank.

Policy message

Determination of the current health status of the Saba Bank is no small task. The area is difficult to reach, waters are generally rough and the average depth is below 20 m, not to mention its enormous size. Fishing on the Saba Bank has to be sustainable and this needs to be assessed by research, just like the general health condition of the coral reefs on the bank. Research also helps to understand the effects of climate change and fisheries and aids in understanding the processes that occur on the bank. It generates essential knowledge to guide management of the Bank towards reaching a good environmental status.

References

Boeke, J., (1907) Rapport betreffende een voorloopig onderzoek naar den toestand van de visscherij en de industrie van zeeproducten in de kolonie Curacao, ingevolge het Ministerieel Besluit d.d. 22 november 1904. Den Haag: Belinfante. pp. 201.

Meesters, E.H., H. Nijkamp, and L. Bijvoet (1996). Towards sustainable management of the Saba Bank, in KNAP Project 96-03. pp. 51.

Van der Land, J., The Saba Bank - A large atoll in the northeastern Caribbean (1977). FAO Fisheries Report. 200: pp. 469-481.

Soft corals. Photo: David Stevens

Silky reef shark (*Carcharhinus falciformis*) during the expedition in October 2015. First record of this species on Saba Bank. Photo: Erik Meesters

4. Fisheries on the Saba Bank

Since 2012 a port sampling programme has been in place to document the characteristics of the Saban fishery on the Saba Bank. The main target species of the trap fisheries are Caribbean spiny lobster and deep-water snappers or “red-fish”.

Author: Martin de Graaf
martin.degraaf@wur.nl
Wageningen Marine Research

Trap at the Saba Bank. Photo: Frank Mazéas

Towards regulated fisheries

Fishing has always been an important cultural activity on Saba. Despite the small size (10 vessels) of the current fishing fleet, the relative contribution of fisheries to Saba's gross domestic product (GDP) is more than 20 times higher than the contribution of the Dutch North Sea fishery to the GDP. Since the mid-1990s only a limited number of predominantly Saban fishers are allowed to fish on the bank. Before that, fisherman from many islands participated in the largely unregulated and unsustainable fishery on the Saba Bank.

Assessment of fishery and fish stocks

The objective of the current research programme is to determine the status of the fisheries and fish stocks on the Saba Bank to enable the responsible local and Dutch management authorities to develop sound policy and regulations to ensure sustainable exploitation of the natural resources.

The research programme collects basic fishery data on catch, fishing effort, species composition and length frequency distribution. Data are collected by interviewing fishers in the harbour and by measuring catch and discards on board fishing vessels. environmental targets formulated in international treaties and conventions and to ensure a sustainable use of the natural resources.

Research on redfish

Stocks and landings have declined

Compared to 2000, the stocks and landings of lobster and deep-water snappers appeared lower in 2012-2015. During 2012-2015 the lobster stock remained stable and total annual landings increased yearly due to increasing effort (number of fishing trips). The temporal pattern in lobster landings is similar to the wider Caribbean region. A potential healthy sign is the consistent large size of harvested lobsters between 2000 and 2015. Rules and regulations of both the lobster and deep-water snapper trap fisheries will need to be updated in the near future to ensure a sustainable fisheries.

Conch stocks have increased

The unregulated fishery on conch was prohibited in the mid-1990s. Recent surveys indicated, however, that conch stocks appeared to have recovered (~14 million adult conch). A properly managed and sustainable fishery may be an option in the future.

Policy message

Fishery is the main manageable anthropogenic activity on the Saba Bank effecting its natural resources and biodiversity. Understanding the Saba Bank fishery and its interactions with the ecosystem is crucial in achieving the environmental targets formulated in international treaties and conventions and to ensure a sustainable use of its natural resources.


Measuring a nurse shark. Photos: Martin de Graaf

Colourful catch. Photo: Michelle Boonstra

Port sampling programme: observers on board. Photo: Michelle Boonstra

5. Habitat use of reef sharks

The reefs of the Saba Bank and neighbouring islands of Saba, St. Eustatius and St. Maarten provide important habitat for multiple species of sharks. In order to effectively protect shark populations, it is important to examine their migratory patterns and habitat use. Such information is essential to determine the size and location of marine reserves and to establish effective fisheries measures.

Author: Erwin Winter
erwin.winter@wur.nl
Wageningen Marine Research

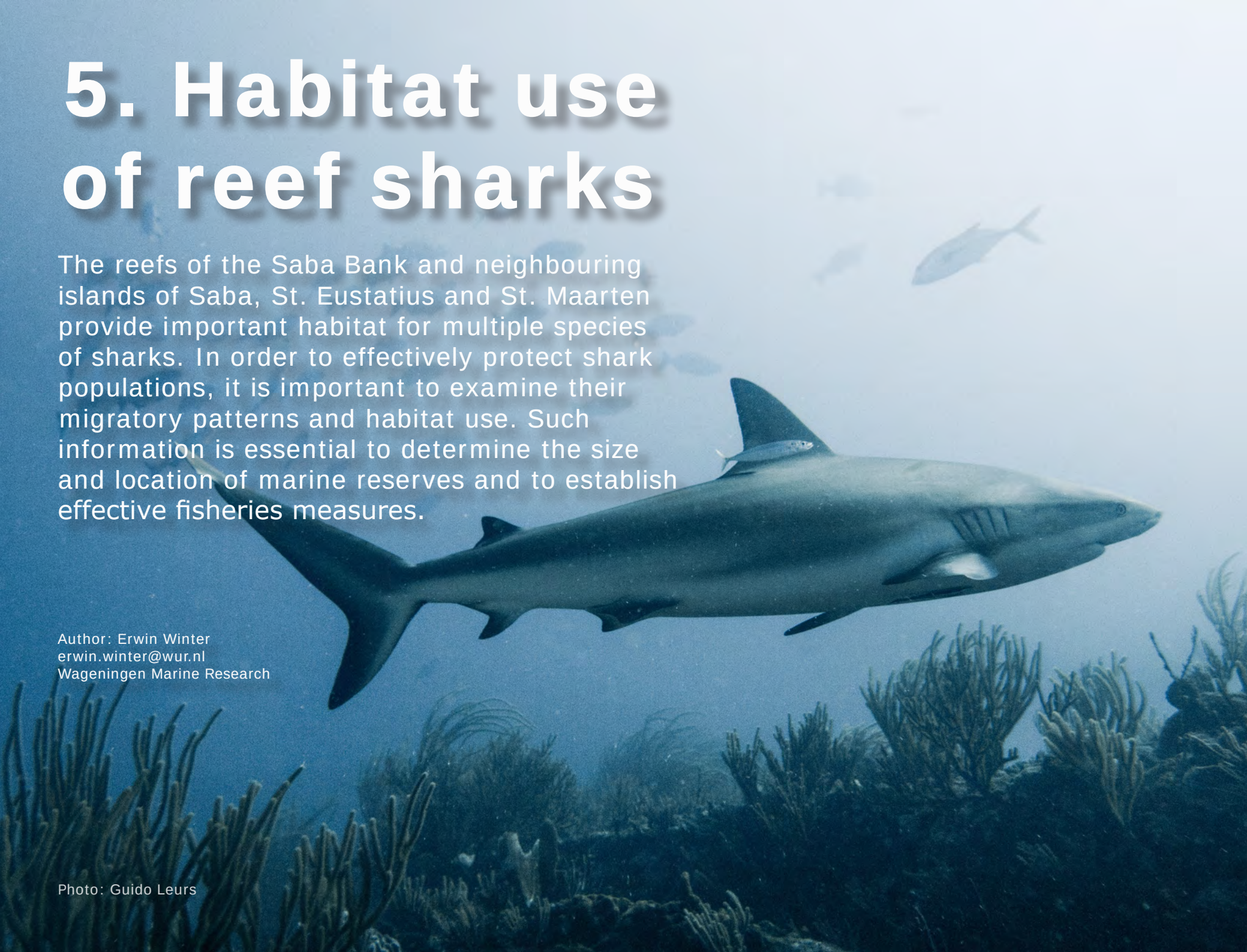


Photo: Guido Leurs

The Saba Bank: important habitat for sharks

Shark populations worldwide have greatly declined by overfishing and habitat loss. Biodiversity is very high around the Dutch Caribbean islands: there are 27 different species of sharks and rays present (and possibly more). For these species very little information is available on distribution, densities or population status. The Saba Bank appears to be an important habitat for the nurse shark (Ginglymostoma cirratum) and Caribbean Reef Shark (Carcharhinus perezi). Unfortunately, juvenile nurse sharks are relatively common bycatch in the numerous lobster cages, which indicates that the area is used as a nursery area. In order to protect sharks, it is important to know on what scale they use various reef habitats. The questions we aim to answer: are sharks very home-loving on a small scale or do they move widely between different reef systems? Are there different subpopulations and to what extent is there exchange? The study is conducted in cooperation with local nature organisations. Local media, as wells as fishermen, are strongly involved and contribute to the success of the research.

Tags

A good way to answer such questions is to tag sharks and follow their movement and behaviour. For this study, we use acoustic telemetry (VEMCO). The tag - a plastic tube about the size of the little finger - is implanted in the abdominal cavity of a shark. Every 80 seconds it broadcasts a unique signal for at least 4.5 years. There is a network of receivers put in place on the seabed to record sharks continuously. The tagged sharks will provide insight in the habitat use (foraging, development), in differences between gender and life stage, seasonal patterns, migration and connectivity among reef systems.

Releasing a tagged shark. Photo: Erwin Winter

Nurse sharks are very site-attached

In 2014-2015 a network of 32 detection stations was built around Saba, Saba Bank, St. Maarten and St. Eustatius. In total, we tagged 21 Caribbean reef sharks and 7 nurse sharks. The first two years of study near Saba (since 2014) and on the Saba Bank (since 2015) showed that nurse sharks are very site-attached and move and forage on a very small scale. Caribbean reef sharks show more variable behaviour; most are very sedentary and stay in a small area around Saba. Similar patterns are observed on the Saba Bank. Some sharks are more mobile and cover larger areas. A few individuals migrated back and forth between Saba and the Saba Bank.

Tagged sharks in 2014

	Nurse-sharks	Caribbean reef sharks
Saba	4	8
Saba bank	1	10
St. Eustatius	1	3
St. Maarten	1	0
Totaal	*7*	*21*

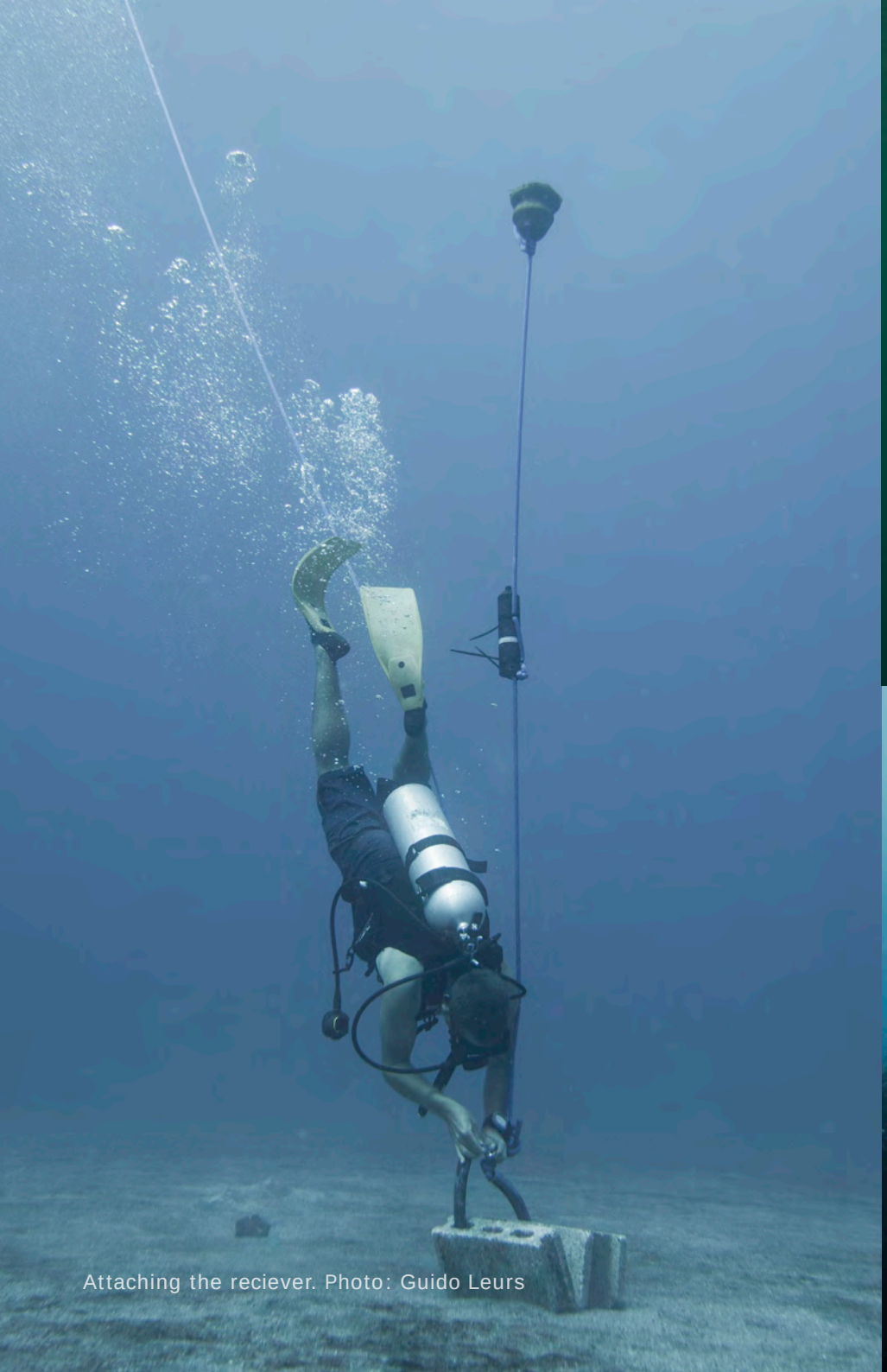
Policy message

The current study shows the scale at which sharks use the Saba Bank and the surrounding areas, and to which extend the different sites are connected. This is important information that will be used to take effective protective measures (e.g. marine reserves, fisheries measures, etc.). Shark protection is an important aspect in various international treaties and specifically addressed within the Yarari shark sanctuary.

Reference

Winter HV, Vink D, Van Beek IJM (2015). Pilot study on behaviour of sharks around Saba using acoustic telemetry - Progress report 2014. IMARES report C026/15 (http://edepot.wur.nl/335032).

Nurse shark. Photo: Frank Mazéas



Attaching the reciever. Photo: Guido Leurs

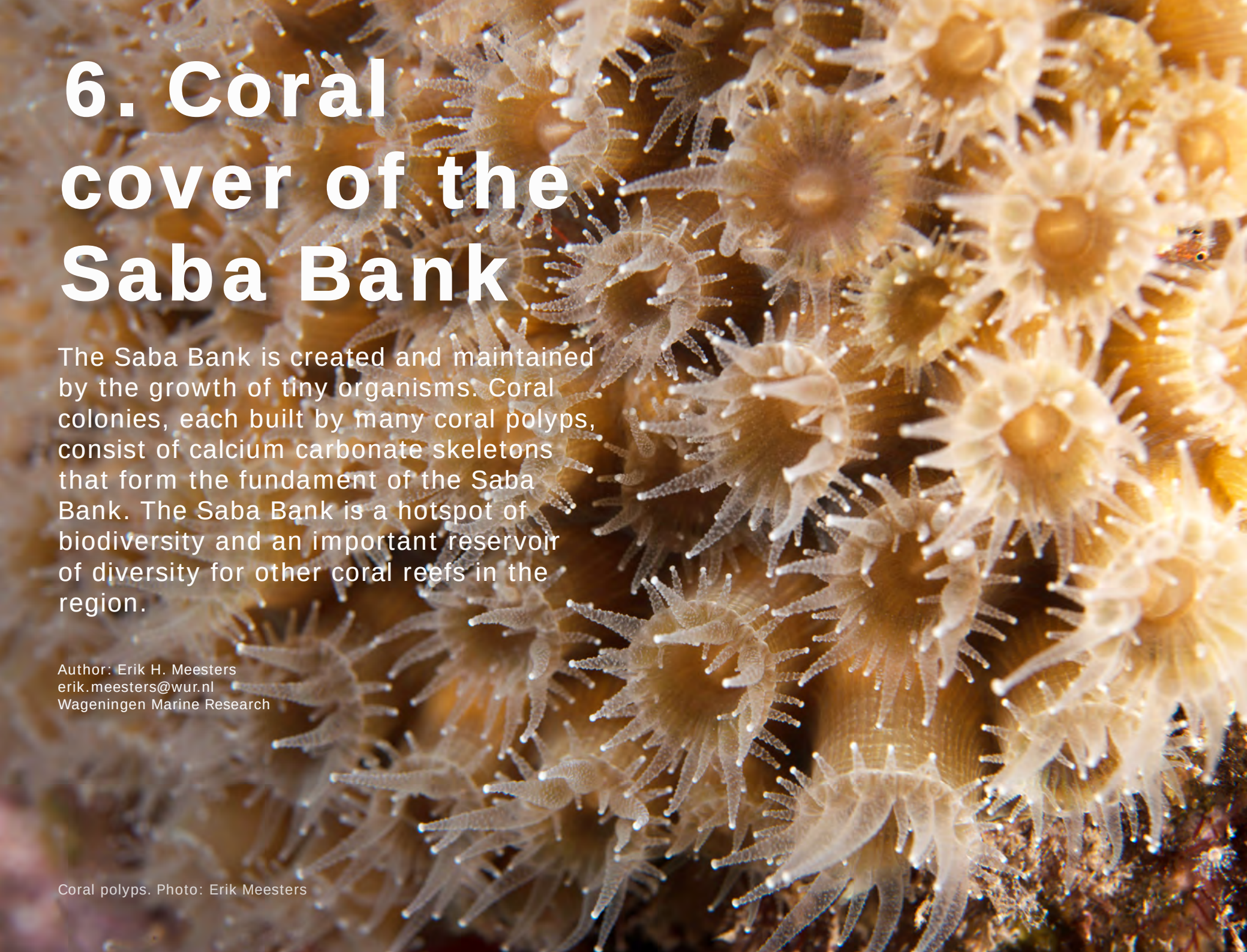
Caribbean reef shark. Photo: Erik Meesters

Reciever. Photo: Guido Leurs

6. Coral cover of the Saba Bank

The Saba Bank is created and maintained by the growth of tiny organisms. Coral colonies, each built by many coral polyps, consist of calcium carbonate skeletons that form the fundament of the Saba Bank. The Saba Bank is a hotspot of biodiversity and an important reservoir of diversity for other coral reefs in the region.

Author: Erik H. Meesters
erik.meesters@wur.nl
Wageningen Marine Research



Coral polyps. Photo: Erik Meesters

Coral reefs: rain forests of the sea

Coral skeletons are incorporated into the framework of the reef. Corals can create large colonies, three-dimensional structures that provide space, food, and shelter for many different reef organisms. By providing habitat and suitable substrate for other species to grow on or live between, corals are the most important animals of a coral reef. The total biodiversity (animals, algae) on coral reefs is the highest of any marine environment and coral reefs are therefore sometimes called the rain forests of the sea.

Corals need algae

Corals are colonial organisms: each polyp in a colony is a genetically identical clone. Additionally, coral live in symbiosis with unicellular algae, so called zooxanthellae, that enable them to grow fast and form reefs. This however makes these corals dependent on light and therefore coral reefs can only form in relatively shallow water. When coral colonies die, their skeleton is broken down to sand and fragments that become part of the reef bottom. Without living corals a reef will be broken down rapidly by boring and scraping animals and disappear together with all the animals and plants that depend on it. Because of climate change, coral reefs need to be in optimal condition for the reef to keep up with rising sea level. Therefore, high coral cover is essential for the survival of the reef.

Assessing the reef's health status

Measuring coral cover and counting new recruits and diseased colonies are means to assess the health status of the reef. A healthy reef can support a high production of fish and is attractive to tourists that come to dive, there by providing important local income. Coral reefs also protect the shore from erosion by waves while the sand from reefs may form appealing natural sandy beaches.

Climate change leads to death of coral colonies

Compared to the 1990s, coral cover on Saba Bank is currently lower. In 2011 monitoring on the Saba Bank started on 10 locations. At each site 3 transects of 50 m were photographed (150m²). Living coral cover turned out to be a mere 8%, which is quite low. In 1996 it was reported as lying between 40 and 60%! 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 causes high coral mortality. It is believed that bleaching is largely responsible for the lower cover of living corals on the bank. During the second and third expedition to the Saba Bank (resp. 2013 and 2015) cover had not declined any further. Cover is not yet improving either, but there are signs that the Bank is not in a bad condition: there are many small young colonies and there are very little signs of disease on the corals. Depending on whether we will be able to stop climate change and the warming of the sea water, the corals of the Saba Bank may survive and increase their cover. However, if the sea keeps warming and episodes of extremely high sea water temperatures occur more frequently, the fate of the Saba Bank seems sealed.

Policy message

The Saba Bank is the largest marine ecosystem in the Kingdom of the Netherlands. More than 2200 km² of tropical marine area forming a hotspot of biodiversity within the Caribbean. The bank is also the most important economic resource for the fishermen of Saba. The Netherlands have an international obligation to protect and manage the bank and its resources wisely and sustainably. Monitoring and research will ensure that we keep on track on how the bank is faring and impose efficient policy measures.

References

Van Beek IJM, Meesters HWG (2013) Saba Bank research expedition 2011 - Progress Report (http://edepot.wur.nl/258198). Report C018/13 IMARES Wageningen UR

Van Beek IJM, Meesters HWG (2014) Saba Bank research expedition 2013 - Progress Report (http://edepot.wur.nl/305508). Report C086/14, IMARES Wageningen UR

Researcher Erik Meesters takes a photo every meter along the transect.
Photo: David Stevens

Transect photo showing corals and sponges. Photo: Erik Meesters

The research teams after the dives. Photo: Erik Meesters

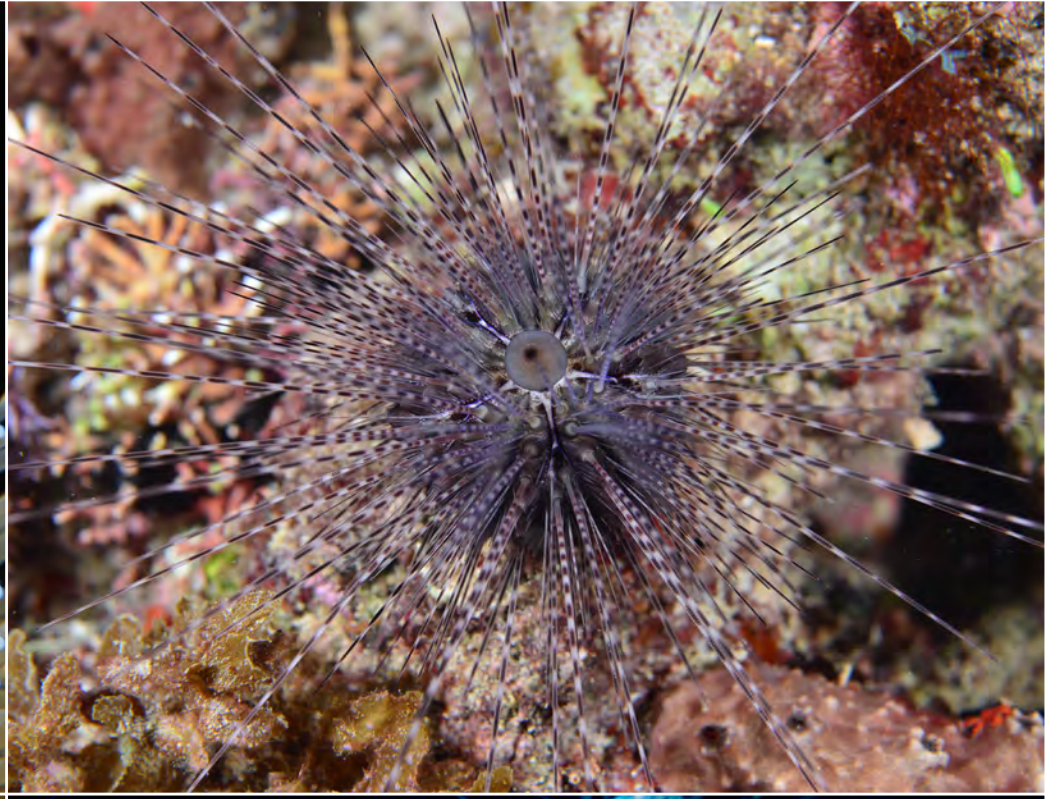
Damaged comon sea fan. Photo: Erik Meesters

Giant barrel sponge. Photo: Erik Meesters

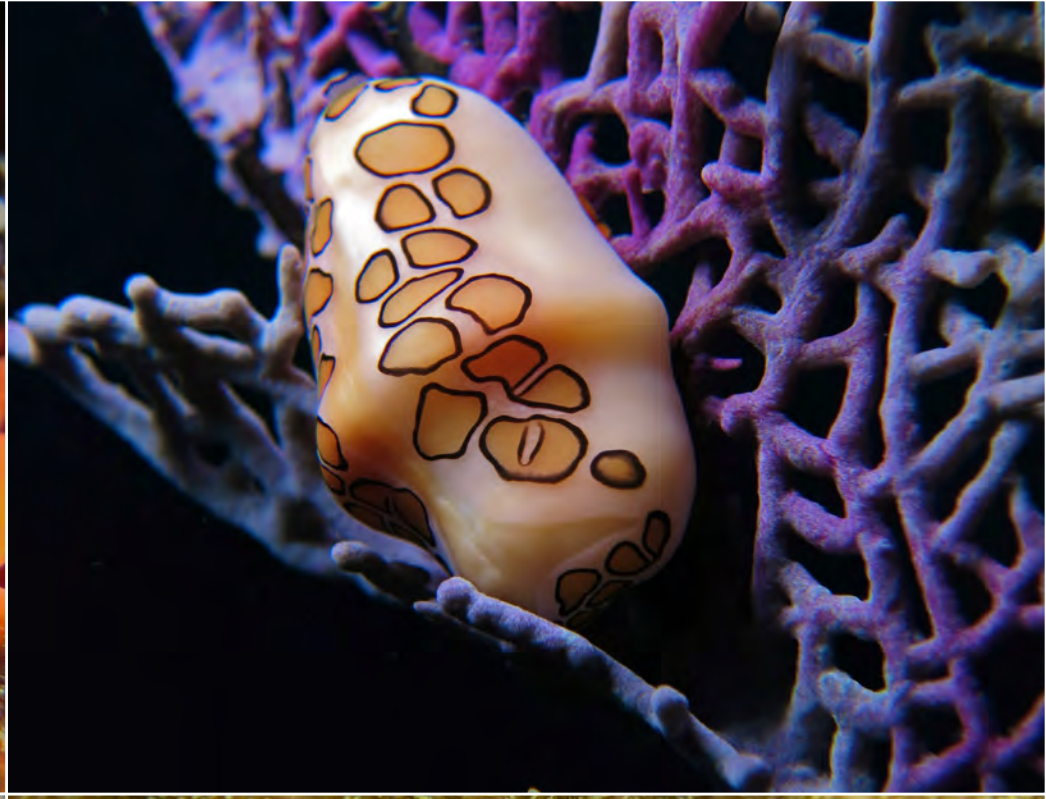
Measuring lobsters. Photo: Martin de Graaf

Christmas tree worms. Photo: Oscar Bos

Anemone (Orange ball corallimorph). Photo: Oscar Bos



Left to right: coral polyps, sea urchin, coral polyps, jellyfish.
Photos: Oscar Bos, Erik Meesters



Left to right: fan worms, flamingo tongue, hidden crab, coral polyps.
Photos: Ewan Trégarot, Erik Meesters, Oscar Bos

7. Coral diversity and historical collections

The Saba Bank has been visited by a few expeditions since the 1970s and during some of them marine fauna and flora could be investigated with the help of specimen collecting.

Author: Bert W. Hoeksema
bert.hoeksema@naturalis.nl
Naturalis Biodiversity Center

Expedition in 1972

Stony coral diversity

Collected material and photographic documentation are necessary as evidence for taxonomic verification, which is relevant in base line studies (Hoeksema et al. 2011; Rocha et al. 2014). The first expedition (1972) used the hydrographic vessel H.NL.M.S. Luymes (Van der Land, 1977). Specimens were collected by divers of the Royal Netherlands navy who had no training in coral taxonomy. Stony coral species (*Scleractinia* spp. and *Millepora* spp.) were recorded per dive station and plotted on a map, which resulted in a total of 25 species for Saba Bank, with highest species concentrations at the southeastern rim (see map). *Helioseris cucullata* was not listed by Van der Land (1977) but found later in collection material (Hoeksema et al. 2016). Hence, the total number of coral species sampled during that expedition is actually 26. In 2006, Paul Hoetjes organised a Rapid Assessement Program with Conservation International and a team of experts. Another, better prepared collecting expedition took place in 2006. During this survey 38 stony coral species were recorded but only 31 were identified with certainty (McKenna et al. 2010). During a recent survey in 2013, the highest number ever recorded from Saba Bank was 39 (Van Beek and Meesters, 2014). The increase in the number of species, however, is likely the result of more thorough survey methods rather than an actual increase since the 70s.

Remarkable rolling coral stones

During a recent coral survey to Saba Bank in October 2015 only one locality was visited during three dives (Tertre de Fleur at 17°23'04" N, 63°17'23" W), which was insufficient to document the complete stony coral fauna of the bank. Only 16 species were found, which did not represent new species records for Saba Bank. However, corals of various species showed remarkable ecomorphs at 15–20 m depth by being free-living, also known as coralliths, rotary corals or rolling coral stones (Glynn 1974; Sorauf and Harries 2009), because of their ability to move. The presence of these unattached corals may be indicative for the wave-swept coral environment that is typical for the top of Saba Bank. Earlier reports did not mention them and no collected specimens were found in historical collections from Saba Bank.

References

Glynn PW (1974) Rolling stones among the Scleractinia: mobile coralliths in the Gulf of Panama. Proceedings 2nd International Coral Reef Symposium 2:183–198.

Hoeksema BW, Van der Land J, Van der Meij SET, Van Ofwegen LP, Reijnen BT, Van Soest RWM, De Voogd NJ (2011) Unforeseen importance of historical collections as baselines to determine biotic change of coral reefs: the Saba Bank case. Marine Ecology 32: 135–141.

Hoeksema BW, Van Beusekom M, Ten Hove HA, Ivanenko VN, Van der Meij SET, Van Moorsel GWNM (2016) Helioseris cucullata as a host coral at St. Eustatius, Dutch Caribbean. Mar Biodivers. doi:10.1007/s12526-016-0599-6

McKenna SA, Etnoyer P (2010) Rapid assessment of stony coral richness and condition on Saba Bank, Netherlands Antilles. PLoS ONE 5: e10749.

Rocha LA, Aleixo A, Allen G, Almeda F, Baldwin CC. et al. (2014) Specimen collection: an essential tool. Science 344:814–815. doi:10.1126/science.344.6186.814

Sorauf JE, Harries PJ (2009) Rotatory colonies of the corals Siderastrea radians and Solenastraea ssp. (Cnidaria, Scleractinia), from the Pleistocene bermont formation, south Florida, USA. Palaeontology 52, 111–126

Van Beek IJM, Meesters EHWG (2014) Saba bank research expedition 2013 – progress report. IMARES, Wageningen.

Van der Land J (1977) The Saba Bank – a large atoll in the northeastern Caribbean. FAO Fisheries Report 200: 469–481.

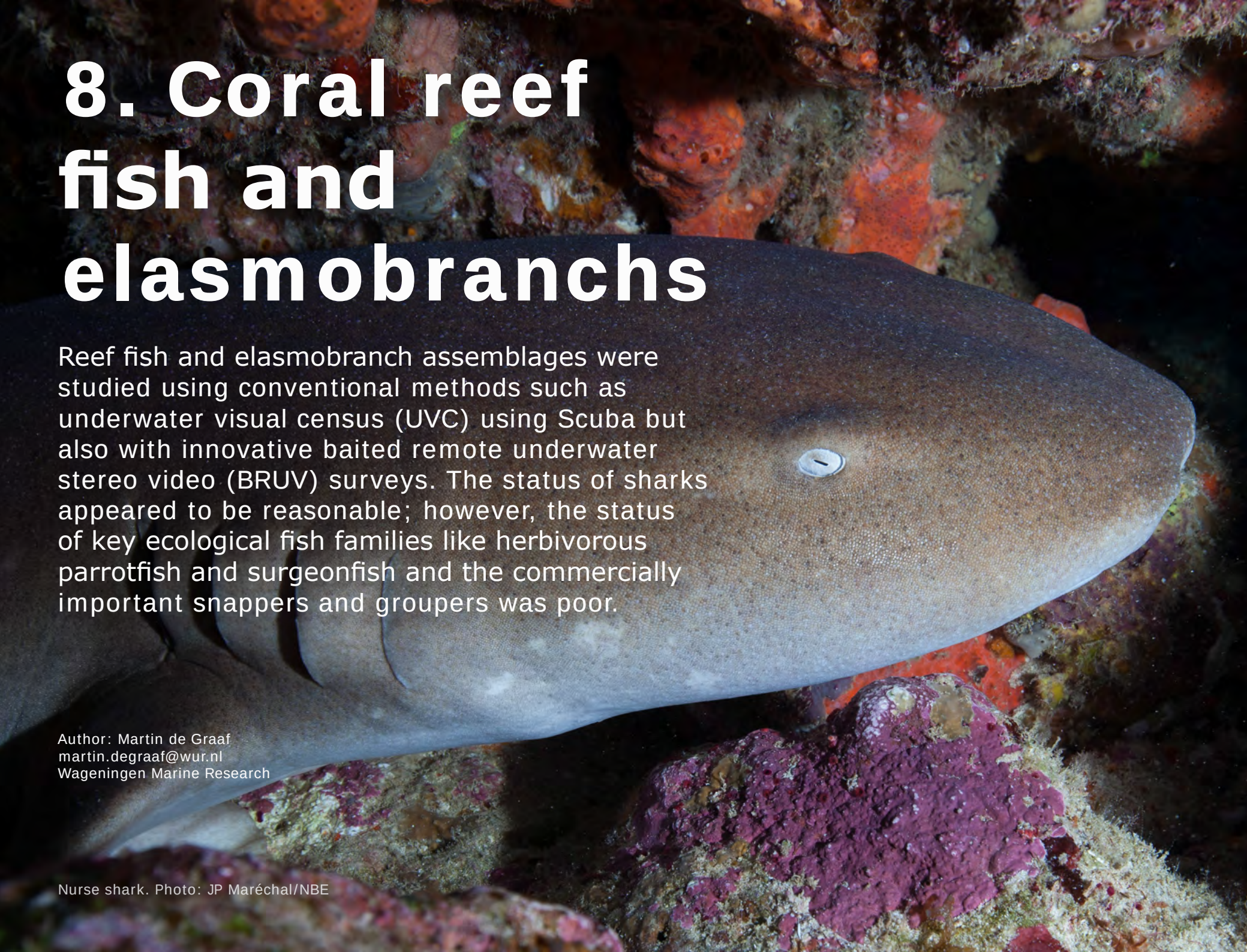
Expedition leader Van der Land in 1972

Rolling coral stones in 2015. Foto's: Bert Hoeksema

8. Coral reef fish and elasmobranchs

Reef fish and elasmobranch assemblages were studied using conventional methods such as underwater visual census (UVC) using Scuba but also with innovative baited remote underwater stereo video (BRUV) surveys. The status of sharks appeared to be reasonable; however, the status of key ecological fish families like herbivorous parrotfish and surgeonfish and the commercially important snappers and groupers was poor.

Author: Martin de Graaf
martin.degraaf@wur.nl
Wageningen Marine Research



Nurse shark. Photo: JP Maréchal/NBE

Baited video surveys and Scuba visual census

The aim of the project was to conduct a base-line survey to describe the current elasmobranch (shark and ray) diversity, distribution and abundance and to determine the status of key ecological reef fish families. A combination of methods was used to determine the composition of reef fish and elasmobranch assemblages. BRUV is a non-invasive method to study large mobile fish species such as sharks that are difficult to sample with UVC. Another advantage of BRUV is that the cameras can be deployed at depths and circumstances that are unsafe for divers.

Relatively many sharks, few fish of key families

Caribbean reef sharks, nurse sharks and tiger sharks were observed during the 155 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. The UVC surveys in 2011, 2013 and 2015 demonstrated repeatedly that the biomass of key herbivorous fish families and key commercial fish families was low, indicating a poor status of these fish families.

Policy message

The standardized BRUV base-line survey and UVC surveys will serve as a reference point to evaluate the performance of future management actions on elasmobranch and key ecological reef fish families on the Saba Bank, an important part of the Yarari Shark and Whale reserve.

References

Van Beek IJM, Meesters HWG (2013) Saba Bank research expedition 2011 - Progress Report (http://edepot.wur.nl/258198). Report C018/13 IMARES Wageningen UR

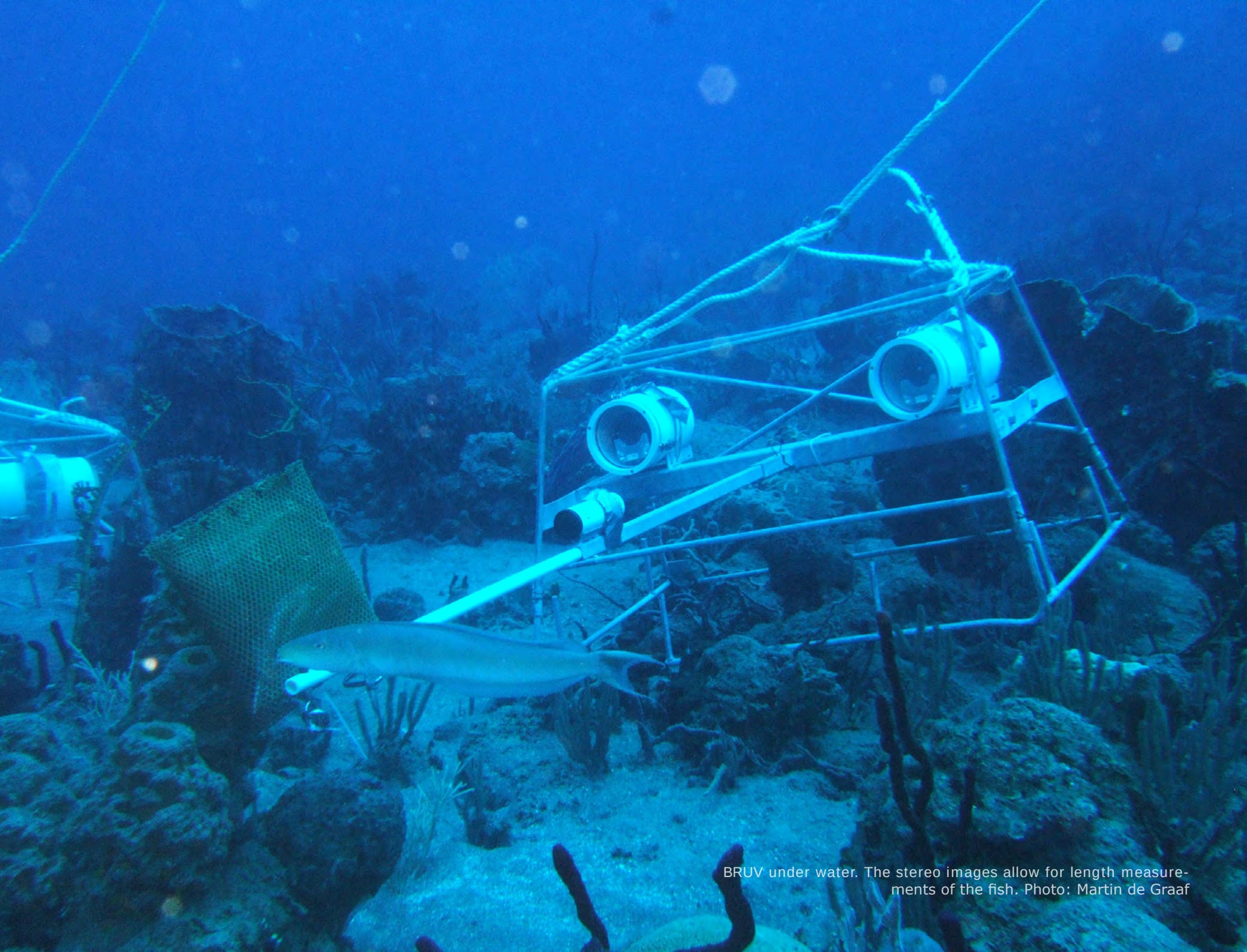
Van Beek IJM, Meesters HWG (2014) Saba Bank research expedition 2013 - Progress Report (http://edepot.wur.nl/305508). Report C086/14, IMARES Wageningen UR

Underwater Visual Census (UVC) survey. Photo: David Stevens

School of horse-eye jacks during the UVC survey in 2013.
Photo: JP Maréchal/NBE

Fish survey (UVC) in 2015. Photo: David Stevens

Baited Remote Underwater Video (BRUV). Photo: Martin de Graaf



BRUV under water. The stereo images allow for length measurements of the fish. Photo: Martin de Graaf








Left page: nurse shark, barracuda, grouper with trumpet fish, invasive red lion fish, stingray, boxfish, queen angelfish, peacock flounder. Photos:Ewan Trégarot, Erik Meesters, Frank Mazéas

Grouper. Photo: JP Maréchal/NBE

9. A bank of sponges

Sponge diversity, cover and health status were determined in photo-transects along on the south-eastern rim of Saba Bank. In addition molecular analysis was done to determine genetic diversity and population connectivity. At present, the cover and diversity of sponges indicate a resilient community, yet a significant portion of barrel sponges is affected by white spots.

Author: Lisa Becking
Lisa.becking@wur.nl
Wageningen Marine Research
Naturalis Biodiversity Center

Sponge. Photo: Oscar Bos

Role of sponges

Sponges are essential, yet often neglected, components of the biodiversity of reef systems. Sponges are the vacuum cleaners of the sea, filtering out all sorts of pathogens from the water column. They provide food for other reef organisms by converting dissolved organic molecules into food particles and also offer shelter to a variety of creatures in their internal channels.

Sponge diversity

During the Saba Bank expeditions in 2013 and 2015, sponge cover, diversity and health status were determined along transects of 50 m² on the south-eastern rim of the bank. In addition, we are also setting up an identification database of Saba Bank sponges by linking information on morphological characters and underwater pictures with DNA profiles of each species. Our results combined with data from previous collections in 1972, 1986, and 2006, show that there are at least 100 sponge species on the bank. The remarkable news is that we documented at least 20 new species records on the bank! Among these we suspect that there is one new (undescribed) species.

Sponge reefs

Sponges and corals are in a constant rivalry for space. It may seem silent and peaceful down there in the reef, but all the while sponges and corals are battling to claim and maintain space by smothering each other or exuding their toxic chemicals. This spatial competition is a natural state, yet in recent years there has been concern that sponges are getting the upper hand and that the Caribbean reefs are turning into so called 'sponge reefs'. Based on our survey in 2013 and 2015, however, the average sponge cover did not increase and was approximately 10%, just marginally higher than coral cover. For Saba Bank there is currently no grave concern that it is becoming a sponge reef.

Sponge. Photo: Erik Meesters

Reefs connected

An important factor for coral-reef resilience is the connectivity between and within coral reefs in different regions. Geographical surveys of genetic variation provide an indirect means of tracing movements made between marine populations by larvae and other propagules. A key question is how populations of reef organisms on the Saba Bank are connected with populations in the region and in the Wider Caribbean. Our investigation of the population genetic structure show high population connectivity within Saba Bank and high connection with populations in the region.

Giant barrels

One prominent member of the sponge community is the giant barrel sponge (*Xestospongia muta*). These red-brown sponges can be big enough to house a diver and have been recorded to be 100s of years old. On Saba Bank this sponge contributed most to the total sponge cover and the densities of this sponge were generally higher compared to other Caribbean locations. However, a significant portion (>80%) of these sponges is affected by white spots (bleaching). Although the long term health effects of this bleaching are unknown, there is a risk of a reduction in population size. The giant barrel sponge plays a crucial role in the coral reef ecosystem by providing habitat complexity and by filtering a substantial volume of the water column.

Policy message

Our results show that Saba Bank could function as an important buffer for the region. Either as a natural source of larvae to replenish diversity or as a storehouse of diversity that can be utilized if needed for restoration practices. The health status of barrel sponges should be monitored, as a reduction in barrel sponge populations would likely cause a significant change in ecosystem functioning.

The sponge team in action. Photo: David Stevens

Sponge. Photo: Oscar Bos

Various sponges on the Saba Bank.
Photos: Oscar Bos

Macro photography of sponges. Photo: David Steven

10. Listening to whales and dolphins

The Saba Bank is an important wintering area for humpback whales and other cetaceans. For proper protection measures, however, information about densities, seasonal migration patterns, species composition, and background noise levels is needed. Noise loggers allow us to listen to these animals and extract valuable information.

Author: Dick de Haan
dick.dehaan@wur.nl
Wageningen Marine Research

Humpback whale. Photo: Jimmy van Rijn

Marine mammals in the Caribbean

The sea area around the Dutch Caribbean islands (the exclusive economic zones, EEZs) has a rich and diverse marine mammal fauna which should be protected. There are at least 19, but possibly more than 30 species of marine mammals present here. One way to study marine mammals is with the use of a noise logger, an autonomous device that records sound produced by marine mammals underwater.

Noise loggers

Noise loggers can capture sounds of whales and dolphins (vocalizations). Attached to an anchoring on the seabed, the noise logger can pick up sounds within a range of tens of kilometres, depending on the species and background noise conditions. Low frequencies produced by whales (30 to 100 Hertz) propagate over a much larger distance than those of dolphins, with vocalizations in higher frequency bands (> 10 kHz). The noise loggers are set for continuous measurement and are able to detect frequencies up to 24 kHz. In this mode, the logger can collect data for up to 5 months, after which storage capacity is reached and batteries need to be replaced.

Migration routes revealed

In October 2011, a first noise logger was successfully deployed on the Saba Bank at a depth of 30 meters. Several species of whales were detected in the months thereafter including Minke whales (*Balaenoptera acutorostrata*) and humpback whales (*Megaptera novaeangliae*). Using other noise loggers around the North Atlantic the migratory route of minke whales could be reconstructed and it has become clear that they use the Saba Bank as an important area to spend the winter.

In the autumn of 2015, two other noise loggers were installed on the Saba Bank. They were picked up again in August 2016, before the hurricane season arrived. The results, however, have yet to be analysed. We will, among other aspects, study if whales are disturbed by ships by comparing the noise logger data with vessel movements based on AIS data (Automatic Identification System).

Policy message

Marine mammals are threatened worldwide and therefore protected under several international treaties. In September 2015, the Yarari Sanctuary was established around the Saba Bank by the State Secretary enabling the protection of marine mammals and sharks. This research will help to obtain high-quality quantitative data on the occurrence of marine mammals in and around the marine mammal sanctuary. This will assist protection and efficient managementof marine mammals in the area.

Noise loggers. Photo: Hans Verdaat

Heading to Saba. Photo: Hans Verdaat

Retrieving noise loggers. Photo: Hans Verdaat

11. Growth or erosion?

Climate change is causing the oceans to warm up and become more acidic. This may exacerbate chemical erosion of corals, coralline algae and other calcifying organisms, threatening the structure and health of the reef. To test whether the reef at the Saba Bank grows or erodes, we performed incubation experiments near Saba.

Author: Fleur C. van Duyl
fleur.van.duyl@nioz.nl
Koninklijk Nederlands Instituut voor Onderzoek der Zee (NIOZ)

Camping near Saba. Photo: Erik Meesters

A delicate balance

Corals and other calcifying organisms grow slowly by producing calcium carbonate ($CaCO_3$) for their skeleton. This can result in large coral reefs such as the one present on the Saba Bank. Such calcified structures are not only growing, but are also continuously being eroded. The balance between these two processes determines whether the reef increases or decreases in size. Erosion is caused by organisms such as parrotfish or sea urchins. These graze for tasty algae or dig holes and grind away the calcium carbonate. Sponges excavating the corals are common here as well and might play a large role in the breakdown and dissolution of calcium carbonate. In addition, acidification of the seawater may make it more difficult for calcifiers to build new carbonate material.

Experimental camping

How do you study calcification and decalcification processes of a reef in an open sea? The solution: enclose of a small part of the coral reef community using a translucent tent, and accurately follow the chemical processes in the water. The NIOZ has designed a special tent in cooperation with a tent factory. The tent is largely made of transparent, flexible vinyl.

Testing if the tent is leaking. Photo: Erik Meesters

Reef near Saba produces carbonaceous material at a healthy rate

We placed a larger tent (4 m^2) and a smaller control tent (0.43 m^2) over a suitable coral reef community. The first 'camp site' was at the Saba Bank, but the swell was too strong for the tents. A better location was found near Saba. We kept the tents and other equipment in the water for several days. Every hour water from the tent was pumped to the surface to measure dissolved inorganic carbon and total alkalinity. Divers went down every 2-3 hours to take additional water samples and inspect the tents. From the research vessel we took depth profiles, measurements of salinity, temperature and oxygen to characterize the water masses in the research area. With turtles now and then inspecting the site, the scene was at times surrealistic. Our initial conclusions are that the sampled part of the reef near Saba is producing carbonacious material at a healthy rate.

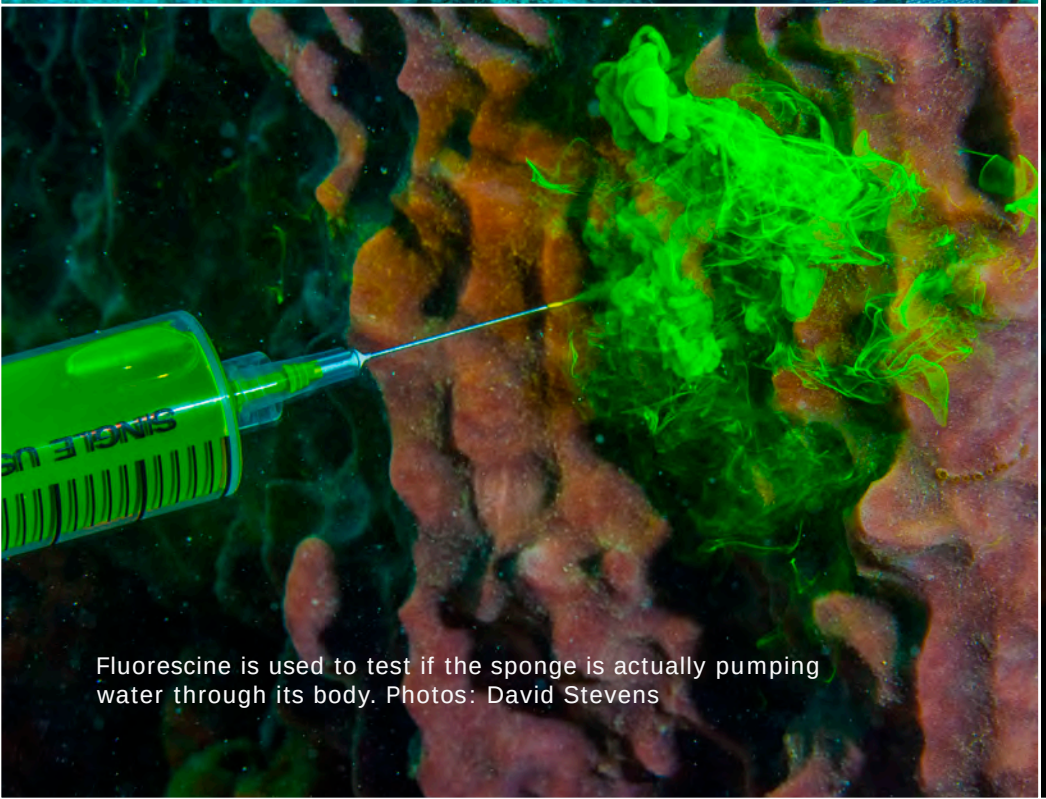
Policy message

This research helps to understand the effects of climate change on coral reefs. The Saba Bank will not stay the same the coming years. Indeed, it is changing while we investigate it. Continued research is required to help develop mitigation measures and to evaluate whether the bank can keep up with rising sea levels.

Sampling the outflow water of a sponge (*Callyspongia plicifera*) on the Saba Bank. Photo: David Stevens

Acoustic Doppler Current Profiler (ADCP) and incubation experiment. Photo: Erik Meesters

Measuring fluxes of nutrients in and out of different sponges on the Saba Bank



Fluorescine is used to test if the sponge is actually pumping water through its body. Photos: David Stevens

Outflow of water with fluorescine. A smoking sponge...

Topographic complexity of the reef

To estimate reef rugosity, PhD students Didier de Bakker and Alice Webb place a transect tape across the reef substrate surface, following the contours of the corals, sponges and other organisms on the seafloor. The length is then compared to the linear length between start and endpoint. This method allows for standardised measurement of topographic complexity at a reef site and is part of the ReefBudget method. It is used to quantify the carbonate budget status of the reef by estimating all reef building (e.g. coral, calcifying algae) and eroding (e.g. excavating sponges, urchins and parrotfish) factors along a transect line.

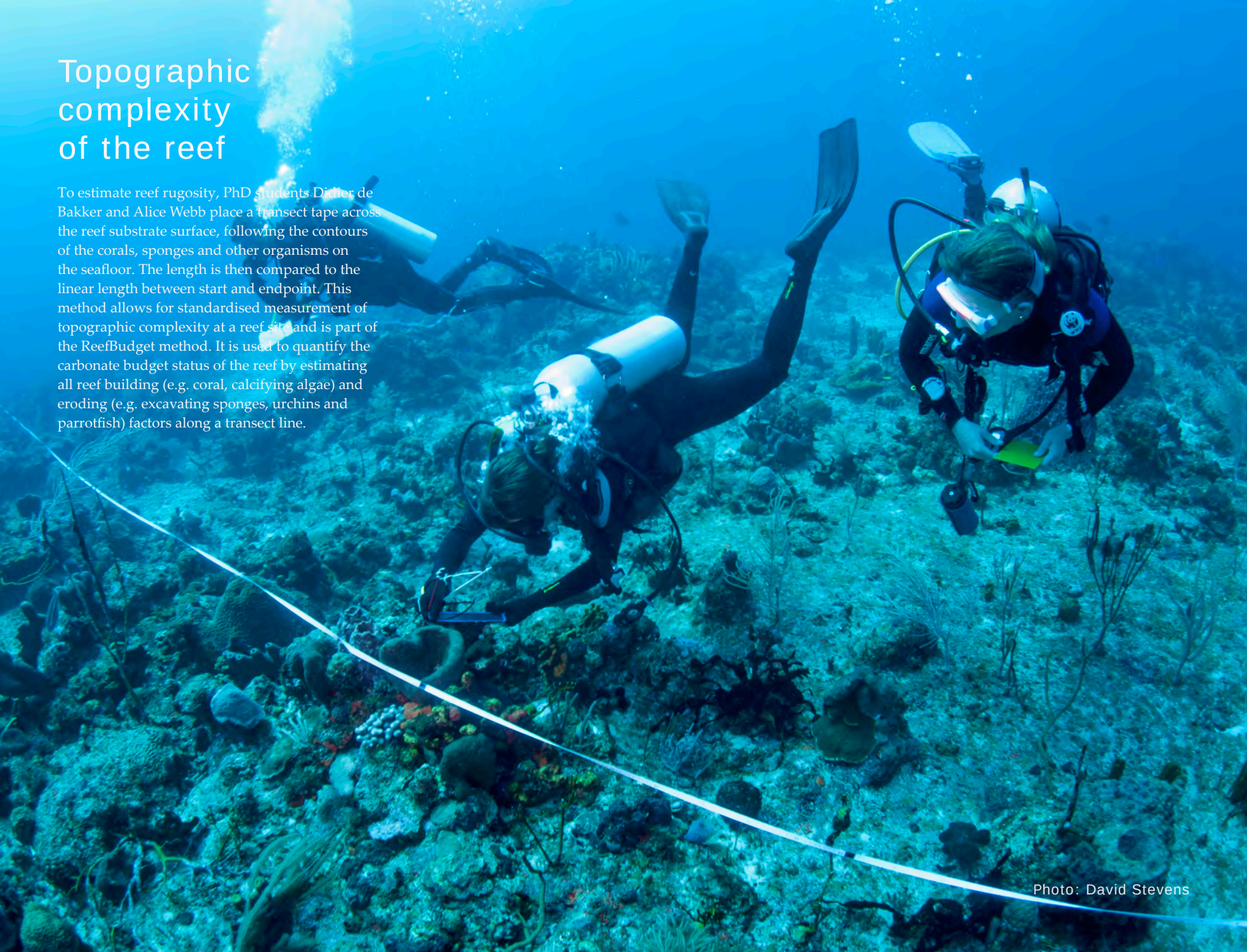
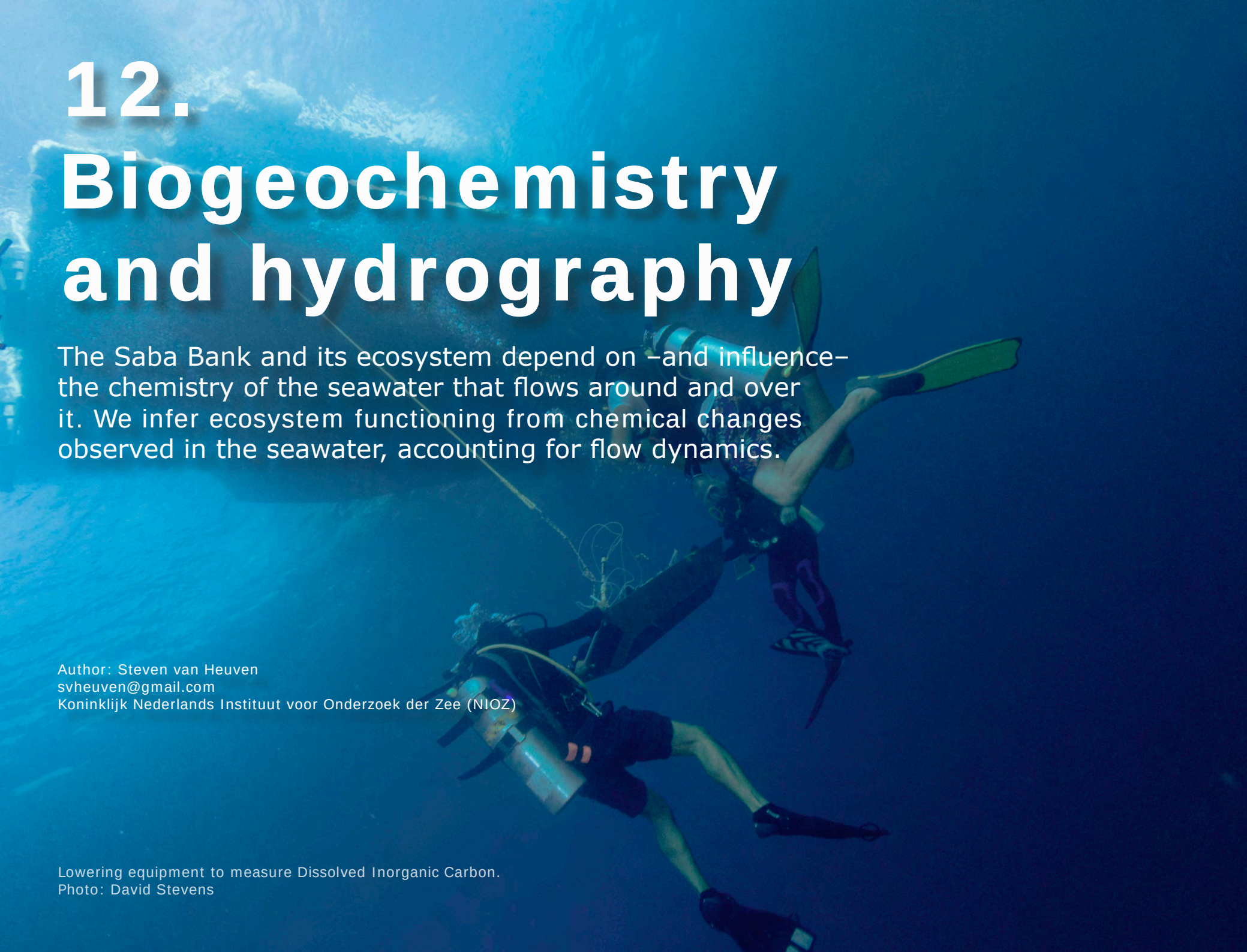


Photo: David Stevens

12. Biogeochemistry and hydrography

The Saba Bank and its ecosystem depend on –and influence– the chemistry of the seawater that flows around and over it. We infer ecosystem functioning from chemical changes observed in the seawater, accounting for flow dynamics.

Author: Steven van Heuven
svheuven@gmail.com
Koninklijk Nederlands Instituut voor Onderzoek der Zee (NIOZ)



Lowering equipment to measure Dissolved Inorganic Carbon.
Photo: David Stevens

A thriving oasis in a barren ocean

The Saba Bank is a large marine carbonate platform that rises up from the deeper seabed. Most of its surface area lies at depths of about 20-40 meters. It is a thriving oasis in an otherwise rather barren ocean. Life on the Saba Bank is thought to depend in part on the inflow of material (plankton and nutrients) from offshore.

The flow is generally from the southeast, which may explains why the best-developed reefs are located at the southeastern edge of the Saba Bank. After being taken up from the water column by the reef, the collected material is retained within the reef ecosystem. However, availability of too much nutrition may shift a coral reef towards an algae-dominated state. Moreover, the episodical exposure to colder, nutrient-laden but slightly more acidic deep waters may be relevant to the calcification balance of the corals and sponges that erode them.

The increasing impact of climate change (e.g., ocean warming, ocean acidification) may gradually upset the calcification balance of the Saba Bank ecosystem. We collected hydrographical and chemical data of the conditions that the organisms of Saba Bank are exposed to, to infer the current state and to provide a baseline against which to compare future biogeochemical surveys of this unique reef system.

Strong hydrographic variability

In August 2016, we sailed over and around Saba Bank on RV Pelagia, measuring water conditions and collecting water samples down from the surface to the bottom. Additionally, on Saba Bank we regularly deployed a small seafloor lander that collected a vertical series of samples from 10-300 cm from the seafloor, revealing intense near-bottom activity of the reef ecosystem. Initial examination of the data revealed strong hydrographic variability and use of offshore material.

Policy message

This research collects basic information on the exchange of nutrients and organic material between the coral reef and the surrounding waters of the Saba Bank. With our results we will be able to determine the degree to which the Saba Bank is exposed to nutrients, for example from sewage of the islands. This research will furthermore aid us in understanding the functioning of the ecosystem as well as the effects climate change may have on it.

On board the RV Pelagia in 2016. Photo: Steven van Heuven

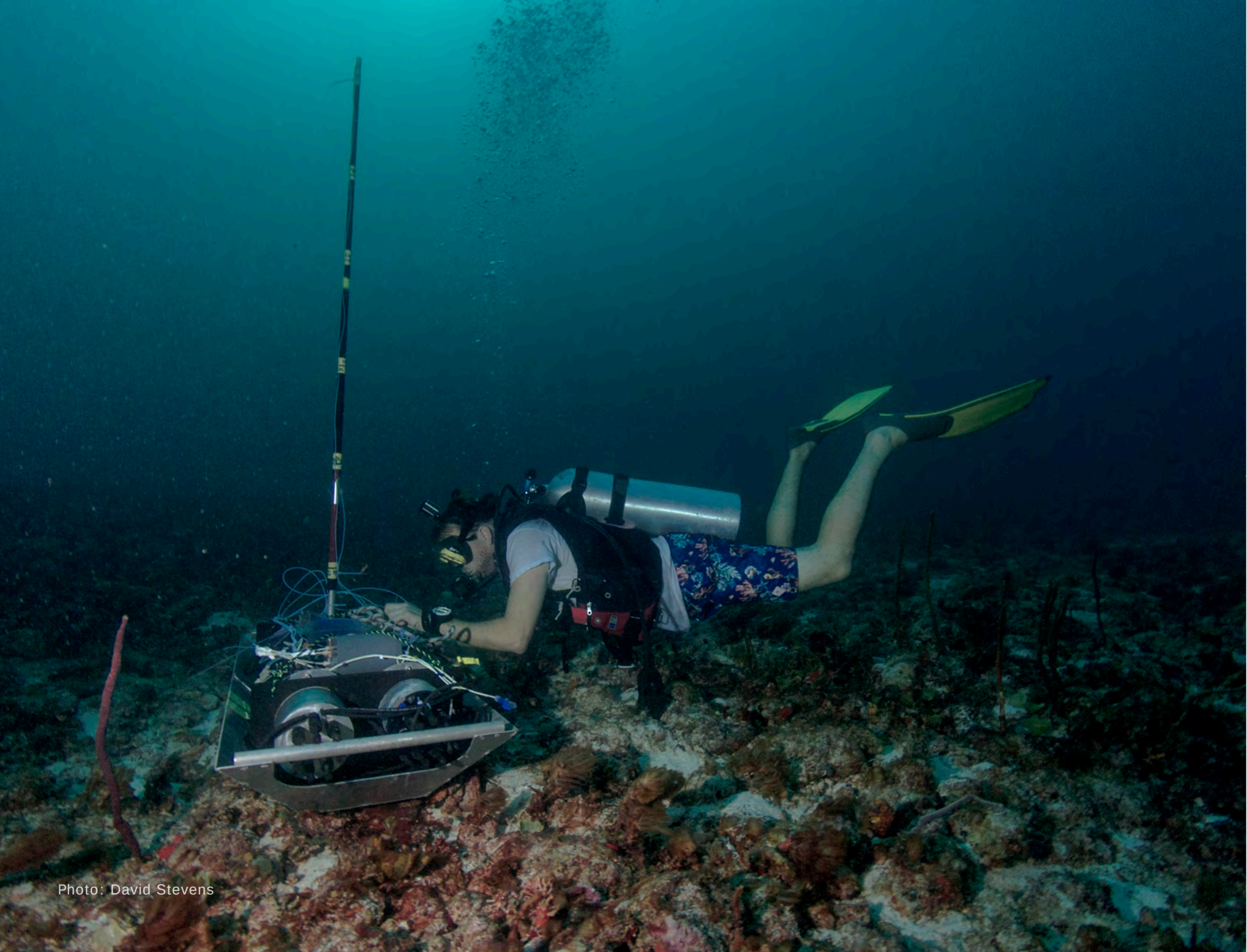
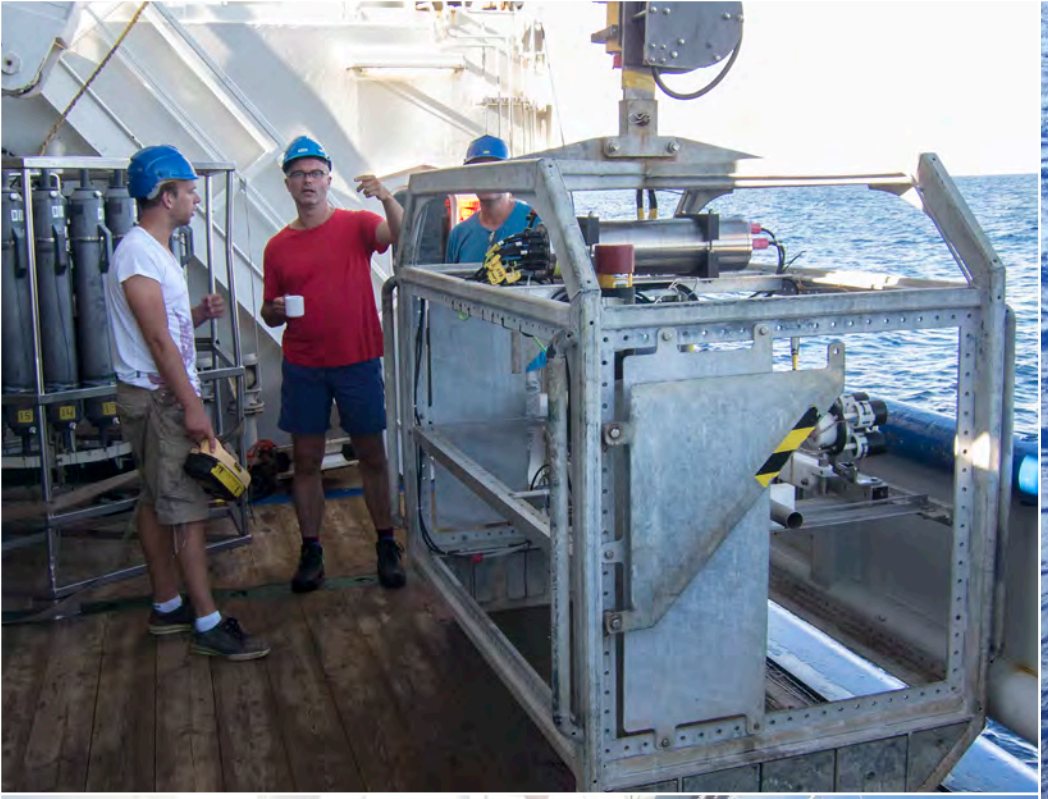
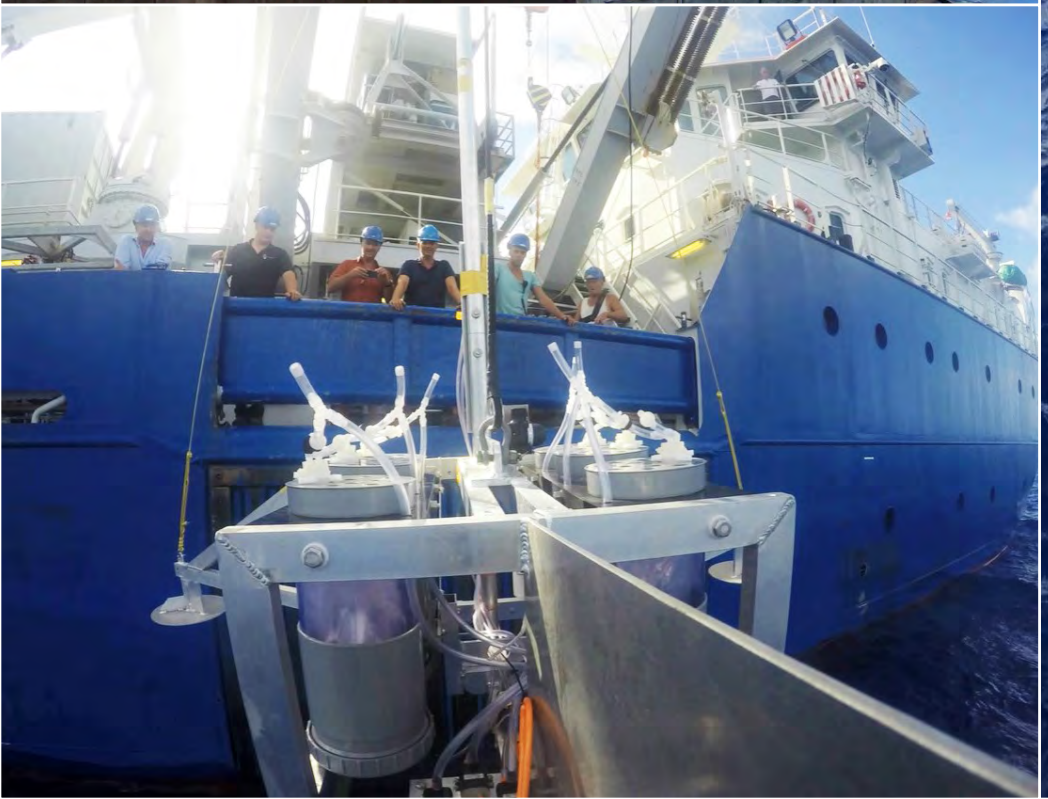
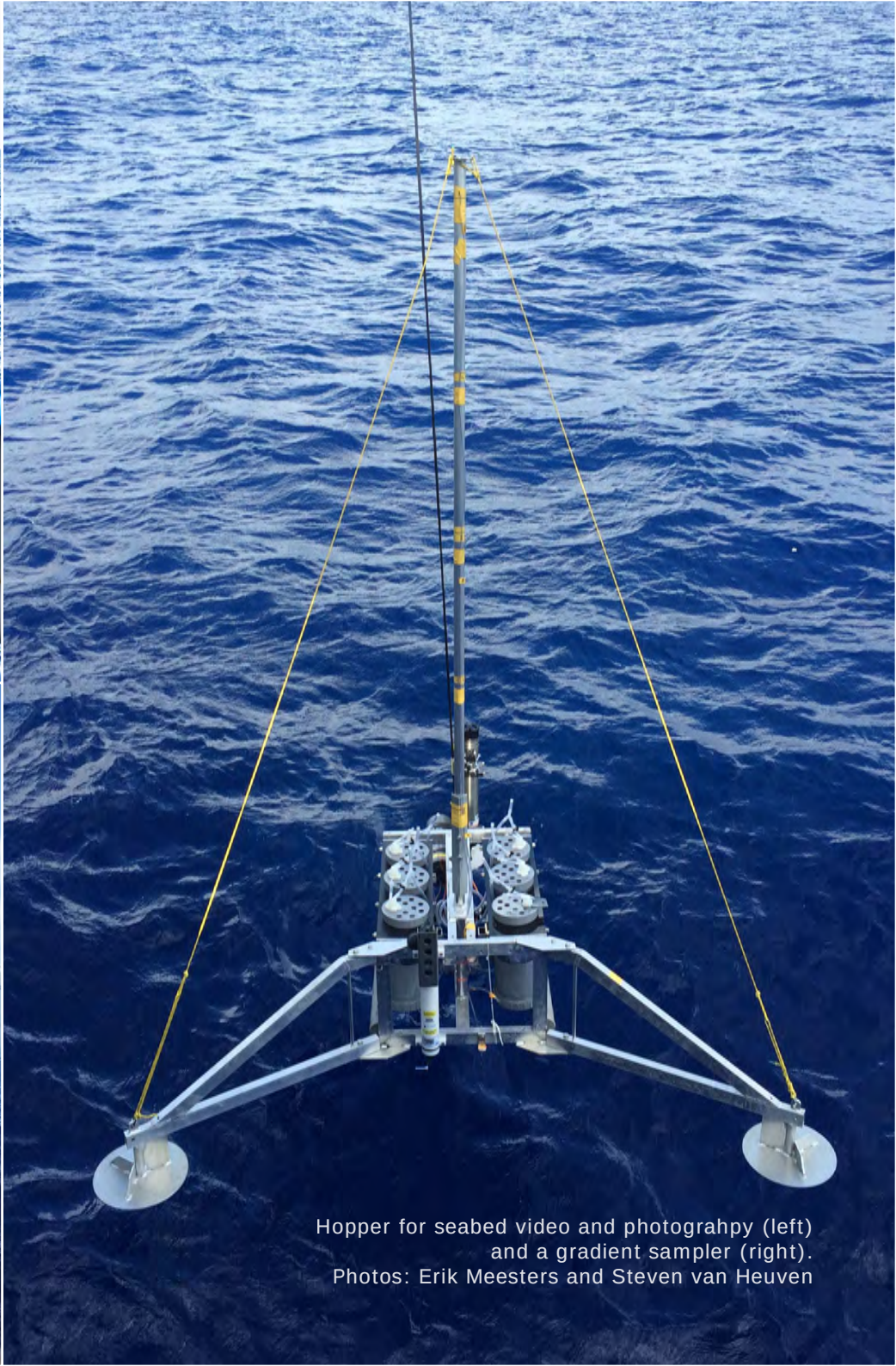


Photo: David Stevens

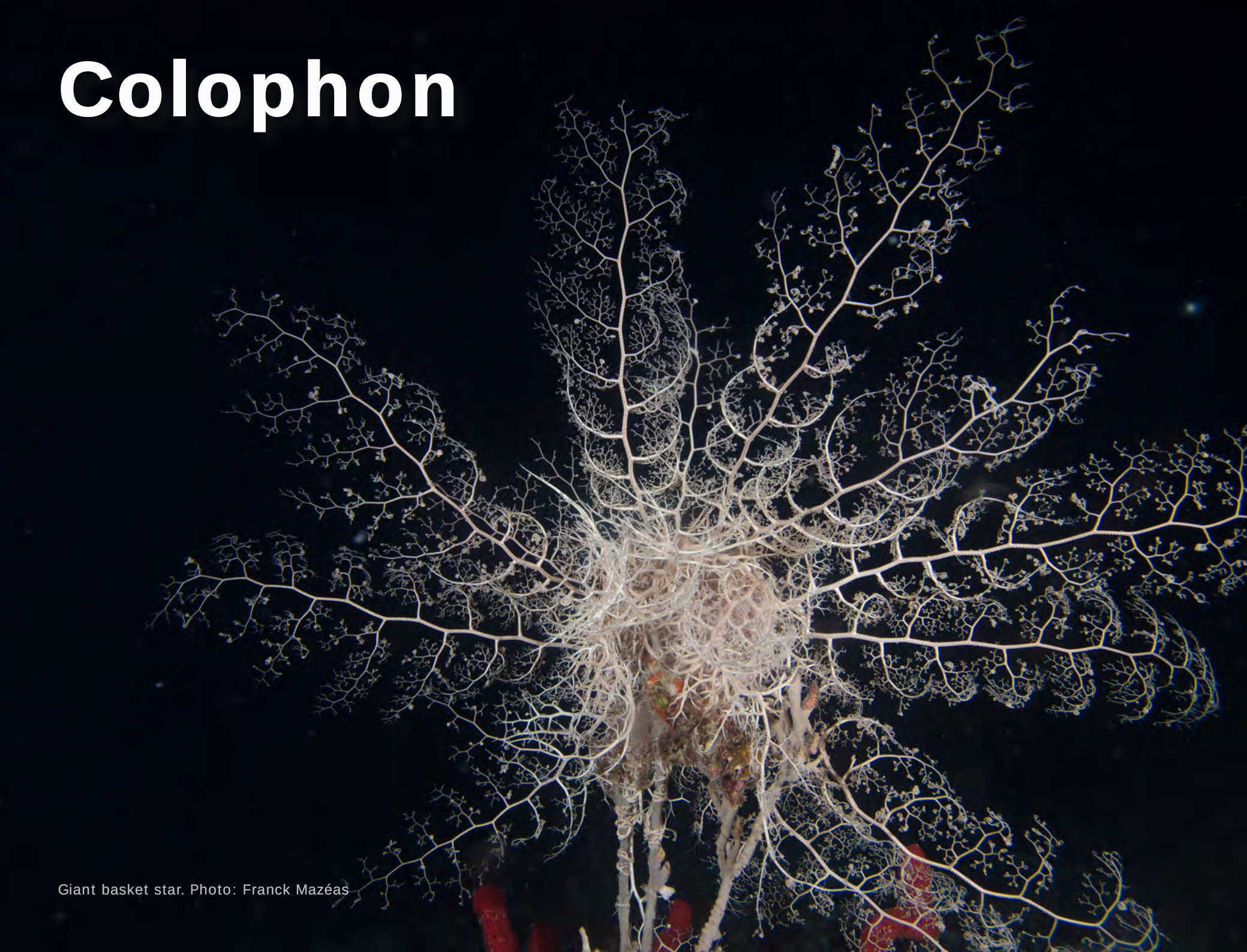






Hopper for seabed video and photograhpy (left)
and a gradient sampler (right).
Photos: Erik Meesters and Steven van Heuven

Colophon



Giant basket star. Photo: Franck Mazéas

Projects

Institute	*Year*	*Programme*	*Project nr*	*Financed by*
Wageningen Marine Research	2011, 2013, 2015	Caribisch Nederland: Saba Bank	BO-11-019.02-008	Netherlands Ministery of Economic Affiars (Min EZ) and World Wildlife Fund (WWF). These expeditions on board the 'Caribbean Explorer II' could not have been done without the help of local experts and scientists from Saba Conservation Foundation (SCF), the Royal Netherlands Institute for Sea Research (NIOZ),St. Eustatius National Parks (STENAPA), St. Maarten Nature Conservation, and from researchers from institutes in Guadeloupe, Martinique, and France.
Wageningen Marine Research	2011-2016	Caribisch Nederland: Visserij	BO-11-019.02-049	Min EZ
Wageningen Marine Research	2011-2016	Caribisch Nederland: Zeezoogdieren	BO-11-019.02-005	Min EZ
Wageningen Marine Research	2015, 2016	Shark tagging and BRUV surveys	DCNA/Postcodeloterij/	
NIOZ	2015, 2016	NWO Caribbean Research: a Multidisciplinary Approach. Caribbean coral reef ecosystems: interaction of anthropogenic ocean acidification and eutrophication with bioerosion by coral excavating sponges.	local marine parks 858.14.020	Netherlands Organisation for Scientific Research (NWO)
Naturalis Biodiversity Center	1972, 2006, 2015	Taxonomy and systematics: Caribbean marine biodiversity		Netherlands Ministry of Education, Culture and Science (Min OCW)

Photographers

Bert Hoeksema (Naturalis Biodiversity Center); David Stevens (WWF) Oscar Bos, Michelle Boonstra, Martin de Graaf, Guido Leurs, Erik W. Meesters, Jimmy van Rijn, Hans Verdaat, Erwin Winter (Wageningen Marine Research); Ewan Trégarot (OMMM, Martinique); Franck Mazéas (Guadeloupe); Jean-Philippe Maréchal (Nova Blue Environment, Martinique) Steven van Heuven (NIOZ)

Authors

Paul Hoetjes (Netherlands Ministry of Economic Affairs); Bert Hoeksema (Naturalis Biodiversity Center, Netherlands); Didier de Bakker, Lisa Becking, Oscar Bos, Martin de Graaf, Dick de Haan, Erik W. Meesters, Erwin Winter (Wageningen Marine Research, Netherlands); Fleur C. van Duyl, Steven van Heuven (NIOZ, Netherlands)

Citation

Bos O.G., Becking L.E., Meesters, E.H. (eds) (2016). Saba Bank: Research 2011-2016. Photo book presented during the Saba Bank Symposium, Den Helder, 8 December 2016. (2nd edition). Wageningen Marine Research. 95 photos, 66 pp.

More photos

The Saba Bank photo collection is available through the Image Collections of Wageningen University & Research:
http://images.wur.nl/cdm/search/collection/coll18/searchterm/sababank/order/nosort

This book is financed under the project 'Saba Bank Marine Biodiversity BO-11-019.02-008' with funding of the ministry of Economic Affairs.

Den Helder, December 2016

Reef on the Saba Bank. Photo: David Stevens