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Editor's note

The islands of the Dutch Caribbean, which are located more than 7000km from Europe, are home to the most diverse and extraordinary ecosystems to be found anywhere within the Kingdom of the Netherlands: from pristine coral reefs to rare elfin cloud forest, the spectacular natural world of the Dutch Caribbean includes plants and animals found nowhere else on the planet.

These diverse ecosystems are a magnet for tourists and at the same time one of the most important sources of income for the Dutch Caribbean. Nature on the islands is unique and important but it is also fragile. The lack of sustainable funding for management, the lack of policy support and adequate spatial planning combine to hamper conservation management. Amongst the most significant threats include poorly regulated (coastal) development, wastewater and waste management as well as overgrazing, overfishing and the impact of invasive species.

Monitoring and researching biodiversity allows conservationists to manage natural resources and react to changes accordingly in order to maintain protection for our valuable nature. Thanks to funding support from the Dutch Ministry of Agriculture, Nature and Food Quality and the dedicated work of our partners, conservationists and scientists a plethora research and monitoring projects are underway within the Dutch Caribbean. DCNA seeks to support this work and to communicate project results to a broad range of audiences and to help facilitate the work of visiting researchers, scientists and students.

Since 2012, DCNA has been producing “BioNews”, a free monthly digital newsletter featuring nature related news-items about the Dutch Caribbean as well as overviews of current research and monitoring programmes, recent publications and events.

In this issue we present a collection of the articles published throughout 2018. These cover a wide range of topics including coral reefs, sea turtles, sharks, NICO science expedition, bats, birds and fisheries.

We would like to take this opportunity to thank our funders, partners, conservationists, scientists and volunteers for their hard work and assistance to help us ‘safeguard nature in the Dutch Caribbean’ – your passion, encouragement and support are invaluable. We look forward to all that we will accomplish together to conserve nature in 2019.

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St. Maarten: Post Hurricane Coral Assessment

This article was published in BioNews 18.

The St. Maarten Nature Foundation scientifically researched the impacts of Hurricane Irma on St. Maarten coral reefs using Global Coral Reef Monitoring Guidelines. They found that the general coral cover is reduced, but the Man of War Shoal Marine Protected Area showed greater resilience than reefs outside of the protected area.

Reef monitoring data has been scientifically analysed to assess the impacts of hurricanes Irma and Maria on St. Maarten’s coral reefs following the Global Coral Reef Monitoring Network (GCRMN) guidelines. The hurricanes caused reduction in coral cover on St Maarten reefs; however, reef health improved due to a decrease in coral bleaching.

Unfortunately, macro algae cover increased after the hurricanes. This high algae cover threatens coral recruitment and coral growth. Caribbean coral reefs have been deteriorated to a macro algal state due to several factors such as the die off or overfishing of herbivores (such as parrotfish), climate change, human and natural disasters. Three months after the hurricanes water quality was decreased on all our reefs, water visibility was reduced by about sixteen meters.

"Coral cover (hard corals) has been significantly reduced from 6.1% to 3.7% since the passage of the hurricanes, which is unfortunate but expected considering the intensity of Irma. Coral cover is still higher than observed in 2016 (3.5%). Scientific research found that coral cover mostly declines the year after large hurricanes, therefore we are concerned to observe a larger reduction of coral cover for this year. The decrease in coral bleaching could be favourable for the health of our corals and is likely caused by the lower sea water temperatures and the decreased visibility after the storms. We are worried about the higher algae cover, this could deteriorate our coral reefs even more” explained Nature Foundation’s Projects Officer Melanie Meijer zu Schlochtern.

The strong surge and swells of the storms caused gorgonian corals (soft corals) and fleshy algae to be ripped off from our reefs, leading to more exposure of coral recruits, sponges and calcareous coralline algae (CCA). After the hurricanes higher carnivorous fish biomass was found on the reefs. This increase of larger fish, especially groupers and snappers, was found to be extraordinary high in the Marine Protect Area’s mostly healthy reefs, such as Proselyte Reef and Mike’s Maze. Herbivorous fish biomass did not change significantly after the hurricanes, however fewer fish species were found.

"More accessible CCA can be profitable as it is used by juvenile corals to settle on and these juveniles can grow into larger corals and build our next generation of coral reefs. Larger pelagic fish can travel long distances. They may look for the best shelter against the impacts of the hurricanes and therefore moved to the reefs with the highest coral cover to find their needs”, stated Achsah Mitchell GCRMN data analyst.

The results of the St Maarten’s reef monitoring also show the significance of protecting our reefs, as coral reefs in the Marine Protected Area performed better and are healthier, with higher coral, gorgonian coral, CCA and sponge cover compared to other St Maarten Reefs outside the protected area. Reefs outside of the Marine Protected Area had significantly more macro algae cover than reefs within the Park. Also, greater densities of coral recruits, which indicate a greater number of healthy and reproducing corals, were found. Moreover, carnivorous fish and herbivorous fish had a greater biomass within the Marine Protected Area.
“If we do not protect our coral reefs, health, fish biomass and coral cover will decrease and our reefs will shift to a macro algae state. Algae cover was the lowest inside the Marine Protected Area, showing us the effectiveness of protecting our coral reefs. Our results demonstrate clearly the importance of our Marine Protected Area ‘Man of War Shoal’ for our fish stocks and coral reef preservation” stated Nature Foundation’s Projects Officer Melanie Meijer zu Schlochtern.

The entire country benefits from reefs with higher coral cover and lower macro algae, these reefs are also more resilient regarding disaster events, such as Hurricane Irma. “The reefs in the Marine Protected Area showed greater resilience to hurricanes than reefs outside the protected area. Especially the lower macro algae cover makes reefs better suited for coral growth and recruitment and would therefore have a higher resilience for hurricanes and other threats. I recommend increasing coral reef protection, management and monitoring, especially within the Marine Protected Area” explained Achsa Mitchell GCRMN data analyst.

Every year, the St Maarten Nature Foundation monitors St Maarten’s coral reefs scientifically using the GCRMN method to determine the health, composition and state of St Maarten reefs. With financial support made available by DCNA the Foundation was also able to monitor and analyze the reefs after the hurricanes in 2017.

Several dive sites in the Man of War Shoal Marine Protected Area and other important dive sites around the island were monitored pre-hurricanes in Augustus and post-hurricanes in December 2017. All measurements were conducted along a transect line and repeated five times on each dive site. First, abundance and biomass of all fish species were determined, secondly the cover of reef organisms (corals) were analyzed based on photo quadrats made during the dives and photo quadrats were assessed for coral health. Monitoring is also done looking for coral recruitments (juvenile corals) and algae coverage and height. Lastly, invertebrate species were counted and water quality was measured. Results were assessed, scientifically analyzed and interpreted by GCRMN data analyst Achsa Mitchell; the full report can be found in the Dutch Caribbean Biodiversity Database (DCBD).
Coral Restoration Bonaire

By F. Virdis & B. Hickey (CRFB). This article was published in BioNews 19.

The Nature funding from the Netherlands’ Ministry of Agriculture, Nature and Food Quality (LNV) (previously Ministry of Economic Affairs), has helped Coral Restoration Foundation Bonaire (CRFB) to take the next step in restoring Bonaire’s shallow reefs. Throughout the past two years, 5,000 Staghorn corals (Acropora cervicornis) were outplanted back to Bonaire’s shallow coral reefs, which brings since 2013 the total of outplanted acroporid corals to 20,000. To accomplish this ambitious goal, the capacity of the nursery was expanded and a comprehensive monitoring program was established. The Foundation also took an important step strengthening its logistics and network to become a more independent organization.

Local Dive Operators Involvement

Partnering with local dive shops has been key to the success of CRFB’s programs since the beginning. These dive operators (CRFB Dive Shop Members) execute a practical restoration program that not only re-grows local reefs, but engages the community and builds their businesses with paying customers that return year after year to help maintain the nurseries and the reefs they helped replant. Through a successful educational program, local dive operators train regularly resident and tourist scuba divers who are the actual volunteer man power of the island coral restoration program.

The Foundation was established thanks to the support of Dive Buddy Dive Resort with Harbour Village Beach Club and Eden Beach Resort joining later. Thanks to the Nature Funding for the BES islands, this partnership has expanded once again. Two new local dive operators, Gooddive and Tropical Divers have also joined the Foundation, bringing the total number of dive shops supporting coral restoration on Bonaire to five. This funding was crucial catalyst in allowing smaller dive shops to join the cause.

Thanks to the expanded dive shop membership facilitated by the project, the Foundation has increased its educational presence throughout the island. Recognizing the importance of involvement from all parts of the community for a restoration program to succeed, future plans focus on three components: 1) a greater presence with the island’s youth through increased educational programs in schools and a more intensive involvement with the STINAPA Jr. Rangers program, 2) reaching more of the visiting and local divers by getting more dive shops involved with the program, and 3) continued awareness and educational communications with residents of the island.

The locations for each nursery were surveyed and approved by the Bonaire National Marine Park (BNMP) with Gooddive’s coral nursery located at Something Special and Tropical Divers’ at Calabas Reef. Both dive shop’s nursery has five trees and can hold up to a total of 500 Elkhorn and Staghorn corals. Trained staff members are responsible for nursery maintenance and related coral outplanting activities in the area. As the network of Dive Shop Members expands, more and more trained manpower is available for the actual restoration of Bonaire’s reefs.

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Nursery installation day at Gooddive

Photo by © CRFB
Coral Outplantings and Restoration Sites

To guarantee the production of the 5,000 corals needed to restore the four snorkeler accessible sites, an expansion of the main production nursery was necessary. The nursery in Klein Bonaire was expanded to 51 trees, bringing that nursery’s capacity to 6,522 corals (+54%), and allowing for enough corals to remain in the nursery after the project for future restoration efforts.

Four snorkel-accessible sites around Bonaire were selected, upon BNMP approval: Playa Lechi, Jeff Davis Memorial, Salt Pier, and Pink Beach. The number of corals needed for each of the four restoration site has been determined according to the abundance restoration criteria listed by NOAA in the 2015 Recovery Plan for Staghorn corals, which requires the establishment of approximately 25% of live Staghorn Coral cover in the restored areas (National Marine Fisheries Service, 2015). With these criteria, each site is comprised of 1,250 Staghorn corals spread over 150 m².

The restoration technique used by CRFB is known as coral gardening, whereby fragments from a healthy, robust wild population are fragmented and grown in nurseries on Christmas tree-like trees. These trees are structures with a PVC trunk and fiberglass branches on which coral fragments are suspended.

When the fragments have reached maturity, they are then outplanted to degraded reef areas. Between January 2017 and March 2018, according to the planned activities, 1,250 nursery-reared coral colonies from 11 different genotypes were outplanted at Playa Lechi, Jeff Davis Memorial, Salt Pier, and Pink Beach, covering an area of 600 m², for a total of 5,000 Staghorn corals. Outplanting requires the use of supporting horizontal bamboo structures elevated 10-20 cm from the bottom in order to support the corals in the first phase of their growth on the rubble bottom and limit the predators' abundance.

At each site, 50 square bamboo structures were installed at each restoration site. Each structure supports 25 corals of the same genotype.

Outplanted corals at Jeff Davis Memorial

Photo by: © David Fishman.
Coral Monitoring Program

The outplanted corals at the four restoration sites have been carefully tagged and monitored over time, taking pictures at the outplanting day, two weeks, three months, six months and one year after outplanting them. The pictures have been subsequently analyzed using CPCe to gather coral cover and mortality data of the different corals genotypes.

The data collection is still in progress, but preliminary results on the first two sites, show large differences in growth between the locations. On average coral cover at Jeff Davis increased linearly 0.06% per day or 21.6% per year with very little mortality. In front of the main urbanised area, at Playa Lechi, growth was erratic and mostly negative (E. Meesters & F. Virdis, unpublished data). Environmental conditions in front of Kralendijk are presumed to be responsible for the lack of growth and high mortality of the restored staghorn corals there.

The monitoring will continue after the funding period has concluded, data analysis and the results will be published in cooperation with Wageningen University. The systematic assessment of this data will guide the Foundation toward doing more of what works, giving key insights into restoration site selection factors, genotype performance, and overall coral coverage after one year. This will allow for adapted and refined strategies, based on knowledge acquired from both fieldwork experience and both quantitative and qualitative results of the monitoring program, that better allocate the Foundation’s limited resources.

What’s next?

Great progress has been made growing and replanting branching Acropora corals in Bonaire and throughout the Caribbean. The restoration success of Coral Restoration Foundation Bonaire with *Acropora cervicornis* (staghorn coral) has been especially noteworthy, thanks to the simplification of logistics and built capacity, the Foundation has been able to scale up its restoration program effectively, and the techniques used to achieve those results are now being duplicated elsewhere in the Caribbean.

Based on the coral restoration experience gained over the years and recognizing the urgency of the threats facing our reefs, CRFB is now embracing a more comprehensive vision and expanding to new techniques, to give Bonaire’s reefs a helping hand on an ecological scale, focusing on not only genetic diversity, but species diversity as well. These new techniques and species will be part of a broader, more inclusive reef restoration approach the Foundation has recently adopted.

Coral Restoration Bonaire
Monitoring Statia’s Marine Ecosystems

CNSI continues to monitor the vulnerable ecosystems of St. Eustatius coordinated by Data Monitoring Officer (DMO) Kimani Kitson-Walters. Coral reef surveys are conducted in collaboration with St. Eustatius National Parks (STENAPA) using the Global Coral Reef Monitoring Network (GCRMN) Protocol. Data on the island’s fisheries are collected and assessed by the DMO with plans to automate data collection using a mobile application under the Statia Blue Project. The aim is to create sustainable practices for Statia’s fisheries while putting the fish buyers in touch with the suppliers on a “real-time” basis.

St. Eustatius’ coral reefs like many others in the Caribbean are under threat from the impact of climate change and other anthropogenic stresses. In an effort to assess the response of these fragile ecosystems, the Global Coral Reef Monitoring Network (GCRMN) supported by the International Union for Conservation of Nature and other international partners developed a standard coral reef monitoring protocol to strengthen coral reef ecosystem management in the region. This is to ensure that useful data is collected for efficient comparison across Caribbean territories.

The GCRMN protocol utilizes eight criteria for data collection on coral reef ecosystems: abundance and biomass of reef fish taxa, relative cover of hard corals and their dominant competitors, health assessment of hard corals, coral recruitment, abundance of key macro-invertebrates (lobsters, queen conch, sea urchins, sea cucumbers), water quality and three-dimensional reef structure. Data within these categories are collected at 20 sites across four monitoring zones. Two of which are marine reserves where it is prohibited to fish with all types of fishing gear except handlines.

According to the Reef Health Index, the coral reef ecosystem of St. Eustatius is in a critical condition. Statia’s coral reefs have been on the decline over the last 20 years, due to the impact of hurricanes and in particular the massive bleaching event of 2005 which reduced our coral abundance by 50%. In 2017, corals were found to occupy 4.94% of the benthos with macroalgae continuing to dominate. The impact on Statia’s reefs due to the reduction of these reef-building species is still unclear.

Herbivorous fish (parrotfish/surgeonfish) biomass which aid in keeping macroalgal biomass in check, has suffered a 58% reduction over the last 18 years with no clear indication for this decrease. Fishing pressure on the island has remained relatively the same during this time. The impact of this reduction is observed in the increased macroalgal cover suggesting that parrotfish were the dominant algal grazers in the past since the black urchin (Diadema antillarum) die off across the region in the 1980’s. Reports on coral reef surveys done on the island in 1999 described low macroalgal cover in the presence of very high parrotfish/surgeonfish biomass. Grouper/snapper biomass is also poor with no large grouper species being observed on any of our survey dives. Even though these species were observed in relatively frequent numbers in 1999 at similar survey sites.

These annual surveys continue to provide insight into the state of Statia’s marine ecosystems. Bringing to our attention the need for further research into the anthropogenic drivers of coral reef degradation on the island and the development of mitigative measures.

By Kimani Kitson-Walters PhD. This article was published in BioNews 20.

Photos by: © Kimani Kitson-Walters
Monitoring Statia’s Fisheries

The marine ecosystems of St. Eustatius have supported a small artisanal fishery for over 30 years with fishing effort being relatively the same during this time. In 2017, there was an average of < 1 fishing trip per day. Lobster traps are the most common gear type used followed by spearguns with SCUBA. Caribbean spiny lobster is the primary product but fish (reef and pelagic) and conch are also caught. Landed lobster are normally exported to St. Maarten but exports declined in the last quarter of 2017 due to the collapse of the tourism market on surrounding islands by Hurricanes Irma and Maria. Landed reef/pelagic fish are sold locally. Morphometric data for all catch types are collected for 20-30% of fishing trips throughout the year. This is done to assess Statia’s fishable stocks for signs of overexploitation.

For 2017, a total of 5,864 kg of lobster and 3,203 kg of fish (mixed reef and pelagics) were landed on St. Eustatius. Monthly landings of lobster ranged from 17.6 – 885.5 kg while those for fish ranged from 50.8 – 553.6 kg. Fishing effort and catch were significantly reduced for the month of September due to Hurricanes Irma and Maria.

A morphometric assessment of the Caribbean spiny lobster landings (9% of fishing trips) revealed that 28% of males and 41% of females were undersized. The average carapace length of females (97 mm) was close to the size limit (95 mm), which is concerning. Length frequency data of mixed reef fish was collected for 26% of trips. Surgeonfish and small groupers accounted for 44% of the sampled catch by number of individuals while squirrelfish and small groupers accounted for 46% by weight. Parrotfish in both weight and number accounted for 3%.

Parrotfish are an important species to monitor as it has a significant impact on reef health by keeping macroalgae in check. The species is caught by both lobster traps as by-catch and intentionally using spearguns with SCUBA. Four species (princess, redband, redtail and stoplight parrotfish) were landed by traps but only the stoplight parrotfish was recorded as being landed by SCUBA. The average length of stoplight parrotfish landed by pots (33 cm) was larger than those landed by SCUBA (29 cm). The average length of landed princess parrotfish was 27 cm, redband parrotfish 22 cm and redtail parrotfish 26 cm. According to Fishbase.org, the common size of the stoplight parrotfish is 36 cm which indicates that mature individuals are present but are smaller than commonly seen throughout the region. The other parrotfish species are slightly larger (by ≤ 2 cm) when compared to those in the region (Figure 2).

Morphometric data was collected for 39% of the queen conch landings for 2017 (1831 individuals harvested). Analysis of the data revealed that Statia’s conch populations are sustainably harvested with no indication of overexploitation. It is currently illegal to export queen conch but local consumption is allowed. The National government is in the process of assessing the feasibility of exporting the resource which would bring increased earnings for the island. This is being done in consultation with the Convention on International Trade in Endangered Species (CITES), the regulatory body responsible for the international trade of queen conch.

St. Eustatius’ fishable resources are currently harvested at a sustainable level due to limited fishing effort. Keeping this fishing effort in check will reduce the pressure on the island’s limited fishing grounds. This will aid in securing the resource for future generations as well as maintaining marine biodiversity. Fisheries data will continue to be collected with the support of the Ministry of Economic Affairs.
Monitoring Statia’s Marine Ecosystems

Statia Blue
A key component of Statia Blue is to ensure that fishermen increase compliance with the principles of sustainable fisheries and thereby play an active role as stewards of the protected reefs, parks and species which form the fragile natural endowments of islands and their people.

Sint Eustatius Foundation (SEF), initiated an, even for global standards, highly innovative project for developing sustainable Caribbean fisheries. The app will be launched in Statia but will be marketed towards the entire Caribbean. Antonio Media, Eindhoven, NL has been contracted to develop the StatiaBlue App. Other partners on the project include the Caribbean Netherlands Science Institute (CNSI) and Sint Eustatius National Parks (STENAPA).

Statia Blue is funded by the EU-EDF Innovation program and involves the support and engagement of fisher-folk in education on pricing and the market mechanism using mobile application technology for creating a real-time market place for fish and seafood. The application will be used for ongoing research and education, supporting market clearing prices and monitoring and evaluation of catches to encourage sustainable practices, such as fishing a safe distance from protected zones and management of invasive species.

Working with a group of Statian fishermen, the project develops a mobile app (“Statia Blue”) and provides fishermen with waterproof mobile phones. As fish are caught, the fish is identified and described and reported back to a central database. At the central database the price of that fish and the total catch is estimated based upon the fish caught by all fishermen on that day. Prices are reported back to the fishermen so that they can make informed decisions about the harvesting of those fish. Fishermen can continue or stop fishing depending upon their satisfaction with the price estimated on the market. A pricing mechanism will be used to signal fishermen as to which fish are in demand. The app will also have an educational element, administered by STENAPA.

Statia Blue will also have a consumer interface, reporting on which fish are advisable for eating during the season based upon data on the stock of fish in waters. The pricing element will also help reduce adverse selection.

The project is expected to directly benefit Caribbean fishermen while at the same time work to innovate and enhance the sustainability of their fisheries.
New Sea Turtle Monitoring Methods

Sea Turtle Conservation Bonaire (STCB) has worked tirelessly since 1991 to protect Bonaire’s sea turtle population and to ensure a safe, protected environment for them on land and in the sea. Bonaire is home to three of the world’s seven species of sea turtles: green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) are found year-round, while loggerhead turtles (*Caretta caretta*) generally visit the island only during the nesting season. Set up as a non-profit organization, STCB began conducting standardized in-water surveys and tagging programs in 2003 to gather information on sea turtles in the waters surrounding the island. STCB staff and volunteers have tagged approximately 3,000 turtles and collected data on turtle abundance, health status, movement patterns, growth rates and preferred habitats. This invaluable information has helped to improve conservation efforts and build support for sea turtle conservation on the island. For example, monitoring efforts in Lac have highlighted the importance of this area to the green turtle population; green turtles that inhabit Lac have much higher growth rates than have been recorded elsewhere in the Caribbean.

STCB works with Population Ecologist and statistician Dr. Frank Rivera-Milán (US Fish & Wildlife Services) to analyze in-water transect counting, netting, and nesting data that STCB has collected over the years and to optimize their methodology for in-water and netting surveys. Together with Rivera-Milán, Wildconscience has also been contracted to help design an improved field methodology, which will result in more accurate yearly population estimates for Bonaire, critical to ensure well-informed management decision making. Enhanced methods will also help improve STCB’s visibility as a premier partner, provide information to enhance research throughout the region through scientific publications and well-recognized scientific journals, and feed the regional pool of information to enhance sea turtle research in the Caribbean and – at the same time – work towards standardization of methods.

**Survey Planning (2018)**

1. State measurable objectives
2. Define the target population and sampling frame (list of sampling units)
3. Select a sampling scheme (systematic)
4. Define the parameters to be estimated and desired precision (CV N)
5. Select count methods for parameter estimation and modeling
6. Decide how to allocate resources (cost-effective sampling)

Photo by: © Frank Rivera-Milán, STCB
STCB’s improved statistical design includes randomized surveys, repeated visits (same area, time and observer power), and the accurate measurement of the survey area and survey region. The four survey regions are Northwest Bonaire, Klein Bonaire, Southwest Bonaire and Southeast Bonaire. Data from the Southeast Bonaire survey region (Lac) will be analyzed separately as surveys there are not randomized but follow one fixed transect. STCB’s new survey methodology also means that turtles are no longer caught to be tagged and measured onboard during the count surveys on the West coast. Instead, the “observers” record the species, number of individuals, and estimated length while the turtles are in the water. A number of environmental measurements are now also recorded during each survey to help understand if and how these environmental factors influence sea turtle abundance. Recorded covariates include visibility, wind direction, water temperature, abundance of jellyfish, rugosity, coral cover, depth, date and time as well as disturbance (boat and human presence in water) and the number of observers and their experience.

A very exciting development is that STCB’s in-water surveys now also include the monitoring of a number of other species, notably sharks, barracudas, tarpons and marine mammals. There is some concern over the declining population of barracudas, and monitoring efforts will help gauge whether the population is healthy or not. Additionally, the number of boats as well as fishermen on shore will be tallied to better understand fishing pressure in the waters surrounding Bonaire. STCB has been central to the protection of Bonaire’s exceptional biodiversity for close to three decades, and the improvement of their science for higher precision and accuracy of populations estimates will ensure that they remain a model of excellence for research and conservation for many years to come.
New research led by Swansea University’s College of Science and recently published in Scientific Reports has reported effective conservation strategies that can mitigate the impacts of climate warming on sea turtle nesting success. A range of experiments were conducted between 2012-2017 in St Eustatius Marine Park in the Dutch Caribbean in association with St Eustatius National Parks, Wageningen University and Groningen University in the Netherlands and Deakin University in Australia.

Swansea University researcher, Dr Nicole Esteban said: “Sea turtles do not have sex chromosomes and it is the incubation temperature in sand surrounding a clutch of eggs that determines the sex of a turtle hatching which is known as Temperature-Dependent Sex Determination. Eggs incubating at cooler temperatures (generally lower than 29 °C) produce male turtles and eggs incubating at warmer temperatures produce females. This has led to concerns that, in the context of climate change, warming air temperatures may lead to female-biased sea turtle populations. Our previous work in St Eustatius showed that incubation temperatures are relatively high (mean of 31°C) so that the majority of turtle hatchlings born at these beaches have been female biased during the past decades. There is therefore a real concern that not enough male hatchlings would be born on the beaches in future to sustain the local population and we decided to investigate options for conservation actions to reduce incubation temperatures.”

The researchers developed a series of trial experiments to test the effect of various shading treatments that were easily available (white sand, white sheet, palm leaves). The sand temperatures below the shaded areas were recorded using small temperature loggers buried at turtle nesting depths on Zeelandia and Oranjebraai beaches in St Eustatius. The data were combined with long-term beach temperature data to estimate the effect of shading and relocation between the beaches on hatching sex ratios.

The results of the study showed that the most effective shading material was palm leaves, decreasing temperature by a mean of 0.6 °C. Variation between beaches that are only 1 km apart was an average of 1.9 °C. Relocation between beaches and shading could shift hatching sex ratio from the current ranges (97-100% female) to 60-90% female. A conservation mitigation matrix is presented to summarise evidence that artificial shading and nest relocation can be effective, low-cost, low-technology conservation strategies to mitigate impacts of climate warming for sea turtles.

“This research underlines that there is real need for effective conservation measures to be put in place to prevent the localized extinction of these turtle populations in St Eustatius. We are planning to relocate turtle clutches to the cooler beach and have already trialed relocation of turtle eggs to a cooler site” reported the Marine Park Manager Jessica Berkel. Read the research “Optimism for mitigation of climate warming impacts for sea turtles through nest shading and relocation” published by Scientific Reports (2018) online: http://www.dcbd.nl/sites/www.dcbd.nl/files/documents/541598-018-35821-6.pdf


Photos by: © Jannie Koning (Turtle hatchlings) & Selma Ubels (Quill)
Global Defaunation and Plant Invasion: Cascading Effects on Seagrass Ecosystem Services

By FOH Smulders & MJA Christianen, Wageningen University & Research. This article was published in BioNews 17.

Ecosystems have been providing our society with useful services to sustain us in our livelihood, survival and health for as long as we exist. Seagrass ecosystems are especially successful in carbon storage, sediment stabilization, and providing food and habitat for fauna (Nordlund et al., 2016). It is important to conserve these ecosystems in order to maintain its high value.

Human impact is changing the seagrass landscape. One of the biggest impacts of humans on the marine ecosystem is defaunation, the removal of (predatory) fish and large herbivores such as manatees and turtles, that has been ongoing for the past centuries. These large vertebrates have a big impact – either direct or indirect – on foundation species. For instance, moderate turtle grazing can increase plant productivity, but overgrazing by turtles can lead to a collapse of a seagrass meadows (Christianen et al., 2014). In case of an abundant herbivore community, sharks can come to the rescue and either prey on the turtles or create ‘landscapes of fear’ that turtles will avoid and where seagrass can grow (Wirsing et al., 2007). Thus, defaunation likely induces strong alterations in ecosystem functioning and the services they provide.

The introduction of exotic species, through increased globalization, is another impact that can have far-reaching consequences on ecosystem services. The spread of invasive species leads to novel ecosystems, where plants and herbivores occur in combinations that are unfamiliar to each other (Williams, 2007). The resulting effect on herbivory rates, food web interactions and ecosystem services are unknown. The PhD project of Fee Smulders will focus on how human impact through defaunation and invasive plant introduction affects ecosystem services in seagrass ecosystems.

Lac Bay on Bonaire is home to extensive seagrass meadows, dominated by turtlegrass (*Thalassia testudinum*). This bay provides one of the most important foraging grounds for juvenile green turtles in the Caribbean. The invasive seagrass *Halophila stipulacea*, native to the Red Sea and the Western Indian Ocean, settled on Bonaire in 2010 and has been increasing throughout the bay ever since (Smulders et al., 2017). Green turtle leaf grazing seems to modify the rate and spatial extent of this invasive species’ expansion, due to grazing preferences, and increased space for settlement (Figure 1, Christianen et al., 2018). Defaunation of e.g. predatory sharks could limit the top-down control on sea turtles. This may cause an increase in grazing pressure, and in combination with the fast-growing invasive *H. stipulacea* may explain the decline of native *T. testudinum* we observe in Lac Bay. The ecological effects of this invasion are still largely unknown.

Summary of the impacts of megaherbivores (here green turtles, *Chelonia mydas*) on invasive expansion (here seagrass *Halophila stipulacea*), and on seagrass species co-occurrence following the introduction of *H. stipulacea* to the Caribbean. In tropical seagrass ecosystems, herbivory can facilitate invasive species expansion by a hypothetical positive feedback mechanism. Green turtles selectively graze on native seagrass species *Thalassia testudinum* that have higher nutritional value (happy emoticon) and rarely choose to eat invasive seagrass (sad emoticon). By leaf cropping, turtles open up the leaf canopy (i.e. shorter leaves, lower shoot density), which can facilitate the settlement and expansion of invasive seagrass (thicker arrow), as found by Christianen et al. (2018). As the biomass of native seagrass species gets scarcer, turtles search for new local grazing locations with native seagrass and initiate grazing patches in shallower areas that were previously ungrazed. As a result, invasive seagrasses can spread into these newly cropped patches in shallow areas and may replace native seagrasses.

By FOH Smulders & MJA Christianen, Wageningen University & Research. This article was published in BioNews 17.
The invasive *H. stipulacea* is likely to become the dominant species in Lac Bay, and therefore this project aims to quantify and compare the ecosystem services of *T. testudinum* and *H. stipulacea*. In this way, potential changes in ecosystem services will be unraveled under the projected species shift. In addition, competition between the native and exotic seagrass species will be investigated. Assessing the impact of the invasion on the ecosystem services of Lac Bay is important for future management and conservation of this protected nature area.

This year, we are collaborating with researchers at 14 other sites in the Caribbean. At all 15 sites, an exclosure experiment will be carried out. We will investigate the effects of nutrient addition and (various levels of) grazing on *T. testudinum* seagrass structure and function. This large-scale project will give insights into the tropicalization of turtlegrass. Gradients in grazing intensity, light and temperature may explain differences in ecosystem services across latitudes. Close collaboration with other seagrass scientists will facilitate knowledge exchange across the habitat range of this important seagrass species.

Global Defaunation and Plant Invasion
Unwelcome guests: Stakeholder perspectives on non-native seagrasses and macroalgae ‘nuisance’ species in Bonaire

By Rapti Siriwardane-Zoysa1, Lucy Gwen Gillis1, Sabine Engel2 & Inés G. Viana3. This article was published in BioNews 18.

Unlike coral reef and mangrove forest ecosystems, public recognition and multiple values of seagrass beds have only but recently been gaining increasing policy attention, particularly with regard to the urgency of their conservation and sustainable management. Dr. Lucy Gillis and Dr. Rapti Siriwardane-Zoysa (researchers at the Leibniz Center for Tropical Marine Research/ZMT, Germany) arrived in Bonaire on fieldwork in January 2018, funded by an interdisciplinary project entitled CIRCULATIONS (Travelling Seagrasses in the Caribbean Sea), with Drs. Sabine Engel (via STINAPA) as their main cooperation partner in Bonaire. In combining insights from coastal ecology and multispecies anthropology, the team set out to explore dynamics around the arrival, spread and management of a non-native seagrass Halophila stipulacea in Bonaire and Jamaica, in comparison with an older native and so-called ‘nuisance’ species - the macroalgae Sargassum sp.

The CIRCULATIONS project investigates contemporary examples of “positive” species invasions - or those that are perceived in more ambivalent terms. To this end, the scientists mapped stakeholder perspectives of the macroalgae Sargassum sp. (a suspected invasive) that has gained a lot more scientific and possibly media attention, as opposed to the relatively slower (and less politicized) ‘creep’ of the Halophila stipulacea, an invasive seagrass.

While tracing their ecosystem functions and services, including the trajectories of arrival and planned management strategies, they also studied similarities and differences between Bonaire and Jamaica, as countries that have been impacted by the spread of a Sargassum sp.-i.e. the macroalgae that is deemed to be clearly problematic in more ways than one. Whilst only Bonaire has been affected by non-native seagrass Halophila stipulacea with a presence that is at times narrated more ambivalently. However, it is only a matter of time before Jamaica is affected by the invasive H. stipulacea.

They interviewed a range of stakeholders spanning state agencies, scientists, NGOs, community-based organizations and businesses which included representatives from the Ministry of Agriculture, Nature and Food Quality (LNV), the department of Spatial Planning and Development (unit Nature and Environment) of the Public Entity of Bonaire (DRO), the DCNA, STINAPA, a recently formed fisher cooperative- Piskabon, Sea Turtle Conservation Bonaire (STCB), a divers’ group, Jibe City, the WindSurf Place, and the Mangrove Centre. The stakeholders interviewed offered diverse and nuanced perspectives on marine invasive and nuisance species, offering both local as well as regionally embedded visions and management strategies. Meanwhile more interviews are being planned remotely, with stakeholders who the researchers could not meet during their first visit; the in-depth interviews were also combined with field visits to Klein Bonaire and a boat tour of mangrove spaces on the main island (organized by STINAPA).

The team presented their work at the DCNA on Tuesday evening as a public talk within the collaborative frame of the STINAPA-DCNA lecture series “Connecting People to Nature”. The talk was entitled “Arrival Tales: Are stakeholder perceptions of the invasive seagrass H. stipulacea more positive compared to an older invasive predecessor the macroalgae Sargassum sp.?”, followed by a lively discussion. They also worked closely with a Junior Rangers group, completing an interactive workshop at Lac Bay.

The diverse stakeholder perspectives revealed a high degree of ambivalence with regard to the management of Halophila stipulacea, which was first monitored by STINAPA between 2010/2011, and was earlier recorded in St. Maarten. What remains a core concern is the rapid increase and spread of this non-native seagrass particularly in spaces bereft of native Thalassia testudinum (turtle grass), together with its monitored encroachment into mangrove spaces around Lac Bay. Especially the effect this invasive species may have on ecosystem services and functions. Moreover, unlike the management of invasive and highly predatory lionfish across the Caribbean Sea, the removal of non-native seagrasses is perceived as being an immense challenge. As H. stipulacea is interlaced with native species, thus selective uprooting could undermine existing efforts at controlling their spread as fragments will be dispersed in the process.

Moreover, unlike more aesthetically appealing and visible ‘charismatic’ ecosystems such as coral reefs and mangrove forests, there is scant public awareness (among locals and visiting tourists alike), when it comes to differentiating seagrasses from algae—particularly as they tend to be generically referred to as “seaweed”. Indeed, public engagement in the eradication of lionfish (at least in shallower depths), were primarily successful due to the adventure and adrenaline rush that hunting was said to have brought.

The ecological importance of seagrass beds (and their public awareness) were linked to ongoing efforts in the conservation of turtles, as one of the island’s flagship species – rather than an ecosystem in its own right unlike Bonaire’s coral reefs and mangrove forests.

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1. Leibniz Center for Tropical Marine Research (ZMT), Germany
2. STINAPA Bonaire
3. University of Vigo, Spain
Perceptions towards its arrival could be clustered into four distinct groups of narratives and viewpoints as diversely expressed by policymakers, scientists, local fisher groups, and tour operators entailing dive, kayaking and windsurfing operators:

a) Ecologically cautionary: its presence being classified as negative was often framed in relation to the rapidity and ease at which it spread, also in relation to colonizing connective coastal ecosystem spaces such as within and around mangrove forests and patches in existing seagrass beds; the macroalgae sargassum was in contrast seen as native but more as a ‘nuisance’ species because of its multi-sensory implications – mainly with regard to smell and its effect on shoreline aesthetics. Seagrass on the other hand is harder to be spotted and smelled (unlike sargassum), hence scientists may have to work harder in communicating its presence to policy makers and the wider public;

b) Ambivalent: *Halophila stipulacea* could well become a ‘frontier species’ (with positive benefits in offering more options for turtle feeding and as become a ‘frontier species’ (with positive benefits in offering more options for turtle feeding and as reef diving or mangrove kayaking).

c) Unselectively beneficial: Despite incidents of both sargassum and seagrasses getting tangled with motors and nets, seagrasses in this context remained undifferentiated;

d) Indifferent: *Halophila stipulacea* could only be seen below water, and was therefore not a core concern among wind and kite surfers; however the presence of any seagrass meant that accessibility to shallower spaces were limited, and often resulted in their trampling. Moreover recreational users tended to perceive seagrass not as a distinct ecosystem in itself but more as a terrestrial ‘weed’ – rather with the same degree of mundanity assigned to those on a garden lawn;

e) Opportunistically adaptable: a few dive-related and other tour operators insinuated the possibility of adding more socio-economic values through activities such as “seagrass snorkelling”, which may eventually become as popular as reef diving or mangrove kayaking.

The findings also revealed how perceptions of species invasion in general, came to be entangled within Bonaire’s existing landscape of policy concerns and challenges. Apart from concerns raised over the increasing population density after 2010 with cross-continental migrants and second-home owners moving to the island from Europe and North America, the exponential increase of cruise tourists en masse that contribute to further pressures placed on coastal ecosystems. Moreover, Bonaire’s historic overemphasis on managing species invasion in general, came to be entangled within Bonaire’s existing landscape of policy concerns and challenges. Apart from concerns raised over the increasing population density after 2010 with cross-continental migrants and second-home owners moving to the island from Europe and North America, the exponential increase of cruise tourists en masse that contribute to further pressures placed on coastal ecosystems. Moreover, Bonaire’s historic overemphasis on managing the presence of any seagrass meant that accessibilities to shallower spaces were limited, and often resulted in their trampling. Moreover recreational users tended to perceive seagrass not as a distinct ecosystem in itself but more as a terrestrial ‘weed’ – rather with the same degree of mundanity assigned to those on a garden lawn; possibilities offered by adding more socio-economic values through activities such as “seagrass snorkelling”, which may eventually become as popular as reef diving or mangrove kayaking.

The findings also revealed how perceptions of species invasion in general, came to be entangled within Bonaire’s existing landscape of policy concerns and challenges. Apart from concerns raised over the increasing population density after 2010 with cross-continental migrants and second-home owners moving to the island from Europe and North America, the exponential increase of cruise tourists en masse that contribute to further pressures placed on coastal ecosystems. Moreover, Bonaire’s historic overemphasis on managing the presence of any seagrass meant that accessibilities to shallower spaces were limited, and often resulted in their trampling. Moreover recreational users tended to perceive seagrass not as a distinct ecosystem in itself but more as a terrestrial ‘weed’ – rather with the same degree of mundanity assigned to those on a garden lawn; possibilities offered by adding more socio-economic values through activities such as “seagrass snorkelling”, which may eventually become as popular as reef diving or mangrove kayaking.

Moreover, the preliminary fieldwork findings draw attention to how nuances in meanings (and historic transformations) inherent in identifying, labelling and in selectively ‘red-alerting’ implications of non-native species shape public perceptions and policy priorities that in turn change over time. What makes a non-native an ‘invasive’ is not merely an ecological question, but also presents a host of socio-economic and political puzzles in terms of how the diverse futures of island seacoasts are eventually imagined and contested by its public, scientists and policymakers. As a marine researcher aptly stated during a public discussion, “we (as scientists) always have to be careful why we say it, how we say it, and to whom we say it to - when you spin a story…”

**Unwelcome guests**

Acknowledgments

The authors gratefully acknowledge a host of stakeholders who lent their time and patience in discussing a range of issues during a spate of in-depth interviews in January 2018. All interviews and informal discussions have been duly anonymised. We also thank Dr. Demian Willette, Loyola Marymount University – also a partner of the CIRCULATIONS project – in offering guidance in relation to the fieldwork.

Meanwhile, organizations and individuals interested in contributing to the ongoing study (by offering their insights and perspectives) are encouraged to contact Rapti Siriwardane (rsi@leibniz-zmt.de) or Lucy Gillis (lucy.gillis@leibniz-zmt.de).
From November 20-24th, 2017 a group of international shark experts gathered at Captain Don’s Habitat on Bonaire to discuss measures for the international protection of sharks. Countries ranging from the Philippines to Saudi Arabia, from the United States to Australia and from Costa Rica to Chile have sent experts to Bonaire for an advisory meeting of the Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MOU) under the Convention on Migratory Species (CMS).

The meeting brought together both the Advisory Committee and the Conservation Working Group of the Sharks MOU, to discuss what shark or ray species need more protection internationally, how they can best be protected, how to cooperate with fisheries organizations and how to build capacity for better shark protection. They formulated recommendations for the Meeting of Signatories, which will take the final decisions.

The Netherlands is one of 41 signatories to the Sharks MOU; the Ministry of Agriculture, Nature and Food quality (LNV) hosted this workshop on Bonaire in order to help profile Bonaire as a shark friendly island and “green destination” and also to promote the Sharks MOU in the Caribbean region, where there are still relatively few signatories. Bonaire has been protecting sharks since 2008 because of their importance to its dive tourism and in 2015 also joined in the Yarari Sanctuary for marine mammals and sharks, comprising the waters of Bonaire and Saba. The Tourism Corporation Bonaire (TCB) supported the meeting and welcomed the participants at a cocktail party on Monday evening.

The Sharks MOU is the first global instrument for the conservation of migratory species of sharks. Sharks are under serious threat around the globe. At present time, it is estimated that one-quarter of shark and ray species are threatened worldwide. The number of sharks being killed every year ranges between 63 and 273 million individuals.

The MOU is a legally non-binding international instrument within the framework of the Convention on Migratory Species (CMS). It aims to achieve and maintain a favorable conservation status for migratory sharks based on the best available scientific information and taking into account the socio-economic value of these species for the people in various countries. Currently 29 species of sharks are listed in Annex I of the MOU.

The Netherlands has taken an active role in the Sharks MoU, and with the Caribbean Netherlands the Netherlands is a range state for numerous migratory shark species. Sharks are an important attractor for dive tourism. Dive tourism is the economic mainstay for Bonaire, which is why the island decided to protect all sharks almost ten years ago already. More recently both Bonaire and Saba requested the Netherlands to establish a sanctuary for both sharks and marine mammals in the water so the islands as well as in the waters of the adjoining Exclusive Economic Zone. As a result, the Yarari Sanctuary was established in 2015 which will help to improve protection of in particular migratory sharks.

Cooperating partners
The Dutch Elasmobranch Society (NEV), the partner organization of DCNA’s Save Our Sharks in the Netherlands, signed an agreement this week making them an official ‘cooperating partner’ of the Sharks MOU. Cooperating partners are asked to use their network and expertise to help attain the objectives of the MOU.
First silky shark sightings by Saba Conservation Foundation!

Whilst nurse sharks and Caribbean reef sharks are regularly spotted on the Saba Bank, it’s not every day that you see silky sharks. During a routine visit to the Saba Bank, a research team from the Saba Conservation Foundation (SCF), Saba Bank Management Unit, made history a few weeks ago when Oceaware’s Guido Leurs spotted around 10 juvenile silky sharks (Carcharhinus falciformis). This was the first time that silky sharks had been reported from the Saba Bank.

Some of the defining characteristics of the silky shark include a small, rounded first dorsal fin that originates behind the end of the pectoral fins, a much smaller second dorsal fin with a free tip that is twice as long as the height of the fin together with long, slender pectoral fins that typically have dusky tips.

These slender oceanic sharks get their name from the smooth, silky texture of their skin which is caused by dermal denticles that are unusually densely packed. Silky sharks inhabit both deep oceans and shallow coastal waters and are highly migratory. The silky shark population in the Western Atlantic follows the Gulf Stream as well as the movements of tuna and swordfish, their main food source. Their appetite for these schooling fish makes them extremely vulnerable to by-catch, and many silky sharks are caught and killed in pelagic longline fisheries or are trapped in purse seines targeting tuna and swordfish.

There are also targeted silky shark fisheries in operation in the Caribbean and Gulf of Mexico, where they are caught by longlines. Silky sharks are ranked amongst the three most important sharks in the global shark fin trade - with up to 1.5 million fins being traded annually from this species. Population data for this species shows a worrying downwards trend since the early 1990s, especially in the northwest and western central Atlantic. The IUCN Red List status of the silky shark was adjusted in 2017 from “Near Threatened” to “Vulnerable” due to an estimated 47-54% decline of the global population over three generations. Silky sharks are especially vulnerable to exploitation because of their life history characteristics: a long gestation period, a slow growth rate, small litters and a long reproductive period. Safeguarding the future of this highly migratory species will require a cooperative approach between all countries through which it migrates, and an increase in safe havens like the Yarari Sanctuary and the Saba Bank.

For more information: http://guidoleurs.org/silky-sharks-new-shark-species-saba-bank/
Increased and targeted fishing pressure has led to the collapse of shark populations around the world. According to worldwide estimates, a staggering 100 million sharks are killed each year (Worm et al., 2013). Modern research has shed light on the key role these oceanic predators play in maintaining healthy oceans, leading to the implementation of conservation actions in many parts of the world to reverse population collapse. Regular monitoring is key to assess the success of these efforts and to improve management strategies. Information about species abundance, migration patterns, habitat use and feeding and nursery grounds enables conservationists to prioritize conservation efforts, target threats and protect specific locations.

The lack of baseline data on the diversity and relative abundance of shark species in the Dutch Caribbean has been a significant barrier to their protection. In an effort to reduce this knowledge gap, a number of research projects that are part of DCNA’s Save Our Sharks Project (generously funded by the Dutch Postcode Lottery) have helped collect information on the occurrence of sharks, their relative and seasonal abundance, movements and behavior across different management zones in the Dutch Caribbean. These include BRUV (Baited Remote Underwater Video) monitoring, acoustic monitoring and the establishment of a shark sighting network. We now know thanks to these efforts that the Saba Bank has the highest shark abundance in the area and must therefore be prioritized for shark conservation, and that endangered shark species (Carcharhinus falciformis, Sphyrna mokarran and Galeocerdo cuvier) live in the waters of our islands.

While traditional monitoring survey methods based on acoustic and direct visual observation have helped garner important information on species abundance and richness, they are typically expensive, labor-intensive, time-consuming and dependent on professional taxonomic identification (Deiner et al., 2017; Littlefair et al., 2017). There has been much interest in recent years in the potential of eDNA metabarcoding as a rapid, cost-effective and non-invasive monitoring tool (Deiner et al., 2017) to complement existing methods. A new study by Bakker et al. (2017) looks into the possible application of this emerging research method for elasmobranch species. They piloted a “novel, rapid and non-invasive environmental DNA (eDNA) metabarcoding approach specifically targeted to infer shark presence, diversity and eDNA read abundance in tropical habitats” which will enhance the ability to assess and monitor sharks and therefore improve conservation strategies that depend on accurate population assessments (Bakker et al., 2017).
Environmental DNA (eDNA) metabarcoding was first used to detect rare and invasive species, and there is now much excitement over its potential to track the presence, richness and abundance of animal species within their natural environment in a fast, efficient and non-invasive way (Creer et al., 2016; Deiner et al., 2017). Animals leave behind DNA in their habitat through feces, gametes, skin cells, etc., and researchers are now able to isolate this DNA from environmental samples (water, soil), amplify and then sequence it to identify the taxonomic identity of the species (Deiner et al., 2017; Littlefair et al., 2017; Bakker et al. 2017). Because eDNA can only be detected in the water column for a few days, it is possible to know whether the species was recently in the area. Several studies have found eDNA metabarcoding to be more effective than traditional survey methods in detecting taxonomic diversity, including teleost fish in freshwater and marine ecosystems, as well as able to detect rare species that would not be detected through visual observations (Lim et al., 2016, O’Donnell et al., 2017; Port et al., 2013; Thomsen et al., 2012) However, because different animal species “have different rates of eDNA production or “origin” and exhibit different “transport” rates from other locations, eDNA in an environmental sample could be inconsistent relative to a species’ true local and current abundance” (Deiner et al., 2017). Acoustic surveys of marine mammals were also found to detect greater species richness than eDNA metabarcoding (Foote et al., 2012).

The study by Bakker et al. (2017) is the first to investigate the application of eDNA metabarcoding to the study of elasmobranch abundance and diversity. Natural seawater samples were taken in the Caribbean (55) and New Caledonia (22) in 2015. Four different locations in the Caribbean were chosen that reflect varying levels of anthropogenic impact, from most (Jamaica and Belize) to least (The Bahamas, which is a shark sanctuary). In New Caledonia samples were collected in three locations: the pristine Chesterfield Atolls, New Caledonia North and the densely populated areas of Noumea. Bakker et al. (2017) used an elasmobranch specific COI primer for the amplification of eDNA metabarcoding markers. Caribbean reef sharks (Carcharhinus perezii) and Lemon sharks (Negaprion brevirostris) were abundant in Caribbean research sites while New Caledonian waters were dominated by Grey reef sharks (Carcharhinus amblyrhynchos) and Whitetip reef sharks (Triaenodon obesus) with the exception of the most impoverished locations (e.g. Belize, Jamaica and Noumea) (Bakker et al., 2017).

The main goal of the study was to examine whether patterns of species diversity reflect the known degree of anthropogenic impact. Previous studies within the Caribbean region have found that sharks are more abundant in areas where population density is low and where strong fishing regulations or conservation measures have been implemented (Ward-Paige et al., 2010). Bakker et al. (2017) also found that MOTU (Molecular Operational Taxonomic Unit) richness and abundance patterns are linked to the level of anthropogenic impact in each location: less remote and non-protected locations showed lower values for both diversity and abundance, while the more pristine/remote/protected locations had higher species richness and abundance. The Bahamas, which was declared a shark sanctuary in 2011, displayed the greatest elasmobranch diversity (11 MOTUs) while Jamaica and Belize displayed the least (2 and 1 MOTU respectively). In New Caledonia, the remote Chesterfield Atolls (11 MOTUs) had similar diversity to New Caledonia North (14 MOTUs) but displayed significantly higher abundance, meaning that read abundance may be correlated with remoteness (Bakker et al., 2017).
Based on the results of the Bakker et al. study (2017), there appears to be much potential for the application of eDNA metabarcoding to the assessment of elasmobranch species abundance and richness. Bakker et al. however site a number of concerns about the methodology that need to be addressed in future developments of elasmobranch eDNA metabarcoding approaches, including the choice of markers and primers. Certain elasmobranch species could also not be detected by the primer set selected by Bakker et al. (2017). The nurse shark (*Ginglymostoma cirratum*), which is known to be abundant in the Caribbean and was visually observed at the time of sampling was not detected by any of the eDNA sequence reads. The authors are however very optimistic about the use of eDNA metabarcoding as an objective and powerful elasmobranch assessment tool, from monitoring the success of shark sanctuaries to mapping differences in shark diversity (Bakker et al., 2017).

Environmental DNA Reveals Tropical Shark Diversity in Contrasting Levels of Anthropogenic Impact
Two Dutch Caribbean Tagged Tiger Sharks Follow Similar Migration Patterns in the Caribbean

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Two years ago the DCNA organized the first of its kind shark tagging expedition to the Saba Bank and St Maarten as part of the Dutch Postcode Lottery funded “Save our Sharks” project. Eight shark researchers with a support crew and two camera teams captured and tagged tiger sharks on St Maarten and the Saba Bank using an expedition ship. During the expedition, scientists and conservationists from the Saba Conservation Foundation (SCF), Nature Foundation St. Maarten (NFSXM), Florida International University (FIU) and Sharks4Kids equipped five tiger sharks with satellite tags in order to track their movements and presence to determine how best to manage and protect these important apex predators.

Wildlife Computer SPOT (Smart Position or Temperature Transmitting) satellite tags were attached to the first dorsal fin of large tiger sharks. These tags transmit to satellites, which allow the sharks to be tracked through the ARGOS satellite system for up to 4 years. The tag uses radio transmissions, so the satellite unit must be exposed to air in order to transmit. Each time the dorsal fin breaks the surface a geo location provides an approximate location with an accuracy of up to 250 meters.

Up to now, two tiger sharks with satellite tags named ‘Sea fairy’ and ‘Quinty’ have provided the research team with some interesting preliminary results. The sharks indicate a similar migration track following the Aves ridge, a ridge in the Eastern Caribbean Sea of about 500 km in length probably of volcanic arc origin.

“The preliminary data we have been receiving is starting to show some interesting results in terms of the migratory patterns of tiger sharks in the Eastern Caribbean Sea. Not only is this data important but it is also critical for the transboundary management of a marine species critical to the health of our Caribbean Sea. Sharks are apex predators and as such keep the ocean food chain healthy, a food chain which in turn supports regional fisheries for example. With recent shark finning and fishing activities occurring in the wider Caribbean including incidents in Curacao, Dominica and Aruba it behoves nation states in the Caribbean to establish a Wider Caribbean Management Plan for the species,” commented Tadzio Bervoets, Project Manager for the DCNA Save our Shark Project.

Shark Quinty was tagged under the supervision of Dr. Mike Heithaus on the Saba Bank. This 3.43 meter female tiger shark provided regular location updates. Quinty left the Saba Bank following the Aves ridge down south and subsequently swam all the way to Trinidad and Tobago, a territory known for its shark finning activities. The last received location of Quinty was close to Barbados about a year ago.

The track of Tiger shark Quinty through the Caribbean
Another Shark dubbed Sea fairy was the first shark which was equipped with a satellite tag in this region and surfaced very frequently, providing researchers with a wealth of location and movement information. Sea fairy was a 2.40 meter female tiger shark at the moment it was tagged in the waters of St Maarten. She stayed the first months around St Maarten while doing forays to Anguilla, St. Barths, Saba and the Saba Bank. In May 2017 Sea fairy migrated south following the Aves ridge in a similar movement pattern as tiger shark Quinty. After spending two months at the Aves ridge Sea Fairy explored the open Caribbean Sea and headed to Puerto Rico and Dominican Republic. The last location received for Sea Fairy was close to Puerto Rico also about a year ago.

“Sea fairy’s movement patterns can indicate a nursing area for tiger sharks around St. Maarten, spending their juvenile years in sand and seagrass habitat before migrating around the Caribbean when large enough in size and maturity. It is interesting to see that both actively tracked sharks are showing similar migration routes following the Aves ridge, which may supply the sharks with an abundant food source” stated Nature Foundation’s Project Officer Melanie Meijer zu Schlochtern.

Sharks are often portrayed as being dangerous killing machines, however the facts show the opposite. Occasionally shark bites do happen, however no unprovoked attack has ever been recorded on St. Maarten. It is more likely that one gets killed by a coconut falling on one's head than by a shark. The species are actually the victims of human impacts such as poaching, finning, overfishing and irresponsible coastal development pressure. Worldwide over 100 million sharks are killed per year resulting in half of all shark species being threatened or endangered with extinction.

“In the coming year, we will expand our shark movement study and will install another satellite tag on a tiger shark on St. Maarten and two more sharks will be equipped with a satellite tag on Aruba. This research will improve our understanding of the life characteristics of sharks and will provide knowledge about the population structure, abundance and migration of sharks in the Caribbean” explained Melanie Meijer zu Schlochtern.
Adopt a Shark Program St Maarten

The St Maarten Nature Foundation launched the “Adopt a Shark” program during St Maarten Shark Week in June 2018, but due to the continued demand of adopting a shark the Foundation decided to extend the program up to the end of this year.

“It is important that we work together to ensure the survival of our shark population, with the ‘Adopt a Shark’ program we are trying to engage the community in our efforts to protect sharks and give them the opportunity to be involved in a large scale scientific research project on St. Maarten. We certainly think this a great opportunity for kids and people interested in science to learn more about research, sharks and marine life on St. Maarten” stated Nature Foundation’s Project Officer Melanie Meijer zu Schlochtern.

Different tags are being applied on adopted sharks; such PIT tags, FLOY tags and even high-tech acoustic tags have been deployed on certain sharks. A PIT tag is a microchip which gives us a unique live time barcode and a Floy tag is used to identify the shark by anyone who catches or sees the shark close-up. An acoustic tag sends out acoustic signals which are detected with acoustic receivers, thereby giving information on how much time the shark spends around a certain location, providing us valuable information about their movement patterns. DNA samples will provide information about the sharks its relationships and their length measurements provide the knowledge about the ages and growth of the sharks.

“By donating a contribution to the Nature Foundation you can adopt a St Maarten shark, you will receive a certificate of adoption and can decide on the name of the shark. As soon as the shark is tagged updates and pictures about the shark will be sent to you. With the support of ‘Adopting a Shark’ we can continue our shark research and tagging activities, we will learn more about the sharks in our waters, providing us the knowledge to better protect them” explained Melanie Meijer zu Schlochtern.

Worldwide sharks are the most misunderstood species on the planet as they are repeatedly displayed as villains and being dangerous; however they are actually the victims of humans poaching, finning, overfishing and coastal development activities. Worldwide over 100 million sharks are killed per year; as a result half of all shark species are threatened or endangered. Sharks, as top predators, play a crucial role in maintaining balance and health within our aquatic ecosystem. Besides, they are important for tourism; many divers would like to see sharks, which makes a shark worth more alive ($200,000) than dead ($50).

The ‘Adopt a Shark St Maarten’ Program is part of the DCNA’s ‘Save our Sharks’ project funded by the Dutch National Postcode Lottery.
Exciting Rare Sighting in the Dutch Caribbean: the Antillean manatee

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Last month STINAPA’s ranger Luigi Eybrecht was diving near Playa in Bonaire when he encountered a very rare marine mammal: the Antillean Manatee (Trichechus manatus manatus). This is the first confirmed record of an Antillean manatee in Bonaire.

Bonaire’s waters are part of the Yarari Marine Mammal and Shark Sanctuary. The Yarari Sanctuary, which encompasses Saba’s and Saba Banks’ waters and Bonaire’s Exclusive Economic Zone waters, does not only protect marine mammals such as whales, dolphins and manatees, but also sharks.

The Antillean Manatee is a subspecies of the West Indian manatee (Trichechus manatus) (Deutsch et al. 2008). The Antillean manatee is estimated at less than 2500 mature individuals sparsely distributed throughout the tropical and subtropical Western Atlantic Coastal Zone from the Bahamas to Brazil, including the Caribbean Sea and Gulf of Mexico (Deutsch et al. 2008). The declining manatee population is threatened by habitat degradation and loss, hunting, accidental fishing-related mortality, pollution, and human disturbance and listed as Endangered on the IUCN Red list as it is predicted to decline by at least 20% over the coming 40 years (Self-Sullivan & Mignucci-Giannoni, 2008).

Manatees can inhabit waters with large changes in salinity concentrations and therefore are often found in shallow rivers and estuaries where they opportunistically feed on aquatic plants (Ortíz et al., 1998; Deutsch, 2008). They can grow up to 4.5 meter and weight up to 630 kg (U.S. Fish and Wildlife Service, 2018).

It is possible that the Dutch Leeward Islands (Aruba, Bonaire, Curacao) prior or during the Holocene could have facilitated colonization and supported small populations of the manatee (Debrot et al., 2006). The geographic isolation of the islands and use of this defenseless species by the early Amerindian inhabitants explain why it is believed that this species could easily have been eradicated around these islands well prior to the European colonization (Debrot et al., 2006). Today, suitable habitat for manatees is clearly missing around the Dutch Leeward island (Debrot et al., 2007). However, the few manatees seen in the past years around the Dutch Leeward Islands suggest that they could still form part of the active range of this rare and elusive species (Debrot et al., 2006). A manatee spotted in January this year by Armand Cranen in Aruba may have been the same as the one seen in Bonaire by L. Eybrecht, passing by the Leeward islands and deriving from the population inhabiting the waters of Venezuela, Puerto Rico or Hispaniola. Evidence from the Lesser Antilles suggests that in pre-Columbian times manatees could have occurred regularly in the Dutch Caribbean Windward islands (Saba, St. Eustatius and St. Maarten) but are now regionally extinct around these islands (Debrot et al., 2006; Deutsch et al. 2008).
The recent sightings show that manatees have the dispersal capacity to reach the Dutch Leeward Islands. The Yarari Marine Mammal and Shark Sanctuary includes habitats of former and potential future renewed importance for the endangered West Indian manatee (Debrot et al., 2011). It is hoped that together with other regional marine mammal protection initiatives this charismatic species could be saved from extinction.

**Table 1**: Overview of the West Indian manatee (*Trichechus manatus*) documented in the Dutch Caribbean.

<table>
<thead>
<tr>
<th>ISLAND</th>
<th>YEAR</th>
<th>RECORD</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aruba</td>
<td>Pre-Pleistocene</td>
<td>Fossil Manatus sp.</td>
<td>Martin, 1888; de Buisonjé, 1974; Van Oort, 1902; Rutten, 1931</td>
</tr>
<tr>
<td></td>
<td>January 2018</td>
<td>Visual sighting alive</td>
<td>Observed by Armand Cranen. Aruba Marine Mammal Foundation (Henriquez, A. personal communication with Paul Hoetjes on 11th of July)</td>
</tr>
<tr>
<td>Bonaire</td>
<td>July 2018</td>
<td>Visual documentation alive</td>
<td>Luigi Eybrecht /STINAPA Bonaire/ (Film footage by L. Eybrecht can be seen here)</td>
</tr>
<tr>
<td></td>
<td>Pre-Pleistocene</td>
<td>Fossil Manatus sp.</td>
<td>Martin, 1888; de Buisonjé, 1974; Rutten, 1931</td>
</tr>
<tr>
<td>Curaçao</td>
<td>1970</td>
<td>Visual sighting alive</td>
<td>M. Rijna, personal communication to G. van Buurt, late 1970s (Debrot et al., 2006)</td>
</tr>
<tr>
<td></td>
<td>February 2001</td>
<td>Visual sighting alive</td>
<td>Huang, A., van Duuren, R., personal communication (Debrot et al., 2006)</td>
</tr>
<tr>
<td>Saba</td>
<td>Pre-Columbian</td>
<td>Fossil Manatus sp.</td>
<td>Hoogland 1996; Hoogland and Hofman 1999</td>
</tr>
<tr>
<td>St. Maarten</td>
<td>Late 1980's, probably 1987 or 1988</td>
<td>Visual sighting alive</td>
<td>Robbie Cijntje, Nature Foundation St. Maarten, personal communication (Debrot et al., 2006)</td>
</tr>
</tbody>
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**Exciting Rare Sighting in the Dutch Caribbean: the Antillean manatee**
Excellent news: St. Eustatius has now become part of the "Yarari" Marine Mammal and Shark Sanctuary. St. Eustatius joined Bonaire and Saba when the Minister of Agriculture, Nature and Food Quality Mrs Carola Schouten and the Government Commissioner of St. Eustatius, Mr Marcolino Franco signed the Yarari declaration on September 20, 2018.

The number of Caribbean territories establishing a marine mammal and shark sanctuary is growing as the importance of these sea creatures becomes better understood. The next step is to implement monitoring and conservation practices. St. Eustatius National Parks Foundation (STENAPA)'s Marine Park Manager Jessica Berkel and Marine Park Ranger Francois Mille are eager to use their training to protect the various marine mammals and shark species found in the Dutch Caribbean waters. "Marine mammals and sharks play an important role in the marine environment. Where there are more sharks, there are – contrary to what you might expect – more fish as well. That makes the established sanctuary important for the fishermen on the island", says Berkel.

The "Yarari" Marine Mammal and Shark Sanctuary was established in the Caribbean Netherlands on September 1, 2015. The name of the Sanctuary "Yarari" is an Taíno Indian word, meaning "a fine place". The Yarari Sanctuary comprises all the waters of Bonaire, Saba and St. Eustatius and is intended to provide "a fine place" for marine mammals and sharks, where they will receive the necessary attention to ensure they are optimally protected.

The Yarari Sanctuary will also participate in the CAR'IMAM project, which kicks off in October this year and aims to develop a network of marine protected areas dedicated to the conservation of marine mammals in the Greater Caribbean and beyond. This network will aim at strengthening managerial skills and developing common tools for management and evaluation purposes. Furthermore, the proposed network includes a focus on the development of respectful, sustainable commercial operations for the observation of marine mammals (whale watching) across the Caribbean, compatible with marine mammal conservation.
Dutch Caribbean: “home” of unique, and likely vulnerable, populations of Bryde’s and humpback whales

By Dr. Per J. Palsbøll. This article was published in BioNews 20.

During the last decade several marine areas in the Wider Caribbean have been awarded extra protection as “marine mammal reserves”, such as the the Yarari Marine Mammal and Shark Sanctuary that was established in the Caribbean Netherlands on September 1, 2015. The Yarari Sanctuary comprises all the waters of Bonaire and Saba and since September 2018 also St. Eustatius. The name of the Sanctuary “Yarari” is a Taíno Indian word, meaning ‘a fine place’. It is intended to provide “a fine place” for marine mammals and sharks, where they will receive the necessary attention to ensure they are optimally protected.

Among the large marine mammals, the North Atlantic Humpback whales (Megaptera novae-angliae) are known to overwinter in the Caribbean as well as in the Cape Verde archipelago and other areas off western Africa. The available data suggests that the humpback whales that overwinter in the Dutch Caribbean are not part of the western North Atlantic humpback whale population that breeds north of the Dominican Republic, as previously assumed, but instead more likely to be part of a relatively small “eastern” population that breeds north of the Dominican Republic, as previously assumed, but instead more likely to be part of a relatively small “eastern” North Atlantic humpback population which summers off Iceland and in the Barents Sea. The Dutch Caribbean is also home to Bryde’s whales, Balaenoptera edeni spp., which is an all-year low latitude resident. However, data on Bryde’s whales are very scarce and our understanding of Bryde’s whales in the Dutch Caribbean and adjacent waters is near-zero.

Humpback migrations between feeding and breeding grounds
Humpback whales undertake some of the longest seasonal migrations known among animals (Stone et al. 1990). Summers are spent in foraging grounds at high latitudes in temperate and sub-polar waters (Katona & Beard, 1990). During the fall and early winter most individuals migrate towards the equator to spend winter in tropical waters in their breeding grounds (Dawbin, 1966; Katona & Beard, 1990). Despite the extensive fall migration humpbacks do not feed during the winter, which is their mating and calving season (Dawbin, 1966). Females give birth to one calf during the winter in their breeding grounds, approximately one year after becoming pregnant (Robbins, 2007). The calf relies upon its mother for sustenance in the form of high caloric milk. The lactation process places very high energetic demands on the mother, which loses around 30 percent of her body weight during this period (Robbins, 2007). During the spring, the calf migrates together with its mother to a high latitude foraging ground where it spends the summer, eventually separating from the mother during fall when it will migrate back to the winter breeding grounds on its own (Clapham et al., 1993; Robbins, 2007). With very few exceptions individual humpback whales keep returning to their maternal summer foraging ground their entire life (Clapham et al., 1993; Palsbøll et al., 1995; Robbins, 2007).

Recovering western North Atlantic humpback population
Humpback whales are relatively slow-moving whales which, along with a tendency to congregate in specific, predictable areas, made them a target for commercial whaling during the late 19th and early 20th centuries in the North Atlantic (Punt et al., 2006). As a result, the population was decimated to very low numbers on both sides of the North Atlantic. After full protection was afforded in the late 1960s, the humpback whales in the western North Atlantic appear to have increased to approximately 10,000 (Smith et al. 1999) and 12,000 (unpublished) individuals in 1992/93 and 2004/5, respectively.

30 years of trans-North Atlantic collaborative research projects
These estimates were based upon two large trans-North Atlantic collaborative research efforts, YoNAH (Years of the North Atlantic Humpback Whale) conducted in 1992 and 1993, and a second, mainly US based effort, in 2004 and 2005 (project MoNAH, More of the North Atlantic Humpback Whale). Two key kinds of data were collected during the YoNAH/MoNAH projects; photographs of the underside (ventral) of the tail, also called the fluke, and, small skin biopsies.

Tail (fluke) photographic identification
The pigmentation pattern on the ventral side of the fluke, as well as, the serrations along the trailing edge are unique to individuals and have been used to identify and map the movements of individual humpback whales globally since the late 1970s (Katona & Whitehead 1981). The large-scale collection of skin biopsies from free ranging whales during the YoNAH project was something new at the time.
Genetic "tagging" from skin biopsies

The genetic analyses of the skin biopsies were not originally intended for identification of individuals, but aimed at assessing large-scale population structure. However, recent advances in "genetic fingerprinting" (i.e., CSI-style DNA identification) made it possible to identify individuals and their sex in all ~3,000 skin biopsies collected from North Atlantic humpback whales at the time (Palsbøll et al., 1997). The subsequent MoNAH project (2004/2005) collected an additional 3,700 skin biopsy samples and the resulting abundance estimate was based mainly upon genetic (rather than photographic) identification of individuals, although fluke photos were also collected. All in all, the current collection of skin biopsy samples from North Atlantic humpback whales now counts ~8,000 skin biopsy samples, representing 5,700 unique genetic fingerprints (i.e., individuals) and is curated by Drs. Per Palsbøll and Martine Berube at University of Groningen (the Netherlands).

Separate eastern North Atlantic humpback whale population

During both the YoNAH/MoNAH projects all efforts in the breeding grounds were directed towards the western North Atlantic. The vast majority of skin samples (and fluke photographs) were collected from humpback whales in the main banks and bays north of the Dominican Republic; such as Silver Bank, Navidad Bank and Samana Bay. In contrast, only few skin samples and fluke photos were collected in the eastern Caribbean and eastern North Atlantic breeding grounds. So far 50 and 13 samples have been collected in the Cape Verde Archipelago and St. Martin in the eastern Caribbean, respectively. One key question is if there is/was a separate eastern North Atlantic humpback whale population. The Yankee whalers from the US east coast caught many humpback whales in the Cape Verde Archipelago during the early 20th Century (Punt et al., 2006), as did the Norwegians off northern Norway during the summer and winter (Ingebritsen, 1936). Re-identifications of individual humpback whales from their fluke photographs, as well as, genetic fingerprints have identified individuals that were “observed” both in the Cape Verde Archipelago and northern Norway (Stevick et al., 2016). Some individuals were even sighted both in the Cape Verde Archipelago and the eastern Caribbean (Stevick et al., 2016).

Humpback "breeding" populations

Genetic data, of the kind collected from the North Atlantic humpback whale skin biopsies, can, among many other uses, be employed to assess how many “breeding” populations the sampled individuals possibly originate from, as well as, which individuals originate from the same breeding population. It is also possible to identify individuals of “mixed” ancestry, i.e., individuals that are offspring of parents from two different “populations”. The result of this kind of analysis in 200 western Caribbean humpback whale samples and all individual humpback whales sampled in the Cape Verde Archipelago/eastern Caribbean revealed an unexpected pattern. All individuals, but one, sampled in the western Caribbean were inferred as originating from one population. In contrast, the samples from the eastern Caribbean and Cape Verde Archipelago contained individuals from two different breeding populations, one was that which the western Caribbean individuals belonged to (Palsbøll et al., unpublished data). The other “population” was only identified among the eastern North Atlantic individuals (and a single western Caribbean individual). In addition, a number of eastern North Atlantic individuals were of mixed ancestry, i.e., they appeared to be offspring of parents of which one parent belonged to an “eastern” and the other to a “western” North Atlantic population.
A preliminary genetic analysis of 14 humpback whale skin biopsy samples collected in Saba Bank during 2014 confirmed this hypothesis, i.e., the humpback whales sampled in Saba Bank were genetically more similar to the humpback whales sampled in the Cape Verde archipelago than they were to samples collected from humpback whales in the “western” Caribbean (Palsbøll et al., unpublished data).

Immigration from western North Atlantic population into eastern North Atlantic population

The outcomes of these genetic analyses led to the hypothesis of a recent relative increase of immigration of humpback whales from the rapidly recovering western North Atlantic population into the essentially non-recovering eastern North Atlantic population. The genetic analyses suggested that approximately ~50-60 humpback whales per generation migrated from the western Caribbean into the Cape Verde Archipelago/ eastern Caribbean. The immigrant western Caribbean individuals appeared to have mated with eastern North Atlantic individuals, resulting in the high proportion of individuals among the eastern North Atlantic individuals with a mixed ancestry (Palsbøll et al., unpublished data).

Before whaling, the abundance in the western and eastern North Atlantic “populations” was estimated at ~5,000 and ~25,000 individuals (Punt et al. 2006). However, now, a century after whaling, the difference in abundance (at 300 and 12,000 in the eastern and western Caribbean, respectively) is an order of magnitude larger due to the very different recovery rates. Hence, even if the immigration rate per “capita” has remained constant in both populations, the western Caribbean population is contributing a proportionally larger number of immigrants to the eastern North Atlantic population per generation. Immigrant individuals inter-breed with eastern North Atlantic humpback whales. The result of this high immigration rate and subsequent mating is an ongoing decline of the eastern North Atlantic “gene pool” (Palsbøll et al., unpublished data).

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Future research

Several key questions have arisen from this work; how far west in the Caribbean does the distribution of humpback whales from eastern North Atlantic population stretch? Are there other breeding grounds in the eastern North Atlantic, such as off Mauritania, where humpback whales have been sighted during the winter? The recently initiated EU funded project CAR’IMAM will likely contribute some new data and potential new insights towards these questions. However, in order to truly understand the current and past processes that determines the presence and abundance in the Dutch Caribbean a wide-ranging assessment of low latitude areas that host humpback whales during the winter is needed. Seasonal migrations also imply that connections between winter and summer areas are key, since endangerment (e.g., entanglement in fishing gear on summer areas) may affect humpback abundance in parts of the winter breeding range, such as in the Yarari Sanctuary.

Dutch Caribbean: “home” of unique populations of Bryde’s and humpback whales
The Dutch Caribbean is also home to Bryde's whales (*Balaenoptera edeni*), a unique baleen whale that (contrary to most baleen whales) do not migrate to high latitudes during the summer to forage, but is an all-year low latitude resident. Only two genetic studies aimed at North Atlantic Bryde's whales have been conducted to date (Rosel & Wilcox 2014; Luksenburg et al. 2015). The little studied Bryde's whale is likely comprised of multiple genetically divergent populations, possibly representing different species. These two studies by Luksenburg et al. (2015) and Rosel and Wilcox (2014) strongly suggest that the Bryde's whales in the Gulf of Mexico and Dutch Caribbean are unique and distinct forms of Bryde's whales. Rosel and Wilcox (2014) analysis found that the Gulf of Mexico Bryde's whale population was (i) evolutionary distinct (Luksenburg et al. 2015) and (ii) contained very low levels of genetic variation. The latter could imply that the current population size is very low, or the low genetic diversity could be due to a low historical population size. However, the published genetic data from four Bryde's whale samples collected in Aruba were from another sub-species, *B. e. brydei*, (Luksenburg et al. 2015). At present the temporal densities and range of Bryde's whales in the Dutch Caribbean, as well as their abundance, is unknown.

In conclusion, the waters of the Dutch Caribbean islands appear to be the “home” to unique, and likely vulnerable, populations of Bryde's and humpback whales. However, the state of our current knowledge of these species in this area is poor and future research will hopefully fill these knowledge gaps.
Molluscs of the Dutch Caribbean Islands

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The journal of the Netherlands Malacological Society, Vita Malacologica, dedicated its December 2017 edition to the malacofauna of the Dutch Caribbean1. The three articles presented in the edition report on the findings of several research projects that recently investigated the marine and terrestrial mollusc fauna of Saba, St. Eustatius and the ABC Islands (Aruba, Bonaire, and Curaçao). What transpires is that the mollusc fauna of these islands is much richer than previously thought, with many rare and endemic species. The biodiversity of the Dutch Caribbean Islands is already recognized as rich and unique, but the findings on the islands’ marine and terrestrial molluscs indicate that there is still much to discover.

A rich mollusc fauna

While previous assessments have been made of the mollusc fauna of the Dutch Caribbean, many of these took place decades ago and are incomplete. Thanks to the dedication of the authors who recently researched the malaco fauna of Saba, St. Eustatius and the ABC Islands (Hovestadt and van Leeuwen, 2017; Hewitt, 2017; Hewitt and van Leeuwen, 2017), we now have a much better grasp of just how rich this fauna is.

ABC Islands

Detailed studies of the ABC Island’s terrestrial malacofauna were carried out in the first half of the 20th century (Baker, 1924; Wagenaar-Hummelinck, 1940). Since then, attempts have been made to create an updated checklist of the islands’ terrestrial molluscs, but these were incomplete and at times unclear (Hovestadt & De Boer, 1982 and Hovestadt, 1987). To rectify this, Hovestadt and van Leeuwen carried out a complete overview of the terrestrial malacofauna of Aruba, Bonaire, and Curaçao1. They compiled information for the study through 1) fieldwork, they carried out on the islands between 1979 and 2016, 2) material collected by others and identified by Hovestadt, and 3) knowledge and data derived from previous publications (Hovestadt and van Leeuwen, 2017). They found that the ABC islands have “a very rich and diverse terrestrial malacofauna both in numbers and in taxa” with a total of 65 taxa (species and subspecies) recorded (Hovestadt and van Leeuwen, 2017). Curaçao was the most species-rich island, and Klein Curaçao the poorest. Klein Bonaire had the highest diversity of species per km2.

Saba

Very little attention has been given to Saba’s marine malacofauna in the past. In 2009, Rosenberg listed 17 taxa for the island, most of which were subtidal species (Hewitt, 2013). Hewitt compiled photographs and information from 2010-2012, adding 38 taxa to this list (26 gastropods, 4 bivalves, 4 chitons and 4 cephalopods), bringing the total of marine mollusc taxa for Saba to 55 (Hewitt, 2013). Hewitt subsequently obtained more information from Rüdiger Bieler and others, and added another 40 new taxa to the list. As of 2018, the total of recorded shallow-water, marine malacofauna for Saba and the Saba Bank is 951 (Hewitt, 2017).

St. Eustatius

Prior to 2015, the marine malacofauna of St. Eustatius had seldom been explored (Coomans, 1958; Kaas, 1972; Hewitt, 2010b). In 2015, Hewitt published the most comprehensive list to date of marine molluscs which had been observed by her and others from 2000 to 2012, for a total of 183 taxa (Hewitt, 2015). Also in 2015, the St. Eustatius Marine Biodiversity Expedition, organized by Naturalis Biodiversity Center and ANEMOON Foundation, took place. This three-week expedition surveyed the island’s shallow (<30m) marine fauna and flora, and presented an unparalleled opportunity to record both the underwater and shoreline molluscs of St. Eustatius.

A total of 356 mollusc species in six classes were recorded during the course of the St. Eustatius Marine Biodiversity Expedition – 300 at dive sites and 277 at coastal sites, with 113 species being found at both (Hewitt and van Leeuwen, 2017). The marine mollusc faunal list for St. Eustatius now stands at 395 species. The dive site with the greatest recorded species diversity (129 species) was STENAPA Reef, due to the exceptionally rich sediment sample collected there. The most widespread species found at dive sites were the flamingo tongue (Cyphoma gibbosum f. gibbosum), and queen conch (Lobatus gigas) (Hewitt and van Leeuwen, 2017). The coastal site with the greatest species diversity (99 species) was Crooks Castle. Some of the most common intertidal species were the West Indian top snail (Citronum pico), green-based tegula (Tegula excavata), checkered nerite (Nerita tessellata) and the marbled chiton (Chiton marmoratus) (Hewitt and van Leeuwen, 2017). Dive stations yielded richer and more varied results than the coastal stations (Hewitt and van Leeuwen, 2017). The research team also collected 130 individual molluscs from 53 species for DNA sampling. This was a contribution to Naturalis Biodiversity Center’s Dutch Barcoding Project, and it also helped settle some questions of identity (Hewitt and van Leeuwen, 2017).
New, rare, invasive and endemic species

All three studies yielded some very exciting discoveries, including new species for the islands and some very rare species. The ABC Islands are also a treasure-trove of endemic land snail species.

ABC Islands

Although no new species were found, two very rare species were observed on Sint Christoffelberg in Curaçao. The land snail *Guppya molengraaffi* had been observed only once before (Baker, 1924) however, nine specimens were found alive on Sint Christoffelberg. The land snail *Helicina dysoni* was recorded for the first time ever in its natural habitat on the same mountain. The uniqueness and genetic variation of the ABC Islands’ malacofauna is highlighted by the large number of endemic species. In fact, 35 (20 species and 15 subspecies) of the island’s 65 taxa are endemic (Hovestadt and van Leeuwen, 2017). Several endemic genera show significant variations related to their geographical distribution pattern.

All endemic species previously described by Baker (1924b) and by Hummelinck (1940c) were found again by Hovestadt and van Leeuwen (2017), meaning that none have become extinct over the past century, despite a significant increase in local threats (Hovestadt and van Leeuwen, 2017). Terrestrial molluscs typically inhabit limestone-rich areas, and this has helped spare them from habitat loss due to the construction of resorts. Hovestadt and van Leeuwen (2017) did, however, identify one area on Curaçao which is seriously threatened by extensive mining for the building industry: Tafelberg near Santa Barbara, which is an important habitat for a number of endemic land snails (*Tudora pilsbryi, Tudora r. newportensis* and *Tudora r. newportensis* and *Brachypodella sanctaebarbarae*) (Hovestadt and van Leeuwen, 2017). Aruba appears to have the greatest decline in terrestrial mollusc species, with several species not found again, of which three are rare or have a restricted range (*Gastrocopta octonaria, Gastrocopta curacaoana, Thysannophora crinita*).

Found on the ABC Islands were seven land snail species which had not been included in previous overviews by Baker (1924b), Wagenaar Hummelinck (1940c), and Hovestadt (1987): *Helicina fasciata fasciata, Leptinaria lamellata, Polygyra cerulea, Oleacina solidula, Bulimus guadalupensis, Zachrisia provisoria and Lissachatina fulica* (Hovestadt and van Leeuwen, 2017). It is likely that these land snail species are introduced, and while their range is still very small, two of the species have the potential to spread rapidly and harm the islands’ garden plants and agricultural produce: *Zachrisia provisoria and Lissachatina fulica* (Hovestadt and van Leeuwen, 2017).

Saba

Hewitt added 40 previously unreported records to the list of marine molluscs for the island, almost doubling the total. Uncommon sea snails recorded were *Polygona infundibulum, Hemipolygona sp.* and *Coralliophila salebrosa* (Hewitt, 2017).

St. Eustatius

Hewitt and van Leeuwen (2017) reported 207 species of marine molluscs that were new for St. Eustatius, some of which were not previously known to inhabit the Eastern Caribbean region. The recently described bivalve *Parvilucina latens* (2016) is a new record for the island and also for the Eastern Caribbean Region. It had only ever been recorded in Guadeloupe, and is therefore a 200 km range extension to the north-northwest (Hewitt and van Leeuwen, 2017). Two other new records for the island and the Eastern Caribbean region represent much larger range extensions. The nudibranch *Melibe arianeae* (2013) has only been recorded once, in Florida, USA, however, two live individuals were found at the dive site Twin Sisters, a range extension of over 2,000 km east-southeast. The invasive species *Doriprismatica sedna*, found at dive site Aquarium, is a new record for the Eastern Caribbean with a range extension of over 1,000 km to the east-southeast (Hewitt and van Leeuwen, 2017).
New observations for St. Eustatius include the sea snails *Arene tricarinata* and *Fossarum ambiguus*, the scallop species *Antilipecten antillarum* and *Canibachlamys ornata*, and the scaphopods *Polyschides tetrachistus* and *Graptacme semistriolata* (Hewitt and van Leeuwen, 2017). Numerous uncommon species were recorded, including several species that had previously not been reported, or only very rarely reported from the Eastern Caribbean ecoregion: the marine bivalve species *Gari circe*, *Pleuroloca henderoni*, *Cratis antillensis*, *Tucetona sericata* and *T. subtilis*, the sea slugs *Elysia ornata* and *Flabellina verta*, and the sea snails *Fissurella punctata*, *Lucapina philippiana*, *Synaptocochlea picta*, *Turritella exoleta*, and *Bivetopsi rugosa* (Hewitt and van Leeuwen, 2017).

**Next steps**

The inventory of the malacoфаuna of the Dutch Caribbean is now much more comprehensive thanks to research carried out these past few years. It is, however, by no means complete.

There is still much to investigate, for example, a complete overview of the marine molluscs of the ABC islands has never been made. Improved knowledge is critical to the conservation of the islands’ mollusc species, and will help identify sites that must be protected. Also the terrestrial mollusc fauna of St. Eustatius is not very well known. During the Statia Marine Expedition, a new species was discovered on the Quill. It was described as new to science and named *Glyphaulus quillensis* (De Winter, Van Leeuwen and Hovestadt, 2016). A complete overview of the terrestrial mollusc fauna of St. Eustatius is not very well known. The marine mollusc fauna of Saba was published in 2005 (Van Leeuwen, Boeken & Hovestadt, 2015). The marine mollusc fauna of Saba requires a great deal more investigation.

The special issue of *Vita Malacologica* on the Dutch Caribbean molluscs is available via [www.conchbooks.de](http://www.conchbooks.de). A report with the preliminary results of the Statia marine expedition 2015 is available at: [http://www.repository.naturalis.nl/record/616970](http://www.repository.naturalis.nl/record/616970).

**Molluscs of the Dutch Caribbean Islands**
December 13th 2017 marked the beginning of an incredibly exciting and ambitious research expedition organized by the Royal Netherlands Institute of Sea Research (NIOZ Sea Research) and NWO-Science (ENW). On that day, NIOZ Sea Research’s research vessel RV Pelagia set sail from Texel, the Netherlands, and was at sea for seven months conducting a multidisciplinary scientific expedition entitled “Netherlands Initiative Changing Oceans (NICO)”. Aboard the vessel were 100 scientists (spread out over seven months) from a wide range of disciplines and representing 20 national and international scientific organizations. The ship visited five ocean provinces (North Sea, Atlantic Ocean, Caribbean Sea, Gulf of Mexico and Bay of Biscay) and collected research data on such diverse subjects as foraminifers, viruses, coral reefs and migratory birds.

The NICO expedition aimed to provide the Netherlands with a better understanding of changing seas and oceans, and data collected “will help answer fundamental questions in marine science and help develop new technical solutions which are essential for planning and making decisions about our future livelihoods” (NIOZ, 2017). An extra motivation for the expedition was the policy document ‘Oceanennotitie’ which was published by the Dutch Government last spring. This document emphasizes the importance of healthy and resilient oceans to the Netherlands and outlines 30 policy ambitions with regard to the sustainable use of oceans.

There were twelve stages to the expedition, some lasting a few days whilst others took several weeks. Four of these legs (legs 3 to 6) took place in Dutch Caribbean waters and collected invaluable data for the management of our islands’ marine resources.

**Leg 3: Chief Scientist: Petra Visser – UvA; Co-Chief Scientist: Fleur van Duyl – NIOZ Sea Research**

During the Southern Caribbean leg of the expedition, the mesophotic reefs (i.e. reefs below 30 m depth) of Bonaire, Curaçao and Aruba were the focus of the expedition’s first research project within the Dutch Caribbean. The goal of this project was to explore the deep reefs along the coast of the ABC-islands, sample and investigate the fields of cyanobacteria that have been observed in front of Kralendijk and detect where onshore groundwater enters the offshore environment. This project will provide vital data to ensure efficient waste water management on the islands and consequently improved health of the coral reefs.

**Leg 4: Chief Scientist: Femke de Jong – NIOZ Sea Research; Co-Chief Scientist: Meike Scheidat-Wageningen Marine Research (WMR)**

The second research project of the expedition in the Dutch Caribbean took place between Aruba and St. Maarten and investigated how eddies in the Caribbean influence the occurrence of pelagic megafauna, more specifically marine mammals, turtles, large fish species (sharks, sunfish) and sea birds. This research project not only gathered important information on the hydrography and cetaceans and other megafauna in the Greater Caribbean, but will help provide insight as to how global warming will impact these species. Eddies in the Caribbean have surface waters that are roughly 4°C warmer than the ambient ocean, and different nutrient availability inside these eddies and altered biological activity may provide insight in what to expect in the future.

**Leg 5: Chief Scientist: Gerard Duineveld – NIOZ Sea Research; Co-Chief Scientist: Furu Mienis – NIOZ Sea Research**

The third research project of the NICO expedition in the Dutch Caribbean focused on Saba Bank’s deep-water environments (100m and beyond). The main goals of this project were to describe the biodiversity of the Saba Bank’s deep slopes, including the benthic habitats of engineering species, macro- and micro fauna and the composition of the fish community, as well as identify environmental conditions that influence these habitats and fauna. This data can be used to develop a sustainable management plan for the Saba Bank.

**Leg 6: Chief Scientist: Fleur van Duyl – NIOZ Sea Research; Co-Chief Scientist: Erik Meesters-WMR**

The last research project of the NICO expedition in the Dutch Caribbean focused on how the net capability of physiographic and hydrodynamic characteristics of the Saba Bank (e.g. bathymetry) affect benthic habitat distribution patterns and the biogeochemical functioning of different reef ecosystem habitats (e.g. coral-, macroalgal-, CCA-, gorgonian, rubble-, sponge and sand dominated habitats). Additionally benthic surveys were conducted to expand the mapping of different habitats, bathymetry, and bottom roughness on the Saba Bank. Furthermore, the research team mapped the largely inaccessible and therefore unknown windward sides of both Saba and St. Eustatius.
You can track the journey of RV Pelagia here:
https://www.marinefacilitiesplanning.com/programme/map

https://www.facebook.com/NICO-expedition-370772906669783/
https://twitter.com/nicoexpedition
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NICO Science Expedition: introduction
Mesophotic reefs, Cyanobacteria mats and Submarine Groundwater Discharge around the ABC-islands

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After setting sail from Texel, the Netherlands the research vessel Pelagia travelled to Aruba, Bonaire and Curaçao where a multi-disciplinary team of researchers explored the island’s mesophotic reefs during the third leg of the expedition. Researchers from the Royal Netherlands Institute for Sea Research (NIOZ Sea Research), Wageningen University & Research, the University of Amsterdam, Federal Institute for Geosciences and Natural Resources and the Delft University of Technology set out to map the islands’ cyanobacterial mats and uncover the cause of their proliferation, specifically whether anthropogenic nutrients stimulate their growth. A secondary aim was to investigate where and at what rate onshore groundwaters enter the offshore environment, and how this groundwater discharge is affecting the islands’ mesophotic reefs (> 30m deep). With this knowledge, seepage areas of nutrient rich water/pollution sources can be mapped and managed.

Mesophotic reefs (> 30m deep)
Mesophotic reefs are still largely unexplored because of their remoteness or inaccessibility but are believed to be of great ecological value, providing offspring to shallow reef communities that are more prone to climate change and pollution. After searching for a week, the research team was able to find a real mesophotic reef (40 to 100m depth) on the eastern tip of Curaçao, at Awa Blancu. Sadly this area has been nominated to be sold and developed into a large tourist area. No mesophotic reefs were found around Bonaire. Many of the researchers on the team were saddened that the deep reefs they remember diving in their youth appear to have disappeared.

The rise of slimy cyanobacterial mats
Cyanobacterial mats which “grow like dark filamentous mats on the sand” were located with underwater camera’s off the coast of Kralendijk, Bonaire and Curaçao, at a depth of 55-75 meters. Unfortunately due to the lack of time and problems with equipment no data on mesophotic reefs and deep water cyanobacteria mats was collected around Aruba. “I have been doing research here for a long time, but blue-green algae bloom is really something of the last years” notes Dr. Erik Meesters, coral researcher at Wageningen Marine Research and one of the principal scientists of this research expedition (Buiter, 2018). Cyanobacteria are important primary producers and suppliers of nitrogen within coral reefs (Charpy et al., 2012). In healthy reefs, almost all dissolved nutrients are absorbed by coral polyps and macroalgae. However, disruption of the reef’s delicate system by an abnormally large inflow of nutrients can lead to the proliferation of cyanobacteria mats, which has “serious direct and indirect effects on numerous reef organisms and ecological processes. Some mats overgrow and smother benthic organisms, including scleractinian corals and fleshy algae” (Ford et al., 2018). Cyanobacteria have certain physiological properties that are potentially harmful to coral reefs. They can fix atmospheric nitrogen, bringing additional nutrients into the system, and can produce toxins that are harmful to the animals that consume them.

De Bakker et al. (2017) carried out a study of the reefs at Karpata, Bonaire, and reefs in Curaçao and found that the benthic coral reef community had shifted from a dominance of hard coral and crustose coralline to a dominance of algae and subsequently cyanobacterial mats (de Bakker et al 2017). This new trend was observed all the way down to 40m, although it was less pronounced at depth. De Bakker et al. (2017) suggest that local (eutrophication) and regional (elevated temperatures) stress likely initiated this shift, and that the sudden and sharp rise of benthic cyanobacterial mats is worrisome as the mats reduce the ability of corals to recover from disturbances such as storms and bleaching events.

* Cyanobacterial mats at Karpata increased from 7.1% in 2002 to 22.2% in 2013 (De Bakker et al 2017)
Erik Meesters, however, does not believe that the deep mats they found are currently a threat to Bonaire’s and Curaçao’s reefs as “they only occur at depth where coral does not catch enough light anymore. Above that, the coral polyps win the competition for the nutrients”. He does however believe that the mats could become a significant issue if nutrient levels in the water increase further, causing the mats to spread over a reef that is already under a lot of pressure from tourism and warming ocean temperatures. This highlights the importance of setting up adequate waste water treatment on both islands.

To investigate the composition and functioning of cyanobacterial mats, Dr. Petra Visser from the University of Amsterdam, with the help of divers, collected samples from the deep mats and took measurements on their photosynthesis and nitrogen fixation. The deep profiles showed that there is a halocline and thermocline between 35 and 60 meters, which may support the favorable conditions for the growth of the deep mats (>40m depth). Due to density differences over the halocline, organic matter sinking from above may settle on the halocline and subsequently settles on the bottom where the halocline intersects with the bottom. This supply of organic matter to the deep cyanobacterial mats probably supports the growth of deep cyanobacterial mats on sandy slopes in front of Kralendijk and elsewhere along urbanized coasts.

Onshore ground waters
The coastline of both Bonaire and Curaçao is primarily made up of limestone formations, and both islands have no rivers. This means that rainwater from land primarily flows into the sea directly during and after rain showers and indirectly via the subsurface as groundwater flow and not via river discharge. Groundwater on both islands is known to be contaminated by inadequate treated waste water which results in elevated nutrient concentrations. While there is no long-term data on nutrient concentrations of reefs on both islands, some indication of eutrophication was found on Bonaire’s reefs in 2014 (Slijkerman et al., 2014); elevated nutrient concentrations were found at Karpata in 2012 and 2013 (De Bakker et al 2017). The hypothesis here is that submarine groundwater discharge (SGD) contributes the eutrophication of waters and to the proliferation of cyanobacterial mats. “These harmful algal blooms are stimulated by environmental factors like light, salinity and nutrient levels such as nitrogen and phosphorus. Nitrogen and phosphorus are found in high concentrations in human waste and wastewater” (Florida Atlantic University, 2018). Based on the distribution of shallow and deep cyanobacterial mats along Curaçao and Bonaire, there is a strong indication that urbanization (assumed to coincide with eutrophication among others) and wave energy (wave height) along the leeward coast plays an important role in the distribution of mats (Brocke et al. 2015). Although correlation between urbanization and occurrence of mats is obvious, the causal agent has not been exactly identified yet.

In order to determine where and at what rate onshore groundwater enters the offshore environment, the research team used photographic and acoustic mapping to map out the bottom topography on both the leeward and windward side of the islands. A small boat was used to get close to shore and find the areas where groundwater flows into ocean. Finding “the relatively small amount of groundwater exiting in the vast ocean was a big challenge”. To detect the seepage of nutrients from groundwater, water samples of the seawater near the seabed were collected, and the salinity, temperature and radon content measured. Water samples were also taken at various depths with the help of an underwater robot (smalllander of NIOZ Sea Research), which collects water close to the bottom for inorganic nutrients and organic matter analyses. In addition CTD profiles (temperature, conductivity and depth measurements) were taken, while sampling contemporaneously water from the bottom to the surface. The team from Delft University of Technology and Wageningen University used the same robot to collect water samples to map the possible groundwater flows around the islands.

Mesophotic reefs, Cyanobacteria mats and Submarine Groundwater Discharge around the ABC-islands

Photos by: © NICO Expeditie
Mapping the Sea Bottom

This article was published in BioNews 13.

Researchers aboard the Pelagia research vessel have been collecting invaluable data on marine biomes in the Caribbean as part of the NICO-expedition. The research vessel has visited the Southern Caribbean where work focused on the mesophotic reefs (>30m deep) of Bonaire and Curaçao. Bathymetric maps from the 1970s did not offer enough detail for the research team to locate the reefs and cyanobacterial mats, which were the focus of their studies. Detailed bathymetric data was absent for other Dutch Caribbean islands, including Saba, the Saba Bank and St. Eustatius and bathymetric maps will therefore be created. Dr. Henk de Haas, an acoustic researcher and data scientist of NIOZ Sea Research who is onboard the Pelagia, has provided insight about how he goes about creating these maps that are so crucial to the success of among others ocean research.

Topography of the sea floor
Bathymetry is the measurement of depth of water in oceans, seas, or lakes. Bathymetric maps provide a visual representation of the topography of the sea floor including the shape and elevation of underwater features like seamounts or ocean trenches. These maps are crucial to ocean research as they enable scientists to locate the specific ecosystems which are being investigated. For example, coral reefs are not found in areas with strong water currents and would therefore not be located in underwater valleys where water flow is powerful.

Normal echo sounder
In the past, sea depth was measured using a type of sonar called an echo sounder. A sound pulse would be sent out by a transmitter located on the hull of the ship. The longer it took for sound to travel to the sea floor and back to the receiver on the ship, the deeper the ocean floor. The problem with this technique is that just one measurement can be taken at a time, making the mapping of the sea floor very labor intensive and not very accurate. “We would very often have to sail lines back and forth to make a map of a piece of seabed”, explains Dr. de Haas.

Modern multi-beam echo sounder
Nowadays, acoustic scientists use a modern multi-beam version of the echo sounder. The model installed underneath the Pelagia transmits 288 sound beams per pulse simultaneously in a fan shape instead of just one vertical pulse. The multi-beam echo sounder generates fast and accurate bathymetric measurements and allows the creation of detailed topography maps. In fact, because many of the bundles take two measurements simultaneously, Dr. de Haas notes that the system on board the Pelagia allows for at maximum 432 depth measurements to be produced per sound pulse. The size of the area mapped is dependent on water depth - the width of the bundle is about five times the water depth, meaning that the bundle will be narrower in shallow waters. The multibeam echo sounder can also help determine the nature of the seabed and whether there is soft or hard sediment. If the sediment is hard, such as sand, the sonar signal will come back stronger. As explained by Dr. de Haas, “a map of the strength of the reflected sound signal is actually a map of the sediment on the seabed”.

So every night, in cooperation with the crew member at the bridge Dr. de Haas stays up collecting data from the Pelagia’s multibeam echo sounder while everyone else is sound asleep. The next morning, after checking the data, he is able to create the bathymetric maps that the research team needs to locate mesophotic reefs and cyanobacterial mats around Bonaire and Curaçao. So far, the maps have resulted in some exciting discoveries, notably the presence of deep channels around Curaçao. This was a real surprise as such deep channels are not always common for small islands. As Dr. de Haas concludes, “there is still much to explore here”.

Example of backscatter data: strength of the reflected sound signal of a sea bottom area.

Curaçao is located just above this image. So in this image from top to bottom it becomes deeper. The lighter the gray, the stronger the signal. The light gray, slightly curved tracks from the right corner above towards the left corner below are small channels on the sea bottom. Here the speed of the current is higher than in the surrounding areas (somewhat darker gray). The light color gray indicates that the sediment in the channels is somewhat more sandy (bounces the sound better back) than the more fine-grained sediment in the surrounding area. The round light gray points in the left corner are possibly blocks that have tumbled down from the steep slopes. The black in the right corner above indicates that here no measurements are taken.

Image credit: NIOZ/WUR/UvA
Mapping the Sea Bottom

The colour bar presents the water depth in meters. Horizontal scale: the bottom of the deep channel in the front is about 250 meters wide. It is clear that the sea bottom is not flat and has many deep channels.

Image credit: NIOZ/WUR/UvA

3D image of a sea bottom area around Bonaire.

Difference between a normal echo sounder and the modern version of the echo sounder, the multibeam echo sounder.

Normal echo sounder:
Transmitting one sound pulse at once in a relative large area. One measurement per "ping".

Multibeam Echo sounder:
Transmitting several sound pulses at once in a fan shape in relative small areas. The model installed underneath the Pelagia allows for 432 measurements per "ping".

Image credit: Henk de Haas, NIOZ

BioNews 2018 - Content
Eddies: influence on marine mammals and seabirds

This article was published in BioNews 14.

Rising ocean temperatures associated with global warming are changing our oceans and are projected to have a considerable impact on sea level, ocean acidification, hurricanes and bleaching of coral reefs over the next decades. While sailing from Aruba north to Hispaniola and then east to St. Maarten, the fourth leg of the expedition focused on eddies and their influence on the distribution and occurrence of pelagic megafauna in the Caribbean, more specifically marine mammals and seabirds. Anti-cyclonic eddies typically have surface waters that are 4°C warmer than the surrounding ocean and “form partially isolated environments with distinct physical and chemical conditions” (NIOZ, 2017). Changes in biological activity within them may provide insight as to how global warming will impact these species (NIOZ, 2017).

Eddies – rotating water bodies
Eddies are rotating bodies of water that spawn from meandering, unstable currents, creating a swirling motions in the ocean waters (NOAA, 2017). Mesoscale eddies, which are common in the Caribbean Sea, are large eddies with a horizontal scale of approximately 100 kms and last for several months (van der Boog, 2018; Adcroft et al., 2017; SFSU, 2018). Their impact on the ocean environment is substantial. As the center of eddies contain water with properties that differ from their environment, they are important for the heat and salt transport in the ocean. Depending on their direction of rotation, mesoscale eddies can transport water up or down. In the case of upward transport, this will favor upwelling of nutrients from deeper levels to the surface (SFSU, 2018). Such mesoscale eddies have been described as hot spots of intense biological and physical activity (Michaels, 2007) that can support and transport whole plankton communities (NIOZ, 2017; SFSU, 2018) and help supply nutrients to the surface of the ocean as well as coastal zones (Adcroft et al., 2017). The reverse may be true for eddies that favor downwelling, which is why NICO 4 also sampled for nutrients and biological parameters. Overall, the eddies also have an important role in regulating the weather in the region by transporting heat from the tropics to the poles (Adcroft et al., 2017), and may contribute to the intensification of hurricanes in the Caribbean (van der Boog, 2018). Satellites (SFSU, 2018) can be used to track and study eddies at the ocean surface, but for the eddies in the Caribbean there is very little data about their vertical structure and what underlying processes govern their development (van der Boog, 2018).

Before departure of the RV Pelagia from Aruba, the research team used recent satellite data and ocean model forecasts to chart the circulation in the Caribbean Sea and was able to locate a mesoscale eddy that formed off the coast of Venezuela and moved east towards Aruba. The research vessel then sailed to the eddy and navigated through its center while taking measurements (van der Boog, 2018). Four autonomous floats were deployed inside and outside the eddy, which continued to measure the temperature and salinity of the Caribbean waters. The float data was combined with satellite observations to keep track of the eddy’s location over a few months and to learn more about the differences in water properties between eddies and the ambient waters (Heinsman, 2018b).

Whales and dolphins
To assess the occurrence of pelagic megafauna, the research team used visual surveys as well as passive acoustic monitoring for whales (NIOZ, 2017). Previous studies have found that both permanent physiographic features (ocean depth, seafloor slope) and hydrographic characteristics influence the distribution of prey and therefore pelagic megafauna, however the specific influence...
of eddies on the distribution and occurrence of organisms at a higher trophic level has never been studied (NIOZ, 2017). Visual surveys for whales and dolphins on board the RV Pelagia were difficult especially during rough seas that made it hard to spot anything in the water (Heinsman, 2018a). Fortunately, the sounds that these deep diving marine mammals make can be detected up to 15 kilometers depth with acoustic methods. During the journey from Aruba to St. Maarten the sounds of some sperm whales and probably a humpback whale were recorded (Vroege Vogels, 2018). Also some dolphins were observed that were attracted to the ship and accompanied it for a little while (Heinsman, 2018a)

Seabirds
Throughout the journey from Aruba to St. Maarten, a team of bird experts surveyed the seabird population to assess whether the presence of an eddy affects bird density. Steve Geelhoed and Mardik Leopold, both marine ecologists at Wageningen University, observed a very small number of seabirds and wondered where all the birds have gone (Buiter, 2018). Ruud van Halewijn described a rich bird life for the area in the seventies (Buiter, 2018), however the total number of seabirds spotted was very small and included some brown boobies, a few black-capped petrels and royal terns. What was even more confusing was the plentiful presence of flying fish, meaning that seabirds have an abundant source of food. Geelhoed and Leopold believe that changes on land rather than at sea are to blame, notably the drastic reduction of seabird breeding habitat on the islands to make way for tourism development, as well as an increased presence of introduced predators such as rats, cats and mongoose that are very fond of bird chicks and bird eggs (Buiter, 2018). “In this case”, explains Leopold, “I think we should look not so much at the oceans but at the dramatic changes on the Caribbean islands. The bigger problems for the seabirds seem to play there. “ (Buiter, 2018)

It was not all bad news, though. Geelhoed and Leopold were excited to spot not one but twelve of the very rare and almost extinct black-capped petrel. Only very few remaining colonies for this seabird are known in Haiti and the Dominican Republic, where the population is greatly endangered and hard to study because the petrels breed on steep slopes about 400 to 1200 meters above sea level (Heinsman, 2018). The unexpected discovery shows that in an age of environmental devastation and loss of species, there is still hope.

Eddies: influence on marine mammals and seabirds
During the Northern Caribbean part of the expedition, two research projects (leg 5 and 6) focused on the Saba Bank. Scientists have a special interest in this large submerged carbonate platform because it is still relatively pristine thanks to its remoteness and therefore offers the chance to monitor the effects of climate change in the Caribbean Sea. While a number of research projects have explored the shallower parts of the bank, very little is currently known about the bank’s deep-sea habitats.

The Saba Bank is a large flat-topped seamount rising from a depth of 1.5 km. The upper area of the Saba Bank covers an area of +/- 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 (DCNA, 2017).

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 Koolstra, 2003).

Research expeditions
Van der Land was the first who explored the Bank in 1972. 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 by Wageningen Marine Research and NIOZ Sea Research to assess the state of the fisheries, coral reef health and shark populations (Bos et al., 2016; DCNA, 2017).

Biodiversity Hotspot
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). The Saba Bank was listed as a protected area of regional importance under the SPAW-protocol (Protocol Concerning Specially Protected Areas and Wildlife of the Wider Caribbean) and designated as the world’s 13th Particularly Sensitive Sea Area (PSSA) by the International Maritime Organisation (IMO) in 2012. In the same year it was officially declared a National Park, making it the largest National Park in the Netherlands (DCNA, 2017; DCNA, n.d.).
Exploring the Saba Bank’s Deep Sea

This article was published in BioNews 27.

During the fifth leg of the NICO expedition researchers from NIOZ Sea Research, Wageningen Marine Research and Naturalis Biodiversity Center studied the only deep-sea in the entire Dutch Kingdom: the Saba Bank. While a number of research expeditions have explored the shallow parts of the Bank, very little is known about the Bank’s deep-sea habitats. Researchers on board investigated the deep-sea environmental conditions and took a first look at what creatures can live at these deep dark depths.

After exploring Aruba, Bonaire and Curacao’s mesophotic reefs (i.e. reefs below 30 meter depth), cyanobacterial mats and the cause of their proliferation, mapping the sea bottom and sailing from Aruba to St. Maarten investigating eddies and their influence on the distribution of marine mammals and sea birds, the vessel arrived at the Saba Bank for another 13 days of research.

Exploring the deep waters

Dr. Gerard Duineveld and Dr. Furu Mienis of NIOZ Sea Research were the chief-scientists of the fifth leg of the NICO expedition. Their project focused on the Saba Bank’s deep-water environments (100 meter 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 (Nagelkerke & Duineveld, 2017). Their research area included the northern and southern side of the Bank (van Duin, 2018a).

Moorings

Two thermistor string moorings were placed on the northern and southern side of the Bank, respectively, for hydrodynamic, temperature and turbulence measurements in the first 300 m of the water column above the bottom. Data collected with the thermistors will provide valuable insights on how the topography of the Bank interacts with the currents, creating turbulence and mixing (Duineveld & Mienis, 2018).

Video hopper

Video-transsects of two hours each were made between 40 to 1,400 meters with a tethered video frame equipped with one camera directed to the seabed and one camera directed straight forward. Video footage is displayed live on the ship (van Duin, 2018a; van Duin 2018c) and provided a very first exciting view on what the deep-sea environment looks like and what creatures can live there.

CTD and (core) samples

Along the video transects Conductivity Temperature Depth (CTD) casts were carried out to measure several environmental conditions that are influencing the deep-sea habitats such as salinity and temperature. In addition water samples were taken at different depths throughout the water column. To get a more complete view on biodiversity, geology and chemistry, sediment samples were taken from the seabed with a box corer (Nagelkerke & Duineveld, 2017).

Baited experiments

A specially designed lander (ALBEX-lander) equipped with bait was dropped on the seabed at depths of 450-1,400 meters. The bait attracted species and two cameras and infrared lights made filming possible whilst not attracting organisms or chasing them away. Also two cages with bait were attached to the frame of the lander to trap scavengers. The number and approach time of species were recorded and this together with (water) flow rate will be used to give a first glimpse of species richness and density (Rijn et al. 2018a; 2018b).

(e)DNA

An advanced environmental DNA (eDNA) technique is being used to estimate the species diversity and abundance in the water samples (Speksnijder et al. 2015; Duineveld & Mienis, 2018). Fish and other organisms leave behind DNA (so-called eDNA) in their habitat through faeces, gametes, skin cells, etc., and researchers are now able to isolate this DNA from environmental samples (water, soil), amplify and then sequence it to identify the taxonomic identity of the species by their DNA fingerprints (Littlefair et al., 2017).

Bottom trawling and DNA analysis

Lastly, species were collected by bottom trawling. All collected species will be identified, individually DNA fingerprinted and submitted to Naturalis’ Biodiversity collection (Beentjes et al. 2015). A DNA fingerprint reference library for the Saba Bank’s deep marine habitats will also be made (Speksnijder & Pracht 2018). In addition fauna will be used to analyze the food web of the deep flanks of the Saba Bank.

First findings

Although the large collected dataset is still being analyzed, the researchers kindly shared already some interesting first findings about the Saba Bank’s deep sea.

Seabed

The seabed seems to be dominated by soft sediment suitable for endofauna and epifauna such as sea urchins, sea cucumbers and starfish (Duineveld & Mienis, 2018; van Duin, 2018b). Areas with hard substrates provided also habitat for corals and sponges (van Duin, 2018b).

This image shows Saba Bank’s seabed between 400-700 meters depth that was filmed with the video hopper. In the middle you can see two laser lights 30 cm apart that are used to determine the size of species. This photo shows five sea urchins (top left), a fish (middle) and a sponge. Credit: NIOZ Sea Research
What creatures can live in the deep dark depths?

The researchers recorded shrimps, congers of up to two meters long and sharks. Also impressive were the giant isopods (Bathynomus) of more than 10 cm that are related to the woodlouse (pill bug).

All collected data are taken to the Netherlands for further analysis and we will know in the coming time which species new to science have been discovered. As the scientists investigated for the first time the only deep-sea habitat of the Kingdom of the Netherlands, many species that they found are likely first records for our country (van Duin, 2018b).

Spatial differences

First observations show spatial differences in fish densities. The baited videos show e.g. larger numbers of snappers in the relative shallows on the southern side. It was also found that the steep southern slopes have a higher biodiversity than the northern slopes especially between 100 and 500 meters depth (van Duin, 2018a).

The water around the Saba Bank seems more productive than the water on top of the Bank concluded from the observed algae densities (van Duin, 2018a). This is an important finding as the deep-sea is dependent on this primary productivity. Future research is needed to reveal the relationship between the top of the Saba Bank and it’s surrounding deep waters to understand the functioning of the complete ecosystem (van Duin, 2018b).

Check out this video to see the Saba Bank’s deep depths:
https://www.youtube.com/watch?v=GoLaNmRlIko
Researchers aboard the Pelagia research vessel have been collecting invaluable data on the Windward islands in the Caribbean during the sixth leg of the “Netherlands Initiative Changing Oceans (NICO)” marine expedition organized by the Royal Netherlands Institute for Sea Research (NIOZ Sea Research) and NWO-Science (ENW). They mapped for the first time the seabed of the windward sides of Saba and St. Eustatius and further investigated what is believed the richest biodiversity area in the entire Dutch Kingdom: the Saba Bank.

Studying the Windward Islands

Fleur van Duyl (NIOZ Sea Research) and Erik Meesters (Wageningen Marine Research (WMR)) were the chief scientists of the sixth leg of the NICO expedition. An advantage was that their research team gained already much experience from previous expeditions to the Saba Bank.

Saba Bank

The Saba Bank is a submerged carbonate platform rising from a depth of 1.5 km. 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. Since 2011 several research expeditions by WMR and NIOZ Sea Research took place to assess the state of the fisheries, coral reef health and shark populations (Bos et al., 2015; DCNA, 2017).

Growing or eroding?

Saba Bank’s coral reefs have suffered as well in recent decades from elevated seawater temperatures induced by global warming which resulted in Caribbean-wide bleaching events. During the bleaching event in 2005 the Saba Bank lost over 50% of its coral cover. In combination with ocean acidification and increased marine pollution, these environmental changes have reduced the capacity of corals to compete with other benthic organisms such as algae, cyanobacteria and sponges which can rapidly invade dead or weakened coral surface (Webb et al., 2018). The research team aims to understand the interaction between the environment and coral reef functioning and determine if and how a community shift changes the balance between calcium-carbonate accretion and eroding processes. In other words: Is the Saba Bank growing or eroding and which factors can explain these processes?

The carbonate budget

To answer these questions, different experiments and (long-term) measurements were taken by NIOZ Sea Research and WMR since 2011. During the NICO expedition the research team further investigated the carbonate budget –that is the coral growth (carbonate production) versus coral break-down (carbonate erosion) budget of the overall Saba Bank (Webb et al., 2018). To do so, they measured the chemistry of the seawater overlying the reef (including dissolved inorganic carbon concentrations and alkalinity, nutrients, phytoplankton, virus, salinity and oxygen levels) with CTD units and a new type of water sampler called Pumpy which can take simultaneous measurements from 2m to 10 cm above the bottom. The method is based on the principle that coral growth (calcium carbonate production) locally extracts dissolved carbon from the seawater surrounding the coral. On the other hand, bio-eroding organisms such as sponges and worms break down the coral’s carbonate skeleton which results in carbon release into the seawater. The measured dissolved carbon concentrations in seawater above the reef provides information on the overall reef growth/erosion rate and allows to quantify spatial and temporal variations (Webb et al., 2018).

Different benthic communities

On the Bank the chemistry dynamics were measured at seven stations with different reef habitat types including coral-, macroalgae-, crustose coralline algae (CCA) - and sand dominated communities located between 15 and 34m depth. The researchers further investigated the benthic-pelagic (seabed-ocean water) coupling of the different benthic habitats by taking measurements on organic matter (bio)deposition, mineralization, marine microbe community and oxygen dynamics in the benthic boundary layer (van Duyl and Meesters, 2018). This will provide insights in the processes influencing the community shifts from corals and CCA to more fleshy algae, cyanobacteria and benthic suspension feeders.

Mapping the seabed

Maps of our marine environment provide important information on the location of different ecosystems and help to identify areas of high conservation value. The remote windward sides of Saba and St. Eustatius have not been mapped before. The research team mapped for the first time the largely unknown benthic communities and bathymetry (topography of the seabed) on the windward sides with video transects and the multibeam echo sounder. Because of its high exposure the ecosystems here mostly thrive in the mesophotic region (more than 30 meters depth). Also the researchers expanded the mapping of different habitats (from 10 until 100m depth) and bathymetry on the Saba Bank with the aim to link the benthic habitat descriptions that result from the mapping to benthic metabolism (van Duyl & Meesters, 2018).
First findings

Hidden landscapes

The total of 25 km of photos and videos that were recorded on the Windward Islands show a large variety of habitat types including areas with patches of seagrass and coral-, algae- and (volcanic) sand dominated communities (van Duyl & Meesters, 2018).

Very excited were the researchers about the first journey of exploration into two deep sinkholes at the northern part of the Saba Bank called the Luymes Bank. The large holes in the carbonate bottom have been created during periods that the bank was above sea. These holes range from 100m to several kilometers in diameter and are 100-300m deep.

The researchers sent video equipment down these sink holes. At the bottom a mysterious landscape was encountered: a large community of calcareous algae that consists of thousands of little pillars that are between hundred and thousand years old (van Duyl & Meesters, 2018; Heinsman, 2018).

Healthy reefs

The researchers also discovered an extreme healthy reef in the southern part of the Saba Bank at 30 meters depth. A hopeful finding that there are still healthy reefs thanks to the Saba Bank’s remote location. For safeguarding Caribbean reefs action is urgently needed. Local stressors have been identified as the most significant drivers of reef degradation throughout the Wider Caribbean, particularly overfishing, introduced species, coastal development and pollution associated with increases in tourism visitation and local populations (Jackson, 2014). With effective conservation measures in place and management of the island’s marine resources in the hands of dedicated professionals, there appears to be good prospects for their survival particularly if there is a political willingness to continue to protect them from harm.

The need to increase the resilience of our coral reefs has never been more pressing. Coral reefs are marine biodiversity hotspots that are not only invaluable for coral protection but also have a high economic value through associated tourism and fisheries. The Dutch Caribbean islands are particularly dependent on the health of the coral reefs due to our economic dependence on nature-based tourism.

Mapping and Studying Changing Coral Reefs: Is the Saba Bank still growing?
TERRESTRIAL BIODIVERSITY

Photo by: © Christian König
Bonaire Caves and Karst Nature Reserve

Bonaire has a rich and complex geological history which is reflected in its current geological landscape. While the core of the island is comprised of volcanic rocks, the coastline and north of the island are made up of limestone formations such as coral-rubble beaches and limestone cliffs (de Buisonjé, 1974). Centuries of water erosion on these cliffs has resulted in extensive freshwater and marine karst (limestone) complexes with extensive caves systems. The majority of the island’s estimated 200 caves are either hard to access or submerged, but several caves are open to the public with little supervision or management (Tourism Bonaire, 2018). As a result, the many important ecological, cultural and historical values of the caves are threatened by unregulated visits and illegal activities such as vandalism and waste dumping.

Thanks to generous funding from the Ministry of Agriculture, Nature and Food Quality (LNV) through the Nature Fund, Bonaire is seeing the establishment of its first caves and karst nature reserve, the “Bonaire Caves and Karst Nature Reserve”. As a pilot project, a 30-hectare cave park is being created in Barkadera due to the high density of caves and sinkholes in the area. (Simal, 2016). The two-year project, which began in the summer of 2017, is a partnership between WILDCONSCIENCE, Openbaar Lichaam Bonaire (Public Entity Bonaire) and The Caribbean Speleological Society (CARIBSS) with the goal of providing “optimum protection and management for the natural, cultural, recreational and scientific values contained in the Bonaire Cave System” through activities in cave management, bat scientific research and education (Simal, 2016).

Bonaire’s karst and caves are extremely valuable natural resources with a rich variety of plants and animals. They typically host unique ecosystems that provide a habitat for unique species; several endemic species of shrimp, fish and brotolas with special adaptations are known to occur exclusively in Bonaire’s caves (Simal, 2016). The caves are an especially important habitat for five of the island’s species of bat, which in turn play a key role in maintaining the island’s biodiversity. Two of Bonaire’s nectar-eating bat species (Leptonycteris curasoae and Glossophaga longirostris) are highly inter-dependent with columnar cacti and agaves. They rely upon the cacti and agaves for food resources, and these plant species in turn rely upon the bats for pollination services and for some seed dispersal (Simal, 2016). The three insectivore cave-dwelling species of bat (Mormoops megalophylla, Myotis nesopolus and Natalus tumidirotris) help control the island’s insect population, notably mosquitoes.

Photo by: © Sophie Zeegers

This article was published in BioNews 14.
Some of the caves have great cultural and historical value due to the ancient inscriptions preserved in them. Rock paintings and petroglyphs have survived at the caves at Spelonk, Onima, Ceru Pungi, and Ceru Grita-Cabai. Many also have impressive speleological formations that are of great interest to both geologists and visitors. While several positive measures have recently been taken to protect and manage the island's caves (e.g. inclusion of caves in the ROB in 2010, the new Nature Ordinance, covenant between local government and the cave tour operators), there is currently no proper management of cave tourism due to a lack of capacity and funds (Simal, 2016). The many values of the caves are threatened by invasive species of fauna and flora as well as unsupervised visits and explorations that do not respect the caves’ fragile ecosystem and carrying capacity (Simal, 2016).

One of the main goals of the “Bonaire Caves and Karst Nature Reserve” project is to significantly improve cave tourism on Bonaire, reducing the impact of visitors as much as possible, especially in the bat maternity caves, while giving them an upgraded and educational experience. The project aims to make cave visits and tours “controlled, safe, educative, non-damaging and non-disturbing” (Simal, 2016). The park is set to have approximately 30 caves open to visitors to avoid overcrowding and make sure cave tourism is sustainable. “One of the most important things that we will be doing” explains Fernando Simal, project leader of the Bonaire Caves and Karst Nature Reserve project and co-managing director of WILDCONSCIENCE “is classify the caves of the park accordingly to their fragility and values. In this way we can designate them on categories that will indicate if they can be accessed freely, only under the supervision and leadership of a certified cave guide and during which periods of the year this will be possible”. In order to ensure that visits are well guided and controlled, CARIBSS will offer a “Bonaire dry cave guide certification course”. During the course guides will be trained on such things as adequate emergency response protocols, proper caving techniques and safety procedures (WILDCONSCIENCE, 2018).

A key focus of the Bonaire Caves and Karst Nature Reserve is the education of visitors, from safety to the many different values of the caves and surrounding habitat. Approximately four kilometers of walking trails are currently being built, with the trails connecting some caves and sinkholes. The trails will have nature interpretation signs that feature the geology, flora and fauna of the surrounding limestone terraces. Signage will also highlight and explain the different values of the caves, and easy to read cave maps will showcase the different levels of difficulty, access restrictions and safety indications. Guides, having completed the certification course, will be equipped with the knowledge to provide visitors with information about the ecological and historical importance of caves.

Approximately 2.8 kms of fencing will surround the park to keep invasive herbivores away (feral donkeys, goats, sheep and pigs) and give native vegetation a chance to recover from decades of overgrazing (Simal, 2016). Existing waste is also being cleaned up. On five other caves outside the park, motor vehicles will not be permitted within 100 meters of the caves to reduce illegal waste dumping.

Another chief goal of the Bonaire Caves and Karst Nature Reserve is to ensure the protection of five keystone species for the island and their ecological interactions: two species of nectar-feeding bats (Glossophaga longirostris and Leptonycteris curasoae) and the three species of candle cactus that they pollinate. “Bat-plant mutualistic interactions are vital for sustaining life in arid and semi-arid ecosystems” explains Fernando Simal, “The protection of this ecological interaction will benefit the entire trophic web that depends on it, which includes many species of terrestrial birds, reptiles and invertebrates.”
Bats rely heavily on caves as diurnal and maternity roosts. The caves that serve as maternity roosts are especially vital to the survival of the island’s bat population and must therefore receive special protection. The Bonaire Caves and Karst Nature Reserve at Barkadera will include two of the island’s five most important maternity chambers, where at least three of Bonaire’s cave-dwelling bat species are known to complete their life cycle, including pregnancy and lactation (Simal, 2016). These maternity chambers will be fully protected with physical barriers and information signs. Research is also being conducted to understand the temporal patterns of use at a new maternity cave located at the southeast of the island by the insectivore species *Myotis nesopolus* and *Natalus tumidirostris*.

The Nature Funded Bonaire Caves and Karst Nature Reserve is the first part of what is hoped will become one of the Caribbean’s best managed and protected cave parks. Next on the horizon is the application for SICOM (Site of Importance for Bat Conservation) status for the maternity caves of *Myotis nesopolus* and *Natalus tumidirostris*, which will be used as a tool to provide legal protection for the caves (Simal, 2016). To support this application, CARIBBS will be creating maps of the caves and carry out research to estimate population size, the yearly pattern of roost use and the life cycle of species. Relative abundance of the species will be estimated by setting harp traps and/or mist nets at the exit of this newly investigated cave (Simal, 2016).

Would you like to stay up-to-date?

You can follow all the Nature funding projects on Bonaire on Facebook @NTBDN and website https://bibadinaturalesa.com.

Check also NTBDN TV: https://bibadinaturalesa.com/nos-ta-biba-di-naturalesa-tv/
In 2015, Naturalis Biodiversity Center set out to create a baseline study of St. Eustatius’ marine and terrestrial fauna and flora. Marine studies were done in collaboration with Anemoon Foundation and terrestrial studies in collaboration with Naturalis, the Dutch Mammal Society, RAVON, EIS and Leiden University. Prior to this effort, the biodiversity of the island had been poorly investigated. One of the many exciting finds of the terrestrial exploratory expedition was the discovery of a new species of bat for the island, the Insular Single-leaf bat (*Monophyllus plethodon*), which was found on the edge of The Quill’s crater. Bats may not be the most conspicuous of animal species in the Dutch Caribbean, however they have a very important ecological niche. Nectar-eating bats are key pollinators of a number of native plant species, and fruit-eating bats assist with seed dispersal. As part of an ongoing study of the chiropteran (bat) fauna of the Lesser Antilles, American and Dutch bat specialists combined their findings to provide the first-ever comprehensive assessment of St. Eustatius’s bat population. The results of the study were recently published by Pedersen et al. (2018) in the Occasional Papers of the Museum of Texas Tech University (Number 353, March 13th 2018).

Over the course of several years, both the US and Dutch researchers set out mists nests around St. Eustatius and identified a total of five bat species for the island: Insular Single-leaf bat (*Monophyllus plethodon*), Antillean Fruit-eating bat (*Brachyphylla cavernarum*), Jamaican Fruit-eating bat (*Artibeus jamaicensis*), Antillean Tree bat (*Ardops nichollsi*) and Pallas’s Mastiff bat (*Molossus molossus*). The Brazilian Free-tailed bat (*Tadarida brasiliensis*) is listed as a provisional species as there is record of it within the literature but no live specimen was found during the course of the study. Of great concern to the researchers is how impoverished and unbalanced St. Eustatius’s chiropteran fauna is compared with nearby islands that boast an average of 8 to 10 bat species. Pedersen et al. (2018) believe that the clearing of the island’s vegetation for agriculture and charcoal production since the 19th century has resulted in chronic environmental degradation and a lack of habitat diversity. This, in turn, has resulted in lack of diversity of the bat fauna in favor of those species that are more adaptable. St. Eustatius’s three most abundant bat species - *Molossus molossus*, *Artibeus jamaicensis* and *Brachyphylla cavernarum* - have a broad environmental tolerance and are “capable of living in habitats that are heavily impacted by human activity and natural disasters”. The other two species, *Ardops nichollsi* and *Monophyllus plethodon*, require much more specialized habitats and are classified by Pedersen et al. (2018) as rare to very rare on the island.
Bats are the only non-introduced mammal species present on St. Eustatius. Goats and cats were brought to the island by humans during colonization and have had a devastating impact on the native bat population. Predatory species such as cats and dogs prey directly on bats; in fact, cats were observed pulling bats out of mist nets during this research project. The uncontrolled grazing of feral livestock is preventing native trees that provide food and shelter to bats from maturing. In some cases, invasive species have outcompeted native plants that are an important food source for the bats. Fruit- and pollen-feeding bats depend upon a diverse collection of tree species providing a year-round supply of fruit, pollen, and nectar.

The active management of the Quill/Boven National Park will allow the island’s bat populations to rebound in the future. The park’s forests are protected and provide roosts, protection and food resources for the bats. In order to further protect St. Eustatius’s chiropteran fauna, Pedersen et al. (2018) recommend the protection of all caves and rock shelters as well as man-made equivalents of these such as mines and wells. Many of the island’s bat species use caves as day roosts as well as a refuge during storms and hurricanes.
New Bird Records for Bonaire 2016-2017

By Peter-Paul Schets. This article was published in BioNews 11.

The island of Bonaire has achieved worldwide recognition for its rich and diverse marine life, but the island is rapidly gaining momentum as a birdwatcher's paradise. Recent estimates put Bonaire's bird population at more than 210 species, with a great variety of terrestrial and sea bird species. While some species reside year-round on Bonaire, many are migratory species that stop on the island on route to or from North and South America.

The island acts as a sanctuary for many rare or endangered bird species, such as the Yellow-shouldered amazon (Amazona barbadensis), known locally as the "Lora". Birdlife International has identified six International Bird Areas (IBAs) on Bonaire: Washington-Slagbaai National Park, Dos Pos, Washikemba-Fontein-Onima, Klein Bonaire, Lac Bay and Pekelmeer Saltworks (see table 1). IBAs are areas recognized as globally important for the conservation of bird populations according to a number of set criteria. Bonaire's IBAs provide vital breeding and foraging grounds to species with a high conservation priority. Dos Pos, in the north of Bonaire, is an especially important breeding and roosting site for the yellow-shouldered amazon, along with Washikemba-Fontein-Onima. Gotomeer and Pekelmeer provide vital breeding grounds for the Caribbean flamingo (Phoenicopterus ruber), Bonaire's flagship bird. Globally and regionally important numbers of tern also nest at Pekelmeer (Common tern (Sterna hirundo), Sandwich tern (Sterna sandvicensis), Least tern (Sterna antillarum)). Klein Bonaire is also an important breeding site for terns, notably least terns. Lac Bay supports many shorebird species, including seven species of heron.

Over the past two years - from January 2016 to the end of 2017 – at least eight bird species have been recorded for the first time on Bonaire. One other species awaits final identification. The record of a 10th species could not be validated due to a lack of footage. This article describes these first records. The discovery of new bird species for the island is extremely exciting and shows that there is still much to discover about Bonaire's biodiversity.
New Bird Records for Bonaire 2016-2017

1. Lesser black-backed gull (Larus fuscus)
   Plaza Resort Bonaire
   On January 6th 2016 Peter-Paul Schets took pictures of a first year Lesser black-backed gull. The bird was resting on a small raft at Plaza Hotel, close to the beach, amidst a number of Laughing gulls, Royal terns and Brown pelicans. This species had been recorded several times on Aruba but so far never on Curaçao and Bonaire. Schets saw the same bird that week on two more days, on different places. Later it became evident Bonaire resident Sipke Stapert had photographed this bird already in December 2015 at Pekelmeer (see Birds of Aruba, Bonaire and Curaçao by J.V. Wells and A. Childs Wells, 2023).

   The Lesser black-backed gull breeds in Europe but can be found in North America year-round, with some going as far south as the Caribbean. It nests in colonies on the ground or occasionally on cliff ledges and even on the rooftops of buildings. Its diet is omnivorous and includes fish, eggs, rodents, berries, seaweed and insects (Kaufman, 1996). As its name suggests, this medium-sized gull has a dark grey back, as well as insects (Neotropical Birds Online). Nests are built by both the male and female on tree branches near or above the eyes (Wildscreen Arkive, 2018). Males are very territorial and will vigorously defend their nesting areas in search for food (del Risco et al, 2011).

   By January 6th 2016, Schets found a Pied water-tyrant at Sewage plant. The last record made was on May 8th 2017 by Herman Sieben. Intriguingly, photos made by Schets on April 23rd 2017 clearly show a male Pied water-tyrant, which means more than one bird was spotted.

   The Pied water-tyrant is a common resident bird in northern South America and occurs on Trinidad as well. This small flycatcher species inhabits marshy wetlands and mangrove swamps where it feeds on insects (Neotropical Birds Online). Nests are built by both the male and female on tree branches near or over water. Adults are white with a contrasting black nape, back, wings and tail. Females often have brown mixed with the black (Farnsworth & Langham, 2018).

2. Pied water-tyrant (Fluvicola pica)
   Sewage plant
   While birding after a working day on January 8th 2016, Schets found a Pied water-tyrant at Sewage plant. This was the first record of this species for the ABC-islands. A snippet in BioNews (January 2016) was dedicated to this record. This bird was seen by various birders until the end of March 2016. Most often it was feeding in one of the dead trees in the biggest pond of Sewage plant.

   Quite surprising, on January 14th 2017 visiting birder Marco Tij recorded a Pied water-tyrant at exactly the same spot. His pictures show a bird with a brown back, indicating a female. Again several birders saw this species during the first months of 2017, all at the same pond of Sewage plant. The last record made was on May 8th 2017 by Herman Sieben. Intriguingly, photos made by Schets on April 23rd 2017 clearly show a male Pied water-tyrant, which means more than one bird was spotted.

   The Pied water-tyrant is a common resident bird in northern South America and occurs on Trinidad as well. This small flycatcher species inhabits marshy wetlands and mangrove swamps where it feeds on insects (Neotropical Birds Online). Nests are built by both the male and female on tree branches near or above the eyes (Wildscreen Arkive, 2018). Males are greater than females and have only during breeding season a distinct V-shaped patch on their yellow chest. Throughout the breeding season, males are very territorial and will vigorously defend their nesting and foraging grounds from other males (Wildscreen Arkive, 2018).

3. Dickcissel (Spiza americana)
   LVV terrain near the Sewage plant
   Just after arrival on Bonaire on October 2nd 2016, Schets went to the LVV fields next to Sewage plant to see if there were any migrating birds. Apart from Fork-tailed flycatchers, Caribbean martins and a Prothonotary warbler he found two Dickcissels. This species, a migrant from North America, had been recorded several times on Aruba and Curaçao but so far never on Bonaire. On October 4th, Schets recorded another three Dickcissels at Sewage plant and six months later (5 April 1st 2017), Sieben took a picture of one Dickcissel at the same location.

   The Dickcissel is a sparrow-like bird that inhabits grassland habitats where it forages for seeds and insects. While most Dickcissels congregate in huge flocks in migration and on their tropical grassland wintering grounds, some individuals venture far from their normal range (Kaufman, 1996). Both sexes have a grayish head with a white chin and yellow stripe above the eyes (Wildscreen Arkive, 2018). Males are larger than females and have only during breeding season a distinct V-shaped patch on their yellow chest. Throughout the breeding season, males are very territorial and will vigorously defend their nesting and foraging grounds from other males (Wildscreen Arkive, 2018).

4. Oilbird (Steatornis caripensis)
   Kralendijk
   The discovery of an Oilbird on the night of January 4th 2017 was spectacular. While having dinner at a restaurant in Kralendijk, Lauren Schmalz and Quirijn Coolen saw it flying to and from a palm tree. It appeared for several consecutive nights in the same garden, feeding on palm nuts. The Bonaire Reporter published an article, including a great picture, on this exciting record.

   The Oilbird is a nocturnal bird that lives in the South American mainland and on Trinidad. This species was only seen once before on the ABC-islands, namely in 1976 on Aruba. It is reddish-orange in color with white-spotted plumage, big eyes and a small but heavily hooked bill (del Risco et al, 2011). Throughout the day, the Oilbird hides in large numbers in dark caves. It uses echolocation to navigate in the dark. It is a frugivore and consumes lipid-rich fruit primarily from the laurel (Lauraceae), torchwood (Burseraceae), and palm (Palmae) plant families (del Risco et al, 2011), and will travel quite far from its cave to forage. Some Oilbirds are known to migrate seasonally away from breeding sites in search for food (del Risco et al, 2012).
New Bird Records for Bonaire 2016-2017

5. Greater ani (Crotophaga major)
   Sewage Plant

While birding at Sewage plant on January 13th 2017, Marco Tjoj found two Greater ani’s, the first for Bonaire. He was able to take pictures and submitted these to observation.org. These two birds were recorded for several months until mid-May and then again from the middle of August. The last record so far was on October 16th 2017 by Sieben. This species had already been recorded on Aruba (first in 2005) and on Curaçao (first in 2010).

The Greater ani is widespread in South America, where it inhabits forested habitats close to water, including mangrove swamps (Riehl, 2010). It is a seasonal migrant. It primarily eats terrestrial insects as well as small lizards and frogs. It is also known as the “Black Cuckoo” due to its glossy blue and black color. It has a distinct long tail and massive ridged black bill (Neotropical Birds Online). They are very social ani-... 56 57 58 59 60 ...

6. Smooth-billed ani (Crotophaga ani)
   Sewage Plant

In the same month of January 2017 Sieben recorded several anis (Crotophaga) at Sewage plant which looked slightly different from the resident Groove-billed ani. On January 21st he took pictures of several birds and submitted them to observation.org as possible Smooth-billed ani. Schets was on the island in February 2017 and while birding at Sewage plant on February 6th he heard an ani calling like an Eurasian curlew. This had to be one of the birds Sieben had photographed a couple of weeks before. There were without doubt several birds involved, but due to the difficulty in identifying this species on appearance only, it is hard to tell how many. This species was recorded by several birders and the call was recorded by Sieben. Last observation so far was in May. As Groove-billed ani is a rather common resident bird at Sewage plant, this means all three species of ani were present at Sewage plant during the first five months of 2017. First record of a Smooth-billed ani on the ABC islands was only in February 2016 on Aruba.

The Smooth-billed ani is widespread in central and South America and also occurs in southern Florida and on several islands in the Caribbean, including the Greater Antilles. Smooth-billed anis inhabit a variety of brushy or semi-open habitats in the lowlands, mainly in humid scrub and forest clearings (Kaufman, 1996). They forage on the ground and in trees and shrubs for insects, lizards, frogs and some fruit (Cornell Lab of Ornithology, 2015). They are very social ani-... 56 57 58 59 60 ...

7. Prairie warbler (Setophaga discolor)
   Sewage Plant

Sewage plant produced another new species for Bonaire on October 24th 2017, namely a Prairie warbler. This species had so far never been found on Bonaire, but has been recorded several times on Aruba and once on Curaçao. Schets found this bird while searching for warblers. The bird was rather restless and mostly moved behind branches and leaves, so it was not possible to take its picture. Schets found it back at the same spot exactly one week later and this time was successful in taking some pictures, although poor, of this male Prairie warbler.

The Prairie warbler breeds in loose colonies in eastern North America and many winter in the West Indies during the non-breeding season. Despite its name, the small warbler inhabits scrubby fields and forests (Cornell Lab of Ornithology, 2015). It feeds on insects such as caterpillars and beetles, spiders, small invertebrates as well as some berries. Female Prairie Warblers often consume the eggshells after their young hatch (Cornell Lab of Ornithology, 2015). The Prairie warbler is currently listed as Least Concern in the IUCN Red List of Threatened Species but it is declining through-... 56 57 58 59 60 ...

8. Black vulture (Coragyps atratus)
   Sorobon

On November 4th 2017 Martijn Hickmann, who works for a diving company on Bonaire, recorded the first Black vulture for this island at Sorobon, near Fisherman’s pier. He saw it flying as well as perched on several occasions during a period of several weeks. In this period, Henrie de Rijke took some pictures of this bird while it was foraging at a landfill at Lagun. After circa two weeks, it was no longer seen (pers. comm. Martijn Hickmann). In December 2017 a Black vulture was again spotted on Bonaire by Elsmarie Beekenboom at Dos Pons and Lagun. From November 2016 onwards two Black vultures have been regularly spotted on Curaçao. It is possible that the Black vulture spotted on Bonaire came from Curaçao.

The Black vulture is widespread in northern, central and southern America, notably on disturbed, agricultural and open areas (Neotropical Birds Online). Adults have a black plumage with white patches under the wingtips, a strongly hooked bill and a small bare grayish head (Neotropical Birds Online). Juveniles, as spotted on Bonaire, have a predominantly brown plumage. It roosts in trees and structures like transmission tow-... 56 57 58 59 60 ...

Photos 5,6 & 7 by: © Peter-Paul Schets
Photo 8 by: © Caren Eckrich (STINAPA)
Possible New Species

Cory's/Scopoli's shearwater (Calonectris borealis/diomedea)

Less than two weeks after finding the first Black vulture for Bonaire, Martijn Hickmann recorded a seabird in bad condition at Lac. The bird was floating on the waters of Lac and was hardly able to fly. The next day, November 18th 2017, Martijn and a colleague caught the bird and brought it to Elly Albers who runs a bird hospital on Bonaire. Unfortunately the bird died a few days later. Experts examined pictures of it but are not certain about its identity: probably a Cory's shearwater but Scopoli's cannot be excluded (formerly these birds were considered as one species). Elly put the corpse in a freezer; future analysis of it will hopefully lead to its final ID.

American bittern (Botaurus lentiginosus)

On December 12th 2016 visiting birder Arjan Ovaa recorded a bird at Sewage plant which he identified as American bittern. He saw the bird only for a few minutes in the middle of the day and could not relocate it that evening. His description of the bird suggests that the bird was an American bittern but unfortunately he was unable to take a photograph of it to validate his description. If he was in fact right, this would have been a first for the ABC-islands. American bittern is a bird from Northern America. Its relative from South America, Pinnated bittern (B. pinnatus), has so far been observed on the ABC-islands only once, in 1972 on Aruba.

New Bird Records for Bonaire 2016-2017

Records and pictures of these new birds species for Bonaire can be checked at: www.bes.observation.org

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Left Photo (Cory’s Shearwater): © Artie Kopelman
Right Photo (American Bitter) by: © Mary Keim
Table 1: Important Bird Areas (IBAs) of Bonaire (source: Wells & Debrot, 2008).

<table>
<thead>
<tr>
<th>Area</th>
<th>Key Features</th>
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| Washington-Slagbaai National Park   | • Significant nesting, roosting, and foraging area for the Yellow-shouldered amazon parrot (Amazona barbadensis).  
• Important nesting area for globally significant numbers of Common tern (Sterna hirundo), and regionally important numbers of Sandwich tern (S. sandvicensis) and Least tern (S. antillarum).  
• Regionally important concentration of Caribbean flamingo (Phoenicopterus ruber).  
• Important habitat for a number of restricted-range species as well as several endemic subspecies. |
| Dos Pos (AN010)                     | • Important breeding and roosting site for the Yellow-shouldered amazon parrot.  
• Significant habitat for Neotropical migrant passerines.  
• Small pond supports waterbirds, including the Caribbean coot (Fulica caribaea).  
• Significant habitat for two restricted-range species: Caribbean elaenia (Elaenia martinica) and Pearly-eyed thrasher (Margarops fuscatus). |
| Washikemba–Fontein–Onima            | • Important breeding and roosting site for the Yellow-shouldered amazon parrot.  
• Important habitat for the Caribbean coot.  
• Coast is regionally important for breeding Least tern. |
| Klein Bonaire (AN021)               | • Stop over point for countless species of migratory wetland birds.  
• Important breeding site for terns, notably regionally important Least terns.  
• Significant for the restricted-range species Caribbean elaenia and the Northern South America biome species Bare-eyed pigeon (Patagioenas corenna). |
| Lac Bay (AN033)                     | • Important habitat for breeding and wintering shorebirds and seabirds.  
• Important feeding area for seabirds, including the Magnificent frigatebird (Fregata magnificens), Osprey (Pandion haliaetus), Brown pelican (Pelecanus occidentalis) and gulls (Laridae sp.).  
• Important roosting area for seven species of heron. |
| Pekelmeer Saltworks (AN044)         | • Supports one of the most important nesting colonies of Caribbean flamingo in the Caribbean.  
• Important feeding area for pelicans, herons and various migratory shorebirds that breed in North America.  
• Globally important numbers of Common tern and regionally important numbers of Sandwich tern and Least tern nest here.  
• Only known nesting area on Bonaire for the Royal tern. |

New Bird Records for Bonaire 2016-2017
Aruba Shoco Conservation Project

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The Dutch Caribbean Islands are a treasure trove of rare and endemic (sub) species. Island endemic (sub) species, that is (sub) species restricted to just one island, are especially vulnerable to extinction due to their narrow geographical range, small population size and need for specialized ecological niches (Isik, 2017). Therefore, they “must be given priority and monitored and managed carefully in an effort to promote genetic conservation” (Isik, 2017). Aruba’s most famous bird, the Aruban burrowing owl (Athene cunicularia arubensis) - locally known as Shoco - is endemic to the island and an important part of the local culture. A recent study by Rose Garrido found that the owl is very much loved by locals and a source of pride (Peterson, 2018a). The Shoco population has however declined considerably over the past few decades due to an increase in anthropogenic pressures. This subspecies of burrowing owl is now at a pivotal moment: if no further actions are taken to protect it, the Shoco will likely become extinct. However, the right conservation actions could help the population recover.

The Aruban burrowing owl is an endemic subspecies of burrowing owl, however David Johnson of the Global Owl Project after having given a workshop on Shoco conservation in Aruba believes that chances are significant that the Shoco is now a completely different species of owl that is unique to the island (BonDia24, 2018). This species of owl is small with large round yellow eyes, prominent white eyebrows and unusually long grey legs. Aruba is the only country within the Kingdom of the Netherlands that has burrowing owls. Burrowing owls get their common name from their unusual habit of nesting underground in already dug-out burrows, but the Aruban Shoco is known to dig its own burrows. When the breeding season is over, the owls continue to use the burrows to rest during the day. Aruban burrowing owls are typically seen in and around their burrows in the morning and evening hours. During the warmest time of the day they remain in their burrow or sit in shady spots near their burrows. They mostly hunt at night and will take rodents, lizards, small snakes, small young birds and insects.

A survey of the Aruban burrowing owl population, which dates back to 1999, found that the island is home to approximately 200 pairs. This number is of great concern to David Johnson of the Global Owl Project, who considers the Shoco now to be critically endangered. It is likely that the population has since decreased further in light of the island’s land development and resulting habitat destruction, as well as due to free roaming dogs and cats, rats and the invasive boa constrictor. The experts of the Global Owl Project now believe that a negative shift of just about 10 to 15% in their numbers could lead to the collapse of Aruba’s Shoco population (Aruba Birdlife Conservation, 2018a). Regrettably, but justifiably so, it is feared that the island’s burrowing owl will follow the same path as other bird species that have already gone lost to Aruba’s landscapes, such as the Yellow-shouldered Amazon Parrot (Lora or Amazona barbadensis), the Scaly-naped Pigeon (Patagioenas squamosa) and the Rufous-collared Sparrow (Zonotrichia capensis).

While the Aruban burrowing owl population receives some form of protection through its listing in Appendix II of CITES, the efforts and capacity by Aruba’s government to setup and implement a comprehensive conservation plan to prevent the Shoco’s extinction have been seriously lacking. “Over the years, excessive, unsustainable, government-driven projects and the lack of know-how, goodwill and conservation efforts have been devastating to Aruba’s nature and our Shoco can now be considered critically endangered” (Aruba Birdlife Conservation, 2018a).
Since 2011, Aruba BirdsLife Conservation has been at the heart of conservation efforts to ensure that the Shoco does not go extinct. Thanks to the foundation’s efforts, the Shoco was made one of Aruba’s National Symbols in February 2012 and now appears on Aruba’s postal stamps and currency (Aruba BirdsLife Conservation, 2018b). However, it has been “a very steep up-hill battle to try and prevent this critically endangered endemic sub-species of Aruba from going extinct” (Aruba BirdsLife Conservation, 2018c). In 2014, legislation was adapted in which the Shoco attained protection as such. In 2017 the protected species list helped to fortify the Shoco’s position one step further (Aruba BirdsLife Conservation, 2018b) The island’s terrestrial protected area, Parque Nacional Arikok, has served as an important refuge for the Aruba borrowing owl, and park staff are actively involved in conservation efforts and monitor the owl’s population within the protected area.

While conservation efforts by Aruba BirdsLife Conservation have pathed the way for improved protection of the Shoco, the species is still extremely vulnerable to extinction; ongoing development of the island to accommodate growing tourist numbers has led to a significant reduction in nesting habitat for the owls. For this reason, the foundation has renewed its efforts to protect this owl through the Aruba Shoco Conservation Project. The Aruba Shoco Conservation Project, which was launched in 2017, is a collective effort by Aruba BirdsLife Conservation, The Global Owl Project and Parke Nacional Arikok. Aruba BirdsLife Conservation and Arikok National Park have taken the initiative to get different Government departments involved in the Shoco Conservation Program and invited Veterinary Services, Santa Rosa (LVV), the Department of Nature and Environment (DNM), the Department of Public Works (D.O.W.), the University of Aruba and the Aruba Airport Authority to participate in the first Shoco workshop of Aruba. The Shoko Beer Co., sponsored Aruba BirdsLife Conservation with $10,000 which was rerouted by Aruba BirdsLife Conservation to the park under the condition that the funds be earmarked for the Shoco conservation program.

Aruba Shoco Conservation Project

Photo by: © Aruba BirdsLife Conservation, Greg Peterson
One of the main goals of the Aruba Shoco Conservation Project is to make 100 artificial nesting sites available island-wide to help the Shocos to find safe located and reliable nests. Due to a structural shortage of nesting locations, too often the Shocos end up digging their burrows in heaps of construction sand or too close to dangerous traffic locations. Another main goal of the project is to relocate Shocos that are in high-risk areas to artificial burrows located in safer locations and in some cases within the safety of Parke Nacional Arikok. When the owls are moved, they are first put in a release cage for approximately four weeks to ensure that they will not fly back to their old burrow (Peterson, 2018b). The first two Shoco nests were relocated from Queen Beatrix International Airport last month, on February 20 and 22nd due to the large amount of construction going on there (Queen Beatrix International Airport, 2018). The relocation of the nests occurred under supervision of David Johnson of the Global Owl Project who incorporated these reallocations within the workshop.

Gian Nunes, Research and Conservation Manager of Parke National Arikok, was entrusted by Aruba Birdlife Conservation and Arikok National Park with developing the Shoco conservation program. Earlier in 2017 Gian established contact with David Johnson, director of the Global Owl Project which brought the conservation intentions to a next level. Plans were made to hold a first conservation workshop in Aruba and to train as many locals as possible about Shoco conservation. The workshop was given by two Shoco experts, David Johnson and Prof. Dr. Martha Desmond. David has been involved with owl conservation for over 42 years and the Global Owl Project works in no less than 63 countries. David has constructed over 600 artificial burrowing sites and has banded more than 6,000 burrowing owls throughout the Americas (Aruba Birdlife Conservation, 2018a). The first Shoco banded in Aruba was done by David on February 20th, 2018, at Queen Beatrix International Airport before the bird was relocated to Parke Nacional Arikok. Dr. Martha Desmond from New Mexico State University has a PhD in burrowing owls. Martha is working on setting up student exchange programs with Aruba in order to help with the conservation program. The “Aruba Burrowing Owl Workshop” took place from February 16 to 20th this year and was attended by 23 participants from Aruba Birdlife Conservation, Arikok National Park and from different government departments. The workshop provided educational training on the scientific and conservation management of the Aruban burrowing owl as well as hands on fieldwork, including the creation of artificial burrows. On the last day of the workshop the participants received their “Shoco Conservation Masters” certificate.

Many items are on the agenda of the Aruba Shoco Conservation Project, varying from placement of a large number of artificial burrows, getting more volunteers involved and of course outreach, notably communicating to the public the importance of protecting the Aruba burrowing owl and how each individual can play a part. Parke Nacional Arikok is already receiving more calls about endangered Shoco nests from concerned residents in different neighborhoods. The road ahead is however not likely to be an easy one. On March 6th 2018, a wetland area with a Shoco nest was bulldozed over for construction by the Mill Resort. Thankfully, the four nestlings were rescued and are being taken care of. The precarious situation of threatened Shoco is ongoing and a lot of work remains to be done to ensure the Aruban burrowing owl a chance of survival.

Photos by: © Aruba Birdlife Conservation, Greg Peterson
Yearly Parrot Count

Every year on Bonaire, dozens of dedicated volunteers wake up before dawn with one simple but important mission: count as many yellow-shouldered amazon parrots (*Amazona barbadensis*), or Lora as they are locally known in Papiamentu, as possible to estimate their numbers on the island. This year marks Bonaire’s twenty-third Lora count, which has been organized by Echo Bonaire with the help of STINAPA and Bonaire’s Department of Environment and Nature (DRO). The Lora census started in 1980 and is central to the protection of this endangered and endemic species of parrot as it provides a yearly population assessment and appraisal of management efforts in place.

The yearly monitoring event of Bonaire’s yellow-shouldered amazons is made possible thanks to the contribution of volunteers. These citizen scientists receive training prior to the count to ensure that they can perform the tally to the best of their ability. This also helps guarantee that volunteers all apply the same methodology and know directions to the monitoring site they have been designated. As Loras are sometimes confused with brown-throated parakeets (*Aratinga pertinax*), volunteers are taught how to identify the parrots visually and vocally. Pre-roost counts begin in early January to work out how many volunteers will be needed per roost site on the day of the count. New identified roosts and those that have become re-active are added to the annual count. Yellow-shouldered amazons typically roost in pairs or small groups during the breeding and nesting season but roosts in large groups from September to January, flying out at sunrise to feed (Williams and Evans, 2011). This makes them easier to count as they are concentrated in a few areas.

When the last Saturday of January comes along it is time for the actual count to take place. Volunteers which have prior experience are sent to the most important roost sites. Each team has at least two counters so that data logged can be cross-checked.

The methodology used is simultaneous counting, during which all volunteers count the parrots at the same time in different places. The fact that the roost count technique is standardized and used consistently facilitates the assessment of population trends (YSAP Management Plan). Volunteers leave home before dusk to their designated site, wearing dark clothes to ensure minimal disturbance to the birds and are equipped with a compass, binoculars and a watch. Once the Loras wake up, shrieking loud and flying up, the volunteers begin to fill out the data collection sheet. They record the number of observed parrots, their point of departure, flight direction, destination and time at which this happened, and complete an observation map. Once all the data has been collected, the organizers of the Lora count tally up the numbers and can estimate the minimum number of Loras present on Bonaire.

Photos by: © ECHO
The yellow-shouldered amazon has a limited and distinct range with genetically isolated populations in Bonaire and Curaçao as well as northern Venezuela and the Venezuelan islands of Margarita and La Blanquilla. This parrot is endangered with a global population estimated at less than 8,000 individuals, and is classified by the IUCN Red List as Vulnerable (Birdlife International, 2018). On Bonaire, the population was once close to extinction due to poaching and habitat degradation. Therefore, in 2002 DRO ringed and registered all existing pet Loras. Anyone after this campaign found in possession of an unringed parrot faces prosecution. Thanks to concerted and continued conservation efforts, legal protection and enforcement – the Lora receives local protection under the Island’s Nature Ordinance - the population has rebounded and is now an important stronghold for the global population. The yellow-shouldered amazon parrot is now considered a flagship species for the island’s dry forest ecosystem. The local non-profit organization Echo is working hard to protect the parrots on the island, find out more about their behavior and increase local awareness.

Information gathered over the years, thanks to the annual Lora count, suggests that the number of parrots on Bonaire is increasing steadily. While numbers of parrots counted has fluctuated each year, the overall trend is clearly an upward one and is linked to the start of conservation efforts on the island, including population monitoring (Echo, STINAPA, DRO, Salba Nos Lora), nest site management (Echo), awareness campaigns (STINAPA, Echo, Salba Nos Lora), rescue and release of injured birds (Echo), enforcement of protected status (STINAPA, Echo) and tree planting (Echo and Salba Nos Lora) [Graph 1]. In 2017, however, the number of Loras recorded was significantly lower than usual, with 700 Loras counted as opposed to 1,000 in previous years (Echo, 2017). This drop in numbers was not the result of fewer parrots on the island, but rather a long period of drought followed by heavy rains caused the parrots to spread out more across the island, making them harder to observe and count. Weather and food supply have been known to drastically affect the count and parrots periodically change roost locations. In the area of Sabadeco, just 11 parrots were counted compared to the previous year’s 229, while in the Washington Slagbaai National Park, just 50 birds were recorded (Echo, 2017). This unpredictable behavior of the Loras makes it challenging for the participating volunteers to count them each year (Echo, 2017). While this shortcoming means that the yearly count can underestimate the island’s Lora population, it provides enough of a baseline data to assess population trend dynamics over the years. By involving locals in monitoring efforts, the count not only gathers vital information but also helps increase local awareness of the need to protect one of Bonaire’s most iconic species.

Graph 1: Population dynamics of the Yellow-shouldered Amazon parrot based on data collected by the yearly Lora count

The green dots on the graph show the actual annual population counts, while the green lines represent the trendlines (average, minimum and maximum) associated with it.
Imagine a vast expanse of rectangular saline ponds in surreal colors—pinks, turquoise, greens— that reach out towards the horizon, flanked by a collection of enormous, immaculately white pyramids of salt. It’s an extraordinary landscape, with an eerie beauty.

Now, there is something even more remarkable about Bonaire’s Cargill Salt Ponds. BirdsCaribbean is excited to share the fantastic news that this important stopover and wintering site for migratory birds has been designated a Western Hemisphere Shorebird Reserve Network (WHSRN) site of Regional Importance. This is the second WHSRN site in the Caribbean, joining the Cabo Rojo Salt Flats in southwestern Puerto Rico. This designation will ensure the protection and management of the site for shorebirds. It’s excellent news for the Red Knot, in particular. In addition to this threatened migratory bird, more than 20,000 shorebirds, representing 27 species, have been recorded at the location.

What is the Western Hemisphere Shorebird Reserve Network?

The Western Hemisphere Shorebird Reserve Network is dedicated to protecting key habitats throughout the Americas, helping sustain healthy populations of shorebirds. With the addition of Cargill Salt Ponds Bonaire, there are now 103 WHSRN sites covering nearly 25 million hectares (38 million acres) in 37 countries. Sites are categorized as having Regional, International or Hemispheric Importance based on the total number of shorebirds they support annually; or if the sites support a substantial percentage of the population of a single species. The new site, the first for the Dutch Caribbean, also lies within BirdLife International’s Important Bird Area (IBA) Pekelmeer Saltworks, Bonaire. This area includes the 400-hectare Pekelmeer Ramsar site (a designation given to Wetlands of International Importance).

The Big Attraction for Shorebirds at Cargill Salt Ponds

Why do shorebirds thrive at the Salt Ponds? What could possibly survive in this alien landscape? The answer: brine shrimp and brine flies. These small invertebrates lay the foundation that supports thousands of shorebirds annually. Most of them are hungry migrants, taking a much-needed break before continuing on their journey, or spending the winter at this food-rich site. A privately-owned salt production facility at the southern end of Bonaire, owned by Cargill Salt Bonaire B.V., the site comprises 3,700 hectares; 2,700 hectares are artificial wetlands – primarily solar evaporation ponds for salt extraction. Brine shrimp fill the ponds. The dike roads running between the ponds are covered with brine flies. For shorebirds, the shrimp and flies are a delicious food source, right amongst the mountains of salt.

Many are familiar with the extraordinary migratory cycle of the Red Knot: every year, this shorebird flies a roundtrip of close to 19,000 miles, from the Arctic to southern Chile and Argentina. If that wasn’t impressive enough, this bird’s journey includes multi-day stretches (even up to one week!) of continuous flight between stopover sites. These sites that allow the birds to rest and refuel are critically important to the success of the Red Knot’s migration. Without them, this fascinating shorebird would not survive.

Cargill’s Invaluable Support for Shorebird Surveys

Daniel DeAnda Jr., Cargill’s Production Manager, collaborated with Lisa Sorenson, Executive Director of BirdsCaribbean, on the nomination of the salt ponds for WHSRN status. With Cargill’s support, BirdsCaribbean led surveys, beginning in 2015, to learn more about the species and numbers of birds using the site. Survey results revealed that more than 20,000 shorebirds visit the wetlands annually, qualifying it as a WHSRN site at the “Regional” level of importance. This large concentration of shorebirds includes at least 1% of the biogeographic population of the threatened rufa (American) subspecies of Red Knot (Calidris canutus rufa) and Short-billed Dowitcher. Unfortunately, shorebird numbers are declining. Some species have seen dramatic and worrying decreases in numbers. The rufa subspecies of the Red Knot has declined 80% over the last 20 years. The population of Semipalmated Sandpiper, which winters on the northern coast of South America, has shown similar declines over 30 years. This is a global problem: The Spoon-billed Sandpiper, which breeds in Russia and winters in Southeast Asia, may have just 100 breeding pairs left. The greatest threats to shorebirds are habitat loss, predators, hunting, and climate change. Areas such as WHSRN sites, which are preserved and protected for shorebirds, are crucial for successful breeding and migration.

BirdsCaribbean and partners recorded 15 other species during the salt pond surveys, including: Semipalmated Sandpiper, Least Sandpiper, Stilt Sandpiper, Semipalmated Plover, and Sanderling. Significant numbers of Snowy Plovers are also found regularly at the location. These are probably a combination of migrants (nominate Charadrius nivosus) and resident birds belonging to the Caribbean breeding subspecies (C. n. tenuirostris). The area is the only known nesting area on Bonaire for the Royal Tern. It also supports one of the most important American Flamingo nesting colonies in the Caribbean.

Photos by: © Sipke Stapert (LEFT) & Lisa Sorenson (RIGHT).
The Power of Partnerships

BirdsCaribbean was very fortunate to have motivated and passionate international and local partners, who were essential during the survey periods. The partnership included staff and volunteers from STINAPA Bonaire, WILDCONSCIENCE, US Fish and Wildlife Service, Cornell Lab of Ornithology, and Dutch Caribbean Nature Alliance. Survey teams led by Fernando Simal (WILDCONSCIENCE) counted birds at 110 points, over five counting periods. Their findings informed the site’s WHSRN designation. Lisa Sorenson, Executive Director of BirdsCaribbean commented, “We are very grateful for the support we received from Cargill and our partners and volunteers, who enabled us to complete this work. We are especially thankful to Environment and Climate Change Canada for its principal funding support for the surveys, as well as the contribution of the U.S. Forest Service’s Department of International Programs. We also deeply appreciate the encouragement and support we received from Manomet for our nomination.”

BirdsCaribbean looks forward to continuing to work together with Cargill and all the partners to monitor and manage the site for shorebirds.

What can we do to help our shorebirds?

What can we do to help our shorebirds and their habitats? The Caribbean is a key link on the Atlantic Flyway. Its beaches, lagoons, marshes, swamps, rice fields, and other wetlands support enormous numbers of shorebirds annually. In order to ensure shorebird survival and mitigate against ongoing population declines, it is critical to identify and protect important sites in the region. One way you can help is by taking part in the Caribbean Waterbird Census, when professionals as well as citizen scientists count waterbirds during a 3-week period from January 14th to February 3rd as well as other times of year. Read more about shorebirds and the efforts to conserve them through the Atlantic Flyway Shorebird Initiative.

Acknowledgments

BirdsCaribbean thanks Fernando Simal (WILDCONSCIENCE), Jeff Gerbracht (Cornell Lab of Ornithology), Frank Rivera-Milan (US Fish and Wildlife Service) and Lisa Sorenson (BirdsCaribbean) for many hours in the field to survey shorebirds. We also thank the following individuals for field assistance: Paulo Bertoul, Caren Eckrich, Herman Sieben, Elise Lara Galtzki, Diana Sint Jago and Luigi Eybrecht from STINAPA Bonaire, Elly Albers from Bonaire Wild Bird Rehabilitation Center, and Jilly Sarpong (Biology student at HAS University of Applied Sciences in The Netherlands). Dr. Frank Rivera-Milan carried out the data analysis needed to support our nomination of Cargill Salt Ponds as a WHSRN site. Funding support was provided by Environment and Climate Change Canada with additional assistance from the US Forest Service and in-kind support from STINAPA Bonaire, Cargill Salt, STINAPA and Dutch Caribbean Nature Alliance.

St. Eustatius: Bridled Quail-Dove Population Continues Declining

By Hannah Madden (CNSI), Frank Rivera-Milán (USFWS) and Kevin Verdel (Utrecht University).
This article was published in BioNews 19.

In the December 2017 edition of BioNews, we provided an overview of the results of two population assessments of the Bridled Quail-dove (Geotrygon mystacea) that had been conducted that year. This article provides the results of a third assessment that was conducted eight months after two major hurricanes impacted St. Eustatius.

The Bridled Quail-dove can grow to a length of around 12 inches (30 cm) and weigh around 230 grams. Perched on a branch, the dove emits a mournful ‘who-whoooo’ call that echoes through the forest. Nevertheless, this is a shy and secretive species that usually walks or flies away when humans approach.

While it is usually seen alone or in pairs, aggregations of over a dozen may occur, especially in the non-breeding season. Local names include “wood dove” and “wood hen”, indicating its preference for forest and woodland habitat.

Despite being classified as Least Concern by the International Union for the Conservation of Nature, with such a limited geographic range (listed as ‘uncommon to rare in the Lesser Antilles and extremely rare in Puerto Rico’) and the fact that it is losing habitat, populations of the Bridled Quail-dove are decreasing across the region and its status could be upgraded to Vulnerable. It is said to be absent from Anguilla, Barbados, St. Vincent, Grenada and the Grenadines.

The Bridled Quail-dove is a regionally endemic species in the family Columbidae that, on Statia, is only found in upper elevations of the Quill (above ~150m) and inside the crater. It is easily distinguished from other dove species by the turquoise patch on its neck and white stripe (bride) under the eye. With its habit of wandering the forest floor during daylight hours in search of food (seeds, fruits and the occasional gecko or snail), observant hikers are likely to spot this bird.

Activity and breeding are very much dependent on rainfall, and the dove is sensitive to hurricanes and extended periods of drought. Similar to other Columbids, the Bridled Quail-dove lays clutches of two eggs in a flimsy nest made of twigs up to six meters above the forest floor. Bridled Quail-doves do not fare well in areas of human activity and numbers have declined across the species’ range, presumably due to habitat loss, but also due to hunting and predation by invasive mammals such as the Black Rat (Rattus rattus).

Irma and Maria were the first recorded category five hurricanes to hit the Windward Islands, and while Statia was spared extensive infrastructural damage in urban areas, its forest ecosystems did not fare so well. According to a recent publication by Eppinga and Pucko (2018), an average of 93% of tree stems on Statia and Saba were defoliated, 83% lost primary/secondary branches, 36% suffered substantial structural stem damage, and average tree mortality was 18% (with mortality being almost twice as high on Statia than Saba).
Our pre-hurricane assessment in May 2017 was initially encouraging, with an estimated 1,030 (standard error [SE] = 275, 95% confidence interval [CI] = 561-1,621) quail-doves across its local habitat of 440 hectares, possibly the highest known density in the region. Post-hurricanes, in November, we repeated the surveys and recorded a decrease of around 22% in the population to 803 (SE = 208, 95% CI = 451-1,229). Nevertheless, we feared that the population would continue to decline as a result of hurricane-induced habitat degradation and the negative impacts of severe vegetation damage, loss of vegetation cover, food limitation, and increased predation.

We repeated surveys in May 2018, hoping to coincide with the quail-dove’s peak breeding season. However, instead of the usual ~70 transects, we had to walk a total of 255 transects in order to detect sufficient doves for analysis. No doves were heard calling, most likely as a result of delayed breeding, and only 32 were detected during 2018 surveys compared with ~92 in previous years. As expected, the quail-dove population continued declining in May 2018 (-76% compared with May 2017) and is currently very small at around 253 individuals (SE = 105, 95% CI = 83-486). With such a small population there is a very real risk that Bridled Quail-doves could become extirpated on St. Eustatius.

Reduced survival and reproduction, and thus abundance fluctuations at low numbers, could lead to local extirpation. Because of the life-history characteristics shared by members of the family Columbidae (e.g., early maturity and short lifespan), conservation efforts are now urgently required. Although survival and reproduction rates of the Bridled Quail-dove on Statia are poorly understood, Black Rats are present in all vegetation types within the terrestrial protected areas. Management of these invasive mammalian predators within the dove’s range is needed as a first step towards increasing reproduction and survival, and therefore population recovery to pre-hurricane levels, of this highly vulnerable species.

The authors are grateful to St. Eustatius National Parks Foundation for granting permission to conduct surveys in the Quill National Park. Thanks to funding by the Dutch Ministry of Economic Affairs (now Ministry of Agriculture, Nature and Food Quality (LNV)) under their Nature Fund initiative, a rodent control project, facilitated through the Caribbean Netherlands Science Institute (CNSI), is running on St. Eustatius. We also wish to thank the many generous donors who contributed to BirdsCaribbean’s post-hurricane fundraising appeal, which covered Dr. Rivera-Milán’s costs to help conduct surveys in November 2017. The end date of this project was recently extended to October 2019.
Crowned Slaty Flycatcher: another new bird for Bonaire and for the Kingdom of the Netherlands

By Peter-Paul Schets. This article was published in BioNews 19.

In BioNews 11 (2017) an article was dedicated to the eight bird species that in 2016 and 2017 were added to the Bonaire-bird list. One of these, Pied Water-tyrant, was even new for the Kingdom of the Netherlands.

Less than one kilometer from the location where that bird was recorded for the first time in January 2016, Peter-Paul Schets found another tyrant-flycatcher which was never recorded before on Aruba, Bonaire and Curaçao.

In the early morning of 3 September 2018 Schets visited Bonaire’s LVV-grounds and sewage plant. At around 7 AM he noticed a mainly greyish flycatcher that reminded him of a phoebe or a pewee. The birds made short sallies to catch insects and repeatedly returned to the same or a nearby bare branch. Schets realized this bird was not in the Sibley guide (birds of North America) or in the field guides for the ABC-islands. He took many pictures that he sent to several birders in the Netherlands. It did not take long before Bert Pietersen answered this bird mostly resembled a Crowned Slaty Flycatcher (Griseotyranus aurantiocrisatus), a species of South America. An unexpected finding because of the southern distribution of that species, but comparison of photos of that species led Schets to the conviction that this was indeed the bird he had seen. Shortly afterwards its identification was confirmed by several experienced birders.

Finding this species on Bonaire is exceptional as its regular range is much more to the south. It mainly breeds in central and in the southern half of South America and migrates in austral winter rarely further north than Orinoco River. There are very few records outside South America. In 2007 it was recorded in Panama and in 2008 in Lousiana, USA.

This record once again shows birding on Bonaire can we very rewarding. Finding another new species for this island probably is just a matter of time.

By Peter-Paul Schets. This article was published in BioNews 19.

Photos by: © Peter-Paul Schets
Urgent Conservation Action Needed To Save The Lesser Antillean Iguana

By Thijs van den Burg. This article was published in BioNews 13.

The Lesser Antillean Iguana is an endangered endemic reptile found in the Lesser Antilles whose population is rapidly decreasing. Although once also found on St. Maarten, St. Eustatius is currently the last stronghold in the Dutch Kingdom of this tree-dwelling iguana. Recent events could change its fate.

Early 2014 RAVON and STENAPA launched efforts to study and conserve the remaining population of the Lesser Antillean Iguana (Iguana delicatissima) on St. Eustatius. Data on nearly 300 iguanas were collected during several studies, and the majority of these iguanas were uniquely tagged to allow the collection of valuable data over time. A primary goal was to assess whether the population is genetically pure with respect to the wide-spread hybridization between non-native Green Iguanas (Iguana iguana) and native Lesser Antillean Iguanas that occur throughout the Lesser Antilles. Since the identification of hybrids can be made based on morphological (Breuil, 2013) and genetic differences (Stephen et al., 2013; Vuillaume et al., 2015; van den Burg et al., 2018), both methods were used. The results indicated that no hybrids or Green Iguanas were present in 2015, which suggests that they are absent on St. Eustatius (van den Burg, 2016).

The discovery of an adult female I. iguana in early 2016 and of the first individual with hybrid characteristics in mid-2016 is alarming. Genetic and morphological data has confirmed that this individual and several subsequently found iguanas are indeed Iguana delicatissima x Iguana iguana hybrids (Figure 1; van den Burg et al., 2018). Ongoing fieldwork performed by local organizations and collaborating partners (STENAPA, Ecological Professionals, and RAVON) has led to the discovery and capture of eight hybrid individuals to date in addition to two Green Iguanas. The Green Iguanas arrived by boat from St. Maarten, which is home to large numbers of these non-native reptiles. The size variation of the hybrids indicates that a minimum of two hybrid nests have successfully hatched on St. Eustatius. It is therefore extremely likely that more hybrid iguanas are present.

Based on the identification of hybridization and remaining presence of non-native iguanas, conservation management action is crucial to ensure the genetic integrity and longer-term survival of St. Eustatius’s Lesser Antillean Iguana. Fortunately, a successful grant application with the Mohamed bin Zayed Species Conservation Fund will boost conservation work by providing accommodation to two experienced researchers on St. Eustatius. These scientists will perform a systematic survey of non-native iguana distribution and abundance, which will help visualize the current extent of the non-native invasion. Distribution knowledge of non-native iguanas will allow the identification of priority areas for removal actions in an effort to remove all non-native iguanas.

Figure 1 - Iguanas on St. Eustatius. Left to right: Iguana iguana - hybrid - Iguana delicatissima. © Thijs van den Burg and Tim van Wagensveld
Urgent Conservation Action Needed To Save The Lesser Antillean Iguana

The progress of biological invasions and the potential for eradication can be visualized using an invasion curve (Figure 2), which is an interplay of three factors: 1) time since the invasion, 2) spread of the invasive species, and 3) costs for controlling the invasion. On St. Eustatius, the lack of hybrids in our initial large dataset and low number of discovered hybrid iguanas suggests the current invasion is of recent origin. It would seem that there is only one small infested area which indicates that eradication at this stage is still feasible. This needs to be verified by thorough survey efforts. A similar situation to several other Lesser Antillean islands, where larger numbers of non-native iguanas are present, will however arise if no dedicated/committed action is taken at this point. Besides a loss of the native Lesser Antillean Iguana population, these non-native iguana can cause extensive economic damage as is evident from other islands, e.g. Grand Cayman.

The Durrell Wildlife Conservation Trust is currently leading a Lesser Antillean Iguana breeding program in collaboration with several European Zoos, including Rotterdam Zoo. To this end, and following necessary health screenings, two animals of each sex were transported from St. Eustatius to the Rotterdam Zoo in early May. They will be displayed at the Zoo (after a quarantine period) to increase public awareness. Their offspring will eventually be crossed with breeding lines that originate from Dominica present in collaborating Zoos.

Sadly, similar declines in Lesser Antillean Iguana populations are taking place throughout the species’ entire range (Anguilla to Martinique) as a result of hybridization, habitat destruction and poaching (Knapp et al., 2014). Besides St. Eustatius recent invasions of Green Iguanas on La Désirade and Dominica have also been reported. In fact, this species’ distribution is predicted to have decreased by 87% by 2050 and only inhabit Dominica if the current rate of decline continues (van den Burg et al., accepted). As a result, the IUCN Red List status of the Lesser Antillean Iguana will change from “Endangered” to “Critically Endangered” (van den Burg et al., accepted). Conservation action along with increased biosecurity is urgently needed throughout the iguana’s range to ensure that all remaining populations are preserved and that future invasions by Green Iguanas onto these last strongholds are prevented.

Grateful thanks to STENAPA, RAVON, CNSI, University of Amsterdam, San Diego Zoo Institute for Conservation Research, IRCF, FONA conservation (SS5.65) and Mohamed bin Zayed Species Conservation Fund (150510459/17253758) for financial and/or logistical support of this project.

Figure 2 - Invasion curve, © Protect Lake George; Davis (2009).
Concerted Caribbean effort for Lesser Antillean Iguana

A team from St. Eustatius National Parks Foundation (STENAPA) laid the fundamentals for a Caribbean conservation plan for the Lesser Antillean Iguana during a workshop in Anguilla in March 2018.

Representatives of the islands with remaining Lesser Antillean Iguanas shared their ideas during the workshop about how to build a bright future for their native iguana. All islands share the main threats to their native iguana, such as habitat loss due to roaming goats, predation by wild cats and rats, car accidents, poaching and the arrival of the invasive Green Iguana. Apart from that, the present iguana population in St. Eustatius is possibly not viable given its small size and fragmented distribution, however there is no genetic structure within this population (van den Burg et al., 2018). Therefore STENAPA works on improving connectivity, putting in place checks in the harbor of incoming containers, and decreasing the roaming goats and wild cats.

In Anguilla the situation with the iguana on the main island has become so critical that the Anguilla National Trust translocated the last individuals to a small uninhabited island nearby, Prickley Pear East. During one of the night patrols in Anguilla last week, STENAPA’s National Parks Ranger Rupnor Redan found one of the last remaining native iguanas. It has been put in quarantine and will be send to Prickely Pear East after genetic testing.

Besides Redan, the STENAPA team was represented by Director Clarisse Buma, Tim van Wagensveld (RAVON) and Sandra Bijhold (Rotterdam Zoo). Buma: “This workshop was very inspiring. We want to increase the corporation with especially Anguilla and St. Barths. We can learn from each other. Anguilla is interested to have an exchange with our ranger and do night patrols with them. And STENAPA can learn from St. Barths, where they made progress in the field of checking sea containers for invasive species. I am looking forward to bring our recovery plan a step further”. The development of the recovery plan is supported by the EU Best 2.0 program for overseas territories.

Urgent Conservation Action Needed To Save The Lesser Antillean Iguana
Three new exotic gecko species identified on Curacao

By Jocelyn Behm (Vrije Universiteit Amsterdam and Temple University). This article was published in BioNews 20.

As part of the Caribbean Island Biogeography meets the Anthropocene project, researchers initiated their surveys for exotic reptile and amphibian species on Curacao. They found three new exotic gecko species on Curacao, which may have negative implications for Curacao’s native gecko species and native ecosystems.

Exotic species, species introduced to a new location outside their native range, can pose significant threats to biodiversity, especially the native species on islands. Across the Caribbean islands, the rate of spread of exotic species has continually increased over the past several decades. Due to their ability to hitchhike undetected in cargo shipments, exotic reptiles and amphibians are spreading rapidly. In particular, adults, juveniles, and eggs are transported inadvertently in shipments of live plants or other cargo from one island to another. Here, we provide the first update of Behm et al.’s surveys for exotic reptiles and amphibians on Curacao.

Prior to their surveys, three exotic amphibians, the Colombian four-eyed frog (Pleurodema brachyops), Johnstone’s whistling frog (Eleutherodactylus johnstonei), and the Cuban tree frog (Osteopilus septentrionalis), and two exotic reptiles, the common house gecko (also known as the wood slave; Hemidactylus mabouia), and the Brahminy blind snake (Ramphophis braminus), were known to have breeding populations on Curacao.

The research team conducted day and evening surveys island-wide to confirm the presence of these exotic species and potentially identify new species. Often exotic species are found more in developed areas than natural habitats, so they searched both natural areas (e.g., Christoffel, Kabouterbos), and developed areas (e.g., resorts, Curaçao Zoo, home gardens). These surveys took place September 19 to 27, 2016 and January 26 to March 11, 2017.

They confirmed the presence of all documented exotic species except the Brahminy blind snake. However, their surveys were not designed specifically to detect it as it usually remains in the soil and they did not systematically survey soil habitats.

The team also discovered two new exotic gecko species in their surveys that had never been documented on Curacao. First, the mourning gecko (Lepidodactylus lugubris) was discovered at several developed habitat locations: private residences in and resorts. Native to the coastal areas of the Indian and Pacific Ocean regions, the earliest introduction of the mourning gecko to the Caribbean region was to Colón, Panama in 1956. However, the mourning gecko was not introduced to a Caribbean island until 2008, when it was found in Curacao Zoo. It is now present in the Bahamas, Grand Cayman Island, Guadeloupe, and Curacao. Upon discussions with their collaborator, Gerard van Buurt, he reviewed older photographs and identified a mourning gecko in a photo taken in 2009. Therefore, they know it has been established on Curacao for nearly a decade.

The second species the team discovered is the Asian house gecko (Hemidactylus frenatus). As the name suggests, it is native to tropical areas of Asia. They found the Asian house gecko at the Curaçao Zoo, the Renaissance Resort (near the cruise ship terminal), and at a private residence. Like the mourning gecko, the Asian house gecko was present in the Caribbean region in Mexico since 1938, but was not documented on a Caribbean island until 2008 in Cuba. It is now found in Cuba, the Dominican Republic and Curacao. It has also been present in Zulia in coastal northern Venezuela since 2000, which may be a possible source for the population in Curacao. Given the limited distribution of the Asian house gecko on Curacao, they estimate that it was introduced only recently, likely within the past several years.

Both species resemble the exotic common house gecko that is already present on Curacao, as well as other geckos with exotic populations in the Caribbean region. Therefore, they used genetic sequencing and confirmed the identity of both the Asian house gecko and the mourning gecko.

While they were processing their genetic samples, Gerard van Buurt received a notification that the exotic Tokay gecko (Gekko gecko) was found in the Santa Catharina neighborhood of Curacao. The L’Aldea restaurant has a small display of animals to entertain visitors including the Tokay gecko, and apparently juvenile geckos escaped from this enclosure and established a breeding population in the neighborhood. The captive Tokay geckos were imported to Curacao in 2011, and based on the reports from residents, the exotic population has likely been established since 2016. Also native to tropical Asia, the Tokay gecko has a smaller distribution in the Caribbean region as it is usually introduced through the pet trade rather than as hitchhikers in cargo. It is present on Martinique, Guadeloupe, and Curacao.

There are three native gecko species on Curacao: the turniptail gecko (Thecadactylus rapicaudus), the Dutch leaf-toed gecko (Phyllodactylus martini), and the Antilles gecko (Gonatodes antillensis). The already established exotic common house gecko is thought to be in the process of displacing Dutch leaf-toed gecko, and to a lesser extent, the Antilles gecko. The obvious question is how will these three new exotic geckos impact the native geckos? Based on studies from other locations, they predict that the Asian house gecko and Tokay gecko both have the potential to significantly impact the native geckos and possibly other native species as well.
Three new exotic gecko species identified on Curaçao

The Asian house gecko is a very successful exotic species globally that has been implicated in the displacement of several native gecko species in the Pacific islands through aggressive territorial and competitive interactions. In addition, the Asian house gecko has displaced both the mourning gecko and the common house gecko in their exotic ranges. If the Asian house gecko’s population spreads on Curaçao, they predict it has the highest likelihood of displacing the Dutch leaf-toed gecko, the common house gecko, and the mourning gecko.

Tokay geckos are one of the largest gecko species in the world, reaching a size of 15cm long (excluding the tail). They are generalist predators feeding on both invertebrates and vertebrates including other lizards, rats, bats, and snakes. On Martinique, they are reported as having a similar ecological impact in home gardens as a cat. Needless to say, the potential ecological implications of the Tokay gecko’s introduction to Curaçao are troubling.

In addition, all three exotic geckos are generalist arthropod predators. Given that comparably less is known about terrestrial invertebrates on Curacao, all exotic geckos could potentially cause substantial negative impacts to uncatalogued biodiversity.

Their research project is ongoing and they will provide additional updates as their research continues. Their full report on the three new exotic geckos can be found at the following link:


Figure 1.
A. L. lugubris from a private residence in Jan Sofat in 2009 (photo: G. van Buurt);
B. Dorsal and ventral views of L. lugubris (HEMA-CU11) with well-developed endolymphatic chalk sacs (neck) (photo: M.R. Helmus);
C. L. lugubris (left; HEMA-CU28) and H. mabouia (right) side-by-side (photo: M.R. Helmus);
D. H. frenatus (HEMA-UR29) with dark dorsal pattern (photo: M.R. Helmus);
E. H. frenatus (HEMA-GU57) with light dorsal pattern (photo: T.J. Tran);
F. G. gecko on an outdoor wall with tape measure for scale (photo: Savine Boersma);
G. G. gecko captured at private residence in Santa Catharina (photo: S. Boersma);
H. G. gecko captured at private residence in Santa Catharina (photo: S. Boersma).
THREATS, MANAGEMENT AND AWARENESS
Increasing concern over Bonaire’s dependence on dive tourism and the importation of food products has led the government to push for the sustainable development of Bonaire’s rural areas. The “2014-2027 Policy Vision for Agriculture, Livestock and Fisheries”, developed at the request of the Public Entity Bonaire (Openbaar Lichaam Bonaire) highlights the pressing need for the expansion of the island’s agricultural and fisheries sector (LVV) in order to boost local food production as well as diversify the island’s tourism product. While Bonaire’s leeward shore has been developed to accommodate the thousands of tourists that visit the island each year, the rural areas have for the most part been overlooked. The neglected agricultural areas in the countryside are a stark contrast to the western coast fringed with hotels, shops and restaurants.

Agriculture on Bonaire has always been severely limited due to the island’s dry climate and unpredictable rainy seasons. As a result each year 95% of the food needed to feed both locals and visitors is imported. Goat farming has dominated rural life throughout Bonaire’s history, however currently more than half (65%) of the island’s 32,000 goats roam free. Free-roaming goats and their endless appetite for young shoots and seedlings have emerged as one of the biggest threats to the island’s natural biodiversity. Overgrazing not only threatens local vegetation and the fauna that relies on these plants, but the resulting wind and water erosion threatens the health of Bonaire’s coral reefs.

Stakeholders and “kunukeros” (farmers) from two rural areas, Rincon and Bara di Karta, attended workshops organized by the Department of Spatial Planning and Development (DRO) and the Dutch Ministry of Agriculture (formerly the Ministry of Economic Affairs) in 2012 and 2013 to identify bottlenecks and opportunities for rural development. These workshops resulted in the development of the Rural Development Program (POB) for Bonaire, which is financed by the Dutch Ministry of Agriculture through their Nature Fund (Natuurgelden) initiative. The aim of POP Bonaire is to revitalize Bonaire’s rural areas by stimulating entrepreneurship, self-reliance and sustainable agriculture. A total of forty projects are being carried out within four main categories: a knowledge center, sustainable goat husbandry, rural tourism development and strengthening of entrepreneurship. The Program is lead by Jan Jaap van Almenkerk (Wayaká Advies) and Sherwin Pourier (BAAB BV) and has broad support and cooperation of stakeholders such as Kriabon, TCB, Mangazina di Rei, SELIBON, Chamber of Commerce, Integral District Approach, and local schools.

With goats (left) and without goats (right). Photo by: © Wayaká Advies

The LVV (Agriculture, Livestock, Fisheries) department is a government department within the Spatial Planning and Development Department.
Knowledge Center “Sembra Futuro”

The knowledge centre, “Sembra Futuro”, which is under development, is intended to become a hub of activity, information and education for agriculture, horticulture and livestock farming. Based at a site owned by the Ministry of Agriculture, where twenty hectares of good soil will allow plots of land to be leased to agricultural entrepreneurs for the production of fruit, vegetables or cattle fodder. Farmers will not only benefit from access to cultivable land and water but will also be encouraged to join forces and share expertise, equipment and surveillance. Knowledge about agriculture and horticulture is being made accessible through a series of workshops as well as practical handbooks. To date eight workshops have been organized providing information on the small-scale cultivation of fruit and vegetables. An estimated 300 school children have attended horticulture workshops organized in collaboration with Mangazina di Rei. Several unemployed youngsters have also received training in agriculture and the use of agricultural machinery in collaboration with the Society and Care Directorate.

Sustainable Goat Farming

Since 2015 researchers from the University of Wageningen have been evaluating the potential for sustainable goat husbandry. Recommendations include the professionalization of goat husbandry in order to make it sustainable. The resulting action plan - which has the support of local kunukeros - includes improved management of goats through a central registration, improved breed selection, production of quality meat products labelled “Platina di Boneiru”, production of a central cattle feed and fenced-in goats and will take 5 years to implement. Fifty of Bonaire’s 175 goat farmers have already attended workshops on goat management and lamb production, and 14 participants have attended a course on professional goat farming. Access to high quality feed is an essential component towards sustainability as it will allow kunukeros to keep goats fenced instead of letting them graze freely. POP Bonaire has carried out a high-quality feed pilot project over the past few years with the participation of eight local goat farmers. Two of the eight grasses tested for fresh cattle feed and hay show promise.
Rural Tourism Development

Bonaire’s rural areas - Bara di Karta, Rincon and Tras di Montaña - have great potential in attracting tourists if they are revitalized and made accessible. Rincon is the island’s oldest village and has a strong cultural identity. Bara di Karta has a typical Bonairean agrarian landscape with many kunukus and some historic plantations. POP Bonaire aims to facilitate the economic development of the countryside through the creation of tourist routes and by supporting the refurbishment of old farms into tourist attractions. Several tourist routes were set up in cooperation with kunukeros and include four car routes, eight walking trails and five mountain bike routes [see map]. Paper maps that highlight these routes and provide information about the culture and nature in the area are being distributed to visitors. POP Bonaire also supports a number of projects that are making the region more attractive to tourists such as the clean-up of debris and car wrecks along tourist routes and the installation of traditional cactus fences. Farmers have begun to renovate farms due to an increase in visitors in the island’s countryside. Several attractions are now offered, including a kunuku tour and a tea house.

Strengthen entrepreneurship

Many locals in Bonaire’s rural areas have ideas for their own business in agriculture or kunuku tourism, but the vast majority do not have the funds or expertise to turn these ideas into successful businesses. POP Bonaire aims to stimulate rural economic development by offering entrepreneurs advice and support in the development and implementation of their business plan. So far, 115 consultations have been held with entrepreneurs, and 10 business plans have been approved and supported with an in-kind donation. As many entrepreneurs lack the necessary funds to start up a business, POP Bonaire has set up an Entrepreneurs fund which is managed by Stichting Ondernemersfonds Bonaire. Entrepreneurs with an approved business plan can request a loan. To be selected, entrepreneurs must bring onto the market an innovative and commercial product. Punta Blanku Farms, which delivers daily fresh free-range eggs to island supermarkets, received money from the fund to purchase a machine that converts seawater into drinking water for its chickens.

POP Bonaire is an ambitious initiative, but with clear objectives and the support of local stakeholders its chances of success are very high. The next step towards the completion of this Program will be the set-up of the “Sembra Futuro” knowledge center and the implementation of the plans for the professionalization of goat farming. The goal of producing 40% of all fresh fruit and vegetables consumed on the island may take many years to reach, but the encouragement towards self-sufficiency and sustainable development within the island’s rural areas is already showing promise.

Would you like to stay up-to-date?

You can follow POP Bonaire on Facebook @POPBonaire.

You can also follow all the Nature fund projects on Bonaire on Facebook @NTBDN.

For more information about the hiking, biking and car trails on Bonaire, please visit: http://www.explore-bonaire.com

POP Bonaire: Rural Development Program: 2014-2018
In July 2017, Environmental Protection in the Caribbean (EPIC) Foundation initiated a project to restore coastal and terrestrial biodiversity by planting native tree species at three ecologically degraded sites on St. Maarten while simultaneously increasing community involvement and appreciation for conservation.

St. Maarten is the most densely populated island in the Caribbean. The massive loss of biodiversity initiated upon human contact has accelerated in recent decades with the development of the tourist industry, upon which most of the economy depends, yet no terrestrial legally protected areas exist on the island.

Three sites served as the focal point for restoration actions: 1) Little Key, 2) Sentry Hill, and 3) Cay Bay. Each offers a different habitat type: coastal mangrove wetland, montane dry forest, and coastal terrestrial scrub respectively.

The aim of restoring Little Key was to increase Red Mangrove coverage, thus increase habitat and nursery grounds for native species and to increase the provisioning of ecosystem services such as water filtration and carbon sequestration. In the past, mangrove restoration at Little Key was hindered by wave disturbances. Therefore, it was decided to use the Riley Encased Methodology (REM) which uses full-length PVC tube encasements to reduce wave action and create an environment favorable to the seedlings’ initial stages of development while protecting the plant long enough to become established. Similarly, the goal at terrestrial sites was to remove non-native plant species and establish a secondary forest comprised of a higher diversity of native species.

Since many mature trees at the restoration sites were lost due to Hurricane Irma in September 2017, the goal was not to increase the number of trees on site over the year-long project but instead to increase the diversity of native species of tall canopy trees and to ensure high survival rates.

The hurricane caused an average two-month delay in the timeline of activities. EPIC’s headquarters lost its roof and suffered major damage to equipment and furniture, complicating operations. In addition, nearly all mangrove propagules were blown or washed away so they could not be grown locally and instead were ordered from Florida. Likewise, many local nurseries lost their terrestrial plant stock to the storm and could not source plants until commercial shipping resumed. During this period, the focus was on preparing the terrestrial sites for planting by removing invasive species.

In November a team of volunteers, with boat support from the Nature Foundation of St. Maarten, planted 290 Red Mangrove propagules at Little Key. In January, a landscaping crew and volunteers planted approximately 309 plants at Sentry Hill and 125 at Cay Bay over three days.
Restoration of Key Biodiversity Areas of St. Maarten

Delays in establishing irrigation systems required significantly more hours of staff time in watering the plants three times per week until April. In addition, goats foraged on a number of plants that escaped through damaged fencing at Cay Bay, all but 13 recovered from the foraging.

Student scientists from the nearby St. Dominic High School were recruited to monitor the individually tagged plants at Sentry Hill once a week for eight weeks while EPIC staff monitored the Cay Bay plants. The mangroves planted at Little Key were monitored every two weeks by volunteers with a boat donated by St. Maarten Sails.

Plant species diversity increased from pre-restoration to post-restoration by 25 to 35 different species at Cay Bay and 42 to 52 different species at Sentry Hill. The post-restoration survival rates were found to be up to 96.1% at Sentry Hill, 89.6% at Cay Bay and 84.5% at Little Key. These results point to an increased biodiversity at the restoration sites when compared with pre-restoration assessments and, as the new plants mature into large trees, an increased carbon sequestration capacity.

To ensure long-term management of the restoration sites, a formal Transfer Agreement was created and signed by the site owners/managers in May 2018. The Transfer Agreement includes a guide of Best Practices and lessons learned during restoration to ensure successful management of the sites over the long-term.

The outreach component of the project reached approximately 4,253 participants who took part in volunteer opportunities, educational presentations, and field trips. Stickers and reusable water bottles with the tag line “plant a tree, grow a forest” were shared with participants. Survey response forms confirm that teachers found the presentations and field trips to be informative, engaging, and beneficial.

A volunteer WhatsApp group created for this project was also active and used to inform volunteers of upcoming events. The group was very motivated and popular with recurring volunteers who contributed 435 days of volunteer time.

A campaign in support of the establishment of terrestrial protected areas was also started and some 507 people signed the online petition and 84 people signed the in-person signature sheet. The advocacy campaign may have been limited by the focus of residents and businesses on rebuilding. A letter writing campaign resulted in one letter of support.

A video summarizing the restoration project was produced and received 1,800 views by the end of project implementation.

Local organizations and government representatives visited the restoration sites, offering an opportunity to share lessons learned and the value of habitat restoration. An open house was held at the end of the project to welcome the community to walk the nature trail established at the Sentry Hill restoration site. Signs along the pathway provide information about biodiversity and the restoration work.
Despite significant challenges caused by Hurricane Irma, the project met its objectives thanks to the dedication and hard work of staff and volunteers. This work has resulted in increased biodiversity and potential carbon sequestration at the restoration sites but has also built local capacity and support for future restoration projects while strengthening community through service projects. Seedlings can also be seen as symbols of hope and the promise they hold for a better future was much needed during recovery from Irma’s devastation.

For further information on this project, please check the Post-Restoration Assessments and Best Practices Report available at EPIC’s website.

This project was made possible through the contribution of the BEST 2.0 Programme funded by the European Union, Global Giving, BirdsCaribbean Hurricane Relief Fund, and donors to EPIC’s Irma Recovery Fund.

Restoration of Key Biodiversity Areas of St. Maarten
Microplastic Contamination on Beaches of the Lesser Antilles

By Thijs Bosker, Associate Professor, Leiden University College/Institute of Environmental Sciences, Leiden University. Email: t.bosker@luc.leidenuniv.nl
This article was published in BioNews 17.

Plastic pollution is one of today’s most pressing global challenges. An estimated 4-12 billion kg of plastic enter our oceans annually, where it is broken down into smaller microplastics. Microplastics (pieces of plastics <5mm) are a group of contaminants of emerging concern, which are now ubiquitous in the environment.

Two types of microplastics are commonly distinguished in the literature: primary and secondary microplastics. Primary microplastics are added to household products (for example cosmetics or body scrubs) or used in industry, and are often uniform in shape. In contrast, secondary microplastics are formed when larger pieces of plastic break down in the environment due to weathering and ultraviolet (UV) exposure. This results in fragmentation into smaller pieces of plastics, with different shapes (e.g., fibers, microspheres, fragments), size ranges (from the nano- to mm-range) and chemical constituents (e.g., polyethylene, polypropylene, polyvinylchloride and polystyrene).

Because of their small size, microplastics are easily ingested by organisms. In addition, laboratory experiments have found adverse impacts of microplastics, including decreased survival, decreased reproductive output, anomalous embryonic development and reduced feeding behavior. This has caused increased concern among scientists and the general public about the long-term impacts of microplastics in the environment.

One area of specific concern are marine environments, which have been identified as a major sink for microplastics. Because of ocean currents microplastics accumulate in certain regions in our oceans. For example, in the North Atlantic subtropical gyre levels of microplastics exceed 100,000 pieces/km². The North Atlantic subtropical gyre is located close to the Caribbean region, which is the location for this study. However, to date, very few studies have investigated microplastics in the Caribbean, or on Caribbean beaches.

To address this gap in our knowledge we started a study to increase our understanding on microplastics levels in beach sediment in the Caribbean region. To this end we investigated the level, distribution, and characteristics of microplastics on four Islands of the Lesser Antilles, located in close proximity to the North Atlantic subtropical gyre. In the summer of 2016, three undergraduate students (Lone Mokkenstorm, Lucia Guaita and Froukje Lots), all BSc students at Leiden University College in The Hague conducted a research project in the Lesser Antilles. They were hosted at the Caribbean Netherlands Science Institute (www.cnsi.nl ) at St. Eustatius.

Over the summer they samples 14 beaches across four Islands on the Lesser Antilles: Anguilla, St. Barthélemy, St. Eustatius and St. Martin/Maarten. These islands are close to the North Atlantic subtropical gyre (Figure 1 and Figure 2). Beach samples were collected, and brought back to the CNSI for extraction of microplastics using a newly developed, standardized sampling and extraction protocol. After extraction microplastics were analyzed under a microscope and to measure levels at different beaches.
Every sample analyzed in this study contained microplastics. The average number of microplastics across all sampling locations was 261 microplastics/kg dry weight of beach sand. There was a wide range in the levels of microplastic among locations. The total number of microplastics ranged from 68 microplastics/kg at Anse des Sables on St. Martin, to 620 microplastics/kg at Grandes Cayes, also on St. Martin (Figure 3).

When comparing the average levels found on the four different islands, the highest levels of microplastic were found on Anguilla (311 microplastics/kg), followed by St. Martin (269 microplastics/kg), St. Barthélemy (239 microplastics/kg) and St. Eustatius (130 microplastics/kg). No difference in microplastic levels was found between windward and leeward beaches. Of all the microplastics collected, 97% were fibers and the remaining 3% were particles (Figure 4).

It is unclear what caused the difference among locations. One explanation could be the difference in population levels between the islands. St. Eustatius has ~3,500 inhabitants, and had the lowest level of microplastics. For comparison, Anguilla hosts ~15,000 inhabitants, St. Martin ~70,000 inhabitants and St. Barthélemy ~9,300 inhabitants.

Although our study provides important data on the microplastics concentration in Caribbean beach sand, there are several important avenues for future research. Firstly, future work should focus on understanding regional microplastic sources. In our current study we only investigated the microplastic levels on beaches, but a study looking at surface and sediment levels in the region is needed to understand the sources and sinks of microplastics. Secondly, we suggest an investigation of microplastic impacts on local organisms.

The results have been published in the academic journal Marine Pollution Bulletin. Our research provides a detailed study on microplastics on beaches in the Lesser Antilles. These results are important in developing a deeper understanding of the extent of the microplastic challenge within the Caribbean region. This will ultimately increasing our understanding on how to develop optimal coastal management regulations to protect these ecosystems. This is of importance, as this region has an exceptionally rich biodiversity, making it a biodiversity hotspot for both terrestrial and marine ecosystems.

Acknowledgements:
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Additional information:
For more background information on microplastics see: www.lucmicroplastic.wordpress.com

Article:

Figure 3: Microplastic contamination levels across beaches on four islands (Anguilla, St. Barthélemy, St. Eustatius and St. Martin) of the Lesser Antilles. Contamination is reported in number of microplastics per kg of dry sediment. Source: Bosker et al. 2018.

Figure 4: An example of a microplastic fiber (left) and particle (right) found in the beach sand. Photo by: © Mokkenstrom, Lots and Guaita.
Health is Wealth: A One Health Approach to Control Vector-born Diseases and Promote Sustainability.

By Teresa E. Leslie, PhD. This article was published in BioNews 17.

At the Sustainability Conference held on St. Eustatius in December 2017, the panel “Health is Wealth” explored the interrelationship between the environment and health within the context of the island’s sustainability. Environmental conservation is often presented as a constraint to development instead of a tool for achieving human wealth (which includes health) (Nunes et al., 2016). A presumption of this panel discussion was that a broad-based and holistic approach to the topic of sustainability could potentially serve to engage the local population and empower them to conserve nature, protect the environment and safeguard their health.

The one health model (Feburay, 2015), which recognizes that the health of populations is connected to the health of animals and their surrounding environment, was specifically emphasized throughout this panel discussion. The goal of the one health model is to encourage collaborative, inter-disciplinary, and inter-departmental actions that will result in the best health for people, animals, and the environment. Within the context of the one health model, a healthy population is not just a concern for the public health department and/or the health care system but is a concern for all.

The panel specifically focused on the topic of vector-borne diseases, more specifically on mosquito-born diseases. Panelists included Dr. Teresa E. Leslie (Eastern Caribbean Public Health Foundation), Ms. Delia Goilo (Erasmus University and Medical Center), Dr. Sharon Viera (Chief Veterinary Officer Sint Eustatius) and Mr. Javier Gomez (Vector Control, Sint Eustatius Department of Public Health).

Vector-borne diseases are transmitted among human, animal, or plant hosts by arthropods, usually insects such as mosquitoes. A broader definition of vector borne diseases recognizes that other animals can serve in the role of infectious disease vector by harboring pathogens that cause disease in susceptible populations (e.g., fleas on rats during bubonic plague).
Recently known examples of mosquito-born diseases impacting the Caribbean human population include dengue, chikungunya (CHIKV) and Zika. Possible symptoms of these diseases include fever, joint pain, headache, vomiting, muscle and joint pain, skin rash and Zika could cause birth defects (microcephaly). Dengue has been endemic in the region for years (Leslie et al., 2014), but CHIKV and Zika recently caused epidemics. It can be assumed that all three are currently endemic which means that the disease is regularly found among people in a certain area (Leslie et al., 2017).

It is possible that other diseases are circulating, however, there is a lack of data available and more information is needed. Little is known for example about the West Nile Virus (WNV) in the Caribbean. WNV, a mosquito-borne pathogen that can affect people and birds, has wiped out millions of birds every year across North America (Morell, 2015). WNV could also impact equine populations such as horses and donkeys (Bolfa et al., 2017). The research raises concern about the long-term impacts of the disease, particularly on threatened and endangered bird species.

On St. Eustatius, mosquito density is correlated with human actions, especially cleanliness. A clean environment helps decrease the number of mosquito breeding grounds and therefore the incidence and prevalence of disease. However, individual/household actions such as proper waste and animal management are sometimes limited. In addition to increasing the risk of mosquito breeding sites, inadequate waste management and roaming animals have the potential to disrupt Statia’s fragile island ecosystem. Furthermore, the accumulation of waste can harbor rat populations which not only threaten the public’s health but also threaten native species such as red-billed tropicbirds (Phaethon aethereus) and iguana nesting sites. Unattended roaming animals not only harbor zoonotic pathogens but can damage the island’s biodiversity by eating many plant species. Proper waste and animal management strategies are therefore not only important to prevent mosquito-born diseases but also to nature conservation.

During the session Ms. Delia Goilo (Ph.D. student, Erasmus University and Medical Center), reported on the the NWO funded project “Dutch Caribbean Preparedness for Mosquito Bourne Diseases (DUCAMID)”. DUCAMID aims to improve research preparedness of the Dutch Caribbean islands and to predict, detect, and study emerging mosquito-borne infectious diseases, as well as establish a network to optimize the investigation of those factors driving arboviral disease emergence. This will be accomplished by the integration of basic laboratory science and epidemiology. Erasmus University and Medical Center is the lead on DUCAMID and brings together key players in Curaçao (Curaçao Biomedical & Health Institute and Fundashon Dier en Onderwijs Cariben), Sint Eustatius (Eastern Caribbean Public Health Foundation) and the Caribbean Netherlands Science Institute (CNSI). Additional partners include the Netherlands Centre for One Health (Erasmus MC) and Wageningen University with its vector ecology research program.

The partners involved in DUCAMID from the Caribbean play an essential role in research on vector-borne diseases and are linked to regional research and public health expertise.
Erosion around Kralendijk, Bonaire

Nick Roos, Master student VU (Vrije Universiteit Amsterdam). This article was published in BioNews 19.

On Bonaire there is a big problem with erosion. In areas with sparse vegetation, intense rainfall events can loosen the soil material, after which it is transported away towards the ocean by rainwater flowing over the surface. Not only causes this a loss of fertile soil, it also has negative consequences for aquatic life and plants along the coast, such as the coral reefs of Bonaire and the species which depend on them. On top of that, scuba diving and snorkeling is an important tourist attraction in, for instance, the capital of Kralendijk where erosion is relative high.

Erosion of soil can be influenced by many factors, such as the infiltration rate of the soil and the vegetation cover. Many human activities, such as deforestation, overgrazing by goats and urbanization affect these factors, and thus the erosion. A low capacity of the urban drainage system and poor spatial planning compound these effects.

An three year-project to reduce Bonaire’s erosion problem, improve water management and restore some of Bonaire’s natural areas is currently in progress thanks to funding by the Ministry of Agriculture, Nature and Food Quality through the Nature Fund. The “Combating Erosion and Nature Restoration” project started at the end of 2016 and will end in October 2019. It is led by Bonaire Agri and Aqua Business NV (Sherwin Pourier), Wayaká Advies (Jan Jaap van Almenkerk) and coordinated by the Island Government, Directorate of Spatial Planning and Development.

Photo by: © Nick Roos
The Vrije Universiteit (VU) and Universiteit van Amsterdam (UvA) are teaming up with partners from Bonaire (Wayaká Advies) to do research into these erosion issues. Nick Roos, a MSc Hydrology student at the VU, examined the causes of erosion by determining the most important soil and hydrologic characteristics of different land types around the capital of Kralendijk. In the picture he is measuring how thick the layer of deposited soil is in the Saliña di Vlijt. This appears to be 50 cm in some areas. This is fertile soil that flowed from higher areas into the Saliña during heavy rainfall and is testimony to the magnitude of the erosion issues in the area. Using his measurements, he developed a hotspot map indicating which areas probably constitute most to the erosion.

His research is a start to determine where action could be taken to reduce erosion and gives input for the type of measure that may be suited for such an area. Most promising measures, are the reduction of paved areas and overgrazing. New methods (e.g. permeable asphalt and more vegetation) are doable and cost friendly ideas to achieve the goal of increasing infiltration in paved areas. Overgrazing is a problem that could be solved by controlling areas for grazing. By fencing off more areas from goats, sheep and donkeys, grazing pressure on multiple areas is reduced. Therefore allowing vegetation to grow and reduce soil erosion. (Roos, 2018).

Would you like to stay up-to-date?
You can follow all the Nature funding projects on Bonaire on Facebook @NTBDN and website https://bibadinaturalesa.com.
Check also NTBDN TV: https://bibadinaturalesa.com/nos-ta-biba-di-naturalesa-tv/
Twenty-five participants attended an informative workshop on invasive species on November 28th and 29th 2017. The Caribbean Netherlands Science Institute (CNSI) hosted the workshop on St. Eustatius under the Nature Awareness project, which is funded by the Ministry of Agriculture, Nature and Food Quality (LNV) (formerly Ministry of Economic Affairs). The workshop was facilitated by three marine and terrestrial biologists from Naturalis Biodiversity Center in the Netherlands (Dr. Bert Hoeksema, Dr. André van Proosdij, and MSc. Niels Schrieken). Participants included staff and students from STENAPA and CNSI as well as relevant government sectors such as Public Health, Agriculture & Fisheries, and Harbor.

Beginning with an overview of terminology on Day 1, the differences between indigenous, cryptogenic, exotic, introduced, and invasive species were explained, with examples of vectors for introduction such as boats, planes, and the pet & ornamental plant trade. Islands are particularly vulnerable to invasive species because many islands are relatively small and isolated. Yet, islands represent the greatest concentration of biodiversity and species extinctions (40% of fauna at risk of extinction; 80% known extinctions since 1500).

Once an invasive species arrives on an island, early detection is crucial to avoid excessive eradication costs and negative side-effects once it becomes established. Actions that can be implemented include species alert lists, action plans, effective border controls, public awareness, invasive species management teams, government policy (and enforcement), and quarantine import documents.

Botanist Dr. André van Proosdij led an afternoon field excursion on land species (plants) during which the group visited areas affected by non-native/invasive flora and compared differences between the sites. Participants used skills developed in the workshop to determine to what extent an area is impacted by invasive flora at present and to predict how it could look in the future if no effort is made to control these. Mexican Creeper, also known as Corallita (Antigonon leptopus), is one of the most pervasive invasive terrestrial plant species on St. Eustatius, covering around one-third of the island and smothering native vegetation in its path. There is no known effective control of this plant, and even free-roaming goats and sheep do not find it palatable. In the sea, the invasive seagrass species Halophila stipulacea has become notorious for aggressively replacing local seagrass species. Because this happens out of sight, most people are not aware of it.

Dr. Bert Hoeksema kicked off Day 2 with an overview of St. Eustatius’s non-indigenous terrestrial animals and potential new arrivals. He highlighted the dangers of existing invasive species such as the giant African land snail (Achatina fulica), which led to an interactive discussion by the stakeholders who are already working to combat this species. Also discussed were the threats of potential invasive species – which may exist on other islands but have not yet reached St. Eustatius – and how to prevent these crossing borders. These include species such as the vervet monkey (Chlorocebus pygerythrus), Cuban tree frog (Osteopilus septentrionalis), red palm mite (Raoiella indica), green mussel (Perna viridis), and much more.

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Dr. Bert Hoeksema also gave a similar presentation on marine animals recorded from St. Eustatius and other areas in the Caribbean and the West Atlantic. The lionfish (Pterois volitans and P. miles) is well known but not many workshop participants were aware of the orange cup coral (*Tubastraea coccinea*) that entered the Caribbean in the 1930s by vessels and appears to thrive well on artificial substrates.

Invasive fauna species can impact human health, native wildlife and ecosystems, and the local economy. The green iguana (*Iguana iguana*) is a perfect example of an invasive species that has spiraled out of control on many Caribbean islands. On Grand Cayman in the Cayman Islands, for example, green iguanas make their homes in trees and buildings located close to water. Roadkill, damage to crops, flowers and plants, and lizards taking a dip in pools are taking their toll on residents. In 2015, scientists estimated the population to be around 152,000; when farmers killed up to 20,000 green iguanas, the population rebounded within about one week. Without adequate control, numbers could soon exceed 1 million.

STENAPA gave an insight into the efforts being made locally to combat the invasive green iguana and lionfish on St. Eustatius. The arrival of the green iguana is terrible news for islands that house the regionally endemic lesser Antillean iguana (*Iguana delicatissima*), and unfortunately, St. Eustatius has recently fallen victim to this. Following the discovery of an adult female green iguana in 2016, six hybrids were captured during intensive search efforts. This is an ongoing cause for concern on the island. In 2000, the first lionfish were spotted in Bermuda and have since spread across the Caribbean Region. With their voracious appetites and rapid reproductive rates, lionfish pose a severe threat to native fish species. On St. Eustatius they are harpooned and brought back to shore where their stomach contents are analyzed, and the flesh can safely be eaten once the poisonous spines are cut off.

Biologist MSc. Niels Schrieken led the afternoon field session on marine species with a focus on the settlement plate (SETL) project, whereby PVC plates are hung at a depth of one meter below the surface and checked quarterly to inspect the marine species that attach to them. Introduced marine species can easily be detected thanks to this globally applied method, especially in the proximity of harbors. Three SETL plates were installed along Oranje Bay, and the data collected will be submitted to a global database.

Invasive Species Workshop on St. Eustatius

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The arrival of the green iguana is terrible news for islands that house the regionally endemic lesser Antillean iguana.

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Photo by: © Rostislav Stach
**SETL project**
The SETL-project is a community study which monitors the diversity of species living on a hard surface. This project was launched in 2006 in the Netherlands by GiMaRIS, in close collaboration with the Smithsonian Marine Invasions Laboratory, and is still run by them. The SETL-project is also run locally in the USA by the Salem Sound Coastwatch and is project-based in other European countries and throughout the Ponto-Caspian region (see figure). The plate design has been deployed along both coastlines of northern America and in Hawaii to facilitate comprehensive comparisons. Within the Caribbean Basin, there are sites in Central America but none on the Atlantic side. St. Eustatius could become the first SETL-location for the Caribbean Basin on the Atlantic side.

**SETL Methodology**
Around 150 SETL plates are deployed each year in the Netherlands at about 12-15 sites, mostly in pleasure craft harbors and ports. A SETL-plate consists of a 14x14x0.5 cm grey PVC plate attached to a brick to keep it horizontal, hanging from a plastic line with a metal core in the water column. It is deployed at a depth of 1 meter under the water line if attached to a floating object, and 1 meter under the low water line in tidal areas if fastened to non-floating structures. Monitoring the plates is best done repetitively. Collected plates can be taken back to the lab for further analyses. When photographed in the field they can be redeployed after photographing. Pictures taken of the plates are divided on an overview photo into 25 grids, and the presence of species is scored for each grid.

**Using SETL data**
In the Netherlands, 233 species have been documented on SETL plates over the years. A new species was recorded in the Wadden Sea immediately after the SETL-project started in 2006, which illustrates the project’s potential as an early detection method for species. The SETL-plate is easy to retrieve, making it user-friendly and a great way to make life underwater more visible for the local population and in student projects.

**Workshop follow-up**
The workshop encompassed interactive sessions and discussions that led to extensive knowledge sharing and development at all levels. A recommendation/discussion document has been created based on particular issues flagged for importance, including inspections/border control, customs, and capacity-building.

CNSI will organize a follow-up session to promote further discussion and to formalize specific action points between key island stakeholders. It will encourage those who could not attend the workshop to become involved and will focus on the creation of a task force and/or training if necessary. The responsibility of various stakeholders for e.g. detection of invasive species will also be discussed.
Sunscreen Awareness Bonaire

By Diana Slijkerman (WMR) & Sharon Bol (BD). This article was published in BioNews 15.

Wageningen Marine Research (WMR) and Boneiru Duradero (BD) supported by World Wide Fund for Nature the Netherlands (WWF-NL) organised a Sunscreen Awareness Conference, on March 21st 2018, inviting stakeholders from the government, NGO’s and tourism sector on Bonaire to participate. The goal of the conference was twofold:

1. Educate participants about international sunscreen research and the studies that were implemented on Bonaire.

2. Create “buy-in” and create partnerships by engaging stakeholders to develop an island wide sunscreen strategy for Bonaire.

The conference started with a presentation by Diana Slijkerman (WMR), to inform participants on international sunscreen research and the studies that were implemented on Bonaire. Sunscreen research is relatively new and still ongoing, but one thing is very clear: the UV-filter oxybenzone has been identified as the major “culprit” harming corals.

Studies done in 2016 and 2017 on Bonaire showed that UV filters from sunscreens are present in the water of Lac Bay at levels that cannot exclude environmental effects on the organisms in the highly valuable ecosystems. The latest study also included nearly 400 interviews among beachgoers on Sorobon, asking the tourists where they are from, what sunscreen products they use, and whether or not it includes oxybenzone. Although the study was indicative, UV-filter levels and thus environmental risk seem to be related to tourist intensity, country of origin and product use. The levels of oxybenzone found in water samples were higher when more beachgoers used oxybenzone-products. These tourists, predominantly cruise tourists, were mostly originating from the US. Stay-over tourists from the EU show a relatively limited use of oxybenzone-based sunscreen products.

Dr. Slijkerman’s problem analyses made clear that sunscreen pollution is neither the biggest nor the only threat to coral reefs. Climate change, overfishing and eutrophication are the main drivers of the degradation of our reefs for the last decades. However, impaired water quality by chemicals such as UV filters adds to the problems of already stressed reefs which undermines their resilience and ability to withstand and recover from e.g. global warming related impacts.

Although not studied extensively, international scientist claim that sunscreen products containing UV-filters based on zinc and titanium are better alternatives. A positive and clear action perspective on the local scale makes it possible to improve water quality in order to make reefs more resilient.

Participants of the sunscreen conference agreed on the clear action perspective. “When we convince tourists on Bonaire to use sunscreens without oxybenzone, every swimmer, snorkeler and diver can contribute to the improvement of water quality today” Sharon Bol says.
There was a general consensus among all participants that action should be taken on Bonaire concerning potentially harmful sunscreens. The attendees of the conference participated in a lively discussion, and the following paths forward were identified:

1. Legal ban of oxybenzone-containing products.
2. Changing consumer behaviour.
3. An environmental tax for cruise tourist.

Representatives from the tourism sector were mostly in favour of a legal ban. They feel that a legal ban on the UV-filter oxybenzone will make it easier to convince their customers of the harmful impact of sunscreens to our reef. In contrast, most NGO's and members of the government are opposed to a ban. They have concerns about the feasibility. In the first place, it would be very difficult to build a legal framework that covers all arguments. Enforcement would also be an issue: “We could try to prohibit the sale of sunscreens with oxybenzone on Bonaire, but it is impossible to control the sunscreen products tourists bring from home.”

A rule in the Bonaire National Marine Park management plan could, however, strengthen the communication about the subject.

The solution for reducing impact of sunscreens on the reef is largely connected to behavioural change. It is as simple as avoiding sunscreens with oxybenzone. That is why most participants of the sunscreen conference viewed awareness as the best way to move forward. Moreover, an awareness campaign can be implemented much faster than a law. Another advantage of sunscreen awareness is that it can help to reinforce Bonaire’s positioning on the “vacation market”. After all, we are striving to be a sustainable island. Participants agreed unanimously that there is a positive and clear action perspective. WMR and BD are in the process of developing communication materials for an island wide awareness campaign. This includes an educational poster and an animation video that should educate tourists and inhabitants on Bonaire about the effect that sunscreens with the UV filter oxybenzone can have on corals.

The informative poster was finalised using the participants inputs, and distributed among dive shops and supermarkets. The online artwork of the poster reached 35,000 people through Facebook. The animation was also launched online and had 3000 views. It could be promoted further e.g. via Tourist TV and TV screens at airport, in hotel lobbies and restaurants.

The fact that cruise tourists do not pay any fee for the use of the marine park is a concern to most participants of the sunscreen conference. Stay-over tourists and other users of the marine park pay an annual fee of 10 USD for water activities such as swimming or bathing but cruise tourists don’t have to pay. Since cruise tourists that enter Bonaire’s sea attribute to the decreased water quality too, an environmental tax for cruise ship visitors should be considered. This tax would allow Bonaire to continually fund awareness campaigns, educating tourists about the use of sunscreens and the unique value of Bonaire’s coral reefs. Most importantly is that the cruise sector has to be engaged, on a strategic island level. Cruise tourists should be made aware of the unique quality of Bonaire’s nature and the fact that they are visiting protected areas. Furthermore, they should be informed NOT to bring oxybenzone-sunscreens to Bonaire while booking their trip.
During the conference, many remarks and questions were brought into the lively discussion. Among many things it was argued whether or not the current law already provides us the ability to prevent the use of oxybenzone inside the Bonaire National Marine Park via a revision or addition in the marine park management plan. The urgent need for more research was also expressed. Research should focus on additional water quality monitoring, and potential levels and effects of current proposed alternatives such as zinc and titanium. The conference concluded with a list of action points and possible opportunities for island-wide cooperation.

Soon after the conference, several positive steps forward were made by the public and private sector on Bonaire. Van den Tweel Supermarket Bonaire is one of the first supermarkets on Bonaire that removed sunscreens with the UV-filter Oxybenzone from their assortment. Furthermore, Jibe City did not hesitate and switched to selling a different brand of sunscreen. And, inspired by the recent decision of Hawaii to ban harmful sunscreens, the Island Council unanimously adopted a motion calling for a ban per January 1, 2021 for sunscreen product containing oxybenzone and octinoxate. The team is willing to share their knowledge and contribute to the steps to be taken in the process that lies ahead.

Coming year, the project team goes ahead with the Sunscreen Awareness project, focusing on both remaining research topics and awareness raising via various media.

Questions and remarks? Please contact the team via: Diana.Slijkerman@wur.nl and Sharon@bolholding.com

We thank Sabine Engel (STINAPA Bonaire), Olivier Kramer and Carolyn Caporusso for their assistance and support.
How to Respond to a Sargassum Influx

In May 2018 the Gulf and Caribbean Fisheries Institute (GCFI) launched a new infographic guide for the tourism sector on how to respond to the sargassum influx, and best practices to apply if cleaning beaches.

“Pelagic sargassum is a brown alga, or seaweed that floats free in the ocean and never attaches to the ocean floor. These free-floating forms are only found in the Atlantic Ocean. Sargassum provides refuge for migratory species and essential habitat for some 120 species of fish and more than 120 species of invertebrates. It’s an important nursery habitat that provides shelter and food for endangered species such as sea turtles and for commercially important species of fish such as tunas. There are two species of sargassum involved in the sargassum influx: Sargassum natans and Sargassum fluitans” (Doyle and Franks, 2015).

Sargassum consolidates into large mats and travels on ocean currents. In recent years, massive quantities of pelagic sargassum have come ashore in the Caribbean, impacting shorelines and beaches, waterways, fisheries and tourism. “It is believed that the recent influxes are related to massive sargassum blooms occurring in particular areas of the Atlantic, not directly associated with the Sargasso Sea, where nutrients are available and temperatures are high” (Doyle and Franks, 2015).

The response to the sargassum influx has often been a knee-jerk reaction - uncoordinated and not always environmentally sustainable. Bad choices that are made in responding to sargassum place at risk the very resources upon which tourism depends - poor beach cleaning practices cause the loss of sandy beaches, worsened coastal erosion, the destruction of sea turtle and sea bird nests. But important lessons have been learned.
As the organizer of the region’s largest annual marine science meeting, GCFI has brought together researchers and coastal managers to examine the latest advances in science and to share management experience in relation to this emerging issue. A GCFI Fact Sheet about the sargassum influx addresses frequently asked questions (Doyle and Franks, 2015). A briefing paper prepared with key regional partners provides guidance for coastal managers (Hinds et al. 2016).

Now in early 2018, with an influx of sargassum again affecting parts of the Caribbean region, the GCFI is responding to the tourism sector’s urgent need for information on how to deal with this recurring phenomenon (Doyle et al. 2018).

GCFI’s sargassum factsheet and A2 poster can be downloaded here: https://www.gcfi.org/sargassum-influx/

A sargassum management briefing paper by key regional partners CERMES, SPAW-RAC and GCFI provides further guidance for coastal managers and can be downloaded here: https://www.cavehill.uwi.edu/cermes/getdoc/b23699d2-3d85-4f1e-ae21-9e9f3fca224/cermes_sargassum_management_brief_2016_08_24.aspx

DCNA is currently working on a briefing paper on the sustainable management of sargassum with a focus on prevention and clean-up of bay habitats (including seagrass beds and mangroves). Input is most welcome. Please email: research@DCNAnature.org
Sea & Learn 2018

This year Sea & Learn celebrated their 16th annual event on Saba. A total of 16 experts provided dynamic hands-on field projects and powerful presentations that engaged community awareness and discussions.

Each year Sea & Learn strives to improve the content, accessibility, and breadth of their program, and 2018 was no exception. International experts were able to interact with the entire Saba community: primary and secondary schools, adults, the elderly home, as well as tourists. The event ran throughout the month of October with a variety of activities from hands-on learning both on land and at sea as well as interactive multimedia presentations to reinforce the importance of environmental awareness on Saba.

Sea & Learn began on October 1st with the event officially opened by Governor Johnson’s address, followed by musical performances by Jen Porter, DJ Janssen, Ayan Farah, and Joost de Jong. They proudly performed for the local community building, the Eugenius Johnson Center. Opening Night at the local venue, Queen’s Gardens Resort, in partnership with Freegan Food Cafe, served a delicious vegan meal, with proceeds supporting those in need within the Saba community.

In 2018, Sea & Learn was taken to another level by partnering with Benevolent Foundation Saba and the Saba LIFE Center to bring the Sea & Learn program to the elderly. Five of their experts (Craig Berg, Angela Collins, Stacey Williams, Jetske Vaas, and Elizabeth Haber) had the pleasure of interacting with participants of the Saba LIFE Center. Presentations which were enhanced with live specimens and hands-on activities, took place at the local community building, the Eugenius Johnson Center. While the participants learned a great deal from the experts, the experts also gained local knowledge from Saba’s older generation. Both parties were very happy with the new partnership and look forward to further collaboration in the future.

The growing networking with the Saba Government and local community is one of many accomplishments fulfilled in 2018. Maud Kok and Jordy van der Beek, current master students at Leiden University, previously traveled to Saba in April 2017 to work with local vector control to assess local mosquito populations and their distribution patterns between urban and natural areas. During Jordy & Maud’s stay, they were able to collect many mosquito species to further their knowledge of Saba’s mosquito populations. They helpfully shared all findings with local vector control.

José Vargas, an invasive species control expert from Puerto Rico, used his platform facilitated by Sea & Learn to create a dialog between community members about priorities and strategies that work best for rat control in Saba. José used discussions with local vector control and placed tracking tunnels with students from local schools to assess which areas of Saba have large rat populations. He felt strongly that the rattraps, which do not use poison, could be an ideal solution to protecting the nests of Saba’s Tropicbirds. Nearly 80% of the world’s breeding population of Tropicbirds exists on the islands of Saba and Statia; therefore, controlling the rat population is vital to the success of this signature, beautiful bird.

The timing of the Sea & Learn event coincided with Saba Conservation Foundation’s launching of their strategic plan. This coincidental timing created the platform for possible future collaborations between our urchin expert, Stacey Williams, and DCNA representatives. Ongoing discussion of coral control continues with Jetske Vaas and Elizabeth Haber.

In order to keep pace with new social media tactics and to provide the program to a broader audience, Facebook-Live was used to live stream the presentations this year. During Director of Saba Archaeology Center, Ryan Espersen’s presentation, they had 900 views, 9 shares, 13 likes, and 8 comments on their live stream video. The team was able to successfully stream 14 Evening Presentations totaling to over 5,000 views. They are excited about the online participation and will continue to improve methods to create more social media presence for all Sea & Learn followers, and not only those present on Saba. They also posted short videos showing the activities experts conducted with students from Sacred Heart School and Saba Comprehensive School. Utilizing social media broadens their reach and provides another means to gauge public reaction to the event.

This year the team also expanded the program by making two field activities available to local students during their October school break. The field activities included a tide pool exploration hike with Stacey Williams and a fish dissection with Angela Collins. They had the help of local teachers, principals, and Saba Nature Education, to promote the October break activities. One student signed up for all of the activities and attended many evening presentations. His questions were insightful and added to Craig Berg’s presentation on Tree Frogs. They look forward to further expanding the Sea & Learn October Break activates for 2019.

Tropic Bird by: © Kao Wulf
Closing night at Scout’s Place ended on a high note with many community members involved in the festivities. In addition to the main presentation by Guido Leurs discussing sharks of the Saba Bank, Jens Odinga of Saba Nature Education spoke about Sea & Learn’s vital role in the community. Four raffle prizes were donated by local artists and Sea & Learn experts. The sale of raffle tickets from these donated prizes contributed over $1000 towards funding Sea & Learn 2018. Adding to the fun of Final Night was a trivia contest with correct answers rewarded with an eco-friendly Sea & Learn reusable water bottle. Shark expert, Guido Leurs, gave an interesting closing night presentation on the work he has done on the newly discovered Silky Shark of Saba Bank. Some lucky locals and tourists even got the chance to assist on his shark-tagging project!

Each year the Sea & Learn team seeks improved participation, not necessarily reflected in statistics but in the enthusiasm and feedback received throughout the community. By impacting both the youngest and oldest generations, they hope to continue the momentum that is created by a program like Sea & Learn where the incalculable value is promoting community engagement that can translate to awareness and involvement creating change. This concept goes beyond their goal of environmental awareness but can be used in any aspects that effect society.

Watch the Sea & Learn presentations:

- **Guido Laura** talk on silky sharks on the Saba Bank (starting at 23:09)
  https://www.facebook.com/seaandlearn/videos/288319162013032/

- **Jośe Vargas**’s presentation on invasive rat control
  https://www.facebook.com/seaandlearn/videos/318647085582662/

- **Tadizo Bervoet**’s (NFSXM) talk on coral and hurricanes
  https://www.facebook.com/seaandlearn/videos/4673480455544/

- **Elizabeth Haber’s** and **Jetske Vaas** talk on invasive species
  https://www.facebook.com/seaandlearn/videos/21582888909098543/

- **Angela Collins** talk about the mighty hogfish
  https://www.facebook.com/seaandlearn/videos/3164917834884/

- **Stacey Williams**’s talk on sea urchins
  https://www.facebook.com/seaandlearn/videos/256186561978171/

- **Craig Berg**’s talk on tree frogs
  https://www.facebook.com/seaandlearn/videos/2644065879031600/

- **Jelle van der Velde** talk on Saba’s Coral health
  https://www.facebook.com/seaandlearn/videos/290225231821228/

- **Jordy van der Beek** and **Maud Kok**’s talk on mosquitos
  https://www.facebook.com/seaandlearn/videos/1120356514796244/

- **Dahlia M Hassell** talk on Saba Sponges
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Mas Piska pa Boneiru: Less talk more action

Identifying and overcoming bottlenecks in Fisheries Management on Bonaire.

By Stacey Mac Donald, PhD researcher at KITLV/ The Royal Institute of South-east Asian and Caribbean Studies. This article was published in BioNews 11.

Fishing is one of the oldest professions in the Dutch Caribbean. Many families have made a living from the fisheries sector, passing on the tradition to their children. Over the years, however, the number of professional fishermen has declined due to various reasons. It has become increasingly difficult to make a decent living from fishing: global developments such as pollution, climate change and global overfishing and by-catch have devastating effects on the health of oceans and coral reefs and consequently local fish populations.

Promoting sustainable fisheries practices is a key element in safeguarding healthy oceans and marine ecosystems, and this crucial role is highlighted in the World Wide Fund for Nature (WWF)’s ocean strategy. Part of WWF’s strategy is to develop economically viable and community-supported sustainable fisheries. World Wide Fund for Nature – The Netherlands (WWF-NL) has been working in the Dutch Caribbean municipalities of Bonaire, Saba and Sint Eustatius for many decades and has an interest to develop economically viable and community-supported sustainable fisheries. Just like WWF-NL, many local fishermen feel an increasing need to take action to improve the fisheries sector. Fishermen are facing changes in the sector, notably increased legislation and restrictions, which affects their livelihood. Over time it is becoming more and more difficult for them to catch a decent amount of fish. And fishermen have traditionally received little help and support from the government.

The success of WWF-NL’s initiative is dependent on participation and support from the fisheries community itself as well as legislators and policymakers. Participatory fisheries management models have been successfully implemented in several places around the world. Close collaboration between fishermen, governments, industry and NGOs has led to effective and sustainable management, increasing fish stocks and economically strengthened fishing communities.

In the past, attempts to introduce participatory fisheries management within Dutch Caribbean have not been very successful. Meetings organized to discuss regulatory changes or to find joint solutions for unsustainable fishing practices have led to heated discussions and resistance from the fishing community. There has been quite some research in recent years which has focused on gathering data on the fisheries sector (e.g. De Graaf, 2016; Johnson & Jackson, 2015; Johnson & Saunders, 2014). Whilst this work helps to increase knowledge about fish catch as well as fishermen views and attitudes, none have so far led to successful co-management of the sector. Attempts by the National government (Rijksdienst Caribisch Nederland), local government and the park management organization, STINAPA Bonaire, have so far failed to adequately engage the fishing community and have sometimes even intensified reluctance among both fishermen as well as (local) institutions to work towards a participative fisheries management model. The need to achieve strong and effective co-management of the fisheries sector has become even more pressing in light of recent changes in fisheries legislation and evidence of declining fish stocks.

To understand how support can be leveraged among the stakeholders in the field to support sustainable fisheries within the Caribbean Netherlands, WWF-NL has initiated several fisheries related projects including a social mapping study of the fisheries sector on each island. I collaborated with the WWF-NL for the first mapping study, which took place on Bonaire and lasted three months. Working closely with local fishermen, as well as other stakeholders responsible for (sustainable) management of the fisheries sector, I identified, analyzed and sought solutions for the bottlenecks inhibiting co-management of the sector by means of a test case: setting up and supporting a fisheries cooperation on Bonaire.

Photo by: © Henkjan Kievit
Institutional framework: where are the fishermen?

On Bonaire, effectively implementing sustainable initiatives within the fisheries sector has been challenging. Fisheries legislation is outdated and deficient and, more importantly, there is much debate over whether the fishing community has been sufficiently involved in the development of local legislation. Despite attempts to manage and improve the fisheries sector, several basic elements for effective management are lacking.

The lack of participation of fishermen in the decision-making process is a significant issue as their involvement is a pre-requisite to the efficient management of the fisheries sector. In the first phase of the project, I created several organograms of the organizational structures currently responsible for the management of Bonaire's fisheries sector. These organograms revealed the absence of fishermen in the decision-making process.

During the interview phase of the project, different stakeholders from Bonaire's fisheries sector gave different reasons and solutions for this lack of fishermen participation. This was based on Smith, Sainsbury and Stevens (1999) who stated that: “Fisheries management is characterized by multiple and conflicting objectives, multiple stakeholders with divergent interests and high levels of uncertainty about the dynamics of the resources being managed” (p. 965). This management complexity is visible on all levels on Bonaire.

Not only is it practically complex to manage a fisheries sector, one must also deal with psychological and behavioral factors such as a perceived sense of fairness, emotional and cultural values, social norms and resistance towards breaking old habits. The consequences of a proposed solution affect each stakeholder in a different manner. Because of their non-participation, the fishermen on Bonaire have often been the direct ‘victims’ and have become increasingly hesitant to support initiatives aimed towards sustainability.

Based on both a literature review and insights derived from interviews with different fisheries stakeholders on Bonaire, it was clear that to truly understand the organizational and social struggles present in the field of fisheries management, and more importantly, to come up with practical, effective solutions, the average research approach (e.g. conducting a series of interviews, distributing a questionnaire, carry out a series of observations) was neither sufficient nor desirable. A new question and goal arose: who are the fishermen of Bonaire, (how) do they want to be included, and if so, what do they need to be included in debates and projects concerning fisheries management on Bonaire?

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Photo by: © Stacey Mac Donald
Launching PISKABON: a functioning fisheries cooperation.

The most obvious approach to empower fishermen to structurally provide input into management decisions taken within the sector is by means of a fisheries cooperative (called PISKABON, which stands for Fish (piska) Bonaire). Previous unsuccessful attempts to establish a fisheries cooperative left the fishermen feeling demotivated and skeptical about why fisheries management is needed or even desirable. Fishermen felt that there were hidden agendas, that the previous cooperative wouldn’t help all fishermen equally and that organizing themselves and collaborating with nature organizations and/or the government would simply lead to more restrictions, rules and regulations. This would consequently mean that the fishermen would lose their freedom, which is one of the main reasons why these men (and women) choose to become fishermen in the first place.

Attempts to improve the monitoring of fish catches, for example, created concern amongst fishermen that this would result in them having to pay taxes — something they’ve never had to deal with. Aware of this sentiment and based on my initial conversations and observations, I decided to apply a more hands-on approach: less talk, more action.

Unexpected achievements
Within a couple weeks after my arrival on Bonaire, a board of directors was elected by the first newly registered members of the cooperation. In the following two weeks, the cooperation secured its first funding from the Dutch Government. In the second and third month, the beginnings of a strategic plan and communication plan were put in writing, amendments were made to the by-laws and introductory meetings with the most important stakeholders were arranged.

Why it worked: Action, trust, patience, and interdependence
By working closely with the board of the directors and consequently with other fisheries stakeholders on Bonaire and in the Netherlands, I was able to observe and experience the struggles in fisheries management up close and personal. This approach also allowed me to try out solutions on the spot. Four key elements led to successful interactions with the fishermen and the realization of the fisheries cooperation: action, trust, patience, and dependence.

Action: Support and mediation
While the previous attempts to launch a fisheries cooperation were unsuccessful, they did provide crucial knowledge of do’s and don’ts throughout the process. Specifically, neither the initiative nor the board members should be politically associated. Also, being a “true fisherman” was not an important criterion for board members, compared to more useful assets such as being available, willingness and commitment, a generally positive or neutral social status, and knowledge of the different types fishermen and fisheries practices on Bonaire.

In addition, the new board members received full time, practical support, which was not the case in the past. Currently, the fisheries cooperation is still made up of volunteers with limited time and in some cases limited knowledge about the procedures needed to follow to succeed. Lack of action amongst fishermen is not due to unwillingness, but due to lack of time and resources. Removing these obstacles by adding someone to support them full time allowed board members to share their input, experience successes and motivate them to increasingly prioritize their efforts for the cooperation. The support provided should be done by someone who is driven, proactive, patient, a fast learner and able to mediate between different stakeholders with different needs and interests.
Patience: step by step
One of the main insights gained during the process is that board members must be given the opportunity to gain knowledge and understanding, formulate their opinions and come up with workable solutions. I stressed this factor amongst stakeholders such as the Ministry of Agriculture, Nature and Food Quality, STINAPA Bonaire, WWF-NL and other individuals eager to collaborate with the cooperative. Simultaneously I remained focused on supporting, informing and pushing the board members to act. Leaving too much room for discussion and discovery might lead to non-action, which in turn can lead to missed chances and opportunities.

Interdependence
The more experienced individuals in fisheries management often feel that their views or knowledge should carry more weight. While their experience is important, it is also crucial for these experts consider the ideas and insights of fishermen. Fishermen must also understand and accept the protocols and procedures that must be followed to achieve certain goals, and that these require persistence, communication and a lot of action. Fortunately, I noticed throughout the project that board members as well as many fishermen have a strong desire to collaborate. Successful participatory fisheries management requires that all stakeholders be aware of their interdependence to each other.

The future of PISKABON
Although much has been achieved during the past months with PISKABON, the road ahead remains long and at times difficult. The current board members possess several strong and important qualities that will help build trust among fishermen. However, several important steps must be taken to ensure the long-term success of the cooperation. For example, board members must receive support and coaching so that they can excel in their role. Gaining more trust from the fisheries community should also help ensure that PISKABON truly represents the fishermen of Bonaire. This can be achieved with the successful execution of tangible (small) projects that favor the fishermen.

Lastly, all stakeholders must be made aware the inclusion of fishermen in participatory fisheries management practices is not PISKABON’s sole purpose. PISKABON is a fisheries cooperative, which aims to address the fishermen’s needs. In addition, PISKABON can inform, educate and represent the fishermen about and during (sustainable) management initiatives. If approached in a transparent manner and with rigorous communication, PISKABON can also facilitate the collaboration of fishermen in monitoring research and the implementation of new sustainable fishing practices or techniques, provided that the different stakeholders’ common values are fostered.

PISKABON’s future looks bright, but its ultimate success will depend on the cooperation between stakeholders and the realization that they are very much interdependent. Like one of the board members repeatedly says: if all parties make the effort, PISKABON can do great things for the fishermen, the entire community and perhaps even become an inspiration for the region. If successful, PISKABON could be the missing link in the co-management of the fisheries sector. This could result in more sustainable fishing practices where everybody wins, a goal WWF-NL full heartedly supports.

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Photos by: © Stacey Mac Donald
Representatives from 15 Caribbean marine national parks recently met on the island of Saba in the Caribbean Netherlands to focus on their role in contributing to sustainable fisheries.

Hosted by the Saba Conservation Foundation, this regional gathering included park managers from Saba, Sint Eustatius, Bonaire, the British Virgin Islands, the Turks & Caicos Islands, Honduras and Belize. The park managers were joined by fishers, fisheries policy advisors and fisheries data officers from Bonaire, Saba and Sint Eustatius, plus fisheries scientists from the US and Mexico, and regional NGO and academic partners.

Marine protected areas (MPAs) are an important tool in fisheries management. Large, multi-use MPAs such as the Saba Bank National Park, Cayos Cochinos Marine Natural Monument in Honduras and Port Honduras Marine Reserve in Belize play a key role in ensuring sustainable local fisheries harvests.

Mrs. Celia Mahung, Executive Director of the Toledo Institute for Development and Environment comments: “In Belize, fishers are allocated specific fishing areas, based on historical use, and they also have access to deep water fishing. MPA co-managers work on creating awareness of regulations and ensuring compliance to build sustainable fisheries for future generations.”

“We cannot do this on our own”, says Mrs. Mahung. “Fishers in turn help us by recording catch data, and a combination of local knowledge and science is used in adaptive management for commercial species. MPA managers, leaders of fishing organizations and international partners work with the Belize Fisheries Department to make sound decisions about sustainable levels of catch and to ensure the implementation of best practices for wise fisheries management,” she explains.

Smaller marine protected areas also have an important role to play in ensuring healthy local reef fish populations through the implementation of no-take fisheries regulations, such as in Saba National Marine Park, Statia Marine Park and Bonaire National Marine Park. These parks support valuable tourism industries associated with diving and snorkelling. They also contribute to sustainable fisheries by protecting large and highly reproductive fish within park boundaries, whose young then spill over into surrounding fishing areas.

Statia Marine Park Manager, Ms. Jessica Berkel, explains: “Our marine parks bring about positive benefits for tourism and for fisheries, but as managers we face many challenges. Effective enforcement is needed to ensure that fish can grow and reproduce, and to ensure protection of the largest, most fertile fish and lobsters. In some parks, pressure from recreational fishing can be high but goes unmonitored. Meaningful communications with park users and dynamic education programs for youth are essential.”

“By exchanging ideas and sharing expertise with other managers we can keep pace with advances in fisheries management in the region, such as new enforcement strategies and technology, and community programs for research and monitoring. We can see how to better support monitoring and management actions to protect coral reef ecosystems in our own parks.”

Parks Manager at the Saba Conservation Foundation, Mr. Kai Wulf, comments about the meeting: “We’ve gained new insights into fisheries biology, ecology and management strategies from top regional fisheries scientists. Visiting Mexican lobster specialist, Dr. Eloy Sosa Cordero, was impressed by the fisheries data we’ve collected on Saba and was enthusiastic about the opportunity we have to apply this data to inform sustainable fisheries.”

“In other countries, fishers and MPA managers have participated in field visits to learn about sustainable fishing practices and share management experiences. Such exchanges, plus small project funding, technical support and sharing of monitoring findings with fishers and communities are among the next steps we look forward to taking,” commented Mr. Wulf.

Making the most of the visitors on-island, the Saba Conservation Foundation Junior Rangers participated in a hands-on lobster session with Dr. Eloy Sosa Cordero. Some faced their fears and got up close with live lobsters. Others learned what it’s like to work as a marine biologist and lobster researcher. They all learned fun facts about the life cycle of lobsters and their distribution throughout the Caribbean.
The meeting was an initiative of the MPACOnnect Network which is comprised of marine protected areas in 10 Caribbean countries and territories, working in partnership with the Gulf and Caribbean Fisheries Institute and the US National Oceanic and Atmospheric Administration’s Coral Reef Conservation Program, with funding from the US National Fish and Wildlife Foundation. Six regional MPACOnnect learning exchanges have been held to date, each bringing together MPA managers from around the Caribbean to share experiences and discuss best practices relating to priority management themes such as marine law enforcement, protected area financing, coral reef monitoring, and MPA outreach and education programs. For more information please contact mpaconnect@gcfi.org.

About the Gulf and Caribbean Fisheries Institute (GCFI): When the Gulf and Caribbean Fisheries Institute was founded in 1947, the riches in our seas appeared limitless. Originally GCFI helped develop new ways to exploit the region’s marine resources and to develop new fisheries based upon this perception of an inexhaustible sea. However, it wasn’t long until the degradation of marine resources and threats to regional fisheries were documented. GCFI now works to advance the goals of sustainable use, wise management, conservation, and restoration of fisheries in the region. GCFI provides a platform for the exchange of information and perspectives among decision-makers, scientists, managers, educators, resource users, and students. For more information please visit www.gcfi.org.

Participants in the peer-to-peer learning exchange on fisheries management for Caribbean MPA managers. Photo by: © K. Wulf

Caribbean Marine Park Managers Dive into Fisheries Management
St. Eustatius: Economic Value of Nature

By Hannah Madden (CNSI). This article was published in BioNews 11.

The Caribbean Netherlands Science Institute (CNSI) hosted two “Economic Value of Nature” workshops on St. Eustatius from 3-6 April 2017. These workshops are part of the “Nature Awareness Project” which is funded by the Ministry of Agriculture, Nature and Food Quality (LNV) (formerly Ministry of Economic Affairs) through the Nature Funds (natu-urgelden) and facilitated by CNSI. The workshops were led by experts from Wolfs Company and Wageningen University who have visited the island numerous times to conduct research projects, such as The Economics of Ecosystems and Biodiversity (TEEB) study.

The one-day private sector workshop was attended by representatives from NuStar Terminals, St. Eustatius National Parks Foundation (STENAPA), St. Eustatius Tourism Development Foundation, Scubaqua, and the Chamber of Commerce. The goal of the workshop was to improve the participants’ understanding of how the private sector depends on ecosystem services and how they impact these services. During the workshop, participants used the Ecology Scan tool developed by Wolfs Company to identify these impacts and dependencies. Subsequently, company strategies were discussed to maximize opportunities and minimize threats related to the natural environment.

The three-day public sector workshop was attended by civil servants from various departments such as the Department of Agriculture and Fisheries, public works, public health, infrastructure and economy, and the licensing unit. The goal of this workshop was for nature managers and civil servants to develop an understanding of why valuing ecosystem services is useful for St. Eustatius, and how to use the valuation results in day-to-day operations. Special emphasis was placed on how this information can be used to develop financial and regulatory policy measures that will improve nature management, support the development of a sustainable island economy and maximize the future well-being of Statia’s citizens.

Both workshops consisted of theoretical sessions combined with interactive discussions and exercises. Working groups were asked to develop cases based on identified policy questions or business operations. The results of the assignments give an insight into how the results of the TEEB St. Eustatius study can be used and lead to recommendations for further research.

The objective of both workshops was to raise awareness of the interdependency of nature and socioeconomic prosperity, as well as to build capacity to incorporate this knowledge into policy and business operations on St. Eustatius. In the public sector workshop, this mainly related to the economy of St. Eustatius as a whole, while the private sector workshop focused on the operations of specific companies.

Participants learned to identify different ecosystems on St. Eustatius and were trained in ecosystem valuation methods and techniques, using specific Statian cases. They also learned about the valuation of ecosystem goods and services studies that have taken place in the Caribbean, as well as their influence on nature conservation, management, investments and policies in the region. The workshop also saw the discussion of factors that increase the effectiveness of a valuation study, as well as the presentation of socio-economic benefits resulting from influencing nature conservation, management investments, and policies. Additionally, the effects of natural resource conflicts and their relation to ecosystem services were demonstrated.

Background: the value of natural capital on St. Eustatius

Healthy ecosystems such as the island’s coral reef patches and the forests on the hillsides of Boven and the Quill are essential to human well-being on St. Eustatius. The St. Eustatius Strategic Development Plan also acknowledges the importance of the island’s natural attractions to the growth of the tourism sector. Local and global developments have led to an increase in serious threats to these fragile ecosystems, jeopardizing the foundations of the island’s economy. To make well-founded decisions that affect the natural environment on the island, it is key that nature’s contribution to St. Eustatius’ economy and well-being is well understood and highlighted.

Economic valuation of Statia’s main ecosystem services has drawn attention to the economic benefits of biodiversity and has highlighted the growing costs of biodiversity loss and ecosystem degradation. The results of the TEEB St. Eustatius study are presented in four reports on the value of Statia’s nature by Wolfs Company and the VU University in Amsterdam. As a part of this study, a survey, which involved over 1,000 respondents including tourists, residents, and citizens of the European Netherlands, demonstrated that natural capital strongly contributes to the island’s economy and the well-being of its residents.

Estimates put the total economic value (TEV) of the ecosystem services provided by the marine and terrestrial ecosystems of St. Eustatius in 2014 at $25.2 million per year. This TEV and its underlying components can be used to evaluate strategies for effective conservation measures and sustainable development on St. Eustatius. After analyzing the impact of different development scenarios on the value of future ecosystem services, it becomes apparent that there are indeed opportunities to develop the tourism industry. However, expanding the tourism sector beyond levels of sustainable use will cause pressures that the local ecosystems cannot endure. Consequently, degradation of the natural environment will result in fewer tourists coming to St. Eustatius. The current demand on the ecosystems of St Eustatius and unsustainable development practices is projected to decrease the TEV of the island’s natural environment from $25.2 million today to around $18.5 million in 30 years.

1 For all reports on the ecosystem service valuation study see http://www.wolfscompany.com/teeb-st-eustatius/
2 Calculations done with currency value in 2014
St. Eustatius: Economic Value of Nature

Public sector workshop (3 days)

The set-up of the public sector workshop was based on the structure presented in Figure 1. The framework reflects the research steps of a natural capital assessment. By combining theoretical presentations, examples from natural capital assessments elsewhere and practical sessions to apply the theory to the context of St. Eustatius, participants were guided through the research process.

The workshops began by defining ecosystems and ecosystem services and identifying relevant stakeholders. Participants then helped determine threats to the selected ecosystems, and developed scenarios to assess the changes in ecosystem service benefits over time and their impact on different stakeholders. Different types of values and available valuation techniques were discussed to quantify this socioeconomic impact and data requirements were established based on selected valuation techniques. The workshop ended with a discussion on how the valuation results could support policy-making processes and how these results could be efficiently communicated to relevant stakeholders and decision-makers.

Private sector workshop (1 day)

The different steps of the Ecology Scan formed the basis of the private sector workshop set-up. Each step comprised a presentation with theory and practical examples as well as an exercise. The first step, “select the scope”, provided participants with an overview of the TEEB St. Eustatius study and described how private companies interact with ecosystem services. In following steps, participating companies determined the most relevant ecosystem services to their business and how these services are developing over time. They then defined the risks and opportunities associated with the identified priority ecosystem services. The assignment in the final step challenged participating companies to come up with innovative strategies to address the risks and opportunities identified in the previous steps.

Figure 1 - “backbone” of economic analysis of ecosystem services

Figure 2 - the total economic value (TEV) map for St. Eustatius depicting the annual value of nature per hectare (left) and an inset of the marine value map in the harbour area of St. Eustatius (right).

St. Eustatius: Economic Value of Nature

Photo by: © Hannah Madden
Post-workshops on natural capital of St. Eustatius

The aim of both the public and private sector workshops was to increase the understanding of natural capital on St. Eustatius. During both workshops, participants extensively discussed how the results of TEEB St. Eustatius study can be used to inform policymakers on the island. The most important issues that were identified are:

- Spatial planning
- Damage assessment
- Managing erosion and roaming cattle
- Biosecurity
- Including ecosystem services in investment decisions

Furthermore, the ecosystem services that were identified as important, but were not covered in TEEB St. Eustatius are:

- Water provisioning
- Agricultural production

To follow up on the workshop and continue to raise awareness about the value of natural capital on St. Eustatius, Wolfs Company developed a toolkit for St. Eustatius that can be used by e.g. CNSI and STENAPA to reach out to stakeholders. The kit includes a tailor-made version of the ecology scan (used in the private sector workshop) to evaluate the interaction of businesses on St. Eustatius with their natural surroundings. The tool is based on locally relevant ecosystem services and can be used to assess risks and opportunities for businesses related to these services.

Furthermore, a tool for the public sector was developed to map out the effects of government interventions (e.g. goat management, erosion control) on ecosystem services. This tool is also based on locally relevant ecosystems, services, and stakeholders on St. Eustatius. The set-up of the tool is a multiple criteria analysis which qualitatively assesses ecosystem changes. A repository of relevant reports related to natural capital on St. Eustatius has also been created. CNSI staff are trained to use the toolbox and continue the training on ecosystem services on St. Eustatius.

All participants were enthusiastic about the knowledge they gained, and CNSI looks forward to a continued discussion on the topic of valuation of nature on St. Eustatius. The tools learned in these workshops were especially relevant following Hurricanes Irma and Maria, enabling relevant stakeholders to assess the economic damage caused to natural capital by these natural disasters.
There is a strong link between economy and nature in the Dutch Caribbean due to our economic dependence on nature-based tourism. TEEB Aruba - The Economics of Ecosystems and Biodiversity-study that was finalized this year, by Wolfs Company together with Yabi Consultancy, provides insight in the value of nature to Aruba’s economy. Aruba’s natural capital value for tourism, culture, fishing and carbon exceeds US$ 287 million per year with tourist expenditures contributing US$ 269 million. These results highlight the importance of Aruba’s nature to the well being of its people and economy.

In September 2015 Aruba and many other countries have adopted the 17 Sustainable Development Goals (SDGs), set by the United Nations, to put an end to poverty, inequality, and climate change by 2030. To reach these global goals Aruba needs to balance out three interconnected fields; social welfare, economic responsibility and ecological resilience.

In order to make sound decisions about the management of Aruba’s ecosystems – which includes coastal marine ecosystems such as mangroves, coral reefs and seagrass beds – it is necessary to estimate the socio-economic value that these ecosystems provide to Aruba. The objective of the TEEB study was to quantify and integrate the value of the island’s natural capital in long-term planning contributing to a sustainable economic development of the island. Wolfs Company have conducted similar TEEB studies on various Caribbean islands such as Bonaire, Saba, St. Eustatius and The Cayman Islands (Yabi, 2017).

Aruba is a very popular tourist destination within the Caribbean because of its warm climate and varied landscape including white beaches, coral reefs, mangroves, tropical shrubs and dry forests. Aruba depends on tourism and tourism depends on the natural capital. A natural capital assessment of tourist expenditures derived US$ 269 million in value. The growth, employment benefits and economic rewards of the tourism industry are related to Aruba’s environmental attributes. The coastal marine environment is especially important for the tourism sector on Aruba, which is the main economic pillar of the island (Yabi, 2017).

Loss of nature could result in a 50% decrease in visitor numbers. Half of all 1.6 million visitors indicated that they were prepared to pay additional fees for improved nature protection on the island (Polaszek et al., 2018).

Aruba’s local population values nature highly. Over 80% of approximately 400 household surveyed want more natural history and cultural heritage to be taught in schools. Also, increased sized (marine) protected areas and increased fish catch were indicated as priority services. Aruba’s inhabitants want to see a larger share of government budget going towards nature protection (Polaszek et al., 2018).

The small fishing industry on Aruba provides its related natural capital with a value of US$ 4.45 million including 36% deriving from recreational fishing activity and nearly 50% from illegal fishing.

Carbon sequestration refers to the process of capture of carbon dioxide and its long-term storage (Zarate-Barrera & Maldonado, 2015). It has been proposed as a way to mitigate the effects of climate change from land use changes and burning of fossil fuels. Aruba’s mangroves, tidal salt marshes, seagrass beds, tropical shrubs and dry forests are considered carbon sinks. Carbon sequestration value on Aruba is estimated to be worth nearly US$ 109,000 per year mainly contributing to the tropical dry forest in the north-west of the island.
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