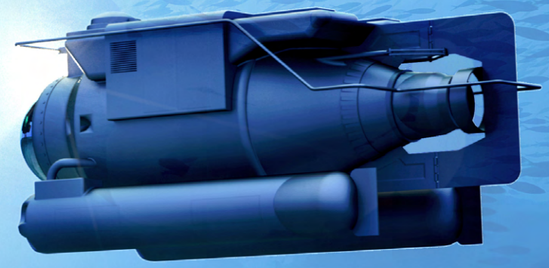
BIONEWS

ISSUE 37 - 2020



DCNAnature.org

Dutch Caribbean Nature Alliance
Safeguarding nature in the Dutch Caribbean

DCNA

BIONEWS ISSUE 37

Editor's Letter

Dutch Caribbean, August 2020

First of all, a very big congratulations to Aruba. Aruba Proudly Introduces 16 Official Protected Nature Reserves which will be managed by DCNA's member organization Fundacion Parke Nacional Aruba. The following areas are now protected: California Dunes, Saliña Tierra del Sol, Saliña Malmok/ Saliña Serka, Saliña Palm Beach/ Plas The Mill Resort
Bubali Plas, Sero Teishi, Ramsar area: Spanish Lagoon Mangel Halto, Rooi Bringamosa
Rooi Taki Red Manoonchi, Rifislands Oranjestad

A new study will examine the genetic connectivity of corals located around the ABC islands. The goal is to find a link between the spatial arrangement of hard coral species to connectivity and population structure between the islands. Understanding these relationships will help expand our knowledge of coral reproduction and island interconnectivity to guide coastal zone management in the future.
Another recent study worked to quantify seagrass's ability to minimize erosion in shallow water of Lac Bay, Bonaire. In addition, this study examined how intensive grazing can drastically effect seagrass' ability to stabilize sediment. This research highlights the benefits of native seagrass over invasive species and the need to match conservation efforts of grazers (i.e. turtles) with the habitats on which they depend.

Researchers compared the effectiveness of three popular artificial reefs to increase fish densities around Saba and St Eustatius. The researchers found that a complex internal structure, providing more shelter availability, resulted in increased fish abundance, biomass and species richness. The results of this study were used to design an even better working artificial reef, the Moreef, which is now being tested on Saba.

Plans for a cutting edge, underwater research station have recently been released. The modular design, inspired by coral polyps, will allow scientists to live and conduct research directly from the ocean floor off the coast of Curacao. Designed by Fabien Cousteau and Yyves Béhar, the station is slated to be built within 3 years and will provide unparalleled access to the deep sea.

Enjoy!
The DCNA Team

Cover photo:
Fabien Cousteau's PROTEUS ™
Credit: PROTEUS ™/Yves Béhar/Fuseproject

Population Structure and Connectivity of Reef-building Corals in the Southern Dutch Caribbean

A new study will examine the genetic connectivity of corals located around the ABC islands. The goal is to find a link between the spatial arrangement of hard coral species to connectivity and population structure between the islands. Understanding these relationships will help expand our knowledge of coral reproduction and island interconnectivity to guide coastal zone management in the future.

Coral reefs are among the most diverse and productive communities in the marine environment. Particularly in the tropics, they are an iconic ecosystem since they are hotspots for biodiversity, attract major tourism, provide employment for many locals and represent the complex nature of the marine environment. Hermatypic corals, also known as reef-building corals, are the basic building blocks of tropical coral reefs. The growth of these reef-building corals and the distribution of coral reefs are strongly influenced by the physical environment.

Coral Reef Reproduction

Hermatypic corals can reproduce asexually, where they produce genetically identical clones of themselves, leading to the production of massive skeletons that collectively form the limestone framework of tropical reefs.

Corals also reproduce sexually, whereby they create genetically new individuals from the combination of male and female gametes (eggs and sperm) produced by different parental colonies. New genotypes and slight variations over many generations can lead to adaptations to resist the susceptibility of corals to stressors such as disease, increased temperatures and pollution.

There are two ways corals can sexual reproduce: "broadcast spawners" and "brooders". Broadcast spawners release eggs and sperm into the water column and the fertilization and larval development occur in the water column. Other species of corals are brooders, which undergo internal fertilization and release their offspring as larvae.

Factors such as mode of sexual reproduction of coral species (whether they are "brooders" (or "broadcast spawners"), currents and coastal zone habitat influence the distance, direction and extent of coral larvae (planulae) dispersal as well as their eventual success of coral larvae to settle to the ocean floor and grow into adult corals (recruitment). The successful reproduction, connectivity (or the exchange of planulae between reefs) and recruitment of planulae is fundamental to coral reef health and development and this is directly linked to the abundance and fitness of other marine organisms that depend on them for their survival. The magnitude of environmental change that is occurring within the Caribbean region as well as globally is considerable, and solutions will require investigating how populations of corals are connected as well as understanding how the interaction between genotype (organism's set of heritable genes) and environment (seascape) and external stressors impact coral larvae dispersal.

Scientific Investigation

Therefore, the goal of this research project is to link the spatial arrangement of hermatypic coral species to connectivity and population structure between the islands that make up the southern Dutch Caribbean (Aruba, Bonaire and Curacao). This study will also compare the extent of planular dispersal between reproductive modes of corals using the brooding mustard hill coral (*P. astreoides*) and the symmetrical and broadcast spawning grooved brain corals (*P. strigosa* and *D. labyrinthiformis*) as the study species.

Photo by: © Eric Mijts

To trace the movement and connectivity of these microscopic coral planulae across the vast southern Caribbean Sea the researchers will primarily use genetic approaches and analyses. Molecular tools such as microsatellite markers will be used to identify and examine the genotypes of the corals of study and allow us to thereby establish distinct relationships among coral individuals and the distance that separates them.

This study is part of Sustainable Island Solutions through Science, Technology, Engineering and Mathematics (SISSTEM) project at the Universiteit van Aruba. Diana Melville, PhD Candidate of the KU Leuven and University of Aruba, is the lead scientist supervised by drs. Eric Mijts, University of Aruba and Prof. Filip Volckaert, Laboratory of Biodiversity and Evolutionary Genomics, KU Leuven, Leuven, Belgium.

Looking for Answers

Questions that arise are: Are corals on the ABC islands genetically related to each other? Which populations are the main source of progeny? What is the role of environmental factors and biological traits in shaping connectivity? Are coral populations adapted to the shifting environment?

The ABC Islands

The three islands, relatively close together, offer an excellent research setting to compare and contrast factors related to dispersal through shared hydrodynamic, ecological and anthropogenic influences. Each island has taken a specific conservation approach with different impacts on the coastal ecosystem. All share a thriving coast-associated tourism, rely on fishing and the other biological services that coral reefs may offer. However, the quality of these services depends on the health of the coral reefs. To date, there hasn't been any study on the genetic connectivity of coral reefs in the region. The findings of this study will provide a sound scientific basis for coastal zone management of the region which is considered ecologically and economic important. Therefore, in this PhD project there will be unique opportunities to explore and disclose the limits of connectivity in the ABC region.

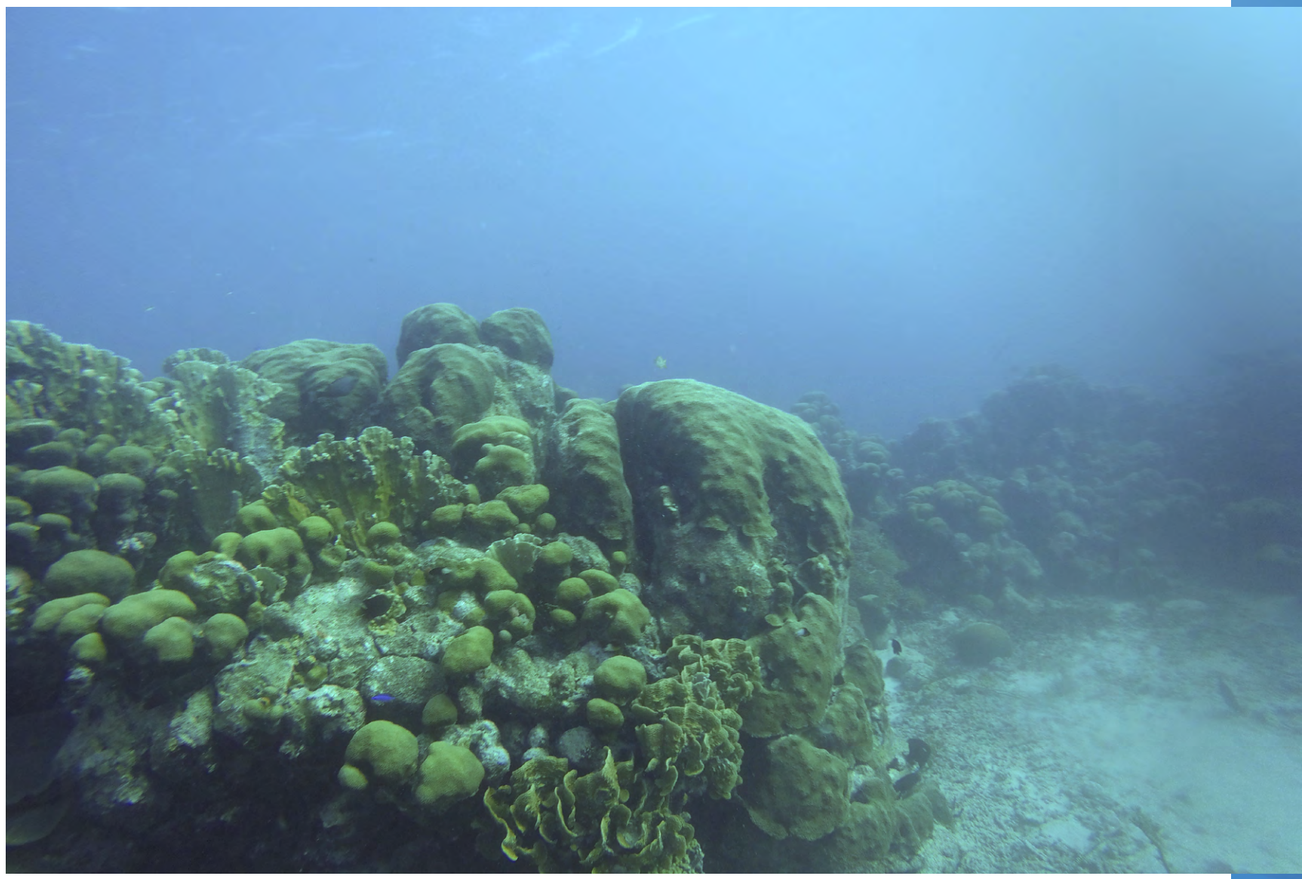


Photo by: © Eric Mijts

Population Structure and Connectivity of Reef-building Corals in the Southern Dutch Caribbean

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Importance of Native Seagrass in the Fight Against Erosion

A recent study worked to quantify seagrass's ability to minimize erosion in shallow water of Lac Bay, Bonaire. In addition, this study examined how intensive grazing can drastically effect seagrass' ability to stabilize sediment. This research highlights the benefits of native seagrass over invasive species and the need to match conservation efforts of grazers (i.e. turtles) with the habitats on which they depend.

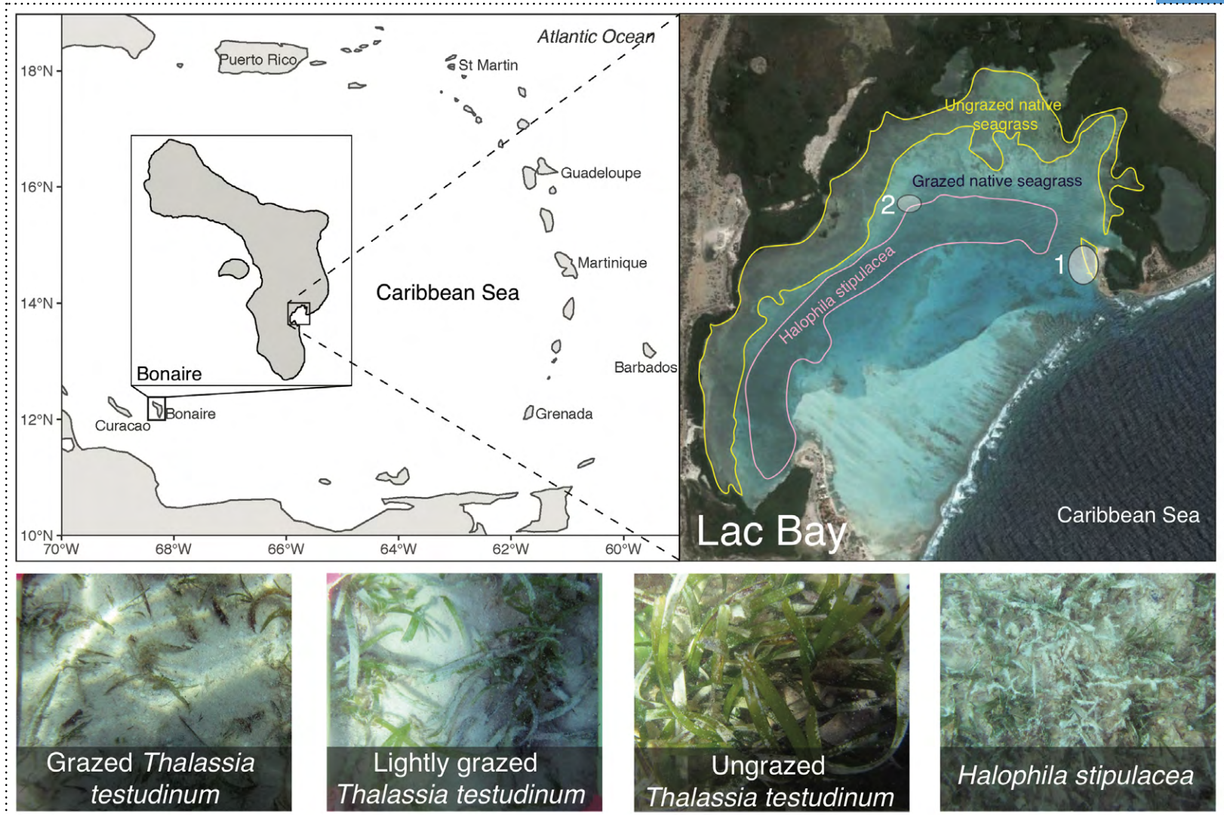
Seagrass fields play an important role in shallow water environments. These fields are important feeding and nursery grounds for a variety of species, provide natural water filters and serve as a buffer between the land and nearby coral reefs and open ocean. In addition, seagrass fields are also an important factor in protecting coastlines by dissipating wave energy, reducing tidal currents, and trapping sediments thus minimizing erosion. Seagrass leaves reduce overall energy in the water by waving back and forth creating drag while also bending over, covering sand and protecting it from erosion. This is particularly true for Bonaire's native seagrass, *Thalassia testudinum*, a thick leaved plant, and a favorite food item for grazing turtles.

Seagrass beds are under immense pressure due to a decrease in water quality and increase in negative human interactions (such as trampling, anchoring and dredging). In addition, opportunistic invasive species, such as *Halophila stipulacea*, have started encroaching on native fields. This species of seagrass has smaller leaves, thus reducing its energy reduction capabilities, along with having smaller, more shallow roots and rhizomes, limiting its ability to stabilize sediment. This invasive species is less capable of withstanding large storms, such as 2017's Hurricane Irma. After this hurricane, entire fields of invasive *H. stipulacea* were uprooted, even in deeper waters, such as those found in Oranjestad Bay, St. Eustatius, where as neighboring native fields of *T. Testudinum* near St. Maarten survived. Scientists believe this is due to the deep roots of native seagrass and their ability to anchor even during strong storm surges and waves.

Furthermore, a combination of declining seagrass coverage and a reduction of apex predators (such as sharks), has led to more intense grazing zones by megaherbivores (such as the green turtle). Current research shows a preference for native seagrass over invasive species by these megagrazers, which means that as native seagrass beds continue to shrink, they are also experiencing greater grazing pressures.

The Study

A collaborative effort between the NIOZ Royal Netherlands Institute for Sea Research, Utrecht University, University of Groningen, Wageningen University and Research, Radboud University Nijmegen and Delft University of Technology conducted a study to understand the ecosystem services provided by native and invasive species of seagrass. Researchers set up an experiment to directly measure the sediment stabilization capacity of various seagrass patches. This experiment explored the impact of both invasive species and increasing grazing by megaherbivores. The study took place in Lac Bay, a shallow bay located on the east coast of Bonaire. Historically this bay had been dominated by the native seagrass (*T. Testudinum*), however, a recent census shows an increase in the presence of the invasive species (*H. stipulacea*) since it was first report in 2010. This bay is an important foraging area for the local turtle population.



Map of study area with examples of native (T. testudinum) and invasive (H. stipulacea) seagrass patches at various grazing levels.

The Results

Through this experiment, researchers were able to demonstrate native and invasive species' ability to stabilize sediment. It was shown that seagrass meadows with dense, tall, ungrazed native seagrass (*T. testudinum*) were able to effectively anchor sandy sediment in a variety of different wave conditions. As canopy density and coverage decreased, there was an overall decrease in seagrass' ability to stabilize sediment, allowing for increased erosion. It was also demonstrated that seagrass patches of invasive *H. stipulacea* that are in deeper waters accumulate fine sediment during calm periods. This fine sediment, however, is easily resuspended when there are strong waves, which increases the vulnerability of the seafloor to erosion over the long-term.

This study demonstrated the effectiveness of the long-leafed native grass's ability to minimize erosion through its strong root system and ability to bend and protect the underlaying sand layer. In areas of highly grazed shorter grass, the blades of grass were not able to offer as much protection and similar erosion patterns were seen as in areas without vegetation.

The Future

Sea turtle conservation has had great success within the Caribbean, the results of which can be seen locally with the increase of the green sea turtle populations within Lac Bay. Parallel conservation efforts of these important habitats are required, especially with the increasing pressure on already degraded native seagrass fields. When designing and implementing conservation projects, it is important to consider all levels within the environment. This study demonstrates the importance of supporting the conservation of habitats along with it's more charismatic residents.

Report your sightings:

Have you observed sea turtles? Help us better understand the grazing pressures of our native seagrass by reporting your sighting on the website DutchCaribbean.Observation.org or download the free apps.

This free website and free apps can be used not only by biologists but by all citizens to report any animals and plants and is available in more than 40 languages. It is now also being translated to Papiamentu. The species reports by local communities are very valuable for the nature conservation organization to learn and protect the species on our islands. For more information contact research@dcnanature.org

For more information, please see the full report here:
James, R.K., Christianen, M.J.A., van Katwijk, M.M., de Smit, J.C., Bakker, E.S., Herman, P.M.J., Bouma, T.J. (2020). Seagrass coastal protection services reduced by invasive species expansion and megaherbivore grazing. Journal of Ecology. DOI: 10.1111/1365-2745.13411

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Designing the optimal artificial reef

A new study compared the effectiveness of three popular artificial reefs to increase fish densities around Saba and St Eustatius. The researchers found that a complex internal structure, providing more shelter availability, resulted in increased fish abundance, biomass and species richness. The results of this study were used to design an even better working artificial reef, the Moreef, which is now being tested on Saba.

Coral reefs within the Caribbean have been slowly degrading since the 1970s. Initially this degradation was due to diseases that wiped out most of the Diadema antillarum (black sea urchin), the most important herbivores, and Acropora, the most important reef building corals. Combined with additional threats such as hurricanes, increased seawater temperatures and human-led pollution, coral cover around the islands of Saba and St Eustatius has decreased to less than 10%.

An artificial reef is a human-made underwater structure, typically built to locally increase biodiversity and productivity. Artificial reefs are gaining popularity as a way to provide increased substrate for coral recruitment and shelter, foraging areas and nursery grounds for fish and other reef creatures. Although there are many artificial reef designs, little research has been done to compare the effectiveness of different designs.

Researchers from University of applied sciences Van Hall Larenstein, Wageningen Marine Research, Wageningen University, the Caribbean Netherlands Science Institute, STENAPA, the Saba Conservation Foundation and Golden Rock Dive Centre worked together in the AROSSTA (Artificial Reefs on Saba and Statia) project, in which the fish abundance, biomass (weight) and species richness of three different artificial reefs was compared.

The Study

The three designs were selected based on their popularity and availability within the Caribbean. The Reef Ball® artificial reef has become increasingly popular, with over 600,000 units deployed worldwide. This reef is made of concrete and has a domed shape with many holes, allowing fish to enter and exit the reef easily. The second design is the layered cake artificial reef, this reef has the same outer shape as the reef ball, but includes multiple layers on the inside, providing a more complex habitat for fish. The final design was constructed with local basaltic rock, which was used to create a pile with the same dimensions as three reef balls or layered cakes.

Beginning in May 2017, four locations were selected around Saba and Sint Eustatius. At each location, four different treatments were tested (reef balls, layered cakes, a rock pile and a control consisting of bare sand). On each plot, 10 fish surveys were performed 11 months post deployments and 4 months after restoration from damage caused by Hurricanes Maria and Irma. After the hurricanes, all of the artificial reefs were at least partially buried in the sand and required human intervention to be cleared out.

The Results

This project provides important insight into the effectiveness of artificial reefs. In general, all three reef designs demonstrated an increase in fish abundance compared to areas with bare sand. In total, 2102 fish from 48 different species were seen in and around the artificial reefs. Interestingly, the popular reefs ball design was not the most effective way to increase the fish abundance. Instead, this study showed that layered cakes, which provide higher complexity and shelter availability, are much more effective and harbored 4 times more fish (both in numbers and in biomass). This study also demonstrated that more economical solutions, such as rock piles, can be effective and up to 10 times cheaper to construct. However, it should be noted that this style of artificial reef is less stable and could be more easily destroyed in high energy waves or hurricanes.

Deploying Moreef modules. Photo by: © Kevin Elies

Lessons Learned

The devastating impacts of hurricanes Irma and Maria which hit Saba and St. Eustatius over the course of this study really highlighted the need for artificial reefs which are weather-proof and resilient in high energy situations. Placing artificial reefs in sandy areas leaves them vulnerable to being smothered or sinking, therefore, careful site selection and monitoring is required if these reefs are to be a long-term solution. Artificial reefs with complex internal structures and a high shelter availability should be selected over simpler designs to optimize fish assemblages.

Using the lessons learned from this study, the researchers worked together with Wortel Product Design and developed a new type of artificial reef, the Moreef (Modular Restoration Reef). The Moreef has all the advantages of the three different artificial reef designs tested in AROSSTA, while all disadvantages were removed. The Moreef design is now being produced and tested in Saba and will hopefully set a new standard in artificial reef design.

Caribbean coral reefs are under unprecedented pressures and will require various levels of human intervention to reverse current trends of reef degradation. Artificial reefs can provide a variety of benefits beyond improving local fish populations, such as coastal protection and creating new dive sites, taking some of the pressure off natural reefs. Studies such as these provide crucial insights into artificial reef functioning and will help to guide the development of artificial reef designs in the future.

For more information, you can find the full article here: A. Hylkema, A.O. Debrot, R. Osinga, et al., (2020) Fish assemblages of three common artificial reef designs during early colonization, Ecological Engineering https/::doi.org:10.1016:j.ecoena.2020.100021 -

Or follow the project here:
http://www.hvhl.nl/arossta

For more information, contact project leader Alwin Hylkema at: alwin.hylkema@hvhl.nl

Researchers counting coral recruits on a reef ball. Photo by: © Alwin Hylkema

Designing the optimal artificial reef

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Curacao's New Underwater Research Station

Plans for a cutting edge, underwater research station 'PROTEUS™' have recently been released. The modular design, inspired by coral polyps, will allow scientists to live and conduct research directly from the ocean floor off the coast of Curaçao. PROTEUS™ is project of the Fabien Cousteau Ocean Learning Center (FCOLC) and is Fabien Cousteau's vision, supported by Yves Béhar through design. The station is slated to be built within 3 years and will provide unparalleled access to the deep sea.

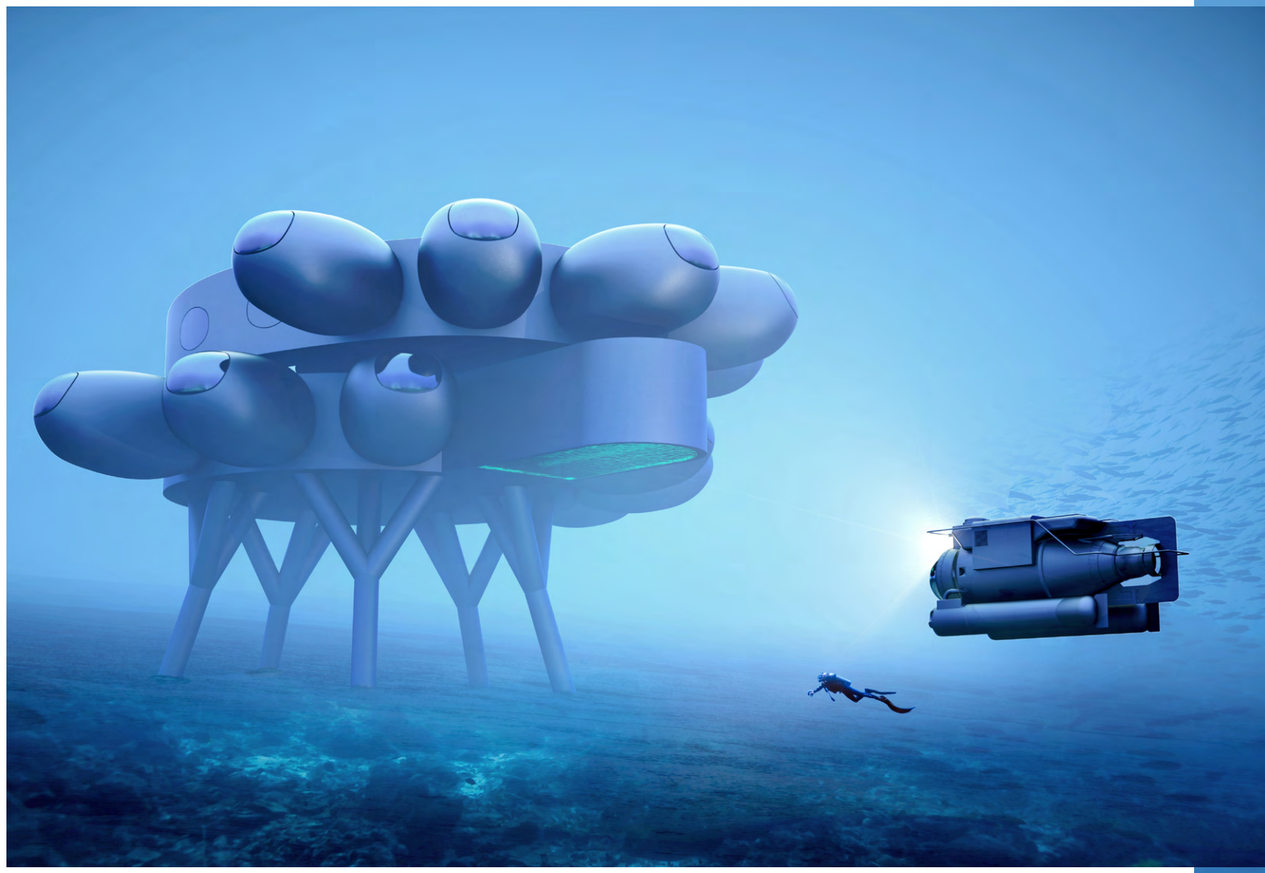
For millennia, people have looked to space in wonderment, dreaming of far away planets with unimaginable life. Little did they know, there were areas on our very own planet, unrecognizable and booming with its own unique life forms. Although nearly 99% of livable space on the planet is located under the surface of the ocean, we've only just begun exploring these areas within the past 50 years. Even with the most advanced ocean satellites, buoys, deep sea submarines and sonar we've only explored about 5% of the ocean floor and mapped less than a fifth to a resolution of 5 km (meaning we can only "see" features larger than 5km). That is to say, we have better maps of the moon and mars than we do of our own sea floor.

Many scientists believe the deep sea holds the keys to solutions ranging from battling climate change to medical breakthroughs, however harsh conditions prohibit access to researchers. Between the crushing depths and total darkness, living and working in these conditions has previously been impossible.

Underwater Research Station

That is all about to change with the new underwater research station 'PROTEUS™'. **PROTEUS™ is project of the Fabien Cousteau Ocean Learning Center (FCOLC) and is Fabien Cousteau's vision, supported by Yves Béhar through design,** and partners from Northeastern University, Rutgers University and the Caribbean Research and Management of Biodiversity Foundation (CARMABI). PROTEUS ™ will be a 300 m2 underwater research station and habitat. This modular lab will be built off the cost of Curaçao and provide unprecedented access to scientists hoping to unlock deep sea secrets for creative solutions to a wide range of problems.

The research station itself is a two-story circular building, which will sit on stilts on the ocean floor. Inspired by the shapes of coral polyps, the design includes individual pods which will house laboratories, medical facilities and sleeping apartments. The design also includes a moon pool which will give divers direct access to the ocean floor.



Fabien Cousteau's PROTEUS ™ Credit: Courtesy PROTEUS ™/Yves Béhar/Fuseproject

Creative Solutions

Its pretty incredible to think, since the start of space travel, 12 people have been to the moon whereas, humans have been exploring the oceans for thousands of years and only three people have ever descended to the deepest part, the Marianas Trench. Deep ocean travel has its own challenges, from crushing pressure to complete and total darkness. After a depth of 200m, sunlight is no longer able to penetrate the water, making imaging and exploration exceedingly difficult.

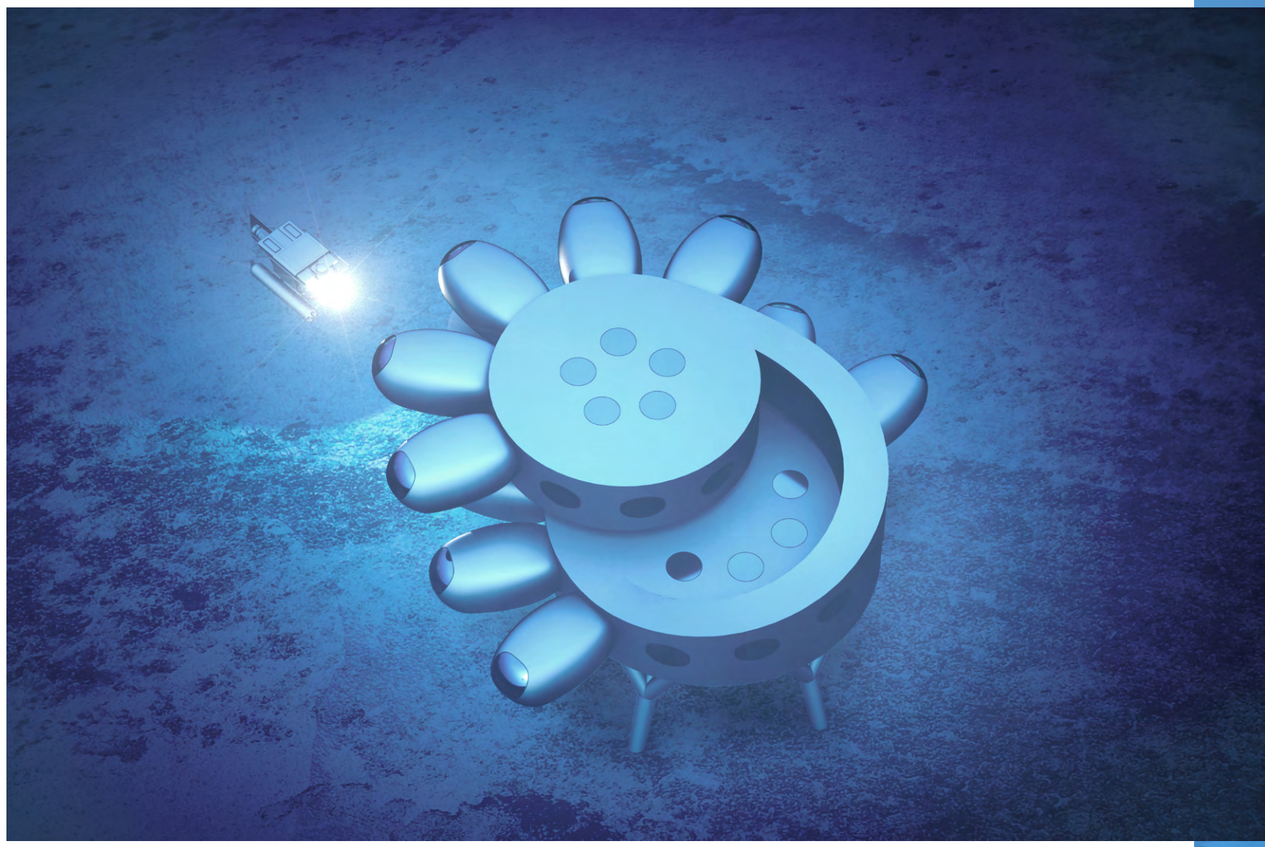
Powered through wind, solar and ocean thermal energy, this cutting-edge research station will showcase the power of green technology. In addition, its deep ocean design could allow for new opportunities for research stations in areas of extreme weather, keeping it safe from tsunamis and hurricanes. By allowing researchers to continuously live at depth, researchers will now be able to work throughout the day without needing to plan decompression stops.

The Future of Science

PROTEUS™ will serve as the International Space Station equivalent for underwater scientists, bringing together government agencies, scientists and the private sector to promote collaboration and scientific research. "*Ocean exploration is 1,000 times more important than space exploration for -- selfishly -- our survival, for our trajectory into the future," stated Cousteau. "It's our life support system. It is the very reason why we exist in the first place."*

The original plan was to build PROTEUS™ within three years, however, due to coronavirus, the project has already experienced delays. The goal is to offer regular live streams and video content, giving the entire world access to the amazing research being conducted. "*Imagine if you found something amazing -- whether it be microcosmic like a pharmaceutical, or macrocosmic like the next greatest animal -- if you could show it to classrooms and universities,*" Cousteau imagined. "*Our mission is to be able to translate complex science into something that the average person not only maybe will understand, but fall in love with.*"

You can follow along or get the latest updates from the PROTEUS ™ website:
https://www.fabiencousteauolc.org/proteus



Fabien Cousteau's PROTEUS ™ Credit: Courtesy PROTEUS ™/Yves Béhar/Fuseproject

Curacao's New Underwater Research Station

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Research Overview

August 2020

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Bats	Bat maternity roost: Effect of barrier on the two species of small insectivorous bats	BON	**Wildconscience**: Fernando Simal, Daniela Simal (student)
Birds	Suitability study and reforestation of exclosures facilitating the Yellow-shouldered Amazon Parrots (*Amazona barbadensis*) on	BON	**Echo:** Julianka Clarenda
Climate change	Teatime4science (seagrass and mangroves http://www.teatime4science.org)	BON	**STINAPA:** Sabine Engel
Fisheries	Lobster larvae recruitment on the Saba Bank	SAB	**SCF:** Ayumi Kuramae Izioka
Fisheries	Market & Supply Chain Analysis study (Funded by WWF-NL)	BON, SAB EUX	**WWF-NL:** Pieter van Baren **The Good Fish Foundation**: Irene Kranendonk
Fisheries	Historical fisheries (Funded by WWF-NL)	BON, SAB EUX	**WWF-NL**: Pieter van Baren **Terramar Museum Bonaire:** Ruud Stelten
Fisheries	Shark bycatch monitoring programme	SAB	**NEV:** Paddy Walker, Irene Kingma **SCF:** Ayumi Kuramae Izioka **MOTE marine lab**: Robert Nowicki
Fisheries	Nurse shark bycatch reduction	SAB	**SCF:** Ayumi Kuramae Izioka
Fish	Assessing the Spawning Potential Ratios of Reef Fish Species on St. Eustatius	EUX	**CNSI:**Kimani Kitson-Walters **IMBRSea**: Lisanne Van Harten (student)
Plants	Testing effective ways to grow native plants	BON	**Echo:** Johan van Blerk
Plants	Germination of seeds of indigenous trees of Curaçao	CUR	**CARMABI:** John de Freitas
Plants	Vegetation Christoffel Park	CUR	**CARMABI**: Erik Houtepen
Reptiles	Red-bellied racer snake research	EUX	**RAVON:** **CNSI:** Hannah Madden, Karolina Pyrycz (student)

Long Term Projects

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Anthropogenic Impact	Anthropogenic Impact Analyses, Aruba National Park	AUA	**FPNA:** Giancarlo Nunes
Terrestrial and marine environment	Open Science for Aruba (a baseline study of the island's environment focusing on air quality, green coverage on land, water quality and coral reef coverage using satellite imagery and setting up monitoring stations for air- and water quality)	AUA	**Metabolic Foundation**: Tony Sevold, Christie Mettes
Coral Reef Ecosystems	Population Structure and Connectivity of hermatypic corals in the Southern Dutch Caribbean (part of SISSTEM)	AUA BON, CUR	**KU Leuven:** Filip Volckaert **University of Aruba:** Diana Melville (PhD student)
Coral Reef Ecosystems	Deep Reef Observation Project (DROP) (ARMS: Autonomous Reef Monitoring Structures)	CUR	**Smithsonian:** Carole Baldwin
Coral Reef Ecosystems	Youth-powered coral reef video surveys in Aruba	AUA	**ScubbleBubbles Foundation:** Miranka van Breugel, Nichole Danser
Coral Reef Ecosystems	Diadema Antillarum Population Assessment & Restoration	EUX SAB	**CNSI:** Kimani Kitson-Walters **VHL**: Alwin Hylkema **STENAPA:** Jessica Berkel **SCF**
Coral Reef Ecosystems	The role of parrotfish behavior in structuring benthic coral reef communities	BON	**FSU:** Joshua Manning (Ph.D. student), Sophie McCoy
Coral Reef Restoration	Epigenetic responses to environmental stressors in Acropora corals, and applications to coral reef conservation	BON	**FIU (EEL)**: Serena Hackerott (PhD student), Jose Eirin-Lopez **RRFB:** Francesca Virdis
Coral Reef Restoration	St. Maarten's Coral Restoration Project	SXM	**NFSXM**: Melanie Meijer zu Schlochtern **CRF**
Coral Reef Restoration	Coral Restoration (coral nurseries)	SAB EUX	**SCF:** Ayumi Kuramae **STENAPA**: Jessica Berkel
Coral Reef Restoration	Plant a million coral initiative (IntelliReefs)	SXM	**NFSXM**: Melanie Meijer zu Schlochtern **SeaLagacy, Reeflife Restoration** and **Sea to Sky ventures**
Coral Reef Restoration	Development of restoration methods for threatened Caribbean coral species	BON, CUR	**RRFB:** Augusto Montbrun, Francesca Virdis **SECORE Project** **CARMABI:** Mark Vermeij **Secore:** Valerie Chamberland

Long Term Projects

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Coral Reef Restoration	Postsettlement dynamics of Caribbean corals & Reef restoration	CUR	**CARMABI:** Mark Vermeij **Secore:** Valerie Chamberland
Coral Reef Restoration	Artificial structures that encourage larvae settlement and discourage the growth of competitor species	CUR	**University of Illonois**: Amy Wagoner Johnson, Bruce Fouke, Gabriel Juarez **San Diego State University**: Forest Rohwer **CARMABI**: Kirsten Marhaver, Mark Vermeij
Database	Dutch Caribbean Species Register: Taxonomic knowledge system Dutch Caribbean (http://www.dutchcaribbeanspecies.org/)	All	**Naturalis:** Sander Pieterse, Hannco Bakker, Bert Hoeksema
Interstitial biodiversity	Moleculair biodiversity analysis of marine communities by metabarcoding	EUX	**Naturalis:** Arjen speksnijder **ANEMOON:** Niels Schrieken
Invasive species	Socio-ecological connectivity of tropical coastal ecosystems: how to enhance restoration and conservation of ecosystem services (Study on (1) carbon and nutrient fluxes between the mangroves, seagrass bed and coral reef at Lac Bay 2) the impact of Sargassum events on seagrass beds and mangroves in Lac Bay and 3) Lac Bay as a socio ecological system.)	BON	**RU:** Luuk Leemans (PhD student), Marieke van Katwijk **WUR:** Marjolijn Christianen
Invasive species	* Impact of Halophila stipulacea on the availability of benthic diatoms as a food source for a commercially important deposit feeders in a native and invasive habitat * Halophila stipulacea regrowth study to understand the general biology and spread of the seagrass.	EUX	**CNSI:** Johan Stapel,Anna Maitz, Kimani Kitson-Walters
Marine ecosystems	Taxonomy and biodiversity in Lac Bay	BON	**STINAPA** Sabine Engel, Caren Eckrich **Ecosub:** Godfried van Moorsel **CEAB:** Daniel Martin
Marine ecosystems	Marine species discoveries in the Dutch Caribbean	All	**Naturalis:** Bert Hoeksema **CNSI, CARMABI**
Marine Park	Marine Park Aruba (Obtain ecosystem baselines and overview for Parke Marino Aruba sites)	AUA	**FPNA:** Sietske van der Wal **DNM:** Gisbert Boekhoudt
Marine Litter	Clean Coast Bonaire (Citizen science project, OSPAR methodology)	BON	**Boneiru Duradero**: Sharon Bol, Carolyn Caporusso
Plants	Botanical Garden Aruba	AUA	**FPNA:** Natasha Silva
Plants	Wildlife Garden Reserve	AUA	**FPNA:** Giancarlo Nunes
Plants	Local vascular plants inventory (Funded by Prince Bernhard Cultural Fund)	SXM	**University of Puerto Rico:** Franklin Axelrod **EPIC**

Long Term Projects

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Public Health	DNA waterscan: Monitoring disease vectors in the Caribbean (mosquitoes and midges)	CUR EUX	**Naturalis:** Klaas-Douwe B. Dijkstra **ECPHF:** Teresa Leslie **CBHRI:** Delia-Maria Goilo (NWO DUCAMID project)
Reforestation	Reforestation Project on St. Eustatius	EUX	**Mac & Field**: Tim van Wagensveld & Stacey Mac Donald **STENAPA**: Clarisse Buma **LVV:** Gershon Lopes
Sponges	The role of sponges as key ecosystem engineers of coral reef ecosystems Pumping iron: can iron availability fuel the sponge loop and affect coral reef community structure? (Misha Streekstra)	CUR	**Uva:** Jasper de Goeij, Benjamin Mueller **CARMABI**: Mark Vermeij **PhD students:** **WUR:** Misha Streekstra **UvA:** Sarah Campana*, Meggie Hudspich*, Niklas Korner* * Part of the ERC project "SPONGE ENGINE — Fast and efficient sponge engines drive and modulate the food web of reef ecosystems"
Sustainability	Sustainable Island Solutions through Science, Technology, Engineering and Mathematics (SISSTEM): - Vertical Farming on Aruba: opportunities for Small Island States (Kryss Facun) - Development of an optimal waste management system for Aruba (Colleen Weekes) - Population Structure and Connectivity of hermatypic corals in the Southern Dutch Caribbean (Diana Melville) - Detection and spatial analysis of urbanization and land use change in small island states, by means of GIS and remote sensing techniques (Start pending) - Connectivity of Marine Fish Populations (Start pending) - Sustainability in the agri-food chain group: life cycle analysis for a more sustainable agrifood chain on Aruba (Start pending) - Comparative research on social innovation and just resilience in the governance of small insular socio-ecological systems (Start pending) - Engineering sustainability… or sustainable engineering. Research project on the edge of sustainability, engineering, entrepreneurship, and education in Aruba (Start pending)	AUA	**University of Aruba**: Eric Mijts **KU Leuven**: Jo Van Caneghem, Wim Dewulf, Karel Van Acker, Bram Van de Poel, Filip Volckaert PhD students: Kryss Facun, Colleen Weekes, Diana Melville
Spational Planning	Nature inclusive spatial planning for Small Island Development States	BON	**WUR:** Peter Verweij
Threats and risks	Are human activities (related to an oil terminal and dive tourism) a risk for ecosystem services ?	EUX	**WUR:** Diana Slijkerman

Long Term Projects

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Wetlands	Wetland habitat enhancement	AUA	**FPNA**: Giancarlo Nunes
NWO Projects in the Dutch Caribbean			
Bioproducts	Stand-alone production of algal products for food, feed, chemicals and fuels - Bioprospecting and directed evolution of microalgae from Bonaire	BON	**WUR:** R.H. Wijffels, Rocca Chin-on, Robin Barten (PhD students) **Institute for Sustainable Technology:** Rita Peachey
Environmental psychology	Confronting Caribbean Challenges: Hybrid Identities and Governance in Small-scale Island Jurisdictions - Behavioral differences between/within the BES islands when it comes to nature conservation and cultural heritage.	BON, SAB, EUX	**KITLV, Leiden University:** Gert Oostindie (Project director) **KITLV, Leiden University:** Stacey Mac Donald (PhD student)
Invasive species	Global defaunation and plant invasion: cascading effects on seagrass ecosystem services	BON	**WUR:** Marjolijn Christianen, Fee Smulders (PhD student) **Smithsonian:** Justin Campbell (coordinator Caribbean wide research project) **STINAPA**: Sabine Engel, Jessica Johnson
BO-projects in the Dutch Caribbean (Min LNV)			
Birds	BO-43-021.04-018 - Flamingo mortality	BON,	**WUR:** Dolfi Debrot **Cargill Salt Bonaire** **Mangrove Center:** Elly Albers STINAPA **OLB**
Coral Reef Ecosystems	BO-43-021.04-003 – Inventory corals Includes monitoring and research of the longest coral reef time-series in the world (since 1973)	BON, CUR	**WUR:** Erik Meesters
DCBD	BO-43-021.04-001 - Expansion knowledge system Dutch Caribbean	AUA, BON, CUR, SAB, EUX, SXM	**WUR (Alterra)**: Peter Verweij

Long Term Projects

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Fisheries	BO-43-021.04-006 + BO-11-019.02-055 - Fish stocks and fisheries Caribbean Netherlands	EUX, SAB, BON	**WUR:** Dolfi Debrot **CNSI:** Kimani Kitson-Walters **PiskaBon, STINAPA** **SCF:** Kai Wulf, Ayumi Kuramae
Goats	BO-43-021.04-019 - Support professionalization goat farming Bonaire	BON	**WUR:** Francesca Nijenhuis
Marine biodiversity	BO-43-021.04-002 – Saba Bank – Marine biodiversity	SAB	**WUR:** Erik Meesters (benthic communities), Dolfi Debrot, Thomas Brunel, Leo Nagelkerke (fish stocks)
Marine mammals & sharks	BO-43-021.04-005 – Management plan marine mammal and shark sanctuary Yarari	SAB, EUX	**WUR:**Bart Noort **SCF (SBMU):** Ayumi Kuramae Izioka
Marine mammals	BO-43-021.04-007 –Marine mammals in the Dutch Caribbean	BON, SAB, EUX	**WUR:** Dolfi Debrot, Dick de Haan, Meike Scheidat
UNESCO	BO-43-021.04-004 + BO-11-019.02-050 Bonaire National Marine Park as Unesco World Heritage	BON	**WUR:** Dolfi Debrot

Monitoring Overview

August 2020

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Birds	Flamingo Abundance	BON	**DRO:** Frank van Slobbe **Cargill**, **STINAPA:** Paulo Bertuol
Birds	Monitoring vulnerable parrot nests (remote camera sensing work)	BON	**Echo:** Julianka Clarenda, Sam Williams
Birds	Aruban Brown-Throated Parakeet Conservation	AUA	**FPNA:** Giancarlo Nunes , **ABC:** Greg Peterson
Birds	Aruban Burrowing Owl Conservation	AUA	**FPNA:** Giancarlo Nunes , **ABC:** Greg Peterson **GLOW:** David Johnson
Birds	Yellow-shouldered Amazon parrot roost counts	BON	**Echo:** Julianka Clarenda, **DRO:** Diego Marquez **STINAPA:** Albert Christiaan
Birds	Bird Monitoring (Caribbean Waterbird Census)	BON, SXM	**STINAPA:** Paulo Bertuol, **EPIC**: Adam Brown
Birds	Tern monitoring(artificial nesting islands)	BON	**STINAPA:** Paulo Bertuol **Cargill, DRO**, **WUR:** Dolfi Debrot
Birds	Terrestrial Bird and Habitat Monitoring	BON CUR SAB SXM EUX	**Echo:** Julianka Clarenda, **FPNA:** Giancarlo Nunes **STINAPA:** Paulo Bertuol, Caren Eckrich **STENAPA , CNSI** **Curassavica:** Michelle da Costa Gomes **CARMABI:** Erik Houtepen **Nature Foundation**: Binkie van Es
Birds	Red-billed Tropicbird reproductive success	EUX	**STENAPA:** Erik Boman**, CNSI:** Hannah Madden
Birds	Red-billed Tropicbird monitoring	SAB	**SCF:** Kai Wulf, **WUR:** Mardik Leopold Michiel Boeken
Birds	Red-billed Tropicbird migration routes	EUX	**CNSI:** Hannah Madden **Clemson University:** Patrick Jodice
Birds	Pelican monitoring	SXM	**NFSXM:** Melanie Meijer zu Schlochtern, Saskia Werner
Coral reef ecosystems	Global Coral Reef Monitoring Network	BON CUR SAB EUX SXM	**STINAPA:** Caren Eckrich, , Roxanne Francisca **CARMABI:** Mark Vermeij **SCF (SBMU):** Ayumi Kuramae Izioka **STENAPA:** Jessica Berkel **NFSXM:** Melanie Meijer zu Schlochtern **CNSI:** Johan Stapel, Kimani Kitson-Walters

Monitoring Overview

August 2020

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Coral reef ecosystems	Monitoring and research of the longest coral reef time-series in the world (since 1973) (Part of BO-11-019.02-022 –Inventory corals)	BON CUR	**WUR:** Erik Meesters, Didier de Bakker **NIOZ:** Fleur van Duyl, Rolf Bak
Coral Spawning	Coral Spawning Monitoring	EUX	**CNSI:** Kimani Kitson-Walters, **STENAPA**
Environmental	Water quality testing (BON: impact of increasing freshwater production on the reefs in front of the desalination plant in Hato)	BON SXM	**STINAPA:** Caren Eckrich, Roxanne Francisca **WEB Bonaire** **NFSXM:** Melanie Meijer zu Schlochtern **EPIC:** Natalia Collier
Environmental	Nutrient (phosphate, ammonium, nitrate and nitrite) monitoring of St Eustatius' coastal waters	EUX	**CNSI:** Johan Stapel
Fish	Shark monitoring: -Shark sightings - Shark Abundance, distribution and movements (tagging, acoustic telemetry)	AUA BON CUR SAB SXM EUX	**WUR:** Erwin Winter, Dolfi Debrot, Martin de Graaf **FPNA:** Giancarlo Nunes **STINAPA:** Caren Eckrich, Roxanne Francisca **CARMABI:** Mark Vermeij **SCF(SBMU):** Ayumi Kuramae Izioka **STENAPA:** Jessica Berkel **NFSXM:** Melanie Meijer zu Schlochtern
Fish	Spawning monitoring: Red hind surveys on Moonfish Bank	SAB	**SCF (SBMU):** Ayumi Kuramae Izioka
Fish	Fish and fishery monitoring (Barracuda's, sharks and eagle rays, tarpons, marine mammals, (fishing) boats, fisherman)	BON	**STCB:** Kaj Schut
Hydrology	Hydrology Lac Bay	BON	**STINAPA:** Sabine Engel, **WUR:** Klaas Metselaar
Insects	Bee tracking	BON	**Echo:** Julianka Clarenda **STINAPA**: Sabine Engel, Johan Blerk
Invasive species	Goat and/or donkey removal: -Washington Slagbaai National Park - Lac Bay area (exclusion plots)	BON EUX	**STINAPA:** Paulo Bertuol **WUR:** Dolfi Debrot, **DRO:** Frank van Slobbe **STENAPA**
Invasive species	Lionfish abundance and control	BON CUR SXM SAB EUX	**STINAPA:** Paulo Bertuol (50 meter traps) **CARMABI:** Mark Vermeij **NFSXM:** Melanie Meijer zu Schlochtern **SCF (SBMU):** Ayumi Kuramae Izioka **STENAPA:** Jessica Berkel
Invasive species	Feral pig population assessment (trapping)	BON	**Echo**
Invasive species	Mitigation and monitoring of Boa, Rubber Vines, and Feral Cats in nature conservation sites	AUA	**FPNA:** Giancarlo Nunes

Monitoring Overview

August 2020

CATEGORY	SUBJECT	DC ISLANDS	ORGANIZATION(S): LEAD SCIENTIST(S)
Mammals	Bat monitoring	AUA BON	**FPNA: Giancarlo Nunes** **WildConscience:** Fernando Simal, Linda Garcia
Mammals	Dolphin monitoring (since 1999)	BON	Ron Sewell
Mammals	Marine Mammal Monitoring (sighting forms and noise loggers)	AUA BON SAB EUX SXM	**WUR:** Bart Noort, Dolfi Debrot **BON**: Caren Eckrich **SCF (SBMU)**: Ayumi Kuramae Izioka **AMMF:** Angiolina Henriquez **STENAPA:** Jessica Berkel **NFSXM**: Melanie Meijer zu Schlochtern **SCCN, CARI'MAM Project**
Plants	Dry forest monitoring	BON	**Echo:** Julianka Clarenda **STINAPA:** Paulo Bertuol
Plants	Monitoring of tree growth and survivorship in reforestation areas	BON	**Echo**: Julianka Clarenda
Reptiles	Lesser Antillean Iguana: Monitoring population density & removing invasive Green Iguana and hybrids (Mohamed bin Zayed Species Conservation Fund)	EUX	**STENAPA:** Erik Boman **RAVON:** Tim van Wagensveld **UvA:** Thijs van den Burg
Reptiles	Boa Life History	AUA	**FPNA:** Giancarlo Nunes **Eckerd College**: Jeff Goessling
Reptiles	Population dynamics of the endemic Aruban Whiptail lizard	AUA	**FPNA** **Eckerd College:** Jeff Goessling
Seagrass and mangrove ecosystems	Seagrass and mangrove monitoring (BON: also conch and benthic fauna)	BON EUX SXM	**STINAPA:** Sabine Engel, Caren Eckrich **WUR:** Klaas Metselaar **NFSXM:** Melanie Meijer zu Schlochtern **CNSI:** Kimani Kitson-Walters
Reptiles	Sea turtle monitoring: -Satellite tracking -Nest monitoring -In water surveys (BON, CUR, SXM) -Fibropapillomatosis presence (BON)	AUA, BON, CUR, SAB, EUX, SXM	**TurtugAruba Foundation** **STCB:** Kaj Schut **STCC:** Sabine Berendse **STENAPA:** Jessica Berkel **SCF:** Kai Wulf **NFSXM:** Melanie Meijer zu Schlochterns, Saskia Werner

Monitoring and Research Wishlist

The Dutch Caribbean nature conservation organisations are in need for research projects on specific topics to safeguard biodiversity and promote the sustainable management of the natural resources of the islands.

1. Coastal water quality/nutrients and interaction with groundwater:

Note: Recently during the NICO expedition researchers looked at this around Bonaire and Curaçao.

- *Possible link to fish diseases/incidence of Fibropapillomatosis in green turtles in Lac, Lagoon and Curaçao can be used to determine the linkages with water quality, pollutants in sediments, etc serving as indicators, or sentinels for the health of these important ecosystems.*
- *Pollutants (oil, heavy metals, pesticides, endocrine disruptors, plastics, microbial etc) entering coastal waters (subterraneously) from land and their effects on marine organisms (Curaçao).*
- *Quantifying terrestrial hydrological controls on nutrient and sediment fluxes into shallow seas (Bonaire).*
- *Stoichiometric aspects of nutrient enrichment on Caribbean reefs (Curaçao).*
- *What do coral communities do "well" in places where they are not expected? What makes corals cope with more nutrients, warmer waters etc? (Curaçao)*
- *Design of cheap but effective waste water systems (using waste to generate biomass, energy etc.) (Curaçao)*
- *Water quality & pollutants in sediment of Spanish Lagoon (Aruba).*
- *Economical and feasible waste and waste water management options (St. Maarten).*
- *Water quality testing and impacts of poor water quality on marine life (St. Maarten).*
- *Monitoring the sedimentation on the reefs around Saba.*

2. Climate Change

- *Evaluation of the most probable effects of climate change and sea level rise (all islands), including risk analysis in coastal zones including coral reefs and recommendations for coastal zone management and climate proofing.*
- *Effects on sea turtles and their nesting beaches.*
- *Effects of changing temperatures and hurricane damage on cloud forest of Saba.*
- *Develop an effective terrestrial monitoring program to enable hurricane damage and recovery assessment.*
- *Island specific mitigation measures for climate change effect (St Maarten).*

3. Hydrology

- *Mapping of groundwater levels and flows [Bonaire].*
- *Nearshore-offshore mixing (Curaçao).*
- *A thorough study of Simpson Bay 's hydrology and water quality, particularly related to land-based sources of pollution. Identify key sources of pollution and track them back to their source (St. Maarten).*

4. Morphodynamics

(near shore coastal hydrodynamics, current models):

- *Currents and sand transportation (and production from Halimeda) in Lac (Bonaire) – very important to management of this Ramsar site.* ***Note:*** *HVL student has started to investigate this*
- *Investigate all sand producing organisms to better understand where sand (and beaches) come from (Curaçao).*
- *Effects on beach accretion and depletion Statia and potential of reef restoration/beach restoration.*
- *Sedimentation rates (St. Maarten).*

5. Yarari Sanctuary

- *Marine mammals: aerial survey (SSS islands (Saba Bank and waters surrounding Saba, St. Maarten and St. Eustatius), seasonal presence, isolation and abundance as well as seasonal migratory destination(s) and population history of humpback and Bryde's whales in the Dutch Caribbean.*
- *Sharks: Ecological role of Saba Bank for sharks (nursery for nurse sharks, tigersharks, silky sharks?).*
- *Analyze 10 year dolphin sighting database (Bonaire)*
- *Ecological role of the Saba Bank passage (between Saba and Saba Bank) for deepwater sharks (e.g. dog fish).*

Monitoring and Research Wishlist

The Dutch Caribbean nature conservation organisations are in need for research projects on specific topics to safeguard biodiversity and promote the sustainable management of the natural resources of the islands.

6. Invasive species:

- *Follow up studies of impact of rats (and cats) on nesting tropic birds.*
- *The effects of the invasive seagrass Halophila stipulacea on the native seagrasses in the area of Lac Bay, St. Eustatius and St. Maarten, and the ecological impacts (e.g on green turtles feeding in Lac [and Lagun], Bonaire and St. Eustatius; on conch feeding and recruitment [aggregations of juvenile conch under Halophila in Statia], sea urchins, etc.)* ***Note:*** *NWO funded Projects by Marjolijn Christianen (WUR) looked at this in relation to sea turtles. Also Erik Boman (WUR) & CNSI looked at this in relation to conch.*
- *Scaevola taccada (White inkberry/Beach naupaka) spread and potential impact on sea turtle nesting on Klein Bonaire.*
- *Donkey, cat, pig population size distribution and grazing impact on Bonaire.* ***Note:*** *Echo is working on a pig control programme.*
- *Management of Corallita* ***Note:*** *A running NWO project looked at this.*
- *Trapping lionfish in deep waters.* ***Note:*** *A project is running by WUR and WNF on the Saba Bank.*
- *Impact and potential management plans for invasive species. This includes: monkeys, iguanas, mongoose, african land snail, racoons, red eared slider (St. Maarten).*
- *Invasive species (size, distribution, threat management): boa, rubber vine, tilapia, goats, rats, cats, dogs, cane toad (Aruba).*

7. Birds

- *Migratory birds – patterns, habitat use with an emphasis on nesting species (Bonaire).*
- ***Yellow shouldered parrot:***
  - ◊ *Genetics of yellow shouldered parrot (establish uniqueness of Bonairean Parrot as compared to Venezuelan islands).*
  - ◊ *What is the effective (i.e., breeding) population size of lora as compared to the total population.*
- ***Flamingos***
  - ◊ *Ecology of the flamingos, in particular the Pekelmeer and flamingo sanctuary. Food availability and fluctuations and effects on breeding success.*

Photo by: © Miro Zumrik

8. Carrying capacity/management effectiveness

- *BNMP reef carrying capacity and implications for management (only old and dubious data available, urgent need for an update under current circumstances and how carrying capacity is influenced by management, e.g. can carrying capacity be increased with proper management. Consider also new types of recreation such as kite surfing and assess actual effects).*
- *Effectiveness of nature management, both marine and terrestrial (is management having an effect and what management actions should be improved or instated?)*
- *Saba/Statia trails (effects of use, potential mitigation measures?)*
- *Assess effectiveness of restoration efforts (e.g. reforestation, are the right species being planted, is the focus on rare species correct or counterproductive?* **Note***: Echo is working on this on Bonaire). Aruba would like to see reforestation of native, endangered, and key fauna supporting flora.*
- *Study the difference between cruise tourism and stay-over tourism regarding their pressure on the terrestrial and marine environment, taking into consideration the infrastructure needed to accommodate these types of tourism [Bonaire].* ***Note:*** *Wolfs Company did a study on this.*

Monitoring and Research Wishlist

The Dutch Caribbean nature conservation organisations are in need for research projects on specific topics to safeguard biodiversity and promote the sustainable management of the natural resources of the islands.

9. Fisheries research

- **Conch:** *vertical (depth) migration of conch.*
- **Commercial fish species:** *identify reproductive season or peak spawning period and area and assess connectivity between islands.*
- ***Saba Bank:***
  - ◊ *carrying capacity of main target species (red snappers and lobster (also part of BO program) Feasibility of habitat restoration/artificial habitat for lobster fisheries on the Saba Bank.*
  - ◊ *Unused stocks: identify potential and sustainability of currently unused fish stocks such as diamond-back squid, swimming crabs.*

Photo by: © Mark Vermeij

10. Sociological study of nature perception in the community

- *How does the local community perceive nature and nature conservation and to what degree do they enjoy nature, how might this be improved? How effective is current communication, if any, to improve enjoyment of nature in the community and perception of the need to protect nature?*
- *Sustainable tourism – perception/expectations of tourists and residents as tourism grows (Bonaire).*
- *Invasive species control on islands where free-roaming livestock is a cultural norm – changing traditions in a changing world (Bonaire).*
- *Sociological/anthropological study of the cultural value of the endangered Lesser Antillean iguana Iguana delicatissima. How often is it caught? Perceived as a delicatesse? (St. Eustatius)*
- *Assess the extent of current pollution from land by plastic bags, styrofoam and other plastic debris. How willing are people to change their behavior vis a vis plastic bags, and what would be needed to effectively curb the continued generation of this type of marine debris.*
- *Sustainable development opportunities for tourism dependant islands (St. Maarten).*

11. DNA barcoding to monitor biodiversity

(is already running on St Eustatius by Naturalis)

- *Biodiversity inventory: terrestrial. (St. Maarten and Aruba (also marine))*
- *Endemic, Endangered, and Keystone species (size, distribution, conservation management): Shoco (continue program), Bats (continue program), Prikichi, Santanero, Cascabel (renew program), Pollinators, Key fauna supporting flora (Aruba).*
- *Natural history Flora and Fauna distribution.*

12. Improve baseline data on sharks

(continue Shark research, especially shark tagging, movement and abundance).

Photo by: © Stan Shea

Monitoring and Research Wishlist

The Dutch Caribbean nature conservation organisations are in need for research projects on specific topics to safeguard biodiversity and promote the sustainable management of the natural resources of the islands.

13. Coral reefs

- *Which herbivores can be used to reverse coral to algal phase shifts? Which algae are consumed and which ones aren't? (Curaçao)*
- *Effects of habitat fragmentation and its effect on gene flow on coral reefs (Curaçao).*
- *The contribution of waterflow to reef health (Curaçao).*
- *Shipping impacts to nearshore coral reef environments (Bonaire).*
- *GCRMN reef monitoring (St. Maarten needs funding for long-term project).*
- *To battle and research the impact of stony coral tissue loss disease (St. Maarten)*
- *Coral restoration, as we lost about 60% of our corals or more in the last 2 years (St. Maarten).*

14. Economic valuation of key habitats

(St. Maarten)

15. Environmental impact assessment landfill

(St. Maarten)

16. Anthropogenic stressors:

- *Effects, potential mitigation measures: Off-road vehicles (Aruba).*
- *Carrying capacity of (1) Off-road vehicles, (2) Conchi – (3)Natural Pool, Caves (Aruba).*

17. Sargassum and Seagrass:

- *Sargassum predictions, impacts, management (All).*
- *Sea grass research such as abundance, distribution and status (St. Maarten).*

18. Turtles:

- *Fibropapillomatosis in green turtles: cause, spread and severity of the disease (Bonaire, Curaçao).*
- *Sea Turtle Research (St. Maarten).*

19.Mangrove Restoration

(St. Maarten)

Photo by: © Brenda Kirkby

Monitoring and Research Wishlist

The Dutch Caribbean nature conservation organisations are in need for research projects on specific topics to safeguard biodiversity and promote the sustainable management of the natural resources of the islands.

Additional notes:

The following are research questions from previous years and still very much valid for Aruba, Curaçao and St. Maarten. They are mostly completed or underway on the Caribbean Netherlands' islands but some are still valid.

Collection and evaluation of baseline data

including species inventories and production/updating of habitat maps for key habitats and species including:

- ***Marine environments***
  (coral reefs, seagrass beds, mangrove forests):
  - ◊ ***Habitat maps*** *for all marine ecosystems: Aruba, Bonaire (windward side), Saba [done], Saba Bank, St Eustatius [done], St Maarten*
  - ◊ *Revised habitat maps for the leeward shore: Bonaire [done], Curacao [note that there are habitat maps for Bonaire and Curaçao produced by Fleur van Duyl but these are now decades out of date. Recently a report from WUR came out (Mücher et al. Hyperspectral Coral Reef Classification of Bonaire). During the NICO expedition bathymetric data has been collected by Dr. Henk de Haas (NIOZ) for the Dutch Caribbean islands but this data still needs to be analyzed.*
- ***Terrestrial environments:***
  - ◊ ***Habitat maps*** *for Aruba [habitat maps produced and ground truthed by CARMABI exist for all islands except Aruba]*
  - ◊ ***Species inventories*** *(all islands) [Statia starting soon]*
  - ◊ *Cost effective methods for assessing terrestrial habitat change [remote sensing is now being proposed for monitoring]*
  - ◊ *Detailed inventories and mapping for **key ecosystems** including*
    - › *Cactus habitats (Bonaire)*
    - › *Elfin forest (Saba)*
    - › *Boven forest types (Statia)*
  - ◊ *Baseline data and population dynamics (including reproductive biology and conservation ecology) for **key species** including:*
    - › *Caribbean coot*
    - › *Northern Caracara*
    - › *Red bellied racer (Saba, Statia)*

Photo by: © Diego Marquez

List of Acronyms

AUA	**Aruba**
BON	**Bonaire**
CUR	**Curaçao**
SAB	**Saba**
EUX	**St. Eustatius**
SXM	**St. Maarten**
ABC	Aruba Birdlife Conservation
AMMF	Aruba Marine Mammal Foundation
BEST	Biodiversity and Ecosystem Services in Territories of European overseas
BO project	Policy Supporting Research project
CARIBSS	Caribbean Speleological Society
CARMABI	Caribbean Research and Management of Biodiversity Foundation
CEAB	The Blanes Centre for Advanced Studies, Spain
CRF	Coral Restoration Foundation
DCNA	Dutch Caribbean Nature Alliance
DCBD	Dutch Caribbean Biodiversity Database
DNM	Directie Natuur en Milieu, Aruba
DRO	Directorate of Spatial Planning and Development, Bonaire
EcoPro	Ecological Professionals Foundation
EPIC	Environmental Protection in the Caribbean
FIU (EEL)	Florida International University Environmental Epigenetics Lab
FSU	Florida State University
FPNA	Fundacion Parke Nacional Aruba
HAS	HAS University of Applied Sciences, the Netherlands
LVV	Department of Agriculture, Animal Husbandry & Fisheries, St. Eustatius
MinLNV	Ministry of Agriculture, Nature and Food Quality
NFSXM	Nature Foundation St. Maarten
Naturalis	Naturalis Biodiversity Center, Leiden, The Netherlands
NEV	Dutch Elasmobranch Association
NIOZ Sea Research	Royal Netherlands Institute for Sea Research
NWO	Netherlands Organisation for Scientific Research
RAVON	Reptielen Amfibieën Vissen Onderzoek Nederland
RRFB	Reef Renewal Foundation Bonaire
RuG	University of Groningen, the Netherlands
RU	Radboud University Nijmegen, the Netherlands
SCCN	Southern Caribbean Cetacean Network
Scripps	Scripps Institution of Oceanography, U.S.A.
SBMU	Saba Bank Management Unit
SCF	Saba Conservation Foundation
SECORE	SECORE International, U.S.A.
Smithsonian	Smithsonian's National Museum of Natural History
STCB	Sea Turtle Conservation Bonaire
STCC	Sea Turtle Conservation Curacao
STENAPA	St. Eustatius National Parks Foundation
STINAPA	National Parks Foundation Bonaire
UU	University of Utrecht, the Netherlands
UvA	University of Amsterdam, the Netherlands
VHL	University of Applied Sciences VHL, the Netherlands
VISR	Venezuelan Institute of Scientific Research
VU	VU University Amsterdam, the Netherlands
Wildconscience	Wildlife Conservation, Science and Education
WWF	World Wide Fund for Nature
WMR	Wageningen Marine Research, the Netherlands
WUR	Wageningen University and Research Centre, the Netherlands
WUR (Alterra)	Wageningen Environmental Research, the Netherlands
ZMT	Das Leibniz-Zentrum für Marine Tropenforschung, Bremen

Reports and Publications Overview

Below you will find an overview of the reports and publications on biodiversity related subjects in the Dutch Caribbean that have recently been published.

These reports and publications can be found in the Dutch Caribbean Biodiversity Database (DCBD) (http://www.dcbd.nl). The DCBD is a central online storage facility for all biodiversity and conservation related information in the Dutch Caribbean.

If you have research and monitoring data, the DCNA secretariat can help you to get it housed in the DCBD. *Please e-mail us: research@DCNAnature.org*

"Atherley, N.A.M., Freeman, M.A., Deniis, M.M. (2020). Post-mortem examination of the Caribbean spiny lobster (Panulirus argus, Latreille 1804) and pathology in a fishery of the Lesser Antilles. Journal of Invertebrate Pathology 175, 107453. https://doi.org/10.1016/j.jip.2020.107453"

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