Annual report
Carmabi Foundation
2012

Carmabi Annual Report 2012

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TABLE OF CONTENTS

FROM THE DIRECTOR

The year 2012 has been very eventful. A lot of progress was made. Examples include the construction of the Science Center, the integration of the park and museum management at the Christoffel Park and the creation of the Savonet Conference Centre. The board and staff of Carmabi are very pleased with the on-going support of and collaboration with Carmabi's old and new friends, associates, partners and the Curaçaoan Government.

Towards the end of 2012, Carmabi's new Science Center at Piscadera is nearing its completion. Many visitors have reacted positively to the new facilities and Carmabi is currently working hard to finish the building in time to receive the first group of students in January 2013. Although the research facilities in the Science Center are not fully operational yet, we can once again offer accommodations for visiting scientists starting January 2013. Carmabi's research department has been very productive in 2012: a total of 103 scientists visited Carmabi in 2012 (2011: 107) and worked on a wide variety of research topics. In addition 35 students participated in various courses that were taught at Carmabi. A total of 23 scientific publications were published based on work done at Carmabi of which 10 were authored or co-authored by Carmabi staff. Such increased scientific insight in the ecological processes shaping Curacao's reefs will be essential for improving existing and new strategies to ensure the long term survival of these unique assets of our island.

As planned, the management of the Christoffelpark, the Shete Boka Park and the Savonet Museum was integrated to reduce overhead costs. The new Savonet Conference Center is now in use and represents a very unique venue for meetings and conferences on the island due to its historic setting on the former plantation Savonet.

Our Nature and Environment Education (NME) Department is responsible for guided tours for primary school children in the Christoffel Park and the areas of Daaibooi, Shete Boka and Kabouterbos. In 2012 more than 13,000 school children visited these parks guided by one of our 5 volunteer guides or learned about the island's nature at school. The establishment of the Marine Education Center (MEC) at Piscadera became slightly delayed in 2012 because of the construction of the Science Center. The production of learning materials for the MEC continued.

Carmabi participated at the World Conservation Congress in Korea which was organized by the International Union for the Conservation of Nature (IUCN) and held every four years. A motion for more support for the Caribbean Initiative, i.e., an initiative to increase awareness on Caribbean environmental issues and to support the region's sustainable development, was accepted. Nature does not know borders and our continued support to regional programs is therefore very important.

What is our outlook for 2013? The new Carmabi Science Center will become fully operational which is a major step forward to expand our existing science program. The establishment of the new Marine Education Center (MEC) will also continue, funded with UNESCO funds.

The Government intends to reduce Carmabi's subsidy by 5% which is a severe challenge since the existing revenues are hardly sufficient to cover all Carmabi's operational costs. It is therefore that in 2013 Carmabi will continue to focus

on increased generation of revenues to avoid that existing successful projects and programs will be affected.

The state of Curaçao's coral reefs is still reason for great concern in general and specifically in light of the Government's plans to allow for intense development of the Eastpoint area. It should be realized that Oostpunt's fringing reefs are one of the few remaining reefs in the Caribbean that still grow and harbor a large variety of internationally protected species. It is therefore of regional, and maybe global, importance. Furthermore it should be realized that the health of the entire Curaçao reef system depends to large degree on Oostpunt's coral reefs as the ocean flows from east to west along our coast takin healthy coral larvae from this area down the coast, thus reseeding degraded areas. Coastal development will lead to the demise of Oostpunt's reefs (as it has happened on many other locations on the island) and subsequently negatively affect all reefs around Curaçao. This will have serious economic consequences since the reef is the base for (amongst others) the tourism industry and local fisheries. Furthermore a healthy reef protects our coast against storms and prevents the rise of (pathogenic) microbes in the island's coastal waters that are used for recreation by locals and visitors alike Carmabi will therefore do everything within its power to prevent Oostpunt's reefs from serious human interference and subsequent deterioration.

Paul Stokkermans
Director Carmabi

1 CARMABI'S MISSION

Missions & Goals

Carmabi's mission is to work towards a sustainable society, in which the sustainable management of nature leads to benefits that future generations can also enjoy. All parts of our community should be involved in this process.

Carmabi's primary goals are therefore:

- To conduct or facilitate research to support effective nature management, nature conservation, nature restoration, and nature development;
- The acquisition, conservation, protection, management, restoration and development of natural areas in the broadest sense, including objects or places of value to geology, history and/or archaeology;
- To create awareness within the community, especially school children, regarding the contribution they can make to achieve sustainable development on Curaçao.

Departments

To achieve the goals of our organization, Carmabi is organized as follows:

- Scientific Research
- Park management & Savonet Museum
- Environmental and Nature Education
- Advisory & Consultancy services
- Organizational support

2 SCIENTIFIC RESEARCH

2.1 Visiting scientists

103 scientists visited Carmabi in 2012. In addition 35 students participated in Coral Reef Ecology courses and workshops that were taught by Carmabi and various universities from the Netherlands. The number of visiting scientists in 2012 illustrates a continued positive trend despite the fact that many facilities were unavailable while the construction of the new lab is on-going. Most scientists in 2012 were from the Netherlands (45.6%; 2011: 22.4%; 2010: 25.9%) followed by the United States (39.8%; 2011: 39.3%; 2010: 41.2%), Germany (6.8%) (Figure 1). None of scientists and students that worked at Carmabi stayed at the Piscadera location due to the loss of dormitories in March 2011 and the construction of the new laboratory/ dormitory facilities. Because of the loss of our former dormitories early in the year, occupancy rates could not be calculated for 2012. A total of 4329 personal working days (i.e. one visiting scientist working one day) were achieved. This is an increase relative to 2011 (3752) and 2010 (1767 days) indicating that visiting scientists spend longer periods of time on the island. An overview of the areas in which all researchers that visited Carmabi were active is shown in Figure 2. An overview of visiting scientists (PI name and home institute) is provided below:

Benjamin Mueller (Royal Netherlands Institute for Sea Research), the Netherlands
Valérie Chamberland (Universite de Quebec a Montreal), Canada
Joost den Haan (University of Amsterdam), the Netherlands
Dr. Petra Visser (University of Amsterdam), the Netherlands
Dr. Ir. Jasper de Goeij (Poriforma BV,), the Netherlands
Dr. Erik Meesters (IMARES), the Netherlands
Hannah Brocke (ZMT), Germany
Gaëlle Quéré (ZMT), Germany
Dr. Maggy Nugues (ZMT), Germany
Dr. Fleur van Duyl (Royal Netherlands Institute for Sea Research), The Netherlands
Dr. Stuart Sandin (SCRIPPS Institution of Oceanography), USA
Aaron Hartmann (SCRIPPS Institution of Oceanography), USA
Dr. Kristen Marhaver (UC Merced), USA
Allison Gregg (San Diego State University), USA
Nate Robbiinett (San Diego State University), USA
Dr. Pedro Frade (University of Vienna), Austria
Dr. Dirk Petersen (Blijdorp ZOO), the Netherlands
Dr. Jonathan Losos (Harvard University), USA
Dr. Rick Hochberg (University of Massachusetts Lowell), USA
Kristiaan van Rooijen (Hogeschool Zeeland), the Netherlands
Bart Roothans (Hogeschool Zeeland), the Netherlands
Laurent Delvoye, the Netherlands
Dr. Dick van Oevelen (Royal Netherlands Institute for Sea Research), the Netherlands
Dr. John Mylroie (Mississippi State University), USA
Dr. Harry ten Hove (Naturalis), the Netherlands
Charlotte Wiseman (Newcastle University), United Kingdom
Cara Simonson (San Diego State University), USA
Rene v/d Zande (Utrecht University), the Netherlands
Bob Snowden (Pittsburgh Zoo), USA
Hendrikje Jorissen (Wageningen University), the Netherlands
Dr. Molly Cummings (University of Texas at Austin), USA
Dr. Sophie Petit (University of Southern Australia), USA
Laura Rix (ZMT), Germany
Dr. Rolf Bak (University of Amsterdam), the Netherlands
Shelby McIlroy (State University of New York at Buffalo), USA
Fernando Simal (STINAPA), Bonaire

2.2 Peer reviewed scientific publications

Twentythree publications appeared in peer reviewed scientific journals based on work that was conducted at Carmabi. Nearly half of those publications (10) were authored or co-authored by Carmabi staff making 2012 again productive year in terms of Carmabi's scientific output. The results of some of these studies have been featured in magazines, news programs and educa-

tional websites around the world. Furthermore, 12 reports were produced by MSc students that did their master's thesis' project at Carmabi. An overview of all peer reviewed scientific publications accepted for publication or published in 2012 is shown below:

Barott KL, Williams GJ, Vermeij MJA, Harris J, Smith JE, Rohwer FL, Sandin SA (2012) Natural history of coral-algae competition across a gradient of human activity in the Line Islands. Mar. Ecol. Prog. Ser. 460: 1–12. (Feature article)

Barott KL, Rodriguez-Brito B, Youle M, Marhaver KL, Vermeij MJA, Smith JE, Rohwer FL (2012) Microbial to reef scale interactions between the reef-building coral *Montastraea annularis* and benthic algae. Proc R Soc Lond B Biol Sci 279: 1655–1664.

Davies SW, Rahman M, Meyer E, Green EA, Buschiazzo E, Medina M, Matz MV (2012) Novel polymorphic microsatellite markers for population genetics of the endangered Caribbean star coral, *Montastraea faveolata*. Marine Biodiversity. DOI 10.1007/s12526-012-0133-4

De Freitas JA, Rojer AC (2013) New plant records for Bonaire and the Dutch Caribbean islands. Caribbean J. of Science 47(1): 114-117.

De León R, Vane K, Vermeij MJA, Bertuol P, Simal F (2012) Overfishing Works: A comparison of the effectiveness of lionfish control efforts between Bonaire and Curaçao. Proceedings of the 64th Gulf and Caribbean Fisheries Institute,Puerto Morelos, Mexico.

Dornburg A, Moore JA, Webster R, Warren DL, Brandley MC, Iglesias TL, Wainwright PC, Neara TJ (2012) Molecular phylogenetics of squirrelfishes and soldierfishes (Teleostei: Beryciformes: Holocentridae): Reconciling more than 100 years of taxonomic confusion. Molecular Phylogenetics and Evolution.

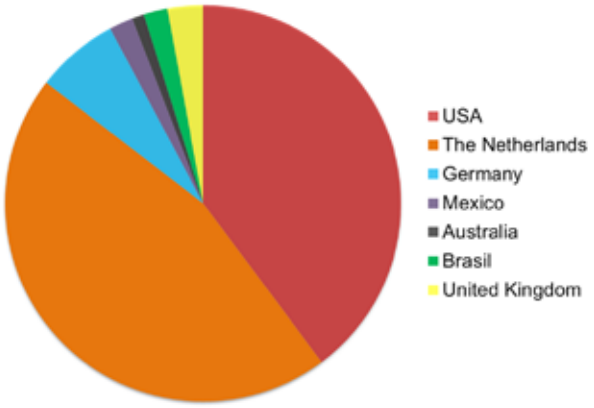


Figure 1. Origin of researchers visiting Carmabi in 2012.

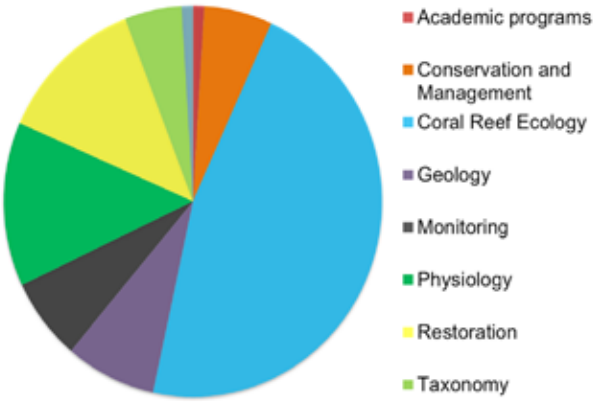


Figure 2. Areas of expertise of visiting researchers.

Foster, N.L. Paris, C.B., Kool, J.T., Baums, I.B., Stevens, J.R., Sanchez, S.A., Bastidas, C., Agudelo, C., Bush, P., Day, O., Ferrari, R., Gonzalez, P., Gore, S., Guppy, R., McCartney, M., McCoy, C., Mendes, J., Srinivasan, A., Steiner, S., Vermeij, M.J.A., Weil, E., Mumby P.J. (2012) Connectivity of Caribbean coral populations: complementary insights from empirical and modelled gene flow. Molecular Ecology 5: 1143–1157.

Foster NL, Baums IB, Sanchez JA, Paris CB, Chollett I, et al. (2013) Hurricane-driven

patterns of clonality in an ecosystem engineer: The Caribbean coral *Montastraea annularis*. PLoS ONE 8(1): e53283. doi:10.1371/journal.pone.0053283

Huijbers CM, Nagelkerken I, Lossbroek PAC, Schulten IE, Siegenthaler A, Holderied MW, Simpson SD (2012) A test of the senses: Fish select novel habitats by responding to multiple cues Ecology 93:46–55.

Kambesis, P. N., Mylroie, J. R., Mylroie, J. E., Larson, E. B., Owen-Nagel, A. M., Sumrall, J. B., and Lace, M. J., 2012 (abstract), Influence of karst denudation on the northwest coast of Cu-

racao. 16th Symposium on the geology of the Bahamas and other carbonate regions program, Gerace Research Centre, p.34.

Kelly LW, Barott KL, Dinsdale L, Friedlander AM, Nosrat B, Obura D, Sala E, Sandin SA, Smith JE, Vermeij MJA, Williams GJ, Willner D, Rohwer F (2011) Iron induced phase-shifts on coral reefs. ISME Journal. doi:10.1038/ismej.2011.114.

Marhaver, K.L., Vermeij, M.J.A., Rohwer, F. Sandin, S.A. (in press) Janzen-Connell effects in a broadcast-spawning Caribbean coral: Distance dependent survival of larvae and settlers. Ecology.

Meesters EH, Mueller B, Nugues MM (2012) Caribbean free-living coral species co-occurring deep off the windward coast of Curacao. Coral Reefs DOI 10.1007/s00338-012-0960-6

Muhs DR, Pandolfi JM, Simmons KR, Schumann RR (2012) Sea-level history of past interglacial periods from uranium-series dating of corals, Curaçao, Leeward Antilles islands. Quaternary Research 78: 157-169.

Nagelkerken I, Grol MGG, Mumby PJ (2012) Effects of marine reserves versus nursery habitat availability on the structure of reef fish communities. PLoSONE 7(6): e36906.

Petit S, Waudby HP, Walker AT, Zanker R, Rau G (2012) A non-mutilating method for marking small wild mammals and reptiles.Australian Journal of Zoology 60(1) 64-71.

Stampar SN, Maronna MM, Vermeij MJA, da Silveira FL, Morandini AC (2012) Temporal and spatial diversification of banded tube-dwelling anemones (genus: Isarachnanthus) in the Atlantic ocean. PLoS ONE 7(7): e41091. doi:10.1371/journal.pone.0041091.

Vermeij MJA, van der Heijden RA, Olthuis JG, Marhaver KL, Smith JE, Visser PM (2013) Survival and dispersal of turf algae and macroalgae consumed by herbivorous coral reef fishes. Oecologia 171: 417-425.

Vermeij MJA, Frade PR, Bak RPM (2013) Zooxanthellae presence acts as a settlement cue for aposymbiotic planulae of the Caribbean coral *Montastraea faveolata*. Caribbean Journal of Science 47: 31-36.

Weigt LA, Baldwin CC, Driskell A, Smith DG, Ormos A, et al. (2012) Using DNA Barcoding to assess Caribbean reef fish biodiversity: Expanding Taxonomic and Geographic Coverage. PLoS ONE 7(7): e41059.

Witte RH , Van Buurt G, Debrot AO, Bermudez-Villapola LA, Simal F (2012)First record of Fraser's dolphin Lagenodelphis hosei for the Dutch Caribbean. Marine Biodiversity 5: 46-50.

Wolf AT, Nugues MM (2012) Predation on coral settlers by the corallivorous fireworm *Hermodice* carunculata. Coral Reefs. DOI 10.1007/s00338-012-0969-x

Wolf AT, Wild C, Nugues MM (2012) Contact with macroalgae causes variable coral mortality in *Montastraea faveolata*. Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia, 9-13 July 2012.

The following reports were also produced:

Debrot AO, van Buurt G, Vermeij MJA (2012) Preliminary overview of exotic and invasive marine species in the Dutch Caribbean. IMARES Report #C188/11. 29pp.

Kutter PK (2012) Changes in primary production rates (13C) of benthic organisms under different nutrient regimes on a coral reef. Student report University of Rostock and University of Amsterdam.

van Rooijen AK, Roothenas BP (2012) Inventarisatie van de invasieve lionfish (*Pterois* spec.) en enkele gevolgen voor de riffen van Curaçao. Carmabi Report 28pp.

Vermeij MJA (2012) The current state of Curaçao's reefs. Carmabi Report 38pp.

Vermeij MJA (2012) Emerging issues on Bonaire's reefs. Carmabi Report 14pp.

All these publications can be requested electronically (in pdf format), by sending an email to camabilog@gmail.com

2.3 Free advice, outreach and consultation

Several organizations, government departments, the press and others received free advice and information from the Carmabi Science Department during the year. We assisted in 72 cases, both oral and written. Four consultancy studies were executed for international and governmental organizations on Curacao or

Figure 3. Carmabi researchers and colleagues at the 12th International Coral Reef Symposium in Australia.

other Caribbean islands. In 2012 the Carmabi Science Department was featured/ interviewed in 57 (known) items for local TV, radio and newspapers. Twelve public and seven invited lectures were given on various topics related to coral reefs during conferences and workshops, such as the 12th International Coral Reef Symposium in Cairns, Australia, where multiple people that conducted their research at Carmabi gave presentations for the international coral reef community (Figure 3). Every four years the International Society for Reef Studies (ISRS) sanctions this major international scientific conference to progress coral reef science, management and conservation. This 5 day event will bring together 2,500 people from some 80 countries, to communicate their science and

hear the latest advances from the international experts in coral reef science. Their research and findings are fundamental in informing international and national policies and protocols in the conservation and sustainable use of coral reefs. During this symposium scientists from around the world endorsed a Consensus Statement urging governments to take action for the preservation of coral reefs for the benefit of present

Figure 4. Filmcrew of the television program "Klokhuis" filming at the Carmabi pier .

and future generations (http://www.icrs2012.com/Consensus_Statement.htm). A summary of this Consensus Statement is as follows:

Changes in coral communities already observed over the last century: (1) approximately 25-30% of the world's coral reefs are already severely degraded by local impacts from land and by over-harvesting.
The surface of the world's oceans has warmed by 0.7°C, resulting in unprecedented coral bleaching and mortality events. (2) The acidity of the ocean's surface has increased due to increased atmospheric CO2.
Sea-level has risen on average by 18cm. Changes in coral communities expected by the end of this century: (3) CO2 emissions at the current rate will warm sea surface temperatures by at least 2-3°C, raise sea-level by as much as 1.7 meters, reduce ocean pH from 8.1 to less than 7.9, and increase storm frequency and/or intensity. This combined change in temperature and ocean chemistry has not occurred since the last reef crisis 55 million years ago. Other stresses faced by corals and reefs include: (4) Coral reef death also occurs because of a set of local problems including excess sedimentation, pollution, habitat destruction, and overfishing. These problems reduce coral growth and vitality, making it more difficult for corals to survive climate changes. Future impacts on coral reefs: (5) Most corals will face water temperatures above their current tolerance. (6) Most reefs will experience higher acidification, impairing calcification of corals and reef growth.

(7) Rising sea levels will be accompanied by disruption of human communities, increased sedimentation impacts and increased levels of wave damage. Together, this combination of climate-related stressors represents an unprec-

Figure 5. Upcoming Carmabi book on the beauty of the island's underwater resources.

edented challenge for the future of coral reefs and to the services they provide to people.

Furthermore, visual materials were provided to numerous organizations to illustrate various reef related topics. Noteworthy was the visit of two Dutch camera teams for the educational TV show Klokhuis (Figure 4) and the scientific TV program Labyrinth that filmed at Carmabi for various reef related items which can be watched at:

http://www.wetenschap24.nl/programmas/labyrint/labyrint-tv/2012/oktober/Sponzen.html

http://www.hetklokhuis.nl/onderwerp/sponzen

In addition a 160 page book (Figure 5) was finished on the reefs of Curacao that will be available in 2013. Carmabi further developed its on-line identification guides for Caribbean corals that can be found under publications at www.reserachstationcarmabi.org.

2.4 Research

A large, collaborative project was continued in 2012 funded by the European Union's 7th Framework Program entitled "Future of Reefs in a Changing Environment: an ecosystem approach to managing Caribbean coral reefs in the face of climate change (FORCE)" and will continue for another year. On Curacao this project largely focusses on the ecology of microbes, coral larvae and phytoplankton in the water overlying reefs and how these functional groups are important to reef deterioration and health. Furthermore socio-economic studies will be conducted (as well as in a.o. Mexico, Honduras, Costa Rica en Barbados) to weigh the importance of factors such as e.g., poverty, corruption, lack of enforcement relative to "natural" factors that contribute to reef degradation.

For more information on the FORCE project led by Prof. Dr. P. Mumby, see: http://www.force-project.eu/

The monitoring of the invasive lionfish that first appeared in Curaçaoan waters in October 2009 was continued and a comparative study was done to determine whether on-going eradication efforts are successful. In cooperation with the Bonaire National Marine Park the number of lionfish was counted on Bonaire and Curacao. On Bonaire the ELF eradication tool has been used for a year and this corresponded to a 2-4 fold reduction in lionfish biomass when compared to Curacao where such eradication efforts were only recently started. While this method surely does not represent a final solution for the lionfish problem, these results clearly indicate that the local abundance of lionfish can be controlled to some degree through active eradication efforts.

Together with a large number of international collaborators gathered within SECORE (see: www.secore.org), Carmabi actively partici-

Figure 6. Larvae of the endangered elkhorn coral (Acropora palmata) were collected in the field and settled on specially designed tiles that can be used to reseed a reef with such endangered coral species. Photo: Paul Selvaggio.

pated in the design of new methods by which the abundance of threatened coral species can be increased around Curacao by raising the larvae of these endangered species (Figure 6). A marine biologist (Valerie Chamberland) was hired with external funds to continue this work at Carmabi for another 3 years. A collaborative project with SCRIPPS Institution of Oceanography and San Diego State University (both U.S.A.) was also continued (for the 4th year). In this project, active reef restoration methods are being an applied to a degraded reef near Westpunt (Curacao) to experimentally test which techniques and approaches are the most successful management tools to restore degraded Caribbean reefs.

During the coral spawning, Carmabi researchers collaborated with various US universities to investigate which factors contribute to the survival of the earliest life stages in corals. Successful survival ensures that coral reefs can basically regrow and adult corals that died due to natural or human-induced causes are replaced. Preliminary findings illustrate that both microbes and algae contribute to higher mortality and less successful settlement compared to historic baselines. It was also found that corals from the Eastpoint area produce approximately 4 times more coral larvae than corals elsewhere on the island and that these larvae (i.e., from Eastpoint) also survive and settle better.

Carmabi continued its membership of the Association of Marine Laboratories in the Caribbean (AMLC, see: www.amlc-carib.org/) and NET-BIOME network (www.netbiome.azores.gov.pt/NetBiome). An AMLC meeting

was attended in Coasta Rica to discuss the latest research finding relevant to Caribbean reef systems. NET-BIOME stands for "NETworking for tropical and subtropical BIodiversity research in Outermost regions and territories of Europe in support of sustainable development", a new network aimed at overcoming the lack of trans-regional funding and increasing the integration of research on biodiversity. Carmabi is part of the oil-spill response team on Curacao (RAC/ REMPTEIC-Carib).

Vermeij still is a topic editor for the journal Coral Reefs, the journal of the International Society for Reef Studies.

2.5 Selected research projects

Below one finds some examples of some of the projects carried out at Carmabi in 2012. Published findings will eventually become available, but because publishing/ reviewing takes generally 1-2 years, this overview aims to provide a current overview of the type of projects that were carried out in 2011.

2.5.1 Influence of karst denudation on the northwest coast of Curaçao

Dr. John Mylroie (Department of Geosciences, Mississippi State University USA)

Dr. John Mylroie and his colleagues visited Curaçao in 2012 to study the island's geology, including the formation of Curaçao's famous "boka's" along the northwest coast of Curacao which is characterized by a series of Pleistocene-age reef terraces at four discrete elevations with dissolutional caves formed in the terraces at specific elevations, large scale linear coastal reentrants (i.e., "boka's) in the lowest terrace, and coastline erosional features formed by a combination of cave collapse and wave erosion. Field mapping documented 17 bokas and identified and surveyed numerous flank margin caves related to the reef terraces and the bokas. Quaternary uplift is evident by the position of the four elevated reef terraces adjacent to the coast. Eustatic sea-level changes, interacting with tectonic uplift, played an important role in the development of flank margin caves associated with the reef terraces. These caves in the inland cliffs fronting the terraces, exposed by cliff retreat, are located above the terrace surface, indicating the degree of dissolutional denudation of the terraces since terrace deposition and exposure. Roof collapse of portions of these caves has formed entrances on top of the terraces that manifest themselves as skylights within the caves. A widespread system of fluvial valleys, formed on interior Cretaceous volcanic rocks, has eroded through the limestone terraces into the underlying basaltic bedrock. Large bokas are developed where these inland streams have incised through the lowest limestone terrace. The bokas are rectilinear re-entrants in the coastal cliffs, commonly 10 m deep and 30-40 m wide, running inland up to several hundred meters. Waves penetrate into the lower portions of the bokas. Their inland termini open to broad valleys. The bokas contain flank margin caves exposed along their vertical walls, including within the broad termini, which have facilitated boka wall collapse. Caves located in the lowest reef terrace that are not associated with ephemeral fluvial drainage are exposed by ceiling collapse and are eventually breached by sea-cliff retreat. As wave-influenced coastal erosion proceeds, these flank margin caves are degraded to natural bridges that parallel the coastline and eventually evolve to short coastal reentrants. The assortment of karst, marine, and fluvial features signify polygenetic processes contributing to boka formation and the erosional degradation of the coast line.

2.5.2 Fate of nutrients entering coral reefs

Joost den Haan (University of Amsterdam, The Netherlands)

Anthropogenic eutrophication from sewage

and land runoff results in increased nutrient loading onto coral reefs, notably in the form of nitrogen and phosphorus. This can alter competitive relationships among benthic organisms (i.e. corals vs. algae) in favour of opportunistic algae. PhD student Joost den Haan, Dr. Petra Visser, and Dr. Mark Vermeij (University of Amsterdam, the Netherlands), together with several MSc students from various countries, investigated which benthic organism in particular benefits from this nutrient enrichment. They found that notably turfalgae and benthic cyanobacteria are quick in utilizing nutrients upon availability, which can in part explain why these benthic organisms are so abundant on many reefs around Curacao. Since nutrients are vital for growth, a fast uptake mechanism for nutrients can increase its competitiveness for space and can lead to corals being overgrown by these turfalgae and benthic cyanobacteria. The researchers from the University of Amsterdam (UvA) also investigated the role of turfalgae within the nitrogen cycle on the reef, and found that this benthic organism fixes atmospheric nitrogen at very high rates, even higher than so far reported in the Caribbean. Nitrogen fixation is a mechanism performed by cyanobacteria within the turfalgal community by which unavailable nitrogen is made available for growth. As a consequence, high nitrogen fixation rates can promote turfalgal growth, and since they are probably the most dominant benthic component on many reefs around Curacao, their role within the nitrogen cycle cannot be neglected. Turfalgae further release dissolved organic nitrogen, which via the microbial community (i.e. bacteria) can be transformed into dissolved inorganic nitrogen, i.e. nutrients that are directly available for growth of many benthic organisms, including turfalgae themselves. As a consequence, a so-called positive feedback might be at hand, by which nitrogen fixation by turfalgae indirectly promotes its own proliferation on the reef. The coming years the researches from the UvA will continue to study the effect of eutrophication on the reefs of Curacao. Several experiments will be conducted with the help of MSc students, where the effect of nutrient availability on growth, nutrient uptake, and nutrient storage is examined to better answer the question 'What is the fate of nutrients entering coral reefs'.

2.5.3 The importance of bats for Curacao's terrestrial ecosystems

Dr. Sophie Petit (University of Southern Australia, Australia)

After several years away, I returned to CARMABI to work on a paper with colleagues Anna Rojer and Leon Pors. We have been studying the impact of predation on cactus recruitment.

Our growth rate data confirm the old age of really large cacti. Recruitment is very low as well and fruit predation (and in some cases flower predation) is very high. Anna's meticulous germination work shows clearly that for seed dispersal to be effective, fruits must be ripe. When they open, seeds are available for dispersal by bats and birds; fruits eaten before they open may not produce viable seeds. Low recruitment and growth rate of cacti suggest that their active conservation is necessary. Last August we also conducted a survey of cave-dwelling bats, which is a big and difficult job, and the report was provided to CARMABI to inform management. We also wrote a protocol for bat surveys for CARMABI. I gave a well-attended

presentation to the public regarding the carrying capacity of cacti for bats and the impact of land clearance. I also gave a newspaper interview detailing my bat work on Curaçao. It was a very busy month but there is nothing better than hugging a cactus on Curaçao.

2.5.4 What is the condition of the coral reefs in Curaçao and Bonaire?

Prof. Dr. Rolf Bak (NIOZ/ University of Amsterdam, the Netherlands)

Coral reefs are changing over time but it is difficult to say how much they are changed without knowing how they looked in the past. In Curaçao /Bonaire we run a program under the care and with support of Carmabi and other institutions (NIOZ, IMARES and University of Amsterdam) to understand the development on the reefs of the islands. Coral reefs in Curaçao/ Bonaire have been photographed for 40 years, since 1973. There are repeated photographs of the same areas of reef bottom. Together this photographic record presents the longest time series that is available on the planet and that over a great depth, ranging from 10 to 40 m. We had a total of 207 m^2 under observation but the area has been expanded in 2012 with an additional 45 m^2. The main conclusions of the analyses show that since the start of the series, in 1973/74 coral cover has dramatically declined, going down from up to 60% to much lower values, in some cases to only 10%. The photographs also show that coral cover is low in the last years and not changing much. There is potential for recovery because a low cover of coral is still present. However, we continue to see still a slow decline or at best unchanged low coral cover. There is an important exception; at Oostpunt Curaçao we measured the only positive development. Here, we have the only site where recovery, in terms of increasing coral cover, was recorded. Positive development here is important when we realize that the Oostpunt reefs are a source of larvae of corals (and other reef organisms, fish etc.) for the whole south coast of Curaçao. How the composition of the coral community has changed over time in terms of presence of different coral species is being analysed.

2.5.5 Herbivory and nutrients are important regulators of the dominant macroalgae *Lobophora variegata* on Bonaire

Rene van der Zande (Utrecht University, the Netherlands)

Healthy coral reefs are important for the Caribbean as they provide lots of benefits such as revenues from diving tourism and fisheries as well as coastal protection. These healthy reefs are characterized by high coral and low macroalgae cover. Caribbean reefs are not doing so well though presently, with 'bad' macroalgae getting more and more abundant on coral reefs throughout the region and thereby replacing the 'good' corals. It is hypothesized that two important reasons for this coral to algae shift are a decrease in herbivorous fish population (which eat the algae but not the corals) and an increase in nutrients in the reef water. In collaboration with Carmabi, the growth and mortality rates of one of the dominant macroalgae, *Lobophora variegata* were studied on Bonaire. It was found that growth rates of Lobophora when herbivores were excluded were almost double the growth rates of when herbivores were present, and that mortality of the algae was higher when

herbivores were present. Moreover, algae cover only increased in the absence of herbivores. The presence of herbivores also resulted in a 10 to 50% lower recruitment of new algae. Additional experiments with nutrients indicated that *Lobophora* could still use more nutrients for its growth than presently available, suggesting that the algae could reach higher growth rates in case nutrient concentrations on the reef increase further. These results clearly show the importance of herbivorous fish in reducing macroalgae abundance on Bonairean reefs, and the potential of high nutrient concentrations to enhance macroalgae growth. A combination of higher herbivore abundance and lower nutrient concentrations is likely to decrease the pressure on coral reefs and increase the probability of reefs remaining in a healthy state.

2.5.6 Population structure of Anolis lizards

Jonathan Losos (Harvard University, USA)

The toteki, *Anolis lineatus*, is a common lizard on the islands of Curaçao and Aruba. Despite its abundance, little of its natural history is well known. Particularly surprising, no one has ever compared populations of the species on the two islands to see how similar or different they are. In 2012, I visited Curaçao and Aruba to conduct such a study. I found that in habitat use and behavior, the species seemed quite similar on both islands—basically, it is found in many habitats on trees and rocks relatively low to the ground. Examination of individuals, however, revealed anatomical differences. The Aruba animals are larger than those from Curaçao, and there are differences in how long their limbs are, and in other aspects of anatomy. Moreover, we sequenced the DNA of individuals from both islands and found that there are subtle but clear genetic differences. We are currently writing up the results of this study for publication in a scientific journal. There is no doubt that *Anolis lineatus* populations on Curaçao and Aruba are different; some people might even consider them different enough to be recognized as distinct species.

2.5.7 Healthy coral reefs disproportionately contribute to reproductive output on island-wide scales

Aaron C Hartmann (Scripps Institution of Oceanography, USA)

Visual metrics of coral health such as live coral abundance are highly valuable, yet can fail to detect ecosystem degradation until it is well underway. With coral abundance of more than twice the region-wide average, the Eastpoint region of Curaçao is one of the healthiest coral reefs remaining in the Caribbean. Given this, we used Eastpoint as a model to examine subtle physiological differences in coral health among reefs. We measured storage lipid content and reproductive output of visually healthy colonies of four species collected at Eastpoint and on "degraded" reefs near the urban center of the island. Our multi-year dataset shows that individuals from Eastpoint (of multiple species) store greater amounts of energetic lipids and can produce more than three times as many offspring as visually healthy conspecifics near the urban center. The combination of higher adult coral abundance coupled with greater per-adult fecundity suggests that Eastpoint reefs are likely a disproportionately large source of offspring on the island. Currently, plans to develop 70% of Eastpoint await government approval. Given that reef degradation has accompanied development elsewhere on Curaçao, Eastpoint will likely meet a similar fate. By revealing that visually healthy corals can differ dramatically in their reproductive output, our work highlights that more than just Eastpoint corals stand to be lost, making conservation of this area of critical importance to the island as a whole.

2.5.8 Restoration of Critically Endangered populations of the Elkhorn coral (Acropora palmata)

Valerie Chamberland (CARMABI/ University of

Amsterdam, The Netherlands)

Prior to the 1980's, the Elkhorn coral (Koral kachu grandi, *Acropora palmata*) was a dominant shallow-water reef building species that provided shelter for a large variety of other reef organisms and significantly contributed to coastal protection during storms and hurricanes. In the early 1980's this species abundance declined by more than 95% due to a disease outbreak and has remained at low densities without noticeable recovery since then (Acropora Biological Review Team 2005). As a result, *A. palmata* was listed as "critically endangered" under the IUCN Red List. To facilitate this species' recovery, Caribbean-wide restoration efforts were started. In 2010, the SECORE Foundation, in collaboration with CARMABI and the Curaçao Sea-Aquarium, launched a restoration program in Curaçao aimed at developing the techniques required to assist the recovery of depauperate *A. palmata* populations throughout the Caribbean. In contrast to more commonly used techniques that depend on the production of offspring by fragmenting existing colonies, SECORE uses large numbers of sexually produced offspring which are reared in nursery conditions at the Sea-Aquarium prior to their reintroduction to the reef. Since the beginning of this project, SECORE has currently succeeded in developing basic methods to reintroduce large numbers of off-spring to the reef. In August 2012, 370 young Elkhorn corals were out planted to the reef out of which 13% had survived after 5 months, exceeding natural recruitment rate of this species. While successful so far, losses of reintroduced offspring due to unknown biological and ecological agents require (1) the continued improvement of the current methods and protocols and (2) additional insight into the factors negatively affecting the survival of reintroduced offspring to enhance the success of *A. palmata* restoration efforts throughout the Caribbean. Those questions will be addressed in 2013.

2.5.9 Uptake of symbionts by the earliest life stages of corals

Shelby McIlroy (Ph.D. Candidate, SUNY at Buffalo, USA)

Shelby McIlroy visited CARMABI in October 2012. As part of her dissertation research with Dr. Mary Alice Coffroth, she has conducted several experiments to explore how corals take up their algal symbionts and which factors influence the ecological success of these symbioses. Shelby visited CARMABI for the seasonal coral reproduction and observed several coral species synchronously spawning over 3 nights. While most of Shelby's work is conducted in the Florida Keys, USA, Curacao reefs reproduce a several weeks later in the year allowing for multiple opportunities to collect and rear coral larvae for various types of research.

2.5.10 Bacteria alter larval behavior of corals

Kristen Marhaver (Postdoctoral Scholar at UC Merced, USA)

In 2012, Dr. Kristen Marhaver conducted field research at Carmabi for an NSF-funded research project with Prof. Monica Medina at UC Merced to isolate and identify bacterial strains from marine surfaces that cue specific larval behaviors in corals, including metamorphosis and settlement. Over 100 bacterial isolates were obtained from marine samples and preserved as glycerol stocks at Carmabi for long-term study. Isolates were tested in replicated bioassays for their ability to induce settlement and alter swimming behavior in coral larvae. The research thus far has produced proof-of-concept data by demonstrating that specific isolates predictably and reproducibly change larval behavior patterns and settlement rates. Bioactive isolates have been identified with 16S DNA sequencing and both phenotypic description and DNA identification is underway for all isolates in the library. Ongoing work on this project will

expand to include additional coral species and examine the effects of various environmental factors on isolate bioactivity. Additional activities in 2012 included successfully rearing larvae of numerous coral species, collaborating with scientists from San Diego State University and Scripps Institution of Oceanography on studies of coral larvae and coral-associated microbes, conducting settlement preference experiments using multiple species of crustose coralline algae, and making new observations of coral spawning in both male and female colonies of the relatively under-studied coral species Dendrogyra cylindrus (pillar coral). Dr. Marhaver's outreach and communication activities in 2012 included writing as a guest blogger for Deep Sea News, speaking for the Women and Minorities in Science group at Scripps, conducting live animal demonstrations with corals and coral larvae at DiveVersity dive shop during coral spawning, speaking about reforming science publishing and science communication at the ICES Conference for Early Career Scientists in Mallorca, Spain, and giving a TEDTalk about coral larvae on the Fellows stage at the TEDGlobal conference in Edinburgh, Scotland.

2.5.11 Coral larvae behavioral responses to chemical cues

Nathanael L Robinett (SDSU/UCR Joint Doctoral Program Evolutionary Biology, San Diego State University, USA)

Large coral colonies that define the reef begin as small larvae, often no more than a millimeter in length. Developed from broad-cast spawned gametes or eggs brooded inside maternal polyps, these small larvae, called planulae, must reach suitable substrate before they can carry out metamorphosis and begin construction of their calcium skeletons as juvenile coral. Reaching a suitable site for future growth as a colony represents an important achievement; young coral compete with macroalgae and other fast-growing benthic organisms for light and reef space. Adult colony distributions reflect settlement of planulae to these sites. Motile planulae are equipped with cilia and sensory organs and have been observed to carry out a range of swimming and navigational behaviors. Observations of planulae suggest that they respond to specific light and chemical cues during settlement. Benthic organisms, including bacteria and species of crustose coralline algae, may provide cues that planulae respond to. In addition, differences between coral species in their responses to these cues may explain

Figure 7. Design to test the navigational behavior of coral larvae to waterborne cues.

the varied distributions of species that characterize the reef environment. In order to better understand planulae navigational behaviors we built a series of testing tools (Figure 7) to measure planulae responses to environmental cues. Using the CARMABI Research Institute Field Station wet lab, Discrete, flow-through gradients of turf algal and crustose coralline algal community derived cues were provided to planulae of the following species: *Agaricia humilis*, *Favia fragum*, *Diploria labyrinthiformis* and *Porites astreoides*. In response to cues, planulae displayed an extensive range of swimming behaviors. Planulae of similar age exhibited varied behaviors but preliminary results suggest that *A. humilis* planulae generally avoid high

concentrations of turf algal community derived cues and respond to pulverized crustose coralline algae cues with tactile examination of the substrate. Future work will expand the range of provided cues and incorporate varied light regimes in the experimental design.

2.5.12 Diseases of crustose coralline algae

Gaëlle Quéré (Leibniz Center for Tropical Marine Ecology, Germany and the University of Perpignan, France)

Gaëlle Quéré, PhD student under the supervision of Associate Prof. Maggy Nugues, conducted her field work at Carmabi looking at diseases affecting Crustose Coralline Algae (CCA). CCA are a key functional group in coral reef ecosystems, they maintain the integrity of the reef framework and they stimulate coral larvae settlement. During her three month trip, Gaëlle conducted experiments to compare the settlement rates of larvae from three different coral species when exposed to three species of coralline algae, healthy and diseased. She found that each CCA has a specific effect on coral larvae and that settlement is less successful in the presence of diseased algae. Gaëlle's previous work on Curaçao showed that two types of diseases affecting CCA could be found on the island and that they were found all along the coast even at sites less impacted by human activity. Diseases affecting CCA are not well understood yet but these results suggest that they might have serious consequences on the structure of coral reefs.

2.5.13 Impact of benthic cyanobacterial mats on Curacao´s coral reefs

Hannah Brocke (Leibniz Center for Tropical Marine Ecology (ZMT) and Max Planck Institute for Marine Microbiology (MPI-MM); Germany)

During the last two decades, dense benthic cyanobacterial mats have become more prevalent on the coral reefs worldwide as well as on Curaçao. Their abundance has been associated with reef degradation. Hannah Brocke, a PhD student under the supervision of Associate Prof. Maggy Nugues (CRIOBE, Perpignan, France) and Dr. Dirk de Beer (MPI-MM) working as part of the project FORCE (Future of Reefs in a Changing Environment) investigate environmental parameters associated with the absence and presence of these mats, their spatio-temporal dynamics, and their impact on local reef ecosystem functioning. A potential explanation for the blooming of benthic cyanobacteria is changes of environmental conditions altered by human activities. In the uninhabited east part of the island the mat occurrence was observed very low (under 1% coverage), the mat abundance increased with populated and industrialised areas, especially in regions of estuary runoffs (over 50% coverage). A variety of experiments and surveys were conducted to investigate the drivers for their growth and how the mats change their micro environment. More detailed results will be expected in 2013.

2.6 Academic programs

2.6.1 'International Excursion Tropical Marine Biology' of the University of Amsterdam 2011
Nine students of the University of Amsterdam attended the MSc field course at CARMABI in April 2010 (Figure 12). This course, focusing on the diverse marine life on coral reefs, is the main field excursion of the Master program Limnology and Oceanography of the UvA, but is also open for students from other master programs. The course was taught by Mark Vermeij and Petra Visser with assistance of Joost den Haan and Valerie Chamberland. Every day started with a lecture on reef organisms and their ecology. Emphasis was on corals and algae, but the biology and ecology of other reef organisms were also discussed. During the rest of the day, the students were underwater, in the laboratory or studying on the identification of the many coral and macro algal species they

observed at the reefs. During the field and lab work, students practiced to make surveys of the benthic community composition, to measure temperature and light profiles, and to determine photosynthetic rates of corals and macro algae using PAM fluorometry. In small groups, students designed their own research plan on a specific topic and performed field and lab work on this topic during one week. This year's topics were: (1) The effect of reef structure on reef fish abundance, (2) Feeding ecology of the red lionfish, and (3) Nutrient limitation assays for *Lobophora variegata* and phytoplankton. After three weeks, the students presented and discussed their results. During the last week of the course, they focused on data analysis and writing of their report.

2.7 Research: Long term developments

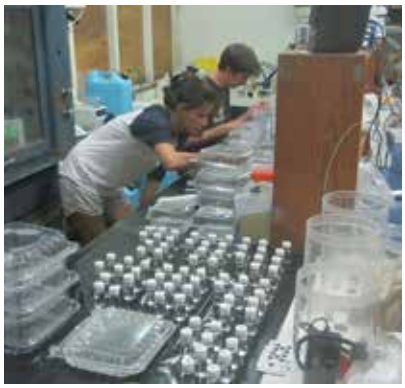
Carmabi is nearing the end of the upgrading of its research facilities and capabilities to provide Curaçao with a modern biological station that will support and improve existing and new management strategies to safeguard the island's natural resources. Recent developments have increased local awareness of the loss of natural areas and the need to protect such areas to preserve the island's identity. The new facilities will triple the amount of laboratory space currently available at Carmabi and provide accommodations for up to 30 people. The upgrading of Carmabi's laboratories and accommodations for visiting scientists has been made possible primarily through financial support of from the Dutch Government through the SEI initiative, the Curaçaoan Government, the Dutch Ministry of Education, Culture and Science (OCW) and Carmabi itself.

Lastly, one staff member of Carmabi, Dr. M. Vermeij is still (part-time) employed by the University of Amsterdam to oversee research projects of their students and teach the course "Tropical Marine Ecology" in Amsterdam and a field course at Carmabi. In addition he started teaching a similar course at the University of Utrecht (Netherlands) since 2011.































3 PARKS AND MUSEUM

3.1 General

Important in 2012 were increasing the effectiveness of park management, cost reduction and income generation. With these goals in mind the management of the Christoffelpark, the Shete Boka Park and the Savonet Museum was integrated and the Savonet Conference Center was enlarged. Other park improvements included the improvement of the entrance of the Savonet complex, increase in entrance fees for tourists and the purchase of a new car for touring purposes.

On the downside the year 2012 has seen some problems with the government. Furthermore 2012 again was a year with heavy rainfall. There was a lot of maintenance because the paths and roads rapidly get overgrown. The state of the main park infrastructure is still worrisome. The main focus with maintenance has been on the main road, which is used the most by the visitors. The hiking trails on the north side of the park and to the top of the mountain need maintenance, but are still accessible. The non-paved roads on the south side of the park are closed for the public, since these trails are heavily overgrown.

In the personnel area the parks have also seen a change in management. A new manager has been appointed. The last 2 months of 2012 the position for parkmanager therefore was vacant. In these months the assistant manager took

over the daily management and the director took over when important decisions needed to be made.

3.2 Integration of park management

The Christoffelpark, the Shete Boka park and the Savonet Museum have since 2012 one management. The manager of the Christoffelpark is now also the manager of the Shete Boka park and the Savonet Museum and the same personnel takes care of all three entities. An integrated management reduces overhead cost and improves efficiency. The marketing of the Christoffelpark product and the Shete Boka Park product will remain separate however, thus emphasizing the special nature of each park.

3.3 Other park improvements

The renovated Savonet plantation is a very important historical entity. So far the entrance of the Savonet complex did not do justice to this historic environment. For this reason the entrance has been cleared of non-relevant activities and is now more in line with its historic surroundings. The shop moved to the same room as the ticket office, at the entrance of the park.Our cars are becoming old. Furthermore tourists require more adequate transport when it comes to touring the park. Tourists are also becoming older. For this reason a new Toyota Hilux was purchased.

Work on the historical route that encompassed amongst others the buildings of Savonet and ruines of the old plantations Zorgvliet and Zevenbergen progresses. The Zorgvliet plantation house ruine has been consolidated. Much work remains to be done however.
In the line of the goal for extra income generation the entrance fee for tourists was raised from 17,50 to 21 guilders. The local entrance fee remains 7,50 guilders.

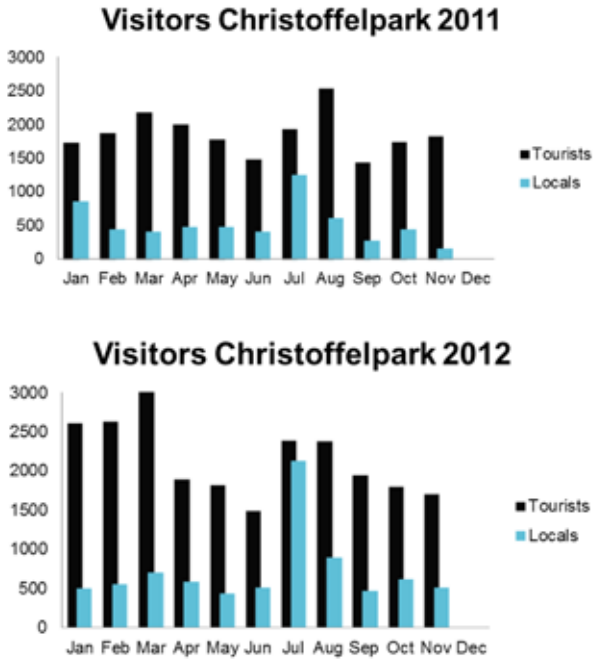


Figure 8. Visitor rates for the Christoffel Park in 2011 and 2012.

3.4 Christoffelpark

Infrastructure

The infrastructure of the Christoffelpark has for many years been the victim of insufficient funds. Much needed maintenance work has not been able to proceed. As a result the fence around the park and the path to the top of the Christoffel mountain are in a deplorable state. Also the parking place at the foot of the mountain is in a bad shape. The main roads are fairly well maintained but it is a constant endeavor. The road to the Zevenbergen ruins and Seru Gracia has been closed to the public and also for our own safari tours since the road is heavily overgrown and full of holes. The hiking trails on the south side of the park are closed as well.

Christoffelpark Special Activities

The Christoffelpark offers many special prod-

ucts such as dear spotting tours, jungle tours, moon walks and holyday plans. Special in 2012 was a running contest was organized in the park for the children of 'Deportivo San Christof".

Christoffelpark Statistics

In 2012 the Christoffelpark had an increase (Figure 8) in the number of visitors, tourists as well as locals, in comparison to 2011. Especially in July the park received a high number of local visitors. This was because of the 'holyday plans" that were organized.

Christoffelpark Shop

The souvenir shop relocated to the entrance of the park in 2012. This caused a significant increase (~2x) in the shop turnover.

Christoffelpark preview for 2013

In the first month of 2013 the parkmanager function was vacant. In that month the daily management was handled by the assistant manager: Cyrill Kooistra. He was supported by Carmabi's director: Paul Sokkermans. Ms. Sabine Berendse started working as the parks manager on the first of February 2013. She has a background in psychology and recreational management. She gained experience in park management when working at Uniek Curaçao. Before working at Carmabi she was manager operations at Onderlingehulp.

In 2013 there will be efforts made to improve the overall infrastructure. Also the remains of the former plantations Zevenbergen en Zorgvliet will be consolidated, so that these important historical marks will not deteriorate further. To make the consolidation of the ruins and the improvement in infrastructure possible, funds need to be attracted. In 2013 the special activities offered will be more divers and more

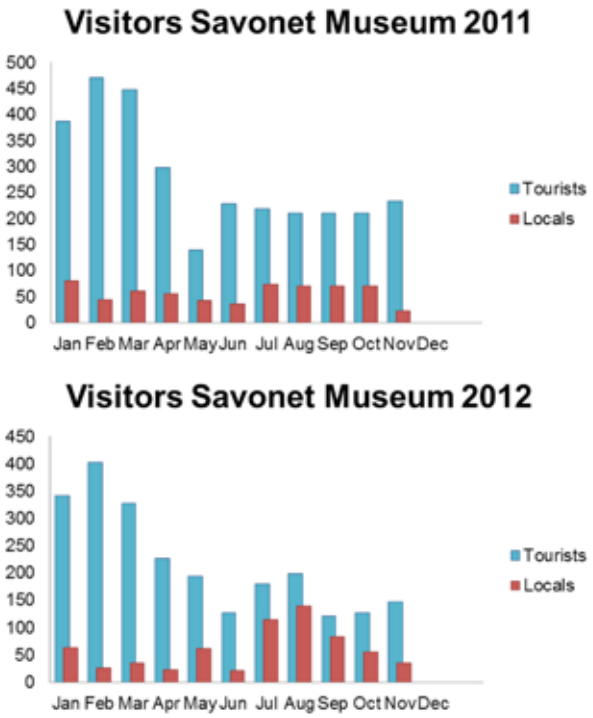


Figure 9. Visitor rates for the Savonet Museum in 2011 and 2012.

actively marketed. Also efforts will be made to increase turnover of the restaurant.

3.5 Savonet Museum

Statistics

In comparison to 2011 the amount of visitors to the Savonet Museum decreased in 2012 (Figure 9). Although the objective for 2012 was to increase the number of visitors, there haven't been any specific marketing endeavors for the Savonet Museum. The Savonet website and the Savonet facebook page weren't maintained due to a lack of personnel, with made it unclear to potential visitors if the museum had opened yet. This probably contributed to the decrease in visitors.

Enlargement Savonet Conference Center

The Savonet Conference Center that started in

one half of the old Savonet Magasina (warehouse) became to small. Many events require more space. For this reason now the whole of the magasina is in use as the conference center. Some conferences and a wedding have been held here already. The conference center has a lot of potential to generate income. The Savonet Conference Center offers a unique product compared to other conference centers on the island. Events can be held on Savonet in a relaxing historic and nature environment that can hardly be found elsewhere.

Savonet Museum preview for 2013

Efforts will be made to increase the number of visitors to the museum. There will be a combination ticket introduced, with a special price to enter the museum as well as the park. Also there will be at least 1 temporary exhibition and the website and facebook page will be updated on a regular basis. Also the conference center will be more actively marketed.

3.6 Shete Boka

In 2012 the management of Shete Boka Park and the Christoffelpark have been integrated. In 2013 the main road at the right side of the entrance will be improved. Attention has to be given to security in the area. CTB will place a warning sign at the entrance of the park, to inform visitors that thieves might be active in the park. Efforts will be made to restore the electricity at the restaurant and also to renovate the restroom building. Also the marketing of Shete Boke will have priority.

3.7 Hermanus / Jan Kok

At the end of August 2012 this area was hit by an oil spill. The oil came from the oil reservoirs at Bullenbaai. Carmabi coordinated the clean-up of the oil, which was finished in the beginning of November.

3.8 Kueba di Yechi & Kueba di Raton

These caves are closed to the public because of the bat populations living in these caves.

3.9 Kabouterbos

The Kabouterbos area was used extensively in the past for our educational tours. Due to inundation problems this is presently not possible.

4 NATURE AND ENVIRONMENTAL EDUCATION (NME)

The school program consists of park visits and school visits. The parks were visited by in total 111 schools. The visited parks included the Christoffelpark, Daaibooi, Kabouterbos and Shete Boka. In total 53 schools were visited for classroom teaching and within these schools 107 classes were taught. During the school year 2011-2012 a total of 13,256 kids participated in Carmabi's educational program. The Christoffelpark was visited by 4,693 students from groups 6 and 7. Shete Boka was visited by 434 students from group 8 and Daaibooi was visited by 2,007 students from group 8. A total of 2,324 students of groups 4 and 5 went to the Christoffelpark for lessons on birds and a total of 1,923 students from groups 1, 2 and 3 went to the Christoffelpark for nature lessons. Historically, groups 1,2 and 3 went to the Kabouterbos ,but because the Kabouterbos is unfortunately flooded by water, visits to this area are no longer possible. The bird lessons involve obtaining knowledge about our local birds in theory and by observing them at the park. School visits were made to 1,875 students of group 4. Schools could choose this year from three topics: Bats (205 students), Reptiles (842 students) and Micro World (828 students).

Since the NME program existed it has focused mainly on the island's terrestrial nature. Nature on land is very important and can be observed easily. The nature in sea is another story. It cannot be observed that easily and is generally more threatened at present than nature on land. Especially Curacao's coral reefs are threatened by factors such as global warming, acidification of the oceans and by local factors such as coastal development, overfishing and terrestrial run-off. The coral reef, however, is very important for Curaçao. The coral reef protects our coasts against storms, enables coastal fishery and represents the foundation for the (dive) tourism industry. Lastly, a healthy coral reef prevents the increase of (pathogenic) bacteria in Curacao's near shore waters. Because of all these reasons we decided to devote more attention in our NME program to the importance of the island's coral reefs. Our aim is that all children will come at least once to Carmabi for a lesson on the importance of coral reefs. Therefore Carmabi has started with preparations to establish a Marine Education Center (MEC) within the existing Carmabi building at Piscadera. The creation of the MEC has been delayed because of lack of funds and because time and energy were initially focused on completing the Science Center. In the mean time we obtained funds from UNESCO for the development of the MEC. Development of learning materials for use at the schools and in the MEC has meanwhile continued according to plan. We hope to complete the MEC in 2013.

5 ADVISORY AND CONSULTANCY SERVICES

The advisory department executed a number of consultancy studies both on terrestrial and marine topics. Clients included governments of several islands in the Caribbean, governmental organizations, private persons and commercial organizations. Examples of some scientific reports published in 2012 are shown below:

Landscape ecological vegetation map of St. Eustatius

Drs. John de Freitas MBA, Ir. Anna C. Rojer, Drs. B.S.J. Nijhof & Dr. Adolphe O. Debrot

A landscape ecological vegetation map is a very valuable tool in land-use planning and the management of natural areas. Land-use planning in the Dutch Caribbean begun in the early 1980s and therefore the need arose for up-to-date quantitative vegetation maps for the islands. The map produced is at a scale of 1: 37,500; this is called a semi-detail scale which is the ideal scale for use in land-use planning and prioritization of natural areas to be selected for protection. Previously vegetation maps projects have been completed for Curacao and Bonaire. The results of the present landscape vegetation map for St. Eustatius show that the best developed vegetation types are found in and around the Quill. Four main and 16 sub-landscape types were distinguished based on geology, geomorphology and different mixes and expressions of the 13 component vegetation types described in the study. The results of the present study are compared with the 1950s color vegetation map by Stoffers. This comparison shows that the rarest and most valuable elfin woodland vegetation of the rim of the Quill crater has been largely lost and that another valuable vegetation unit Stoffers described as 'Montane thickets' (covering a significant part of the eastern slope of the Quill) has declined and been degraded. These losses van possibly be attributed to the impact of recent hurricanes and/or aridification. Failure to regenerate after impact may be ascribed to the omnipresent feral grazers. On the other hand some regeneration is taking place in other areas of the island. On the lower slopes of the Quill, several areas mapped by Stoffers as farmland have been abandoned and have evidently regenerated into better developed vegetation types. Although the vegetation of the area called The Mountains shows recovery (e.g. more evergreen bushes are present), there is reason for concern due to the dramatic increase of the invasive vine Antigonon leptopus ('corallita'). The field data of the present study indicate that all wilderness areas of St. Eustatius remain heavily affected by grazers. This reduces the resilience of natural vegetations and interferes with natural succession by imparting heavy losses to hardwood seedlings and saplings, by reducing plant biomass (which increases exposure to sun and wind), and by favoring hardy invasive plant species. The number one priority for terrestrial conservation in St. Eustatius will therefore be to reduce feral grazer densities and impacts in key natural areas.

Bat research and conservation plan for Curaçao

Drs. John de Freitas MBA, Clifford de Lannoy MSc, Odette Doest MSc, Chris Richards, Briand Victorina (Christoffelpark ranger), Mark Paul Wisman (Christoffelpark ranger), Helena de Bekker (volunteer) and Alexander Thoma (volunteer)

The populations of bat species of the ABC is-

lands (Aruba, Bonaire and Curaçao) are (very) small and considered threatened or endangered. Little is known about the status of the (cave-dwelling) bat species in the last ten years, especially on Curaçao and Aruba. The ABC islands are undergoing a drastic reduction of natural areas due to land conversion, mainly driven by development projects. Most of the natural landscapes that still remain in these islands are not protected inside the existent national parks or legally protected in any other form. Protecting the bat fauna of the ABC islands is essential to preserve their biodiversity and is also relevant to public health (insect eating bats). Many of the bat species on the ABC islands rely on caves as diurnal and maternity roosts. Two important groups of bats among the nine bat species known to occur on Curaçao are the nectar-feeding bats and the insect-feeding bats. The nectar-feeding bats are the sole pollinators of the flowers of the indigenous columnar cacti species. The former group also provides food and water to a broad range of vertebrates and invertebrates, like birds, lizards, butterflies and bees. The insect-feeding bats contribute to the control of (unwanted) insect populations on the islands. Many of these insects can cause problems to humans, attacking locally important crops (e.g. Sorghum) and transmitting diseases such as dengue. The present research project is a baseline bat research program and is part of the larger project that consists of several research projects. The objectives of the baseline study are: 1) to determine and confirm the abundance of bats for the main caves used by bats at each island and describe the bat community composition in terms of species and population demographics for each island; 2) to gather data on temperature and humidity in the cave over time in order to understand use of the caves by the different species. On each island the project is co-ordinated by a local nature organization; on Curaçao this is Carmabi Foundation. Before the start of the research project a workshop was held at Carmabi on May 2-5 in which two Carmabi biologists, two park rangers of the Christoffel park and two volunteers were trained in the theory and practice of the research techniques that will be used. The workshop was given by two bat experts that have been doing the same type of research on Bonaire since 2008: Dr. Jafet Nassar and Fernando Simal MSc. The Curaçao team visits bimonthly the four main caves of the island for a mist netting session. Data of bats recorded during the research in the cave include sex, life stage, weight, the length of the forearm, the reproductive condition of the animal and the presence of parasites and other noteworthy features the animal is showing. One of the research topics is to test the migratory capabilities of the Curacao long-nosed bat Leptonycteris curasoae (one of the nectar-feeding bat species). Several publications indicate that this species has the capacity for long-distance and migratory movements in northern South America, including the ABC islands. If this is true, this behavior would have important implications for the conservation of this species and the plants (columnar cacti and the calabash tree e.g.) that depend on it on the ABC islands and the Paraguaná Península. If this bat species actually moves between these islands and the mainland, then it is clear that its population status in the region strongly depends on the condition of all caves that occur in the area covered by the bat's migrations. The research group has held monthly meetings in order to discuss progress made with the research and other topics relevant to ensure a better protection of the bats of the island.

The Rif mangroves at Otrabanda

Erik M. Horstman MSc, University of Twente (Department of Water Engineering & Management)

The mangrove areas of Curacao are one of the eight wilderness area of the island that possess exceptional conservation value. The mangroves

of Curacao cover approximately 55ha of the island's surface area and that is only 0.1% of the islands total surface area). The Rif-Otrobanda mangroves constitute, with a total area of 12 ha, a significant portion of the mangroves of Curacao. Mangrove areas are ecologically closely linked to the reef ecosystem and are an important habitat type for Curacao, providing year-round green vegetation in the coastal zone of the inland bays of the island. A very important function of mangrove areas is that they constitute important habitat for larval and juvenile stages of many coral reef fishes, among which are grunts (Haemulidae) and snappers (Lutjanidae). Field studies show that juvenile fish are attracted to these areas due to the presence of food, structures to hide from predation and/or for shade. Over time these juvenile fishes will mature and move to the reefs and become part of the coral reef ecosystem. Mangroves also buffer coral reefs against inorganic nutrient pollution from land by entrapping such nutrients and converting them into an organic form. The patch of mangroves between the Holiday Beach Hotel and the SVB causes mosquito nuisance in the surrounding areas. Moreover, the area is also characterized by a very poor water quality which affects the recreational potential of the area negatively. These problems exist for many years and stem from the past due to continuous disposal and influx of waste and sewage in this mangrove area. This gave rise to a fast expansion of the mangroves within the area. These disposals are relatively less nowadays, but the former open water adjacent to the coral reef system has largely been colonized by mangroves. Within this newly formed mangrove forest many shallow pools are found. Water exchange of these pools is poor due to very limited tidal flushing and the local topography within the mangrove area. These pools offer perfect breeding ground for mosquitoes. Additionally, surface water circulation is limited throughout the entire mangrove area. This results in a situation of poor water quality because of the long retention of periods of waste and occasional influx of sewage spill into the area. The request to send a mangrove expert to have a look at the situation of the mosquitoes' nuisance and poor water circulation search was made by the local environmental organization Amigu di Tera to the ABC Advies foundation in The Netherlands. Carmabi and Amigu di tera were involved in the whole process of and contributed significantly to the project. Relevant governmental departments provided relevant information upon request. Gold Invest Curaçao provided funding for the trip and lodging of mr. Horstman. The report by E. Horstman gives possible solutions to improve

the present situation and turn the Rif-Otrabanda area into a pleasant natural area that attracts visitors as well.

The Advisory and Consultancy Department furthermore produced the following reports:

Smith SR, Davaasuren N, Debrot AO, Simal F, de Freitas JA (2012) Preliminary inventory of key terrestrial nature values of Bonaire. 87 pp.

Van der Burg WJ, de Freitas JA, Debrot AO, Lotz LAP (2012) Naturalized and invasive alien plant species in the Caribbean Netherlands: status, distribution, threats, priorities and recommendations. Report of a joint Imares Carmabi PRI; project financed by the Dutch Ministry of Economic Affairs, Agriculture & Innovation. 87 pp.

De Freitas JA (2012) Belangrijke natuurwaarden Lima (Bonaire): vegetatietypen en zeldzame plantensoorten. Rapport in opdracht van de Dienst Ruimtelijke Ontwikkeling Bonaire. 9 pp.

De Freitas JA, Rojer AC, Nijhof BSJ, Debrot AO (2012). A landscape ecological vegetation map of Sint Eustatius (Lesser Antilles). Imares Wageningen UR. 61 pp.

De Freitas JA, Rojer AC (2013) New plant records for Bonaire and the Dutch Caribbean islands. Caribbean J. of Science 47(1): 114-117.

van Buurt G, Debrot AO (2012) Exotic and invasive terrestrial and freshwater animal species in the Dutch Caribbean. Imares Wageningen UR. 37 pp.

The Advisory and Consultancy Department furthermore supervised the following student reports:

Gent van, M. 2012. The effects of human disturbance on the bird species community composition of Curacao. Master Thesis Report University of Wageningen. 25 pp.

6 OTHER ACTIVITIES AND CONFERENCES

6.1 Four wetlands on Curacao protected under the Ramsar Treaty

The government of the Netherlands has designated four new coastal and near-coastal Wetlands of International Importance on the Netherlands Antilles island of Curaçao, a constitutent country within the Kingdom of the Netherlands, in the Leeward Antilles 70km north of Venezuela. The Netherlands presently has 53 Ramsar Sites, the 5th highest national total after the United Kingdom, Mexico, Spain, and Australia.

Staff of the Carmabi Foundation (Caribbean Research and Management of Biodiversity) in collaboration with the Ministry of Health, the Environment and Nature in Willemstad were helpful in the preparation of the designation materials. The brief Annotated List site descriptions below were compiled by Ramsar's Assistant Advisor for Europe, Ms Laura Máiz-Tomé, based on the Ramsar Information Sheets.

Malpais/Sint Michiel. 05/02/2013; Curaçao; 1,100 ha; 12°10'N 069°00'W. Important Bird Area. Malpais is a former plantation just to the north of Sint Michiel. There are two freshwater lakes and the hyper-saline St. Michiel lagoon connected to a bay in which coral reefs are found, surrounded by dry deciduous vegetation and a well-developed woodland habitat. The area provides refugee for many birds, such as the IUCN Red Listed Caribbean coot (*Fulica caribaea*). The lagoon also supports a significant fraction of the global population of the Common tern (*Sterna hirundo*) and is part of a regional network of foraging sites for the Caribbean flamingo (*Phoenicopterus ruber*), protected under the Convention of Migratory Species. Freshwater is scarce in Curaçao and therefore of great ecological, social and economic value. The dam of Malpais is located downstream. Freshwater infiltrates into the soil, recharging groundwater reservoirs which allow woodlands to grow in the area. Some of the current threats which may affect the ecological character of the site are the landfill and runoff from a pig farm situated only 1km away. Ramsar Site no. 2117. Most recent RIS information: 2013.

Muizenberg. 05/02/2013; Curaçao; 65 ha; 12°09'29"N 068°55'07"W. Important Bird Area; Natural Park. Muizenberg comprises an intermittent shallow lake created by the damming of a stream that drains the surrounding low hills. Periodically inundated grassland and shrubland surround the wetland. A separate small pond, Kaya Fortuna, is situated 200m to the west. This area is internationally significant for its population of the Caribbean coot (*Fulica caribaea*), near-threatened under the IUCN Red List, and the Caribbean flamingo (*Phoenicopterus ruber*) conserved under the Convention of Migratory Species, but it also supports many other waterbirds, both residents and migrants. The Muizenberg dam was built by Shell Curaçao in 1915 to collect freshwater for industrial cooling purposes; with a capacity of 650,000 m^3, it

represents the largest freshwater reservoir on the island. The area was designated as a Natural Park for the improvement of the urban living conditions of the nearby population and is mainly used by hikers for recreational purposes. Illegal dumping of garbage, pollution, drainage of surrounding wetlands, and recreational disturbance are seen as the main potential threats. A general environmental education programme is being implemented. Ramsar Site no. 2118. Most recent RIS information: 2013.

Northwest Curaçao. 05/02/2013; Curaçao; 2,441 ha; 12°21'11"N 069°05'00"W. Important Bird Area, Natural Parks. The area comprises a great variety of ecosystems such as coral reefs, coastal lagoons with sea grass beds and mangroves, coastal limestone terraces, inland hills supporting evergreen woodland, freshwater dams, natural springs and dry deciduous shrublands. The Ramsar site includes parts of Shete Boka and Christoffel Natural Parks. The wetland covers approximately 20 km of the rocky, wave-exposed north coast of Curaçao, including 10 pocket beaches (bokas) and 3 inland bays that are used as nesting and foraging sites for threatened sea turtle species as *Dermochelys coriacea* and *Eretmochely imbricata*. There is also a breeding colony of more than 500 individuals of Least Tern. Moreover, the northwestern coast of Curaçao locally harbours a fringing coral reef, characterized by more than 50% coral cover and the presence of such critically endangered coral species as *Acropora palmata* and *Acropora cervicornis* as well as endangered fish species like the *Epinephelus itajara*. Some of the caves in the area were used for spiritual rituals in the past, and Indian drawings can be found estimated to be more than 5,000 years old. Numerous manmade dams in the area retain freshwater for several months after the wet season has passed. Subterraneous groundwater reservoirs in turn sustain local vegetation types year-round which are used by several bird species, pollinating bats and mammals to survive during Curaçao's dry season. Ramsar Site no. 2119. Most Recent RIS information: 2013.

Rif-Sint Marie. 05/02/2013. Curaçao; 667 ha; 12°12'16"N 069°03'16"W. Conservation Area, Important Bird Area. The area of Rif-Sint Marie is relatively undisturbed and undeveloped and comprises a salt mash surrounded by mud flats, shrub land, and forests. The marsh is a strategic feeding habitat for flamingos and several waterbirds. The coral reef of Rif-Sint Marie is well developed and shelters several threatened coral species such as *Acropora palmata* and *Acropora cervicornis*, as well as such endangered turtle species as *Dermochelys coriacea* and *Eretmochely imbrica* and threatened fishes like Goliath grouper *Epinephelus itajara*. Dense thickets of Elkhorn coral sustain major ecological processes such as gross community calcification and nitrogen fixation; dense populations

of this branching species dissipate wave energy and thus protect the coast. The area is currently used for recreational purposes like hiking, biking and guided eco-tours. The major threats to the site are uncontrolled access of visitors with dogs disturbing flamingos and potentially unwise development of touristic infrastructures in the surrounding area. Ramsar Site no. 2120. Most recent RIS information: 2013.

Original post: *http://www.ramsar.org/cda/en/ramsar-news-archives-2013-curacao-4/main/ramsar/1-26-45-590%5E26081_4000_0__*

6.2 New Carmabi report on the current state of Curacao's coral reefs 2012

The coral reefs of Curaçao represent one of the best reef systems left in the Caribbean at present. However, this does not mean that these reef systems are doing well. On the contrary: increased coastal development has resulted in pollution of near shore waters through the release of (untreated) sewage, nutrients and chemicals and overfishing represent some of the factors that have contributed to a near 20% decrease in the abundance of corals on the island in the last 25 years. Fish communities have been impacted similarly through uncontrolled fishing practices and Curacao presently holds an intermediate rank among Caribbean nations in terms of fish abundance. Coral reef systems provide the foundation for the island's tourism and fishing industry and protect near shore developments against storms. Furthermore, healthy reefs prevent the rise of disease-causing bacteria in near shore waters preventing people, locals and visitors alike, from becoming ill. At the current rate of decline, coral reefs will have virtually disappeared around Curacao around the year 2060. Presently, it is estimated that Curaçaoan reefs bring in at least $1.6 million per kilometer per year through revenue from tourism, fishing and coastal protection alone. The decline of reefs will thus come with severe economic consequences for a recently formed country that finds itself still in a position to avert such catastrophe.

This report summarizes some of the information currently available to illustrate a potentially dark future for Curaçaoan reefs. Hopefully this report helps to illustrate some of the factors contributing to this decline so directed management strategies can be designed and put in place in order to maintain a unique aspect of Curaçao that makes it stand out in the region: its coral reefs.

To download the report: *http://tinyurl.com/curacaocoralreport2012*

6.3 Carmabi aids in Jan Kok oil spill clean up.

On August 16th 2012, local authorities (Coastguard, Havendienst, Oil response coordinator etc) were warned by Carmabi and local fishermen that a large had occurred at the oil facility at Bullenbaai. The concerns were repeated but hardly any action was taken. Later in the week, while tropical storm Isaac, caused unusually strong south winds, much of the oil got trapped in the northwestern corner of Rif Marie where it entered the saliña of Jan Kok through a man-made canal. Serious responses to the ongoing disaster were started on Saturday, August 25th,

almost a week after the spill had occurred. On August 28th a large fraction of the oil was collected by various organizations on the island (mostly by workers of ISLA, Selikor, CPA and various volunteers) and the saliña started "to appear" normal. The fact that hardly any oil is presently found at the site should at no moment be considered a sign that the ecological impacts of the oil spill have disappeared as well. Oil is still present in the saliña of Jan Kok and the shore and reefs near Rif Marie where it will have long term ecological consequences for both systems. Ironically, Rif-Sint Marie and Jan Kok were given the "Conservation" status in the island's zoning plan locally known as the EOP ("Island Development Plan"; AB 1995 no. 36), which became effective on May 23, 1997. The conservation destination is attributed to areas with a scientific, historic, cultural or scenic value. The area was recently designated as a Ramsar area by the local government. Ramsar is an international treaty to protect wetlands of special ecological value and is comparable to the UNESCO designation of Willemstad's historic center. Part of the saliña is owned by Stichting Monumentenzorg, the eastern part is owned by the Government of Curacao and managed by Carmabi. To mitigate the effects of the spill, several volunteer groups and local NGO's collaborated in a for Curacao uniquely successful fashion. Monitoring efforts of both the bay and the reefs in front of Rif Marie were started on August 31st and September 1st 2012 to assess the long term ecological consequences of the spill. In short: the reef still appeared in relatively good health, though endangered *Acropora* corals were observed to suffer from previously unknown tissue mortality. From published studies elsewhere, we know that effects of oil on corals are not visible immediately after a spill and might even take years to manifest themselves. Now that oil removing and initial monitoring efforts are finished, all participating groups will strive to (1) evaluate the events that led to the complete failure to minimize the effects of this spill despite the fact that it was announced long before it affected Jan Kok; (2) work towards the development of an effective management plan of the affected area (and hopefully other conservations areas), especially those that are about to receive a Ramsar designation, such as Jan Kok/ Rif St. Marie and (3) work towards the development of an effective disaster response plan that should include scenarios other than oil spills as well.

6.4 IUCN meeting Costa Rica

A meeting of the Caribbean Regional Committee and the IUCN Regional Office for Mesoamerica and the Caribbean Initiative (IUCN-ORMA/Caribe) and was held at the office of ORMA in San Jose, Costa Rica on 23 – 24 April 2012. Carmabi director Paul Stokkermans who also is the treasurer of the committee attended the meeting. The IUCN helps the world find pragmatic solutions to the most pressing environment and development challenges. It supports scientific research, manages field projects all over the world and brings governments, non-government organizations, United Nations agencies, companies and local communities together to develop and implement policy, laws and best practice. Carmabi is a member of the IUCN. During the meeting the implementation of the Caribbean Initiative was discussed. The Caribbean Regional Committee

also discussed the motion requesting more support from the ICUN for the Caribbean and the possibility of an IUCN office for the Caribbean. This motion was to be submitted during the IUCN World Conservation Congress in Korea in September 2012.

6.5 IUCN World Conservation Congress in Korea

Carmabi Direcor Paul Stokkermans has participated in the World Conservation Congress (WCC) of the IUCN in Korea from the 6th till the 15th of September 2012. De IUCN (International Union for Conservation of Nature) is the biggest nature conservation organization in the world and assists in finding solutions for nature and environmental problems. Carmabi is the only member of the IUCN on Curaçao. Director Stokkermans participated in the congress at the request of the IUCN and is participation was fully sponsored by the IUCN. The WCC is held once every four years. In 2012 the WCC was held on the island of Jeju (South Korea) which is located between South Korea and Japan. Jeju is a volcanic island with a special nature and also appears on the UNESCO World Heritage List. The island has the longest lava tube in the world. The congress was opened by the president of South Korea, Mr. Lee Myung-Bak. The Secretary General of the United Nations, Mr. Ban Ki-moon addressed the participants by means of a video message. In total 4000 participants of 175 countries participated in the congress. During the congress near 200 motions were discussed. Carmabi director Stokkermans, also treasurer of the IUNCN Regional Caribbean Committee, was involved in the motion requesting more support for the IUCN program for the Caribbean region (the so-called Caribbean Initiative) and the possibility for a IUCN office in the Caribbean region. At this moment the Caribbean region is part of the IUCN regions North and Central America. The motion was accepted. More support for the Caribbean Initiative is important for conserving nature on the Caribbean islands. This is also important for Curaçao. Presentations on many topics were held during the so-called Forum of the congress. Carmabi director Stokkermans has presented two presentations on the so-called "Ridge to Reef" concept that deals with the influence of developments on land on the coral reef. This is a topic that is also locally very important because of the plans of the government to develop Eastpoint.

6.6 Meeting Dutch Caribbean Nature Alliance (DCNA) on Curacao

Carmabi is a member of the Dutch Caribbean Nature Alliance (DCNA). The objective of the DCNA is to safeguard the biodiversity and promote the sustainable management of the

natural resources of the islands of the Dutch Caribbean, both on land and in the water, for the benefit of present and future generations, by supporting and assisting the protected area management organizations and nature conservation activities in the Dutch Caribbean. Furthermore the DCNA manages a trust fund. This trust fund is funded by donors such as the Dutch Postcode Lottery. The purpose of the trust fund is to provide core funding to cover the operational costs of the designated marine protected area (marine nature park) and the designated terrestrial protected area (land nature park) on each of the islands of the Dutch Caribbean. Before the parks can receive any funds the trust fund needs to accumulate a target of Euro 24 million. The DCNA holds two meetings every calendar year. In 2012 the meetings were held 24-26 May in Saba and 16-18 November in Curaçao. Carmabi was host for the Curaçao meeting. During the meeting many conservation and organizational issues were discussed. On Tuesday evening the Seaquarium was visited including a demonstration of the submarine. The meeting was held in the Renaissance Hotel but the session on Wednesday was held in the Carmabi Savonet Conference Center at Savonet. The session at Savonet was followed by a fieldtrip in the Christoffelpark were the ruines of the Zorgvliet Plantation were visited.

6.7 Eco edition monument day Caracasbaai peninsula

Carmabi was one of 3 organizations who with Fundashon Pro Monumento were responsible for the organization of this open monument day; the first Eco-edition of this well-known event. The "Monumento Habrí 2012 edishon EKO" was held on the peninsula of Caracasbaai on Sunday may 27 from 10:00 A.M to 6:00 P.M. On this peninsula many historical (e.g. Fort Beekenburg) and natural monuments (e.g. relict vegetation on big boulders) could be visited for free with guide tours or independently. The purpose of this open monuments day was to raise awareness about these natural and historical monuments and to build support for the main purpose of the entire event; to appoint the peninsula of Caracasbaai as a National Park. The event was very well visited. Estimates vary between 3.000 and 3.500 visitors. Clifford de Lannoy, Junior Enviromental Consultant, represented Carmabi in the organizing committee of this event. John de Freitas, senior biologist and head of the advice and consultancy department, and Mark Vermeij, marine biologist and head of the science and research depart-

ment, contributed on behalf of Carmabi to this event by providing scientific literature, text and photos about the natural assets of the area both on land and in the surrounding marine habitat. This information was incorporated in the Monumento Habrí 2012 booklet that was sold during the event. Carmabi was present at the event with its own information stand next to that of Amigu Tera. Two volunteers of the Educations Department (Retty Schoop and Naly Borgschot) and one employee of the Christoffel park (Cyrill Kooistra) were present during the entire event to provide visitors with information about our organization, Curacao's natural treasures and our vast experience with the management of nature areas.

6.8 The effectiveness of lionfish removal efforts on Curacao and Bonaire

Lionfish (*Pterois volitans/miles*) have spread rapidly throughout the Caribbean Sea after they were first noticed in this region in 1985. Lionfish negatively impact native fish communities and therefore by some considered as the most damaging invasive species in the Caribbean to date. To combat further population growth and spread of lionfish and protect native fish communities, various Caribbean islands have started control efforts. On Bonaire a removal program based on volunteer using spear guns was started immediately after the first lionfish was sighted in 2009 and on Curaçao a similar program was started two years later. To determine the effectiveness of these removal efforts, differences in the density and biomass of lionfish were compared between areas from which lionfish were directly targeted during removal efforts (i.e., "fished") and areas where they were not. Lionfish biomass in fished locations on Bonaire was 2.76-4.14 times lower than in unfished areas on the same island or on unfished Curaçao. While removal efforts are effective at reducing the local number of lionfish, recruitment from unfished locations, such as those too deep for recreational diving and at difficult to access dive sites, will continuously offset the effects of removal efforts. Nevertheless, our results show that local removal efforts using volunteers are a cost-effective, rapid-response option that is successful at significantly reducing the abundance of invasive lionfish on small Caribbean islands.

Between the depths at which this study was conducted, the reef communities on both islands are very similar, minimizing the possibility that spatial variability in reef community

structure caused the observed differences in lionfish abundance between the two islands. Our initial hypothesis that lionfish preferred highly complex reefscapes could not be confirmed despite the fact that lionfish prefer complex landscapes in a variety of marine habitat types. Because both islands were invaded simultaneously in October 2009, our findings likely portray the outcome of two different local management approaches, i.e., the one on Curaçao (no response) and Bonaire (immediate response). The immediate initiation of organized, local removal efforts on Bonaire by training many (± 300) local divers for lionfish removal efforts has resulted in a significant decrease of lionfish abundance on the leeward side of the island within two years after the first lionfish was sighted on this island. A rapid (local) response to reduce the abundance of invasive species is widely accepted as the most efficient methodology to reduce excessive growth of invasive populations and this study shows that such local management interventions can be successful.

6.9 Oostpunt

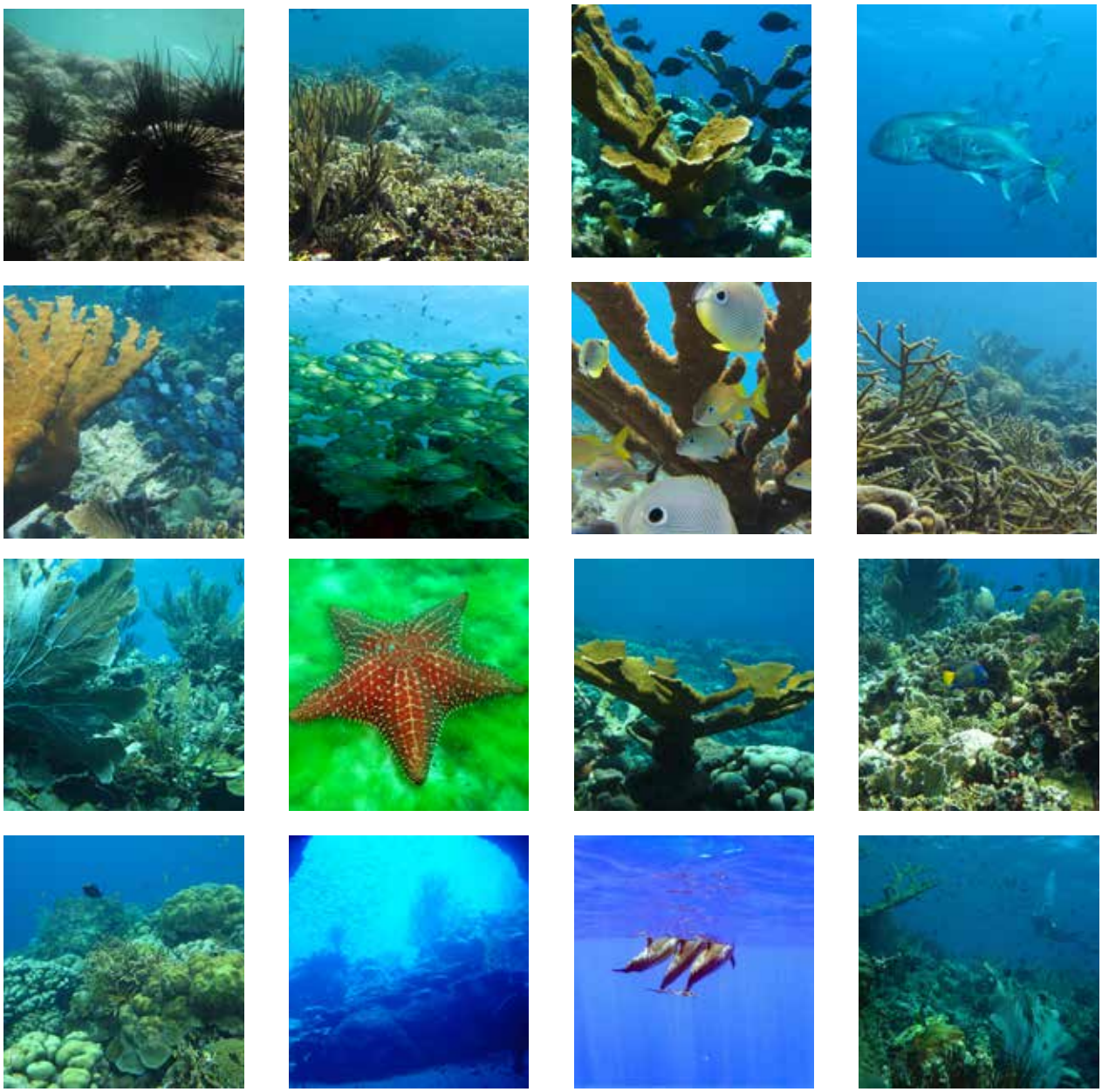
Carmabi has produced various informative documents to inform Curaçaoans and other interested parties about the unique nature that can be found near/ at Oostpunt, both below and above the water surface. In addition, Carmabi has produced various documents that overview the Foundation's concerns regarding the proposed development of Oostpunt as published on the website of the Curaçaoan Government. These documents serve to share existing concerns to promote discussion and inform stakeholder groups on aspects that have not been addressed in the Oostpunt study made available on the Government's website:

http://tinyurl.com/oostpuntdescription

All documents that Carmabi send to request a more thorough evaluation of Oostpunt's nature values and possibilities for development can be found at: *http://tinyurl.com/oostpuntconcerns*

We also like to stress that Carmabi does not oppose sustainable and "smart" development of the Oostpunt area, we simply believe that the proposed plans are not suitable to discuss future possible options and will contribute to the loss of unique ecosystems that make the island stand out positively in the Caribbean region. Eastpoint is an uninhabited area measuring approximately 60 km2 near the eastern tip of the island of Curaçao. The area, which is currently owned by one person (Mr. W. Maal) harbours various ecosystem types such as salinas, inland bays, seagrass beds, mangroves, several mountains, coral reefs etc which all remain in a untouched state. Along the entire area coral reefs are found, which due to the absence of development on land and their upcurrent location from any form of development, are among the few reefs in the Caribbean that actually grow. The southern shore of Eastpoint represents the Curaçao Underwater Park which was established in 1982 and covers 600 hectares. While the park is currently not actively managed due to lack of funding, the fact that Eastpoint is hardly ever visited by people, effectively makes it an area where nature is still found in a semi-pristine state. Areas like Oostpunt (and its neighboring coral reefs) are becoming more and more valued for their contribution to local economies as they can attract diverse recreational uses, generating significant income that benefits local communities and helps promote the sustainable management of the wetlands concerned. For example: Recreational diving on coral reefs in Bonaire National Marine Park contributes US$30 million to the island's economy every year. Tourism to the Moremi Game Reserve in the Okavango Delta (Botswana) generated US$16 million in 2003. Unsustainable tourism and recreation developments are a significant cause of loss and degradation of many areas that would otherwise generate in-

come far exceeding that of traditional land-use practices, e.g., unsustainable development. Prof. Dr. J. Ogden, working on Caribbean reefs since 1969 and former director of the Florida Institute of Oceanography and Professor of Biology at the University of South Florida, summarizes the dilemma regarding Oostpunt very elegantly: "*The plan to develop Oostpunt with resort hotels and to transform its coastal lagoons into yacht harbors has brought world-wide attention to the reefs of Curacao and brought the people of the island to a crisis point of decision. Will the projected development be allowed to proceed, practically guaranteeing the eventual destruction of the unique reefs and economic resource of the Oostpunt, or will the area be recognized as the jewel in the crown that it is for the future of the people? Typically, similar hotel developments have a life of only several decades and much of the money they generate is sent off-island. Left in its natural state the reef of Oostpunt will deliver its economic and aesthetic benefits directly to the people year in and year out into the foreseeable future*".



7 BESTUUR

De bestuurssamenstelling is in 2012 veranderd. Bestuursvoorzitter Dito Abbad is afgetreden als bestuursvoorzitter maar wel aangebleven als bestuurslid. Hij heeft de voorzittersfunctie veel jaren vervuld en wij bedanken hem voor zijn grote inzet de afgelopen jaren. De voorzitterstaak is inmiddels overgenomen door de heer Peter Bongers die tot dan fungeerde als penningmeester. Recent is de heer Alvin Francisco toegetreden tot het bestuur en bereid gevonden om de penningmeestersfunctie op zich te nemen. Verder is mevrouw Olga Lodowica toegetreden tot het bestuur als bestuurslid.

Peter Bongers
President

Alvin Francisco
Treasurer

Jeff Sybesma
Secretary

Erwin Koense
Board member

Olga Lodowica
Board member

Dito Abbad
Board member

8 FINANCIAL OVERVIEW

BALANCE SHEET AS AT DEC. 12 2012

	2012	2011
	ANG	ANG
Assets		
Non-current assets		
Property and plant	268,079	282,847
Other fixed assets	257,229	123,669
	525,308	406,516
Current Assets		
Receivables	156,231	231,646
Stock	19,454	11,104
Cash and cash equivalents	1,016,160	1,162,502
	1,191,845	1,405,252
Total assets	1,717,153	1,811,768

Equity and liabilities		
	2012	2011
	ANG	ANG
Equity		
Capital	106	106
Earmarked reserve	459,732	420,782
Retained Earnings	181,021	337,903
	640,859	758,791
Non-current liabilities		
Non interest bearing loans and borrowings	154,000	154,000
Deferred income	65,128	65,128
	219,128	219,128
Current Liabilities		
Pension contribution payable	16,304	106,561
Taxes and social security Payable	53,403	51,390
Other Liabilities	787,459	675,898
	857,166	833,849
Total equity and liabilities	1,717,153	1,811,768

9 SPONSORS

Carmabi wishes to thank all those who financially supported Carmabi in 2012.

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (BZK) Nederland
Ministerie van Onderwijs, Wetenschap en Cultuur (OCW) Nederland
Ministerie Gezondheid, Milieu en Natuur (GMN) Curacao
European Union
Nationale Postcode Loterij
Prins Bernhard Cultuurfonds
Percy Henriquez Fonds
Maduro & Curiels Bank (MCB)
Ontwikkelingsbank Nederlandse Antillen
Caribbean Nautical
Bellevue Curaçao NV
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Marcel Kooijman
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Jeroen Blokzeijl
Mark Derks

10 PERSONNEL

Board
Peter Bongers, President
Jeffrey Sybesma PhD, Secretary
Alvin Francisco, Treasurer
Dito Abbad M.Sc., Board Member
Erwin Koense, Board Member
Olga Lodowica, Board Member

Patron
Professor Jaime Saleh, Former General Governor of the Netherlands Antilles

Carmabi ambassador in the Netherlands
André Cohen Henriquez

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Mark Vermeij PhD, Deputy and Scientific Director

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Valerie Chamberland, M.Sc., Researcher

Parks Management Department
Sabine Berendse, Head of Department
Cyrill Kooistra, Head Ranger & Deputy Head
Oswald Ricardo, Senior Ranger (Security)
Wolter Samboe, Senior Ranger (Events)
Pedro Andrea, Senior Ranger
Briand Victorina, Ranger
Roëlley Juliana, Ranger
Araceli Ersilia, Front Desk Officer
Merely Albertoe, Front Desk Officer
Rachel Tokaai, Assistant Events and Sales
Shudeska Eisden, Senior Assistant Restaurant
Ingerelli Francois, Assistant Administration
Xiomara Concetion, Janitor

Hato Caves
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Arien Liberia
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Shahaira Martina, Assistant Financial Administration
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Sisline Rosalia, Janitor
Rosemary Olivo Busto, Janitor
Carlos Winterdaal, Technician

Left the organization in 2012
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Abigail Flocker
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