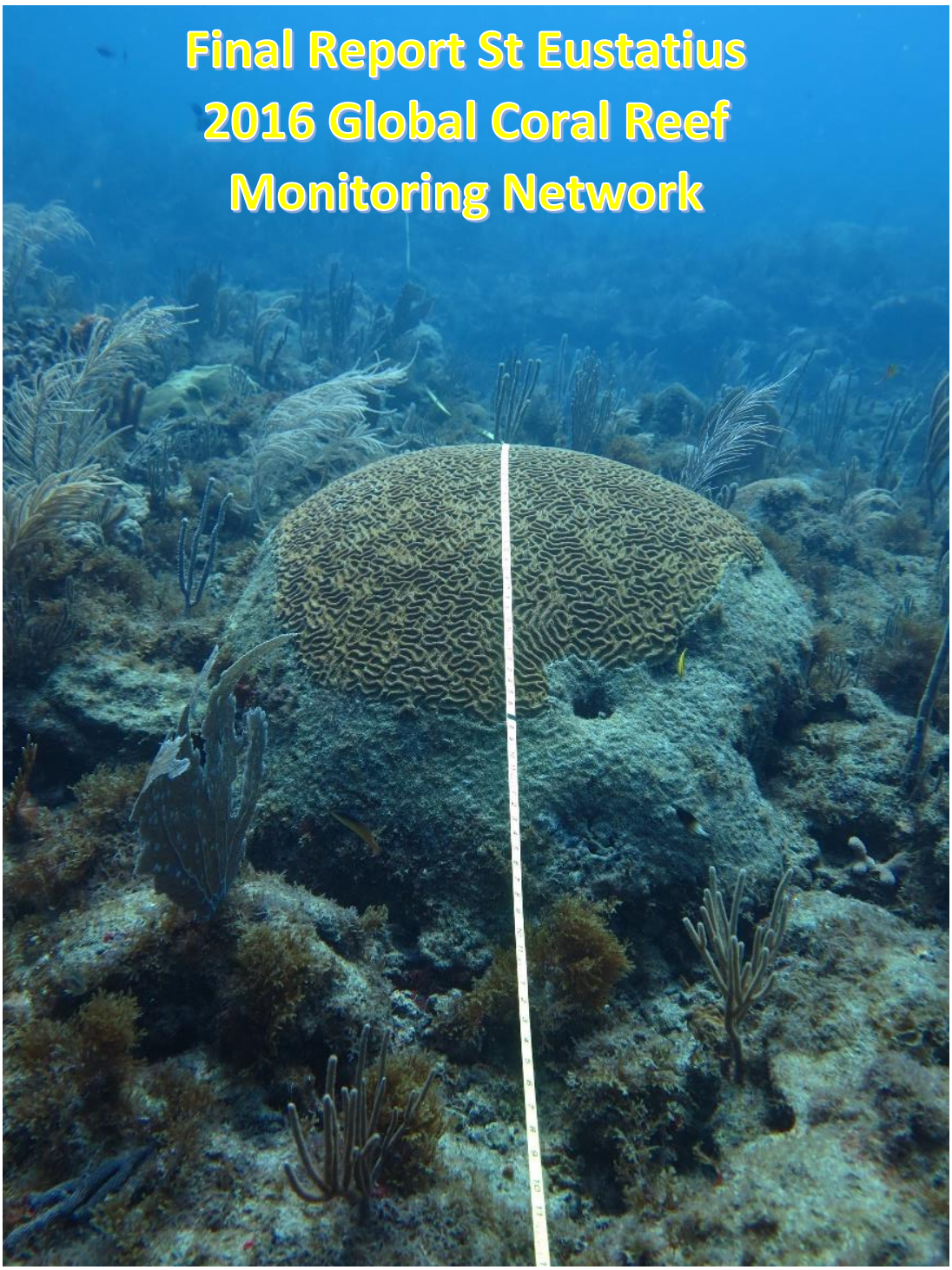

Image: Johan Stapel

This report is presented to:
The Island Government of St Eustatius and
The Netherlands Ministry of Economic Affairs

Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
piontekstеve@yahoo.com

Table of Contents:

Primary Investigator:
Steve Piontek
Gem City Consulting
Zeelandia, St Eustatius
piontekstеve@yahoo.com

Sampling team members: Matt Davies, Captain Nadio Spanner, Johan Stapel, Masru Spanner, Heleen Visser, Martin de Graaf, Paula Anglada Vink, Dennis van der Gaag, Ambrosius van Zanten and Hannah Madden.

Acknowledgements:
Gem City Consulting would like to recognize The Ministry of Economische Zaken, STENAPA, CNSI and the Island Government of St Eustatius for their direct assistance in performing this survey; Golden Rock Dive Center for tanks and IMARES for slates and waterproof paper. Personal communications with Bert Hoeksema, Godfried van Moorsel and Paul Hoetjes concerning interpretation of the protocol guidelines and species identification and Peter Verweij and Anouk Cormont of Alterra for the statistical analyses of the observations.

Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
piontekstеve@yahoo.com

1. INTRODUCTION:

The goal of the Global Coral Reef Monitoring Network (GCRMN), an operational network of ICRI, the International Coral Reef Initiative, is to improve data collection, archiving and the network internal functioning for a better diffusion of information on coral reef development and to increase the support for regional and sub-regional cooperation.

By applying the GCRMN monitoring methods for a second year, St Eustatius is now on the way to providing scientifically pertinent coral reef data to the Marine Park management and the Island Government.

2. BACKGROUND:

The Ministry of Economic Affairs, as part of its efforts for the International Coral Reef Initiative (ICRI), together with GCRMN and the SPAW protocol convened a regional workshop in Curacao August 6th – 8th, 2014 during which coral reef experts from the region came together and discussed how to better coordinate ongoing Caribbean coral reef monitoring and stimulate and support monitoring in areas that lack capacity for sustained monitoring efforts. There was a clear consensus on the importance of revitalizing and formalizing the regional network, with the adoption of a simple and accessible regional coral reef data set and associated monitoring methods. The group agreed on a minimum core set of data to be collected, with associated recommended protocols and methods, developing a model for simple, accessible, but also scientifically pertinent and sustainable coral reef monitoring, both from a regional and local perspective.

The local situation on St Eustatius is in desperate need of scientifically pertinent and sustainable coral reef monitoring. Historically there have been only widely scattered and non-sustainable coral reef monitoring efforts in Statia's waters. Following the protocols established at this and subsequent GCRMN workshops has allowed the Island Government of St Eustatius to establish a 2015 baseline of coral reef health indicators, and now with the 2016 monitoring round, to record changes in coral reef health and manage natural and anthropogenic perturbations which may affect the coral reefs.

3. METHODS:

3.1 The survey location is the St. Eustatius National Marine Park (SNMP), which surrounds the island from the high water mark to a depth of 30 meters. To maximize comparability across the region, GCRMN data will be collected solely from fore reef habitats at depths ranging from 8 – 18 meters. An effort was made to include sites within the industrialized harbor area along with sites having perceived lower anthropogenic influence on the east, north and south sides of the island. Within the SNMP the 20 sites selected for 2015 were again monitored in 2016: Crooks Castle, Humps, Twin Sisters, Ledges, Valley of the Sponges, Five Fingers South, Double Wreck, Northman, The Blocks, The Cave, Aquarium, Anchor Point, Dump, White Wall, Gibraltar, Outer Jenkins Bay, Barracuda Point, Triple Wreck, Mushroom Gardens and Hangover.

Image 1. Northern survey sites.

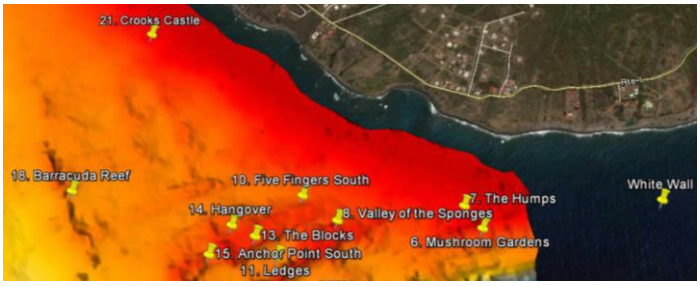

Image 2. Southern survey sites. Images from Google Earth

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Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
piontekstеve@yahoo.com

3.2 The GCRMN methods describe eight elements of the coral reef ecosystem to be surveyed:

3.21 Abundance and biomass of reef fish taxa.

To measure fish density, all fish (of all species) observed within a belt transect (30m length x 2m width) were counted, with the survey time limited to 6 - 8 minutes per transect. To measure size structure and calculate biomass, the length of each fish was estimated and assigned to the following size categories: <5cm, 6-10cm, 11-20cm, 21-30cm, 31-40cm and >41cm. At each site, five transects were surveyed and the data pooled to provide an average assessment of the density and size structure of all fishes observed at the site. Such high resolution estimations of the fish assemblage provide the core information (snappers, groupers, parrotfish and surgeonfish), while also providing fundamental information about other members of the fish assemblage that may serve important roles in fisheries or ecosystem management.

Image 3. Photo by J Stapel

3.22 Relative cover of reef-building organisms (corals) and their dominant competitors.

Percent cover of key benthic taxa was assessed by taking digital photographs of the reef surface in standardized 0.9m x 0.6m quadrat areas. High resolution photographs were taken along the five fish density transect lines, capturing 15 images per transect (one image taken at every odd numbered meter mark on the 30m transect tape). Data was captured from the images through post – processing using Coral Point Count (CPCe) software. 25 software generated random points on each image were identified and classified into a standardized benthic category, such as Seagrass, Sponge, Zooanthid or Cyanobacteria. Reef building corals were identified to species level; soft corals and macroalgae to genus level.

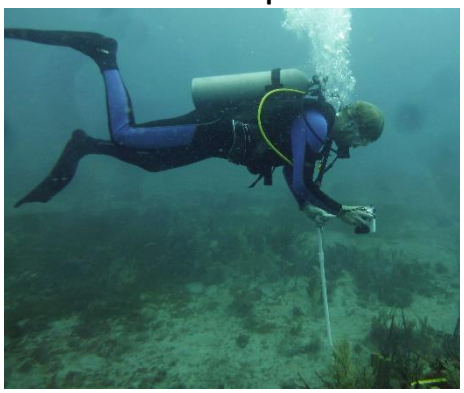

Image 4. Photo by S Piontek

3.23 Health assessment of reef-building corals.

Disease prevalence in corals was estimated using the photoquadrats from the benthic cover assessment. Data was recorded as the proportion of images collected that contained a coral with any disease pathology. For example, if there were four colonies in a particular photoquadrat and any of these colonies showed signs of disease, this image would be tagged as “with disease”. The number of images that were “with disease” was divided by the total number of images (1479) to generate a proportional estimate of disease prevalence.

Image 5. Photo by S Piontek

Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

3.24 Recruitment of reef-building corals.

Coral recruits are defined operationally for this assessment as any stony coral (except *Favia fragum*) that is greater than 1.0 cm² and less than 4.0 cm². Valuations of coral recruit density were recorded from replicate 25cm x 25xm (625cm2) quadrats. Five quadrats were surveyed along each of the first three transects used for fish and benthic surveys. The lower left corner of the quadrat was placed at the 2, 4, 6, 8 and 10 meter marks. Each coral within the target size range was recorded to species.

Image 6. Coral recruits in situ. (Photograph by S Piontek)

3.25 Abundance of key macro-invertebrate species (sea urchins and sea cucumbers).

The density of sea urchins and sea cucumbers was recorded in situ. Density was calculated by dividing the total number of sea urchins and sea cucumbers observed by the area of 100 belt transects (30x2x100=6000m²).

Image 7. Photo by S Piontek

3.26 Water quality (i.e. water transparency).

The Secchi disk (a black-and-white disk 20 cm in diameter) was used to estimate the concentration of particulates in the water column. The Secchi disc was placed on the seafloor and the diver swam away along the transect line until the Secchi disc could no longer be seen. The diver then swam back until the Secchi disc could be seen. Recording this distance gives a measurement of water clarity.

Image 8. Photo by J Stapel

3.27 Macroalgae height.

The macroalgae height was estimated to calculate macroalgae biomass. Algal impacts scale with biomass and canopy heights are the best (nondestructive) way to estimate biomass. The canopy height of algae in the recruit quadrat was measured at a pre-determined number of points relative to algal biomass.

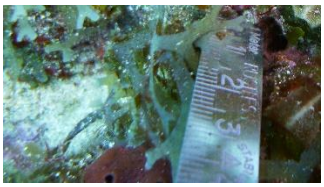

Image 9. Photo by S Piontek

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Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

3.28 Rugosity.

The three dimensional structure of the reef was measured using a weighted line. A ten-meter-long weighted line was laid along the reef bottom, following the contours of the reef, starting at the 10-meter point of each transect. The distance covered by the weighted line was then measured lineally against the transect tape.

Image 10. Photo by S Piontek

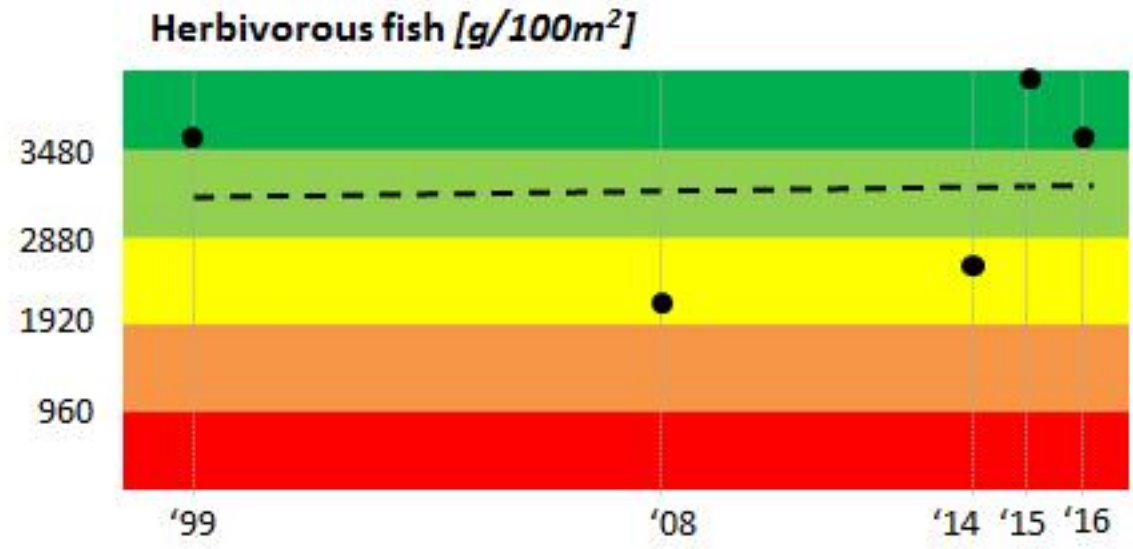
4. RESULTS:

4.1 The same 20 sites monitored in 2015 within the SNMP were surveyed following the GCRMN protocol between January 25 and May 4, 2016.

4.21 Abundance and biomass of reef fish taxa.

All 20 sites were surveyed for abundance and biomass of reef fish taxa by Marine Park Ranger Matt Davies, with the assistance of Ambrosius van Zanten, Masru Spanner, Heleen Visser, Paula Anglada Vink and Martin de Graaf. 100 transects were sampled. Using conversion values from the Fishbase website the abundance/length data was converted to grams/100m² for the two main groups of herbivorous reef fish (parrotfish and surgeonfish) and the two main groups of carnivorous reef fish (groupers and snappers).

Figure 4.1 Biomass (g/100m²) of herbivorous fish.



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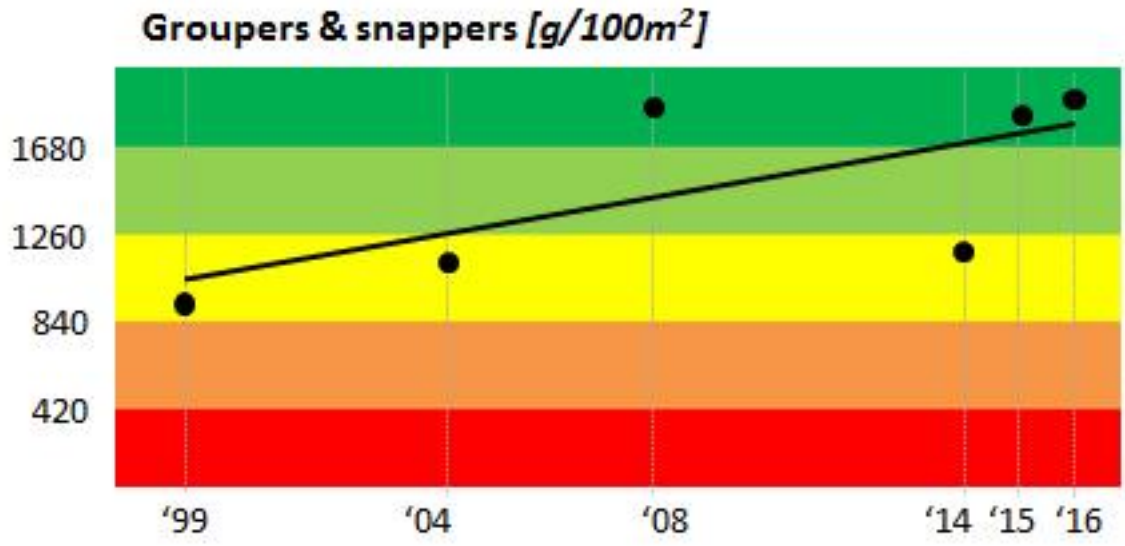
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

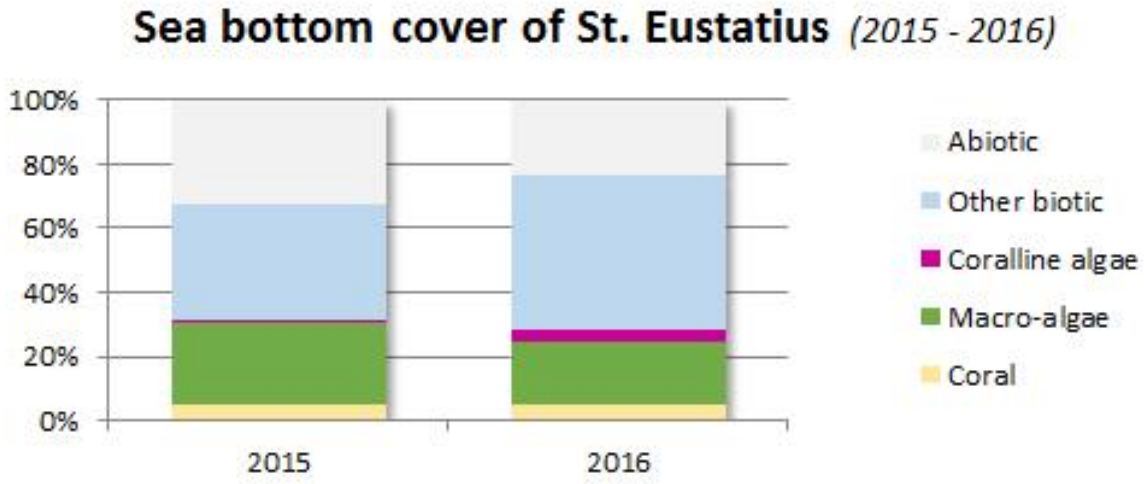
Figure 4.2 Biomass (g/100m²) of carnivorous fish.



4.22 Relative cover of reef-building organisms and their dominant competitors.

All 20 sites were photographed by Johan Stapel for relative cover of reef-building organisms (corals and coralline algae) and their dominant competitors. The 36,975 points (1479 photographs x 25 random points) created by CPCe software were analyzed by Steve Piontek, giving the following results.

Figure 4.3 Relative Sea Bottom cover.



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Zeelandia 1, St Eustatius, Caribbean Netherlands
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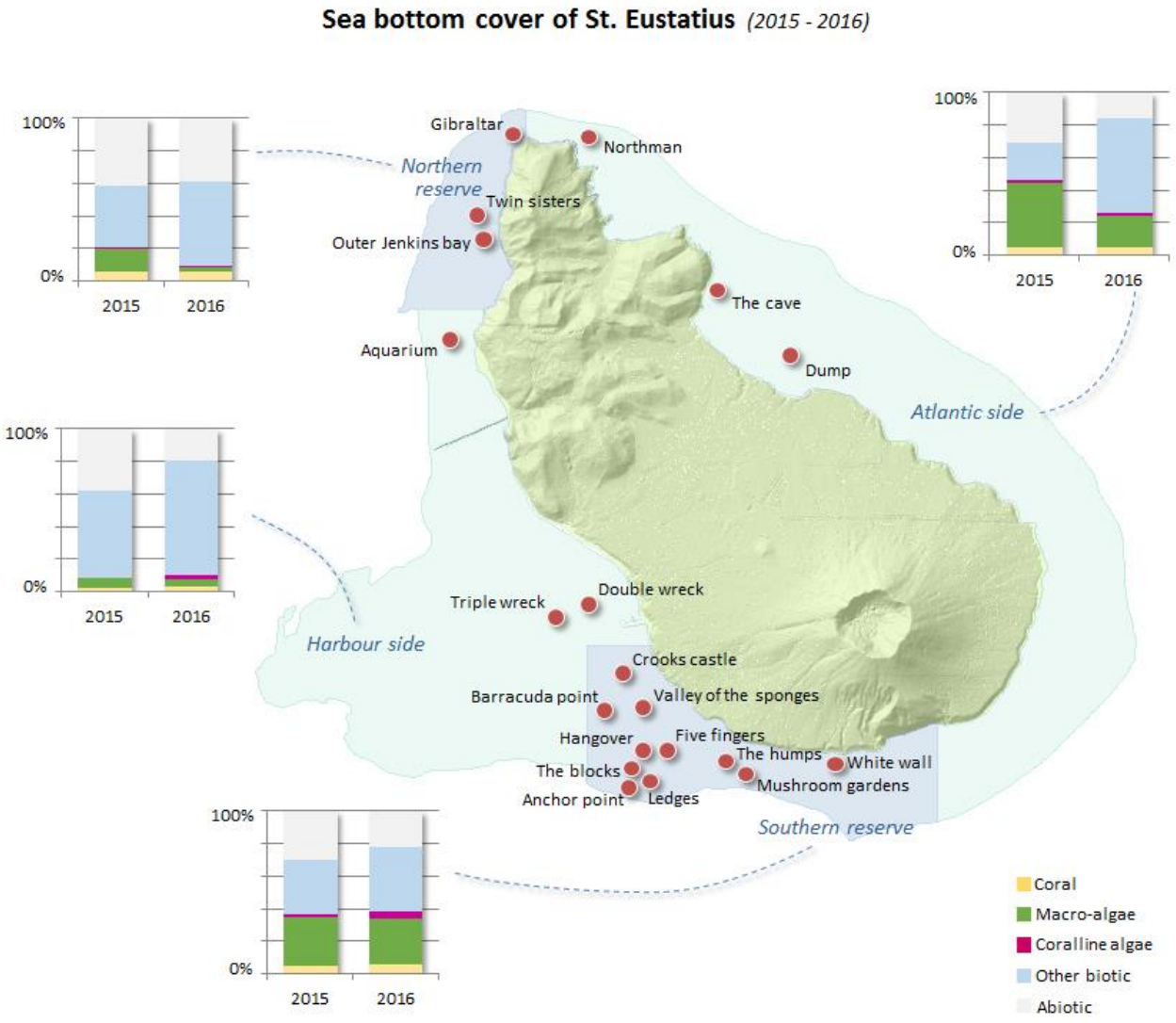
Figure 4.4 Relative Sea Bottom cover of the four monitoring zones.



The "Other biotic" category, when averaged over all 20 sites, consisted of: 32% Cyanobacteria, 3.1% Seagrass, 32.3% Gorgonians/Soft corals, 30.4% Sponges and 2.2% Zooanthids. It should be noted that the differences in macroalgae cover, especially in the Northern Reserve and Atlantic Park regions are a result of separating turf algae from macroalgae in 2016. Turf algae was included in macroalgae cover in 2015.

4.23 Health assessment of reef-building corals.

All 20 sites were surveyed for health of reef-building corals using the 1479 photoquadrats analyzed by Steve Piontek. 60 of the 1479 (4.01%) photoquadrats contained one or more diseased reef building corals. Of these 60 photoquadrats, 46 were observed in the Southern Reserve, 7 were observed in the Northern Reserve, 4 were observed in the Atlantic Park and 3 were observed in the harbor Park.

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Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

Figure 4.5 Number of Quadrats "With Disease" by Region.

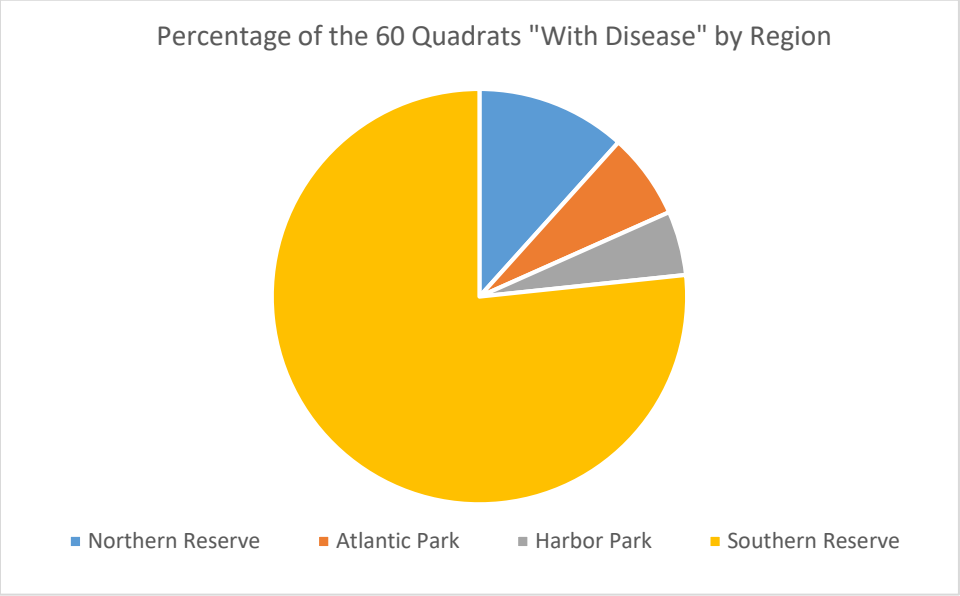
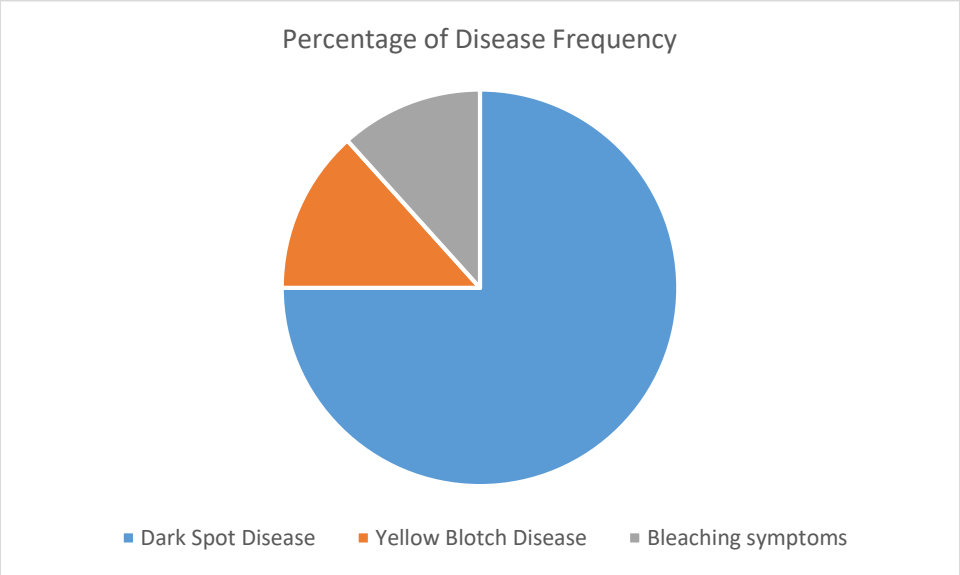


Figure 4.6 Frequency of Disease type



4.24 Recruitment of reef-building corals.

All 20 sites were surveyed in situ for recruitment of reef-building corals by Steve Piontek, who recorded 190 reef building coral recruits in 300 (.0625m²) quadrats; a density of 10.13 recruits / meter². 39% of the observed recruits were one species: *Siderastrea siderea.*

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599-318-4364
pionteksteve@yahoo.com

Figure 4.7 Coral Recruit Abundance

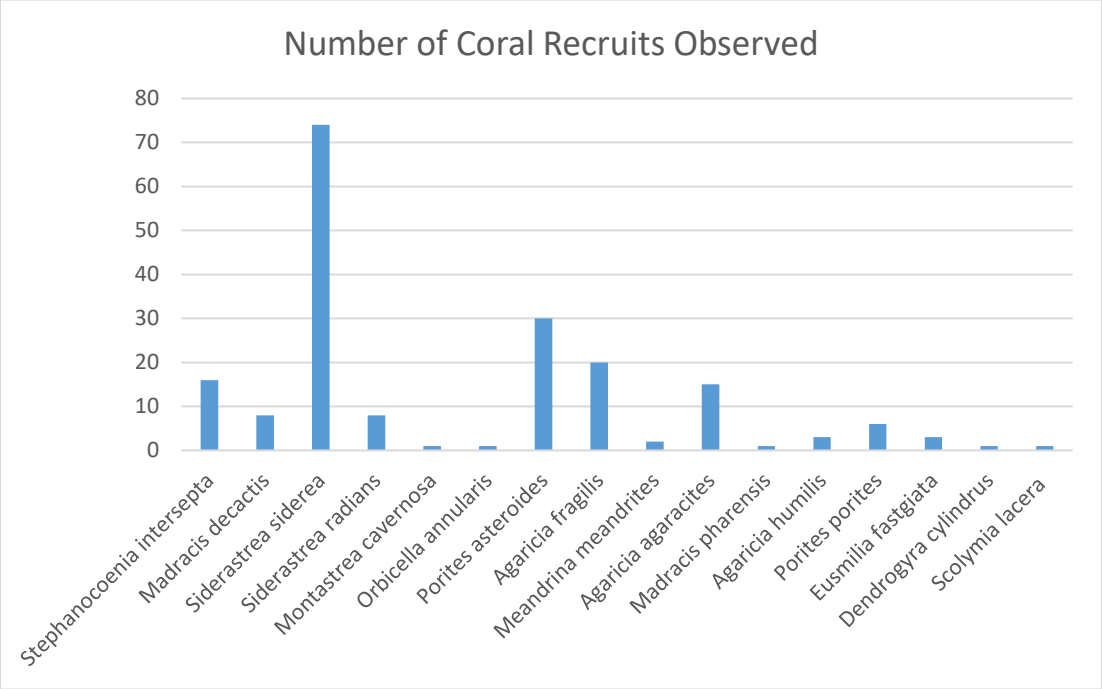

Figure 4.8 Coral Recruit Distribution

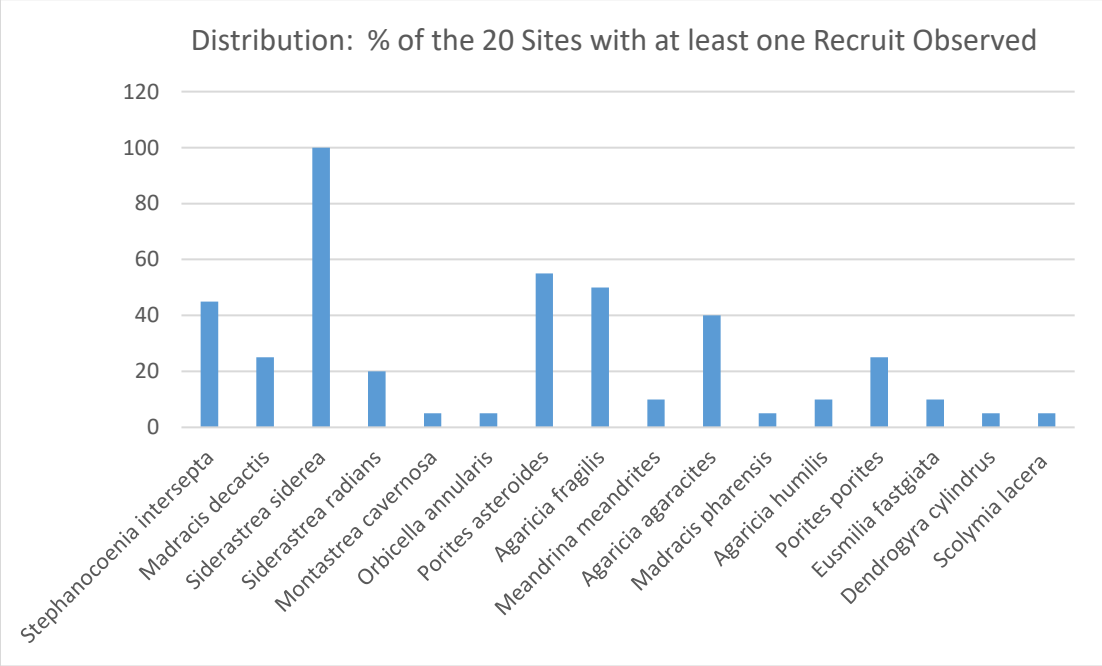

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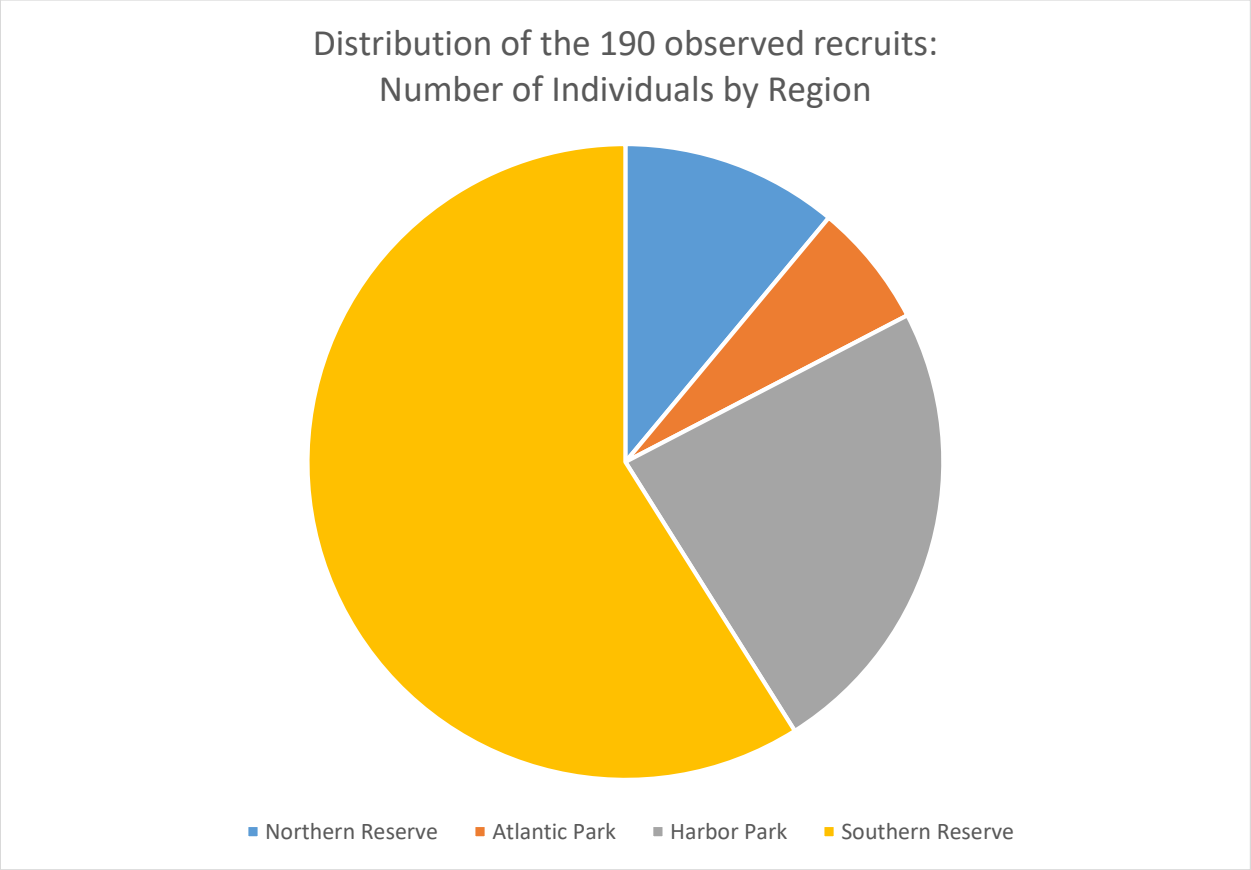
Figure 4.9 Coral Recruit Distribution by Region.



4.25 Abundance of key macro-invertebrate species (sea urchins and sea cucumbers).

All 20 sites were surveyed in situ for abundance and density of key macro-invertebrate species (sea urchins and sea cucumbers) by Dennis van der Gaag. 13 sea urchins were observed in 5920m², which gives a sea urchin density of .0022 individuals/m². No sea cucumbers were observed in the belt transects.

4.26 Water quality (i.e. water transparency).

All 20 sites were surveyed using the Secchi disc for water quality (i.e. water transparency) by Steve Piontek. Horizontal visibility had a range of 14 to 41m and a mean of 23.95m with standard deviation of 6.54.

4.27 Macroalgae height.

All 20 sites were surveyed in situ to estimate algal height by Steve Piontek. Each quadrat containing macroalgae was measured in five locations, the heights averaged for each quadrat and the five quadrats averaged for the transect. If the quadrat contained no macroalgae, this was noted and the quadrat was not included in the transect average. Individual measurements ranged from 0.5 to 12cm. Average macroalgal height for the 20 sites was 2.07cm

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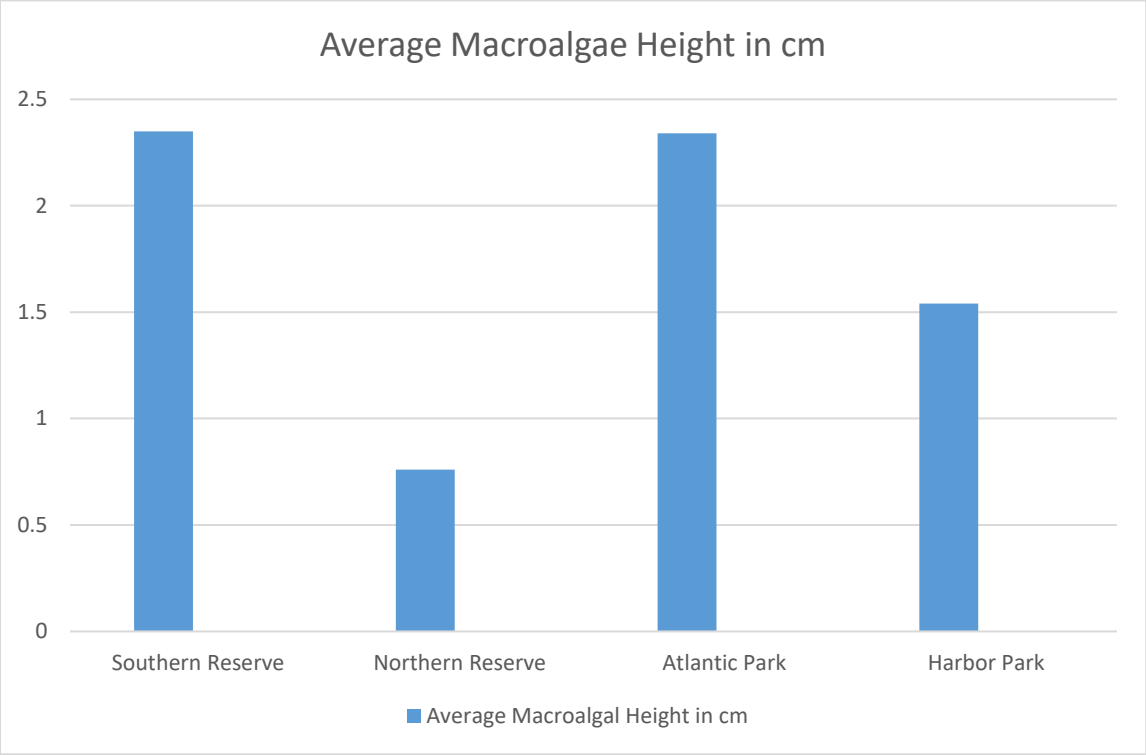
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

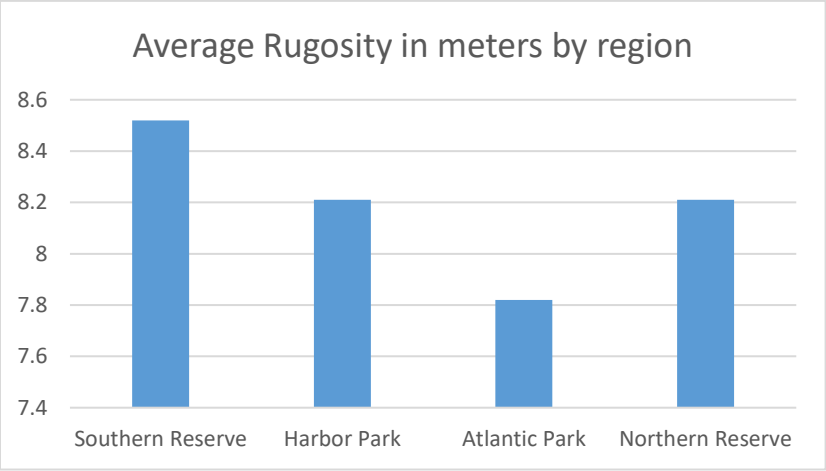
Figure 4.10 Average Macroalgae Height in cm by region.



4.28 Rugosity.

All 20 sites were measured with a 10-meter-long weighted line to determine rugosity. Lower values correlate to a more complex reef structure (the weighted line distance is shorter because there is more three dimensional structure to traverse). Rugosity measurements ranged from 5.3 to 10m. A value of 10m means the reef was flat. The average rugosity for the 20 sites was 8.31m.

Figure 4.11 Average Rugosity in meters by region.



Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

5. DISCUSSION:

5.1 The 20 sites surveyed in 2016 are the sites surveyed in 2015. The sites were chosen following a variety of criteria. The 11 sites in the Southern Reserve were described in the 1993 report by Sybesma et al as "the most extensive system of encrusted rock ledges and coral reefs is found between Crooks Castle and White Wall." We wanted to ensure that the "best" coral reefs in the SNMP were well represented in the monitoring. The Southern Reserve area was also chosen because it has been a no anchoring / no fishing reserve since 1996, and should serve to counterweight the more industrial / fished areas of the harbor and Atlantic areas of the SNMP. Although the harbor area has historically low coral cover (1993), it is a priority of the monitoring program as it is closest to the oil terminal and receives a large amount of run off from the populated areas of St Eustatius. The Northern Reserve was chosen for many of the same reasons as the Southern Reserve, and the three Atlantic sites represent the "best" examples of coral reef that is also heavily fished. 15 of the 20 sites were surveyed from a SNMP mooring.

5.21 Abundance and biomass of reef fish taxa.

The density of reef fish in the surveyed areas was further analyzed in the 2015 IMARES report 'Status and Trends of St Eustatius Coral Reef Ecosystem: 2015 Report Card' and appears to be reasonable when compared to similar areas in the Caribbean. As more Caribbean locations are sampled it will be possible to compare the findings with more confidence. There is cause to be concerned with the size structure of the reef fish. Although the six Schoolmaster snappers, four Yellowtail snappers and two Red Hind groupers greater than 41 cm recorded in the 2016 fish surveys are an increase over the one grouper recorded in 2015, the low frequency of large snappers and groupers is troubling even though the overall snapper / grouper biomass is reasonable. In 2015 one Yellowfin grouper was observed, in 2016 no individuals of the large grouper species known to be found in St Eustatius waters (Nassau, Tiger, Yellowfin and Yellowmouth) were observed in the transects during the survey dives.

5.22 Relative cover of reef-building organisms (corals) and their dominant competitors.

The recorded percent cover of reef building corals is low at 4.99% in 2015 and 5.198% in 2016. The actual cover of reef building corals is even lower, since CPCe includes the Milleporids (fire coral) as reef building coral. There are sites within the SNMP which may have higher coral cover, however they are found deeper than the GCRMN protocol's depth range and have not been quantitatively measured (Debrot etal 2014).
The high percent cover of macroalgae (27.925% in 2015, 27.292% in 2016) is troubling, as it can prevent recruit settlement, outcompete reef building corals and has been linked to coral disease. The actual macroalgae biomass is higher than recorded, since much of the recorded cyanobacteria is growing over the macroalgae. More troubling may be the high cyanobacteria cover (15.02% in 2015, 16.529% in 2016). Cyanobacteria are thought to be a sign of anthropogenic impacts, particularly nutrient loading, and is linked to coral disease.
Although not represented statistically, there is a low occurrence of large reef building coral colonies. This may be a result of natural impacts such as frequent hurricanes and siltation caused by erosion and resuspension. In 1993 this was described "this siltation can most likely be considered natural, being the result of groundswells and runoff. Coral development at such sites may be poor, but is probably in equilibrium with the impact from siltation." The negative impact of naturally occurring erosion and runoff into the coastal waters of Statia has been amplified by the subsequent 24 years of overgrazing by free roaming livestock and poor building practices. The coral colonies may be expending too much energy removing this eroded sediment, which leaves too little energy available for growth.

Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

When comparing all sites in 2016 there is an increase in the cover of an invasive seagrass, *Halophila stipulacea* (1.026% in 2015, 1.389% in 2016). *H. stipulacea* was first observed at St Eustatius in 2012 (Willette et al) in the Northern Reserve and has been spreading across the harbor area. Sites with observations of *H. stipulacea* have increased (five in 2015, eight in 2016) and the percent cover at Double Wreck (15.988% in 2015, 22.94% in 2016) and Triple Wreck (.938% in 2015, 2.448% in 2016) show an increase in the harbor.

5.23 Health assessment of reef-building corals.

Although coral cover is low, so is the prevalence of diseased coral colonies. The 2015 monitoring report listed the disease component requiring management attention as white band affecting the already distressed *Acropora cervicornis* population, and Marine Park Ranger Matt Davies initiated a treatment of placing copper wire around the infected branches. While this did not eliminate the problem, there were no observations of white band disease in the 2016 survey. While the prevalence of quadrats "with disease" remains low, there is an increase in the number of quadrats (32 in 2015, 60 in 2016).

5.24 Coral recruit abundance

The density of coral recruits remains encouraging, although there is a decrease from last year (12.27 recruits/m² in 2015, 10.13 recruits/m² in 2016) there is still potential for higher coral cover in the future.

5.25 Abundance of key macro-invertebrate species (sea urchins and sea cucumbers).

The low density of sea urchins reflects the Caribbean wide decline in these populations. In situ observations did record more individuals than were found in images last year, but given the larger area of the belt transects the density of sea urchins is comparable (.0025 individuals/m² in 2015, .0022 individuals/m² in 2016). The density of sea cucumbers also remains very low, in 2015 the observed density of sea cucumbers was .0025 individuals/ m², and in 2016 there were no observed sea cucumbers.

5.26 Water quality (i.e. water transparency).

The Secchi measurements reflect the water quality during the sampling as a minimal indicator. In the future, if sufficient field support is available it would be advisable to sample additional parameters related to water quality: sedimentation, dissolved oxygen, nutrients, temperature, pH, salinity and others. At the minimum it is advisable to do Secchi measurements frequently throughout the year at each site/area to get an average value.

5.27 Macroalgae height.

The macroalgae canopy height was measured for all 20 sites for the first time in 2016. The algal composition of the Southern Reserve is dominated by Dictyota spp and Lobophora spp., and while these genus of algae were observed in all regions, the other three regions contained lower proportions of Dictyota and Lobophora and higher proportions of turf and Sargassum spp. algae. Further study is warranted to determine how this may or may not impact coral reef development.

5.28 Rugosity.

Rugosity was measured for the first time in 2016. Rugosity was low since nearly all reefs on St. Eustatius are not true coral reefs, i.e. structures built by hard corals, but are better described as encrusted boulders and low relief rock ledges (solidified lava flows).

Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com

6. RECOMMENDATIONS:

It is recommended to continue scientifically pertinent monitoring annually in the Statia National Marine Park in order to provide insight into temporal trends in the reef condition. The use of the regionally accepted GCRMN-Caribbean methods allows for comparison across the region and will help to reflect good management practices. Annual monitoring will not only describe the status of coral reef health in the SNMP but will also assess the effectiveness of local and regional management efforts, if taken and (scientifically) documented. Annual monitoring of 20 sites in the SNMP provides a 50% chance of documenting a change of 5% in coral cover as a general guideline

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Gem City Consulting
Zeelandia 1, St Eustatius, Caribbean Netherlands
599-318-4364
pionteksteve@yahoo.com