NORTH BRAZIL SHELF MANGROVE PROJECT

REVIEW OF THE EFFECTIVENESS OF EXISTING COASTAL RESTORATION EFFORTS IN GUYANA

FINAL REPORT
Suggested Citation
Executive Summary

This study was conducted to review the efficiency and effectiveness of the mangrove restoration activities conducted within Guyana 2010 -2018. It specifically addressed relevant literature and data relating to work completed in country on mangrove restoration and establishing that the restoration activities were conducted. It also assessed the efficiency and effectiveness of restoration activities using key ecological indicators. In addition, the report forecasted that future of sustainable mangrove restoration in Guyana.

This study found that the Project monitoring mechanisms and public awareness and education campaign was good enough to provide the kind of feedback that contributed to significant reduction on mangrove destruction by coastal dwellers (NAREI, 2017) and further guidance to the restoration process. This was possibly because most of the coastal dwellers attached a great level of importance to the Project (Social Survey, 2019, Appendix 2); were aware of the project, participated and benefitted from its establishment.

It forecasted that mangrove restoration can achieve a greenbelt width of between 500–1000m for self-sustaining mangrove forest width depending the availability of naturally suitable sites and artificially created sites. To date an estimate of 526 ha of mangroves have been restored (NAREI Mangrove Department, 2018). The total cost of restoration initiatives between 2010 and 2018 for mainly planting mangrove seedlings and Spartina grass, construction of engineering structures, and monitoring is GYD$178,853,966 (Table 3). The total cost of naturally destroyed (coastal erosion processes and Sargassum invasion) sites is GYD$119,151,755 (Table 3.) and the cost for intact site is GYD$59,702,211 (Table 4.). These figures reflect a great lost in terms of finance over a period of nine years (2010-2018) where only 7 out of 17 restoration sites survived (41% success rate).

This is also based on the restoration adaptation along the way that led to these successes. The adaptations manifested in the use of other restorative innovative interventions (geotextile tube groynes and brushwood dams) to protect remaining mangrove stands and create suitable environments for mangrove colonization. The study also found that capacity building within project partners was robust...
enough to provide the kind of support that was responsible for the new interventions that led to the success of these sites.

The dynamic nature of Guyana’s coastline along with the initial limited understanding of the role of coastal processes in mangrove restoration, including movement of mud banks along the coastline along with Sargassum invasion contributed in a large way to the earlier loss of restoration sites. However, identifying suitable site characteristics to support an accelerated mangrove restoration through seedling planting program is now less challenging as a result of the use of the GIS technology.

Also, the restoration process is not without its challenges. There are still unresolved conflicts with regards to land tenure and the protection of mangroves on private lands. Also, the laws surrounding the mangrove resource are still under the jurisdiction of many agencies and have proved challenging to enforce by any one organization. However, the 2010 legislation protecting mangroves, has had a positive effect on mangrove destruction by coastal dwellers. In addition, the invasion of Sargassum along the coastline during 2015 raised a number of concerns and highlighted that there is need for research on a workable and sustainable solution to the problem. Some challenges related to the completion of the assessment included the reformatting of the seedling monitoring data for analysis which was quite a tedious process and caused delays.

Further, as a result of the naturally destroyed sites and the associated financial loss attached to their establishment and monitoring, careful consideration should be made to further understand the coastal dynamics for future restoration activities. Also, the use of the coastal structures to promote accretion will have to play a very important role in future restoration efforts and must be combined with the use of Spartina grass and Avicennia seedling planting to promote sustainable growth and regeneration of mangroves. This, along with the participation of the local community in the new mangrove restoration and conservation initiative will be critical to the future restoration designs for long term sustainability.
TABLE OF CONTENTS

EXECUTIVE SUMMARY ................................................................................................................................. 1
LIST OF FIGURES ............................................................................................................................................ 4
APPENDICES .................................................................................................................................................. 4
LIST OF ACRONYMS AND ABBREVIATIONS ............................................................................................... 4
1 INTRODUCTION ........................................................................................................................................... 6
  1.1 Project Background ............................................................................................................................... 6
  1.2 Report Objectives .................................................................................................................................. 6
2 MANGROVE CONTEXT IN GUYANA ........................................................................................................ 8
3 THE GUYANA MANGROVE RESTORATION PROJECT ........................................................................ 10
  3.1 Overview .................................................................................................................................................. 10
  3.2 Constraints to Project Execution .......................................................................................................... 11
  3.3 Establishment of the Mangrove Action Committee (MAC) ..................................................................... 12
  3.4 Establishment of Mangrove Secretariat (MS) ....................................................................................... 12
  3.5 Monitoring ............................................................................................................................................... 14
  3.6 Enforcement ............................................................................................................................................. 15
4 MANGROVE LEGISLATION .................................................................................................................................. 16
5 COMMUNITY MANGROVE MANAGEMENT ............................................................................................ 17
6 MANGROVE RESEARCH AND DEVELOPMENT ..................................................................................... 18
  6.2 Planting Mangroves ................................................................................................................................ 18
  6.3 Application of Coastal Engineering Structures .................................................................................. 19
7 PUBLIC AWARENESS .................................................................................................................................... 20
  7.1 Mangrove Education .............................................................................................................................. 21
8 NAREI MANGROVE RESTORATION AND MANAGEMENT ........................................................................ 21
  8.1 GMRP Location ....................................................................................................................................... 21
  8.2 Restoration Activities 2014 ................................................................................................................... 23
  8.3 Restoration Activities 2015 ................................................................................................................... 27
  8.4 Restoration Activities 2016 ................................................................................................................... 29
  8.5 Restoration Activities 2017 ................................................................................................................... 31
  8.6 Restoration Activities 2018 ................................................................................................................... 34
9 EFFICIENCY AND EFFECTIVENESS OF RESTORATION ACTIVITIES .................................................... 35
  9.1 Ecological Restoration (Flora) .............................................................................................................. 35
  9.2 Ecological Restoration (Fauna) .............................................................................................................. 38
  9.3 Enhanced Carbon Stocks ....................................................................................................................... 41
10 ASSESSMENT OF RESTORATION INTERVENTIONS AND RECOMMENDATIONS .......................... 43
  10.1 Planting Success ..................................................................................................................................... 43
  10.2 Comparison of Monitoring Costs for Sites ........................................................................................ 45
  10.3 Status of Administrative Capacity and Recommendation ..................................................................... 2
  10.2 Assessment of Past Research with Recommendation ......................................................................... 4
  10.3 Status of Community Involvement with Recommendation ................................................................... 4
  10.4 Legislation Supporting Mangrove Management with Recommendation ............................................. 6
  10.6 The Forecast for Future Restoration with Recommendation .................................................................. 9
11 CONCLUSION ............................................................................................................................................... 10
12 REFERENCES ............................................................................................................................................... 11
11 APPENDICES ............................................................................................................................................... 14
List of Figures

FIGURE 1. MAP SHOWING THE TEN REGIONS OF GUYANA
FIGURE 2. COMPLETED BRUSHWOOD DAM AT THE MAINSTAY FORESHORE, REGION NO. 2
FIGURE 3. 100M GEOTEXTILE TUBE GROYNE, RELIANCE, ESSEQUIBO COAST, REGION NO. 2
FIGURE 4. BRUSHWOOD DAM IN REGION NO. 2
FIGURE 5. DEVONSHIRE CASTLE, ESSEQUIBO COAST, REGION NO., GEOTEXTILE TUBE GROYNES
FIGURE 6. AERIAL VIEW OF LIMA, ESSEQUIBO COAST, REGION NO. 2
FIGURE 7. NATURAL REGENERATION AT OGLE/SPARENDAAM AS A RESULT OF BETTER HOPE RESTORATION
FIGURE 8. BIODIVERSITY IN MANGROVE RESTORATION AREA
FIGURE 9. VILLAGE MANGROVE ACTION COMMITTEES (VMACS)

List of Tables

TABLE 1: AVAILABLE MONITORING DATA PROVIDED FROM NAREI ......................................................... 7
TABLE 2: PLANTED SITES WITHOUT INTERVENTION .......................................................................................... 44
TABLE 3: INTERVENTION SITES WITH PLANTING .............................................................................................. 44
TABLE 4 COST OF RESTORATION INTERVENTIONS AND MONITORING NATURALLY DESTROYED SITES (NAREI, 2018) .... 1
TABLE 5 COST OF RESTORATION INTERVENTIONS AND MONITORING INTACT SITES (NAREI, 2018) ............ 2

Appendices

Appendix 1. Social Survey Questionnaire

Appendix 2. Restoration Sites Showing Significant Growth and Extension of Forest

Appendix 3. Questionnaire

List of Acronyms and Abbreviations
EPA  Environmental Protection Agency
EU  European Union
GEF  Global Environmental Facility
GFC  Guyana Forestry Commission
GIS  Geographic Information System
GMRP  Guyana Mangrove Restoration Project
GoG  Government of Guyana
GUYWID  Guyanese Women in Development
GYD  Guyana Dollar
IICA  Inter-American Institute for Cooperation in Agriculture
ICM  Integrated Coastal Management
MAC  Mangrove Action Committee
NAREI  National Agricultural Research & Extension Institute
NBS  North Brazil Shelf
NDC  Neighbour Democratic Council
NGO  Non-Governmental Organization
NMMAP  National Mangrove Management Action Plan
TA  Technical Assistance
ToR  Terms of Reference
VMAC  Village Mangrove Action Committee
WWF  World Wildlife Fund
1 Introduction

1.1 Project Background

The project entitled “Setting the foundations for zero net loss of the mangroves that underpin human wellbeing in the North Brazil Shelf LME (NBS-LME)” (from here on the “NBS Mangrove Project”), funded by the Global Environment Facility, is a one-year primer project to help establish a shared and multi-national process for an Integrated Coastal Management (ICM) in the NBS. The project recognizes the prevalence, socio-ecological importance and connectivity of mangroves in the retention and generation of key ecosystem services (fisheries, coastal protection and defenses, water quality, blue carbon etc.) from which communities in the NBS countries are beneficiaries. This project builds on, and supports, the antecedents and key elements of the regional agreement established within the CLME+SAP for the NBS region.

The objectives of the NBS Mangrove Project are:

• To generate the necessary baseline knowledge and technical assessments as inputs towards a collaborative vision and a coordinated well-informed management of NBS mangrove systems, with emphasis on the information needs of Guyana and Suriname.

• To support development of transboundary coordination mechanism(s) between the countries of Guyana, Suriname, French Guiana, and Brazil (state of Amapá) towards the improved integrated coastal management of the extensive, ecologically connected yet vulnerable mangrove habitat of the NBS region.

1.2 Report Objectives

The objective of this report is to conduct desktop review of relevant literature, fieldwork and stakeholder interviews to produce a report on the efficiency and effectiveness of the mangrove restoration activities conducted within Guyana. This study has been actively pursued and background information gathered from The National Agricultural Research & Extension Institute (NAREI). Ms Kene Moseley, Project Coordinator of the Mangrove Restoration and Management Department and Mr. Rudolph Adams, Mangrove Officer, NAREI were engaged. The relevant data, research documents and reports were provided. This included monitoring data for all sites planted in Regions #2, #4, #5, #6. However, during
the screening the areas of the study which could not be done as the relevant data was lacking was highlighted and the scope of work adapted. The specific objectives are to:

- Review relevant literature and data relating to work completed in country on mangrove restoration.
- Verify the restoration activities conducted by relevant agencies in Guyana.
- Assess the efficiency and effectiveness of restoration activities in achieving the project objective through the examination of key ecological indicators.
- Forecast the efficiencies achievable at scale for future restoration activities to achieve a greenbelt width of 500–1000m for self-sustaining mangrove forest.
- Produce evidence of capacity building within project partners on ecological assessments and predictive modelling related to field research conducted.

Table 1: Available monitoring data provided from NAREI

<table>
<thead>
<tr>
<th>No.</th>
<th>Research Area</th>
<th>Data available from NAREI</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ecosystem functionality: ecological succession dynamics.</td>
<td>Natural regeneration (all species) at restoration sites</td>
<td>Data available</td>
</tr>
<tr>
<td>2</td>
<td>Seedlings survival rates.</td>
<td>Monitoring data for restoration sites (planted)</td>
<td>Data available</td>
</tr>
<tr>
<td>3</td>
<td>Which and to what extent ecosystem services have been recovered.</td>
<td>Carbon (Silvestrum reports) on coastal defence GMRP research on biodiversity (fish, birds)</td>
<td>Data available</td>
</tr>
<tr>
<td>4</td>
<td>Determine the level of faunistic recruitment compared to a natural equivalent mangrove system.</td>
<td>No data available</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Vegetation development and floristic succession.</td>
<td>No data available</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Primary productivity (the system presents a similar productivity to the original or in a similar trajectory).</td>
<td>Productivity Research conducted by Collis Primo</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Species abundance and composition, as well as vertical stratification of vegetation and soils.</td>
<td>Monitoring data set; Collect soil data for analysis (texture, npk)</td>
<td>Data available</td>
</tr>
</tbody>
</table>
### Social Dimension: How locals perceive the restoration process? How they perceive the potential for sustainable use of restored mangroves?

Rapid assessment survey to collect new data

### Financial investment or total restoration cost, human resources utilized (e.g. hours of human labour per hectare), cost of restoration technology transfer and time frames (e.g. ecosystem recovery pace or vegetative growth rates).

Available from NAREI. Include monitoring cost per sites/year

---

Additional reports and research papers used in this evaluation process:

- Landell Mills Final Report October 2013
- Mangrove Department Annual Report 2014
- Mangrove Department Annual Report 2015
- Mangrove Department Annual Report 2016
- Mangrove Department Annual Report 2017
- Mangrove Department Annual Report 2018
- Monitoring cost data sheets for 2014 – 2018

## 2 Mangrove Context in Guyana

Guyana is a highly forested country with substantial mangrove belts along the coastal region and river estuaries. In the late 18th century the mangrove belt covered the entire Guyana coastline, except for the main river outlets. At the present time, significant stands of mangroves still exist (over 80,000 hectares in 1992 reduced to 22,000 in 2001), with the largest intact mangrove system along the Waini-Pomeroon coast in Region 1 of the country. Mangroves contribute substantially to sea defence in Guyana by damping wave action and reducing wave energy, trapping sediments and stabilizing shoreline substrates and play an important role in carbon sequestration and essential habitat for biodiversity including rare and migratory species.

Guyana’s remaining standing mangrove forests are threatened by a range of natural and man-made factors. Natural threats to mangroves in Guyana include natural erosive and accretive cycles.
characteristic of the coastline of the Guianas (Amazon river to the Orinoco river) and large-scale mud bank movements. These patterns have been well documented by researchers in Guyana as well as in the neighbouring countries of Suriname and French Guiana.

Originally, the Guyana mangrove belt appears to have been wide enough to recover after erosion periods (a minimum width seems to be about 200 m). However, the introduction of man-made factors due to intensive settlement on Guyana’s coastline has allowed erosion cycles to remove a large proportion of the mangrove belt. These factors vary greatly from region to region within Guyana depending on historical patterns of human inhabitation of the coastline. Mangrove depletion has been particularly serious in the 20-30 years, especially in Regions 3 and 4 (East and West Demerara).

Man-made factors affecting mangroves in Guyana include the direct loss of habitat as a result of land development for housing and urban development, agriculture and aquaculture and infrastructure development (e.g. canals, sea defence infrastructure, power lines etc). In addition, the widespread loss as a result of overharvesting of mangroves for raw materials such as firewood and bark and the effects of fire are some other factors (Landell Mills, 2013). Less understood are the indirect impacts on mangroves brought about by additional human use factors including grazing and reduction of natural recruitment and resilience of natural forests changes to salinity as a result of changes to hydrology through canal building (Pastakia 1991); reductions in availability of mangrove seeds essential for the natural recovery of Guyana’s mangroves; and degradation through factors such as garbage dumping and water pollution.

Recognition of the above values of mangroves, threats and the increased risks to Guyana’s low lying coastline posed by predicted rises in sea level and the rising cost of maintenance of the sea defence structures, have prompted a commitment on the part of the Government of Guyana to the conservation, restoration and protection of the mangrove forest through activities described in the National Mangrove Management Action Plan (NMMAP, 2010).
3 The Guyana Mangrove Restoration Project

3.1 Overview

The Guyana Mangrove Restoration Project (GMRP) was developed and funded with joint support from the Government of Guyana (GoG) and the European Union to support implementation of the National Mangrove Management Action Plan (NMMAP). The GMRP was implemented through sector budget support (centralized management) and project support (decentralised management) and executed by the National Agriculture Research and Extension Institute (NAREI) representing the Ministry of Agriculture of the Co-operative Republic of Guyana. A financing agreement (GY/DCI-ENV/21549) was signed on 1 September 2009 between the European Commission and the Government of Guyana based on the Environmental and Natural Resources Thematic Programme (ENRTP): Priority 2 Global Climate Change Alliance.

Landell Mills was contracted to deliver a Technical Assistance Contract in support of the Guyana Mangrove Restoration project (GMRP). The purpose of the TA contract was to support Guyana’s policies on Sea Defence, Climate Change and Mangrove Management, and to provide Technical Assistance to the Mangrove Action Committee and mangrove project unit in the Implementation of the National Mangrove Management Action Plan (NMMAP, 2010).

A technical assistance report by the Landell Mills Limited (2013) provides an early but comprehensive review of the establishment of the project with specific reference to seven thematic areas:

- **The establishment of the administrative capacity for the management of mangroves in Guyana:** This component aimed at establishing a strong management system for mangroves in Guyana encompassing an effective MAC oversight committee and adequately staffed and resourced project unit.

- **The promotion of the sustainable management of mangrove forest (monitoring and enforcement):** This component aimed to develop a comprehensive database of knowledge on Guyana’s mangroves that can be used as the basis for improved mangrove management in Guyana as well as performance monitoring of initiatives implemented by the GMRP.
The establishment and completion of a legal framework for mangrove ecosystem management and encourage community-based mangrove management: This component was developed as a result of project stakeholders identifying the need to review the institutional arrangements and legal framework for mangrove protection in Guyana develop and implement appropriate policies and strategies for the management and conservation of these essential ecosystems.

Support of research and development of Guyana's mangrove forest: This component is in response to the finding that the limited data on mangrove ecosystems in Guyana is a major constraint affecting the management of Guyana’s management resources and rational management of these mangrove forests is based on an understanding of the forest and its environment, which can only be obtained through research (NMMAP 2010). This component aimed to support targeted research which addressed key management questions relating to the sustainable use of Guyana’s mangroves.

The development and effectiveness of mangrove ecosystem protection and rehabilitation: This component targeted the restoration of Guyana’s mangrove forests by planting, protection of existing stands and facilitation of natural recruitment of mangrove seedlings along the Guyanese coastline.

Increase of public awareness and education on the benefits of the mangrove forests: This public awareness component of the NNMAP aimed to “Increase of public awareness and education on the benefits of the mangrove forests” aimed to develop sensitivity and awareness of the vital roles that mangroves play; the extraordinary environment to which they have adapted and their vulnerability to external pressures. The rationale for the public awareness campaign is that as public understanding of mangroves grows and a sense of shared national responsibility is fostered, the work of restoration and protection will be made easy.

3.2 Constraints to Project Execution

The GMRP was launched in February 2010 with a budget of GYD$124M for execution of first year’s activities. Twenty-four million (G$24M) of this budget was expected from Specific funds (Guyana
Mangrove Restoration Project – Progress update Feb-Aug 2010). However, the Financing Agreement between the Government of Guyana and the European Union was not signed until August 2010. These funds were therefore not available to the project and thus the activities programmed for execution utilizing these funds could not be fully implemented. These included, networking with similar projects in the Region i.e. sharing expertise and experience on mangrove management and restoration, procurement of nursery equipment and implementation of educational campaign.

Similarly, the Project has been unable to commence full implementation of the Research component of its 2010 work plan. Additional releases from the Ministry of Finance were not forthcoming for the first four months of implementation. The Project received its first release of GY$3M on 27th May 2010 following a more significant release of G$7M and G$41.4M in July and August respectively. The implementation of the project’s activities was therefore totally dependent on NARIE’s resources, which while forthcoming, resulted in reduced level of implementation of some activities (Landell Mills, 2013).

3.3 Establishment of the Mangrove Action Committee (MAC)

In early 2010, a Mangrove Action Committee (MAC) was formed as an advisory body to guide the project in the implementation of the NMMAP. The MAC comprised members of twelve (12) organisations as follows: Ministry of Agriculture, Ministry of Public Works - Sea and River Defense Division, Ministry of Education, Ministry of Local Government and Regional Development, Fisheries Department, National Drainage and Irrigation Authority, Ministry of Finance, University of Guyana, Environmental Protection Agency (EPA), Hydrometeorological Service, National Agricultural Research and Extension Institute, and the Guyana Forestry Commission.

Meetings were held on a monthly basis and were run according to an agenda with minutes prepared for each meeting and a monthly report prepared. In June 2012, the Terms of Reference for the MAC was revised which defined its role and updated the list of representatives. This Committee continued to function up until 2013 and its functions were subsumed by the NAREI Board in 2014.

3.4 Establishment of Mangrove Secretariat (MS)

To support project activities, the MAC Secretariat (MS) was established in the compound of NAREI in Mon Repos in 2010 and equipped with computer equipment, monitoring equipment, furniture and two
vehicles. As of May 2013, the MS had a staff of seven (7) persons including a Project coordinator, Administration and finance officer, Administrative assistant, two Monitoring officers (one recruited in December 2012), a Community development officer, Coastal engineer and a Driver. Administrative and financial systems were established to meet the requirements of the Government of Guyana.

Progress reports were submitted to the MAC on a monthly basis prior to the MAC meetings and occasional reports were also submitted to the EU reporting on Performance Criterion 1 (September 2011), Performance Criterion 2 (September 2011) and Performance Criterion 3 (October 2012) and financial reports submitted on a monthly basis to the Ministry of Finance. This Secretariat functioned until 2013 after which it was subsumed by the NAREI.

There were early challenges of the secretariat that were noted by the TA team Leader. These included the lack of defined role for the MAC. This lack of clarity regarding the role of the MAC and whether this committee should keep its focus on strategic direction and oversight of the mangrove project or also include a hands on role in mangrove management addressing particular issues affecting mangroves (e.g. illegal cutting in particular areas or commenting on particular development proposals). This lack of clarity reduced the effectiveness of the committee as committee meetings often addressed detailed operational issues as opposed to the oversight of program plan implementation.

There were also several other related challenges:

- Lack of a detailed overarching annual plan which the MS can report progress against to the MAC.
- Insufficient level of detail in MS reports to allow for the MAC to an effective role in program oversight.
- Inconsistent turn out of senior staff and constituent agencies to MAC meetings.

The other major issue was such insufficient resourcing of the Mangrove Secretariat (MS) to be truly functional.

The overall staff numbers and skills of MS staff was insufficient throughout the life of the GMRP to efficiently carry out the Project mandate. This was severely affected by the poor access to coastal
locations by the lack of vehicles. Also, recruitment of Regional Mangrove officers was negatively impacted by low salary levels allocated for these positions and or lack of job security as positions were only on a contract basis. This made it difficult to coordinate activities in Regions located far from NAREI’s Mon Repos base. As a result of these deficiencies there was a delay in expansion of the GMRP into the Regions further away from NAREI.

Other deficiencies experienced were:

- Skill gaps amongst the staff of the MS in the technical aspects of mangrove restoration planning and implementation and GIS.
- High turnover of MS staff. The GMRP experienced high staff turnover including Project Coordinators and Monitoring personnel. Associated with this change of personnel was loss of data (e.g. monitoring data) and overall continuity and institutional memory of the GMRP activities and loss of specialist expertise relevant to implementation of the GMRP workplan (e.g. monitoring, community development, public awareness and education).
- Unreliability of essential equipment of the MS including the Project leading to numerous vehicle breakdowns and resulting difficulties in carrying out required field work.
- Finally, office space at the NAREI compound was of a temporary nature and was insufficient to house the MS team as it increased in size to carry work programmes.

3.5 Monitoring

The NMMAP 2010 recognized that loss and degradation of mangroves was occurring and that there was need for accurate information on the current extent of mangroves, rate of loss and specific threats to mangroves in Guyana’s different administrative regions. This was unavailable at the time with limited verification of the general anecdotal claims about the cause of the loss of mangroves and status of existing mangrove areas.

In addition, there was also no system in place for monitoring effectiveness of project activities (e.g. planting/ coastal engineering/ enforcement) and feedback of this information into future restoration (e.g. improved improve planting techniques or improved site selection processes) or management plans. As a result, the current mangrove activities that were occurring could not contribute to learning and development that would improve approaches to mangrove restoration and management over time.
Coupled with this was the need for the GMRP to develop and establish a monitoring system to satisfy performance criteria of the European Union related to mangrove monitoring. Guidelines for mangrove monitoring were developed by the project through the Mangrove monitoring protocols for Guyana (2011) and Mangrove Restoration Monitoring Plan (2012). These two documents provided the technical basis for monitoring work to be conducted by the project, the first document describing the theoretical basis for monitoring including details of a proposed monitoring strategy and recommended methodologies and the second describing strategies for Data Collection, Data Analysis and a Monitoring reporting structure and formats. The full implementation of the GMRP’s two published monitoring documents mentioned above has been hampered by a lack of technical expertise within the MS and the lack of a database system which can be used to manage, analyse and display field data and data derived from other sources (e.g. satellite/aerial imagery).

Under an MoU between the Guyana Forestry Commission (GFC) and NAREI (National Agriculture Research and Extension Institute), the GFC undertook an assessment of the extent of mangroves across 470 kilometres of mangrove forest coastline in Guyana and produced a report on the mapping and inventory of coastal zone forests in Guyana (Persaud, 2011). Project personnel were recruited for the MS to carry out the required monitoring roles. Field equipment was also procured for field monitoring. Field monitoring commenced in the period 2010 and continued in 2012 but detailed records were not kept of the location of monitoring plots and methodologies used.

### 3.6 Enforcement

As a result of Guyana’s mangrove forests being threatened by extensive natural cycles of erosion and accretion introduced by large scale mud bank movements and man-made factors including the direct loss by land and infrastructure development, overharvesting of mangrove wood and the effects of fire and grazing. The GMRP saw the need to reverse these trends of degradation of its remaining mangrove forests and retain the essential ecosystem values. During the project phase 2010-2013 the GMRP sought to put in place and enforce existing laws to protect standing mangrove forests from further loss. This was affected through the establishment of management mechanisms for mangrove areas in Guyana including strengthening the overall enforcement effort through mangrove rangers and development of a management plan for a pilot mangrove protected area.
Eight (8) mangrove rangers were employed to protect existing standing forest areas from grazing by
cattle and goats and disturbance by other human activity (e.g. fishing boats and illegal harvesting of
mangrove wood). In 2010-mid 2012, 25.6km of the coastline were being patrolled by rangers including
the areas Mon Repos to Success, Golden Grove to Belfield, Vigilance to Buxton, Ann’s Grove to Green
Field, Nooten Zuil to Hope (Region 4), Village # 6-11, Mahaicony River to Cottage (Region 5), and
Wellington Park (Region 6). An additional ranger was recruited for Leguan (Region 3) in October 2012.

Rangers were equipped with field equipment and carry out regular patrols of their designated range
which extended from between 3 and 7km of the shoreline. Major activities undertaken by mangrove
rangers on a day to day basis are:

- Public awareness activities with community groups and users of the shoreline to remind them
  of the values of mangroves
- Enforcement of regulations restricting unsustainable practices as cutting of trees, grazing and
dumping of garbage.
- Maintenance and protection of planted mangrove seedlings/ coastal engineering infrastructure
  at each site.

Rangers were trained in 2012 in mangrove ecology, monitoring techniques and first aid and were
required to produce monthly reports detailing the work that they carried out in the previous month.

In support of the enforcement activities a Code of Practice for Mangrove harvesting developed and a
concept note for the Cove and John mangrove reserve was developed in 2011. Initial meetings were
held with the local community to discuss formulation of a management plan for the reserve.

4 Mangrove Legislation

Stakeholder feedback in 2010 suggested that there was need to review the institutional arrangements
and legal framework for mangrove protection. This led to the initiation of development and
implementation of appropriate policies and strategies for the management and conservation of the
mangrove ecosystems. Legislation for the management of the mangrove ecosystem in Guyana was
established on 29 January 2010 through amendment of Regulation 17 of the Principal Regulations of
the State Forest Act by the substitution of the following:
Protected Trees

17. (1) “No bullet-wood tree or red, black or white mangrove trees shall be felled without first obtaining the permission in writing of an authorized forest officer not below the rank of an Assistant Commissioner of Forests”

Further, National and Regional stakeholders’ consultations on legislative changes for mangrove protection/ management were conducted and a Mangrove Management Plan was reviewed, adopted and submitted to Cabinet for approval.

5 Community Mangrove Management

The GMRP realized that the initiatives of the NMMAP would not succeed without regard to the support of the involvement, support and commitment of local communities. A community-based mangrove management initiative was undertaken involving local communities living adjacent to mangrove areas and facilitating their participation in management activities and livelihood activities aimed at providing an alternative source of income for community members dependent on mangroves for their livelihoods. The GMRP worked with individuals who use the coastal zone as a means of livelihood through two interventions (Village Mangrove Action Committees, and Mangrove Reserve Producers) to provide alternative economic livelihoods which are environmentally friendly and profitable.

Village Mangrove Action Committees (VMAC) were established in each community where the project engaged. As at 2012, five VMACs have been established at Buxton/Friendship, Mon Repos, Victoria/Belfield, Village #8 and Greenfield/Beehive. VMACs met monthly and produced minutes of their meetings for the Mangrove Secretariat and participated in training on mangrove monitoring data collection. To support the role of the VMACs, the project developed a Community Development Manual and provided training to VMAC members in Mangrove Ecology & Public Awareness strategies.

During the 2010-2012 period eight (8) communities were classified under the Mangrove Reserve Producers (MRP). The objectives of the MRP were to:

- Support efforts to restore and protect the natural environment of Guyana’s coast in and around the reserve, inclusive of planting activities.
• Promote income generating activities, as well as related services such as training and marketing of products for mangrove forested communities.

• Create opportunities for members of the cooperative to receive training in agro-processing techniques.

• Provide product development and marketing support to the members.

• Educate members of the cooperative and the general public on matters relating to the environment, conservation and the sustainable use of mangroves and natural resources.

• Represent the interests of all members of the cooperative and coastal communities nationally, regionally and internationally on all issues related to conservation and preservation that are of importance to them.

• The project supported the development of a Business Plan for the Mangrove Reserve Producers and established the Mangrove Reserve Producers as a

• Enhance the apiculture program through site visits, knowledge transfer and technical assistance/handholding.

6 Mangrove Research and Development

In 2010 the GMRP found that there was limited data on mangrove ecosystems in Guyana and that this was a major constraint affecting the management of Guyana’s management resources. It also noted that rational management of these mangrove forests is based on an understanding of the forest and its environment, which can only be obtained through research (NMMAP 2010). As such, a project research sub committee was formed by the project comprised of MAC members who agreed on research priorities for the project, reviewed research proposals and agreed to fund a series of research projects for final year students at the University of Guyana. 6 Research projects were completed in 2010-2011 (5 local, 1 foreign student facilitated) and in 2012, 11 research projects have been supported (see list of research projects in Annex 3).

6.2 Planting Mangroves

The initial approach to mangrove restoration by the GRMP was through planting, protection of existing stands and facilitation of natural recruitment of mangrove seedlings along the Guyanese coastline. The GMRP’s original planting sites were selected based on recommendations in the 2010 report “A situational analysis of Coastal Mangrove Sites in Guyana (Shell Beach to Mahaica (Bovell, 2010).
Temporary nurseries were established near planting sites to support the planting activities of the project. Contracts for seedling production were drawn up between the project and community groups/individuals responsible for planting who were paid GYD$100 per seedling. A Mangrove Nursery Manual was developed, and community groups were trained to propagate black mangrove seedlings.

Planting was initiated at 10 sites along the Guyana coastline in the GMRP phase (2010-2013), 30 community contracts have been completed for seeding production while 421,599 mangrove seedlings were produced and distributed to restore 5.59km of coastline or 35ha of mangroves along the East Coast Demerara, West Coast Berbice and Corentyne Coast. However, results from planting were mixed across the different planting sites, with survival rates ranging from 0-100% (Landell Mills, 2013).

6.3 Application of Coastal Engineering Structures

The GMRP felt that allowing the groynes, originally constructed by the Dutch, to deteriorate has accelerated the erosion of the coastal mangroves. As an alternative to groynes, low-crest, low-cost structures running parallel to the shore acting as wave-force breakers were proposed. It was perceived that these structures can be constructed quickly could have contributed to protecting established and developing stands from erosion (Landell mills, 2013). The NMMAP identified two sites where coastal engineering structures are required to protect existing mangrove forests or stabilize the coast prior to mangrove planting.

Recognizing the need to encourage accretion and stabilization of coastal mud banks, the project has also collaborated with the Work Services Group and the Ministry of Agriculture identified suitable low-cost designs for coastal engineering structures which could be used to provide additional protection for mangrove areas. This collaboration resulted in the identification of the three possible low-cost structures as suitable measures:

- Geotextile Detached Breakwater
- Brushwood Dam
- Rubble Mound Groyne

Designs for a geotextile detached breakwater structures were developed and constructed at Victoria, East Coast Demerara, Region 4.
7 Public Awareness

The public awareness component of the NNMAP aims to “Increase of public awareness and education on the benefits of the mangrove forests” to develop sensitivity and awareness of the vital roles that mangroves play; the extraordinary environment to which they have adapted and their vulnerability to external pressures. The rationale for the public awareness campaign is that as public understanding of mangroves grows and a sense of shared national responsibility is fostered, the work of restoration and protection will be made easy.

In order to create public awareness in the project phase of the mangrove restoration a number of initiatives were undertaken (Landell Mills, 2013). This involved the development of a project website (www.mangrovesgy.org, ) which was launched in January 2011 and redesigned in September 2011. Informational Billboards were erected in various coastal villages informing people about the values of mangroves and the need to protect them; house to house education visits by mangrove rangers A mangrove Jingle was developed along with the production of a mangrove Documentary “Holding Back the Sea”.

Other initiatives included:

- Infomercials on mangrove protection aired on National Television. For example, a Mangrove Documentary on mangrove preservation and the work of the GMRP.
- Continuous press coverage of project related activities as well as participating in exhibitions to educate the public on mangroves and the GMRP
- The Convening of Guyana Mangrove Forum in April 2013 which involved the wider international mangrove community
- Public awareness through VMAC activities including school presentations
- Development of informational brochures and posters. These include brochures included a Mangrove Forest Guide; Mangrove Fact Sheet; About Guyana Mangrove Restoration project; Garbage dumping flyer; Poster- Why We need to Protect Guyana’s Mangroves; Why are mangroves important; How are mangroves Protected; What are mangroves and where are they found.
- Conducting of tours for local and overseas tourists at the Golden Grove/Belfield Mangrove Reserve.

7.1 Mangrove Education

The mangrove education programme targeted the primary, secondary and tertiary level students on the value of mangroves so that communities can work with government to address unsustainable use of mangroves in Guyana. Educational activities carried out during this GMRP phase included:

• Development of a Resource Manual for Secondary School Teachers entitled “Mangroves: Our Natural Sea Defence - A Teacher's Resource for Secondary Schools in Guyana” by Phillip Da Silva and Michelle Kalamandeen and 120 teachers trained to use the manual. An additional thirty (30) teachers have been trained for the mangrove outreach program.

• Development of a Visitor’s centre at the Golden Grove/Belfield Mangrove Reserve.

• Conducting of school tours and camps to the Visitor’s Centre and the Golden Grove/Belfield Mangrove Reserve in collaboration with NCERD. At least 20 schools visited the mangrove reserve and learning centre so far in 2012.

• TV ads, radio ads, jingle and documentary on mangrove protection produced and disseminated

• Field guides were developed for rangers and community members

8 NAREI Mangrove Restoration and Management

8.1 GMRP Location

The GMRP operates across the entire coastline of Guyana, from Region 1(Barima-Waini) to Region 6 (East Berbice-Corentyne) (Figure 2). The initial operational duration of the project was forty-eight (48) months from the signature of the Financing Agreement (no 9732/GUA) in 2010.
The beginning of 2014 marked the transition of the Mangrove Secretariat to the Mangrove Restoration and Management Department under the National Agricultural Research and Extension Institute following the completion of the project phase under the Guyana Mangrove Restoration Project. All technical and field staff previously engaged under GMRP, were contracted under NAREI to form the new department. At the beginning of the year the Department’s staffing consisted of four technical staff, three administrative staff and nine field staff (rangers).

The Department’s 2014 Programme of Work was developed based on recommendations and lessons learned during the implementation of GMRP. The recommendations and results contained in the final report and other technical reports submitted by Landell Mills Limited, provided the main input for the development of the 2014 Programme of Work.
During the implementation of GMRP, it was noted that the reality of work on the highly modified shoreline in Guyana, is that few perfect sites existed along the shoreline which will lead to development of a mangrove forest within a short timeframe. The Mangrove specialist attached to the project, noted to restore the mangrove belt in the scale and timeframe required in Guyana, mangrove planting needs to be carried out in conjunction with other methods of mangrove restoration would be recommended. This recommendation, combined with ongoing community involvement, public awareness and education formulated the basis for the activities executed under the 2014 Programme of Work.

The Mangrove Action Committee which functioned up until 2013 was subsumed by the NAREI Board when the NAREI Mangrove Restoration and Management Department was formed in 2014 to replace the Guyana Mangrove Restoration Project Mangrove Secretariat.

8.2 Restoration Activities 2014

Mangrove restoration activities in 2014 focused on several combined interventions based on specific site conditions (NAREI, 2014). Restoration interventions included, planting *Avicennia germinans* (Black mangrove) seedlings, planting *Spartina brasiliensis* (*Spartina* grass), construction of coastal engineering structures, restriction of community use and restoration of natural hydrology.

I. *Planting Avicennia germinans*: The Department in collaboration with a local NGO, Guyanese Women in Development (GUYWID), completed planting of 1057 meters of coastline with 34,478 *Avicennia germinans* (Black mangrove) seedlings. Twelve community nurseries were established and thirty residents from the villages of Mon Repos, LBI, Pigeon Island, Buxton, Friendship and Strashtphey were trained in mangrove seedling propagation. Planted restoration sites completed during the year were Buxton (5,758 seedlings, 338 meters), Lusignan (19,395 seedlings, 669 meters) and Nooten Zuil (9,325 seedlings, 50 meters).

II. *Transplanting of Spartina brasiliensis*: Given the limited number of suitable sites for mangrove restoration through planting, sites identified as having unsuitable soil characteristics (sling mud as opposed to consolidated mud), were selected based on other criteria for planting Spartina grass as a means to consolidate the mud and support natural recruitment of mangrove seedlings. One thousand and eight plugs of *Spartina* grass were transplanted to four sites in
Region #2 and Region #5 (La Belle Alliance 240 plugs; Lima 284 plugs; Coffee Grove 240 plugs; Kilmarnock 244 plugs) to support the restoration of a total of 163.7 ha of coastline.

III. **Construction of coastal engineering structures**: During the period one coastal engineering construction project was completed in Region #2. Phase (1) of the Devonshire Castle groyne field was completed with the construction of two geotextile tube groynes measuring a total of 150m (Groyne 1-150m; Groyne 2-50m). The project was designed to support accretion of sediments along 500m of the Devonshire Castle foreshore resulting in an increase in the elevation of the foreshore to a height that can support mangrove restoration. The project was successfully completed by Samaroo Investments at a cost of GYD$27,984,000.

IV. **Restoration of natural hydrology**: The Department commenced the first project to restore the hydrology of a mangrove site that has been altered over the years. The Wellington Park Hydrological Restoration Project was awarded, and mobilization works commenced in December 2014. The project consists of the excavation of two 200m channels in an effort to reintroduce tidal flow into the salt pan at the site to restore the natural hydrology of the area. The Wellington Park project aimed to restore 7.5ha of shoreline to mangroves within a year.

V. **Restriction of community use**: Anthropogenic activities in mangrove forests continue to be one of the main contributing factors to mangrove destruction. Site assessments conducted by the Department resulted in the identification of stresses on several areas due to livestock grazing. Following several unsuccessful community consultations, the Department constructed several gates and fences at threatened sites (threats to planting and natural recruitment) to restrict livestock grazing in the mangroves. Interventions included the construction of three cattle guards with gates and fences (two steel guards and one virtual guard) in Region #5 and Region #6 (No. 7 Village, Kilmarnock and Wellington Park). Two gates and fences were constructed in Region #4 at Lusignan and Mon Repos to protect the planted seedlings at Lusignan from grazing. Combined, these restrictive measures were done to protect and restore 5.6 kilometers for coastal mangrove forest.

Mangrove protection and monitoring activities during the period focused on several areas: monitoring standing forest; monitoring planted restoration sites (*Avicennia* and *Spartina*), assessments to select
suitable restoration sites and monitoring the effectiveness of coastal engineering structures against design parameters (NAREI, 2014).

I. **Monitoring standing forests:** During the period the Department maintained nine mangrove rangers to monitor 30.3 kilometers standing forests in Region #4, #5 and #6, plus the entire Essequibo coastline from Walton Hall to Anna Regina and Leguan Island. The area in Region #3 from Rotterdam to La Jalousie was continuously monitored by the Department’s Monitoring Officer. The capacity of rangers was further increased through completion of training programs in Mangrove Ecology, Restoration and Management and the identification of avifaunal biodiversity in the mangrove forest and conducting bird guiding tours on the coastline. Notable issues observed during the period included loss of mangroves along West Coast Demerara (Rotterdam to La Jalousie) attributed to natural erosion, mangrove losses due to livestock grazing in Region #5 and extensive natural regeneration of mangroves following the implementation of restrictions at Village #7, WCB.

II. **Monitoring restored sites (Avicennia and Spartina):** During the period the monitoring team completed ongoing monitoring of all planted restoration sites based on a quarterly scheduled from the restoration date. Monitoring parameters measured included site elevation, seedling growth (height, base diameter, bole height, DBH), salinity, temperature, fertility and pH. Analysis of the monitoring data collected supported site selection and provided critical information for future restoration activities.

An integral part of the monitoring has been the use of technology, i.e. GIS, to support data analysis and storage. Updated imagery of the coastline obtained from Google Earth was processed to capture and document the extension of mangroves resulting from restoration activities (NAREI, 2014).

Monitoring results indicated that the use of *Spartina* grass supported mud consolidation and accretion and resulted in natural regeneration of mangroves. This success was evident at Lima on the Essequibo Coast and Village #7, West Coast Berbice. Another observation was that the *Spartina* grass planted in 2013 extended an additional 20m along the shoreline at a width of 20m and the area contained significant number of naturally regenerated mangrove seedlings (NAREI, 2014).
In addition, the planted *Avicennia* also had significant regeneration in Region #5, Village #7 beyond the planted area increasing in length and width. The established forests also supported increase elevation to the east (Village #6) thereby encouraging extensive natural regeneration.

III. *Monitoring coastal structures*: Coastal engineering structures constructed under GMRP caused an increase in foreshore elevation of 0.2m to 0.5m leeward of Mon Repos rubble mound groyne. The Geotextile tube breakwater constructed at Victoria resulted in increased elevation of the foreshore as a result of protection from the heavy wave action. This positively impacted the coverage of planted *Spartina* grass and the concomitant natural recruitment of mangroves.

Mangrove Research and development activities during the year involved Departmental research on restoration sites and research projects by University postgraduate students. The projects involved the assessment of the role of coastal mangroves in Guyana. This project was completed 2015 and provided scientific information on wave attenuation in a planted black mangrove site. The other University project examined the avifaunal biodiversity in a natural and planted mangrove site. Both projects provided valuable information on ecological restoration at planted sites (NAREI, 2014).

Community involvement is key to the success of mangrove restoration projects worldwide. At the end of 2014, seven Village Mangrove Action Committee (VMAC) groups with an active membership of thirty community volunteers were formed. These groups participated in mangrove awareness activities in Region #2, #4, #5 and #6. The capacity of VMAC members to better support mangrove restoration and protection activities was further enhanced through participation in mangrove ecology and management workshop, particularly training in the identification of avifaunal biodiversity in mangroves and conducting tours. Activities of the VMACs included conducting community house to house mangrove awareness also awareness in churches members (NAREI, 2014).

Finally, to complement the other mangrove awareness activities, the Mangrove Visitor Center and the Mangrove Heritage Trail Tour that were established during the phase of the GMRP continued to positively impact students and tourists in this period under NAREI Mangrove Management and Conservation Department. This tour facility continued to be active into, 2015 through 2018 impacting approximately 3500 persons (NAREI, 2014-18, Landell Mills, 2013).
8.3 Restoration Activities 2015

Mangrove restoration activities completed during 2015 focused on alternative restoration interventions i.e. the use of *Spartina* grass and coastal infrastructure as interventions to promote and encourage sedimentation and natural regeneration. An assessment of the status of coastal mangroves forests completed early 2015 indicated that there were limited sites available with suitable conditions to support mangrove restoration through seedlings planting.

The *Spartina* grass planting project was completed in collaboration with GUYWID as part of the implementation of the Community-led Mangrove Restoration Project. *Spartina* grass planting was conducted during the period February 18, 2015 to June 19, 2015. Eight thousand and thirty-eight (8,038) shoots/plugs of grass were planted at locations in Region #2 and Region #4 across five sites in an area measuring a total of 950m in length.

The Walton Hall coastal engineering (Bamboo Brushwood dam) was constructed as the first two projects completed. The was done to promote sediment accretion and consolidation, thereby creating an environment suitable for mangrove colonization.

Repairs and maintenance works were completed on the Buxton Brushwood groyne field and the Victoria Geo-tube breakwater. Works completed on the Victoria Geo-tube groyne included, replacing five fill ports, patching long tears due to extensive abrasion with a combination of materials. Repairs to the Buxton Brushwood dam were completed with support from the Community Led Mangrove Project and included, replacement of vertical bamboo piles spaced at a minimum distance of 0.5meter apart and repairs to the bamboo fences beginning with the westernmost T-shaped groyne working from the long shore section cross-shore fence followed by breakwater (head of groyne). The three T-Shape fences were revamped at the Buxton foreshore.

Other mangrove protection and monitoring activities completed during the year focused on updating the Mangrove GIS Monitoring System and monitoring of all restoration sites. New datasets added to the GIS database included:

- Social mapping of communities in Region #3 showing all the social groups within the villages.
- Mapping *Spartina* grass planted sites completed during the year.
- Update of the GIS monitoring database with new datasets of boundaries for NDC villages from Regions #3, #4, #5 and #6.
- Planted *Spartina* grass sites, pre-existing infrastructures (physical landmark features), elevation data, ranger monitoring points and new engineering structure.

Planted restoration sites revealed mixed results of planted seedlings. Planted mangrove seedlings at Lima on the Essequibo Coast showed outstanding growth rates. This site showed fast growth rate of planted seedlings and substantial natural recruitment as the planted seedlings produced seeds and supported sediment accretion that facilitated new natural regeneration.

The two planted sites at Lusignan and Nooten Zuil, Region2. which were planted in 2014 in collaboration with a project funded by the Global Environment Facility (GEF) small grants programme and executed by GUYWID and were selected based on suitable elevation for planting were naturally destroyed due to changes in shoreline dynamics, coastal erosion and *Sargassum* invasion.

The planted site at Village #6 West Coast Berbice showed great potential expanding both seaward and further along the coast. Substantial natural regeneration occurred at this site with both black mangroves and *Spartina* grass reaching as far as Village No 2 which is approximately 2.8 kilometers east of the initial restoration area. The success of this site was however threatened by extensive grazing of livestock by residents.

Substantial changes to the shoreline were recorded as by rangers monitoring shorelines in Regions #2 to #6. Increase in erosion was recorded at sites along the East Coast Demerara with significant erosion in Region #3 along West Coast Demerara. Natural regeneration of mangroves was however recorded in Region #2 with substantial growth of the planted site at Lima and the recorded sediment accretion at Devonshire castle. On the other hand, *Sargassum* invasion negatively impacted newly planted seedlings at Lusignan and Nooten Zuil on the East Coast of Demerara and the *Spartina* planted site at Walton Hall on the Essequibo Coast.

Mangrove Research and development during the year conducted studies to better understand the potential for low cost engineering infrastructure to assist in the recovery of mangrove at field sites. In
additionally other studies were conducted to understand of the use of *Spartina brasiliensis* as an alternative to the traditional mangrove restoration technique, using mangrove seedlings.

Community involvement ensures that the initiatives implemented by the department have the support, participation and commitment of residents who live in close proximity to the project site. During the period under review, the department completed a number of activities geared towards promoting community ownership and fostering a shared national responsibility for mangrove restoration, protection and management.

Communities in Region #3, specifically the NDC of La Jalousie/Novelle Flanders, West Cost Demerara and Leguan Island, were targeted for the establishment of Village Mangrove Action Committees. This initiative resulted in the successful establishment of a VMAC on Leguan Island with 18 members. The stakeholders from the of La Jalousie/Novelle Flanders community were not willing to commit to forming themselves into a VMAC. A different approach was developed to raise awareness about the importance of mangroves and the status of mangroves in this community through presentations to the congregations of religious organizations and schools.

Due to the electoral climate during the first half of the year, VMAC participation in planning meetings and awareness activities was very limited during the year as compared to previous years. While this was not the case for all VMACs, it must be noted that there was a reduction in participation by as much as 50%. In order to stimulate participation, a VMAC exchange programme was reinitiated in August 2015.

Finally, the Department enhanced its implementation of the public awareness and education campaign on the importance of mangroves. The Mangrove Visitor Center and complimenting Mangrove Heritage Trail Tour facilitated over 1,000 visitors inclusive of students and tourists. Fourteen educational institutions participated in mangrove education tours, while seventeen private tours totaling 158 participants were facilitated.

**8.4 Restoration Activities 2016**

Mangrove restoration activities completed during 2016 concentrated on seedling planting and coastal infrastructure as interventions to promote and encourage sedimentation and natural regeneration.
Restoration by seedling planting was completed at Better Hope, East Coast Demerara. Ten thousand nine hundred and eighty-seven (10,987) *Avicennia germinans* (black mangrove) seedlings, grown in six community nurseries, were planted along 335m of coastline. The Better Hope restoration project was completed with funding through the WWF EFN Restoration Grant which NAREI supported the Mangrove Reserve Producers Coop to access.

Coastal engineering interventions executed during the year included the completion of brushwood dam field at Walton Hall on the Essequibo Coast and a brushwood dam at Lusignan on the East Coast of Demerara. Phase 2 of the Walton Hall Bamboo Brushwood dam project resulted in the construction of 300m which is expected trap sediments and increase shoreline elevation by approximately 1.17m to achieve the minimum optimal elevation of 2.3m above Chart Datum (CD) that is suitable for the natural regeneration of *Avicennia germinas* following the first 2 years after construction.

The Lusignan project resulted in the construction of a groyne field consisting of three brushwood dams measuring a total of 275 meters. Similar to the Walton Hall structure the Lusignan is expected to trap sediments and increase shoreline elevation by to achieve the minimum optimal elevation for the natural regeneration of *Avicennia germinas*. The resulting increase in elevation is expected to support natural regeneration of black mangroves and *Spartina* grass along the shoreline.

Mangrove protection and monitoring activities completed during the year concentrated on updating the Mangrove GIS Monitoring System and monitoring of all restoration sites. Monitoring information showed significant and extensive erosion occurring at planted sites in Region 6 and 4 and natural forest in Region 3. Extensive erosion was recorded at Wellington Park and Kilmarnock in Region #6; Greenfield, Hope Beach and Belfield in Region #4 and on the West Coast Demerara in Region #3.

While these sites showed significant mangrove loss, restoration sites at Village #6 - #8, West Coast Berbice, Chateau Margot to Felicity, ECD and Lima, Essequibo Coast continue to show significant growth and natural regeneration expanding the forest both seaward and further along the coast. It was suggested that community involvement continued to play a critical role in the success of restoration activities, for example through educational and awareness activities, producing nursery seedlings, planting both seedlings and *Spartina* grass and providing the labour force for the construction of brushwood dams and geotextile groynes, also, during the year the Department worked to improve
relations with local communities through engagement with the newly elected village councils and the establishment of Village Mangrove Action Committees. Presentations were made to NDCs on the status of mangroves and this was complimented by house to house awareness, school presentations and community development activities.

The Department enhanced public awareness and education campaign on the importance of mangroves through the Mangrove Heritage Trail Tour which facilitated 449 visitors inclusive of students and tourists. This was augmented by increased school presentations which reached an additional 700 students.

8.5 Restoration Activities 2017

Mangrove restoration activities during 2017 focused on Spartina grass planting and coastal infrastructure as interventions to promote and encourage sedimentation and natural regeneration. Coastal engineering interventions executed during 2017 included the completion of 400 m brushwood dam fields at Mainstay and Reliance on the Essequibo Coast and a 100m geotextile tube groyne at Reliance, Essequibo coast, Region No. 2. The 2017 program projected to complete 600m brushwood dam along the foreshores of Land of Plenty to Bushlot. However due to the dynamic nature of the shoreline and the rapid changes which occurred within the nine months between design and mobilization, the Bushlot site was no longer suitable based on the initial design. At the end of the reporting period 400m of brushwood was completed at Mainstay and Reliance.
The completed brushwood dams at Mainstay and Reliance is expected to support restoration of 450 meters of mangroves parallel to the shoreline. A 100m geotextile tube groyne consisting of two 50m geotextile tubes was completed at Reliance on in 2017. The structures were expected to support the restoration of 880 meters of mangroves parallel to the shoreline by reducing wave action along 530 meters within the leeward side of the structure and tapping sediments along 350 meters.
The combined structures were expected to trap sediments and increase shoreline elevation to achieve the optimal elevation of 2.3m above CD that is suitable for the natural regeneration of *Avicennia germinas* within the first 2 years after construction.

Mangrove protection and monitoring activities completed during the year were updating the Mangrove GIS Monitoring System and monitoring of all restoration sites. Monitoring data indicated significant and extensive erosion occurring at restoration sites in Region 6 and 4 and natural forest in Region 3. Extensive erosion was recorded at Wellington Park in Region #6 which was due to natural processes and extensive pollution from the dumping of sawdust in the Canje Creek. Erosion continues to affect the Hope Beach and Greenfield restoration sites and has resulted in 98% loss of the natural forest in West coast Demerara (Rotterdam to La Jalousie).

While mangroves were naturally destroyed at these sites, restoration sites including Village #6 - #8, West Coast Berbice, Chateau Margot to Felicity, East Coast Demerara (ECD) and Lima to Devonshire Castle, Essequibo Coast continue to show significant growth and natural regeneration expanding the forest both seaward and further along the coast, resulting in a net gain.
Community involvement continued to play a critical role in the success of restoration activities. During the year the Department worked to improve relations with local communities through continued engagement the NDCs. During the period, the Department enhanced its public awareness and education campaign on the importance of mangroves through the Mangrove Heritage Trail Tour which facilitated 845 visitors inclusive of students and tourists. This was augmented by school presentations which reached an additional 283 students.

8.6 Restoration Activities 2018

Mangrove restoration activities completed during 2018 focused on mangrove seedling planting and coastal infrastructure as interventions to promote and encourage sedimentation and natural regeneration. 2018 restoration projects included the completion of 700m brushwood dam field at Aberdeen and Columbia and planting 14,876 *Avicennia germinans* seedlings along 300m at Walton Hall, Essequibo Coast, Region No. 2. The completed brushwood dams at Aberdeen and Columbia were expected to support restoration of 1,000 meters of mangroves parallel to the shoreline. The structures were expected to trap sediments and increase shoreline elevation to achieve the minimum optimal elevation of 2.3m above CD that is suitable for the natural regeneration of *Avicennia germinans* within the first 2 years after construction.

![Figure 4. Brushwood dam at Walton Hall Region No.2](image)

Mangrove protection and monitoring activities completed during the year resulted in enhanced monitoring capacity with the procurement of one DJI Phantom 4 Advance UAV and the installation of permanent graduated monitoring gauges in Region 2 and 4. An analysis of available updated imagery
on restored sites indicates that approximately 500 hectares of mangroves have been restored as at the end of 2018.

Community involvement continued to play a critical role in the success of restoration activities. During the year the Department worked to members of the volunteer groups (Village Mangrove Action Committees) to implement a series of community awareness and activities and continued to engage NDCs on mangrove conservation and management issues. The public awareness and education programme resulted in 538 visitors to the mangrove Heritage Trail Tour, 640 students reached through school presentations, 121 youths engaged through Easter and summer camps and completed of Mangrove Photo and Quiz competitions as part of NAREI’s celebration of International Mangrove Day 2018.

9 Efficiency and Effectiveness of Restoration Activities

Ecological restoration aims to recreate, initiate, or accelerate the recovery of an ecosystem that has been disturbed. Restoration activities may be designed to replicate a pre-disturbance ecosystem or to create a new ecosystem where it had not previously occurred. A limitation in the assessment of efficiency ecological restoration was the lack of information to determine of the level of faunistic recruitment compared to a natural equivalent mangrove system as well as the vegetation development and floristic succession over time which would have aided a more complete picture of ecological restoration.

The restorative interventions employed at various sites included:

1. the planting of *avicennia* seedlings and *spartina* grass at individual sites;
2. planting of *avicennia* seedlings in combination with *spartina* grass;
3. planting of *spartina* grass in combination with the construction of a geotextile groyne;
4. the construction of brushwood dams alone.

9.1 Ecological Restoration (Flora)

To determine the success of some of the restoration sites, observations were made of the establishment of the planted mangrove stands as well as the increase in natural regeneration associated with both
planting interventions (Avicennia seedlings and Spartina grass) and construction interventions (geotextile groynes and brushwood dams. The ecological restoration parameters assessed in the area of flora was the increase in mangrove area.

There was a significant amount of mangrove restoration success in three of the four Regions (#2, #4, and #5). Successful sites were determined by the establishment of planted mangroves as well as recruited natural mangrove vegetation in length and width on the coastline as a result of restoration interventions. At all the successful sites the interventions resulted in increases in mangrove vegetation with lengths ranging from 100-5000m and widths from 60-600m (Table 3).

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
</table>

![Figure 5. Devonshire Castle, Essequibo Coast, Region #2, Geotextile tube groynes (NAREI, Dec 2018)](Image)

In Region #2 the intervention was successful at Devonshire Castle with combination of the Geotextile tube Groyne and Spartina grass planting in 2014. This manifested in extensive natural regeneration of mangrove and Spartina grass seaward as a result of sediment buildup following construction of Geotextile tube groynes (Table 3.)

The seedling/Spartina grass planting intervention at Lima in 2013 and 2015 has caused the natural mangrove stands to grow in the neighboring villages to date. This is as a result of the accretion together with the natural seed fall providing a source of seeds for the site and the adjacent coastline (Table 3).
The planted *Spartina* grass in 2015 at La Belle Alliance has caused a mangrove stand at Richmond to extend both north and south filling the gaps between the two sites with mangrove (Table 3).

The Bush Lot Brushwood Dam constructed in 2013 resulted in the regeneration of forest within brushwood dam and further inland to Bushlot with a mixture of coastal grass such as *Spartina*, Antelope grass and *Cyperus articulatus* (Table 3).

At the Better Hope site in Region #4, East Coast Demerara, ten thousand nine hundred and eighty-seven (10,987) *Avicennia germinans* seedlings were grown in six community nurseries, and planted
along 335m of coastline in 2016. This restoration site was a success in that there was high survival of planted seedlings and a significant natural regeneration of neighboring sites east, with significant growth of *Spartina* grass north toward Atlantic. In addition, there was also a great increase in length and width of the natural stand at the site and in the neighboring coastline (Table 3.)

In Region#5 seedling planting completed at Village #6 and #7 in 2011/2012 has resulted significant regeneration to other village coastlines east and west of the planted site and north towards the Atlantic.

### 9.2 Ecological Restoration (Fauna)

To determine the level of ecological restoration of the mangrove restoration sites, observations were made of the increase in level biodiversity, specifically the colonization or recolonization of the area by avifauna and aquatic life (fishes) in and around the mangrove areas. Mangroves are home to an incredible array of species; mangroves are biodiversity hotspots. They provide nesting and breeding habitat for fish and shellfish, migratory birds, and sea turtles. An estimated 80% of the global fish catch relies on mangrove forests either directly or indirectly (Ecoviva, 2017).
Bird surveys conducted in mangrove restoration sites at Golden Grove-Belfield and Wellington Park show a rich assemblage that varies between sites. The diversity and bird counts are greater within dense mature mangrove stands, with a third of species being migratory (Da Silva 2015). It was found that many species used mudflats and mangrove habitat to forage. In addition, these areas also provided the nesting and breeding ground for many local and migratory species.

Faunal ecological improvement in Regions #4 and #5 is following an upward trajectory with the establishment of specially reserved mangrove areas eg. Cove and John and Wellington Park restoration sites. The total number of birds observed over the period of study was 1184. Thirty-seven (37) species of birds were recorded from seven (7) orders, fourteen (14) families and thirty-seven (37) genera. The greatest representation of species was from the Order Passeriformes, which had 37.80% of all species recorded followed by Pelicaniformes with 21.60% of all species recorded. The Caprimulgiformes contained the least recorded number of species with 2.80%.

The family with the greatest number of species was the Ardeidae with seven (7) species, followed by Tyrannidae and Accipitridae with five (5) species each. Three families had three (3) species each, three families had two (2) species each and five families had one (1) species each. The most abundant species recorded were the Rufous Crab-hawk (Buteogallus aequinoctialis), Great egret (Ardea alba), greater kiskadee (Pitangus sulphuratus), Scarlet Ibis (Eudocimus ruber) and the washer woman or pied water tyrant (Fluvicola pica). Twenty-four (24) of the thirty-seven (37) species of species were observed during all of the 28 Phillip Da Silva site visits, seven (7) species were observed on four of the six site visits, three (3) species were observed on three of the site visits and three (3) were observed on two of the six site visits.

The percentage relative abundance of the species was recorded based on categories of abundance after Khan (2005) and Braun, Finch, Robbins and Schmidt (2000) and are shown in Figure 1. Figure 1: Relative abundance of observed species. The greatest proportion of abundance was recorded for the Status Uncertain category with (35.10%) followed by the Fairly Common category with 32.50%, Abundant (13.50%), Uncommon (10.80%).

The abundance category Common had the least percentage of species with 8.10% of the species recorded. Four families, Ardeidae (24.8%), Accipitridae (17.7%), Tyrannidae (17.5%) and
Threskiornithidae (10.8%) accounted for 70.8% of the total number of birds observed. The next highest families were Scolopacidae (5.9%), Icteridae (5.7%) and Cuculidae (5.4%) which together accounted for 17% of the total birds observed. The remaining 12.2% were accounted for by the remaining seven (7) families: Alcedinidae, Emberizidae, Jacanidae, Nyctibidae, Parulidae, Traupidae and Troglodytidae.

This has further served to recognize the value of mangroves in preserving biodiversity. Given the results and observations obtained in the DaSilva (2015) study, it may be concluded that mangrove restoration areas are supporting local and migrant avifauna populations. Also, the ecological conditions appear to be improved and good for supporting a fair diversity of avifauna at the restoration sites as well as adjacent coastal areas.

![Figure 8. Bird diversity in mangrove restoration area East Coast Demerara, Region No. 4. (GMRP, 2010)](image-url)

Another study conducted by Ram (2018) in the mangrove restoration area suggests that restoring mangroves significantly increased fish diversity and abundance. Different mangrove habitat types (natural, restored, degraded) along Guyana’s coast were surveyed to investigate fish species diversity, community structures and ecosystem degradation impacts in order to protect and to improve the mangrove fish resources. Per habitat type, nine random plots of 1ha were established at each site for habitat evaluation, followed by sampling during both wet and dry season, using cast nets, gills and hand nets of different mesh sizes. A total of 24 species from 14 families were recorded, with the sea catfishes, Ariidae, (6 species) being the most family. The mean Simpson Diversity Index showed that the natural
habitats had the greatest fish diversity in both the dry and wet season followed by the degraded and restored mangrove habitats respectively. Significantly higher fish abundance, biomass and mean length were observed in natural and restored mangrove habitats in comparison to the degraded habitats. These results indicate that mangrove restoration significantly increased fish diversity and abundance. It also demonstrates the need for an integrated approach to mangrove resource management/conservation, including intensive mangrove restoration, and habitat protection for ecosystem recovery of degraded mangrove ecosystems.

9.3 Enhanced Carbon Stocks

Mangrove forests have great potential for maintaining and sequestering carbon stocks (Beers et al. 2019). Dead leaves, branches and roots containing carbon are buried in the soil, which is frequently, if not always covered by coastal waters. This oxygen-poor environment causes a slow breakdown of plant material, resulting in significant carbon storage. The fact that mangroves can sequester carbon at a rate two to four times greater than mature tropical forests and store three to five times more carbon per equivalent area than tropical forests" like the Amazon rainforest (Ecoviva, 2017), this means that conserving and restoring mangroves positively contributes to fighting climate change.

The figures below as set out by Beer et al (2019) and Marchand (2017) in studies in Suriname and French Guiana respectively indicate that the restoration of mangroves in conditions similar to Guyana can also lead to improvement in soil carbon. These estimates can be used to extrapolate the current increase in soil storage capacity by the restored mangrove area of 526ha NAREI, 2018).

<table>
<thead>
<tr>
<th>Mangrove stage</th>
<th>Age (yr)</th>
<th>Pedogenic layer thickness (cm)</th>
<th>C stock in pedogenic layer (Mg C ha$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pioneer</td>
<td>3 ± 1</td>
<td>6 ± 2</td>
<td>4.8 ± 1.3</td>
</tr>
<tr>
<td>Young</td>
<td>6 ± 2</td>
<td>15 ± 2</td>
<td>12.5 ± 2.3</td>
</tr>
<tr>
<td>Young mature</td>
<td>9 ± 1</td>
<td>25 ± 2</td>
<td>20.4 ± 8.4</td>
</tr>
<tr>
<td>Mixed mature</td>
<td>40 ± 7</td>
<td>40 ± 2</td>
<td>68.6 ± 31.3</td>
</tr>
</tbody>
</table>
Marchand (2017) also examined the soils under mangrove stands of differing ages in French Guiana and determined that the depth of mangrove-influenced soil (the pedogenetic layer) increased with stand age and that the oldest senescent stands had mangrove-influenced soil that was nearly 50 cm deep (Table 1). Below that, organic carbon content in the mud bank sediment was never greater than 1% and was comparable to that from shoreface sediment (Marchand 2017). Further, Marchand (2017) also quantified soil carbon accumulation rates based on stands of different ages (Table 2). Beer et al. (2019) suggest that in the absence of empirical data from Guyana that these results can be extrapolated to show the potential sequestration benefits that may be applicable to Guyana because of the similarity of the ecological zones. Based on the increase of 526 acres of mangroves up to 2018 there should be a positive contribution to the soil carbon gain.

### Table 2. Soil accretion and carbon burial rates for mangrove stands of varying ages in French Guiana.

<table>
<thead>
<tr>
<th>Mangrove stage</th>
<th>Accretion rate (cm yr(^{-1}))</th>
<th>Carbon burial rate (Mg C ha(^{-1}) yr(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pioneer</td>
<td>2</td>
<td>0.72</td>
</tr>
<tr>
<td>Young</td>
<td>2.5</td>
<td>2.54</td>
</tr>
<tr>
<td>Young mature</td>
<td>2.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Mixed mature</td>
<td>1.0</td>
<td>1.35</td>
</tr>
<tr>
<td>Senescent</td>
<td>0.9</td>
<td>4.86</td>
</tr>
</tbody>
</table>

Source: Table 1&2 from Marchand 2017
10 Assessment of Restoration Interventions and Recommendations

10.1 Planting Success

Based on the available data from NAREI Mangrove Management and Restoration Department there were four parameters examined to determine the effectiveness of the restoration activities, namely, establishment of planted *Avicennia* seedlings; natural regeneration at restoration sites; restoration of biodiversity (fish, birds) and restoration benefits to the community. The efficiency was measured based on the cost of the restoration interventions.

The establishment of restoration sites dated from 2011 to 2016 with most of the older sites being planted seedling sites. The sites had varying interventions, from engineering interventions (geotextile tube groynes and brushwood dams) and the planting of *Avicennia* seedlings and *Spartina* grass. In some instances, there was the planting of the two species singly or in combination. In other cases, there was construction of the engineering structures independently or in combination with planting of *Avicennia* seedlings.

The success of sites was determined when it was evident by the greater seedling establishment and recruitment at these sites compared to the sites that planting was the only restoration intervention. Similarly, the effectiveness of restoration activities was more pronounced when planting of *Avicennia* seedlings and *Spartina* grass was done in combination with construction of coastal structures such as geotextile groynes and brushwood dams. The sites that were lost were the ones that were planted with Avicennia seedling alone and probably suffered as a result of inadequate sedimentation due to the dynamic nature of the shoreline and the rapid changes which occurred.

The experience of the mangrove restoration activities of 2010-2018 have shown effective methods for establishing coastal structures nearshore, which reduces wave impact and allows sediment accumulation along the coastline. With these structures, mangroves are better able to naturally recolonize formerly forested areas and planted seedlings have thrived in the created conditions.

Coastal zone development and the construction of many artificial structures can be designed in such a way that they do not impair sediment transport along the shoreline. In some cases, when these precautions are coupled with a plan to ensure that the impact of sediment supply is kept minimal,
mangrove soils accumulation can be optimized. Regardless of the scale or location of the area to be restored, it is safe to say that unless adequate sediment flows are ensured, the success of any future mangrove restoration and conservation effort will likely be compromised.

Table 2: Planted sites without intervention

<table>
<thead>
<tr>
<th>Region</th>
<th>Site Name</th>
<th>Intervention</th>
<th>Date (Year)</th>
<th>Construction</th>
<th>Structure</th>
<th>Cost of Planting (GYD)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 2</td>
<td>Lima</td>
<td>Seedling planted</td>
<td>2013</td>
<td>none</td>
<td>N</td>
<td>$1,617,840</td>
<td>Intact</td>
</tr>
<tr>
<td>Region 4</td>
<td>Triumph/BV/LBI</td>
<td>Seedling planted</td>
<td>2010</td>
<td>none</td>
<td>N</td>
<td>$8,581,621</td>
<td>Lost</td>
</tr>
<tr>
<td>Region 4</td>
<td>Hope Beach</td>
<td>Seedling planted</td>
<td>2010</td>
<td>none</td>
<td>N</td>
<td>$8,581,621</td>
<td>Lost</td>
</tr>
<tr>
<td>Region 4</td>
<td>Chateau Margot/Success</td>
<td>Seedling planted</td>
<td>2011</td>
<td>none</td>
<td>N</td>
<td>$2,771,415</td>
<td>Intact</td>
</tr>
<tr>
<td>Region 4</td>
<td>Section C Enterprise</td>
<td>Seedling planted</td>
<td>2011</td>
<td>none</td>
<td>N</td>
<td>$2,039,580</td>
<td>Lost</td>
</tr>
<tr>
<td>Region 4</td>
<td>Victoria/Belfield</td>
<td>Seedling planted</td>
<td>2011</td>
<td>none</td>
<td>N</td>
<td>$3,676,995</td>
<td>Lost</td>
</tr>
<tr>
<td>Region 4</td>
<td>Greenfield</td>
<td>Seedling planted</td>
<td>2011</td>
<td>none</td>
<td>N</td>
<td>$2,452,275</td>
<td>Intact</td>
</tr>
<tr>
<td>Region 4</td>
<td>Le Ressouvenir/Felicity</td>
<td>Seedling planted</td>
<td>2012</td>
<td>none</td>
<td>N</td>
<td>$18,388,350</td>
<td>Intact</td>
</tr>
<tr>
<td>Region 4</td>
<td>Nooten Zuil</td>
<td>Seedling planted</td>
<td>2014</td>
<td>none</td>
<td>N</td>
<td>$800,875</td>
<td>Lost</td>
</tr>
<tr>
<td>Region 4</td>
<td>Better Hope</td>
<td>Seedling planted</td>
<td>2016</td>
<td>none</td>
<td>N</td>
<td>$1,118,600</td>
<td>Intact</td>
</tr>
<tr>
<td>Region 5</td>
<td>Village #6-8 – Site 1</td>
<td>Seedling planted</td>
<td>2011</td>
<td>N</td>
<td></td>
<td>$9,750,915</td>
<td>Intact</td>
</tr>
<tr>
<td>Region 6</td>
<td>Kilmarnock</td>
<td>Seedling planted</td>
<td>2013</td>
<td>none</td>
<td>N</td>
<td>$4,379,940</td>
<td>Lost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Cost of Planting</td>
<td>$64,160,027</td>
</tr>
</tbody>
</table>

Table 3: Intervention sites with planting
10.2 Comparison of Monitoring Costs for Sites

To date an estimate of 526 ha of mangroves have been restored (NAREI Mangrove Department, 2018). The total cost of restoration initiatives between 2010 and 2018 for mainly planting mangrove seedlings and Spartina grass, construction of engineering structures, and monitoring is GYD$$ 178,853,966 (Table 3). The total cost of naturally destroyed (coastal erosion processes and Sargassum invasion) sites is GYD$119,151,755 (Table 3.) and the cost for intact site is GYD$59,702,211 (Table 4.). These figures reflect a great lost in terms of finance over a period of nine years where only 7 out of 17 restoration sites survived (41% success rate). This also reflects poor efficiency.
Table 4: Cost of restoration interventions and monitoring naturally destroyed sites (NAREI, 2018)

<table>
<thead>
<tr>
<th>Region</th>
<th>Site Name</th>
<th>Intervention</th>
<th>Planting Date (Year)</th>
<th>Construction of Structures</th>
<th>Year of Construction</th>
<th>Cost of construction (GYD)</th>
<th>Cost of Planting (GYD)</th>
<th>Cost of Monitoring (GYD)</th>
<th>Year of Monitoring</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 4</td>
<td>Mon Repos</td>
<td>Seedling plantation</td>
<td>2010</td>
<td>65m rubble mound groyne</td>
<td>2013</td>
<td>$29,751,000</td>
<td>$8,581,621</td>
<td>Not available</td>
<td>Not available</td>
<td>$38,332,621</td>
</tr>
<tr>
<td>Region 4</td>
<td>Triumph/BV/L BI</td>
<td>Seedling plantation</td>
<td>2010</td>
<td>none</td>
<td>NA</td>
<td>$8,581,621</td>
<td>Not available</td>
<td>Not available</td>
<td>2014, 2017</td>
<td>$8,581,621</td>
</tr>
<tr>
<td>Region 4</td>
<td>Hope Beach</td>
<td>Seedling plantation</td>
<td>2010</td>
<td>none</td>
<td>NA</td>
<td>$8,581,621</td>
<td>$168,557</td>
<td>Not available</td>
<td>2014, 2017</td>
<td>$8,750,178</td>
</tr>
<tr>
<td>Region 4</td>
<td>Section C Enterprise</td>
<td>Seedling plantation</td>
<td>2011</td>
<td>none</td>
<td>NA</td>
<td>$2,039,580</td>
<td>Not available</td>
<td>Not available</td>
<td>$2,039,580</td>
<td>$2,039,580</td>
</tr>
<tr>
<td>Region 4</td>
<td>Buxton</td>
<td>Seedling plantation</td>
<td>2014</td>
<td>463m Bamboo brushwood dam</td>
<td>2013</td>
<td>$16,000,000</td>
<td>$797,330</td>
<td>$160,758</td>
<td>Not available</td>
<td>$16,958,088</td>
</tr>
<tr>
<td>Region 4</td>
<td>Nooten Zuil</td>
<td>Seedling plantation</td>
<td>2014</td>
<td>none</td>
<td>NA</td>
<td>$800,875</td>
<td>$81,588</td>
<td>2015</td>
<td>$882,463</td>
<td>$882,463</td>
</tr>
<tr>
<td>Region 4</td>
<td>Lusignan</td>
<td>Seedling plantation</td>
<td>2014</td>
<td>275m bamboo brushwood dam</td>
<td>2016</td>
<td>$12,232,184</td>
<td>$3197540</td>
<td>$564,844</td>
<td>2014, 2017</td>
<td>$15,994,568</td>
</tr>
<tr>
<td>Region 6</td>
<td>Wellington Park Site 1 &amp; 2</td>
<td>Seedling plantation</td>
<td>2011 &amp; 2012</td>
<td>Hydrological restoration: excavation of 200m channels</td>
<td>2014</td>
<td>$8,300,000</td>
<td>$9653850</td>
<td>$924,542</td>
<td>2014, 2015, 2017</td>
<td>$18,878,392</td>
</tr>
<tr>
<td>Region 6</td>
<td>Kilmarnock</td>
<td>Seedling plantation</td>
<td>2013</td>
<td>none</td>
<td>NA</td>
<td>$4379940</td>
<td>$326,498</td>
<td>2014</td>
<td>$4,379,490</td>
<td>$4,379,490</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$66,283,184</td>
<td>$50,290,973</td>
<td>$2,577,598</td>
<td>$119,151,755</td>
</tr>
</tbody>
</table>

These sites were lost.
### Table 5 Cost of restoration interventions and monitoring intact sites (NAREI, 2018)

<table>
<thead>
<tr>
<th>Region</th>
<th>Site Name</th>
<th>Intervention</th>
<th>Planting Date (Year)</th>
<th>Construction of Structures</th>
<th>Year of Construction</th>
<th>Cost of Construction (GYD)</th>
<th>Cost of Planting (GYD)</th>
<th>Cost of Monitoring (GYD)</th>
<th>Year of Monitoring</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 2</td>
<td>Lima</td>
<td>Seedling plantation</td>
<td>2013</td>
<td>none</td>
<td></td>
<td>$1,617,840</td>
<td>$1,838,366</td>
<td></td>
<td>2014, 2015</td>
<td>$3,456,206</td>
</tr>
<tr>
<td>Region 2</td>
<td>Walton Hall</td>
<td>Seedling plantation</td>
<td>2018</td>
<td>(100m and 300m of bamboo brushwood)</td>
<td>2015 and 2016</td>
<td>$3,135,033</td>
<td>$469,849</td>
<td></td>
<td>2014 &amp; 2018</td>
<td>$20,510,882</td>
</tr>
<tr>
<td>Region 4</td>
<td>Chateau Margot/Success</td>
<td>Seedling plantation</td>
<td>2011</td>
<td>none</td>
<td></td>
<td>$2,771,415</td>
<td></td>
<td></td>
<td></td>
<td>$2,771,415</td>
</tr>
<tr>
<td>Region 4</td>
<td>Greenfield</td>
<td>Seedling plantation</td>
<td>2011</td>
<td>none</td>
<td></td>
<td>$2,452,275</td>
<td>$431,997</td>
<td></td>
<td>2014-2018</td>
<td>$2,884,272</td>
</tr>
<tr>
<td>Region 4</td>
<td>Le Ressouvenir/Felicity</td>
<td>Seedling plantation</td>
<td>2012</td>
<td>none</td>
<td></td>
<td>$18,388,350</td>
<td></td>
<td></td>
<td></td>
<td>$18,388,350</td>
</tr>
<tr>
<td>Region 4</td>
<td>Better Hope</td>
<td>Seedling plantation</td>
<td>2016</td>
<td>none</td>
<td></td>
<td>$1,118,600</td>
<td>$530,314</td>
<td></td>
<td>2016-2018</td>
<td>$1,648,914</td>
</tr>
<tr>
<td>Region 5</td>
<td>Village #6-8 – Site 1</td>
<td>Seedling plantation</td>
<td>2011</td>
<td>none</td>
<td></td>
<td>$9,750,915</td>
<td>$294,257</td>
<td></td>
<td>2014, 2015</td>
<td>$10,045,172</td>
</tr>
</tbody>
</table>

These are intact sites.
The choice of Restoration intervention is critical to the successful scaling up of the of future restoration activities. It has been reported that mangrove forests around the world can regenerate naturally or successfully undergo secondary succession over periods of 15-30 years if: 1) the normal tidal hydrology is not disrupted and 2) the availability of waterborne seeds or seedlings (propagules) of mangroves from adjacent stands is not disrupted or blocked (Watson 1928, Lewis III, 1982, CintronMolero 1992).

The Guyana coastal dynamics are not fully understood as such, the following recommendations should be followed so as to aid sustainable mangrove restoration:

- Restoration planning should first look at the potential existence of stresses such as blocked tidal inundation, garbage dumping, fire, unregulated cutting of mangroves, grazing etc. that might prevent secondary succession from occurring.
- A plan to remove these stresses before attempting restoration (Hamilton and Snedaker 1985, Cintron-Molero 1992) should be developed. This is done by observation if natural seedling recruitment is occurring once the stress has been removed. Only if natural recovery is not occurring should the third step of considering assisting natural recovery through planting be considered.

Unfortunately, many mangrove restoration projects move immediately into planting of mangroves without determining why natural recovery has not occurred. There may even be a large capital investment in growing mangrove seedlings in a nursery and out planting to mangrove sites before stress factors are assessed (Lewis III, 2001). This often results in major failures of planting efforts. For example, Sanyal (1998) has recently reported that between 1989 and 1995 9,050 ha of mangroves were planted in West Bengal, India with only a 1.52% success rate. A similar large-scale project in the Philippines is reported to have attempted the restoration of 22,723 ha of mangroves primarily by direct planting on mudflats and in existing seagrass meadows (Silliman University 1996, Lewis III, 1999, de Leon and White 1999). Plant survival varied from 0 to 66 % in a subsample of planted sites covering 491 ha, averaging 19% in Bohol and 17% in Cebu.

On the other hand, careful data collection by Duke (1996) at an oil spill site in Panama showed that “…densities of natural recruits far exceeded both expected and observed densities of planted seedlings in both sheltered and exposed sites” (emphasis added). Soemodihardjo et al. (1996) report that only
10% of a logged area in Tembilahan, Indonesia (715 ha) needed replanting because “The rest of the logged over

According to Lewis III (2001) another common problem is the failure to understand the natural processes of secondary succession, and the value of utilizing nurse species like *Spartina* in situations where wave energy may be a problem. Further, one of the most important factors in designing a successful mangrove restoration project is determining the normal hydrology (depth, duration and frequency of tidal flooding) of the existing natural mangrove plant communities in the area in which you wish to do restoration. The normal surrogate for costly tidal data gathering or modeling is the use of a tidal benchmark and survey of existing healthy mangroves. When this is done, it can be used as model for your project.

The earlier site selection process was done visually and there was much need for a better understanding of the role of coastal processes in mangrove restoration and investigation on the movement of mud banks along the coastline in order to improve planning and allocate restoration resources. This situation combined with coastal erosion and the dynamic nature of Guyana’s coastline created challenges for the selection suitable environment for mangrove colonization. However, with the acquisition of GIS equipment and access to aerial photography/imagery the selection process is more robust and precise.

Finally, based on the previous restoration initiatives and significant financial loss due to site failures, planting in combination with the construction of geotextile tube groynes and brushwood dams should be the most preferred restoration initiative recommended. However, further investigation should be done to establish which areas may be ideal for this action (see recommendations under Research heading).

10.3 Status of Administrative Capacity and Recommendation

The GMRP was established in 2010 and was closed since 2013. After that the Mangrove Restoration and Management Department has been established in 2014 under the National Agricultural Research and Extension Institute following the completion of the project phase under the Guyana Mangrove Restoration Project. All technical and field staff previously engaged under GMRP, were contracted under NAREI to form the new department.
The Department’s Programme of Work to date is developed through the guidance of the National Mangrove Action Plan; recommendations and lessons learned during the implementation of GMRP; and recommendations and results contained in the final report and other technical reports submitted by Landell Mills Limited.

Meetings are held on a monthly basis and are run according to an agenda with minutes prepared for each meeting and a monthly report prepared.

Administrative and financial systems have been established which meet the requirements of the Government of Guyana in keeping with the NAREI regulations. A monthly reporting system is established where progress reports are submitted to the NAREI Board meetings.

The Department has guidelines for mangrove monitoring through two documents: The Mangrove Monitoring Protocols for Guyana (2011) and Mangrove Restoration Monitoring Plan (2012). These two documents provide a technical basis for monitoring of mangroves. The first document provides the theoretical basis for monitoring including details of a proposed monitoring strategy and recommended methodologies and the second describes strategies for Data Collection, Data Analysis and a Monitoring reporting structure and formats. Storing data was done using the integrated monitoring system utilizing GIS technology and human resources.

The Department now has a staff complement fifteen (15) inclusive eight Rangers, a GIS officer, three (3) Monitoring Officers, a Community Development Officer, a GIS Officer and a Department Coordinator who have mangrove–related field experience ranging from 2 to 9 years. However, further training and upgrading of staff skill will be required for future restoration initiatives.

Lewis III (2000) has pointed out that the failure to adequately train and retrain coastal managers in the basics of successful coastal habitat restoration all too often leads to projects “destined to fail, or only partially achieve their stated goals.

This lack of training also leads to a routine failure to look for the most cost-effective means of achieving restoration goals. Cost effective here means the least cost alternative that achieves both successful
restorations, and those target ecological and economically important functions identified as restoration goals.

10.2 Assessment of Past Research with Recommendation

The research conducted over the 2010-2018 period provided project staff and stakeholders with pertinent feedback and a better understanding the potential for low cost engineering infrastructure (brushwood dams, Geotextile Tube groynes) to assist in the recovery of mangrove at field sites and understanding of the potential of *Spartina brasiliensis* as alternative to traditional mangrove restoration techniques using mangrove seedlings as well as restoration by seedling planting.

However, as a result of the failed sites, further investigations into the reason for successes and failures should be the primary focus of the research agenda. This is critical to embarking on future restoration activities. Foremost is that studies should be done on the stresses to mangrove establishment and regeneration. Further, work on understanding the autecology *Avicennia* species of the mangrove at the site, in the patterns of reproduction, propagule distribution and successful seedling establishment. Also understanding the normal hydrologic patterns that control the distribution and successful establishment and growth of targeted mangrove species as well as assessing the modifications of the previous mangrove environment that occurred that currently prevents natural secondary succession. Finally designing a restoration program to initially restore the appropriate hydrology and utilize natural volunteer mangrove propagule recruitment for plant establishment should be considered.

Lewis III and Marshall (1997) indicate that failure in most restoration projects can be traced to no fully understanding the above-mentioned areas and planting at proposed sites. They refer to this approach as “gardening,” where simply planting mangroves is seen as all that is needed.

10.3 Status of Community Involvement with Recommendation

Key to any mangrove restoration project is the aspect of community involvement. Community involvement over the past project period has resulted in successful support, participation and commitment of residents who live in close proximity to the project site in activities geared towards promoting community ownership and fostering a shared national responsibility for mangrove restoration, protection and management.
Village Mangrove Action Committees (VMACs) are established in all four Regions where project activities took place. This approach positively impacted awareness about the importance of mangroves and the Mangrove project. A feedback from the community in a (Social survey, 2019) indicated that the community was very much involved in the restoration process and many persons have felt that the planting was necessary, and the project was important (Appendix 2).

Public awareness is integral part of the Mangrove Restoration Programme. The establishment of the Mangrove Visitor Center and complimenting Mangrove Heritage Trail Tour facilitated visitors inclusive of students, the general public and tourists. Educational institutions at all levels (primary, secondary and tertiary) participated in mangrove education tours. In addition, public lectures and school presentations were conducted in all four targeted Regions (#2, #4, #5 and #6) as well as Region #3 where natural mangrove stands existed. Many of the coastal dwellers living adjacent to the mangrove restoration sites indicated that their awareness of the project and the importance of the mangroves (Appendix 2).

It is apparent that the coastal dwellers were well informed about the restoration activities and many persons were actively involved in the process. This is gleaned from a social survey of 274 persons conducted between August 9 – 16, 2019 in Administrative Regions #2, #4, #5 and #. Below is a synopsis of the responses:

There were 67 respondents in the age rage 20-30; 49 between 30-40 and 156 above the age of 40.

- Of the respondents, 81% acknowledged that they were aware of the GMRP;
- 65% said they understood the goal of the project;
- 33% indicated that they got knowledge of the project directly from project staff, 13% were informed of the project via the media, 32% indicated that they were informed about the project through other sources and 22% declined to respond.
- 77% agreed that the planting of seedlings was necessary, while 18% disagreed.
- 60% of the respondents indicated that their community was fully involved, 16% stated that their community was partially involved, 14% stated that their community was not involved at all and 10% declined to respond.
• 85% of the respondents believed that overall the community benefited from the project while 8% did not believe that there was any benefit to the community. 7% of the respondents choose not to respond.

It is important to note that to date most communities adjacent to restoration sites felt that they have benefitted and were much involved in project activities. This is a positive for future restoration initiatives, as community participation is key to the success of most mangrove projects worldwide (Lewis III, 2000). The Mangrove Department should continue with its outreach and education Programme to primary secondary and tertiary institutions, religious institutions, the village councils, Existing VMACS should be maintained and new ones formed in new restoration areas. In addition, the Visitor Centre and Heritage Tour should be ongoing to target visitors and other interested persons. Communities are also integral to the restoration activities and capacity building endeavours.

10.4 Legislation Supporting Mangrove Management with Recommendation

A legal basis for mangrove ecosystem management in Guyana was established on 29 January 2010 through amendment of Regulation 17 of the Principal Regulations of the State Forest Act by the substitution of the following:

- Protected Trees17. (1) “No bullet-wood tree or red, black or white mangrove trees shall be felled without first obtaining the permission in writing of an authorized forest officer not below the rank of an Assistant Commissioner of Forests”. National and Regional stakeholders were consulted on legislative changes for mangrove protection/management and a Mangrove management plan was reviewed and adopted and submitted to Cabinet for approval. It is this plan that formed the basis for project activities 2010-2018 and onwards.

There has been a reduction in the illegal cutting of mangrove (NAREI, 2018). This was observed to protect some restoration sites. Ecological restoration in a sustainable way depends on protection of the restored mangrove. One of the most effective ways this can be done is through legislation. This enforcement should be part of the future of mangrove restoration activities. 10.5 Status of Capacity Building with Recommendation
At the end of 2014, seven VMAC groups with an active membership of thirty community volunteers participated in mangrove awareness activities and participation in training in the identification of avifaunal biodiversity in mangroves and conducting tours.

The Mangrove Restoration Department in 2015 focused on training in mangrove ecology and coordination with sister agencies involved in coastal zone management. Fourteen persons (rangers, VMAC members and tour guides) participated in the Conservation Training curriculum “Mangrove Biodiversity and Ecosystem”. Further, training was conducted to improve their presentation and community skills through participation in a training program funded by Caribbean Aqua-Terrestrial Solutions and implemented by Iwokrama. Training also included birding and provided an opportunity for community tour guides associated with the newly established Mahaica River Tour to interact and learn from the Mangrove Heritage Trail Tour guides. In preparation for the completion of a study “Measuring Growth Rates and Carbon Sequestration Potential in Planted and Successional Tropical Plants Using Unmanned Aerial Vehicles”, the Department’s Monitoring/GIS Officer benefitted from a training session on the use and operation of UAVs. The training focused on UAV operation, assembly and maintenance.

During the year (2015) the Department provided input into the preparation of a coastal engineering manual developed by the Ministry of Public Infrastructure, Sea and River Defence Division. The Manual provides appropriate practical guidance for application of methods and techniques about the design
and implementation of coastal engineering projects. Chapter 6 of the Manual provides information on
the importance of natural flood protection systems along Guyana's coast and riverbanks and their
relevance to the shore zone management process. Substantial focus is placed on mangrove forest. The
Department Engineer and Monitoring Officers participated in a training program on the use of the
Manual in December 2015. The Project Coordinator and Engineer were trained in Risk Identification
and Communication Workshop facilitated by IICA in Paramaribo in November 2015.

The Department 2016 program, aimed to increase the capacity of staff members to better manage the
coastal mangrove ecosystems, focused on training in mangrove ecology and coordination with sister
agencies involved in coastal zone management. The Project Coordinator attended at the Caribbean
Urban Forum in April 2016 in Parimario Suriname and the Department’s Engineer attended a
Caribbean Coastal Conference in September 2016 in Barbados. Both forums presented an opportunity
for the department to present its work to regional colleagues and learn from similar projects being
executed. Training was provided for two (2) rangers in Mangrove Ecology, Restoration and
Management during March 2016 as part of a Workshop Grant under the WWF Education for Nature.

During 2017, the Department focused on in-house capacity building and training for community rangers,
development of project proposals for funding and participation in Regional workshops. Staffing
compliment within the Department was completed with the recruitment of an Admin Assistant in
February 2017. The Department Coordinator participated in a workshop in Suriname in June 2017 to
provide input for development of the project document. The successes, challenges and lessons of
Guyana’s mangrove restoration program were presented at a Regional Mangrove Conference titled
“Protection of Coastal Ecosystems along the Guiana Shield Conference” held in Suriname in August
2017. The Conference, hosted by the US Embassy Suriname and Suriname’s Anton de Kom University,
provided and opportunity for increased networking and information sharing among researchers focusing
on climate variation and sea level rise in the Guiana Shield region. Staff participation provided an
opportunity to compare current management practices being conducted in regional countries, as well
as modeling trends and outlooks.

In 2018, training was provided to eight rangers on monitoring of avian diversity in mangroves. The
training was conducted by a Monitoring Officer and the Community Development Officer. This training
provided rangers with skills to identify the various species of birds found in the mangrove forest. This
training is the first in a series of trainings planned in order to integrate biodiversity monitoring into the
mangrove monitoring plan. In 2018, The Department’s Coordinator, was trained in Sustainable Environmental Management following participation in the University of California, Berkely, Environmental Leadership Program during July 2018.

10.6 The Forecast for Future Restoration with Recommendation

Over the past 9 years of mangrove restoration in Guyana, there has been mixed results. This has prompted the need for an assessment of the restoration interventions employed to make recommendations for the continuance of future restoration activities.

Based on the results of the intact restoration sites (Table 1.), 526 ha of mangrove stand with varying lengths ranging from 1300– 5000m and widths variations between 60-600m have been restored over the nine-year period. It would therefore be safe to forecast that with the improvement of the technical, administrative and legislative capacity of the NAREI Mangrove Restoration and Management Department to date coupled with the endowment of public and institutional knowledge base of mangrove restoration in Guyana, the future restoration activities can achieve a greenbelt width between 500–1000m of self-sustaining mangrove forest.

The forecasted success is however contingent upon a number of deliverables. Firstly, the participation of the local community in mangrove restoration and protection initiatives; the continued partnership with NAREI and the local NDCs to implement community projects to enhance community participation and awareness; the maintenance and support of the complement of rangers to build stronger ties with their communities and NDC Officials; continuous training rangers in communication skills so as to bridge the gap with the communities so as to help persons living in the communities to understand more about mangrove restoration and help to maintain and form VMACs.

Finally, there is need for continued inter-agency collaboration to address the problem of land tenure, enforcement and other social issues. Also, given that coastal dynamics and erosion along the coast are major challenges to mangrove restoration, there is need to understand coastal hydrological processes, mud bank movement as well as conditions suited for Avicennia growth and natural regeneration.
11. Conclusion

Finally, I recommend that the following steps be taken progressing into future restoration initiatives as suggested by Lewis III (2001):

- Understand the autecology (individual species ecology) of the *Avicennia* species at the site, in particular the patterns of reproduction, propagule distribution and successful seedling establishment
- Understand the normal hydrologic patterns that control the distribution and successful establishment and growth of targeted mangrove species
- Assess the modifications of the previous mangrove environment that occurred that currently prevents natural secondary succession
- Design the restoration program to initially restore the appropriate hydrology and sedimentation and utilize natural volunteer mangrove propagule recruitment for plant establishment for example, use of Geotextile groynes and Brushwood dams.
- Only utilize actual planting of propagules, collected seedlings or cultivated seedlings after determining through the previous steps that natural recruitment will not provide the quantity of successfully established seedlings, rate of stabilization, or rate of growth of saplings established as goals for the restoration project.

Directly planting proposed sites without following the above steps will only result in great financial and other resource losses as was experienced earlier at the lost restoration sites.
12. References


3. **Bovell O. 2010.** Situational Analysis of Coastal Mangrove Sites (Shell Beach to Mahaica, Guyana Mangrove Restoration Project.

4. **Bovell O. 2010,** Guyana Mangrove Nursery Manual, Guyana Mangrove Restoration Project

5. **Bovell, O., 2010,** Code of Practice for Mangrove Harvesting, Guyana Mangrove Restoration Project


8. **Da Silva, P. 2015.** Mutual benefits from mangrove reserves in Guyana: coastal protection and avifaunal habitats.


24. Murray, O. 2012, An Examination of Mangrove Conservation Awareness Amongst Secondary School Students in Region 4, School of Earth and Environmental Sciences, University of Guyana


27. NAREI, 2016, Mangrove Management and Restoration Department, Annual Report.


29. NAREI, 2018, Mangrove Management and Restoration Department, Annual Report.


Thomas-Holder, B., 2013. An Exploratory study of residents readiness to advance mangrove restoration in Buxton/Friendship

11 APPENDICES

APPENDIX 1: Results of social surveys

Social Survey Results

Awareness of the Project

1- Yes  
2- No  
0- No response

1 81%  
2 17%  
0 2%

1- Yes  
2- No  
0- No response
Did you Understand the Project Goal?

1- Clearly
2- Not so Clearly
3- Not at all
0 - No Response

How did you learn about the Project?

1- Project Staff
2- Media
3- Other
0 - No response
Was Planting of Seedlings is Necessary?
1 - Agreed
2 - Disagreed
0 - No response

Community Involvement
1 - Fully involved
2 - Partially involved
3 - Not at all
0 - No response
Women's Perception of Community Benefits

1 - Yes
2 - No
0 - No Response

0% 0
16% 2
84% 1
## APPENDIX 2

### APPENDIX 2: Restoration Sites showing significant growth and extension of forest (NAREI, 2018)

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Restoration intervention Type/Date (XXXX)</th>
<th>Extent as at 31/12/18 (Length x Width)</th>
<th>Area restored (Ha)</th>
<th>Date source: Imagery</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hampton Court to Devonshire Castle</td>
<td>Geotextile tube Groyne/2014 Spartina Grass</td>
<td>2300m/150-581m</td>
<td>70.4ha</td>
<td>Google Earth 2/12/2018</td>
<td>Extensive Natural regeneration of mangrove and <em>Spartina</em> grass seaward as a result of sediment buildup following construction of Geotextile tube groyne</td>
</tr>
<tr>
<td>Lima/ Coffee Grove/ Dainelstown/Sprata to Windsor Castle</td>
<td>Seedling and <em>Spartina</em> Planting/2013 and 2015</td>
<td>2450m/171-480m</td>
<td>75.8ha</td>
<td>Google Earth 2/12/2018</td>
<td>As a result of successful seedling planting at Lima the forest has extended to the neighbouring villages as the area accreted and the Lima forest provided a source of seeds.</td>
</tr>
<tr>
<td>Henrietta/ Richmond/LaBella Alliance to Lima</td>
<td><em>Spartina</em> grass 2015</td>
<td>2034m/60-345m</td>
<td>23.9ha</td>
<td>Google Earth 2/12/2018</td>
<td>As a result of an existing forest at Richmond and planted <em>Spartina</em> grass in 2015 at La Belle Alliance the forest extend both north and south filling the gap with natural regeneration of mangrove.</td>
</tr>
<tr>
<td>Bush Lot/ Cotton Field to Anna Regina</td>
<td>Brushwood Dam/2013</td>
<td>1312m/140-355m</td>
<td>31.9 ha</td>
<td>Google Earth 2/12/2018</td>
<td>Regeneration of forest within brushwood dam and further inland to Bushlot with a mixture of coastal grass such as Spatina, Antelope grass and <em>Cyperus articulatus</em> (Bsi Bsi)</td>
</tr>
<tr>
<td>Location</td>
<td>Action</td>
<td>Year 1</td>
<td>Year 2</td>
<td>Area</td>
<td>Google Earth Date</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>Chateau Margot/Success Le Ressouvenir/Felicity to Montrose</td>
<td>Seedling planting</td>
<td>2011</td>
<td>2012</td>
<td>1624m/107-285m</td>
<td>32.6ha</td>
</tr>
<tr>
<td>Montrose/Vryhid’s Lust/ Better Hope/ Sparendaam to Ogle</td>
<td>Seedling planting</td>
<td>2016</td>
<td></td>
<td>2056m/63-584m</td>
<td>85.6ha</td>
</tr>
<tr>
<td>Region #5, West Coast Berbice</td>
<td>Seedling planting</td>
<td>2011/2012</td>
<td></td>
<td>5,053m/200-600</td>
<td>206 ha</td>
</tr>
</tbody>
</table>

**Total area restored**: 526.2Ha
APPENDIX 3: QUESTIONNAIRE

SOCIAL DIMENSION: LOCALS’ PERCEPTION OF THE MANGROVE RESTORATION PROCESS AND THE POTENTIAL FOR SUSTAINABLE USE OF RESTORED MANGROVES?

Dear Sir/Madam

My name is …………………………..I am conducting this survey for Conservation International (Guyana) to find out how successful the planting of the mangroves was over the past 8 years under the National Mangrove Restoration Project and the NAREI Mangrove Restoration and Management Department. I would like to ask you a few questions of what you observed during the process of establishing the project.

I will only take 10 minutes of your time.

Thank you.

1. Age Range (years)
   - 20-30
   - 30-40
   - 40 and above

2. Sex
   - Male
   - Female

3. Occupation ……………………………..

4. How long have you been residing here?
   - 10-15 years
   - 15-20 years
   - 20 years and above

5. Do you know what is mangrove/Courida? Yes  No

6. Do you know of the National Mangrove Restoration Project? Yes  No

7. If yes, how did you get to know about the project? Project Staff  Media  Other
   Please Explain:
8. a) Do you think that you understood the goal of the Project?
   Clearly □ Not so clearly □ Not at all □

   b) What do you think may have caused this type of clarity?
   ………………………………………………………………………………………………………………………………………………………
   ………………………………………………………………………………………………………………………………………………………
   ………………………………………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………………………………

9. Were there clear measurable goals defined for the project? Yes □ No □

10. Are there more mangroves growing in your area than before?
    Much more □ Little More □ None at all □

11. Are there more birds and other animals in your area than before? (such as Bees, Mosquitoes, Shrimps, Fishes)
    Much more □ A little more □ None at all □

12. What is the basis for your evaluation in questions 10 and 11?
    Monitoring □ Spot checks □ Gut Feeling □ Other □

13. a) Do you agree that planting seedlings was necessary?
    Strongly Agree □ Agree □ Disagree □

   b) Why did you agree OR Disagree?
   ………………………………………………………………………………………………………………………………………………………
   ………………………………………………………………………………………………………………………………………………………
   ………………………………………………………………………………………………………………………………………………………
   ……………………………………………………………………………………………………………………………………………………

   c) If you agreed, do you think enough seedlings were planted in your community?
   ………………………………………………………………………………………………………………………………………………………
   ………………………………………………………………………………………………………………………………………………………
   ………………………………………………………………………………………………………………………………………………………
d) If you agreed, do you think that the planting benefited your community? If so, in what way?

14. a) How do you think your community was involved in this process?
   - Fully ☐
   - Partially ☐
   - Not at all ☐

   b) If not fully, how do you think your community should have been involved? And Why?

15. a) Do you think your community has benefited from the restoration project? Yes ☐
   - No ☐

   b) If yes, how? If no, why not?

16. How do people in the community use the restored mangroves?

17. Do you think with the current use, the mangroves will remain in the area for the next:
   - <5 years ☐
   - 5 years ☐
   - 10 years ☐
   - 15 years ☐
   - >15 years ☐

18. Why?