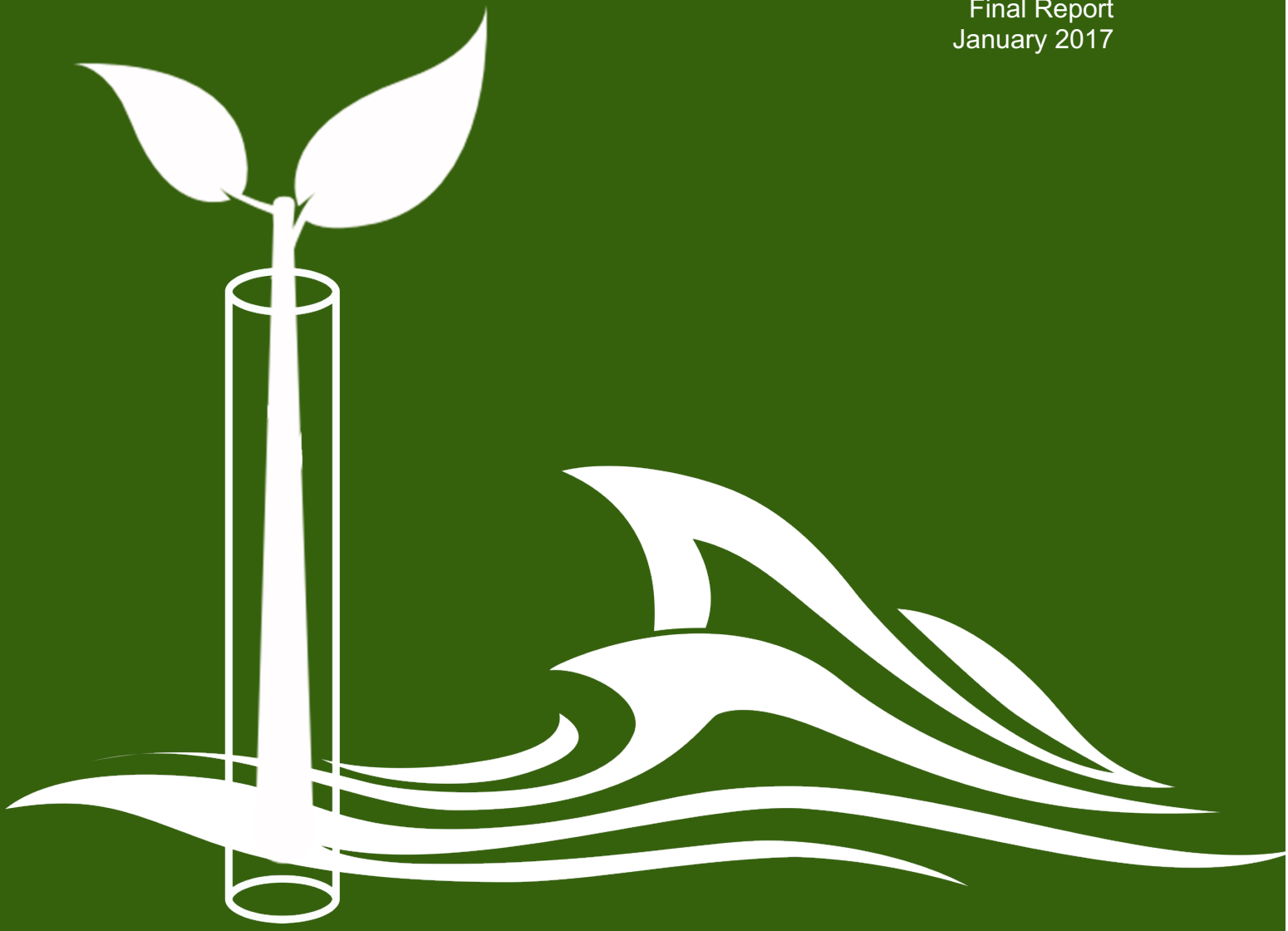
Mangrove Reforestation Plan
Fragments of Hope Ltd.

Final Report
January 2017



Acknowledgements

Fragments of Hope Belize is a community based organization located on the Placencia Peninsula. Our focus is the restoration of coral reef habitats and advocacy for the sustainable management of associated habitats including mangroves. The mangrove reforestation activities are being funded by both the COMPACT program and the C-ARK Project.

COMPACT is a global initiative led by Global Environment Facility's Small Grants Programme and the United Nations Foundation to demonstrate the importance of community based action in the preservation and protection of World Heritage Sites. COMPACT provides technical and financial support to demonstrate how community-based initiatives can significantly increase the effectiveness of biodiversity conservation within the Belize Barrier Reef Reserve System.

The C-ARK Project is implemented by CARIBSAVE with funding provided by the Multilateral Investment Fund of the Inter-American Development Bank to increase resilience of coastal communities against climate change impacts. CARIBSAVE (INTASAVE Caribbean) is a Caribbean regional not-for-profit organization that innovates, connects and implements practical solutions for sustainable development and climate change.

Fragments of Hope works closely with regulatory agencies and protected area managers to ensure that reforestation efforts maintain synergy with national priorities for conservation and biodiversity management. Partner agencies include the Belize Fisheries Department, Belize Forest Department, Department of Environment and the Southern Environmental Association.

C-ARK Climate Change, Coastal Community Enterprises: Adaptation, Resilience and Knowledge

CARIBSAVE INTASAVE Caribbean Working together in a changing climate

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1.0 Background

Coral reefs and mangroves are interconnected ecosystems that contribute significantly to the economy of Belize. They play a vital role in supporting a wide range of species that make Belize a globally recognized tourism destination. Tourism is one of the most important industries contributing about 25% of the country's GDP. The coast of Belize is predominantly mangroves, sheltering about half of the mainland coastline and about 75% of the shoreline on cayes. Sandy beaches account for only a small percentage of Belize's coastline and are considered the greatest expectation of visitors.

Mangroves provide habitat for a wide range of marine and avian species but they also play a critical role in reinforcing the integrity of Belize's coastline. The value of shoreline protection services provided by mangroves is estimated at US$111-167 million per year. Throughout the years, development has resulted in significant mangrove clearing followed by the dredging of seagrass beds to create artificial beaches for tourism. The health and ecosystem function of mangroves is significantly affected by such unsustainable practices.

Reforestation projects have been established in the Placencia Lagoon with the aim of stabilizing the coastline and restoring the mangrove habitat. The primary reforestation technique in the Placencia lagoon has been transplants from natural nursery areas. Several known sites have had considerable success with some sites exhibiting mangrove survival of over 10 years.

Reforestation in high-energy environments poses a greater challenge due to the extreme conditions that such efforts are required to overcome. The Riley Encasement Methodology (REM) has been used at several sites in Belize to successfully established mangroves in such conditions. This approach offers great potential for windward coastlines and offshore cayes that are affected by climate change and human activities. Mangrove reforestation could potentially enhance the coastal resilience of our coastlines as a form of community adaptation to climate change.

2.0 Situation Analysis

2.1 Laughing Bird Caye

Laughing Bird Caye National Park (LBNP) is one of 7 marine protected areas declared as a UNESCO World Heritage Site in 1996. The protected area encompasses 10,119 acres and is considered to be one of the best examples of coral faro formation in the Caribbean (an angular atoll situated on a continental shelf). The long and narrow caye is located on the southern portion of the protected area and is known to attract thousands of visitors each year. Legal mandate for LBNP is held by the Forest Department and the area is managed through a collaborative partnership with the Southern Environmental Association (SEA).

The national park is part of the Belize Barrier Reef System and is an important tourism resource for adjacent communities. The protected area serves as a haven for conch, lobster and finfish that contributes to the sustainability of the fishing industry by replenishing nearby areas. Littoral vegetation and herbaceous beach vegetation support a number of nesting birds and provides a stopping point for migratory birds. The beauty and high biodiversity of the national park provide significant socio-economic benefits to communities of the Placencia Peninsula.

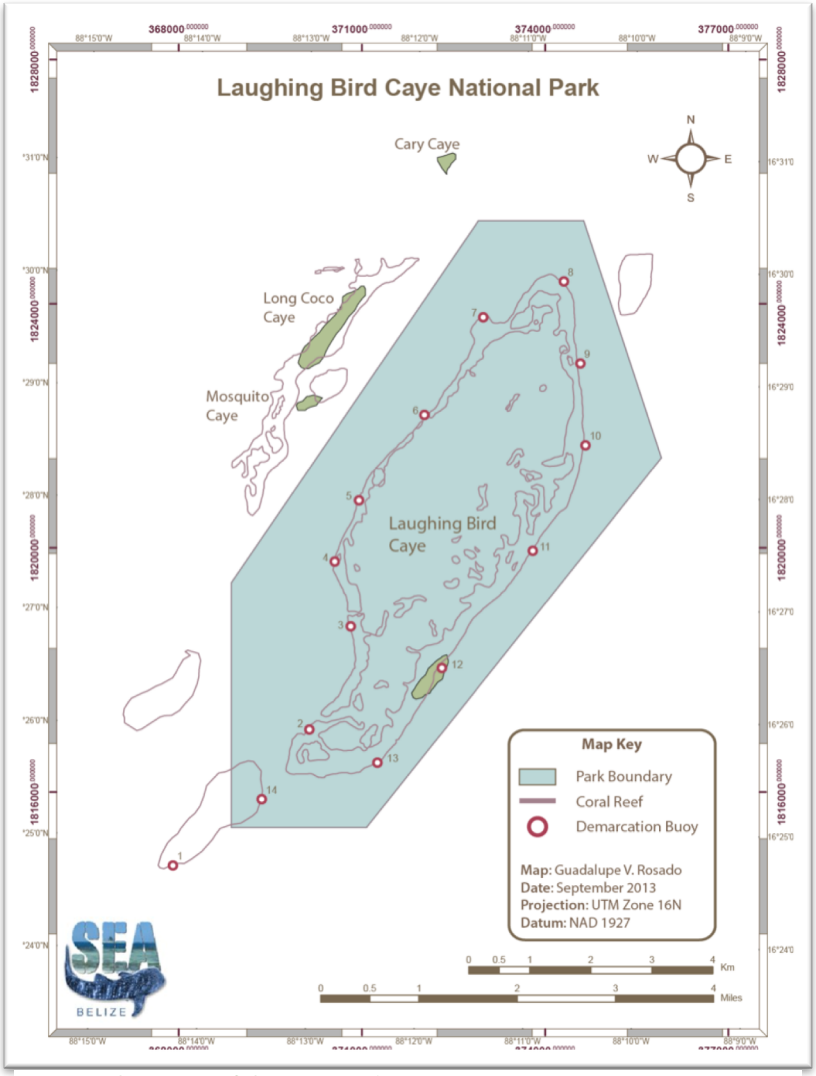


Figure 1: The extent of the protected area.

EROSION

Laughing Bird Caye is well known for its sandy beach and beautiful corals. A sand and shingle beach, located on the northwest side of the island, serves as the primary landing area for visiting boats due to the leeward wave action. Although the beach area in known to shift throughout the year, the extent of the beach has remained relatively stable for the past 20 years. This shifting beach is typical of coral islands that undergo seasonal changes of the prevailing wave action.

Figure 3: Beach at July 2010

Figure 2: Erosion at March 2015

It is important to consider that the beach face may undergo significant shifts depending on the impact of wave action and the intensity of sand accretion. However, Laughing Bird Caye has seen significant loss of beach that has even affected the beach berm. The beach berm is the area located immediately above the high tide mark that often exhibits greater stability on established cayes. According to anecdotal information, several high storm events have resulted in this major spike of erosion in recent years. The erosion has affected existing vegetation and is beginning to affect tourism infrastructure. It is anticipated that the beach will be replenished when prevailing winds become more favorable but the impact on the beach berm may be irrevocable. Proactive measures are required to increase the resiliency of the coastline in order to withstand storm events that will inevitably occur in the coming years.

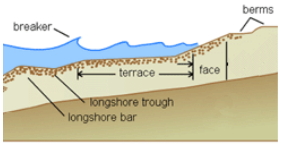


Figure 4: General Beach Profile

Figure 5: Erosion of Beach Berm

Managing the coastline also requires much consideration of how vulnerable the beach berm has become. The beach terrace remains shallow and beach face consists of sand and shingle but this could easily wash away as wave action increases. Stabilizing the beach profile is high priority for Laughing Bird Caye.

Figure 6: Seasonal shift of beach has resulted in overall loss at Laughing Bird Caye.

Figure 6: Erosion has begun to affect tourism infrastructure and natural vegetation of the island

2.2 Barranco Village

Barranco Village is the southernmost, coastal community of Belize. It dates back to the 1830s and is home to the indigenous Garinagu, a unique Afro-Caribbean culture. The language of the Garinagu is Garifuna and UNESCO has declared the language, music and dance a masterpiece of the oral and intangible heritage of humanity. The community is rich in history and shares culture with communities of the bay; Guatemala and Honduras.

Barranco is a quaint community with a small population due to out-migration. People seek education, jobs and better economic opportunities elsewhere. There is a notably high abundance of vegetation throughout the community, including the coastline. The area on the immediate coast of the village consists of small vegetated cliffs.

Figure 5: Top view of cliff (note reference point).

Figure 6: Bottom view of cliff (note reference point).

EROSION

Interestingly, outright-clearing of coastal vegetation is not an issue in this community as residents have always lived in close synergy with nature. Loss of mangroves and coastal vegetation has been due to the gradual erosion of the cliffs. Villagers are concerned that as erosion of the cliff moves farther inland, it will begin to affect coastal homes. According to anecdotal information, stands of mangroves had existed along the coast and supported shrimp fishing near the village. Loss of mangroves is still happening near the village and is attributed to incoming wave action and storm impacts. Residents have been seeking support to address the ongoing erosion and loss of coastal vegetation before it is too late.

Figure 9: Clay-like material of cliffs support vegetation but break apart when exposed.

Figure 10: Mangrove and coastal vegetation near village keep falling into the sea.

2.3 Placencia Lagoon

The Placencia Lagoon is a shallow estuary located west of the Placencia Peninsula. A total of 3 important watersheds empty into the lagoon including mango creek, Jenkis creek and waha leaf creek. The lagoon is home to remarkable biodiversity with much of the coastline covered by mangroves. However, tourism development and aquaculture has been affecting the health of the lagoon and associated biodiversity.

Several communities that rely primarily on tourism exist along the peninsula. The protected area co-manager and many conservation organizations are also based in the village of Placencia. A strong focus currently exists on advocacy efforts that emphasize the importance of maintaining healthy ecosystems for the benefit of the communities of the lagoon.

Figure 11: Mangrove transplants in Placencia of 10+ years.

EROSION

The growth of the tourism industry has resulted in development practices that have resulted in major alteration of mangrove habitats buffering the Placencia Lagoon. Mangroves forests are replaced with land fill and tourism infrastructure. The coastline is hardened with sea walls and other forms of coastal protection. Several community leaders have been working with property owners in an attempt to reforest coastal properties with mangroves as a form of ecosystem based adaptation for coastal management. Efforts have been through the use of nursery grown mangroves and transplants sourced from natural nursery areas. Several of these mangrove reforestation projects have had considerable success with some sites showing over 10 years of successful growth. Interest still exists to use mangroves as a form of coastal management but there has been limited expansion of reforestation initiatives in recent years.

Figure 12: Placencia resident sourcing mangroves from natural nursery areas.

Figure 7: Mangrove transplants have had considerable success in Placencia lagoon.

3.0 Coastal Management Theory

3.1 Reforestation and Ecosystem Restoration

It is important to distinguish between the terms restoration and reforestation. The term restoration is used widely when referring to the planting of trees aimed at enhancing forest ecosystems. Conditions may be established by planting efforts but such efforts cannot guarantee ecosystem restoration. Additionally, forests undergo constant states of forest succession and disturbance, so the status of an ecosystem and its function is a moving target. Although reforestation efforts cannot guarantee restoration of ecosystem, a comprehensive and thorough understanding of the biological functions and requirements is key to ensure that reforestation efforts indeed result in ecosystem restoration.

Mangrove.org focuses on reforestation of mangroves using sustainable development technology. The process aims to restore the ecosystem function of the mangrove forest and its associated ecosystems. Laughing Bird Caye provides a unique opportunity for coastal reforestation using mangroves. The efforts will compliment the successful coral restoration that has now resulted in a thriving coral reef ecosystem. This will become the only known island in the Caribbean where restoration of both key ecosystems has been applied in situ. Demonstration sites will also be established on the Placencia Lagoon and the village of Barranco. It is important to consider that to achieve ecosystem restoration there is need to ensure that the end goal is mature and reproductive trees with sufficient foliage and extensive root structure. The planning and implementation of the reforestation efforts aims to ensure this is the end result.

3.2 Mangroves as Ecosystem-based Adaptation

Coastal protection and management has traditionally had a strong focus on hard engineering; seawalls, revetments, and geo-tubes. Solutions aim to reduce high-wave energy and retain shoreline material. Hard engineering is an extensive process that usually requires major alterations to the shoreline and very costly solutions. Mangroves and coastal vegetation are usually considered non-functional players in coastal resilience. In Belize, coastal deforestation has been mostly as a consequence of tourism development and urban expansion. Ironically, recent research is confirming that mangrove deforestation has actually increased the vulnerability of coastal communities against storm impacts.

Many countries, including Belize are re-evaluating the management of their coastal zones. There is a growing paradigm shift that looks at integration of soft engineering (vegetation) with hard structures for coastal protection. Using mangroves to address the vulnerability of coastlines is a form of ecosystem-based adaptation. The objective of reforestation efforts is to reforest mangroves and restore the shoreline protection function of this habitat. In addition, it will enhance ecosystem health of the surrounding area. The approach will be in direct synergy with coastal zone management plans and policies that encourage sustainable and integrated development planning. Mangroves take many

years to become fully established and begin providing this function. Hence, it is of great importance to carry out a comprehensive assessment of the project site and develop an informed reforestation plan.

3.3 Coastal Management Using REM™

The Riley Encasement Methodology (REM) uses sustainable development technology that facilitates the establishment of mangroves in extreme conditions. It consists of a specialized encasement that has undergone extensive proof of concept. A benefit of using REM encasements is that the precise location for mangrove growth can be established, provided that the biological conditions are met. Additionally, the survivorship is very high as has been demonstrated in several project sites.

REM encasements facilitate the establishment of mangroves at extreme locations by allowing elevation adjustments within the encasements. The methodology prescribes this elevation to be set at the mean high tide level of the reforestation site. This is the optimum placement of the propagules from which the root and foliage begin to extend.

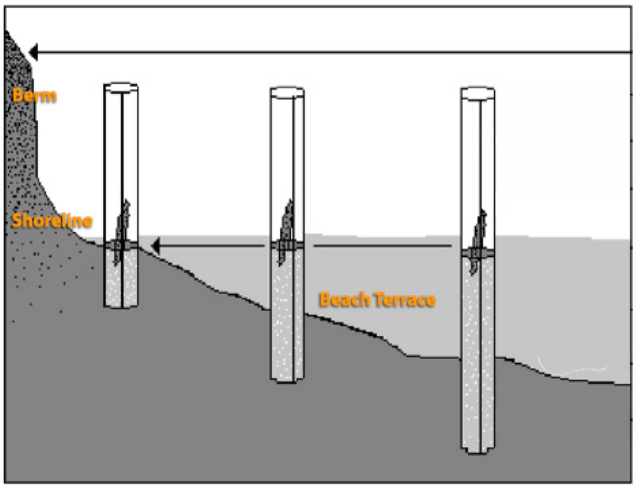
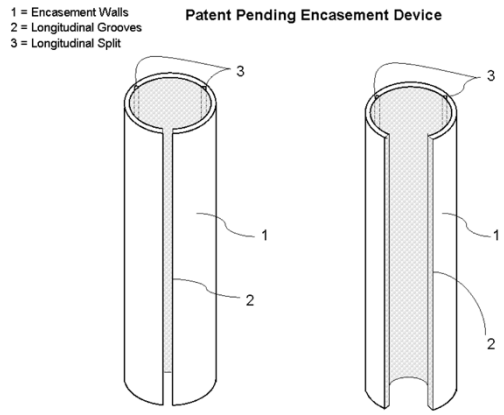
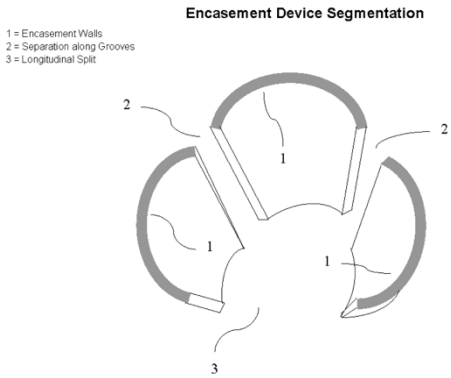


Figure 8: Optimum elevation based on site hydrology.

REM encasements provide the mangroves protection from storms and natural elements. This isolates the mangrove and allows it to adapt to extreme conditions. Translucence allows adequate light to diffuse through the walls so that early plant growth is stimulated. It is distinguished from pipes due to a longitudinal cut spanning the entire length of the encasement. This ensures flexibility and facilitates expansion of the mangrove stem as the plant grows. The spilt also allows for water exchange that keeps with the surrounding salinity and tidal fluctuations.





REM encasements have been demonstrated to accelerate growth rate of foliage and root structure when compared to mangrove seedlings growing non-encased. They filter UV rays and force the foliage to grow upwards with little room to spread laterally.

Figure 9: Growth comparison of encased vs non-encased at 75 days and root structure at 24 months

Mangroves are resilient plants that are highly adapted to the coastal environment. The conditions established by the REM encasement accelerates growth of both the foliage and root structure during early plant growth. Encasements are removed at the end of the adaptation process when the mangrove tress have developed resilient primary and secondary roots (3yrs +). It takes several years for the mangroves to grow and begin to stabilize the substrate so these interventions are long-term solutions and may still be complimented with short-term erosion interventions.

3.4 Hard Engineering Integration

The use of hard engineering for coastal protection is considerably expensive and requires long-term maintenance. Preliminary observations indicate that shoreline management may be achieved in some of the areas without the use of hard engineering. However, it is important to note that mangroves would take several years to fully establish on the shoreline and begin to stabilize the substrate. In the areas where erosion has begun to affect the tourism infrastructure, there is possibility that the rate of erosion would result in a major increase of depth before that happens. Considerations for integration of hard engineering with REM reforestation would be required if the level of erosion affects the ability of the REM mangroves to become established.

Hard engineering integration is not part of this reforestation plan but there is need to assess the erosion status of the reforestation areas during implementation, and identify hard engineering requirements. A subsequent action plan would be developed in close coordination with the project teams for any potential hard structures. It is important to

consider that the recommended structures would be rock revetments that provide relief and shelter for marine life, and are very low impact.

3.5 Coral Cayes and the Role of Island Plants

Islands are relatively isolated and their mangrove and littoral forests have the lowest species diversity making them vulnerable to ecosystem disturbances. Sand and rubble cayes such as Laughing Bird Caye depend significantly on the existence of plant and animal communities to maintain the island's stability. Island vegetation consists of vines, grasses, shrubs, mangroves, and many species of littoral plants. Through a biotic process called island plant succession they are able to facilitate the creation of conditions that lead to the establishment of a stable and functional island. In the absence of island plant vegetation, sand and coral cayes would be highly unstable environments that would easily wash away when subjected to high wave and storm conditions.

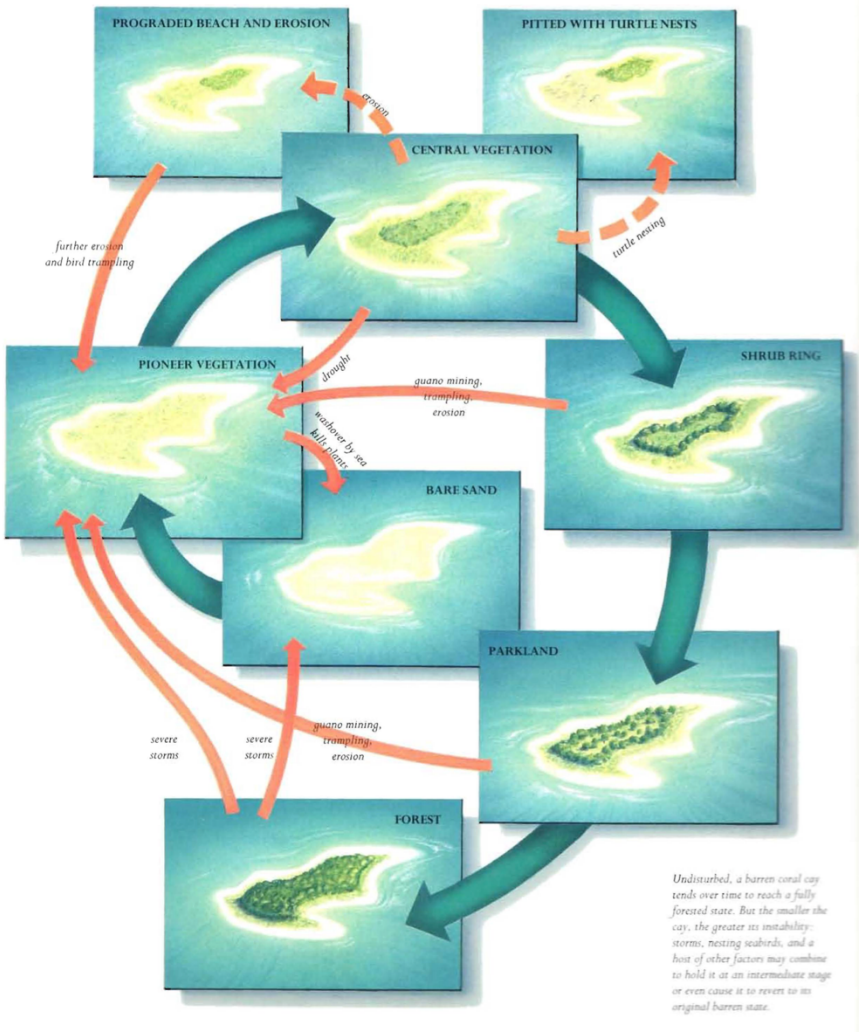


Figure 10: Island plants play an important role in the development of coral islands.

The peripheral zone of cayes consist of low herbs, grasses, and vines, often of a creeping habit. These species are able to withstand high salinities and salt spray, scarcity of water, shifting sands, and bright sunlight. These are referred to as pioneer species and are adapted to life on a shifting substrate. They put out runners over bare sand with small roots at intervals that are adapted to life on a shifting substrate as they tend to stabilize sand. These plants create conditions leading to the establishment of its successor; a higher zone of shrubs in the upper beach. Shrubs are of utmost important to cayes because they ameliorate conditions such that other sea-dispersed shrubs and trees find favorable germination sites.

Pioneer species stabilize shifting sand, shade the surface of the ground, and add dead leaves and other organic matter that enrich the soil. In addition, these plants serve as a windbreak, provide extensive shade, screens salt spray and stabilize the sand and shingle substrate. If sufficient freshwater becomes available, these changes facilitate island conditions that are favorable for larger littoral plants and the abundance of bird species. The greater the process of island plant succession, the more resilient the island becomes against storms and the impacts of climate change. The following pictures of Laughing Bird Caye compare a beach area where natural vegetation has been removed to an area where it remains undisturbed.

Figures 11-12: Showing highly eroded beach vs natural shoreline showing no erosion (note reference point).

Reforestation efforts aim to create a buffer zone of mangroves that provide storm protection and enhance the biomass of important marine and bird species. However, the functional vegetative structure of the island has been significantly affected by the tourism activities onshore. A healthy vegetative structure that consists of herbs, grasses, shrubs and larger littoral species is important to ensure that the biotic function of these plants continue to create conditions that stabilize the island. It is important to ensure that in tandem to the mangrove reforestation efforts, there is also a focus to reforest island plant species onshore. A pilot landscaping plan should be developed that aims to identify and use island plant species that provide beneficial ecosystem functions to improve coastal stability and biodiversity. This approach has the potential to provide invaluable educational opportunities and serve as a regional example of ecosystem-based adaptation.

4.0 REM Implementation

4.1 Mangrove Technical Workshop

Figure 13: Participants included community representatives, NGOs, private sector and regulatory agencies.

A mangrove technical session was carried out with the aim to engage participants in constructive dialogue about reforestation efforts taking place in Belize. Observations and results of previous mangrove reforestation efforts were shared with participants and they were introduced to a variety of reforestation methods. Technical presentations focused on reforestation case studies, avoiding maladaptation, reforestation techniques, hard engineering integration and introduction to REM technology. The aim of the session was to ensure that participants are able to prioritize coastal management interventions based on site vulnerability to natural and anthropogenic threats, and to use the most effective method that would result in the highest survival potential. The training session also included a site visit to historical reforestation sites in the Placencia lagoon and to natural mangrove nurseries. It involved 26 participants, including representatives from the Department of Environment, The Belize Zoo, SEA, CZMAI, PTGA, other small organizations and the private sector.

Mangrove reforestation efforts in the Placencia Peninsula had primarily focused on low-energy environments where there is an abundant supply of mangrove propagules and mangroves are easily planted in the most ideal substrate. Participants concluded that reforestaton in such areas had the advantage that little capacity and equipment was required because the conditions met the biological requirements of mangroves.

Figure 14: Property owner provides tour of his reforestation site in the Placencia Lagoon.

It was noted that low-energy reforestation sites are vulnerable to wave energy and there is a tendency to plant very high numbers with the anticipation that a large percentage will be lost to the elements. SEA and partners have generated a draft guide for mangrove restoration with emphasis on low-energy sites. However, the considerable amount of effort and resources required to continue monitoring and replenishing reforestation sites has affected the proliferation of reforestation projects in the Placencia Lagoon.

The second part of the mangrove technical session consisted of developing a coastal management approach for Laughing Bird Caye using the Riley Encasement Methodology (REM). The practical session built on the lessons learnt from the class lectures, and the site visit to the historical reforestation sites. Participants concluded that the REM approach has an initial cost of technology but allows for a more targeted approach to coastal management, considering that it allows the mangroves to adapt to problematic conditions. Additionally, it is expected that the monitoring cost and effort is reduced due to higher survival rate of mangroves.

A demonstration REM reforestation site was planned for a site in the Placencia Lagoon where historical reforestation efforts yielded very low survival due to heavy wave action from boat traffic. In addition, a second demonstration site was planned for the village of Barranco where leaders emphasized that REM mangroves would benefit erosion problems their community was having.

4.2 Laughing Bird Caye

Based on a thorough site assessment of the erosion status of Laughing Bird Caye, and the conditions affection the site, REM mangroves were established by participants on November 07th, 2015. They received hands-on training on adherence to the methodology and monitoring considerations. The objective of the practical session was for participants to get first hand experience with the methodology and its implementation. Mangrove leaders responsible to advance the reforestation work for Fragments of Hope conducted subsequent trips to reinforce the mangrove setup and expand the number of reforested REM mangroves. A total of 53 REM mangroves were established as part of the initial training and follow up activities. This number was expanded by later activities.

Figure: 15: Training participants get hands-on experience setting up REM mangroves at Laughing Bird Caye.

The reforested mangroves were sketched on a site map to faciliate monitoring of the growth progress. The primary area of focus was the area of severe erosion that had been affecting the restroom facilities of the island. Due to storm events, this area underwent major changes of substrate elevation and beach extent in the immediate months following establishment. The mangroves were monitored for almost 2 months in order to observe how they would fare the conditions and determine what adjustments would be required with the initial setup. A second effort was conducted on December 29th, 2015 (with technical machinery), to re-establish REM mangroves that had been lost in this area and to expand the number of mangroves. The final number of reforested REM mangroves was tallied at 84 and the following site map was created to facilitate monitoring of the growth progress.

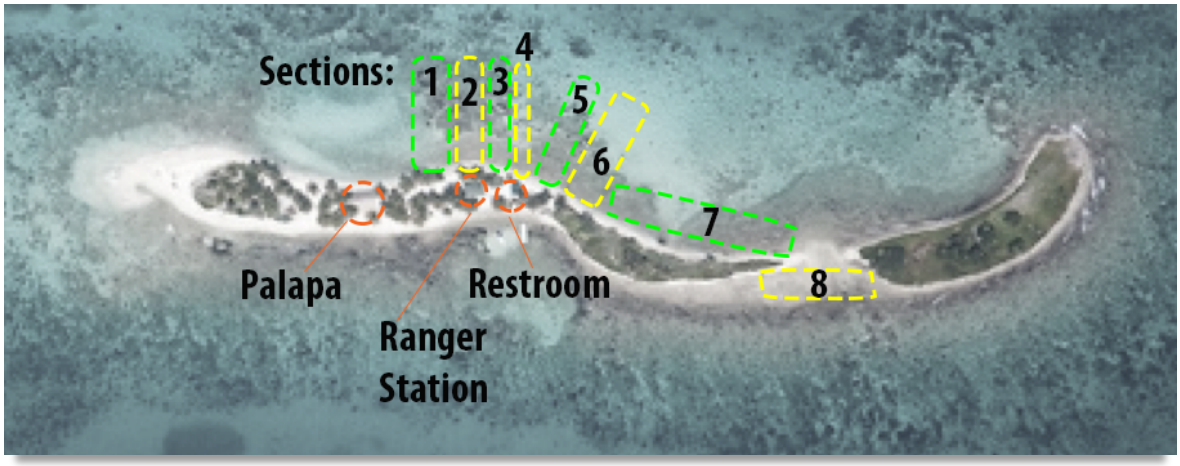
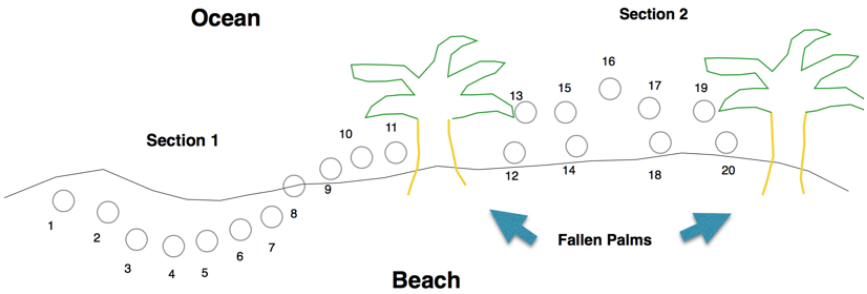


Figure 16: Laughing Bird Caye site map showing the monitoring locations of REM mangroves by section 1-8.

The site map outlines 8 distinct sections that are being used to monitor the growth progress and REM establishment. The mangroves in each of the individual sections are subjected to similar erosion challenges and wave energy conditions. Sections 1-5 were considered the most problematic areas due to the island vegetation that had been falling into the sea. Sections 6 and 7 did not exhibit major erosion and was further away from the island's tourism infrastructure. Section 8 faces the windward side of the island at a location where the island had been split by a past hurricane and now exhibits water exchange from one side of the island to the other. Visuals of these areas are seen below.

Section 1

Section 2



Figures 17-19: Showing REM mangroves and locations described as Section 1 and Section 2.

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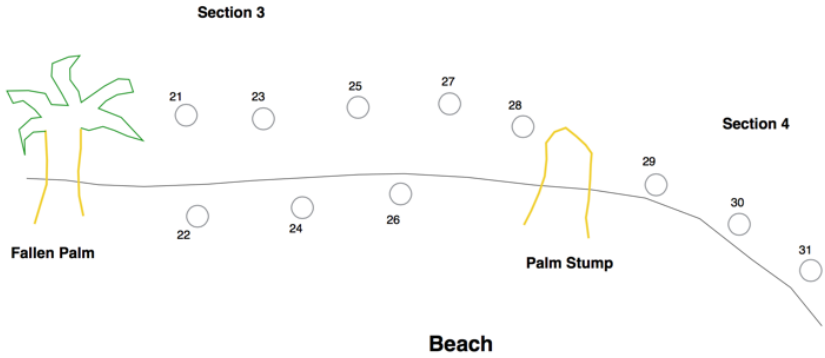
Section 3

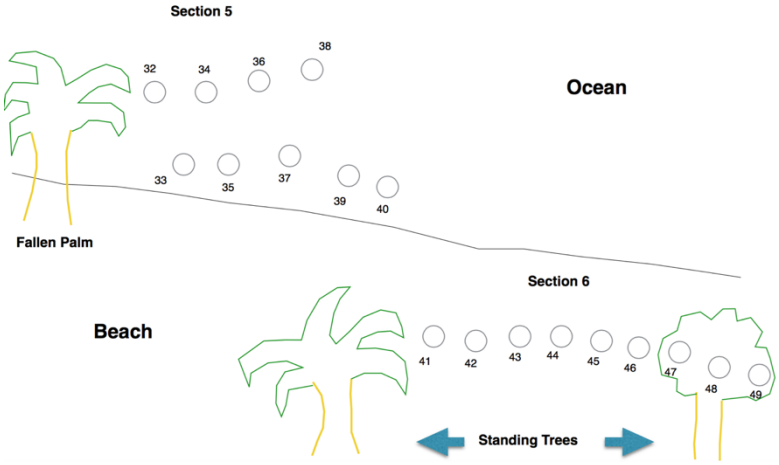
Section 4



Figures 20-22: Showing REM mangroves and location described as Section 3 and Section 4.

Section 5

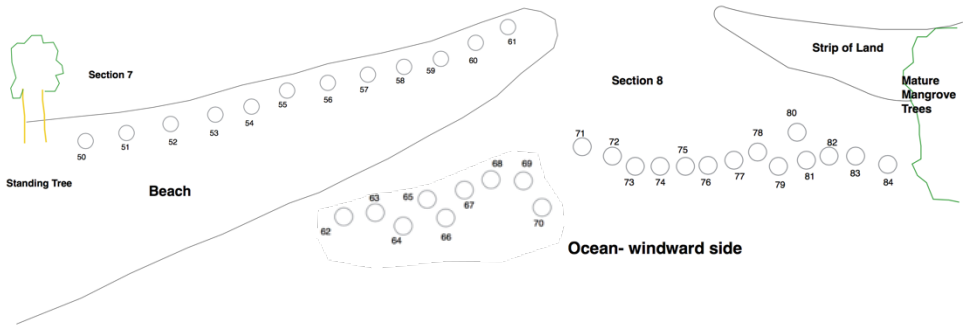
Section 6



Figures 23-25: Showing REM mangroves and location described as Section 5 and Section 6.

Section 7

Section 8



Figures 26-28: Showing REM mangroves and location described as Section 7 and Section 8.

A summary of adjustments carried out for the reforestation sites during monitoring trips will be provided in a monitoring report document. The summary will include updates on erosion status and growth progress of the REM mangroves. Additional recommendations will also be detailed for further review and implementation.

4.4 Placencia Lagoon Demonstration

In December of 2015, a demonstration site was established in the Placencia Lagoon at an area where low-energy methods had been attempted several years ago with minimal success due to high boat traffic. A total of 12 REM mangroves were established by mangrove technicians with the aim to increase awareness of the project. The location was chosen because it was one of the sites that had shown the least success of previous reforestation efforts.

In an effort to secure ownership from nearby land owners they were consulted before implementation. The land owner to the immediate east of the project was supportive of the initiative and acknowledged that the site was in public land. The land owner to the immediate west considered mangroves a nuisance and did not want them on his property. Further consultation with the Placencia Village Council confirmed that the target location was adjacent to what is considered a public road. The council was very supportive of the reforestation efforts and indicated that the area was public land and establishment of mangroves would be beneficial to the community. It is expected that the demonstration site will assist to gauge the public reaction towards the project.

Figure 32: Demonstration site of REM mangroves established along a channel that exhibits high boat traffic.

4.3 Barranco Village Demonstration

In January of 2016, Fragments of Hope leveraged grant funding from the Placencia projects to establish a mangrove demonstration site in the village of Barranco. Community leaders that had attended mangrove reforestation workshops led the establishment of REM mangroves. A total of 30 REM mangroves were established on January 24th and they were left to observe how they would fare the elements. On March 19th, the technical team returned to inspect the mangroves and carry out an educational presentation for community residents about the reforestation efforts and its benefits to climate change adaptation.

Given the rural location of the village and lack of financing to scale-up reforestation efforts, monitoring of the demonstration site has been limited. Community fishers report that storm action has affected several of the encasements and there is need to increase the number of mangroves to ensure long-term establishment. It is important to recognize that in all project sites across Belize a primary challenge is securing community ownership for reforestation efforts. In Barranco, the community has been actively requesting the application of mangroves for coastal protection.

Figures 29-30: Community fishers establish REM mangroves along the coastal cliffs of the village to protect homes.

Figure 31: A community presentation was held after 2-months and mangroves were already showing growth.

3.0 Monitoring

Mangroves are resilient plants but there is much need to ensure short-term monitoring of reforestation sites during the first months of establishment. In high erosion areas, this is critical in observing how the surrounding conditions will affect adherence to the Riley Encasement Methodology. Once the REM mangroves become established at the reforestation site, mangrove growth will be slow but adjustments will be minimal.

The monitoring plan will ensure the long-term survival of reforestation sites and provide relevant documentation of the efforts. This information will be useful in determining additional coastal management interventions that may be required. It will also assist in tracking the status of erosion and how it affects the area. Monitoring of the site will be carried out by FoH mangrove technicians in close coordination with reserve rangers and community leaders.

The following table serves as a template that will be used for monitoring trips. This initial template details the condition of the site at the end of actual site establishment. Monthly monitoring is conducted for initial 3-months after site establishment. Subsequent monitoring will be conducted yearly or on a biannual basis, depending on availability of mangrove technicians. Adjustment and replenishment of REM mangroves will be carried out based on the status of each individual site and recommendations derived from site observations.

Table 1: Monitoring report of site establishment for each of the 3 REM mangrove reforestation sites.

Location	# of Survival	Observation of Seedlings	Observation of Surrounding Conditions
Laughing Bird Caye (LBC)			
LBC Section 1	(x) of 11	freshly harvested	Beach berm was recently eroded and beach sand has been washed away
LBC Section 2	(x) of 9	freshly harvested	- Beach berm was recently eroded and beach sand has been washed away - Area is vulnerable due to depth of water and toppled trees nearby
LBC Section 3	(x) of 8	freshly harvested	- Beach berm was recently eroded and beach sand has been washed away - Area is vulnerable to high wave action and toppled trees nearby

LBC Section 4	(x) of 3	freshly harvested	- Beach berm was recently eroded and beach sand has been washed away - Area is vulnerable to high wave action and restroom facility about to cede to the sea
LBC Section 5	(x) of 9	freshly harvested	- Area is a slight transition away from the high erosion locations - REM mangroves are placed several feet offshore to observe how they would fare conditions
LBC Section 6	(x) of 9	freshly harvested	REM mangroves are placed right at the high tide line in optimum wave and beach berm conditions
LBC Section 7	(x) of 12	freshly harvested	REM mangroves are placed right at the high tide line in optimum wave and beach berm conditions
LBC Section 8	(x) of 23	freshly harvested	Wave energy is broken by shallow reef and water 'over washes' across the island
Barranco Village			
Demo Site	(x) of 30	freshly harvested	- Lots of flotsam and large debris seem to wash onshore - Coastal cliffs exhibit gradual erosion
Placencia Lagoon			
Demo Site	(x) of 12	freshly harvested	Marine sheet seawall exhibits bending and vertical failure; high wave energy from boat traffic

END