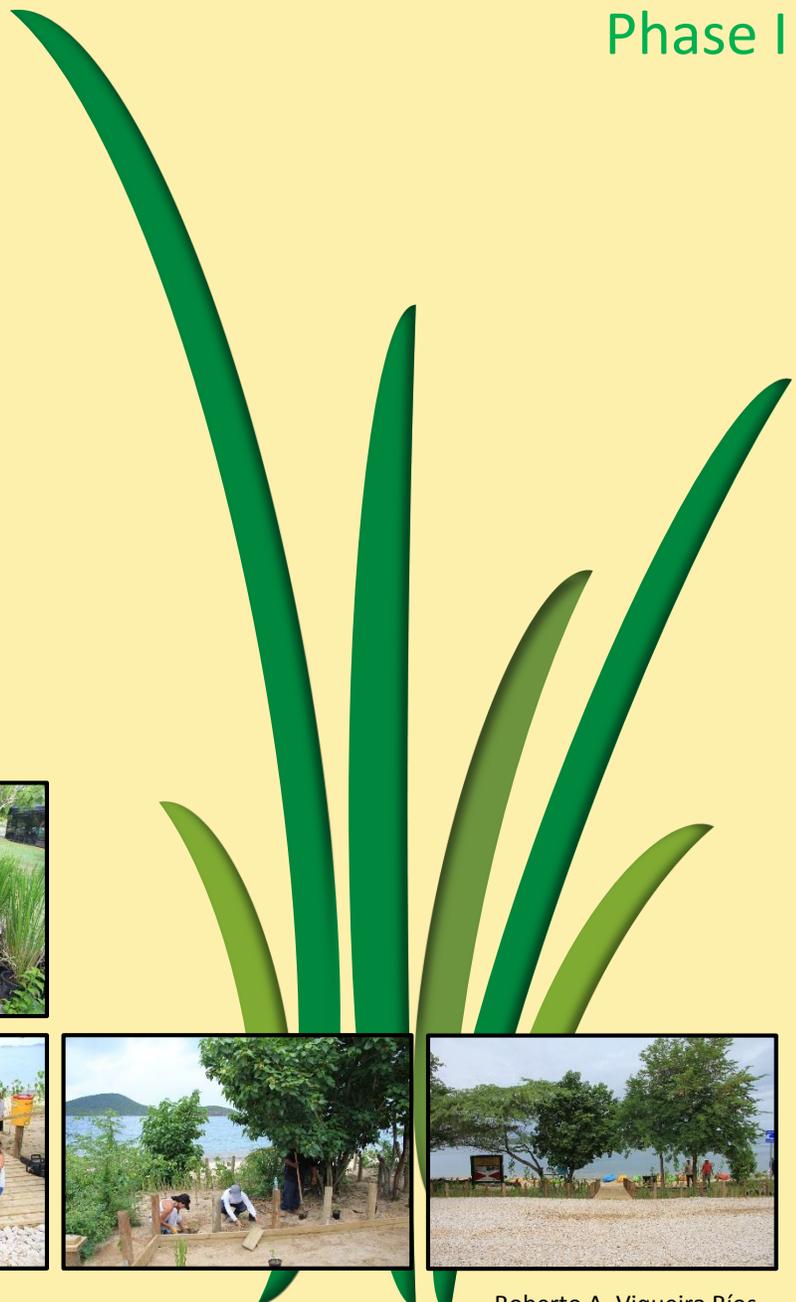


Environmental Restoration Project Playa Tamarindo Culebra, Puerto Rico Phase I



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19 al 23 de agosto de 2013

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Contact us:

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Vandiver of NOAA's Restoration
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Photo by Ricardo Colón USFWS

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Executive Summary

A pilot project was carried out from August 19 to August 23, 2013 as part of efforts to develop a **Watershed Management Plan for the Municipality of Culebra** (a small island off the coast of Puerto Rico). It is widely known that the degradation of coastal water quality as well as rising sea surface temperatures have caused a decline in the populations of coral reefs. This phenomenon is mainly due to the lack of sustainable management of sediment/bare soil, excess nutrients from agriculture, stormwater runoff and sanitary sewer leaks and overflows which are some of the main causes of the degradation of the marine ecosystems.

After several meetings with strong community participation, Playa Tamarindo was selected as the highest priority location due to concerns generated by erosion and sedimentation and impacts to the natural beach berm vegetation and high use. It was also possible for motor vehicles to illegally enter the beach and to impact the beach berm area. The beach berm was no longer vegetated and hence the loss of an important buffer from stormwater runoff. This was resulting in sediment and pollutant transport into this important marine ecosystem. The NGO (nonprofit) CORALations helped to select the site and provided an educational component by coordinating the participation of students from the Ecological School of Culebra in reforestation and coordination of irrigation of the restored vegetation.



Area affected by runoff associated to the parking, previous to the restoration project.



One of the goals was to address runoff from the adjacent roads and bare soil areas prior to being discharged to the marine environment. Another organization that assisted in the project in site selection and prioritization for restoration is the Society of Marine Environment (SAM) and its Student Chapter (CESAM) were able to demonstrate adverse effects on marine sedimentation and reefs from Playa Tamarindo over the years impacting their successful efforts to restore coral reefs in the area through its coral farming and out-planting efforts.

This project is also part of the **Sustainable Forestry Network**, Department of Natural and Environmental Resources Bureau coordinated through the Forest Service and Program initiatives Coastal Zone Management of Puerto Rico. The effort also has the endorsements of the Municipality of Culebra Conservation and Development Authority of Culebra (ACDEC). The latter is responsible for maintaining the facilities provided as part of the restoration as the vegetated areas. The project also had the endorsement of the Tourism Company of Puerto Rico. Funding for this project came from the Coral Reef Conservation Program of the National Oceanic and Atmospheric Administration (NOAA). The project was designed and implemented by nonprofit organizations Protectores de Cuencas, Inc. and Ridge to Reefs, Inc., with the cooperation and active participation of the community. Much of the labor for the project came from Culebra. The project received technical assistance from the Department of Natural and Environmental Resources (DNER), the US Fish and Wildlife Service (USFWS) and NOAA. The DNER provided the trees planted as part of reforestation program and provided accommodation for the team in their facilities Culebra.



A group of students from Abby's school in Culebra with their caregivers.



Sponsors and Collaborators

Sponsors

Department of Natural and Environmental Resources (DNER)

National Oceanic and Atmospheric Administration (NOAA)

Contributors

Municipality of Culebra

Authority Culebra Conservation and Development (ACDEC)

U.S. Fish and Wildlife Service (USFWS)

Natural Resources Conservation Service (NRCS)

CORALations

CORALations Marine Explorers

Tourism Company of Puerto Rico

Marine Environment Society, Inc.

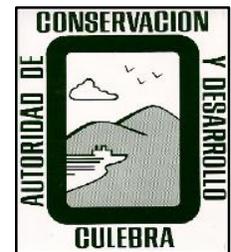
Student Chapter Society of Marine Environment

Center for Applied Tropical Ecology and Conservation, University of Puerto Rico, Río Piedras

Culebra Eco School

Abby's School of Culebra

Municipality of Culebra



United States Department of Agriculture
Natural Resources Conservation Service



Acknowledgements

This project could not have taken place without the active participation of the community of Culebra. In particular we want to acknowledge all the help and support from Omar Villanueva, Alexander Ayala, Thomas Ayala, Julio Figueroa (Apa), Antonio Albert, Paul Aquilina (Poly) and Tyson, who were instrumental in all the work including the use of heavy equipment, transportation of materials to Culebra, labor and carpentry. We also acknowledge the support and assistance provided by the following persons and entities: the Mayor of Culebra, Honorable Ivan Solis, for the support given to the project and their active participation in community meetings and to last ACDEC Director, Ms. Arlene Robles and current director, Mrs. Sindymar Villanueva, for their part in the initial



Hon. Iván Solís Major of Culebra in one of his visits to the restoration Project area.



Sindyamar Villanueva, Director of ACDEC, taking notes on maintenance needs.

discussions of this project and to adopt this project as part of the recreational areas managed by ACDEC and for all maintenance post-restoration. We also wish to thank Mr. Miguel Canals Mora, Management Officer for the International Biosphere Guanica Dry Forest Reserve for his technical assistance in planning visits prior to the development of the project and for sharing his experience managing natural coastal areas for over 25 years. To Mr. Ernesto Diaz, Director of the Coastal Zone Management from



Alex, Apa and Tomasito doing carpentry work.



Omar and Tomasito stabilizing the soil.



Mary Ann Lucking, Director of Coralatons, with students from the Ecological School of Culebra.



Carolina Morales, from the Tourism Company, planting seagrapes, alongside Louis Meyer.



Department of Natural and Environmental Resources for his assistance in project planning and permission and Mr. Edgardo Gonzalez, Natural Resources Administrator for DNER for all the support provided by the Department to make this project successful. Mr. Robert Matos, Culebra Management Officer, for his technical assistance and to coordinate the use of the facilities of the Department in Culebra. Thanks also to Jeiger Medina, NOAA Coral Fellow with the Coral Reef Conservation Program,



Laura and Mary giving an architectonic touch to the planting.

for his unconditional support and help in the coordination of projects and his supervisor, Damaris Delgado, Director of the Bureau of Coastal Reserves and Refuges (DNER) for all the help in the development of the management plan for Culebra. From the Tourism Company of Puerto Rico thanks to Carolina Morales Gomez, for all the efforts to involve the Tourism Company

in the project and also for rolling up her sleeves and being with us all day planting in the hot sun. NOAA, Lisa Vandiver and Rob Ferguson, for all the hard work in order to secure funding for the project and Lisa being there all week providing arduous technical support and labor. Ricardo Colón USFWS, Wildlife Biologist in Culebra, for his technical assistance and logistical support. The Natural Resources Conservation Service (NRCS), Edwin Mas, (Plant Materials Specialist) for his technical assistance in helping us select the most appropriate plants for the project, Fernando Arroyo (Assistant State Conservationist for Field Operations) and Damaris Medina (State Conservation Engineer) for their participation in community meetings. Mary Ann Lucking, Director of CORALations, and her active participation in discussions on the feasibility of the project and engaging students at the Ecological School of Culebra. To our beloved companion Beverly Yoshioka for her constant advice. Dr. Edwin Hernandez (Affiliate Researcher) of CATEC-UPR and Samuel Suleiman Director SAM, for sharing your work and knowledge about Tamarindo area, which has been key to the selection of Playa Tamarindo as a priority for restoration. University of Puerto Rico Rio Piedras students: Alfredo Montanez, Yasiel Figueroa and Abimarie Otaño of CESAM, for their voluntary cooperation and assistance. Landscape architects, Laura Lugo Caro and Mary Bingen, for sharing their experience and knowledge in design by helping us incorporate a touch of beauty and functionality into the landscapes in the project. The engineers, Juan Amador and Angel Garcia, thanks for all the long hours of calls and site visits to help give practical advice to our lofty ideas.



Lisa Vandiver from NOAA documenting the project.

Introduction

The degradation of coastal water quality in Puerto Rico has caused a decline in the population and health of coral reefs. The ability of these reefs

to survive is being reduced gradually as discharges

increase fine sediment and nutrients

from the land to coastal waters of Puerto Rico.

From the point of view

of conservation of marine ecosystems, degradation of water quality due to land-based sources of pollution dispersed has negative and sometimes irreversible damage to the integrity of the structures of coral reef communities, sea grasses, mangroves and other coastal ecosystems. High rates of sedimentation, excess nutrients from agriculture and sanitary sewage overflow are the main causes of the degradation of marine ecosystems. This phenomenon is mainly due to the lack of sustainable management from the



Drainage channel in Culebra.



Sediment discharge to the Lobina Canal because of erosion from a dirt road after a water tank overflowed in Culebra.



Culebra runoff channel enlarged and devoid of vegetation by the municipal administration of Culebra last before being restored through hydroseeding technique.



One of the many existing dirt roads in Culebra



perspective of integrated coastal watershed management. Erosion is another serious problem for our wetlands, estuaries and coastal waters. In particular the removal of vegetation and the movement of land for the construction of infrastructure and homes, in the absence of good practices to control erosion and sedimentation, marine and coastal ecosystems are impacted and the attractiveness of coastal areas for recreation and tourism is diminished. Playa Tamarindo is one of the busiest areas in the Canal Luis Peña Natural Reserve, managed by the Department of Natural and Environmental Resources. The beach has become the second most visited beach in Culebra, second to the famous Flamenco beach. This rise is mainly due to the great diversity of marine organisms that inhabit the area. The presence of



Photos of coral estates in Playa Tamarindo which show the abundant presence of marine species by Edwin Hernández.

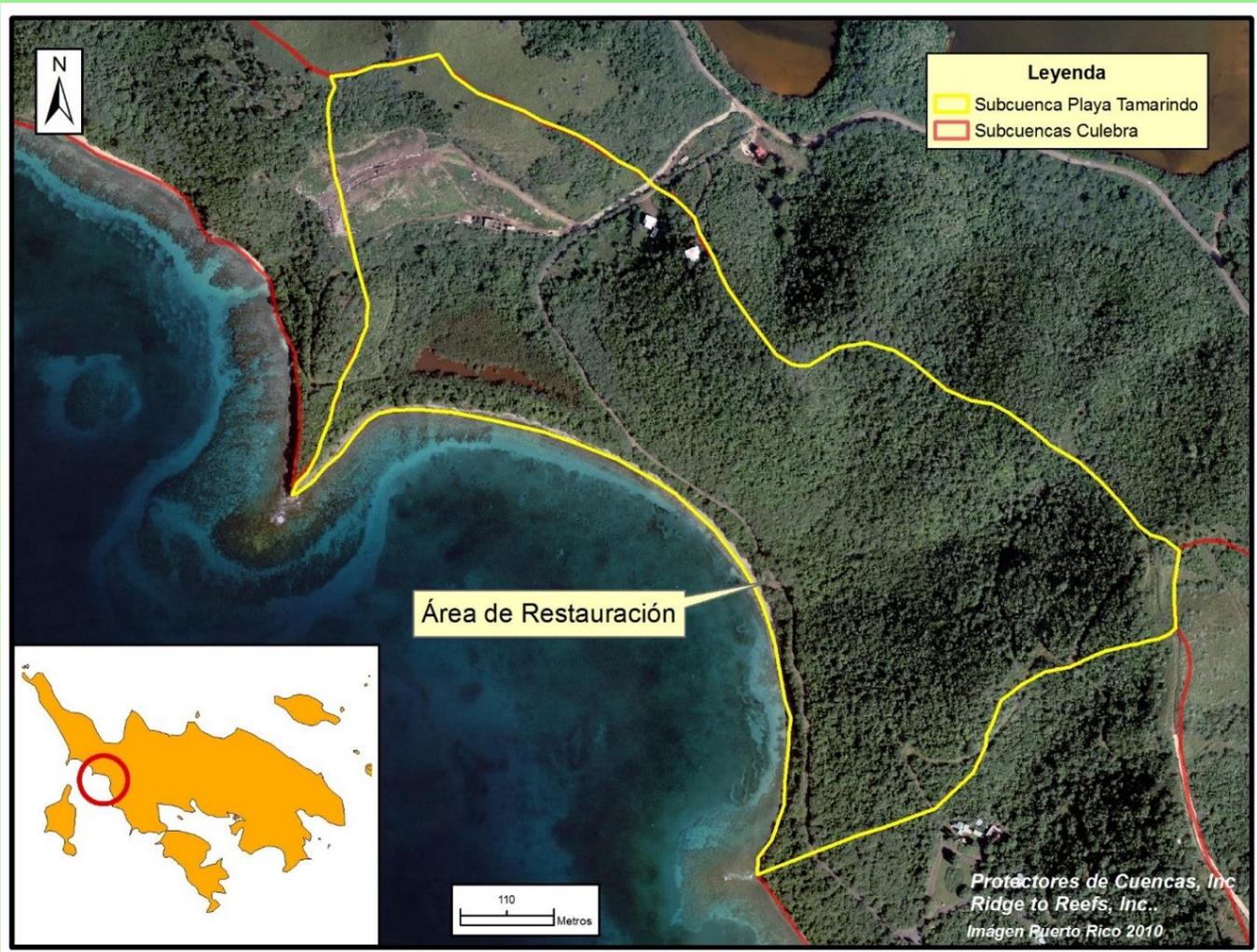
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organisms is partially attributable to a community project of Coral Reef Rehabilitation and Aquaculture which began in 2003 and has been led by the Society of Marine Environment (SAM), in collaboration with the Center for Applied Tropical Ecology and Conservation (CATEC) of the University of Puerto Rico in Rio Piedras.



A kayak tour company providing instructions to the group before the tour.

People around Puerto Rico, as well as other parts of the world, are looking for areas where you can swim with the turtles and see relatively healthy coral reefs. No doubt this is a good resource that contributes to the local economy of Culebra. Currently, there are three companies offering guided snorkeling and kayaking tours. The high visitation in Tamarindo has resulted in increased pressure on natural resources and increased need for implementation of management practices to ensure both the enjoyment of visitors to the area as the protection and conservation of coastal resource.



Map of Culebra delimitating the area of the Project and the sub-basins.

Project Description

Tamarindo Beach Project consists of the following elements directed towards the conservation and protection of coral reefs and other marine ecosystems; erosion and sedimentation control, reforestation and habitat restoration through dune restoration, restoration of the line permanent vegetation, and through the delineation of vehicular and pedestrian access.



Parking area prior to restoration.



The problems of erosion and sedimentation in Tamarindo beach are mainly associated runoff coming from the dirt parking lot and access road to the beach that is only partially paved and in a critical state of disrepair with lots of exposed soil. The parking lot covers an area of approximately 160 m². Prior to the rehabilitation of the parking area, motor vehicles had direct access to the permanent vegetation areas of the beach and in several places, vehicles could get to the beach area, and sometime traversed the beach in the evenings.



Current conditions to the road leading to Playa Tamarindo.



The procedure was, first, to delineate the parking area above the permanent vegetation zone of the beach. This delineation was conducted by installing wooden posts buried about 18 inches deep and fixed with concrete at base leaving about 30 inches pole to demarcate the area. Wooden posts were placed at a distance of three feet from



Process of demarcation and delimitation of the new parking area.

each other to prevent the passage of small vehicles such as golf carts that have become a major means of transportation in Culebra. Each pole was connected to each other by using 2x6 boards, which in turn, act as a barrier to keep in place the stone used to stabilize the parking lot.



Process of creating the new parking area.





Parking stabilization process.



Second, stone was laid in the parking lot to promote infiltration and reduce surface water flows causing erosion during rainy periods. Approximately 60 m³ were used of A1 washed stone. The material used has the same specifications of the material that was approved by the DNER to stabilize coastal roads and trails in the Reserve International Guanica Dry Forest. The stone was compacted slightly using manual equipment to both maintain a safe walking surface and some degree of infiltration in the area. Prior to the placement of the stones the ground was leveled. Third, erosion control plants and infiltration galleries were added to enhance deposition of sediment from the runoff from the road and parking lot. 600 vetiver plants (*Vetiveria zizanioides*) were planted to reduce runoff and enhance sediment deposition. The vetiver has a dense and deep root system that intercepts surface runoff and reduces energy of the water and traps sediment. Fourth, the shoulder area of the road where most of the runoff was generated and conveyed now intercepts water through cross swales at five locations to break up flow paths and reduce concentrated flow of runoff over the historically dirt parking lot.



Improvements to the road drainage -- attenuation and flow reduction and redirection.

Fifth, we created two small bio-filters/infiltration galleries to treat runoff not infiltrated by the parking lot. The bio-filters were built with wood, sand and gravel. Temporary sedimentation measures (silt fence) controls were installed prior to construction and remained in place for the duration of the implementation.



Images of bio-filters/infiltration galleries been built.



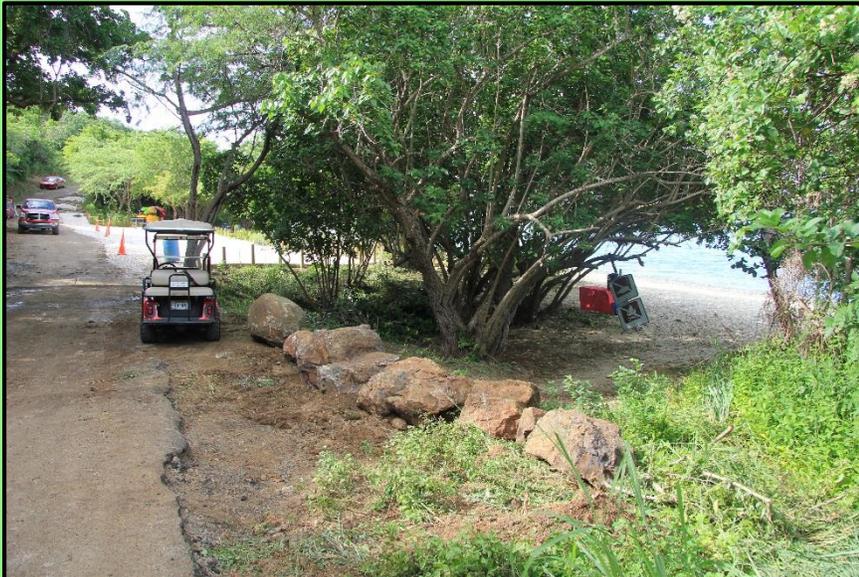
During the last municipal administration there were some attempts to pave the road and only stage culminated with concrete cross swales with exposed bare soil at both ends (which actually worsened sedimentation problems from the access road).

Currently, the Municipal Administration of Culebra is finalizing details to complete the paving of the road. The second phase of the Environmental Restoration project involves the reforestation of the Tamarindo access road and creating rain garden catchments at many of the cross swales along the road. This final phase of the project will begin during the month of October or November depending on rainfall. As a precaution, large rocks were placed to prevent the passage of vehicles on the exposed soil areas and areas were created to temporarily trap sediment.



Images of erosion problems of the road and temporary measures to control erosion and sedimentation





Another aspect of our work was to stabilize and block an area sometimes used to access the beach with vehicles which also was an eroding conveyance of runoff from the access road to Tamarindo beach. The work in this section consisted of placing large rocks that surround the vehicular access and stabilizing the eroding access with large stone sized gravel to minimize erosion. The area was reforested with seedlings and emajagüillas. This section was designed and implemented by the Culebrenses, Omar Villanueva, Alexander Ayala and Tomás Ayala, who took part in a workshop on techniques for erosion and sedimentation control that we facilitated about a year ago in Culebra. The Ayala's were also volunteers in the effort providing their technical assistance and expertise to benefit their community. It was great to see the community leading the establishment of erosion and sediment control practices.

Sedimentation and erosion control practices established by the community.



The coastal habitat at Tamarindo beach had been seriously impacted by public uncontrolled public access and was in a very dilapidated state where the soil was compacted and eroding into the near shore waters. In order to restore the coastal vegetated berm and buffer, the team re-planted native species of endemic to coastal areas of Puerto Rico. Over 325 trees and shrubs were planted including a hundred sea grapes (*Cocoloba uvifera*), a hundred emajagüilla trees (*Thespesia populnea*), a hundred cooperwood (almácigo) seedlings (*Bursera simaruba*) and thirty icaco bushes (*Chrysobalanus icaco* L.). Furthermore, the project defined the pedestrian access areas to the beach. Reforested areas were delimited and access restricted primarily to three areas of public access. In two of these areas small elevated boardwalks were constructed for the public to access the beach without impacting vegetation and sand dunes. In the area closer to the coast the sea grapes planted at an average distance of one foot apart, and in two parallel lines



Design process to reforest areas.

with the purpose of accelerating the accumulation of sand trapped by the wind. This process will increase the height and diameter of the sand dune. In the upper berm area, we successively planted emajagüillas and almácigos and between the parking area and division of permanent vegetation zone icaco bushes were planted. All trees planted were a contribution of DNER nurseries including Cambalache in Arecibo and the Mayagüez nursery. The plants and assistance were provided by the nurseries as part of the Sustainable Forestry Network. For irrigation at the restoration site, a 400 gallon cistern was installed in the area and the Municipality of Culebra has been filling it once a week.



Reforestation process.



Boardwalks to delimit the beach access and protect the dunes and vegetation.





Images of the completed project.





Images of the completed project.





Images from a video camera located in the Project area during the process. From left to right, the pictures show the Project from day one to day five.



Costs

The cost of this project and the specific expenses are summarized in the following tables. The first table shows the direct costs of the project and the entity responsible for providing the funds. The second table shows the indirect costs associated with the project and the contributions made by different entities. Indirect costs are estimates based on current market value. The team Protectores de Cuencas and Ridge to Reefs, was composed of ten workers skilled in masonry, carpentry and general environmental restoration, two biologists, an agronomist, an engineer and two landscape architects.

Table I. Costs summary

Activity	Entity	Cost
Labor and Manpower	NOAA Coral Reefs Conservation Program	\$4,043.50
Rental Equipment and Materials Transportation	NOAA Coral Reefs Conservation Program	\$7,768.75
Materials	NOAA Coral Reefs Conservation Program	\$7,413.40
Coordination, Design and Engineering	NOAA Coral Reefs Conservation Program	\$11,025.00
Gasoline and Transportation	NOAA Coral Reefs Conservation Program	\$1,889.01
Per Diem	NOAA Coral Reefs Conservation Program	\$1,173.72
TOTAL		\$ 33,313.38

Table II. Contributions Summary Indirect Estimates

Entity	Activity	Quantity	Total Cost
DNER	Adult tres	300 trees/\$20 per tree	\$6,000.00
DNER	Accommodations	12 persons/ one week / \$100 / night	\$8,400.00
DNER	Technical assistance	40 hours	\$2,000.00
USFWS	Technical assistance	20 hours	\$1,000.00
TourismCompany of Puerto Rico	Technical assistance	20 hours	\$1,000.00
CORALations	Coordination with Green School for reforestation and irrigation for the first 2 months	60 hours	\$3,000.00
Abby's School Culebra	Assistance maintenance and irrigation	30 hours	\$1,500
Municipality of Culebra	Using rolo road roller	\$100 / day/ 2 days	\$200.00
Municipality of Culebra	Labor	2 people 4 days	\$1,800.00
NOAA	Labor and technical assistance	1 person for 7 days	\$3,000.00
Protectores de Cuencas y Ridge to Reefs	Uncompensated work hours	Time donated to the project	\$3,000.00
TOTAL			\$ 30,900.00