Developing Community-Based Management Approaches for the Punta Cabullones Natural Area

An Interactive Qualifying Project submitted to the faculty of
WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment
of the requirements of the Degree of Bachelor of Science on
December 16, 2015.

By: Dan Bettigole, Emma Healey, Kimberly Marrion, and Anna Wortman

Submitted to:

WPI Advisors: Karla Mendoza-Abarca, Fred Hart

Sponsor: Para la Naturaleza

Abstract

Punta Cabullones, an unutilized area home to many endangered species, is adjacent to the impoverished community of Vallas Torres. Working with Para la Naturaleza, we developed a plan to protect the fragile ecosystems while creating economic growth for the community. By surveying the land, assessing community attitudes, and researching opportunities for economic growth, we created a proposal for community-based management and tourism in Punta Cabullones. We propose a community garden, a beekeeping initiative, trails for tourism, and educational programming.

Acknowledgements

We would like to thank the staff of Para la Naturaleza for all of their assistance and support throughout our proposal development. Additionally, we would like to thank them for the opportunity to learn and work with their organization. We would like to extend special acknowledgements to: Elizabeth Padilla, Elsie Aponte Florenciani, José Silva Almodovar, Sandra Franqui Román, and all of the nature interpreters who gave us tours.

We would like to thank Ricardo Caraballo, an Administrator of the Apiarios Caraballo Corporation, and WPI professor, Robert Gegear, for their consultation regarding our beekeeping initiative.

Finally, we would like to thank Professor Anna Jaysane-Darr for her assistance and guidance in composing our initial project proposal and Professors Karla Mendoza-Abarca and Fred Hart, our project advisors, for their input, direction, and encouragement throughout the project process.

Executive Summary

Background

Puerto Rico is facing an economic crisis with a crippling $72 billion debt and a 12% unemployment rate (As Puerto Rican Economic Crisis Deepens, Supporters of Statehood See Opportunity, 2015). Due to these dire circumstances, many Puerto Ricans are choosing to leave the island in search of new opportunities elsewhere (Cohn, Patten, & Lopez, 2014). In addition to the deteriorating economy, the environment has been suffering as well, with only 8% of its land currently conserved, compared to upwards of 50% on surrounding islands (Para la Naturaleza, n.d.).

Ponce, the second largest city in Puerto Rico, is no exception to the suffering economy with over half of the inhabitants below the poverty line and a staggering 14.4% unemployed. Within the municipality of Ponce, a sensitive ecological area, Punta Cabullones, has been recently acquired by our sponsor, Para la Naturaleza (PLN). Ideally, Punta Cabullones will provide economic income for the surrounding community of Vallas Torres through a community garden and a beekeeping initiative while also conserving and protecting the fragile ecosystems. However, the land is currently unutilized, and the local community does not have the necessary knowledge to preserve it.

We developed a plan for community-based management and tourism in the Punta Cabullones area. The goals of our plan are to:

- Create economic input
- Create community involvement in the conservation efforts led by PLN
- Educate locals and tourists about the significance of the unique ecosystems
- Conserve the natural environment of Punta Cabullones
- Promote ecotourism

Methodology

In order to develop a successful community-based management and tourism plan, we did the following:

- Gained an understanding of the geography of the land
- Determined a potential plan for the use of the area
- Determined the cost of our plan and potential revenue for the local community
- Evaluated how our plan will impact the surrounding area
- Developed an educational program for locals and visitors

The methods utilized to achieve these objectives consisted of developing an area layout through Geographic Information Systems (GIS) surveying, GPS mapping, and geographical observation. We also determined the best options for community participation through research, analyzing the societal effects on the community through communications with our sponsor, and creating an educational program using knowledge gained during site visits.

In order to develop a plan for Punta Cabullones, we needed a clear understanding of the geography of the area. GIS surveying and first-hand observation of the land gave us the insight we needed to determine where to place gardens, trails, a visitors' center, and other facilities.

Next, to incorporate community involvement, we researched the best ways for the people of Vallas Torres to not only engage in the development of Punta Cabullones, but also improve their economic standing. Based on our research and our site visits, we found that utilizing community gardens and beekeeping for honey production would accomplish both of these goals. Therefore, we employed literature review, interview, and cost analysis methods in order to accurately articulate the best way for PLN to operationalize our proposal recommendations.

Finally, according to the information provided to us by PLN's Elsie Aponte Florenciani, we determined that the community needs educational outreach regarding conservation. Through

our visits at other PLN sites, we gained knowledge regarding typical educational programming, signage, and tours.

Findings and Recommendations

Finding #1 – Vallas Torres is a discouraged, impoverished, and unmotivated community in need of unity, income, and responsibility.

Through our correspondence with Ms. Aponte, we learned that the majority of the community is unemployed, the youth are bored, and the neighborhood lacks proper access to transportation, garbage disposal, and recreational areas. The people of Vallas Torres are looking to "be united as a community" and obtain a source of employment and income (Florenciani, 2015).

Recommendation: We recommend creating a community-based management plan for the Punta Cabullones site that includes a community garden, beekeeping initiative, and tourism.

Finding #2 – A community garden will be an impactful form of community-based management to generate income and give families a stake in the community.

Based on our site visit to Hacienda la Esperanza, we are confident a community garden can be implemented and flourish in Puerto Rico's climate. We calculated that giving each household 128 square feet of gardening space has the potential to generate an average of $360 of crops per year. Through our research we have found a substantial list of crops that are known to successfully grow in this area (Table 2.1).

Recommendation: We propose providing each of the 53 families with four 4'x8' plots in the community garden for a total of 212 plots. Additionally, we recommend placing a community orchard adjacent to the community garden.

Finding #3 – Proper management and nectar sources will ensure that a beekeeping initiative will be another successful form of community-based management.

Through contact with one of Puerto Rico's major beekeeping corporations, we learned that Perone hives best mimic the natural nesting behavior and minimize beekeepers' interaction with *Apis mellifera scutellata*, the most efficient honeybee species. Full bee suits and ample amounts of smoke are necessary in order to protect those working with the bees. In order to provide the bees with suitable flowers for foraging, we created a list of potential flowers to be planted in a pollinator garden.

Recommendation: The *Apis mellifera scutellata* honeybee, Perone hives, and proper management techniques should be implemented for successful honey production. In addition, example flowers for the pollinator garden include the common sunflower, Mexican marigolds, billygoat weed, and more may be found in Table 5.1.

Finding #4 – In order to reduce the boredom of the youth, we determined that soccer and volleyball nets are cost-effective activities that could be implemented in a recreational area.

Research and analysis of various outdoor activities to alleviate the youth's boredom found that soccer goals would cost around $100-$150, and a volleyball net would cost $250. Comparatively, a basketball court would cost upwards of $4,000 and playground equipment would cost $5,000-$15,000.

Recommendation: We suggest providing soccer and volleyball nets initially in the recreational area and potentially purchasing playground equipment with further development of Punta Cabullones.

Finding #5 – We determined the materials and locations of the trails at the Punta Cabullones site.

Through our site visits and research, we analyzed various types of materials commonly used in trails. Using GIS, GPS, and observation of our site, we designed the trail map and area layout.

Recommendation: We recommend a trail design, including gravel and boardwalk trails, as seen in Figure 5.2 and an area layout as seen in Figure 5.1.

Finding #6 – The existing Don Q Kiosk needs to be restored to its original state.

Based on the information provided by PLN and our site visit, we were able to analyze the existing site design and create a 3D CAD model of the building. Once this model was created, we used our experiences at other PLN sites to redesign the interior layout while maintaining the historical significance.

Recommendation: We propose that the Don Q Kiosk is restored and repurposed as a visitors' center for the Punta Cabullones site as seen in Figure 5.3 and Figure 5.4.

Finding #7 – Educational programming is one method in which PLN promotes conservational awareness and environmental learning.

Through our tours at other site visits, we determined that tours, open houses, and workshops are common ways of getting visitors involved while teaching them the importance of protecting natural ecosystems.

Recommendation: We recommend implementing educational programming such as guided tours, workshops, and open houses as advertised in Figure 5.5. We designed potential educational signage as seen in Appendix G.

Project Summary Video

Click the image below for a short video summarizing our proposal for the Punta Cabullones area:

Authorship Table

		Written By:
	Title Page	DB
	Abstract	All
	Acknowledgements	All
	Executive Summary	All
	Project Summary Video	All
	Authorship Table	DB
	Table of Contents	DB
	List of Figures	DB
	List of Tables	DB
1	Introduction	All
2	Background	EH
2.1	Ponce: History, Demographics, and Culture	AW/KM
2.2	Punta Cabullones: Geography and Geology, History, and Importance	AW
2.3	Ecosystems in the Conservation Area	DB
2.3.1	Mangroves	DB
2.3.2	Tidal Marshes	DB
2.4	Threatened Species	DB
2.4.1	Illegal Hunting	DB
2.4.2	Local Birds	DB
2.5	Education	AQ
2.6	Community-Based Management: Definition and Successes	EH
2.6.1	Community Garden	AW/EH
2.6.2	Bee/Honey Production for Community	AW
2.7	Trail Design	AW
2.8	Tourism	HM
2.9	Summary	All
3	Methodology	All
3.1	Area Layout	KM
3.1.1	GIS Surveying	EH
3.1.1.1	GIS of Punta Cabullones	KM
3.1.2	Observation of Land	KM
3.1.2.1	GPS and Area Layout	KM
3.1.3	Don Q Kiosk 3D Modeling	KM
3.1.4	Site Visits	KM
3.2	Community Participation	AW
3.2.1	Community Garden	DB
3.2.2	Beekeeping and Honey Production	AW

Table of Contents

List of Figures

List of Tables

1 Introduction

Puerto Rico is facing an economic crisis with a crippling $72 billion debt and a 12% unemployment rate (As Puerto Rican Economic Crisis Deepens, Supporters of Statehood See Opportunity, 2015). Due to these dire circumstances, many Puerto Ricans are choosing to leave the island in search of new opportunities elsewhere (Cohn, Patten, & Lopez, 2014). In addition to the deteriorating economy, the environment has been suffering as well, with only 8% of its land currently conserved, compared to upwards of 50% on surrounding islands (Para la Naturaleza, n.d.).

Ponce, the second largest city in Puerto Rico, is no exception to the suffering economy with over half of the inhabitants below the poverty line and a staggering 14.4% unemployed. Within the municipality of Ponce, a sensitive ecological area, Punta Cabullones, has been recently acquired by our sponsor, Para la Naturaleza (PLN). Ideally, Punta Cabullones will provide economic income for the surrounding community of Vallas Torres through a community garden and a beekeeping initiative while also conserving and protecting the fragile ecosystems. However, the land is currently unutilized, and the local community does not have the necessary knowledge to preserve it.

To begin the development of this project, we established two main objectives: to involve the local community and to conserve the protected area. To complete these objectives, we had to do the following:

- Take into account the community's feelings of isolation and hopelessness
- Establish opportunities for the community members to gain a sense of responsibility for the area and generate income

- Create an education plan for locals and tourists to be implemented by the people of Vallas Torres

While research regarding conservation, ecotourism, and community-based management is readily available individually, these topics are not often discussed collaboratively to be implemented in one location. Utilizing our research on these three major topics and our findings in Puerto Rico, we designed a plan that aims to establish a sense of responsibility among the community, create an opportunity for income, and educate locals and tourists about important conservation practices.

Development of this plan was broken down into three major steps. First, a layout for the area was determined based on the geography of Punta Cabullones. Next, using our research, findings, and correspondence with key contacts, we established a proposal for community-based management, including gardens and a beekeeping program, in order to give the community a stake in the plan. Lastly, we developed programs to educate locals and tourists about the ecosystems themselves and the appropriate techniques required for conservation. These three major objectives will produce a means for economic growth through land management and ecotourism based in Punta Cabullones.

2 Background

This chapter provides the background information relevant to developing a plan for community-based management and tourism in the Punta Cabullones area. Our plan aims to create economic input, promote ecotourism, conserve the natural environment, educate locals and tourists about the significance of the unique ecosystems, and create community involvement in the conservation efforts led by PLN.

2.1 Ponce: History, Demographics, and Culture

When studying in an unfamiliar place, it is important to gain an understanding of the area and its people. Insight and understanding fosters cross-cultural communication and promotes the sharing of information and experiences (Deeks, 2004). This type of sharing is integral for understanding the community attitudes in the area of study, Ponce, Puerto Rico.

The city of Ponce, located in the municipality of Ponce, is Puerto Rico's second largest city with a population of 166,327 people (Current Ponce, Puerto Rico Population, Demographics and stats in 2014, 2015, n.d.). Ponce struggles economically, with a median household income of $17,211, compared to the median income for all of Puerto Rico, $19,624. Over half of the population of Ponce (50.9%) is considered to be below the poverty level and only 72.3% of Ponce's population attains a high school level education or higher (Ponce Municipio, Puerto Rico, 2010).

Within the municipality of Ponce is the community of Vallas Torres. This community, which has 53 homes, lacks employment, recreation, and unity. In order to give the people of Vallas Torres income and community involvement, developing and conserving Punta

Cabullones, a protected natural reserve two and half miles south of Vallas Torres, is one of PLN's current projects (GoogleMaps).

2.2 Punta Cabullones: Geography and Geology, History, and Importance

Punta Cabullones is a conservation area located in the municipality of Ponce, Puerto Rico. The designation, Punta Cabullones, also includes the areas known as La Esperanza and Las Quintas. It is a land area managed by PLN and covers about 670 acres (La Esperanza-Las Quintas Natural Protected Area, 2014).

The protected area of Punta Cabullones plays an integral part in protecting Puerto Rico's coastline and its endangered species. This area is incredibly unique and fragile. It is an ecological area that contains wetlands, tidal marshes, and a small fringing reef, along with two mangrove channels, one on the east and one on the west side (Bourque, Digeser, Partridge, & Yatim, 2012). The geology of the area, consists of: beach deposits (sand, gravel, and shell fragments), coral reefs, and swamp deposits (clay, silt, and organic materials), as seen in Figure 2.1 (Glover, 1977). The geography and geology of Punta Cabullones is important to consider when developing trails and facilities.

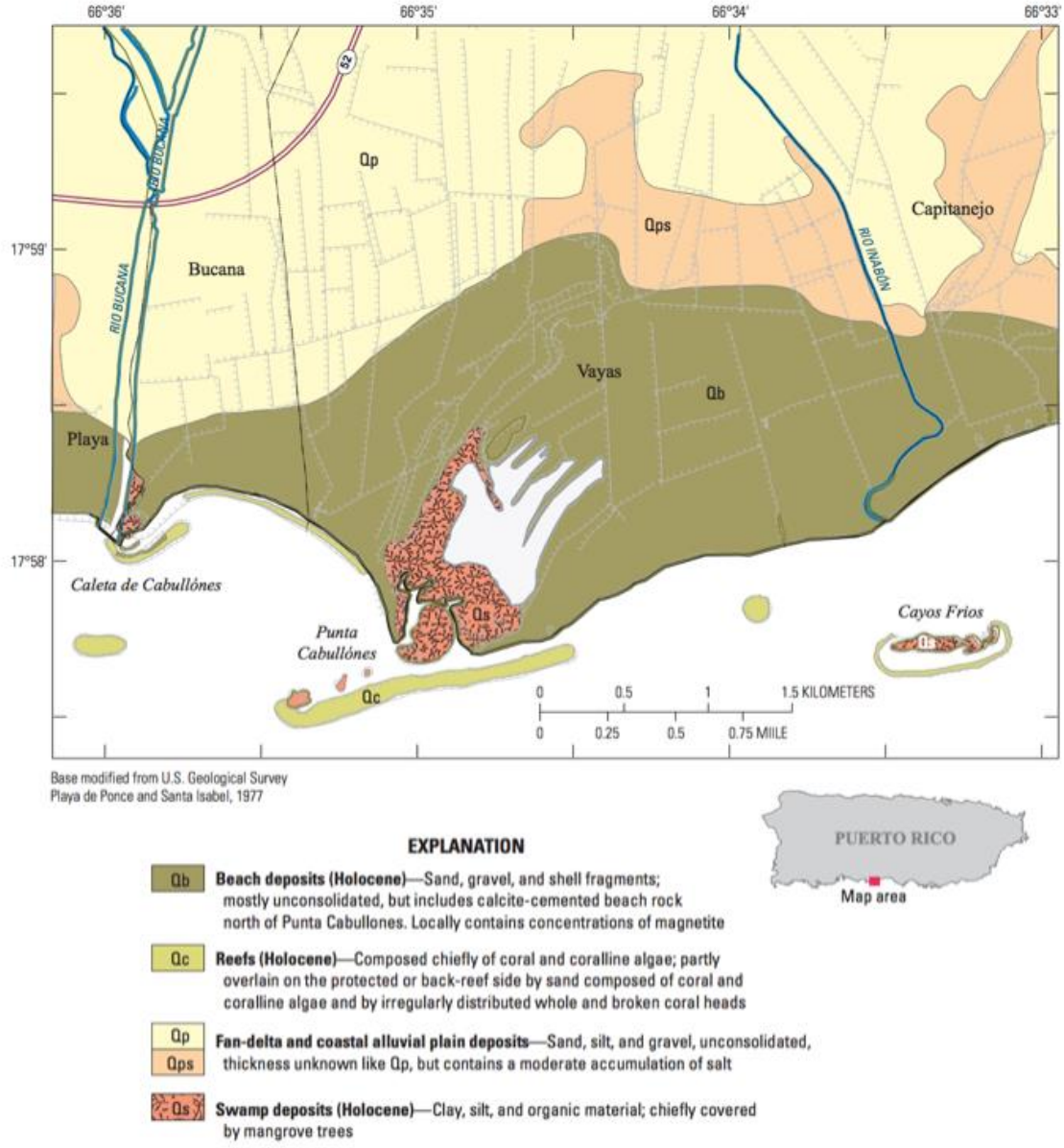


Figure 2.1 – Generalized Surface Geology of the Punta Cabullones Study Area (Glover, 1977).

In the 1980s, the U.S. Fish and Wildlife Service designated Punta Cabullones as a coastal barrier because it acts as a buffer zone to alleviate the effects of storm surges and other natural phenomena. In 2003, the area was set aside as a wetland reserve "as part of the wetlands mitigation effort required by Federal and State agencies to compensate for the negative effect of

dredging the Ponce Bay to build the Las Américas Transshipment Port" (Rodríguez-Martínez & Soler-López, 2014, pp. 1-2). This port improved the export and import of goods into Ponce by making the area a major transnational center. However, by the mid-1900s, "Punta Cabullones had an average progradation rate of 5 feet per year, the highest of any coast in Puerto Rico" (Rodríguez-Martínez & Soler-López, 2014, pp. 51-53). Progradation occurs when a river delta expands farther out into sea over time (Dictionary, Grammatical Category of Progradation, 2015). Because progradation is already being documented on the southern shore and in Punta Cabullones, it is clear that the area needs increased protection.

As a coastal barrier habitat, Punta Cabullones supports a tremendous variety of organisms. These wetlands are vital for the feeding, spawning, maturing, nesting, and resting of millions of fish, shellfish, birds, and mammals. Without this coastal barrier, the organisms and coastline would both suffer. Punta Cabullones is a buffer from erosive waves, high winds, and hurricanes due to the complex system of mangroves on the coastline (The United States Committe on Banking, Finance, and Urban Affairs, 1990, p. 13). For more information on the history of Punta Cabullones refer to Appendix A.

2.3 Ecosystems in the Conservation Area

In 2014, The Conservation Trust of Puerto Rico acquired the Punta Cabullones area in order to conserve the fragile ecosystems. The Conservation Trust then gave PLN the responsibility of conserving the land while increasing tourism and educating both locals and tourists. For more information regarding PLN, refer to Appendix B.

In the Punta Cabullones conservation area, there are many unique ecosystems that are native to Puerto Rico. However, there are two specific ecosystems that are very important for protecting the island: mangroves and marshes. Both provide a base for a distinctive ecosystem of

plants and animals while protecting the coastline of Puerto Rico. These ecosystems in Punta Cabullones need protection due to the past human interactions that have endangered them. They are also a main attraction for tourists visiting Puerto Rico and, therefore, can contribute to economic input into the community if preserved correctly.

2.3.1 Mangroves

Mangroves are defined as “any tropical tree or shrub of the genus Rhizophora, the species of which are mostly low trees growing in marshes or tidal shores, noted for their interlacing above-ground adventitious roots” (Mangrove, n.d.). There are 80 different types of mangroves across the world and four types in Puerto Rico (Marine Life, n.d.). Mangroves are the base of the ecosystems that they grow in, providing food and nutrients to an entire food chain. They provide a habitat for many animals, from small organisms, such as earthworms and algae, to the larger animals, such as birds and reptiles (Miller & Lugo, 2009, pp. 203-204).

Figure 2.2 – Mangroves

(St. John, 2014)

Mangrove forests cover about 25 million acres of land across the world while covering about 75% of the tropical coastlines between 25° N and 25° S (Miller & Lugo, 2009, p. 205). The intricate design of mangroves' root systems makes mangrove forests a necessity for protecting the coastline of Puerto Rico. A mangrove forest with a density of about 30 trees per .01 hectare (1090 square feet) with a depth of about 100 meters (330 feet) can reduce a hurricane's damage to a coastline by 90% (Mangrove Forests, n.d.). Mangrove forests also slow down the speed of the water approaching the shore during high tide to prevent the erosion of the coastline (What is a "Mangrove" Forest, 2014).

The four different types of mangroves in Puerto Rico are red, black, white, and buttonwood. Red mangroves, the most commonly found species in Punta Cabullones, release nutrients that color the water red, giving them their name (Marine Life, n.d.). The mangrove population in Puerto Rico and across the world has been greatly reduced due to human interactions. In Puerto Rico, the mangrove population decreased by 45% during the agricultural era (1800-1940). The population decreased again during urbanization in the 1960's and 1970's (Martinuzzi, Gould, Lugo, & Medina, 2009, p. 78). However, due to conservation efforts, the mangrove population grew by 12% between 1977 and 2002, but it still has not returned to the population that it was before the settlement of Puerto Rico (Martinuzzi, Gould, Lugo, & Medina, 2009, p. 79). Though the Department of Natural and Environmental Resources (DNER) of Puerto Rico declared mangroves a protected species, they are still being damaged due to the lack of education about their ecological importance and the laws that protect them. In addition, there is very limited law enforcement available to protect the mangroves (Miller & Lugo, 2009, pp. 207-209). Therefore, it is imperative that conservation efforts are implemented in Punta Cabullones in order to protect its mangroves.

2.3.2 Tidal Marshes

In addition to mangroves, tidal marshes are another important ecological feature for protecting Punta Cabullones and other coastlines. A marsh is defined as “a tract of low wetland, often treeless and periodically inundated, generally characterized by a growth of grasses, sedges, cattails, and rushes” (Marsh, n.d.). Tidal marshes are marshes which are located on the coastline and are affected by the tides of the ocean. Tidal marshes supply a habitat for a large variety of microorganisms and vegetation (Marshes, 2012). Protecting coastlines across the world, tidal marshes can be freshwater, brackish (somewhat salty), or saline (salty). Each type of marsh provides a habitat for unique types of vegetation and animals (Marshes, 2012).

Figure 2.3 – Tidal Marshes

Tidal marshes function similarly to mangroves in the way that they protect the shoreline from erosion and slow down incoming waves during storms. Additionally, coastline marshes absorb many essential nutrients from the land and rivers before they spread to the ocean. These nutrients are vital for the growth and development of the plants and animals. However, without proper conservation, the collection of runoff leads to high concentrations of pollutants from fertilizers and construction sites as well as sulfur from the surrounding seawater. An increase in pollutants into the ecosystem can lead to bioaccumulation of chemicals, such as mercury, which then enter the food web (Greenburg, Maldonado, Droege, & McDonald, 2006, pp. 680-683). Thus, these consequences must be avoided by educating the locals on the appropriate ways of conserving tidal marshes, a habitat to many threatened species.

2.4 Threatened Species

Punta Cabullones' ecosystems are home to 84 species of animals and 85 species of plants. 77 of the 84 species of animals in the area are birds. Some of these birds have been labeled as vulnerable, threatened, endangered, or critically endangered (La Esperanza-Las Quintas Natural Protected Area, 2014, pp. 13-14). While loss of habitat threatens many species of birds, waterfowl are mainly threatened due to illegal hunting.

2.4.1 Illegal Hunting

In 2009, the DNER tasked a WPI IQP team with developing initial plans to turn Punta Cabullones into a hunting and fishing grounds (Bourque, Digeser, Partridge, & Yatim, 2012). However, before the plan was implemented, hunting and fishing was made illegal on this land when Punta Cabullones was acquired by PLN. Nonetheless, illegal hunting of waterfowl exists due to DNER's initial plan. "This activity in contrary to the conservation goals set for La Esperanza...poses a security risk for users that could visit the property for educational and

recreational purposes" (La Esperanza-Las Quintas Natural Protected Area, 2014, p. 23). Hunting not only poses a risk for the users of the area, but also threatens the species of birds, which have been labeled as vulnerable to critically endangered.

2.4.2 Local Birds

Appendix C contains a table of all of the birds that can be found in Punta Cabullones throughout the year. Some of these birds are endemic, such as the Adelaide's Warbler and the Puerto Rican Spindalis. Others, such as the Prairie Warbler and the Short-billed Dowitcher, are migratory. The table also includes the level at which each bird is threatened. For example, the Brown Pelican is Commonwealth Endangered and the Caribbean Coot is Commonwealth Threatened.

2.5 Education

It has been established that when community members have input and take part in the development of an area, they are more likely to consider and resolve environmental concerns (Armitage, 2005). Education is one way in which community members may become involved in their environment and the protection of all the endangered species that live there.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), environmental education is described as a "learning process that increases people's knowledge and awareness about the environment and associated challenges…. and fosters attitudes, motivations and commitments to make informed decisions and take responsible action." (Solomon, 2010). Community responsiveness to environmental issues is positively affected by community-based environmental education because this type of learning not only builds on individual knowledge, but also creates a sustainable infrastructure for change. Long-term, voluntary actions are more likely to be implemented in conservation practices by those

who have learned through educational strategies like employee training, workshops, and one-on-one demonstrations (Dietz, 2002, pp. 161-162). Teaching people about their surroundings will motivate them to maintain the integrity of the natural areas.

For example, in a German study, an experiment was performed to test whether or not environmental and ecological education increased students' concern and awareness of the ecosystem while changing their behaviors concerning conservation. During the study, one group of students participated in a 1-day field trip to the Bavarian Forest National Park while another group participated in a 5-day residential educational program. In both test groups, outdoor lessons with biological themes and structured participatory learning activities took place. One major difference was that in the 1-day test group, simulations of environmental activities were performed, while the 5-day group utilized the longer trip to complete biological experiments. The results of the experiment showed that both groups of children made significant gains in environmental knowledge. However, students in the 5-day program "were more willing to plan and take action toward the environment with this change remaining constant for a 6-month period" (Bogner, 1998). Also, the participants of the 5-day program were found to have more positive attitudes towards nature, which correlated to an improved behavioral response to conservation. This experiment demonstrated that long-term environmental education can increase one's ability and willingness to preserve the environment.

2.6 Community-Based Management: Definition and Successes

Similar to education, community-based management is a way locals can become involved in conservation. Instead of creating interest as education does, community-based management creates a sense of responsibility for conserving the environment (Singh, Timothy, & Dowling, 2003).

Community-based management is an unconventional “bottom up” plan for dealing with both ecological and economic struggles that a community faces. A traditional “top down” plan is implemented by the government, where economic and ecological concerns are dealt with separately. These plans are executed with little input from the locals or consideration for the community. Top down plans have limited success, as they often fail to account for the viewpoints of those they are aiming to assist. Community-based management is an approach that takes into account the community’s needs, views, and opinions and has the capacity to deal with the many objectives a community may have (Senyk, 2005, p. 5). This style of management is commonly used to make the most of natural resources in and around a community. The collective empowerment that occurs through community-based management aims to aid in overcoming poverty by various tactics including sharing knowledge and community involvement (International Foundation for Agricultural Development, 2006).

A 2008 article in the *Forest Ecology and Management* journal compared neighboring government protected areas in Central Mexico. One, named Zona Maya, had a community-based resource management plan in place, while the other, La Montaña, did not. Historically, Mexico’s plans for protected areas have ignored community members’ needs. However, Mexico also offers “some of the most successful examples of community-based forest management…that had a positive impact regarding forest conservation” (Edward A. Ellis, 2008). The economy of Zona Maya relied heavily on the land due to the implementation of community forestry management. It was found that the plans implemented in Zona Maya were conducive to conserving the area by maintaining forest cover and counteracting deforestation despite the higher populations and infrastructure (Edward A. Ellis, 2008).

Another example of successful community-based resource management comes from the management of mangroves in southeastern Thailand. The mangroves are located in the coastal community of Ban Pred Nai. The locals have been practicing community-based management since 1986 when a group of villagers teamed up to fight off corporate harvesting of shrimp and other resources in the local mangrove forests. Some of their actions included forming the Pred Nai Community Forestry Group, informally patrolling the mangroves, and using the mangroves as a source of income (Senyk, 2005, pp. 16-19). The Pred Nai Community Forestry Group successfully halted destructive corporate agriculture and implemented many conservation methods. These actions have conserved the local mangrove forest, one of the only remaining mangrove forests in the area. Poverty was reduced and there has been an overall increase in "community well-being" (Senyk, 2005, p. 38). PLN emphasized that it is necessary to create a plan utilizing community-based management in order to establish a sense of responsibility to assist in conservation of the area.

2.6.1 Community Garden

A community garden, common in urban areas that have little space for personal gardens, is any piece of land that is gardened and maintained by multiple members of a community. These gardens are an effective way to foster community-based management, allowing locals to plant and take care of plots of land within a specified area. The designation of the plots of land is up to the discretion of the residents, however "the gardens are usually used for horticulture, small-scale food production, cultural and social gatherings and art events" (Eizenberg, 2011). Not only does community gardening produce crops for use by the community (for eating or selling), but also it helps to "generate a sense of ownership and control over the living environment"

(Eizenberg, 2011). Much like community-based management, community gardening "helps forge a sense of belonging towards the overall community" (Neo & Tan, 2009).

Two studies of community gardening, one in urban Singapore and the other in New York City, found that "the production of community gardens changed the status of these residents within the urban power structure" (Eizenberg, 2011). It was noted that the gardens enabled community members to increase their socioeconomic status. Finally, community gardens "also serve an educational purpose" (Neo & Tan, 2009) by educating community members (typically children) about gardening practices and where their food comes from. These gardens benefit communities in numerous ways, from fostering ownership to creating a source of food and economic income.

It is important when considering a community garden option to also take into account the variety of fruits and vegetables that can be grown in a climate like Puerto Rico's. Because it is located in the tropics, average temperatures are around 80°F year round and "most land areas lie at low or middle elevations where there is no frost hazard" (Winters & Miskimen, 1967, p. 1). This means that a wide range of food products can be cultivated and grown crops during all 12 months with generous sunshine most days. For example, during the warm and rainy season (May-October), tropical fruits flourish in Puerto Rico. Bananas, papayas, mangos, citrus fruits, coconuts, pineapples, avocados and even strawberries are grown across the island (Gwenn, 2009). In contrast, during the relatively dry season (November-April), most vegetables can be grown. A full list of vegetable options that would be successful in Puerto Rico can be seen below in Table 2.1.

Table 2.1 – Vegetable Varieties Likely to Succeed in Puerto Rico

Crop	Variety	Remarks
Asparagus	Mary Washington	Can be grown from seed or divisions
Bush Green Bean	Black Valentine, Bountiful, Contender, Improved Tendergreen, Stringless Green Pod, Tendergreen, and Puerto Rico improved white varieties, such as Bonita	
Bush Lima Bean	Burpee Bush, Fordhook 242, Fordhook Bush	
Beets	Crosby Egyptian, Detroit Dark Red, Early Wonder, Improved Blood Red	Other varieties may perform satisfactorily. Tops of all these table varieties may be used for greens.
Broccoli	Calábrese, Propageno	
Mustard	Florida Broad Leaf, Fordhook Fancy, Tendergreen (mustard spinach)	Other varieties probably are as suitable. Curled varieties are likely to harbor insects
Okra	Clemson Spineless, Gold Coast, Louisiana Evergreen, Perkins Spineless, White Velvet	Clemson Spineless, Gold Coast, Louisiana Evergreen, Perkins Spineless, White Velvet
Onion Bulb	Red Creole, Texas Early Grano, White Creole, White Grano, Yellow Bermuda	Seed must be fresh
Parsley	Extra Curled Dwarf, Moss Curled, Paramount, and plain or single	Extra Curled Dwarf, Moss Curled, Paramount, and plain or single
Edible Podded-Pea	Dwarf Gray Sugar, Manoa Sugar, Melting Sugar	Last is a white-seeded variety that may be eaten as shelled peas
Pepper	Blanco del País, California Wonder, Chato, Corozal, Yolo Wonder, Yolo Wonder L	First has thin pale-green flesh
Pumpkin	Alagold, Large Cheese, Small Sugar	First is superior in flavor
Radish	Earliest Scarlet Button, Scarlet Globe Sparkler, White Icicle	
Soybean	Hardee, Improved Pelican, Lee, Seminóle	
Squash	Black Zucchini, Borinquen, Butternut, Camaguey, Cocozelle Bush, Fortuna, Golden Straightneck, Yellow Summer Crookneck	
Sweet Corn	Improved USDA-34, Puerto Rico 50	Perform satisfactorily at low to medium altitudes only
Tomato	Campbell 146, Floralou, Homestead 24, Indian River, Manalucie, Marglobe, Michigan State Forcing, Pritchard, Roma, Rutgers, Selección Platillo	Hybrids have not been thoroughly tested in Tropics
Turnip	Purple Top White Globe, Shogoin	Second is a foliage turnip, grown largely for greens.
Yam	Agua, Congo Yellow, Guinea, Guinea Yellow, Mapuey Morado, Potato, Purple Ceylon, Tongo	

(Winters & Miskimen, 1967, pp. 10-13)

2.6.2 Bee/Honey Production for Community

Another way in which community-based management may help relieve economic crisis and aid socioeconomic constraints is through local beekeeping and honey production.

Due to the nature of beekeeping, it is a "low-cost, sustainable activity with minimal environmental impact" (Nel, Illgner, Wilkins, & Robertson, 2000, p. 28). It is considered a low-cost option because other than the maintenance, hive construction, and honey extraction, there is little physical or economic input for beekeepers. The practice is sustainable in that, beekeeping promotes environmental conservation by using little land and enhancing pollination of indigenous plant species. Finally, there is minimal environmental impact because honey as a product is of high-value and more diverse than traditional agricultural goods (Hilmi, Bradbear, & Mejia, 2011). Thus, beekeeping for the production and sale of honey gives impoverished communities the tools to improve their well-being with little to no negative impacts.

In one African study, beekeeping was shown to improve the lives and economic standing of a local Zimbabwe community. Within Bondolfi, Zimbabwe, there was a severe and on-going economic crisis that led community members to re-evaluate their practices and turn towards self-reliance. In 1994, after a period of crippling drought and based on neighboring systems, the people of Bondolfi initiated a beekeeping project. By 1995, the Bondolfi Beekeepers Association (BBA) was established in order to formalize and optimize their honey production methods. With the BBA in place, "numerous benefits began being derived by participating households…including income, food diversification and a degree of empowerment" (Nel, Illgner, Wilkins, & Robertson, 2000, p. 30). The incorporation of community beekeeping led to the direct improvement of the lives and economic standing of the rural Zimbabwe area. With

similar implementation and practices in Punta Cabullones, results akin to those in Bondolfi may be experienced by the people of Vallas Torres.

When beginning to plan a beekeeping initiative, it is imperative to first find which species of honeybee would be the most effective for use in Punta Cabullones. From a journal article in *Insecta Mundi* titled "The Bees of Greater Puerto Rico," it was gleaned that there is actually only one species of honeybee widely distributed throughout Puerto Rico, *Apis mellifera scutellata*, or the Africanized honeybee (Genaro & Franz, 2008). These are the only species of honeybee used in Puerto Rico for several reasons. First, as told by Ricardo Caraballo, of the Apiarios Caraballo Corporation for honey production in Puerto Rico, *Apis mellifera scutellata* is one of the most efficient honey-producers and has proven very successful for the Apiarios Caraballo Corporation and many other Puerto Rican honey companies. Next, Mr. Caraballo also said that 99% of the honeybees in Puerto Rico are of Africanized blood due to their unique grooming practices that kill *Verroa* mites (Caraballo, 2015). These mites are a common honeybee parasite that are causing Colony Collapse Disorder and killing European bee populations across the globe. Although the Africanized honeybees appeared to be the perfect honey producers, additional research found issues with their demeanor. For example, from a similar interview with Professor Robert Gegear, a professor at WPI, who specializes in the behavioral study of bees, the nature of this Africanized honeybee was discussed. Mr. Gegear mentioned that the Africanized bee is a subspecies of the Western honeybee and has a particularly defensive behavior that has given it the nickname of "Killer Bee" (Gegear, 2015). When *Apis Mellifera scutellata* was introduced to Puerto Rico in 1994, several deaths were actually attributed to these bees (Gegear, 2015). However, since that time, no other deaths have occurred. Recent data suggests that the Africanized honeybees of Puerto Rico are not as

dangerous as their name implies. In a 2012 study called “Gentle Africanized Bees on an Oceanic Island,” research was conducted as to determine why the *Apis mellifera scutellata* bees of Puerto Rico were more gentle and had stopped killing as compared to their ancestors in Africa. It was concluded that due to the tropical climate, the lack of natural predators, and "drift where the African alleles may have been diluted through hybridization with European bees,” the Africanized bees of Puerto Rico are more docile and safer than their counterparts in Africa (Rivera-Marchand, Oskay, & Giray, Gentle Africanized Bees on an Oceanic Island, 2012).

2.7 Trail Design

When working to create recreational trails, it is necessary to be knowledgeable about proper design and construction so that trails may be developed to be sustainable and easy to maintain. Approaches to recreational trail design are well chronicled in *Woodland Stewardship*, a guide written by Melvin J. Baughman, an Extension Forester, and Terry Serres, a graduate research assistant from the University of Minnesota. This guide breaks down trail formation into 9 steps:

1. Determine the Trail Uses
2. Select the Corridor
3. Establish Design Standards
4. Mark Trail Location
5. Clear the Trail
6. Construct the Tread
7. Install Structures
8. Sign the Trail
9. Install Facilities

See Appendix D for a description of each step listed above.

2.8 Tourism

One of the main reasons for implementing trails at Punta Cabullones is so that tourists and locals may enjoy the area. Many places around the world, including Puerto Rico, rely

heavily on tourism to bring economic growth into the area. For most, this economic growth comes from increased employment rates, profits from the tourists themselves, and the secondary effects of having large numbers of foreigners in a condensed area. However, in addition to creating employment opportunities and economic input, tourism can also educate the community and travelers about the surrounding area's history, environment, architecture, and in the case of Ponce, the unique ecosystems in the Punta Cabullones area. Implementing ecotourism in the Punta Cabullones area would bring income for the Vallas Torres community and would educate locals and tourists about the importance of conservation. See D.1 for more information regarding tourism.

2.9 Summary

Punta Cabullones, an area on the coast of Ponce, is an ideal location for the implementation of a community-based management plan for a community garden, pollination garden, visitors' center, and potentially ecotourism in the area. This plan aims to create economic input while educating the locals and tourists about the area and the importance of conservation. With the assistance of PLN, this plan will provide the people of Vallas Torres with the necessary means to conserve their environment and improve their economy.

3 Methodology

In order to develop a successful community-based management and tourism plan, we did the following:

- Gained an understanding of the geography of the land
- Determined a potential plan for the use of the area
- Determined the cost of our plan and potential revenue for the local community
- Evaluated how our plan will impact the surrounding area
- Developed an educational program for locals and visitors

The methods utilized to achieve these objectives consisted of developing an area layout through Geographic Information Systems (GIS) surveying, GPS mapping, and geographical observation. We also determined the best options for community participation through research, analyzing the societal effects on the community through communications with our sponsor, and creating an educational program using knowledge gained during site visits.

3.1 Area Layout

In order to develop a plan for Punta Cabullones, we needed a clear understanding of the geography of the area. GIS surveying and first-hand observation of the land gave us the insight we needed to determine where to place trails, a visitors' center, and other facilities.

3.1.1 GIS Surveying

GIS has many applications that were useful in developing a plan for the infrastructure in Punta Cabullones. GIS surveying attaches various data to specific geographic locations (National Geographic, 2015). This allowed for analysis and understanding of the land in ways that normally could not be seen through simple observation of aerial photos. The information from GIS surveying was used to determine the current state of Punta Cabullones prior to our first site

visit. The use of GIS surveying also enabled us to determine the locations of the waterways, such as the wetlands and lagoons of the area.

GIS software is often used to determine areas that are suitable for tourism. For example, in Kayseri, Turkey, GIS was used to assess the viability for tourism in various rural areas. These areas were determined by using information such as elevation, slope, and precipitation (Meliha Akhbasunda, 2014).

With a similar methodology, we used GIS software to determine elevations, water levels, and the locations of wetlands. After our site visit, we were able to upload the GPS points of locations of interest to the GIS software. This allowed us to identify sites for walking paths and other facilities, such as parking, a visitors' center, and community garden in the Punta Cabullones area. GIS mapping showed us an aerial view of the land with pertinent data overlaid, allowing us to see more information than available when observing the land firsthand.

3.1.1.1 GIS of Punta Cabullones

Using the program ArcMap and data collected by PLN, we were able to study different maps of the Punta Cabullones area such as land cover and satellite images from various years. When PLN acquired the Punta Cabullones site, they took GPS points and created an outline of the property that they now own (Figure 3.1). When looking at this outline, we determined that the land we had previously believed was under PLN's ownership belonged to someone else. Throughout our preparation, we had believed that the actual cape of Punta Cabullones, where the majority of the mangroves are concentrated, was going to be the focus of our project site. However, once we determined that the cape itself does not belong to PLN, we had to focus on the dry land and how we could utilize that area in our plan without focusing on the mangroves.

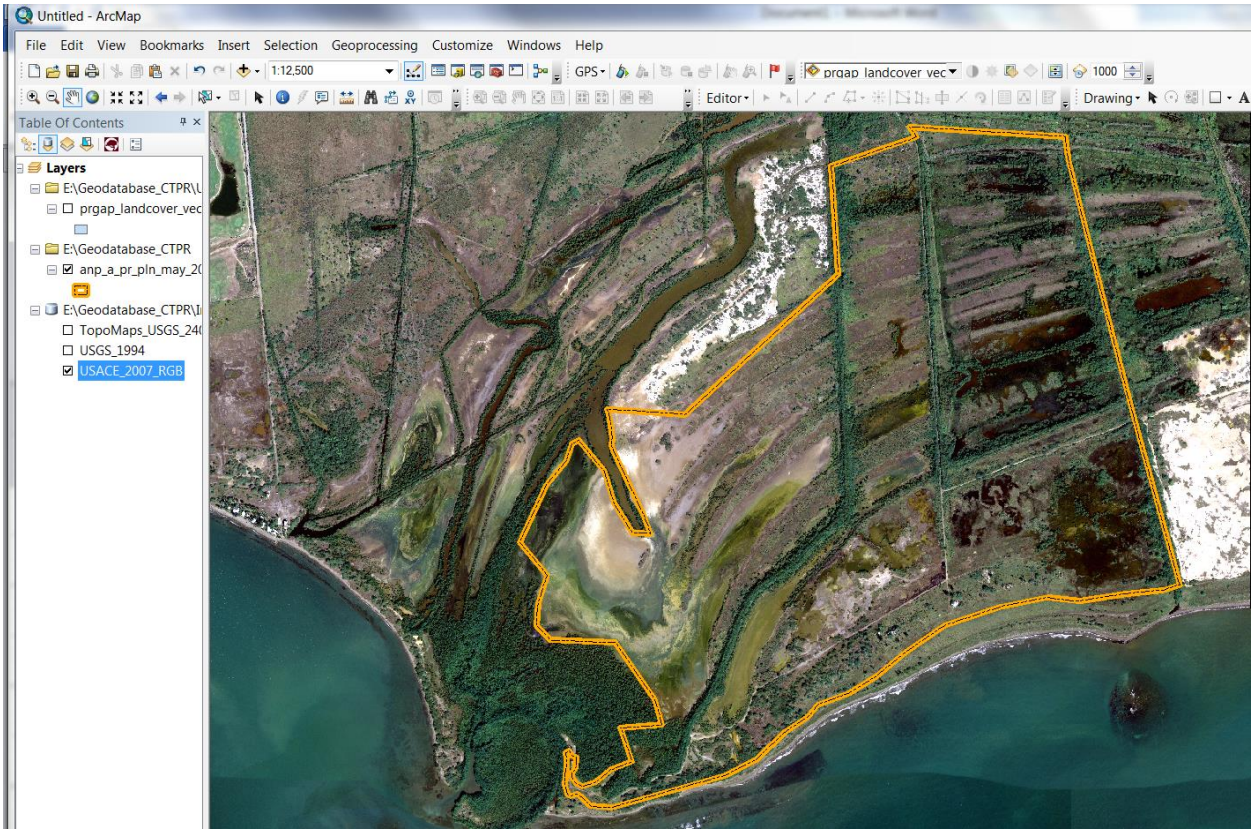


Figure 3.1 – ArcMap GIS Output

3.1.2 Observation of Land

Despite the extensive information available on the geography of Puerto Rico through GIS mapping and research, the most valuable information regarding the geography of Punta Cabullones came from empirical observation. Our site visit to Ponce provided insight into the ecosystems of the area, the best locations for paths, a visitors' center, and lookouts, as well as the current condition of the area that, in combination with the data from GIS mapping, provided enough information to develop a successful plan for the area.

In order to confidently propose a plan for the Punta Cabullones area, we conducted a field survey onsite. To prepare for our visit, we studied the GIS maps of the area and determined a plan of action. We planned to assess the land in order to find the best locations for a community garden, walking trails, and various other facilities.

To reach the Punta Cabullones site, we traveled down an unpaved road for approximately two miles. This road, which is prone to flooding, is not entirely owned by PLN. Upon arrival we began our site visit at an abandoned building known as the Don Q Kiosk. This building, currently in disrepair, will be restored into a visitors' center. From this point, the sea and the mountains are both visible. Throughout the property, there are various pre-existing paths and trails that allowed us to explore and document the approximately five acres of dry land surrounding the abandoned building that may be used for development. The remaining 665 acres consist of wetlands, coastline, and mangrove forests. We walked around this area in order to survey as much of the land as we could.

3.1.2.1 GPS and Area Layout

Upon returning from our site visit, we uploaded all of the GPS points taken in the field into a GPS software. This software identified the longitude and latitude of each point in addition to the corresponding notes taken in the field on the GPS device. From this software, we imported the data into the GIS maps, as seen in Figure 3.2, and proceeded to mark out the trails, locations for facilities, and the areas we surveyed.

Figure 3.2 – GPS Tracking Points

Using ArcGIS, we drew shapes on the map to designate the areas for the community garden, community orchard, pollination garden, compost, nursey, parking lot, and picnic area. We placed pins at each location for the shelters and drew lines along the trails we had marked with the GPS points. We were able to see the building on the map, and marked that with a star to represent the visitors' center. Refer to Figure 5.1 in section 5.1 for a completed map of the area. The use of GPS and GIS programs enabled us to translate our location in the field to locations on a map so that we could accurately layout the area and trails of our site.

3.1.3 Don Q Kiosk 3D Modeling

In order to design the renovations necessary to convert the Don Q Kiosk into a visitors' center, we utilized Autodesk Revit, a computer-aided design software, to redesign the historical kiosk. PLN provided the documentation that a local engineering and surveying company created after an initial investigation into the structures at the site. From these documents (Figure 3.3), we were able to use the scale to determine the dimensions of the building and create a model in

Revit. Then, using pictures and videos taken during our site visit, we were able to make the building look as realistic as possible in order to restore it to its original state.

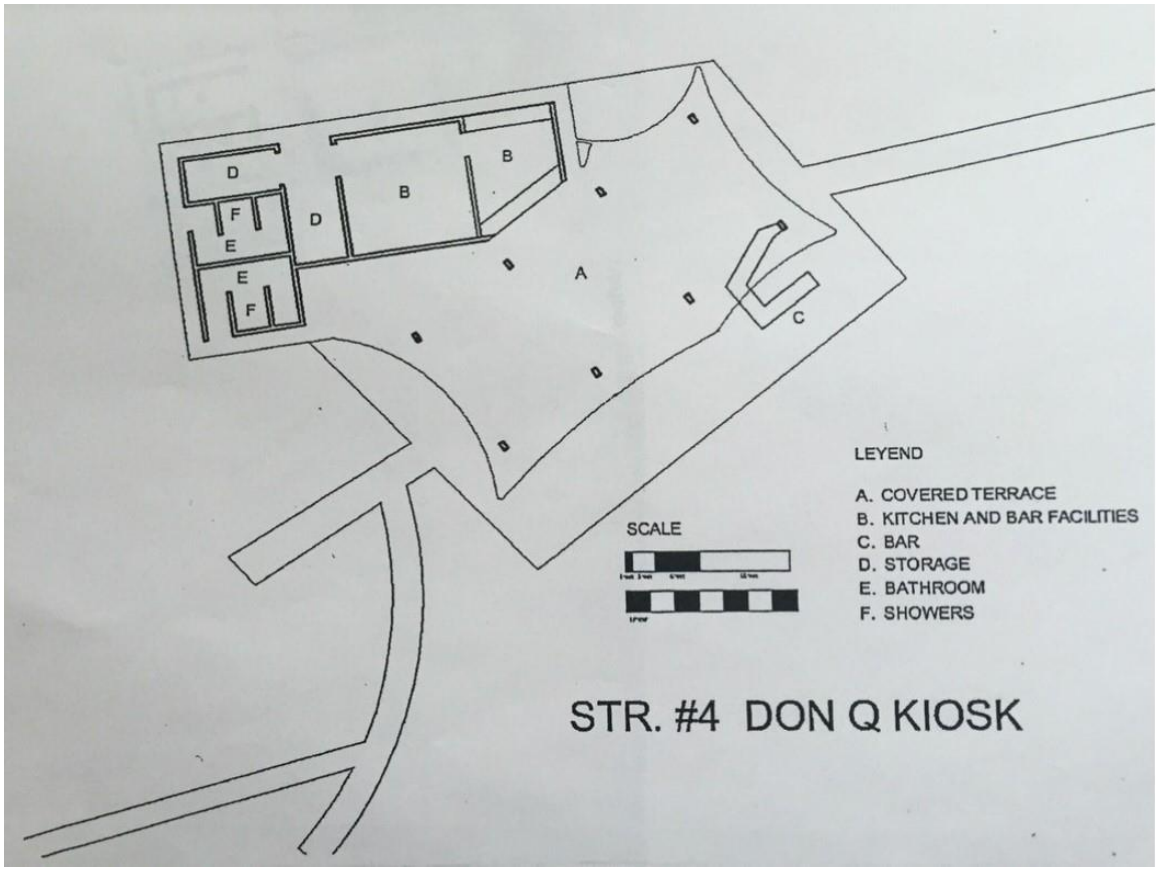


Figure 3.3 – Don Q Kiosk Documentation

(Colón-Zavala, 2012)

Given the dimensions of the Don Q Kiosk in the documents from PLN and the appearance from our site visit, we were able to create a 3D model of the building. The first step was to create the floor plan of the building. To do so, we used dimensions and estimated the height of each wall. Because the building lacked doors and windows, we left all the walls with simple openings. After the walls were in place, we moved on to the roof. The roof of the Don Q Kiosk overhangs the building and the adjacent patio and is supported by eight concrete columns.

Using the document from PLN as an underlay, we were able to trace the abnormal shape of the roof as the footprint and extrude it into a flat roof system. The entire building sits atop a building pad that extends under the overhang of the roof as a patio. Refer to Figure 5.4 in section 5.1.2.3 for the completed rendering of the Don Q Kiosk.

3.1.4 Site Visits

In addition to observing the Punta Cabullones area, we visited two other PLN sites to see examples of what we could implement in our site design. The first site visited was Hacienda Buena Vista, a waterfall that powered a coffee plantation in the mountains. The second site was called Hacienda La Esperanza, a sugar plantation in Manatí that once employed slaves. Both of these site visits gave us insight into what PLN expected from our project.

3.2 Community Participation

In order to incorporate community involvement, we researched the best ways for the people of Vallas Torres to not only engage in the development of Punta Cabullones, but also improve their economic standing. Based on our research and our site visits, we found that utilizing community gardens and beekeeping for honey production would accomplish both of these goals. Therefore, we employed literature review, interview, and cost analysis methods in order to accurately articulate the best way for PLN to operationalize our proposal recommendations.

3.2.1 Community Garden

An important aspect of a community garden is the layout of the garden and the size of each individual plot. In order to better our understanding of these aspects, we observed the community gardens at Hacienda la Esperanza. This garden, shown in Figure 3.4, gave us an idea of what PLN expects of a community garden. Next, we were able to research other details about

how to make an ideal garden, which we then used to develop our final plan for the garden plots in Punta Cabullones.

Figure 3.4 – Community Garden in Hacienda la Esperanza

In order to determine the initial cost of building the community garden, we determined the size that each plot should be and how many plots each family should get. From this information we were able to determine how many wood planks would be needed to create a border and the amount of topsoil needed to fill each garden.

3.2.2 Beekeeping and Honey Production

In addition to community gardens, pollination gardens and beekeeping are other positive forms of community management that could generate economic growth. When planning for beekeeping and honey production, it is important to determine the best species of bee for production, the management needed to raise them, and the flora needed to support maximum honey yield.

To start, we contacted several relevant and knowledgeable people. The first of which was a professor with essential insect pollinator research experience from Worcester Polytechnic Institute (WPI), Professor Robert Gegear. Next, we reached out to, and were able to speak with, a local Puerto Rican honey producer, Ricardo Caraballo of the Apiarios Caraballo Corporation. With the help provided by interviewing and questioning these two contacts, we were able to determine which species of honeybee would best be suited for use in the Punta Cabullones beekeeping initiative.

Next, based on the interviews, several additional questions were raised that could not be answered by our contacts due to time constraints and their busy schedules. However, by utilizing key research practices, we were able to discover the information needed to answer said questions. This information included data on the management of the honeybees and the species of flowers they need to make enough honey for the people of Vallas Torres to sell for an economic benefit.

3.3 Societal Effects and Involvement

Developing a community garden and beekeeping initiative in Punta Cabullones could significantly impact the surrounding communities and their businesses. Therefore, one of the main components of this project is to gain insight for the growth and advancement of the Punta Cabullones area. This section discusses the means by which we have gathered the information necessary to assess the opinions and desires of local businesses for this proposal and the community involvement.

3.3.1 Determining Effects on Businesses

We sent interview questions to the Hilton Ponce Golf & Casino Resort, Costa Caribe Resort, Ponce Plaza Hotel, and the Howard Johnson Hotel, the hotels closest to Punta Cabullones

(The Best Lodging in Ponce, Puerto Rico, n.d.). We contacted their managers and asked questions regarding how they feel about increased tourism and if they would like to be involved with possible tourist excursions to Punta Cabullones. We also asked about their interest in purchasing locally grown, organic crops. This will determine if selling the crops grown in the community garden will be a viable source of revenue for the local community. Refer to Appendix F for interview questions.

3.3.2 Ethical Concerns

In gathering the opinions and attitudes of local businesses through questions and interviews, we needed to be cognizant of the ethical concerns these practices could potentially raise. As the psychologist Milton Rokeach said, "conflict is activated in situations where one or more conflicting values become activated" (Singh, Timothy, & Dowling, 2003, pp. 136-138). If we asked a question that caused a subject strife, their discomfort would become a source of contention in our method of study and conflict would arise. Therefore, in order to maintain subjects' rights and avoid ethical controversy, questions were developed with careful thought.

Asking more general questions when we interviewed helped us to maintain the integrity of our study and dispense of any ethical concerns. The most important aspects of interviewing were that we minimized risk, protected confidentiality, and made sure subjects felt free to decline participation.

3.3.3 Understanding Community Opinions

In order to assess community attitudes and opinions for our site, we planned to interview locals in the community of Vallas Torres. However, upon speaking with the community coordinator for Punta Cabullones, Elsie Aponte Florenciani, we learned that there were too many security issues and that we would not be able to speak with any locals. Nonetheless, we were

able to direct our questions to Ms. Aponte and gain an understanding of what would be best for the community.

3.4 Education

According to the information provided to us by Ms. Aponte, we determined that the community needs educational outreach regarding conservation. Through our visits at other PLN sites, we gained knowledge regarding typical educational programming, signage, and tours.

3.4.1 Signs and Graphics

Through site visits, discussions with our sponsor, and observation of current PLN graphics and posters, we established the style often used by PLN. Using these references as a guideline, we were then able to develop educational signs on the local birds and posters for marketing the educational programs to be offered in the area. We utilized Adobe Photoshop, photos we took at Punta Cabullones, and PLN's current graphic designs in order to develop the educational signs and posters.

3.4.2 Educational Programming

Through our site visits to Hacienda Buena Vista and Hacienda la Esperanza, we experienced tours that discussed the historical, environmental, and social aspects of the different sites. In addition to tours, many of the sites offer various programs that educate participants on conservation and the environment while getting them actively involved. Using our experiences, we have designed similar programs for our site to educate the local community members and other visitors on how to manage the land.

3.5 Summary

By analyzing the area layout, community participation, societal effects and involvement, and educational programing, we were able to successfully design a plan for the Punta Cabullones

site. This plan aims to give the community a stake in the conservation of the area while giving them a means of income through the community garden, pollination garden, and educational programing.

4 Results

This section discusses the findings and results of the research outlined above. Through our site visits, area design, community involvement investigations, and research on gardens, we determined the best way to develop a plan for Punta Cabullones.

4.1 Community Outreach Initiative

Through our observation and research we have determined that community-based management in the form of a community garden and beekeeping initiative at Punta Cabullones will be beneficial for the impoverished community of Vallas Torres. As stated in background sections 2.6.1 and 2.6.2, both of these methods have helped similar impoverished communities to become more self-sustained and more economically stable. The following sections discuss the findings and analysis from our observation and research.

4.1.1 The Vallas Torres Community

Our correspondence with Ms. Aponte has given us much of the necessary information regarding the Vallas Torres community. The sugarcane plantation in Punta Cabullones once offered many opportunities for employment. However, from the time the plantation closed in 1935, there have been no new sources of employment in the area surrounding Vallas Torres. The high unemployment rate has made this community very impoverished. The area has no access to public transportation, proper garbage disposal services, or recreational areas. The majority of the youth are unemployed, bored, and lack motivation, hope, confidence, and a sense of community. The people of Vallas Torres are looking to “be united as a community” and obtain some source of employment and income (Florenciani, 2015).

Therefore, we have developed a plan for Punta Cabullones to give the community an area to grow crops to sell for income, and have spaces to play, relax, and learn. Based on the fact that the community is impoverished, we developed a community garden and beekeeping initiative that will give them a source of economic income. In order to give the youth a place to play, we designated an area for a recreational field. Lastly, we created trails and educational programs to prevent boredom in the community and give Punta Cabullones potential for a tourism plan for educational programs, concessions, and a visitors' center that could continue to increase the economic wellbeing of the community. Generating a community-based management plan in Punta Cabullones would create the opportunity for the locals of Vallas Torres to develop the land and earn money, while giving them a stake in the conservation of the area and establishing a sense of pride and unity.

4.1.2 Community Garden at Hacienda la Esperanza

We had the opportunity to take a tour of one of PLN's protected areas that is open to the public, Hacienda la Esperanza. After the tour, the nature interpreter was able to give us useful information about the community garden located in this protected area.

The volunteers, who maintain this garden, are offered the harvest in return for their gardening services. All of the plots are shared by the volunteers, and the plants are either edible or medicinal. Crops such as bananas, peppers, papayas and mint are grown in the garden. The garden encompasses a small area but also includes a nursery and a small-scale compost station which are vital for a self-sustaining garden. The compost station, supplied by garden and food waste, produces compost which is used as fertilizer.

The community garden at Hacienda la Esperanza served as a model for the community garden to be implemented at Punta Cabullones. Similar to the beds at Hacienda la Esperanza,

raised plots will be beneficial for Punta Cabullones due to its saline soil. However, rather than having communal plots, we plan to dedicate specific plots to each household in the community. The plants at Hacienda la Esperanza provided a standard for the crops to be recommended in Punta Cabullones' community garden. Lastly, the example compost station gave us the idea to include a compost station in our proposal.

4.1.3 Community Garden

Based on the garden at Hacienda la Esperanza, we are confident that a community garden can be implemented and can flourish in Puerto Rico's climate. Similar to the garden we saw at that site, plots in Punta Cabullones would be sectioned off by raised soil boxes. An example image may be seen below in Figure 4.1.

Figure 4.1 – Hacienda la Esperanza Community Garden

Raising the soil in this manner provides several key advantages. First, with each box being 4'x8', there will be sufficient room for growth, competition for nutrients in the soil will be lessened, and overcrowding of the plants will not occur. Secondly, using the boxes will ensure that the growing space is leveled; an important feature for even water distribution and drainage. Also, using the boxes will allow the use of imported topsoil rather than the native, saline soil which is poor for growing. Lastly, sectioning the land in this way will provide every household with an equal amount of space in which to grow. Separate growing spaces will allow families to grow crops specific to their needs.

4.1.3.1 Cost of the Community Garden

There are two main expenses in order to build the community garden in Punta Cabullones: wood planks and soil. Based on our research, we found that the most common height for a raised garden is 11 inches above the ground (Raised Garden Beds, 2014). Based on these findings, 2"x12"x12' pressure-treated wooden planks would be the best selection for the garden plots. The 12-inch boards would be slightly less than 11 inches high because they need to be dug into the ground, but they should suffice for the implementation of these raised gardens. The boards that are selected to be used need to be pressure-treated so that they will withstand the salt and water from the soil. We estimated the cost of implementation by referring to Home Depot, where these boards are $37 per plank (2 in. x 12 in. x 12 ft. #1 Pressure-Treated Lumber, 2015).

In order to provide adequate growing soil, topsoil needs to be purchased. Soil does not need to reach the top of the plot, so buying enough to fill eight inches deep in each garden should be sufficient. At Home Depot, topsoil is about $27 per cubic yard (20 cu. yd. Loose Bulk Top

Soil, 2015). However, topsoil alone is not sufficient to grow plants because fertilizer is necessary for nutrients.

During our site visit to Punta Cabullones, we observed that there is an abundance of horse manure that needs to be cleaned up before the community can fully utilize the area. When mixed with soil, dried horse manure provides an ample amount of nutrients (McGinnis, 2008). Using the horse manure as fertilizer will not only clean up the surrounding area for a cleaner site to visit, but also provide free fertilizer to the local community. Table 4.1 shows the estimated price for wood and soil. Total costs are based on having 212 plots (four plots per family and 53 families in Vallas Torres).

Table 4.1 – Estimated Cost of Community Garden

Resource	Price per unit	Cost for one garden plot	Total Cost
2”x12”x12’ Wood Planks	$37 per plank	$74	$15,688
Topsoil	$27 per cubic yard	$21.33	$5,146.20*
	Total Cost	**$95.33**	**$20,834.20**

*Cost includes delivery fee of $69 per truckload

4.1.3.2 Community Garden Impact Analysis

Through analysis of produce cost and harvest yield for small scale gardens, we have determined average potential revenue for each family. Plots for families in the community garden will have positive socioeconomic impacts for the members of Vallas Torres. Allotments of four 4’x 8’ gardening plots creates 128 square feet of gardening space for each family of the community. Because small-scale gardening can produce a half pound of crops per square foot of garden per each of Puerto Rico’s two growing seasons, one pound of crops can be grown per square foot per year. Therefore, throughout the year, each family can expect an average of 128

pounds of crops, which may be used for consumption or sale (Rabin, Zinati, & Nitzsche, 2012, p. 1).

Calculations comparing the average cost per pound of produce in the United States versus Puerto Rico show that produce is on average 83% more expensive in Puerto Rico (Table 4.2). Using these calculations, the average cost for produce in Puerto Rico is close to $2.82/lb compared to $1.53 in the US. With 128 square foot area for growing, a family can grow an estimated 128 pounds or $360.96 of crops in a year. This harvest can generate another source of income for the families of Vallas Torres.

Table 4.2 – Average Produce Cost/lb – US vs Puerto Rico

Produce	USDA Avg $/lb	Pueblo $/lb	% Difference
Tomatoes	$1.19	$2.29	92%
Onions	$0.57	$0.80	39%
Spinach	$4.45	$9.58	115%
Green Peppers	$1.50	$2.49	66%
Apples (Gala)	$0.87	$2.19	152%
Lemons	$0.99	1.99	101%
Oranges	$0.94	1.89	101%
Papaya	$1.07	0.99	-7%
Potatoes	$0.76	1.69	122%
Red Peppers	$2.99	4.29	43%
Average	**$1.53**	**$2.82**	**83%**

(US Department of Agriculture, 2015) (Pueblo, 2015)

4.1.4 Beekeeping Initiative

When it comes to beekeeping for the cultivation of honey to sell for economic benefit, multiple factors need to be considered for a successful startup. These considerations include:

- The type of hive, its construction, and its maintenance
- The necessary flora for the bees' food and nectar gathering
- An analysis of the economic benefit

As stated in the methodology, section 3.2.2, this information was gathered by interviewing key contacts and performing additional research.

4.1.4.1 Honeybee Management

First, our group performed research in order to assess the management practices needed for the Africanized bee species. From Mr. Caraballo, we learned that his company, similar to other honey companies in Puerto Rico, uses the beehive known as a Perone Hive for the *Apis mellifera scutellata* bees. A cross-sectional view of this type of hive may be seen below in Figure 4.2.

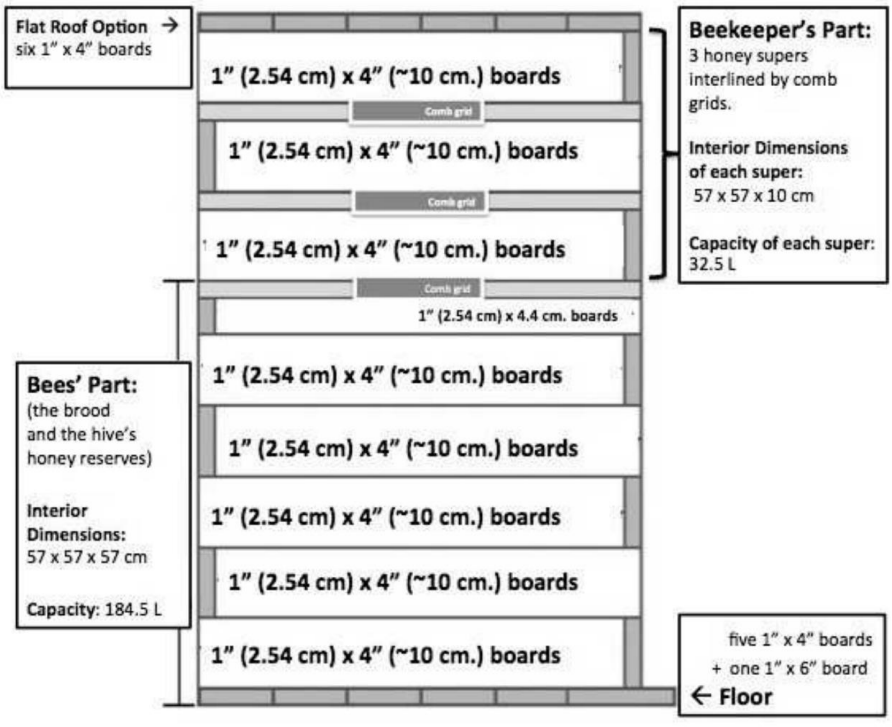


Figure 4.2 – Diagram of the Structure of a Perone Hive

(Perone, McHale, & Torres, 2012)

We determined that this is the best type of hive to manage the Africanized bees. First, we concluded that the construction of this type of hive is relatively easy and inexpensive. The materials needed include a hammer, nails, measuring tape, saw, and untreated wood. For a full description of how to build this type of hive, refer to Oscar Perone's article, "Making a Perone Hive: The PermApiculture Way" (Perone, McHale, & Torres, 2012). This type of hive is beneficial for Africanized bees because it "aims at managing bees in a way more closely analogous to their natural behavior" (Beehives, n.d.). With this type of hive, there are less human interferences with the hive, and thus, the bees would not be disturbed and their aggressive tendencies would be minimized. Also, with this type of hive at a "capacity of 280 L," about 60,000 bees can populate it and produce an average of 30 pounds of honey every year (Honey, 2007). These numbers mean the Perone hive aides *Apis mellifera scutellata* in maximum honey production.

However, beekeepers need to utilize the following additional management practices when dealing with *Apis mellifera scutellata*.

- Each hive should have its own stand so that only one colony at a time is being worked. Individual Perone stands are an ideal way in which to accomplish this. In order to allow beekeepers easy access to each hive, there needs to be adequate space between each individual stand.
- Ample amounts of smoke need to be used when working with the African bee colonies. Because smoke covers the alarm pheromones of the bees, the defensive response of the colony is lessened when more smoke is used.
- Protective gear should always be worn when directly working with the beehives. Unlike beekeepers of some European bee species that only wear a bee veil, keepers

of Africanized bees should wear a full bee suit, boots, gloves, and veil. Additionally, the veil should be white so that bees are not as attracted to it, and the boots and gloves should be taped to the bee suit so that access to the bees is limited (Ellis & Ellis, 2008).

4.1.4.2 Flora Species for the Bees

The next step in establishing a successful beekeeping initiative is to provide the bees with the necessary food for their honey production. Therefore, we researched not only the best wildflowers for honeybees, but also native wildflowers to Puerto Rico. After compiling all information from online sources and from the book, *Descriptive Flora of Puerto Rico and Adjacent Islands*, we have established a list of 10 species of wildflower to be used in a pollinator garden. These flowers are not only native and non-invasive, but also most likely to help the honeybees maximize honey production. For the flowers to work well for *Apis mellifera scutellata*, the length of the carpels, the part of the flower where the nectar is stored, has to be relatively short due to the short length of the Africanized bee's tongue (McFarland, 2013). However, we also wanted to make sure that the flowers were native to Puerto Rico so that invasive plants would not be introduced and potentially harm the natural ecosystem (Liogier, 1995). Based on our research, we created the list of flowers shown in Table 5.1 in section 5.1.1.2.3.

4.1.4.3 Analysis of Economic Benefit of Honey Production

Through the evaluation of the economic benefits of honey production, we have estimated the projected profits for the people of Vallas Torres. Data from *Bee Culture* magazine suggests that retail honey prices per pound are valued at about $6.50 across the United States (Bee Culture

Magazine, 2015). With every hive producing about 30 pounds of honey per year, the calculated value would be about $195 per hive per year for the community in Punta Cabullones.

4.1.5 Recreational Area

The youth in Vallas Torres articulated to Ms. Aponte that they are bored and do not have anywhere to play. Due to this knowledge, we were tasked by PLN to make a space in Punta Cabullones for the youth to play. In the recreational area, there are many activities that could be implemented for the enjoyment of the youth. Soccer goals and a volleyball net would provide endless hours of amusement for the kids while keeping costs low. A pair of full size soccer goals can be bought for about $100-$150 (Soccer Nets - Full Size 24' x 8' Straight Back Nets, 2015). Additionally, a full size, adjustable volleyball net can be bought for about $250 (Park & Sun Spectrum Classic Volleyball Net, 2015).

There are other options for additional activities to add to Punta Cabullones for recreation. A playground is one possible activity that the local youth could enjoy. However, many community-sized playgrounds can range from $5,000-$15,000 (Santos, 2010). Additionally, a basketball court is a common activity to have in a park. Though this would provide entertainment for the kids, basketball courts are very expensive to install. The cost of a half basketball court can start around $4,000, while the cost of a full court starts around $8,000 (Kelly, 2015). Not only is the price hefty, but also due to the condition of the entrance to Punta Cabullones, it may prove difficult to drive a cement truck into the property.

4.2 Trail Design and Visitors' Center

In order to design and plan the trails and visitors' center at Punta Cabullones, we visited other PLN sites to gain insight into what they usually implement.

4.2.1 Trails at Hacienda Buena Vista

While at Hacienda Buena Vista, we were able to study and investigate the design and materials used to build their trails. The majority of the trails were built into the mountainside and consisted of gravel trails with wooden handrails and multiple shelters, as seen in Figure 4.3, to protect visitors from the elements. All of the materials used were natural to the area and blended well with the surrounding environment. The cable fencing reduces the visual obstruction, enabling visitors to see more of the surrounding environment than a completely wooden design. At places where the trail needed to be built up, PLN utilized a wooden boardwalk style path. In some locations, this boardwalk acted as a bridge over rivers and creeks. This boardwalk still contained railings on both sides to ensure the safety of visitors.

Figure 4.3 – Shelter as Hacienda Buena Vista

From this trip, we decided that gravel and wooden boardwalks with wooden railings could potentially be utilized at our site, so we began researching these trail types.

4.2.2 Trail Design and Cost

In order to determine proper trail design and placement, cost comparisons of materials needed to be assessed. Online research methods of tread varieties and maintenance were implemented in order to accomplish this.

In a document from the Ped and Pedal organization titled, *Trail Cost Analysis*, a table of "general costs for elements typically included in trail projects" was included (Trail Cost Analysis, 2010). The information from this table (Table 4.3) may be used to provide cost comparisons for necessary trail elements. Additionally, this document laid out the estimated cost of a five foot wide natural hiking trail to be $8,462 per mile (Trail Cost Analysis, 2010).

Table 4.3 – Unit Costs for Trail Elements

Trail Element	Unit	Price per unit (year 2009 Construction)
Clearing and grubbing	Acre	$2,550.00
Grading for hard-surfaced trails	Mile	$3,800.00
Grading for natural-surfaced trails	Mile	$3,200.00
Granular surfacing	Sq. ft.	$.50
Granular subbase	Sq. ft.	$.50
Asphalt surfacing	Sq. ft.	$1.30
Concrete	Sq. ft.	$3.00
Wood chips	Sq. ft.	$.50
Seeding/mulching	Acre	$2,040.00
Other costs (drainage, signage, and support services)	Mile	10% of trail cost
Planning	Mile	2% of trail cost
Preliminary design	Mile	2% of trail cost
Construction documents	Mile	5% of trail cost
Construction services	Mile	5% of trail cost
Administration	Mile	5% of trail cost

(Trail Cost Analysis, 2010)

After determining this information, we decided that cost analysis for boardwalks also needed to be researched due to the wetland conditions of the Punta Cabullones area. Due to the sensitive ecological nature of wetlands, they are "of great interest to students, scientists, and the general public" (Kusler). However, it is not always convenient or safe to venture into them. Raised boardwalks are one way in which to allow access into these areas and open them up as areas for public education and understanding. Therefore, we found a guide titled, “Constructing Wetland Boardwalks and Trails,” that included several cost options. First, the guide stated that ultimately, costs will depend greatly on the materials used, but "per lineal foot costs may be lower than $20...for a four foot wide, pressure treated boardwalk with eight foot sections utilizing four-by-four pilings, two by eight rafters, and two by eight decking" (Kusler, p. 5). On the other hand, per lineal foot costs could be as high as $100 when using composite materials and a six-foot wide tread. The document then went on to discuss methods by which to reduce costs. These include: using volunteers for construction and maintenance, soliciting lumberyards or other suppliers to donate materials, and reducing the size and length of the boardwalk (Kusler, p. 6).

4.2.3 Punta Cabullones Site Visit

During our site visit to Punta Cabullones, we surveyed the land and decided where the different aspects and trails of our development plan should be located. Upon arrival, we determined that there were already many trails and paths from the prior inhabitants. Because these paths already exist and would not require any destruction to the area, developing these existing paths would be the best decision. We walked many of these trails and determined which ones would be suitable for gravel and which would need a built-up boardwalk. All of the trails on

the five acres of dryland will be suitable if gravel is added. The trails along the beach will be left without any gravel as the sand is suitable for walking. However, the majority of the trails that are near the wetlands will require a boardwalk to prevent flooding and damage to the ecosystems. Based on our findings at Hacienda Buena Vista and through our research, we created a plan for which trails would need gravel, which would need boardwalks, and which would be acceptable as they are.

Figure 4.4 – Key Locations in Punta Cabullones

The figure above shows the key locations that we found when visiting Punta Cabullones. At the end of the access road is an existing building that used to be a kiosk for Don Q. PLN plans to restore this existing Don Q Kiosk into a visitors' center for the site. Therefore, we began our investigation at the kiosk (1) and determined that the parking area should be located close to the building. We found a large area near the access road that would be dry enough for cars to park

(2) and close enough to the visitors' center. In front of the kiosk, towards the beach, is a large, flat, and relatively dry area. We determined that this flat area would be best for the community garden (3) because it lacked trees, rocks, debris and was the least likely area to get flooded by the wetlands. We determined that a small area close to the visitors' center would be a good place for composting (4) so that community members would not have to walk far from the visitors' center to deposit waste. Next to this area, we also decided to add a nursery (5) for the younger plants, similar to that at Hacienda la Esperanza. Because the area was larger than needed for a community garden, we determined that east of the community garden, there would be room for an orchard (6) for families to grow larger trees if they so desired. North of the kiosk, along one of the trails, is another flat area that we determined would be best for the pollination garden and beehives (7). This area is far enough away from the community garden to prevent injuries from the bees but still along a path so that visitors can enjoy the beautiful flowers. West of the visitors' center is another large flat field. We determined that this area would be best utilized as a recreational field (8) for the community. Lastly, south of the community garden is an area of land that we decided could be used as a picnic area (9) due to the beautiful view of the ocean.

4.3 Educational Programming

Through our observation and research we have developed various aspects of educational programming for the Punta Cabullones area. As stated in background section 2.5, education can increase one's ability and willingness to preserve the environment. The following sections discuss the findings and analysis from our observation and research.

4.3.1 Tours and Programs at Hacienda la Esperanza

A variety of tours are offered at Hacienda la Esperanza, including historic and nature tours. We were given a tour on the historic implications of the estate and how nature played a role in sugar production.

This tour served as a model for our signs and graphics. The graphics utilized at this site were minimalistic, modern, and colorful, as seen in Figure 4.5. We created educational and marketing materials for Punta Cabullones based on these standards. The simplistic nature of PLN's graphics and signs made things easy to read and understand. They also utilized both Spanish and English versions of many of their signs.

Figure 4.5 – Sample of PLN's Educational Material

Our tour guide gave us information on the other programs they offer at Hacienda la Esperanza, such as Citizen Science. Citizen Science is a program offering events where

community members can be involved in natural research. Based on the eager involvement of participants in Citizen Science programs at Hacienda la Esperanza, a similar hands-on program would be beneficial and well received at Punta Cabullones.

Hacienda la Esperanza's historical tour was interesting and engaging. This tour showed us that creating a tour at Punta Cabullones integrating both the history and the nature of the area is feasible. All of the tours provided at the estate were guided by a nature interpreter. We will utilize this tour as a basis for the tours that we propose for Punta Cabullones.

4.3.2 History and Technology at Hacienda Buena Vista

Our tour began with a walk through the forest to see the coffee, vanilla, and other species of plants native to the area. The tour was interactive as we were able to try a small-scale cornmeal mill and coffee grinder. The tour ended in the plantation owner's house where we were able to walk around and observe a typical house from that time period. All of the buildings on the plantation were restored to their original state in order to remain true to their history. PLN utilized one of the historical buildings for restrooms and another for offices. The gift shop and visitors' center were outdoors under the roof of a restored patio.

From this tour, we witnessed another example of how PLN structures their tours and educational programing. We were able to observe the environment first, and then learn about the historical context and mechanics behind the plantation itself. The entire tour was interactive and multidisciplinary. We could implement similar programs at Punta Cabullones by providing tours through the ecosystems and explaining their importance before returning to the Don Q Kiosk and discussing the history of the area. The buildings at Hacienda Buena Vista demonstrated the importance of restoring historical buildings to their original state and repurposing them instead of demolishing and rebuilding them. The environment and history of both Punta Cabullones and

Hacienda Buena Vista provide many educational opportunities for the visitors. Refer to section 5.2.2 for our proposed educational programming for Punta Cabullones.

4.4 Summary

Analysis of all of our research and experiences has led us to develop a plan for the Punta Cabullones area. The analysis of the community's thoughts and attitudes led to further investigation of community-based management applications. The knowledge we gained from our site visits supplied us with the information we needed in order to successfully design the trails and layout of Punta Cabullones. These tours also provided a basis for our proposed educational programming. All of the insight gained from these results has led to our finalized recommendations.

5 Conclusions and Recommendations

The following section includes the complete list of our conclusions and recommendations for the development of a community-based management plan located in Punta Cabullones. Through our background, methodology, and findings, we have established seven key recommendations for the area layout and educational programming.

5.1 Layout of Area

Based on our research, site visits, and GIS and GPS mapping, we recommend that the layout of Punta Cabullones is as depicted in Figure 5.1. In this layout, we have included the following:

- Community Garden and Orchard (Section 5.1.1.1)
    - Nursery
    - Composting Area
- Pollination Garden (Section 5.1.1.2)
- Recreational Area (Section 5.1.1.3)
- Trails (Section 5.1.2)
- Visitors' Center at the Don Q Kiosk (Section 5.1.2.3)
    - Parking
    - Picnic Tables

Additionally, there is extra space nearby for any further developments that PLN wants to include in order to help the Vallas Torres community.

Figure 5.1 – Area Layout of Punta Cabullones

5.1.1 Community Involvement

We recommend creating a community-based management plan for the Punta Cabullones site that includes a community garden, beekeeping initiative, recreational area, and tourism.

The best method of management to involve the community of Vallas Torres in the Punta Cabullones protected area is community-based management. This style of management creates a sense of responsibility and a feeling of ownership for the land. More information regarding the benefits of community-based management can be found in section 2.6.

5.1.1.1 Community Garden and Orchard

We propose providing each of the 53 families with four 4'x8' plots in the community garden for a total of 212 plots. Additionally, we recommend placing a community orchard adjacent to the community garden.

These allocated plots would allow each family to produce about 128 pounds of fruits and vegetables such as: tomatoes, eggplant, hot peppers, sage, basil, and mint. Additional recommendations for vegetable varieties may be found in Table 2.1 of Section 2.6.1.

Each plot should be constructed with two 2”x12”x12’ pressure-treated wooden planks. This will allow the height to be 8”-10” for each raised garden. We recommend that the purchased topsoil be mixed with the horse manure and any other compost that is naturally available in Punta Cabullones. This will provide nutrients for the plots resulting in a larger crop yield.

Next to the community garden, we propose setting aside a plot of land for an orchard in which families can grow fruit bearing trees, such as banana or papaya. After the produce has been grown, the household will have the opportunity to either keep all that they produce or sell their goods to local hotels or farmers' markets, depending on the availability of these concessions. The local community will have the opportunity to create economic input through not only a community garden, but also the sale of honey.

5.1.1.2 Beekeeping Initiative

The *Apis mellifera scutellata* honeybee, Perone hives, and proper management techniques should be implemented for successful honey production. In addition, example flowers for the pollinator garden include the common sunflower, Mexican marigolds, billygoat weed, and more may be found in Table 5.1.

We propose a beekeeping initiative to be implemented in Punta Cabullones. The main aspects of this initiative are as follows: the species of honeybee, the management of the bee, the flora for nectar gathering, and the layout of the pollinator garden. The sections that follow outline what we propose for each facet of the initiative.

5.1.1.2.1 Species of Honeybee

As found based on research and interviews explained in section 2.6.2, we recommend using the *Apis mellifera scutellata* species. These honeybees are not only the most predominant species of honeybee in Puerto Rico, but also the most efficient and disease resistant, making them excellent candidates to provide honey for the people of Vallas Torres.

5.1.1.2.2 Management of Honeybee

In order to best manage the *Apis mellifera scutellata* colonies, we propose the use of a specific type of beehive, the Perone hive. Due to the aggressive predisposition of this species of honeybee, additional precautions need to be taken in order to keep the bees and their keepers secure. The Perone hive is constructed in a way that not only imitates the Africanized bee's natural nesting conditions, but also minimizes the need for the keepers' intervention. With the bees located in a more instinctive setting and with the beekeepers interfering less, the aggressive tendencies of the Africanized bees will be minimized and safety will be maximized.

However, utilizing the correct hive does not always ensure protection. Therefore, we also propose that the most thorough measures are taken when suiting up to work with the bees. We recommend beekeepers wear a full bee suit, boots, gloves, and a white bee veil. Covering up in this manner will ensure that there is less risk of being stung.

5.1.1.2.3 Flora Species for the Honeybee

As stated in section 4.1.4.2, based on the results and findings of our research, we created Table 5.1, a table of 10 wildflowers that would potentially help the *Apis mellifera scutellata* colonies flourish. These are the species of flora that we recommend in order to maximize honey yield.

Table 5.1 – Wildflowers Best Suited for *Apis mellifera scutellata*

Common Name	Ulam Raja	Saltmarsh Aster	Common Sunflower
Scientific Name	Cosmos caudatus	*Aster subulatus*	*Helianthus annuus*
Image	 (Cosmos caudatus, 2015)	 (Aster subulatus, n.d.)	 (Heliantus annus, n.d.)
Common Name	Mexican Marigold	Billygoat-Weed	Silver Grass
Scientific Name	*Tagetes erecta*	*Ageratum conyzoides*	*Echinops fruticosas*
Image	 (Tagetes erecta, n.d.)	 (Ageratum conyzoidea, n.d.)	 (Gree, 2011)

Table 5.1 – Wildflowers Best Suited for *Apis mellifera scutellata* (Continued)

Common Name	Tickseed	Brazilian Begonia	Church Blossom
Scientific Name	*Coreopsis alba*	*Begonia hirtella*	*Capparis baducca*
Image	 (Roscoe, n.d.)	 (Hart, n.d.)	 (Capparis spinosa, 2015)
Common Name	Clustered Yellowtops		
Scientific Name	*Flaveria trinervia*		
Image	 (Flaveria trinervia, n.d.)		

5.1.1.2.4 Layout of the Pollinator Garden

Finally, based on our research, we have designed a layout for the pollinator garden that would be safest for honeybees and visitors alike. First, with the layout of the area being 108’

wide and 236’ long, we have decided to designate the upper ⅛ area (27’x59’) for an enclosed section for the beehives. This space is enclosed and located the farthest away from the visitors’ center in order to decrease the chances that the visitors and the bees come into contact. Within this enclosed space, we propose that five Perone hives are setup with at least a foot of space in between each hive. The rest of the area allotted for the beekeeping initiative may be used as a pollinator garden with raised beds containing different wildflowers.

5.1.1.3 Recreational Area

We suggest providing soccer and volleyball nets initially in the recreational area and potentially purchasing playground equipment with further development of Punta Cabullones.

Based on our research on recreational activities, we propose to include soccer goals and a volleyball net as recreational activities as they are the least expensive options. A pair of soccer goals will cost about $100-$150 and the volleyball net will cost about $250 (Soccer Nets - Full Size 24' x 8' Straight Back Nets, 2015) (Park & Sun Spectrum Classic Volleyball Net, 2015). If there is additional funding for the recreational area, we propose the next purchase to be a playground for the Vallas Torres community. Many communal playgrounds cost about $5,000-$15,000, a substantial investment for PLN (Santos, 2010).

5.1.2 Trail Design and Visitors’ Center

Based on our research, site visits, and GIS and GPS mapping, we recommend the following layout of the trails in Punta Cabullones (Figure 5.2). In this layout, we have included:

- Gravel Trails (Blue)
- Boardwalk Trails (White)
- Shelters and Bird Watching Areas (Blue Balloon)
- Visitors’ Center (Blue Star)

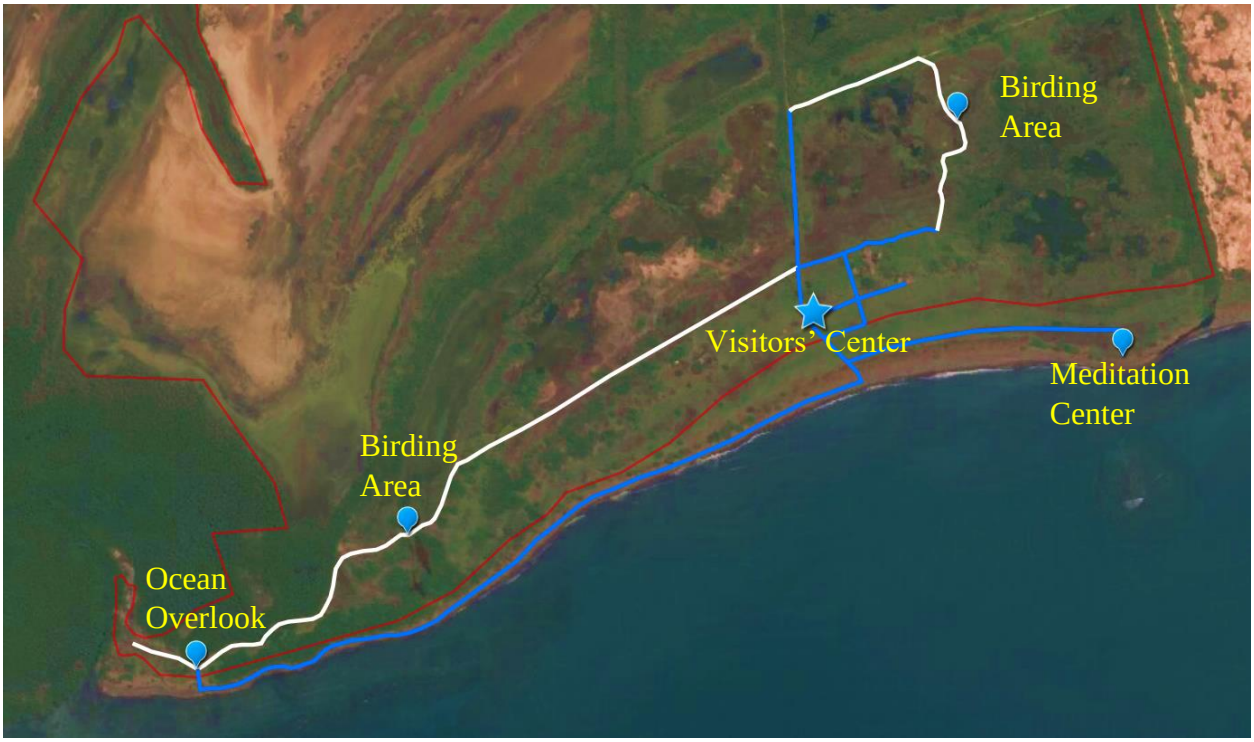


Figure 5.2 – Trail Layout

5.1.2.1 Trail Locations

We recommend a trail design, including gravel and boardwalk trails, as seen in Figure 5.2.

We propose three major trail routes for the Punta Cabullones site that can be seen in Figure 5.2. The main pathway is along the major access road, past the visitors' center to the beach. To the east of the main pathway, we propose a trail that ends at a quiet shelter area for meditation. To the west, we propose a loop to the mangrove forest and an ocean overlook. This trail travels along the beach as shown by the blue line and back through wetlands as shown by the white line. Also, included in this loop is a bird watching site in the wetlands. The third route is another bird watching route. It travels from the visitors center, up the access road, and then around the lagoon where many different species can be seen. We also propose a shelter for this path where visitors can sit and observe the birds and read the bird index we have included in Appendix G. In addition to the three major trails, we propose small gravel paths between the community gardens so that people are not walking in the garden and damaging the plants.

5.1.2.2 Trail Materials

We recommend that the trails highlighted in blue be laid with gravel, while the white trails be boardwalks. Gravel is the best option for the blue trails for several reasons. First, these paths are not prone to flooding and are already relatively flat, negating the need for raised or concrete paths. Next, gravel is an inexpensive and easily maintained material. Finally, the small rocks offer good drainage and will not disrupt the natural flow of water in the area. Boardwalks are necessary for the white trails because these locations have an increased chance of flooding. With a raised boardwalk, visitors may enjoy a close-up view of the fragile wetland ecosystems while still remaining safe and dry.

5.1.2.3 Don Q Kiosk

We propose that the Don Q Kiosk is restored and repurposed as a visitors' center for the Punta Cabullones site as seen in Figure 5.3 and Figure 5.4.

In order to convert the prior Don Q Kiosk into a functional visitors' center, we propose restoring it to its original state. First, we propose adding both a men's and women's bathroom with two stalls and a sink. The rooms, which are smaller than typical bathrooms, required a smaller sink in order to comply with the necessary distance between the sink and wall. In the main room, we added two large desks with an additional table that will allow for people to work at computers, prepare for tours, and organize the educational programs. In the second room, originally used as a preparation room for the bar, we propose adding a small kitchen similar to that in Hacienda la Esperanza. This kitchen would be mainly for the employees working at the site or possibly by the community working in the gardens. The floor plan can be seen in Figure 5.3.

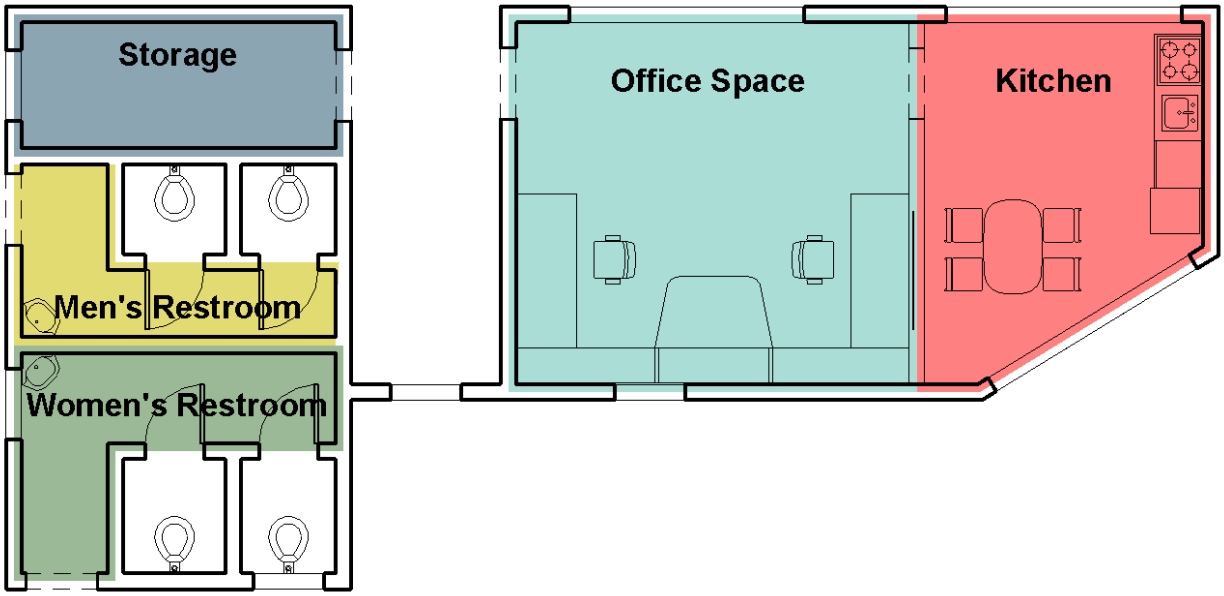


Figure 5.3 – Don Q Kiosk Floor Plan

Next, we propose that the outdoor bar be used for concessions and a small store similar to that in Hacienda Buena Vista. This small store could sell snacks, educational materials, and souvenirs similar to those sold at other PLN sites. In addition, we added picnic tables to the patio so that people can have a place to rest in the shade. Renovations are shown in the 3D model below (Figure 5.4).

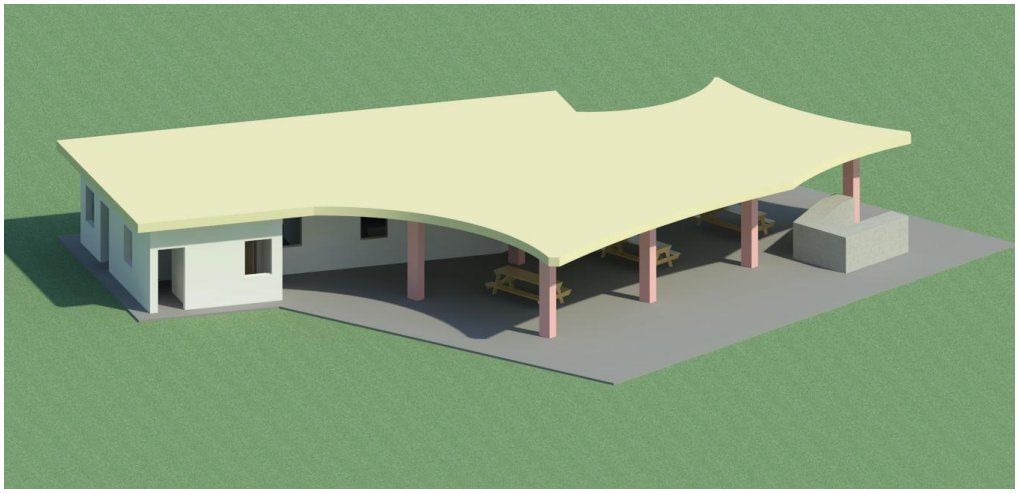


Figure 5.4 – Rendering of Don Q Kiosk

5.2 Educational Programming

We recommend implementing educational programming such as guided tours, workshops, and open houses as advertised in Figure 5.5. We designed potential educational signage as seen in Appendix G.

We recommend utilization of educational programming at the Punta Cabullones protected area in order to educate and involve the community members and visitors in preserving the environment. Self-guided tours, signage, and programs will offer educational opportunities for locals and visitors alike.

5.2.1 Local Birds

As PLN requested, we propose having two bird watching areas in Punta Cabullones. Figure 5.2 shows our proposed trail layout of Punta Cabullones where there are two areas designated for bird watching. In order to fulfill our goal of educating the local community and the tourists about Punta Cabullones and the animals that live in it, there will be educational signs at these birding sites. These signs, which are showed in Appendix G, include basic information about the habits of each bird, as well as information about the differences between the male and female, with a picture of each.

5.2.2 Programs

In order to best educate locals and visitors, we recommend educational programming in the form of self-guided tours, guided tours, educational classes, and open houses. Our proposed programs would highlight the history, ecosystems, and organisms of the area as well as the community garden and beekeeping initiative in Punta Cabullones.

We first recommend self-guided tours. These tours will offer visitors the opportunity for a relaxing excursion that can be tailored to their own pace and interest. Educational material provided to visitors will focus the tours on areas of interest and importance, such as the wetlands,

mangroves, and tidal marshes. These tours will guide visitors around the various walking trails in Punta Cabullones. Educational signage will also be erected along these walkways to provide additional information for the self-guided tours.

We next recommend guided tours. These tours will be similar to those currently offered by nature interpreters at the PLN sites we visited. The guided tours we propose will encompass both the nature and the history of the Punta Cabullones area. These tours will begin at the visitors' center, the former Don Q Kiosk, and give a brief history of the area, including information about the sugarcane industry, the Serrallés family, and how nature played a role in sugarcane and rum production. The information regarding the history of the area for the historical tour may be found in Appendix A. Next, the nature interpreter will guide visitors along the trails through the wetlands. The tour will then highlight the importance of conservation and the role that tidal marshes have in protecting the coastlines and providing habitats for endangered birds. The tour will follow the trail back to the visitors' center, ending with information regarding the other programs offered by PLN at Punta Cabullones.

Finally, we recommend educational classes and open houses at Punta Cabullones that will highlight the unique features of the area. We recommend classes covering the subjects of organic gardening and beekeeping to be offered on a regular basis. These classes may be led by community volunteers who are active users of the community garden and beekeeping initiative. Visitors will benefit greatly from these classes by learning about a healthy, self-sustaining lifestyle that they can implement in their own homes. Educational classes will also be offered to children, teaching them the basics of gardening and where their food comes from. In addition to classes, open houses with a farmers market may be offered regularly for members of the Vallas

Torres community to sell crops, honey, and other goods. A sample poster including information for an educational open house can be seen in Figure 5.5 below.

Figure 5.5 – Marketing Poster

5.3 Recommendations for the Future

Although we have laid out the majority of the proposal for Punta Cabullones, we recommend the following is researched to further develop the area:

- The access road into Punta Cabullones needs renovation so local community members and tourists can easily reach the area. These renovations could consist of digging swales along the sides of the road or raising the road.
- To control the mosquitos in the area, we recommend using plants around Punta Cabullones that repel mosquitoes, such as citronella.

- The feral horses may be a risk to the crops in the garden as horses are likely to eat the plants. We recommend installing a fence around the community garden to protect the plants.
- Similar to that at Hacienda Buena Vista, an animal farm can provide eggs, meat, and milk to the local community members if implemented. There is additional land that is not utilized in our proposal that could be used for a community farm.
- Our proposal includes four shelters along the trails throughout Punta Cabullones. However, we recommend looking further into the type of shelter (i.e. a sun shade or enclosed shelter) that would best suit the area.
- We reached out to local businesses in Ponce to gauge interest in buying vegetables from the community garden or setting up an exchange program. Unfortunately, we did not receive many responses from these companies. Edwardo Aviles, Operations Director, from the Hilton Ponce Golf and Casino Resort responded that the hotel was interested, but because it was the busy season, he could not respond until January. We recommend following up with this hotel and the others mentioned in section 3.3.1 in the near future.
- We recommend using a rainwater collection system at the various shelters to irrigate the community garden.

The implementation of these additional recommendations could improve our plan for the Punta Cabullones site.

5.4 Conclusion

Both the threatened area of Punta Cabullones and the impoverished community of Vallas Torres are in need of Para la Naturaleza's help. This proposal will provide PLN with the means

to promote economic growth for the community through tourism while maintaining the integrity of the local ecosystems through education and conservation. Though this specific report is intended for use in the Punta Cabullones area, it may prove useful for PLN and other organizations interested in developing similar community-based management plans across Puerto Rico's islands. Utilizing community-based management plans in order to protect these areas will continue PLN's mission of conserving 33% of Puerto Rico's land by the year 2033.

Bibliography

2 in. x 12 in. x 12 ft. #1 Pressure-Treated Lumber. (2015). Retrieved November 17, 2015, from Home Depot: http://www.homedepot.com/p/WeatherShield-2-in-x-12-in-x-12-ft-1-Pressure-Treated-Lumber-185027/204862941

20 cu. yd. Loose Bulk Top Soil. (2015). Retrieved November 17, 2015, from Home Depot: http://www.homedepot.com/p/Unbranded-20-cu-yd-Loose-Bulk-Top-Soil-SLTS20/205325477

Ageratum conyzoidea. (n.d.). Retrieved November 19, 2015, from Pant Illustrations: https://www.google.com.pr/search?q=ageratum+conyzoides&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&sqi=2&ved=0CAYQ_AUoAWoVChMImMuG56KLyQIVBe4mCh3mPgo1&dpr=2#tbm=isch&q=billygoat+weed+flower+drawing&imgrc=WK-AcYwSeUYsiM%3A

Armitage, D. (2005, May 27). Adaptice Capacity and Community-Based Natural Resource Management. *Environmental Management, 35*(6), 703-715. doi:10.1007/s00267-004-0076-z

As Puerto Rican Economic Crisis Deepens, Supporters of Statehood See Opportunity. (2015, August 24). Retrieved October 5, 2015, from Fox News Latino: http://latino.foxnews.com/latino/politics/2015/08/24/as-puerto-rican-economic-crisis-deepens-supporters-statehood-see-opportunity/

Aster subulatus. (n.d.). Retrieved November 19, 2015, from SnipView: https://www.google.com/search?q=aster+subulatus&espv=2&biw=1440&bih=828&sour

ce=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMI9q2Z5_ODyQIVheYmCh0BHwOd#imgrc=zHPaPJ_sZtbudM%3A

Baughman, M., & Serres, T. (n.d.). Recreational Trail Design. In *Woodland Stewardship* (pp. 147-174). Retrieved November 19, 2015, from http://woodlandstewardship.org/wp-content/uploads/ch13/content/ch13_content.pdf

Bee Culture Magazine. (2015). *Unit Honey Prices by Month - Retail*. (National Honey Board) Retrieved December 14, 2015, from Honey: www.honey.com/honey-industry-statistics/unit-honey-prices-by-month-retail/

Beehives. (n.d.). Retrieved November 19, 2015, from Project Gutenberg Self-Publishing Press: http://www.self.gutenberg.org/articles/beehives

Bogner, F. X. (1998). The Influence of Short-Term Outdoor Ecology Education on Long-Term Variables of Environmental Perspective. *The Journal of Environmental Education*, *29*(4), 17-29. Retrieved September 28, 2015

Bourque, M., Digeser, D., Partridge, S., & Yatim, H. (2012, May 2). *Management Plan for La Esperanza Nature Preserve in Ponce, Puerto Rico.* Retrieved September 18, 2015, from WPI, E-Project: https://www.wpi.edu/Pubs/E-project/Available/E-project-051712-180121/unrestricted/DNER_Proposal.pdf

Buckley, R., Pickering, C., & Weaver, D. B. (2004). *Nature-Based Tourism, Environment and Land Management.* CABI Publishing. Retrieved September 18, 2015

Capparis spinosa. (2015). Retrieved November 24, 2015, from Caper: https://www.google.com.pr/search?q=capparis+baducca&espv=2&biw=1440&bih=828&

source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMIiJ6qn5-VyQIVAuYmCh0eLAo3#tbm=isch&q=capparis+baducca+drawing&imgrc=RZvAXkBOEWjV4M%3A

Caraballo, R. (2015, November 4). Administrador. (A. Wortman, Interviewer)

Cohn, D., Patten, E., & Lopez, M. H. (2014, August 11). *Puerto Rican Population Declines on Island, Grows on U.S. Mainland*. Retrieved October 7, 2015, from Pew Research Center.

Colón-Zavala, E. (2012). *Serrallés/Wirshing Beach Houses, Documentation & Historical Overview of La Esperanza Site, Vayas Ward, Ponce, Puerto Rico.* San Juan: ECZ Group P.S.C. Retrieved December 14, 2015

Conservation Trust of Puerto Rico. (n.d.). *Conservation Trust of Puerto Rico*. Retrieved September 17, 2015, from Conservation Trust of Puerto Rico: http://www.fideicomiso.org/

Cosmos caudatus. (2015, June 15). Retrieved November 19, 2015, from Wikipedia: https://www.google.com/search?q=cosmos+caudatus&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMI2sHT8vGDyQIVCHgmCh3vNQF0#imgrc=fco6Te9V4U1InM%3A

Current Ponce, Puerto Rico Population, Demographics and stats in 2014, 2015. (n.d.). Retrieved September 18, 2015, from Suburban Stats: https://suburbanstats.org/population/puerto-rico/how-many-people-live-in-ponce

Deeks, M. (2004). *Cross-Cultural Team Working Within the Cochrane Collaboration.* Cochrane. Retrieved September 28, 2015

Dictionary, Grammatical Category of Progradation. (2015). Retrieved September 2015, 2015, from Lexbook: http://lexbook.net/en/progradation

Dietz, T. (2002). *New Tools for Environmental Protection: Education, Information, and Voluntary Measures.* National Academies Press. Retrieved September 28, 2015

Edward A. Ellis, L. P.-B. (2008). Is community-based forest management more effective than protected areas?: A comparison of land use/land cover change in two neighboring study areas of the Central Yucatan Peninsula, Mexico. *Forest Ecology and Management*. doi:10.1016/j.foreco.2008.07.036

Eizenberg, E. (2011, June 23). The Changing Meaning of Community Space: Two Models of NGO Management of Community Gardens in New York City. *International Journal of Urban and Regional Research*. doi:10.1111/j.1468-2427.2011.01065.x

Ellis, J., & Ellis, A. (2008, January). *African Honey Bee*. (U. o. Florida, Producer) Retrieved November 19, 2015, from Featured Creatures: http://entnemdept.ufl.edu/creatures/misc/bees/ahb.htm

Flaveria trinervia. (n.d.). Retrieved November 24, 2015, from Plant Illustrations: https://www.google.com.pr/search?q=flaveria+trinervia&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMIk9-55J-VyQIVhm4mCh0omw2j#tbm=isch&q=flaveria+trinervia+illustration&imgrc=GEkGvCIoJokbVM%3A

Florenciani, E. A. (2015, November 2). WPI Punta Cabullones Questions. (K. Marrion, Interviewer)

Gegear, R. (2015, November 3). Assistant Professor. (A. Wortman, Interviewer)

Genaro, J., & Franz, N. (2008). The Bees of Greater Puerto Rico. *Insecta Mundi*, 1-24. Retrieved November 23, 2015, from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1569&context=insectamundi

Glover, L. I. (1977). Surficial geologic map of the Playa de Ponce and Santa Isabel quadrangles. *Puerto Rico: Miscellaneous Field Studies Map MF-886, 1 sheet*.

Gree, B. (2011). *Echinops*. Retrieved November 24, 2015, from Botanical Drawings Gallery: https://www.google.com.pr/search?q=Echinops+fruticosas&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMIz-6JkqSLyQIVg-wmCh0oNwEV#tbm=isch&q=Echinops+fruticosas+drawing&imgrc=KltEM7-MPmLuhM%3A

Greenburg, R., Maldonado, J. E., Droege, S., & McDonald, M. V. (2006, August). Tidal Marshes: A Global. *BioScience, 56*(8), 675-685. Retrieved September 17, 2015, from http://bioscience.oxfordjournals.org.ezproxy.wpi.edu/content/56/8/675.full.pdf

Grupo Editorial EPRL. (2014, 9 15). *Sugar in Puerto Rico*. Retrieved 11 18, 2015, from Puerto Rico Encyclopedia: http://www.enciclopediapr.org/ing/article.cfm?ref=08111801

Gwenn. (2009, June 4). *Sample the Tropical Fruit Available in Puerto Rico*. (R. Bentz, Producer) Retrieved November 19, 2015, from Puerto Rico Day Trips: http://www.puertoricodaytrips.com/tropical-fruit/

Hall, M. C. (2007). *Pro-poor Tourism: Who Benefits?: Perspectives on Tourism and Poverty Reduction.* Channel View Publications. Retrieved September 18, 2015

Hart, M. (n.d.). *Begonia hirtella*. Retrieved November 24, 2015, from Plant Illustrations: https://www.google.com.pr/search?q=begonia+hirtella&espv=2&biw=1440&bih=828&site=webhp&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMI6oXX256VyQIVAyQmCh2NSwsF#tbm=isch&q=begonia+hirtella+drawing&imgrc=LXIzYwt7_MborM%3A

Heliantus annus. (n.d.). Retrieved November 19, 2015, from Climate Change Ecology: https://www.google.com.pr/search?q=helianthus+annuus&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMI7PyW4PWDyQIVhOUmCh225A3k&gws_rd=cr&ei=e49MVtWIGYPzmAHz3ImoAQ#tbm=isch&q=helianthus+annuus+drawing&imgrc=PcjFf9hhkiCz9M%3A

Hilmi, M., Bradbear, N., & Mejia, D. (2011). *Beekeeping and Sustainable Livelihoods* (2 ed.). Rome, Italy: Rural Infrastructure and Agro-Industries Division Food and Agriculture Organization of the United Nations. Retrieved November 19, 2015, from http://www.fao.org/docrep/015/i2462e/i2462e00.pdf

Honey. (2007). Retrieved November 19, 2015, from The British Beekeepers Association: http://www.bbka.org.uk/learn/general_information/honey

Honey, M. (2008). *Ecotourism and Sustainable Development: Who Owns Paradise?* Washington DC, USA: Island Press. Retrieved September 18, 2015

International Foundation for Agricultural Development. (2006). *Community-based natural resource management.* Rome, Italy: IFAD. Retrieved September 17, 2015, from http://www.ifad.org/pub/other/cbnrm.pdf

Kelly, G. (2015, June 9). *Know the Cost to Get Your Dream Basketball Court Installed*. Retrieved November 30, 2015, from Angie's List: http://www.angieslist.com/articles/know-cost-get-your-dream-basketball-court-installed.htm

Kirschbaum, J. B., Axelson, P. W., Longmuir, P. E., Mispagel, K. M., Stein, J. A., & Yamada, D. A. (2001). Recreation Trail Design. In *Designing Sidewalks and trails for Access Part II of II: Best Practices Design Guide* (pp. 1-42). Federal Highway Administration. Retrieved November 19, 2015, from http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf/16chapter15.pdf

Kusler, J. (n.d.). *Constucting Wetland Boardwalks and Trails.* Retrieved November 24, 2015, from Rails to Trails: https://www.railstotrails.org/resourcehandler.ashx?id=4231

(2014). *La Esperanza-Las Quintas Natural Protected Area.* San Juan: Para La Naturaleza. Retrieved November 10, 2015

Liogier, H. A. (1995). *Descriptive Flora of Puerto Rico and Adjacent Islands* (Vol. 5). Retrieved November 19, 2015, from https://books.google.com.pr/books?id=MwgkoARaIH4C&pg=PA266&lpg=PA266&dq=cosmos+flower+in+puerto+rico&source=bl&ots=WPuM4q06aG&sig=ZipgUJOhnWtS4t301ijogFuAQlk&hl=en&sa=X&redir_esc=y#v=onepage&q=clover&f=false

Mangrove. (n.d.). Retrieved September 17, 2015, from Dictionary.com: http://dictionary.reference.com/browse/mangrove

Mangrove Forests. (n.d.). Retrieved September 17, 2015, from Wetlands.com: http://www.wetlands.org/Whatarewetlands/Mangroveforests/tabid/2730/Default.aspx

Marine Life. (n.d.). Retrieved September 17, 2015, from Pure Adventure: http://www.pureadventurepr.com/marine_life/

Marsh. (n.d.). Retrieved from Dictionary.com: http://dictionary.reference.com/browse/marsh?s=t

Marshes. (2012, October 10). Retrieved September 15, 2015, from United States Environmental Protection Agency: http://water.epa.gov/type/wetlands/marsh.cfm

Martinuzzi, S., Gould, W. A., Lugo, A. E., & Medina, E. (2009). Conversion and recovery of Puerto Rican mangroves: 200 years of change. *Forest Ecology and Management, 257*(1), 75-84. doi:10.1016/j.foreco.2008.08.037

McFarland, C. (2013, August 5). *Top 30 Flowers for Bees*. Retrieved November 19, 2015, from Honey Love Urban Beekeepers: http://honeylove.org/top-30-flowers-for-bees/

McGinnis, R. (2008, July 30). *Using Manure to Fertilize Your Garden*. Retrieved November 17, 2015, from Vegetable Gardener: http://www.vegetablegardener.com/item/2427/using-manure-to-fertilize-your-garden/page/all

Meliha Akhbasunda, Y. B. (2014). Analysis of terrains suitable for tourism and recreation by using geographic information systems. *Environmental Monitoring and Assessment*.

Miller, G. L., & Lugo, A. E. (2009). *Guide to the Ecological Systems of Puerto Rico.* United States Department of Agriculture. Retrieved September 17, 2015, from http://www.fs.fed.us/global/iitf/pubs/IITF_gtr35.pdf

National Geographic. (2015). *GIS (geographic information system)*. Retrieved September 27, 2015, from National Geographic Education: http://education.nationalgeographic.com/encyclopedia/geographic-information-system-gis/

Nel, E., Illgner, P. M., Wilkins, K., & Robertson, M. (2000). Rural Self-Reliance in Bondolfi, Zimbabwe: the role of beekeeping. *The Geographical Journal, 166*(1), 26-34. doi:130.215.36.83

Neo, H., & Tan, L. H. (2009, June 12). "Community in Bloom": local participation of community gardens in urban Singapore. *Local Environment: The International Journal of Justice and Sustainability*. doi:10.1080/13549830902904060

Para La Naturaleza. (n.d.). Retrieved October 5, 2015, from Berliner Benson: http://www.berlinerbenson.com/para-la-naturaleza/

Para la Naturaleza. (n.d.). *Para la Naturaleza*. Retrieved September 17, 2015, from Para la Naturaleza: http://paralanaturaleza.org/en/

Park & Sun Spectrum Classic Volleyball Net. (2015). Retrieved November 30, 2015, from Amazon: http://www.amazon.com/Park-Sun-Spectrum-Classic-Volleyball/dp/B0009PVUOG/ref=sr_1_1?ie=UTF8&qid=1447866965&sr=8-1&keywords=spectrum+classic+volleyball+net

Perone, O., McHale, C., & Torres, A. (2012). *Making a Perone Hive*. Retrieved November 19, 2015, from BioBees.com: http://www.biobees.com/library/hive_perone/Making-a-Perone-Hive.pdf

Peters, J. W. (2008, February 17). Puerto Rico's Second City Steps Out. *The New York Times*. Retrieved September 10, 2015

Ponce Municipio, Puerto Rico. (2010). Retrieved September 18, 2015, from United States Census Bureau: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk#none

Pueblo. (2015, December 2). *Pueblo Shopper.* Retrieved December 2, 2015, from Pueblo: http://www.pueblo.net/shopper-del-2-8-diciembre-2015

Rabin, J., Zinati, G., & Nitzsche, P. (2012, September). Yield Expectations for Mixed Stand Small-scale Agriculture. *Sustaining Farming on the Urban Fringe*, *7*(1), 1-4. Retrieved November 24, 2015, from https://njaes.rutgers.edu/pubs/urbanfringe/pdfs/urbanfringe-v07n01.pdf

Raised Garden Beds. (2014). Retrieved November 17, 2015, from Earth Easy: http://eartheasy.com/grow_raised_beds.htm

Rivera-Marchand, B., Keularts, J., Oskay, D., & Giray, T. (2008). Coexistence of Feral Africanized and European Honey Bees. *Caribbean Journal of Science, 44*(2), 264-266. Retrieved November 19, 2015, from http://caribjsci.org/July08/44_264-266.pdf

Rivera-Marchand, B., Oskay, D., & Giray, T. (2012). Gentle Africanized Bees on an Oceanic Island. *Evolutionary Applications, 5*, 746-756. doi:10.1111/j.1752-4571.2012.00252.x

Rodríguez-Martínez, J., & Soler-López, L. R. (2014). *Hydrogeology and Hydrology of the Punta Cabullones Wetland Area, Ponce, Southern Puerto Rico, 2007-08.* Ponce, Puerto Rico: U.S. Geological Survey. doi:10.3133/sir20145102

Roscoe, M. (n.d.). *Coreopsis Grandiflora*. Retrieved November 24, 2015, from Ursus Books & Prints: https://www.google.com.pr/search?q=coreopsis+reptans&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMI8PS05saNyQIVxOQmCh3bJQXK#tbm=isch&q=tickseed+drawing&imgrc=lV_G_2XrWzdsfM%3A

Santos, M. C. (2010, June 11). *Move the park to your backyard*. Retrieved November 30, 2015, from Statesman: http://www.statesman.com/news/lifestyles/parenting/move-the-park-to-your-backyard/nRtXn/

Senyk, J. (2005). *Lessons from the Equator Initiative: Community-based management by Pred Nai COmmunity Forestry Group in the mangroves of Southeastern Thailand.* Winnipeg, MB, Canada: Centre for Community-Based Resource Management. Retrieved September 27, 2015, from http://hdl.handle.net/10625/34217

Singh, S., Timothy, D. J., & Dowling, R. K. (2003). *Tourism in Destination Communities.* CABI Publishing. Retrieved September 18, 2015

Soccer Nets - Full Size 24' x 8' Straight Back Nets. (2015). Retrieved November 30, 2015, from Net World Soccer: http://www.networldsoccer.com/soccer-nets-straight-back.html

Solomon, U. (2010, March 25). A Detailed Look at the Three Disciplines, Envionmental ethics, Law and Education to Determine Which Plays the most Critical Role in Environmental Enhancement and Protection. *Environment, Development, and Sustainability*, 1-12. doi:10.1007/s10668-010-9242-z

St. John, J. (2014, March 14). *Rhizophora mangle (red mangroves) (San Salvador Island, Bahamas) 7*. Retrieved October 7, 2015, from Klickr: https://www.flickr.com/photos/jsjgeology/15786145972

Tagetes erecta. (n.d.). Retrieved November 19, 2015, from Twigs and Flowers in Bunny Diet: https://www.google.com.pr/search?q=tagetes+erecta&espv=2&biw=1440&bih=828&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMIy-vSxJ2LyQIVjCsmCh1wDANY#tbm=isch&q=tagetes+erecta+drawing&imgrc=dAdV2F2W1eeorM%3A

The Best Lodging in Ponce, Puerto Rico. (n.d.). Retrieved October 8, 2015, from Trip Advisor: http://www.tripadvisor.com/Hotels-g147323-Ponce_Puerto_Rico-Hotels.html

The United States Committe on Banking, Finance, and Urban Affairs. (1990). *The Coastal Barrier Improvement Act of 1990 / hearing ... 4.B 22/1:101-167. United States.* Washington, DC: U.S. Government Printing Office. Retrieved September 18, 2015, from http://babel.hathitrust.org/cgi/pt?id=pst.000017590099;view=1up;seq=1

Trail Cost Analysis. (2010). Retrieved November 24, 2015, from NIRPC: http://www.nirpc.org/media/3539/appendix_b___trailcosts.pdf

US Department of Agriculture. (2015, November 27). Advertised Prices for Fruits & Vegetables at Major Retail Supermarket Outlets ending during the period of 11/21 to 12/03. *National Retail Report - Fruit and Vegetables*, 1-31. Retrieved December 2, 2015, from http://www.ams.usda.gov/mnreports/fvwretail.pdf

What is a "Mangrove" Forest. (2014, November 26). Retrieved September 17, 2015, from National Oceanic and Atmospheric Administration: http://oceanservice.noaa.gov/facts/mangroves.html

What is Ecotourism? (2014). Retrieved September 18, 2015, from The International Ecotourism Society: https://www.ecotourism.org/what-is-ecotourism

Winters, H. F., & Miskimen, G. W. (1967). *Vegetable Gardening in the Caribbean Area* (Vol. 323). Washington, D.C.: U.S. Department of Agriculture. Retrieved November 19, 2015, from http://naldc.nal.usda.gov/download/CAT87209120/PDF

Appendix A Historical Significance of the Punta Cabullones Area

The areas La Esperanza and Las Quintas, now under the designation Punta Cabullones, were once used for agricultural purposes. The first record on the history of the area comes from 1862. The area was initially two separate estates, mainly used for sugarcane production. From 1862 until 1935, the land was managed by many different owners. Sugarcane was one of Puerto Rico's most important exports, but by the mid-20th century, sugar production slowed and the demand for Puerto Rican sugarcane weakened (Grupo Editorial EPRL, 2014). Finally, in 1935 the areas were consolidated into one property.

The land then transferred ownership to the Serralles-Wirshing family in 1938. Julia Serralles, heir to the Serralles rum business (creators of Don Q rum), and Herman Wirshing, a German engineer, built a beach retreat on the land. There were once 11 structures but only three remain today. The remaining structures are concrete buildings: a beach house, gazebo, and a small Don Q Kiosk and bar. Currently, the land is abandoned and unutilized except for the occasional crabbers and fisherman who can be found in the area (La Esperanza-Las Quintas Natural Protected Area, 2014).

Appendix B Para la Naturaleza

Para la Naturaleza (PLN) is a nonprofit organization that works to conserve and protect Puerto Rico's natural ecosystems. Launched in 2013, PLN is a unit of the Conservation Trust of Puerto Rico (also known as "the Trust") (Para la Naturaleza, n.d.). Created in 1970 through the implementation of a Deed of Constitution of Charitable Trust, the Trust's mission "is to secure functional and healthy ecosystems in the islands of Puerto Rico, and to instill in their inhabitants a sense of responsibility toward the conservation of our natural resources, so that we may count on the ecosystem services that will help us achieve our social, economic and quality-of-life goals" (Conservation Trust of Puerto Rico, n.d.).

The goal of PLN is to integrate the communities with the environments surrounding them in order to protect and conserve these natural ecosystems. PLN achieves this by managing all of the Trust's events as well as its educational and volunteer programming. They are also responsible for managing the visitors' centers and natural areas that are under the Trust's protection. PLN works to complete its mission through educational outreach and coordinated volunteerism across the island (Para la Naturaleza, n.d.).

PLN currently manages 42 natural areas across the islands of Puerto Rico, including a few in the municipality of Ponce. Majority of the natural areas managed by PLN have been acquired by the Trust, while others have been donated. Compared to other Caribbean islands, the current percentage of protected lands is quite low. The US Virgin Islands, whose economy relies heavily on tourism, protects nearly 52% of its land. PLN is working to increase the portion of protected lands in Puerto Rico from its current 8% to 33% by 2033 (Para la Naturaleza, n.d.).

Appendix C Local Birds

SCIENTIFIC NAME	FAMILY	COMMON SPANISH NAME	COMMON ENGLISH NAME	ORIGIN	STATUS
Actitis macularius	Scolopacidae	Playero Coleador	Spotted Sandpiper	M	
Ammodramus savannarum	Emberizidae	Gorrión Chicharra	Grasshopper Sparrow	R	DD, UV
Anas bahamensis	Anatidae	Pato Quijada Colorada	White-cheeked Pintail	R	CL, CT
Anas crecca	Anatidae	Pato Aliverde	Green-winged Teal	M	
Anas discors	Anatidae	Pato Zarcel	Blue-winged Teal	M	
Anthracothorax dominicus	Trochilidae	Zumbador Dorado	Antillean Mango	R	
Ardea alba	Ardeidae	Garza Real	Great Egret	R	
Ardea herodias	Ardeidae	Garzón Cenizo	Great blue Heron	M	
Arenaria interpres	Scolopacidae	Playero Turco	Ruddy Turnstone	M	
Asio flammeus portoricensis	Strigidae	Múcaro Real	Short-eared Owl	R	
Aythya affinis	Anatidae	Pato Pechiblanco Menor	Lesser Scaup	M	
Aythya collaris	Anatidae	Pato Acollarado	Ring-necked Duck	M	
Brotogeris versicolurus	Psittacidae	Periquito Aliamarillo	Canary-Winged Parakeet	I	
Bubulcus ibis	Ardeidae	Garza Ganadera	Cattle Egret	R	
Buteo jamaicensis	Accipitridae	Guaraguao Colirrojo	Red-tailed Hawk	R	
Butorides virescens	Ardeidae	Martinete	Green Heron	R	
Calidris alba	Scolopacidae	Playero Arenero	Sanderling	M	
Calidris alpina	Scolopacidae	Playero Espaldicolorado	Dunlin	M	
Calidris mauri	Scolopacidae	Playero Occidental	Western Sandpiper	M	
Calidris minutilla	Scolopacidae	Playero Menudillo	Least Sandpiper	M	
Calidris pusilla	Scolopacidae	Playero Gracioso	Semipalmated Sandpiper	M	
Cathartes aura	Ciconiidae	Aura Tiñosa	Turkey Vulture	I	
Charadrius alexandrinus	Charadriidae	Chorlito Blanco	Snowy Plover	R	CL, CCE
Charadrius melodus	Charadriidae	Chorlito Melódico	Piping Plover	M	CL, CCE, FT
Charadrius semipalmatus	Charadriidae	Chorlito Acollarado	Semipalmated Plover	M	
Charadrius vociferus ternominatus	Charadriidae	Chorlito Sabanero	Killdeer	R	
Charadrius wilsonia	Charadriidae	Chorlito Marítimo	Wilson's Plover	R	CL
Chordeilies gundlachii	Caprimulgidae	Querequequé	Antillean Nighthawk	R	
Coccyzus minor	Cuculidae	Pájaro Bobo Menor	Mangrove Cuckoo	R	
Coereba flaveola	Coerebidae	Reinita Común	Bananaquit	R	
Columbina passerina	Columbidae	Rolita	Common Ground Dove	R	
Crotophaga ani	Cuculidae	Garrapatero o Judío	Smooth-billed Ani	R	
Dendroica adelaidae	**Parulidae**	**Reinita Mariposera**	**Adelaide's Warbler**	**E**	
Dendroica discolor	Parulidae	Reinita Galana	Prairie Warbler	M	
Dendroica magnolia	Parulidae	Reinita Manchada	Magnolia Warbler	M	
Dendroica petechia	Parulidae	Canario de Mangle/Reinita Amarilla	American Yellow Warbler	R	CL
Egretta caerulea	Ardeidae	Garza Azul	Little Blue Heron	R	
Egretta thula	Ardeidae	Garza Blanca	Snowy Egret	R	
Egretta tricolor	Ardeidae	Garza Pechiblanca	Tricolored Heron	R	
Elaenia martinica	Tyrannidae	Juí Blanco	Caribbean Elaenia	R	
Eulampis holosericeus	Trochilidae	Zumbador de Pecho Azul	Green-Throated Carib	R	
Falco sparverius	Falconidae	Falcón Común	American Kestrel	R	
Fregata magnificens	Fregatidae	Fragata Magnífica/Tijerilla	Magnificent Frigatebird	R	
Fulica caribaea	Rallidae	Gallinazo Caribeño	Caribbean Coot	R	CL, CT
Gallinago gallinago	Scolopacidae	Becasina	Common Snipe	M	
Gallinula chloropus	Rallidae	Gallareta Común	Common Moorhen	R	
Himantopus mexicanus	Recurvirostridae	Viuda	Black-necked Stilt	R	
Icterus icterus	Icteridae	Turpial	Troupial	I	
Ixobrychus exilis	Ardeidae	Martinetito	Least Bittern	R	
Limnodromus griseus	Scolopacidae	Chorlo Picocorto / Agujeta Piquicorta	Short-billed Dowitcher	M	
Margarops fuscatus	Mimidae	Zorzal Pardo	Pearly-eyed Thrasher	R	
Megaceryle alcyon	Alcedinidae	Martín Pescador	Belted Kingfisher	M	
Mimus polyglottos	Mimidae	Ruiseñor	Northern Mockingbird	R	
Molothrus bonariensis	Icteridae	Tordo Lustroso	Shiny Cowbird	R	
Nycticorax nycticorax	Ardeidae	Yaboa Real	Black-Crowned Night Heron	R	
Pandion haliaetus	Accipitridae	Águila de Mar/Pescadora	Osprey	M	F-SOC
Patagioenas leucocephala	Columbidae	Paloma Cabeciblanca	White-crowned Pigeon	R	CL, DD
Pelecanus occidentalis	Pelecanidae	Pelícano Pardo	Brown pelican	R	CL, CE
Pterochelidon fulva	Hirundinidae	Golondrina de Cuevas	Cave Swallow	R	
Plegadis falcinellus	Threskiornithidae	Ibis Lustroso	Glossy Ibis	R	
Pluvialis squatarola	Charadriidae	Chorlito Cabezón	Black-bellied Plover	M	
Podilymbus podiceps	Podicipedidae	Zaramago	Pied-billed Grebe	R	
Porzana carolina	Rallidae	Gallito Sora	Sora	M	
Quiscalus niger	Icteridae	Chango/Mozambique	Greater Antillean Grakle	R	
Rallus longirostris	Rallidae	Pollo de Mangle	Clapper rail	R	
Seiurus noveboracensis	Parulidae	Pizpita de Mangle	Northern Waterthrush	M	
Setophaga ruticilla	Parulidae	Candelita	American Redstart	M	

SCIENTIFIC NAME	FAMILY	COMMON SPANISH NAME	COMMON ENGLISH NAME	ORIGIN	STATUS
Spindalis portoricensis	**Thraupidae**	**Reina Mora**	**Puerto Rican Spindalis**	**E**	
Sterna maxima	Laridae	Gaviota/Charrán Real	Royal Tern	R	
Streptopelia roseogrisea	Columbidae	Paloma Collarina	Ringed Turtle-Dove	I	
Tiaris bicolor omissus	Emberizidae	Gorrión Negro	Black-faced Grassquit	R	
Tiaris olivaceus bryanti	Emberizidae	Gorrión Barba Amarilla	Yellow-faced Grassquit	R	
Tyrannus dominicensis	Tyrannidae	Pitirre gris	Grey Kingbird	R	
Vireo altiloquus	Vireonidae	Julián Chiví	Black-whiskered Vireo	R	
Zenaida asiatica	Columbidae	Tórtola Aliblanca	White-winged Dove	R	
Zenaida aurita	Columbidae	Tórtola Cardosantera	Zenaida Dove	R	
Zenaida macroura	Columbidae	Tórtola Rabilarga o Rabiche	Mourning Dove	R	

Origin: **E:** Endemic (letters in bold) **R:** Resident **M:** Migratory **A:** Accidental

Status: **CL:** Critical Element (DNER)
CT: Commonwealth Threatened (DNER)
CE: Commonwealth Endangered (DNER)
CCE: Commonwealth Critically Endangered (DNER)
DD: Data Deficient (DNER)
FT: Federal Threatened (USFWS)
FE: Federal Endangered (USFWS)
F-SOC: Federal Species of Concern (USFWS)
UV: Under Vigilance (DNER)

Appendix D Steps of Trail Design

1. In order to develop a trail, how the trail will be used, how much it will be used, and the quality of the user experience needs to be determined. When considering these points, things like seasonal use of the trail, purpose of the trail, and personal risk as well as user ability of the trail visitors must be examined.
2. The trail corridor, or actual location of the trail should be determined. To start, this step involves using maps and photographs. Aerial photographs may be used to get the initial understanding of the land, and then topographic, soil, and GIS maps would be used to find features of the land that may need to be assessed when placing the trail. Then, the trail corridor may be physically scouted to look for any natural pathways, scenic locations, or hazards that may affect trail location or construction. When scouting, physical or legal constraints on the trail's location and natural obstacles, like wetlands and sensitive ecological areas, should also be noted.
3. Design standards encompass the trail's configuration, length, tread surface and width. Linear trails, spur trails, and loop trails are all configurations suitable for recreational trail development but depending on the route and destination not all of these shapes may be appropriate. Tread surface refers to the material and its condition on the usable portion of the trail. Depending on what the trail is being used for, and what environments it passes through, the trail material and the clearing methods for the trail will vary.
4. After the design standards are established, marking of the trail may commence. Within this section of recreational trail creation, a GPS may be used to mark the route of the trail. Using the GPS, sites of interest or importance may be noted and marked for the trail's

development. Also, during this stage, pictures of the suggested trail area may be taken and used for further investigation or planning.

5. The trail must next be cleared in preparation for laying the tread. First, small trees and shrubs should be removed, then large trees should be cut down. Next, stumps and boulders need to be removed, and finally, soil should be moved in order to level the tread.
6. Once the trail is clear, construction of the tread may begin. When considering tread choice, factors like compaction, displacement, and erosion are important. It is especially significant to note erosion impacts in areas with poor drainage, mud, and flowing water. Such aspects suggest that the tread should be hardened with rock pavers or other materials like boardwalk. Tread materials may include mineral soil, composed primarily of sand. This soil resists compaction and erosion while also allowing internal drainage; however, it is subject to wind displacement. Another material that could be used is rock. Treads like gravel are good for areas of heavy use or areas where horses will be. Materials like these are less expensive and easier to maintain than bedrock or concrete.
7. After construction of the trail in under way, structures may begin to be installed for recreational use. One such structure is boardwalks. Boardwalks "enable trail users to cross over wetlands, fragile vegetation, or unstable soil" (Baughman & Serres, p. 164). However, it is important to consider that boardwalks may become slippery when wet. A solution to this problem is to leave ⅜" to ½" gaps between planks to increase traction and facilitate the drying of the wood.
8. The trails then need to be marked. This encompasses trailhead signs, difficulty markers, directional signs, and warning signs. Trailhead signs and warning signs are arguably the most important of these features. Trailhead signs would include maps of the trails and

rules for trail use. Warning signs would alert trail users about possible hazards along the way. An example of a warning sign might be, “Please stay on the trail to protect fragile wetland plants.”

9. Lastly, facilities need to be installed. Facilities would include access roads, a parking lot, restrooms, water fountains, and trash containers (Baughman & Serres, pp. 148-173).

D.1 Trail Accessibility

As in step one outlined by Baughman and Serres in *Woodland Stewardship,* when creating trails for recreational use, the accessibility of the trail to the visitors must come into consideration. As the *Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide* by the Federal Highway Administration (FHWA) states, "recreational trails should provide users with disabilities with access to the same range of trail experiences offered to other users at the site" (Kirschbaum, et al., 2001, p. 1). Although it is not always possible for trail designers to meet all recommended specifications for the accessibility of trails, this guide states that designers and builders should strive to comply with the recommendations to the greatest extent possible. Examples of such recommendations are as follows:

- The trail should be cleared of natural barriers and have as smooth and stable a tread as feasible. See Table D.1 below.
- The steepest grade on the trail cannot be more than 20 percent
- Public areas such as restrooms and picnic grounds should contain Outdoor Recreation Access Routes (ORARs), or paths that allow visitors with disabilities to reach built elements that are a part of the recreation experience (Kirschbaum, et al., 2001).

Table D.1 – Firmness, Stability, and Slip Resistance for Various Trail Surfacing Materials

Surface Material	Firmness	Stability	Slip Resistance (Dry Conditions)
Asphalt	Firm	Stable	Slip Resistant
Concrete	Firm	Stable	Slip Resistant
Soil with Stabilizer	Firm	Stable	Slip Resistant
Packed Soul without Stabilizer	Firm	Stable	Not Slip Resistant
Soil with High Organic Content	Soft	Unstable	Not Slip Resistant
Crushed Rock (3/4" minus) with Stabilizer	Firm	Stable	Slip Resistant
Crushed Rock without Stabilizer	Firm	Stable	Not Slip Resistant
Wood Planks	Firm	Stable	Slip Resistant
Engineered Wood Fibers	Moderately Firm	Moderately Stable	Not Slip Resistant
Grass or Vegitative Ground Cover	Moderately Firm	Moderately Stable	Not Slip Resistant
Wood Chips (Bark, Ceder, Generic)	Moderately Firm to Soft	Moderately Stable to Unstable	Not Slip Resistant
Pea Gravel or 1/2" Minus Aggregate	Soft	Unstable	Not Slip Resistant
Sand	Soft	Unstable	Not Slip Resistant

(Kirschbaum, et al., 2001, p. 10)

Following the guidelines established by the FHWA and keeping accessibility in mind when developing recreational trails will lend itself to the creation of trails that may be enjoyed by locals and tourists.

Appendix E Tourism

E.1 Current Tourism in Ponce

Over the past decade, Puerto Rico has been trying to increase tourism in Ponce, which has been overshadowed by San Juan as a travel destination for many years. While Ponce is home to beautiful architecture, multiple museums, and extensive history, San Juan brings in more tourists due to its high-rise hotels, casinos, and resorts. In 2006, the Puerto Rican government decided to begin promoting Ponce as a tourist destination as well. The government took three major steps in order to do this: renovating the airport in Ponce, expanding and upgrading the Ponce Museum of Art, and marketing Ponce towards tourists. Between 2005 and 2007, the tourism in Ponce increased eight percent (Peters, 2008).

E.1.1 Benefits of Tourism

Many studies have been conducted to weigh the benefits of increasing tourism in poverty-stricken areas. In 1997, the World Tourism Organization created the Global Code of Ethics for Tourism, which insists that the population in the tourist area should receive the economic, social and cultural benefits of tourism while also increasing the number of job opportunities (Hall, 2007, p. 147). Since then, multiple programs have been created by the United Nations and other worldwide organizations to produce sustainable tourism to help alleviate poverty. A study conducted in an impoverished area of southern Africa discovered that "increasing the proportion of local people lifted out of poverty due to employment through tourism improves [the local area's] economic sustainability" (Hall, 2007, p. 156). Tourism is especially effective in poor communities because it provides a means for profit. Most of these areas under the poverty line lack resources that would enable them to manufacture or produce goods to export:

> Localities can use tourism as an invisible export in the same way they may use the production of tangible manufactured or agricultural goods to attract necessary foreign exchange and fulfill their overriding economic goals of wealth creation, employment generation and enhancement of the host population's living standards (Singh, Timothy, & Dowling, 2003, p. 41).

Though Ponce does not produce tangible manufactured goods, it still offers unique ecosystems and history. Oftentimes, cities with historical impact or unique ecological features benefit the most from tourism. These cities are also the most attractive to business owners looking to expand or construct new buildings, which ultimately adds to the local economy. It has been shown that tourism consistently improves the economy and employment rates when implemented in these areas. The effort to use tourism to alleviate poverty is sometimes known as "pro-poor tourism." Pro-poor tourism is "growth that enables the poor to actively participate in and significantly benefit from economic activity" (Hall, 2007, p. 37). The goal of pro-poor tourism is to provide job opportunities and economic growth in poor areas where employment is otherwise hard to find. While tourism does create employment and profits, it does not come without some negative impacts towards environmental, social, and cultural characteristics of the city.

E.1.2 Risks of Bringing Tourism

While tourism often brings in large economic growth for a community, nature-based tourism can have negative effects on the surrounding area. If tourism is brought to the Punta Cabullones area, there is a risk of negatively impacting the ecosystems of the cape. Buckley, Pickering and Weaver's book (2004) on ecotourism weighs the benefits and risks of using natural ecosystems for ecotourism to promote economic growth in surrounding areas. Because ecotourism focuses on a specific ecosystem, that ecosystem and the organisms within it may

suffer from the increased frequency of visitors, both directly and indirectly. Some examples of ecotourism negatively impacting an environment are:

> (i) impacts from a specific source, such as hikers and helicopters; (ii) impacts of a specific type or mechanism, such as trampling or noise; and (iii) impacts on a specific ecosystem component or function, such as air quality or a particular plant or animal species (Buckley, Pickering, & Weaver, 2004, p. 93).

In addition to harming the ecosystem, the surrounding environment may suffer due to the increase in population and commercial buildings in the area. For example, in the Galapagos Islands, "ecotourism has…precipitated immigration, increased pressures on the ecosystem and civic infrastructures, and raised the risk of introduced alien species, a principle threat to endemic species" (Honey, 2008, p. 122). Without proper management and balance, ecotourism can have detrimental consequences that affect not only the ecosystems themselves, but also the surrounding area. As was the case in the Galapagos, ecotourism can lead to an increase in the population of the islands and threat to the infrastructures. Therefore, it is important to weigh both the negative and positive effects of increasing tourism, especially when considering ecotourism.

E.1.3 How to Increase Tourism

While tourism could help the economies of many countries, it takes strategic planning and management to implement a successful tourism plan. Many of these tactics require complex marketing strategies in order to advertise the area as a tourist destination in addition to changes to the actual area. Over the past decade, Costa Rica has been going through these steps in order to bring more tourism into the country.

In 2006, Costa Rica was "perceived internationally as the world's prime ecotourism destination" (Honey, 2008, p. 160). However, Costa Rica was not always perceived that way; ten years prior, Costa Rica was still an area dedicated to war and scientific testing. Costa Rica was able to transform into the "number one ecotourism destination in the world" by implementing advertising campaigns, environmental organizations, a large national park system, and government policies that promote ecotourism (Honey, 2008, pp. 160-161). By marketing Costa Rica as a tourist destination and using the unique biodiversity as a draw for travelers, the country was able to convert from a rarely visited nation to a highly sought after vacation spot.

If similar plans are implemented in the Punta Cabullones area, on a much smaller scale, the tourism in the Ponce municipality could benefit as well. Because these areas offer biodiversity that cannot be found in other places around the globe, they are ideal locations to implement ecotourism plans.

E.2 Ecotourism

As previously stated, nature-based tourism, also known as ecotourism, is often used as a means of economic growth while preserving the natural environment of an area. The International Ecotourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment and improves the well-being of local people" (What is Ecotourism?, 2014). While many tourist destinations offer history, museums and architecture, it is often the natural landscapes, ecosystems, and wildlife that draw in substantial tourism. A 1998 study found that "global nature tourism…is worth at least US$250 billion a year" and "continues to grow faster than the tourism sector overall" (Buckley, Pickering, & Weaver, 2004, pp. 1, 7). In addition to growing the economy, ecotourism focuses on incorporating the community in the conservation of the environment. By implementing ecotourism in the Punta Cabullones area, the

community can reduce the risks associated with increasing tourism while still benefiting from the economic growth and increased employment.

Appendix F Interview Questions

1. Would you be interested in purchasing locally grown, organic crops from the area?
2. If so, is there any crop in particular that you use frequently?
3. Is there anything you would like to see in the Punta Cabullones area for use by your guests?
4. Do you have any other comments on the Punta Cabullones area?

Appendix G Bird Index

PUERTO RICO SPINDALIS

The Puerto Rico Spindalis is the official bird of Puerto Rico

- Usually found in pairs, but can also fly in small flocks
- Mainly eats berries and fruits, but will also eat some insects
- Lays 2-4 light blue eggs with brown dots

REINA MORA

La Reina Mora es el ave official de Puerto Rico

- Generalmente se encuentran en pares, pero también puede volar en bandadas pequeñas
- Principalmente come bayas y frutas, pero también come algunos insectos
- Pone 2-4 huevos de color azul claro con puntos marrones

ENDEMIC TO PUERTO RICO

MALES/*MACHOS*

Brightly Colored
De colores brilliantes

Weighs 0.8 to 1.3 ounces
Pesa 0.8 a 1.3 oz

FEMALES/*HEMBRAS*

Olive-green
Verde oliva

Weighs 0.9 to 1.4 ounces
Pesa 0.9 a 1.4 oz

para la Naturaleza

www.paralanaturaleza.org

ADELAIDE'S WARBLER

Spanish name "Mariposera" loosely translates to "butterfly hunter"

- Travels in flocks with other warblers such as the Puerto Rican Todies and Vieros
- Mainly eats insects such as caterpillars, beetles, and butterflies
- Lays 2-4 white eggs with brown dots

MARIPOSERA

Su nombre español "Mariposera" en términos generales se traduce como "cazador de mariposas"

- Viaja en bandadas con otras currucas como las Puerto Rico Barrancolí y Vieros
- Principalmente come insectos como orugas, escarabajos y mariposas
- Pone 2-4 huevos de color blanco con puntos marrones

ENDEMIC TO PUERTO RICO

MALES/*MACHOS*

Grey body with a yellow breast
Cuerpo gris con un pecho amarillo

Weighs about 0.25 ounces
Pesa acerca 0.25 oz

FEMALES/*HEMBRAS*

Grey and yellow but more dull
Gris y amarillo, pero más opaco

Weighs about 0.25 ounces
Pesa acerca 0.25

para la Naturaleza

www.paralanaturaleza.org

SEMIPALMATED SANDPIPER

Labeled as vulnerable due to the continual loss of habitat

- Breeds in the Arctic tundra in the summer and migrates south in the winter
- Mostly eats insects
- Usually lays 4 eggs which hatch after 20 days

PLAYERO GRACIOSO

Etiquetada como vulnerable debido a la pérdida continua de hábitat

- Se reproduce en la tundra del Ártico en el verano y migra al sur en el invierno
- Mayormente come insectos
- Por lo general, pone 4 huevos que empollan de 20 días

MIGRATORY BIRD

MALES/*MACHOS*

Grey body with a lighter breast
Cuerpo gris con pecho claro

Weighs 0.7 to 1.1 ounces
Pesa 0.7 a 1.1 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecida al macho en apariencia y peso

para la Naturaleza

www.paralanaturaleza.org

SEMIPALMATED PLOVER

Only lives on coastlines and sometimes swims for hunting

- Breeds in northern Canada during the summer and migrates south in the winter
- Mostly eats insects
- Usually lays 4 eggs which are incubated by both the male and female

PLAYERO GRACIOSO

Sólo vive en las costas y en ocasiones nada para la caza

- Se reproduce en el norte de Canadá durante el verano y migra al sur en el invierno
- Mayormente come insectos
- Por lo general, pone 4 huevos que son incubados por tanto el macho y la hembra

MIGRATORY BIRD

MALES/*MACHOS*

Brown body with a white breast and black neck

Cuerpo marrón con un pecho blanco y el cuello negro

Weighs about 1.7 ounces

Pesa acerca 1.7 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

RUDDY TURNSTONE

Gets its name from turning over stones in order to find food underneath

- Breeds on the Arctic coastline during the summer and migrates south in the winter
- Mostly eats insects, but sometimes eats bird's eggs
- Usually lays 4 olive or brown eggs with dark brown spots

PLAYERO TURCO

Obtiene su nombre porque voltea piedras para encontrar comida

- Se reproduce en la costa del Ártico durante el verano y migra al sur en el invierno
- Mayormente come insectos pero a veces come huevos de ave
- Por lo general, pone 4 huevos verde oliva o marrón con manchas marrones oscuras

MIGRATORY BIRD

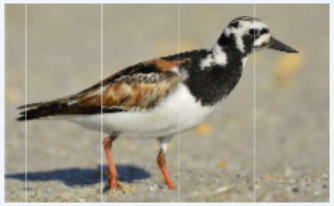
MALES/*MACHOS*

Brown and black body with a white breast and black and white head

Cuerpo marrón y negro con el pecho blanco y la cabeza en blanco y negro

Weighs 3 to 6.7 ounces

Pesa 3 a 6.7 oz



FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

BLUE-WINGED TEAL

Usually the first duck to migrate south in the winter

- Breeds in northern North American in the summer and migrates south in the winter
- Mainly eats aquatic plants, seeds, and invertebrates
- Lays 6-14 creamy white eggs which hatch after 19-29 days

PATO ZARCEL

Por lo general, es el primer pato de migrar al sur el invierno

- Se reproduce en el norte de Norte América en el verano y emigra al sur en el invierno
- Principalmente come plantas acuáticas, semillas e invertebrados
- Pone 6-14 huevos de color blanco cremoso que empollan después de 19-29 días

MIGRATORY BIRD

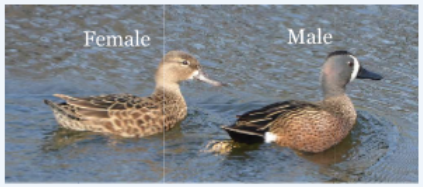
MALES/*MACHOS*

Brown body with black spots, blue upper wings, and a white crescent in front of each eye

Cuerpo marrón con manchas negras, alas superiores azules, y una media luna blanc en frente de cada ojo

Weighs about 16 ounces

Pesa acerca 16 oz



FEMALES/*HEMBRAS*

Brown-gray bodies and the wings are more dull

Cuerpos marrón-gris y las alas son más opacas

Weighs 12 to 13 ounces

Pesa 12 a 13 oz

para la Naturaleza

www.paralanaturaleza.org

GREEN-WINGED TEAL

The smallest of the North American ducks

- Breeds in northern United States and Canada in the summer and migrates south in the winter
- Mainly eats aquatic plants, seeds, and invertebrates
- Lays 8-9 eggs

PATO ALIVERDE

El más pequeño de los patos de Norte América

- Se reproduce en el norte de Estados Unidos y Canadá en el verano y emigra al sur en el invierno
- Principalmente come plantas acuáticas, semillas e invertebrados
- Pone 8-9 huevos

MIGRATORY BIRD

MALES/*MACHOS*

Grey body with a red and green striped head
Cuerpo gris y cabeza de rayas rojas y verdes

Weighs 11 to 12 ounces
Pesa 11 a 12 oz

FEMALES/*HEMBRAS*

Brown-gray bodies and the wings are more dull
Cuerpos marrón-gris y las alas son más opacas

Weighs 9 to 10 ounces
Pesa 9 a 10 oz

para la Naturaleza

www.paralanaturaleza.org

LESSER SCAUP

One of the highest populated and widespread diving ducks in North America

- Breeds in northern United States and Canada in the summer and migrates south in the winter
- Eats aquatic plants, seeds, invertebrates, clams, and snails
- Lays 6-14 olive-green eggs

PATO PECHIBLANCO MENOR

Uno de los patos buceadores mas numerosos y esparcidos en Norte América

- Se reproduce en el norte de Estados Unidos y Canadá en el verano y emigra al sur en el invierno
- Come plantas acuáticas, semillas, invertebrados, almejas y caracoles
- Pone 6-14 huevos verde oliva

MIGRATORY BIRD

MALES/*MACHOS*

Black head and tail with grey and white body

La cabeza y la cola negro con el cuerpo gris y blanco

Weighs 28 to 30 ounces

Pesa 28 a 30 oz

FEMALES/*HEMBRAS*

Mostly brown with grey patches

En su mayoría marrón con manchas grises

Weighs 25 to 26 ounces

Pesa 25 a 26 oz

para la Naturaleza

www.paralanaturaleza.org

RINGED-NECK DUCK

It is distinguished from other similar looking ducks by its peaked head

- Breeds in northern United States and Canada in the summer and migrates south in the winter
- Eats aquatic plants and invertebrates
- Lays 6-14 eggs

PATO ACOLLARADO

Se distingue de otros patos de aspecto similar por su cabeza de pico

- Se reproduce en el norte de Estados Unidos y Canadá en el verano y emigra al sur en el invierno
- Come plantas acuáticas e invertebrados
- Pone 6-14 huevos

MIGRATORY BIRD

MALES/*MACHOS*

Black head and body with grey sides
Cabeza negra y cuerpo gris a los lados
Weighs 25 to 26 ounces
Pesa 25 a 26 oz

FEMALES/*HEMBRAS*

Mostly brown with white circle around the eyes
En su mayoría marrón con círculo blanco alrededor de los ojos
Weighs about 24 ounces
Pesa acerca 24 oz

para la Naturaleza

www.paralanaturaleza.org

PRAIRIE WARBLER

The female eats the eggs of her chicks after they hatch

- Breeds on the east coast of the United States and migrates south into the Carribean for the winter
- Eats insects, spiders, and other invertebrates
- Lays 2-5 brown or grey eggs a ring on one side and spots over the entire egg

REINITA GALANA

La hembra se come los huevos de sus polluelos después de que empollan

- Se reproduce en la costa este de los Estados Unidos y migra hacia el sur en el Caribe para el invierno
- Come insectos, arañas y otros invertebrados
- Pone 2-5 huevos de color marrón o gris con un anillo de un lado y manchas en todo el huevo

MIGRATORY BIRD

MALES/*MACHOS*

Olive-green upper body with a yellow belly with black stripes

Parte superior del cuerpo de color verde oliva con un vientre amarillo con rayas negras

Weighs 0.2 to 0.3 ounces

Pesa 0.2 a 0.3 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male, but colors are more dull

Parecido en apariencia y pesa al macho, pero los colores son más opacos

para la Naturaleza

www.paralanaturaleza.org

AMERICAN REDSTART

The male can mate with up to two females in a single breeding season

- Breeds in northern United States and Canada in the summer and migrates south in the winter
- Mostly eats insects and berries
- Lays 1-5 creamy eggs with brown or reddish blotches

CANDELITA

El macho puede aparearse con un máximo de dos hembras en una sola temporada de reproducción

- Se reproduce en el norte de Estados Unidos y Canadá en el verano y emigra al sur en el invierno
- En su mayoría come insectos y bayas
- Pone 1-5 huevos de color crema con manchas marrones o rojizas

MIGRATORY BIRD

MALES/*MACHOS*

Black body with orange sides and a white belly

Cuerpo negro con lados de color naranja y el vientre blanco

Weighs 0.2 to 0.3 ounces

Pesa 0.2 a 0.3 oz

FEMALES/*HEMBRAS*

Grey and black body with yellow sides and a white belly

Cuerpo gris y negro con lados de color amarillo y el vientre blanco

Weighs 0.2 to 0.3 ounces

Pesa 0.2 to 0.3 oz

para la Naturaleza

www.paralanaturaleza.org

PIPING PLOVER

The Piping Plover is a near-threatened species because of the human disturbance it encounters on beaches.

- Lives along beaches of Atlantic Ocean during the summer and migrates to Gulf of Mexico and Caribbean in the winter
- Eats insects, worms, and crustaceans
- Lays 4 eggs that hatch after 27 days

CHORLITO AFLAUTADO

El Chorlito Aflautado es una especie casi amenazado por causa de perturbación de la gente en las playas.

- Vive en las playas del Atlántico durante el verano y emigra al Golfo de México y el Caribe en el invierno
- Come insectos, gusanos, y crustáceos
- Pone 4 huevos que empollan después de 27 días

NEAR THREATENED SPECIES

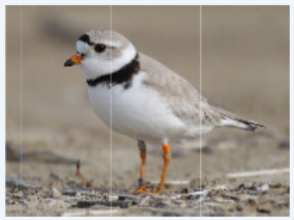
MALES/*MACHOS*

Sand-colored, yellow-orange legs, and black neck

De color arena, patas amarillas-anaranjadas, y cuello negro

Weighs about 1.5 to 2.3 ounces

Pesa cerca de 1.5 a 2.3 oz



FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

WILSON'S PLOVER

The Wilson's plover is a medium-sized plover that lives on the beaches and is threatened in some states.

- Lives along coasts of Americas and migrates south for the winters
- Eats insects, worms, and crustaceans
- Lays 3 eggs that hatch after 23-25 days

CHORLO PICO GRUESO

El Chorlo Pico Grueso es un chorlito de tamaño medio que vive en las playas y esta amenazado en algunos estados.

- Vive en las costas del América durante el verano y emigra al sur en el invierno
- Come insectos, gusanos, y crustáceos
- Pone 3 huevos que empollan después de 23-25 días

SPECIES OF LEAST CONCERN

MALES/*MACHOS*

Grey and white, yellow-orange legs, black neck

Gris y blanco, patas amarillas-anaranjadas, cuello negro

Weighs about 1.9 to 2.5 ounces

Pesa cerca de 1.9 a 2.5 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

YELLOW WARBLER

The Yellow Warbler is a small, yellow bird that lives in the woods near water and wetlands.

- Lives North America and migrates south to mangrove forests for the winter
- Eats insects
- Lays gray eggs that hatch after 10-13 days

PARÚLIDO AMARILLO

El Parulido Amarillo es un ave pequena que vive en bosques cerca del agua y el pantanos.

- Vive en América del Norte y emigra al sur a los manglares en el invierno
- Come insectos
- Pone huevos gris que empollan después de 10-13 días

SPECIES OF LEAST CONCERN

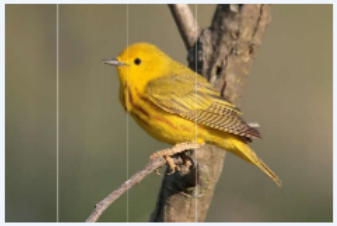
MALES/*MACHOS*

Yellow, brighter than females, reddish underparts

Amarillo, mas vivo que las hembras, barrigas rojizas

Weighs about 0.3 to 0.4 ounces

Pesa cerca de 0.3 a 0.4 *oz*



FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

WHITE-CROWNED PIGEON

The White-Crowned Pigeon is a large bird that lives in island forests and mangroves.

- Lives on Caribbean islands and coasts of Mexico and Florida.
- Eats fruits and berries
- Lays 1-3 white eggs

NEAR THREATENED SPECIES

MALES/*MACHOS*

Grey with white cap
Gris con gorro blanco

Weighs about 7.8 to 9.9 ounces
Pesa cerca de 7.8 a 9.9 oz

PALOMA CORONA BLANCA

La Paloma Corona Blanca es un ave grande que vive en bosques de islas y manglares.

- Vive en el Caribe y las costas del México y Florida.
- Come fruta y bayas
- Pone 1-3 huevos blancos

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

GRASSHOPPER SPARROW

The Grasshopper Sparrow is a small songbird that lives in open grasslands.

- Lives in the United States in the summer and migrates south in the winter
- Eats insects, especially grasshoppers
- Lays 3–6 white and reddish brown eggs

GORRIÓN CHAPULÍN

El Gorrión Chapulín es una ave cantora que vive en praderas abiertas.

- Vive en los Estados Unidos en el verano y emigra al sur en el invierno
- Come insectos, especialmente los chapulines
- Pone 3-6 huevos blancos y marrones rojizos

SPECIES OF LEAST CONCERN

MALES/*MACHOS*

Brown with dark crown, large head, small tail

Marron con corona oscura, cabeza grande, cola pequena

Weighs about 0.5 to 0.7 ounces

Pesa cerca de 0.5 a 0.7 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

WHITE-CHEEKED PINTAIL

White-cheeked Pintail is threatened due to overhunting and destruction of their habitats

- Usually travels in small flocks, but when food is abundant flocks as large as 1000 birds have been seen
- Eats a diet of grasses and aquatic plants
- Lays 5-12 creamy white eggs which hatch after about 25 days

PATO QUIJADA COLORADA

Se considera amenazada debido a la caza excesiva y la destrucción de sus hábitats

- Generalmente vive en pequeños rebaños, pero cuando la comida es abundante rebaños como se han visto 1000 pájaros
- Come principalmente hierbas y plantas acuáticas
- Pone 5-12 huevos de blanco que eclosionan después de 25 días

COMMONWEALTH THREATENED SPECIES

MALES/*MACHOS*

Brown body with black spots
Cuerpo marrón con manchas negras

Weighs about 18.5 ounces
Pesa cerca de 18.5 oz

FEMALES/*HEMBRAS*

Brown with a dull white face
Marrón con una cara opaca blanca

Weighs about 17.75 ounces
Pesa cerca de 17.75 oz

para la Naturaleza

www.paralanaturaleza.org

MAGNOLIA WARBLER

The Magnolia Warbler is a small, migratory songbird that spends it's winters in Puerto Rico.

- Commonly breeds throughout Canada and migrates through the east coast of the US
- Often flocks with other migratory birds
- Eats a diet of larvae, adult insects and spiders
- Lays 3-5 white, speckled eggs

REINITA MANCHADA

La Reinita Manchada es un pájaro cantor pequeño, migratorio que pasa sus inviernos en Puerto Rico.

- Comúnmente se reproduce a lo largo de Canadá y emigra a través de la costa este de los E.U.
- Amenudo se une a otras aves migratorias
- Come una dieta de larvas, insectos y arañas adultas
- Establece 3-5 huevos blancas moteados

MIGRATORY BIRD

MALES/ *MACHOS*

Yellow chest and throat, black mask and heavy stripes

Cuerpo marrón con manchas negras

Weighs about 0.2 to 0.5 ounces

Pesa cerca de 0.2 a 0.5 *oz*

FEMALES/ *HEMBRAS*

Yellow chest and throat, grey mask and dull stripes

Pecho y cuello amarillos, máscara gris y rayas opacas

Weighs about 0.2 to 0.5 ounces

Pesa cerca de 0.2 a 0.5 *oz*

para la Naturaleza

www.paralanaturaleza.org

BLACK-WHISKERED VIREO

The Black-Whiskered Vireo is a small, resident bird common to Caribbean forests.

- Commonly found in coastal mangroves, sea-level forests and mountain forests in the Caribbean
- Eats a diet of fruit and insects
- Gleans good from trees
- Lays 2-4 white eggs with brown dots

JULIÁN CHIVÍ

El Julian chivi es un pequeño pájaro residente común en los bosques del Caribe.

- Comúnmente se encuentran en manglares costeros, bosques del nivel del mar y los bosques de las montañas en el Caribe
- Come una dieta de frutas e insectos
- Recoje bien de los árboles
- Pone 2-4 huevos blancos con puntos marrones

RESIDENT BIRD

MALES/*MACHOS*

Small, drab, olive-brown with a light belly

Pequeño, pardoso, de color marrón con una barriga clara

Weighs about 0.6 to 0.8 ounces

Pesa cerca de 0.6 a 0.8 *oz*

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

LEAST BITTERN

This small species of heron is one of the most difficult marsh birds to spot due to it's impressive camouflage

- Found in Caribbean marshes year round, but can also migrate throughout the Americas
- Eats a diet of small fish and insects
- Lays 2-7 pale blue or green eggs

MARTINETITO

Esta pequeña especie de garza es una de las aves más difíciles pantano de detectar debido a su impresionante camuflaje

- Se encuentra en los pantanos del Caribe durante todo el año, pero también puede migrar todo el continente Americano
- Come una dieta de pequeños peces e insectos
- Pone 2-7 huevos de color azul o verde pálido

RESIDENT BIRD

MALES/*MACHOS*

Glossy brown with dark back and crown

Marrón brillante con la parte posterior oscura y la corona

Weighs about 1.8 to 3.6 ounces

Pesa cerca de 1.8 a 3.6 *oz*

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

GREAT BLUE HERON

The Great Blue Heron is the largest North American heron

- Breeds throughout North America and spends its winters in Mexico and the Caribbean
- Eats a diet of fish, amphibians, reptiles, small mammals, other birds and insects
- Lays 2-6 pale blue eggs

GARZÓN CENIZO

El Garzón Cenizo es la garza norteamericana más grande

- Se reproduce en toda América del Norte y pasa sus inviernos en México y el Caribe
- Come una dieta de peces, anfibios, reptiles, pequeños mamíferos, otras aves e insectos
- Pone 2-6 huevos de color azul pálido

MIGRATORY BIRD

MALES/*MACHOS*

Blue-gray in color
Cuello largo, pico largo

Weighs about 75 to 90 ounces
Pesa cerca de 75 a 90 *oz*

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

BLACK-CROWNED NIGHT HERON

These small, squat herons with thick proportions can be found in the Caribbean year round

- Social birds that nest in groups
- Eats a diet of leeches, worms, fish, clams, amphibians, reptiles, rodents, birds and eggs
- Lays 3-5 pale green-blue eggs

RESIDENT BIRD

MALES/*MACHOS*

Light grey with black crown and back
Gris claro con corona y espalda negras

Weighs about 26 to 36 ounces
Pesa cerca de 26 a 36 *oz*

YABOA REAL

Estas pequeñas garzas con proporciones gruesas se pueden econtrrar todo el año en el Caribe

- Aves sociales que anidan en grupos
- Come una dieta de sanguijuelas, gusanos, peces, almejas, anfibios, reptiles, roedores, aves y huevos
- Pone 3-5 huevos de color verde azul pálido

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

SORA

The Sora is a small marsh bird that spends its winters in southern North America and the Caribbean

- Conservation status is of least concern, but they may be declining due to hunting
- This bird is a ground forager and eats a diet of insects
- Lays 10-12 eggs

GALLITO SORA

El Gallito Sora es un pequeño ave de pantano que pasa sus inviernos en el sur de América del Norte y el Caribe

- El estado de conservación es de preocupación menor, pero puede estar disminuyendo debido a la caza
- Esta ave es un recolector de tierra y come una dieta de insectos
- Pone 10-12 huevos

MIGRATORY BIRD

MALES/*MACHOS*

Gray in color with black face and bib
De color gris con la cara y babero negro

Weighs about 2 to 4 ounces
Pesa cerca de 2 a 4 *oz*

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

GLOSSY IBIS

The Glossy Ibis is a dark wading bird that lives in the Caribbean and south east U.S. year round

- Glossy ibis are typically found foraging in small flocks
- This bird eats a diet of insects
- Lays 3-4 eggs

IBIS LUSTROSO

El Ibis Lustroso es un ave zancuda oscura que vive en los E.U. y Caribe durante todo el año

- Ibis brillante se encuentran típicamente en pequeñas bandadas de forrajeo
- Este pájaro come una dieta de insectos
- Pone 3-4 huevos

RESIDENT BIRD

MALES/*MACHOS*

Body is primarily dark red and black

El cuerpo es de color rojo oscuro y negro principalmente

Weighs about 18 to 28 ounces

Pesa cerca de 18 a 28 *oz*

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

CARIBBEAN COOT

The Caribbean Coot is a large resident waterbird of Puerto Rico

- Breed in freshwater lakes and marshes and build a floating nest
- This bird is an omnivore, eating plants, insects, and fish
- Lays 4-8 speckled white eggs

GALLINAZO CARIBEÑO

El Gallinazo Caribeño es una gran ave acuática residente de Puerto Rico

- Se reproduce en lagos de pantanos de ague dulce, y construye un nido flotante
- Esta ave es un omnívoro, comiendo plantas, insectos y peces
- Pone 4-8 huevos blancos manchados

COMMONWEALTH THREATENED SPECIES

MALES/*MACHOS*

Gray in color with black head and neck
De color gris con la cabeza y el cuello negro

Weighs about 23 ounces
Pesa cerca de 23 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

SNOWY PLOVER

The Snowy Plover is a small resident shorebird of Puerto Rico

- Raises 2-3 broods a year, each with a different mate
- This bird has a diet of aquatic and terrestrial invertebrates
- Lays 2-6 small buff eggs

CHORLITO BLANCO

El Chorlito Blanco es una pequeña ave playera residente de Puerto Rico

- Cria de 2 a 3 camadas por año, cada una con un compañero diferente
- Esta ave tiene una dieta de invertebrados acuáticos y terrestres
- Pone 2-6 huevos pequeños buff

COMMONWEALTH CRITICALLY THREATENED

MALES/*MACHOS*

Pale tan back with white underside
Espalda bronceada pálida con pecho blanco

Weighs about 1.2 to 2 ounces
Pesa cerca de 1.2 a 2 *oz*

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male
Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

BROWN PELICAN

The Brown Pelican is a huge resident seabird of Puerto Rico

- Stands on it's eggs in order to keep them warm
- This bird eats small fish that swim in schools near the water surface
- Lays 2-4 chalky white eggs

PELÍCANO PARDO

El pelícano pardo es una enorme ave marina residente de Puerto Rico

- Se para en sus propios huevos con el fin de mantener el calor
- Este pájaro come pequeños peces que nadan en los bancos cerca de la superficie del agua
- Pone 2-4 huevos blancos calcáreos

COMMONWEALTH ENDANGERED SPECIES

MALES/*MACHOS*

Gray-brown in color with yellow heads and white necks

Gris-marrón en color con cabezas amarillas y cuellos blancos

Weighs about 70 to 176 ounces

Pesa cerca de 70 a 176 oz

FEMALES/*HEMBRAS*

Similar in appearance and weight to the male

Parecido en apariencia y peso al macho

para la Naturaleza

www.paralanaturaleza.org

All information for the bird index was compiled from the following websites:

- www.allaboutbirds.org
- www.puertoricobirds.com
- www.fs.usda.gov
- www.neotropical.birds.cornell.edu
- www.ducks.org
- www.birdweb.org
- www.arkive.org
- www.audobon.org

All pictures for the bird index were compiled from the following websites:

- www.wikipedia.org
- www.commons.wikipedia.org
- www.flickr.com
- www.neotropical.birds.cornell.edu
- www.puertoricobirds.com
- www.notesfromthewildside.com