Developing a Watershed Council for the Río Espiritu Santo Watershed in Puerto Rico

An Interactive Qualifying Project to be submitted to the Faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the degree of Bachelor of Science.

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Abstract

The goal of this project was to assist the U.S. Forest Service in the creation of the Río Espiritu Santo Watershed Council to promote the conservation and restoration of the area. We used background research to provide support and inform our research. We collected data through surveys and interviews of watershed council officials and the community of the watershed. Using these data, we created seven deliverables that will serve as recommendations for the council including a Rapid Watershed Assessment, a Restoration and Community Development Assessment, a Google blog, a charter draft, a project poster, a discussion of the "ideal" watershed council, and a final presentation. These deliverables will serve to assist the initial stakeholders in founding the Río Espiritu Santo Watershed Council.

Executive Summary

Environmental preservation and management are currently crucial worldwide issues. The health of the global environment is declining, and without proper management this pattern of decline will continue (Weiskel, 1989). Currently, the majority of environmental preservation strategies are focused on large global issues. While this type of management and preservation is necessary, the organizations managing these strategies do not provide ecological plans for smaller community-based problems. These problems are most commonly solved using a watershed council, a community based non-regulatory agency committed to the environmental preservation of a specific watershed. The watersheds, or geographic hydrological communities, of Puerto Rico have their specific environmental issues and concerns. Due to the extremely varied ecological structure, community driven organizations can play a significant role in managing each individual watershed on the island and addressing their unique environmental concerns.

The aim of this project was to aid the United States Forest Service in the development of a watershed council for the Río Espiritu Santo Watershed, located in the Río Grande municipality of northeastern Puerto Rico. This watershed council will give the community surrounding the Río Espiritu Santo a place to voice their environmental concerns, educate the community in proper ecological preservation practices, and improve the environmental health of the area.

Methodology

The United States Forest Service requested a plan for the development of the Río Espiritu Santo Watershed Council. The goals of this project were to determine what criteria go into the creation and management of a successful watershed council and how the Río Espiritu Santo Watershed Council and its stakeholders should implement those criteria. The following research objectives were developed in order to achieve these project goals:

1) Study the most frequent challenges faced by watershed councils and determine if budget size or funding sources had an impact on the frequency of reported challenges.

2) Examine the common activities that watershed councils perform in their communities and how the time spent on these activities can be affected by budget size.

3) Evaluate the perceived effectiveness of watershed councils and define any potential effect that budget size, time spent on different types of activities, funding sources, or frequency of reported challenges have on perceived effectiveness.

4) Gauge the community interest in the development of a watershed council and suggest methods of community outreach for the proposed Río Espiritu Santo Watershed Council.

There were three key groups of people that were taken into consideration in the development of the project methods: current officials of established watershed councils throughout the U.S.; the communities of Puerto Rico, particularly the Río Grande municipality; and a set of business, academic, and private individuals identified by the U.S. Forest Service as initial stakeholders in the watershed council. The following is a summary of the methods that were used to complete the project objectives:

1) **Watershed Council Official interviews:** Interviews were conducted with watershed council officials from the Massachusetts area before arriving on-site to determine the basic structure of a watershed council and what makes a watershed council effective.

2) **Watershed Council Official Survey:** A survey was distributed to additional watershed council officials in order to obtain more quantitative data on the typical governance structures of watershed councils, as well as their funding sources, activities, challenges, and perceived effectiveness.

3) **Initial Stakeholder Interviews:** Interviews were conducted with the individuals from the initial stakeholder list provided by the U.S. Forest Service to determine their willingness to participate in the Río Espiritu Santo Watershed Council, as well as their goals for the council, their concerns about the challenges the council might face, the environmental issues that they have observed in the area, and ideas they have to better the council.

4) **Community Survey:** A survey was distributed to community members throughout the island of Puerto Rico to gauge the community's willingness to participate in various aspects of a watershed council, along with their knowledge of watersheds and watershed councils and the environmental issues they have observed in their community.

5) **Rapid Watershed Assessment:** We conducted a Rapid Watershed Assessment; a written assessment that briefly describes the watershed as a whole and includes information on the land use, hydrology, species, and habitat status and trends of the watershed. This document will be utilized by the U.S. Forest Service in the development of the Río Espiritu Santo Watershed Council to explain the status of the watershed to the community or interested parties.

Results

Through the various project methods, results were gathered and analyzed for the purpose of the recommendation of a plan for the development and operation of a watershed council for the Río Espiritu Santo Watershed. Analysis was conducted using both graphical and statistical methods. An outline of the findings is described below.

Although the governance structure of a watershed council can vary greatly, there are certain criteria that impact the effectiveness of a watershed council.

After analyzing the data from the watershed council official survey using a regression analysis, it was determined that the budget of a watershed council has a direct positive relationship with the perceived overall effectiveness and conservation/restoration effectiveness of that council. This result suggests that watershed councils with larger operating budgets are perceived to be more effective overall and in conservation/restoration.

There are certain activities that influence the overall effectiveness of a watershed council.

Using a regression analysis of the data from the watershed council official survey, it was determined that the time a council spends on restoration/action activities has a direct relationship with the perceived overall effectiveness of that council. This result implies that councils that spend more time on restoration/action activities are perceived to be more effective.

There are common trends within the anticipated challenges that the Río Espiritu Santo Watershed Council might encounter.

From the interviews conducted with the initial stakeholders of the Río Espiritu Santo Watershed Council, there were several common challenges identified that the Río Espiritu Santo Watershed Council might face in its development and operation. These challenges include, but are not limited to: educating the community in proper ecological practices, community involvement in the council, the lack of enforcement of environmental regulations, and the funding of the council. These data were consistent with the data obtained from the watershed council official survey.

There are many common environmental concerns within the community surrounding the Río Espiritu Santo.

From the initial stakeholder interviews and the community survey, there were many shared environmental concerns within the community of the Río Espiritu Santo Watershed. Some of these concerns include: pollution, urban development/construction, education, and the damming of the Río Espiritu Santo.

The community is overall "Somewhat Likely" to participate in a watershed council, and there were many common suggestions for effective community outreach methods.

After collecting the results of the community survey, analyses were performed on the willingness of community members to participate in various watershed council activities. It was determined that on average, the community was overall "Somewhat Likely" to participate in some aspect of the Río Espiritu Santo Watershed Council. There were also several common suggestions for community outreach methods from the initial stakeholder interviews, including: a public values forum for the community to voice their concerns, getting churches in the area involved as community leaders, having a river cleanup/barbeque, and utilizing the 4H Rangers to complete a project involving the river.

Deliverables

Using the data and relationships established through the analysis of our results, the following deliverables were produced:

Rapid Watershed Assessment

As described above, the Rapid Watershed Assessment was performed in order to provide the Río Espiritu Santo Watershed Council with a baseline analysis of the current state of the watershed.

Draft of a charter for the Río Espiritu Santo Watershed Council

The Río Espiritu Santo Watershed Council will use this charter draft as a baseline for the creation of the official charter of the council.

Restoration and Community Development Assessment

This document consists of suggested activities and projects for the first official actions of the Río Espiritu Santo Watershed Council once it is established. Also included in this document is a list of interested contacts for the watershed council.

Google Blog

The framework for this blog website will be used by the U.S. Forest Service in informing both the initial stakeholders of the Río Espiritu Santo Watershed Council and the community of the watershed about the project and its status.

Project Presentation

This presentation was delivered to our sponsor at the U.S. Forest Service as well as several of the initial stakeholders upon the completion of our project.

Project poster for the Río Espiritu Santo Watershed Project

The project poster, containing information about our project as well as the continued timeline, will serve to inform and generate interest about the Río Espiritu Santo Watershed Council.

Discussion on characteristics of the ideal watershed council

We developed a series of recommendations on the governance structure and operation of the ideal watershed council. These recommendations were delivered to the sponsor in the form of the discussion section of this report.

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Authorship

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Primary contributor to background sections “Rainforests” and “El Yunque”, as well as methodology sections “Drafting Watershed Council Charter” and “Developing Google Blog”, survey and interview findings section “Environmental Issues”, and the Restoration and Community Development Assessment. Diego also took minutes for all interviews as well as performed interviews with Spanish-speaking individuals. He also performed all regression analyses as well as compiled data from all interviews. Finally, he was also the individual responsible for the development of all meeting agendas and minutes.

Samuel Naseef:

Primary contributor to Executive Summary, background section “Watersheds”, methodology sections “Surveying the Community” and “Rapid Watershed Assessment”, survey and interview findings section “Watershed Council Effectiveness”, as well as “Project Deliverables” chapter and “Appendix A: Background on Rapid Watershed Assessments”. Samuel was also responsible for the EndNote, the formatting of all documents, and he was a primary editor for all sections.

Alexander Verrelli:

Primary contributor to background section “Watershed Councils”, methodology sections “Watershed Council Official Interviews & Survey” and “Initial Stakeholder Interviews”, as well as the remaining sections of the survey and interview findings chapter and the “Discussion” chapter. Alexander also conducted all interviews with English-speaking individuals and was one of the primary editors of all documents.

All team members worked on other sections and documents equally.

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1.0 Introduction

Although rainforests cover only seven percent of the world's land area, they provide a variety of unique and important natural resources. Primarily, the rainforest is a habitat for approximately half of the world's animal population. In addition to providing a habitat for these animals, the rainforests are instrumental in the production of oxygen, as well as the storage of carbon. Rainforests also contribute to the ecosystem by means of soil stabilization and flood prevention (Holzman, 2008). Finally, since rainforests are some of the world's largest natural wonders, they become major draws for tourists as long as they are still pristine. All of this leads environmental experts to believe that establishing the framework for environmental preservation of rainforests is extremely important.

Rainforests, along with all other types of ecosystems, are divided up into individual sections known as watersheds. A watershed is a specifically defined area of land in which streams and rivers carry water to lakes and oceans. Other geographical features, such as mountain ridges, create the natural borders between watersheds. These characteristics separate each watershed into its own ecosystem, each of which contains unique assets and issues. The protection of the environment requires that each watershed be managed individually based on its unique characteristics.

Many communities have addressed the environmental issues in local watersheds using organizations known as watershed councils. These councils are community based non-regulatory agencies committed to the environmental preservation of a specific watershed.

Watershed councils also strive to increase public participation in environmental conservation and knowledge about how the natural resources of the community are managed.

For this project, we worked in the Río Espiritu Santo Watershed. This watershed contains a section of the El Yunque rainforest, which is located in northeastern Puerto Rico. While the environmental condition of this watershed is not irreparable, immediate management is required to preserve the natural resources the watershed contains. Problems including, pollution, erosion, and misuse of the land have seriously damaged the health of the Río Espiritu Santo Watershed (El Yunque National Forest & US Forest Service, 2011). Therefore, it has become a priority for Puerto Rican citizens and government officials to establish a system for the preservation and management of this rainforest.

The goal of this project was to assist the U.S. Forest Service in the creation of the aforementioned watershed council. To address this goal, we first performed background research on rainforests, El Yunque, watersheds, and watershed councils. This background research led us to develop a set of objectives for the project. These objectives were:

1) Study the most frequent challenges faced by watershed councils and determine if budget size or funding sources had an impact on the frequency of reported challenges.

2) Examine the common activities that watershed councils perform in their communities and how the time spent on these activities can be affected by budget size.

3) Evaluate the perceived effectiveness of watershed councils and define any potential effect that budget size, time spent on different types of activities, funding sources, or frequency of reported challenges have on perceived effectiveness.

4) Gauge the community interest in the development of a watershed council and suggest methods of community outreach for the proposed Río Espiritu Santo Watershed Council.

These objectives became the basis for a variety of data acquisition methods. First, we interviewed and surveyed existing watershed council officials to determine the effectiveness of their councils' respective governance structures. Second, we interviewed stakeholders crucial to the development of the watershed council. Third, we administered a survey to various community members of Puerto Rico. This survey was designed to gauge community interest in a watershed council for the Río Espiritu Santo Watershed. Finally, we conducted a Rapid Watershed Assessment of the Río Espiritu Santo Watershed to evaluate the current health of the watershed.

The data gathered from the previously listed methods were analyzed using a variety of statistical tests, including single-sample t-tests, two-sample t-tests, ANOVA tests, and regression analyses. Using these analyses, we were able to determine several relationships associated with the perceived effectiveness of watershed councils. We were also able to assess the interest of the Puerto Rican community in a watershed council, particularly from those individuals that reside in the Río Grande municipality, where the Río Espiritu Santo is located. Finally, we were able to provide recommendations to help increase the chance of success for the council.

The results of our analysis were applied to the creation of several deliverables for the Río Espiritu Santo Watershed Council. The first of these deliverables was the RWA, which will allow the council to assess the current environmental health of the watershed and determine which environmental issues most require the council's attention. Second, we produced the outline for a watershed council charter that defines the governance structure of the council.

Third, in order to determine what types of activities the watershed council could undertake, we performed a Restoration and Community Development Assessment (RCDA). Next, we also started a Río Espiritu Santo Watershed Council blog designed to keep the public informed about the activities of the council. Our final presentation to the U.S. Forest Service and the initial stakeholders will be one of the deliverables posted on this blog. Furthermore, we designed a project poster that described our project as well as the future of the council. Finally, we developed a set of recommendations on the governance structure and operation of the ideal watershed council using the data we collected.

The information and resources we have provided to the U.S. Forest Service and the initial stakeholders will allow these entities to officially form the Río Espiritu Santo Watershed Council. The establishment of this council will lead to a more organized and unified environmental management effort for the Río Espiritu Santo Watershed. Ideally, the establishment of this council will result in an increase of the environmental health of the area and the El Yunque rainforest as a whole, thus helping to preserve this important natural resource.

2.0 Background/Literature Review

To aid in the understanding and development of the project and its goals, we performed background research on rainforests in general, the El Yunque National Rainforest, watersheds, and watershed councils. We also researched rainforests, specifically El Yunque, to gain a better understanding of rainforest ecosystems. We conducted this research because a section of El Yunque is contained within the Río Espiritu Santo Watershed. Understanding the basic principles of watersheds and their composition was also important in determining the most effective means of watershed management. One of the most common forms of watershed management is a watershed council. Research was also done on watershed councils to further our understanding of the organization and functions of these councils.

2.1 Rainforests

Rainforests are generally located in hot, humid areas near the equator where the rainfall is in excess of 1,800 mm (70 inches) per year (Encyclopedia Britannica, 2013). These ecosystems provide for a myriad of animal and plant species that have come to flourish in this type of environment. Rainforests also contain a variety of resources that people use on a daily basis. Most importantly, rainforests are a valuable resource due to their efficiency in reducing carbon dioxide and other greenhouse gases. These reasons make it apparent that the conservation of rainforests should become a major priority for government leaders and the communities they serve.

Rainforests provide a sanctuary to a diverse population of plants and animals. In a Malaysian rainforest, for example, there are approximately 375 different plant species inhabiting an area only 23 hectares in size (Encyclopedia Britannica, 2013). Similar to the plant species, animal species within rainforests are also extremely varied. A variety of parrots, pigeons and seed-eating weevil beetles are typically found in any tropical rainforest, along with certain species unique to the region in which the rainforest is located (Holzman, 2008).

The rapid disappearance of rainforests is a serious concern because rainforests provide many of the resources used in the production of many products. Some examples of these products are resins, prescription drugs, latex, wild meat, and honey. Rainforests play a particularly critical role in the production of prescription drugs; approximately 32% of the raw materials for the pharmaceutical industry are supplied by rainforests (Inter-Agency Technical Committee of the Forum of Ministers of the Environment of Latin America and the Caribbean, 2000).

Another benefit of rainforests is their contribution to soil stabilization and flood prevention. Rainforests also serve to counteract the increase of atmospheric carbon dioxide and other greenhouses gases. These traits create a healthier environment and may help mitigate the effects of climate change. Climate change is a serious concern among many industrialized nations, and retaining and growing the existing rainforests is an effective method of abatement (Holzman, 2008).

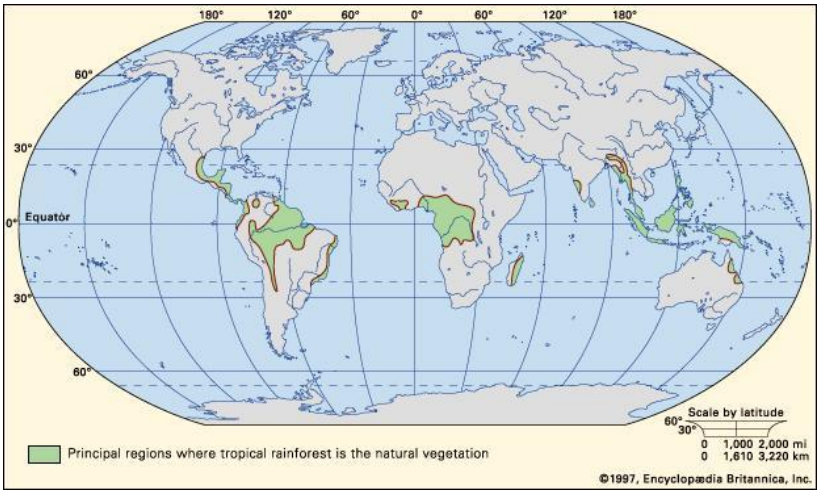

Figure 1: Tropical rainforest: worldwide distribution - (Encyclopedia Britannica, 2013)

As depicted in Figure 1, tropical rainforests only comprise a small portion of the world's geographic area. Tropical rainforests account for approximately seven percent (nearly five million acres) of the Earth's land. There has always been international concern in preserving the rainforests, however tropical rainforests are still being destroyed at a rate of about 80,000 acres per day (Holzman, 2008). The reasons discussed above suggest that the conservation of rainforests must be a priority.

2.2 El Yunque

El Yunque National Forest, located in northeastern Puerto Rico, is the only tropical rainforest in the U.S. National Forest System and spans approximately 28,000 acres. The forest contains the Luquillo Mountains that rise to a peak height of 3,533 feet above sea level. With an annual rainfall of over 200 inches and an average temperature of 73 degrees Fahrenheit, El Yunque has an ideal climate for tropical vegetation (United States Forest Service, 2013).

2.2.1 History

In order to understand previous conservation efforts, it is important to examine the history of the ownership of the forest. In 1876, Puerto Rico was a Spanish colony and El Yunque was owned by the Crown Reserve. In 1898, after partial reparation for the Spanish-American War, the United States was ceded control of Puerto Rico at the Treaty of Paris. In 1903, President Roosevelt renamed the reserve the "Luquillo Forest Reserve," which at that time spanned 5,116 acres. Two years later, in 1905, the U.S. Forest Service began to supervise the forest and in 1907 the reserve was renamed the "Luquillo National Forest". In 1935, the forest was renamed the "Caribbean National Forest" and because of land grants, donations, and purchases of privately owned parcels, the forest land grew to approximately 20,000 acres. With the supervision of the Forest Service, the Civilian Conservation Corps (CCC) worked on various projects to create roads, reforest the area, and construct recreational facilities. In 1948, a technical assessment showed that four million trees and 22 tons of seed comprising 34 tree species had been planted in the forest over an 11 year period. In that same time period, with the protection of the Forest Service, approximately 8,000 acres had reforested naturally. In 1956, the forest was designated the "Luquillo Experimental Forest" because of the scientific research that was done there (United States Forest Service, 2013).

In the past 20 years, the U.S. Forest Service has created an organized effort for the conservation of El Yunque. One example of a conservation action the Forest Service has taken is the creation of a drought emergency plan in 1994. This plan was used to supply the communities around El Yunque with millions of gallons of water per day in the case of an emergency. Also, in 1998, a formal Environmental Education Teachers Training program was

developed by the El Yunque National Forest's Customer Service Team in partnership with the Commonwealth of Puerto Rico Education Department and island schools. The purpose of this program was to educate middle and high school students about the conservation of the forest (United States Forest Service, 2013).

The Forest Service has also created programs to facilitate the expansion of tourism. One example of these types of programs is the Rent-A-Ranger program, where tourists could receive a guided tour of the forest from a U.S. Forest Ranger. In addition, the El Portal Tropical Forest Center was opened in 1996. This visitor center provides information for visitors from around the world, and educates them about El Yunque and the importance of forest conservation (United States Forest Service, 2013).

2.2.2 Environmental Characteristics of the El Yunque Rainforest

El Yunque is home to thousands of native and diverse flora and fauna. The forest includes approximately 150 fern species and 240 tree species. Of the 240 tree species within the forest, 88 of them are endemic or rare and 23 are exclusively found in El Yunque. The animal population within the forest is equally diverse. One of the most common animals in Puerto Rico is the Coqui Comun. The Coqui Comun is a tree frog that lives in the forest and helps protect the forest by eating the mosquitoes and bugs. El Yunque is also the habitat of five endangered species and one threatened species including the Puerto Rican Parrot, the Puerto Rican Boa, the Puerto Rican Broad-Winged Hawk, and the Puerto Rican Sharp-Shinned Hawk (United States Forest Service, 2013).

The unique environment of El Yunque attracts many visitors from around the world. According to the United States Department of Agriculture (USDA), approximately 1.25 million people visit El Yunque each year, half of which are native Puerto Ricans (United States Forest Service, 2013). This high level of tourism has the potential to provide economic benefits to Puerto Rico. However, there is also the possibility that tourism can have a negative environmental impact on the rainforest. Although tourism does not directly cause environmental harm, increased tourism can lead to higher levels of pollution. Tourism can also create the need for new roads and other infrastructure which reduces the capacity of ecosystems to thrive. For tourism to provide economic growth without damaging the environment, the U.S Forest Service needs to regard environmental conservation as their main objective while managing tourism in the area.

2.2.3 Environmental Problems and Preservation Strategies

The U.S. Forest Service is constantly working to ensure the sustainability of El Yunque's ecosystems by working very closely with the Puerto Rican government and the public. El Yunque, like any ecosystem, has specific issues that need to be resolved, such as invasive species and water quality. A major threat to El Yunque is invasive species such as dogs, cats, rats, and mongooses. These species are problematic in that they can be infected with rabies and other diseases, making them dangerous to humans and other animals (United States Forest Service, 2013). The plant "enredadera" is also a damaging invasive species as it actively seeks to attach itself to trees and strangle them. These plants originate from urban and suburban gardens from which they have the ability to migrate into El Yunque. Currently, there is an active management program dealing with these species. The aim of this program is to educate people

in the area about the negative effects of the invasive species and show the community some ways that they can help in the removal of invasive species. One of the main goals is to keep these species from becoming fully integrated into the forest.

One of the main resources that require preservation is the clean water that El Yunque provides to the surrounding communities. Due to the island geography of Puerto Rico, clean water has always been a critical resource for the population of the island. El Yunque is a major supplier of this resource, providing 50 million gallons a day to approximately 20% of the population of Puerto Rico (Bosworth, 2003). The current population density of the areas surrounding El Yunque reaches upwards of 1,000 people per square mile (Census, 2010). Due to the steadily increasing population, however, the availability of clean water is becoming a concern. A common strategy to alleviate this concern is by the management of the geographic hydrological communities from which water is drawn. These hydrological communities are known as watersheds.

2.3 Watersheds

In our research of watersheds, we sought to understand the environmental characteristics and functions of a watershed. We began by researching general information on the definition of a watershed. We then investigated the various ecological problems common to watersheds such as sediment, erosion, and pollution. We also studied a common method of assessing watershed health, known as a Rapid Watershed Assessment. Finally, we examined the various watersheds in the El Yunque region of Puerto Rico.

2.3.1 Watershed Definition and General Information

A watershed can be defined as a specific region of land where all the water drains into the same location. John Wesley Powell, an early Director of the U.S. Geological Service (USGS), defined a watershed as "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community" (Environmental Protection Agency, 2013, para. 1).

A watershed can be any shape and size, ranging from relatively small to large enough to cross state or national borders. Watersheds provide natural services to all of their inhabitants, and are usually the main sources of drinking water for more urban areas. Watersheds are also natural habitats for wildlife, providing a sanctuary for animals to live and thrive. The figure below, which is provided by the EPA, depicts a typical layout of a watershed.

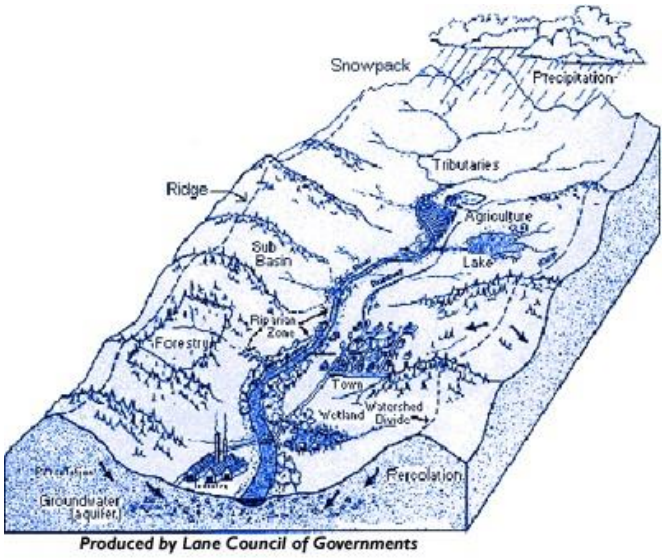

Figure 2: Watershed Layout - http://water.epa.gov/type/watersheds/whatis.cfm

The watershed, especially if it is larger, can be broken up into smaller sections, called sub-watersheds, which are combined to make up the larger "parent" watershed. These sections are connected by rivers or streams, which create a form of "biological corridor". A biological corridor is a form of geographic link between ecosystems. These ecosystem links aid in conserving and restoring the fragile connection between habitats that can be fragmented by both natural causes as well as human involvement (Boyle & Hogan, 2010).

2.3.2 Watershed Environmental Problems

The health of a watershed can be affected by many different factors, including both natural and human sources. The main sources of watershed problems are sediment in the water, erosion and pollution. Secondary problems due to human activities are also prevalent in watersheds, including deforestation, land development, climate change, and diversions of water such as with dams (Watershed Atlas, 2012).

2.3.2.1 Sediment

Sediment is defined as solid fragments of material that have been produced by the weathering of rock. These fragments are typically transported by the flow of water or air. Sediment is a natural occurrence in rivers and streams, and it has many benefits. One of these benefits is that deposited river sediment is often rich in minerals and makes exceptional farmland. These minerals can also replenish the soil of flood plains, deltas, mudflats, and estuaries (Capital Regional District, 2013). Too much sediment, however, can be detrimental to the environment. A surplus of sediment in rivers can damage manmade dams and reservoirs. Also, too much sediment can hurt aquatic plants by decreasing the amount of light that

penetrate. Sediment can clog the gills of fish, as well as irritate their skin and eyes, thus harming them. Also, when the sediment is deposited, it may bury salmon spawning beds, eelgrass meadows and other habitats of aquatic animals (Capital Regional District, 2013).

2.3.2.2 Erosion

Sediment is produced by the process of erosion, which is the weathering of material by wind, water, or ice. Erosion happens over long periods of time, and is a natural occurrence that has a multitude of causes ranging from raindrops to tidal waves. Soil is less likely to erode when anchored down by the roots of plants or covered by decaying plant matter. Human activities can accelerate the erosion process by either weakening the material being eroded, as in deforestation, or by strengthening the cause of erosion, as in acid rain (Capital Regional District, 2013).

2.3.2.3 Pollution

Pollution is defined as the emission of harmful substances into the environment due to human activities (Capital Regional District, 2013). Unfortunately, pollution is an extremely common occurrence in virtually every global environment, and it can have a wide range of health effects on animals, plants, humans, and ecosystems. Chemical pollution is one of the most common forms of pollution, and according to the Capital Regional District (CRD), it can result in a significant decrease of water quality in a variety of ways. Some chemicals simply dissolve in water, which can lead to the chemicals being absorbed directly into the tissue of aquatic plants and animals. The chemicals that do not dissolve are denser than the water and tend to sink, where they become bound to sediments. These chemical bound sediments may

not break down for as many as three hundred years, and can be ingested by bottom-dwelling animals such as invertebrate larvae and crabs. A small percentage of these persistent chemicals undergo bio magnification. Bio magnification is a process that causes these chemicals to become more concentrated, and therefore more toxic, as they move up the food chain from smaller animals to large predators (Capital Regional District, 2013).

2.3.4 Watersheds in Puerto Rico

Some of these problems can be found in the five major watersheds of Puerto Rico. These watershed are the Eastern Puerto Rico Watershed (USGS Cataloging unit: 21010005); The Southern Puerto Rico Watershed (USGS Cataloging unit: 21010004); The Interior Puerto Rico Watershed (USGS Cataloging unit: 21010001); The Cibuco-Guajataca Watershed (USGS Cataloging unit: 21010002); and The Culebrinas-Guanajibo Watershed (USGS Cataloging unit: 21010003). The smaller, surrounding Puerto Rican islands are also a part of their own watershed, The Puerto Rican Islands Watershed (USGS Cataloging unit: 21010006). These watersheds can be seen in the figure below, provided by the USGS (United States Geological Survey, 2013b).

Figure 3: Puerto Rican Watersheds - (United States Geological Survey, 2013b)

2.3.4.1 El Yunque Watersheds

Although El Yunque is considered to be one rainforest, the forest is a part of eight distinct sub-watersheds shown in Figure 5, including the Río Espiritu Santo Watershed, the Río Mameyes Watershed, the Río Sabana Watershed, the Río Pitahaya Watershed, the Río Fajardo Watershed, the Río Santiago Watershed, the Río Blanco Watershed, and the Río Canovanas Watershed (USDA Forest Service, 2010). All of these sub-watersheds are part of the larger Eastern Puerto Rico Watershed. Our project deals specifically with the Río Espiritu Santo Watershed, which is shown in Figure 6 (Centro para la Conservación del Paisaje, 2011). A section of the El Yunque Rainforest is contained within the Río Espiritu Santo Watershed.

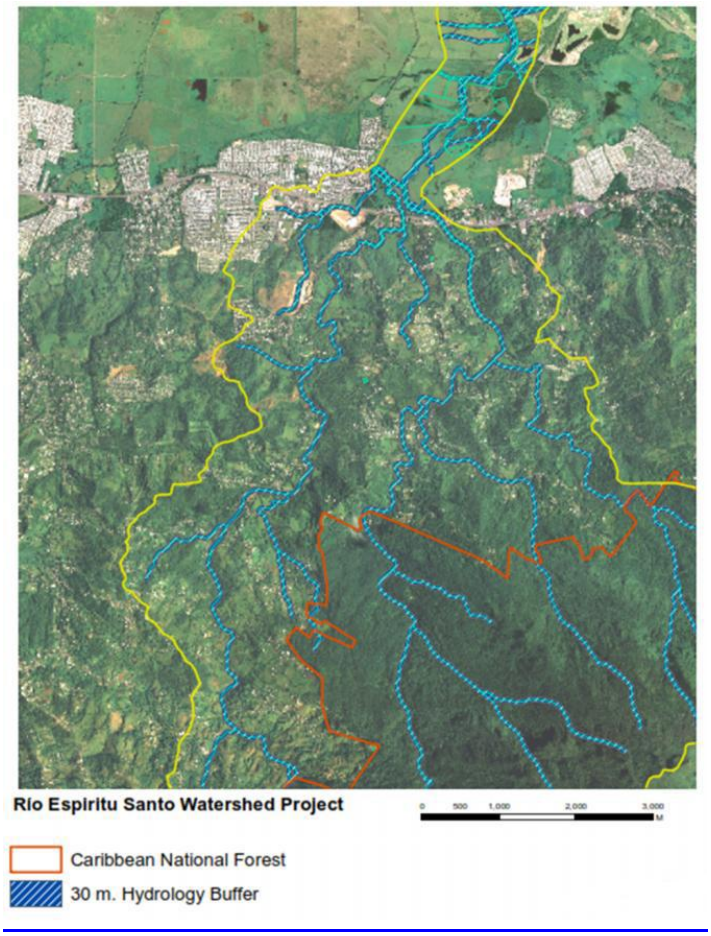

Figure 4: Río Espiritu Santo Watershed - (Centro para la Conservación del Paisaje, 2011)

The Río Espiritu Santo Watershed is located in the Río Grande municipality of Puerto Rico, and is a top priority watershed for the U.S. Forest Service (USDA Forest Service, 2010). This watershed is very diverse in its land use, containing sections of the El Yunque rainforest, urban developments, rural communities, and floodplains. The Río Espiritu Santo, from which the Río Espiritu Santo Watershed derived its name, flows from the El Yunque Rainforest northward to the Atlantic Ocean.

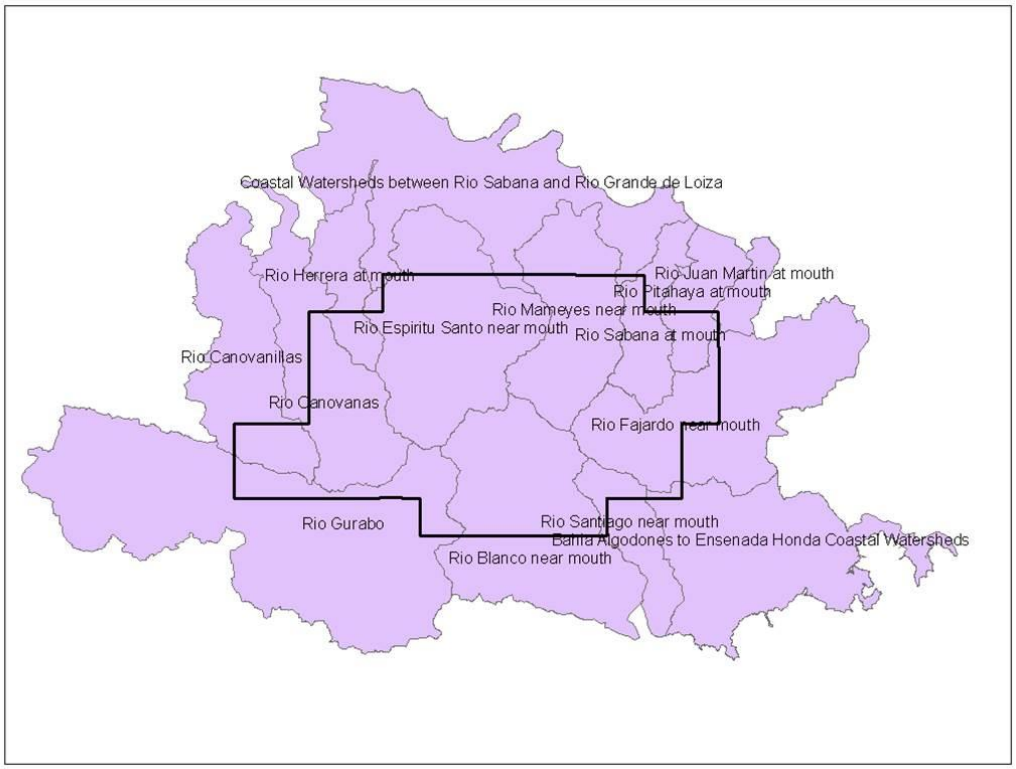

Figure 5: Watersheds of El Yunque - (USDA Forest Service, 2010)

2.3.3 Rapid Watershed Assessment

In order to determine the baseline environmental conditions of the Río Espiritu Santo Watershed, we will conduct a Rapid Watershed Assessment (RWA). A RWA is a common and extremely effective form of watershed analysis. According to the USDA and the Natural Resources Conservation Service (NRCS), RWAs are able to provide organizations with initial data that suggest which areas most require restoration (United States Department of Agriculture, 2007). These assessments are used for a variety of reasons, including the determination and prioritization of the best actions to achieve conservation goals within a watershed. Information on the conventional methods for a Rapid Watershed Assessment can be seen in Appendix A: Background on Rapid Watershed Assessments.

2.4 Watershed Councils

An RWA is one of several methods of watershed management. This management is typically conducted by organizations known as watershed councils. We researched the various aspects of these organizations, including their goals, activities, governance structure, and factors that contribute to their effectiveness.

2.4.1 Definition and History

According to Douglas Kenney in *The New Watershed Source Book*, a watershed council can be defined as:

> A primarily self-directed and locally focused collection of parties, usually featuring both private and intergovernmental representatives, organized to jointly address water-related issues at the watershed level or a similarly relevant physical scale, normally operating outside of traditional governmental processes or forums, and typically reliant on collaborative mechanisms of group interaction characterized by open debate, creativity in problem and solution definition, consensus decision-making, and voluntary action. (Lubell, Schneider, Scholz, & Mete, 2002, p. 148-149)

A watershed council is a non-governmental regulatory agency comprised of individuals, business, and government officials in a given community who work together to address local environmental issues (Griffin, 1999). The concept of a watershed council was conceived out of a frustration with agencies such as the Bureau of Land Service or the EPA after these agencies

began to form in the 1960's. The EPA and other environmental agencies were successful in large scale environmental preservation by utilizing various techniques. These techniques include, but are not limited to, technology requirements and emission criteria. By implementing these techniques, the agencies were able to control the use of resources on a large scale to successfully reduce point source pollution (Lubell et al., 2002). Large agencies, however, have historically been slow to react with regards to smaller, local issues that involve different environments and that cross political boundaries. This inability is due to the limitations on interagency cooperation and the effects of massive regulatory battles waged between these agencies and large corporations (Lubell et al., 2002).

Economic interests, such as local businesses, became frustrated with the inflexibility and uncertainty stemming from large organizations; while environmental groups believed that large agencies needed to better protect the environment. These concerns caused groups of local businesses and environmentally concerned individuals to assemble with the goal of forming policies unique to the local area. These partnerships, also known as watershed councils, allowed the interested parties to influence policy while avoiding the long and costly legal processes involved (Lubell et al., 2002). Another major benefit of the formation of watershed councils was to give the public an increased voice in the management of their resources. In the past, public participation was limited to attending public meetings and submitting oral or written comments on proposed policy. In the late 90s, however, the rise of watershed councils has allowed the public a greater voice in calling for widespread changes as to how natural resources are managed (Griffin, 1999).

2.4.2 Goals

Most watershed councils are formed with a specific set of goals. Many watershed councils, such as the Luckiamute Watershed Council in Independence, Oregon, place these goals directly in their charters: “The goal of the Council is to promote broad and informed public participation in the ecologically and economically sound sustainability and improvement of natural resources and environmental quality in the Luckiamute watershed” (LWC Board, 2000).

In the 2003 article, “Role of Adaptive Management for Watershed Councils”, Geoffrey Habron performed a case study on the activities, governance, and membership of the Umpqua Basin Watershed Council in southwest Oregon. This study was conducted to determine the key themes or goals upon which all watershed councils tend to center their efforts. Through Habron’s efforts, a large majority of the watershed council’s goals were placed into the following categories that will be examined in the sections below:

1) Organizing Activities and Projects
2) Involving the Community
3) Reducing Bureaucracy
4) Providing Financial Support

2.4.2.1 Organizing Activities and Projects

One of the primary reasons watershed councils are formed is to conduct activities and organize programs to help with the preservation and restoration of the natural environment. These activities can be divided into four major categories:

1) Restoration and Action

2) Outreach and Education

3) Monitoring and Research

4) Assessment and Planning

The main actions that councils take involve restoration projects in the community in which they operate. The exact goals of these projects vary by region, but the general goals involve improving water quality, removing invasive species, improving living conditions for local flora and fauna, and restoring the aesthetic quality of local landmarks and environments. The Coast Fork Williamette Watershed Council in Cottage Grove, Oregon undergoes a variety of these projects, including their ongoing Row River Nature Park Project. The aim of this project is to restore 42 acres of land that have been without any previous restoration activity. This restoration will improve habitats for at-risk species such as Western pond turtles, birds, and river otters.

Despite the positive outcomes of watershed council restoration projects, the council's work will be ineffective if the community continues to harm the environment. To prevent this abuse, a fundamental objective of watershed council activities must be the education of the community. The education provided by the watershed council must focus on the ecological conservation and promotion of their agenda among the community. This outreach can be accomplished in a variety of ways; some examples are newsletters, mass mailings, town hall meetings, and local media coverage. The Long Tom Watershed Council has significant experience in this type of outreach. The council has published a newsletter every two months

since May 2003 that is sent to everyone on their mailing lists, along with being published on their website. This council has also published educational news articles in various newspapers and magazines since 2000. Through these types of communication, the council can send its message to the entire community.

Monitoring and research allow councils to assess baseline environmental conditions, determine if their efforts are improving those conditions, and identify areas in which to focus more research. By implementing monitoring stations on stream quality, water quality, fish migration, groundwater, and other metrics, watershed councils can effectively measure the environmental health of their watershed. These measurements can then be communicated to government officials who are determining where to focus their conservation efforts. One successful example of monitoring activities is the watershed monitoring program conducted by the Long Tom Watershed Council in Eugene, Oregon. Since 1999, the council has conducted monthly monitoring of about 50 separate stream sites of varying elevations, ecosystems, and stream size. Through collecting these data, the council has shown that many sites have water that is too warm for certain kinds of trout. This type of information allows the council to directly focus their conservation efforts on areas they have already identified as problems.

Another trademark of watershed council activities lies in planning for the future and developing new methods of preservation. Much of this assessment and planning is done by scientists and local experts in conjunction with some of the large governmental regulatory agencies. For example, the Walla Walla Basin Watershed Council in St. Milton-Freewater, Oregon is currently working with the U.S. Fish and Wildlife Service to develop a Habitat

Conservation Plan. This plan assesses the impact of the landscape on the existing wildlife in order to help protect those species. Much of the planning that councils do eventually leads to the restoration projects already discussed, but studies of such magnitude requires significant time and capital.

2.4.2.2 Involving the Community

Environmental groups often express frustration with government agencies due to a lack of community input into their regulations and policies (Lubell et al., 2002). In an effort to resolve this issue, watershed councils allow all stakeholders, including private citizens, businesses, environmental groups and government officials, the equal right to voice their opinions. Because local landowners are allowed to voice their opinions freely, they are more comfortable working with a local institution, such as a watershed council, than any other kind of agency (Habron, 2003). Some citizens, however, are disillusioned with government authority, and therefore will not respect a watershed council that allows government involvement (Habron, 2003). Because of the different opinions within the population, an effective watershed council must utilize management techniques capable of uniting all of the involved interests. By using such techniques, a watershed council has the potential to redefine the relationship between competing interests and cause them to begin working towards the same goals (Griffin, 1999).

It is also the responsibility of the watershed council to keep the public informed of projects and activities that are occurring in their area. However, it is difficult to accomplish this task when most individuals fail to take an active role in the council or consistently attend

meetings. In a survey of the residents affected by the Umpqua Basin Watershed Council in southwest Oregon, only 11% of agricultural landowners felt very informed of the council's activities (Habron, 2003). This observation suggests that a watershed council should keep the general public informed, otherwise the council will not be effective (Griffin, 1999).

2.4.2.3 Reducing Bureaucracy

One of the reasons that watershed councils are formed is because interested stakeholders are frustrated with the inefficiency of large government agencies (Habron, 2003). Specifically, some individuals are frustrated with the way the government separates management responsibilities. In most cases, responsibility is divided by political lines, rather than by geographic characteristics. By defining their efforts within a specific region, watershed councils eliminate this practice of politically divided responsibility and simplify the creation of comprehensive policy for a region. In spite of these efforts, it is difficult for watershed councils to be free of bureaucratic procedures. Usually, councils seek to establish set procedures for responding to issues while being both accurate and timely with their response.

2.4.2.4 Providing Financial Support

Financial capital is a vital resource for any watershed council seeking to have a meaningful impact on the environment. In order to complete conservation projects, approximately 71% of landowners seek a type of financial aid (Habron, 2003). For many watershed councils, the amount of funding received directly impacts their ability to manage stakeholder interests as well as the actions they take (Griffin, 1999). According to the 2012 Network of Oregon Watershed Council Survey, 62.10% of the 62 councils surveyed had an

annual operating budget of less than $100,000 while only 5.1% had a budget of $400,000 or more (Gordon, 2013). Underfunding is a major problem for many watershed councils, as it can lead to restrictions on the achievements of a council. These restrictions can further cause members to become disillusioned with the council, which can negatively impact the council's effectiveness. There are, however, many sources of funding available for councils that seek it. In "Watershed Councils: An Emerging Form of Public Participation in Natural Resource Management" C.B. Griffin (1999) lists grants, donations, allocations from agencies, legislatures, businesses, interest groups, and members as potential sources of funding. Furthermore, any council must carefully consider from which sources to accept funding, as making biased decisions based on the source of funding is detrimental to public or member relations. Griffin also warns that if a greater portion of the council's time is spent acquiring funding, significantly less will be spent trying to accomplish other goals.

2.4.3 Governance Structure

Most watershed councils are governed by a Board of Directors or Executive Council. This executive group is usually responsible for making the most important decisions for the council as well as running the meetings. There also tend to be a series of committees under the Executive Council to whom tasks can be delegated. These committees are managed by either volunteers or paid employees, depending on the financial resources of the council. Finally, there are the stakeholders, who comprise the most important piece of the council governance structure. Stakeholders can generally be anyone who takes up an interest in the watershed council, whether it is an individual, business, or government official. These stakeholders

comprise the major part of most watershed councils and tend to have significant influence in the policy that the council tries to implement (Lubell et al., 2002).

2.4.3.1 Executive Committee

The Executive Committee or Board of Directors of a watershed council typically consists of anywhere from 8-14 members with a variety of backgrounds that serve in a leadership role for the council (Coast Fork Williamette, 2013; Long Tom Watershed Council, 1998; Powder Basin Watershed Council, 2006; Walla Walla Basin Watershed Council, 2013). The length of executive board terms and the councils' methods of election are extremely varied. Most Executive Committees also have officers within themselves, such as Council Chair, Treasurer, and Secretary. Table 1 below describes the governance structures of the Executive Committees of four different Oregon watershed councils. These data shows the vast amount of variety in watershed council governance structures even within a small geographic area.

	Luckiamute Watershed Council	Powder Basin Watershed Council	Long Tom Watershed Council	Coast Fork Williamette Watershed Council
Term Length	1 Year	3 Years	4 Years	2 Years
Election Method	Popular Election	Appointment by County Court	Popular Election	Volunteer
Number of Members	12	10	14	8
Number of Officers	3	3	5	4
Officer Positions	• Council Chair • Treasurer • Secretary	• Council Chair • Council Vice Chair • Treasurer	• Council Chair • Council Vice Chair • Council Past Chair • Treasurer • Secretary	• Council Chair • Council Past Chair • Treasurer • Secretary

Table 1: Executive Committee Structure of Various watershed councils

2.4.3.2 Committees

In most large organizations, the majority of the administrative and technical work is not completed by the Executive Committee, but rather by a series of committees underneath them. Watershed councils are no exception to this rule. Each watershed council has a unique set of local environmental and social circumstances that leads to a unique set of committees. In general, there is a recruitment committee (often called a search committee) that identifies individuals who are willing to volunteer their time and efforts as a member of the executive committee (Long Tom Watershed Council, 1998). There are also a multitude of technical committees that represent people with scientific backgrounds that assist the council with understanding different environmental issues and what actions need to be taken to resolve them (Long Tom Watershed Council, 1998).

2.4.3.3 Stakeholders

According to the Water Quality 2000 Report in 1992, the ideal stakeholder composition for a watershed council is, "20 percent each from industry and the environmental community, 15 percent each from professional organizations and academia, and 10 percent each from local, state, and federal government" (Griffin, 1999). A majority of councils allow participation by any interested parties, which makes this composition very difficult to achieve.

Some of the most important participants in a watershed council are regulatory agency representatives. With representatives from these agencies participating, a watershed council has significantly more power. However, there is not always incentive for such agencies to work with watershed councils due to the council's non-regulatory status. A watershed council can attract many of these agencies by providing a forum to resolve environmental disputes between these agencies and individuals and local businesses (Griffin, 1999).

2.4.4 Effectiveness Factors

Numerous studies have been conducted to determine what factors, contribute to the success of the development of a new watershed council. For this reason, two articles were examined that created of a summary of the aforementioned studies. In their 2002 article, "Assets to Move Watershed Councils from Assessment to Action", Smith and Gilden listed seven crucial institutional assets that they believe drive watershed council success. These factors are enumerated below, as well as their definitions as stated in the article:

1) **Leadership-** The individuals who organize and provide direction for watershed activities.

2) **Vision-** A concept for the future direction and activities of the watershed.
3) **Trust-** Having confidence in an individual or organization's words and actions.
4) **Social Networks-** The individuals and organizations with which the council interacts.
5) **Capital-** Investments to restore, rehabilitate, and protect watershed services and build, social infrastructure.
6) **Power-** The ability to carry out one's will.
7) **Local and Technical Knowledge-** The information needed to select and implement watershed actions. (Smith & Gilden, 2002, p. 655)

These factors were identified by examining a series of synthesis studies on a network of watershed councils in Oregon. These studies attempted to identify the reasons behind the success of these councils. However, the authors state at the end of the article that the presence of these 7 assets will not necessarily lead to success. The article suggests that for new watershed councils, leadership and vision is much more important than capital, which should be focused on after the council has decided their priorities. The authors also identified lack of power, capital, and trust as the 3 most limiting factors to watershed councils. Without regulatory power, watershed councils must always fight to have their priorities and policies implemented. A lack of capital will severely limit the programs and activities a council can accomplish. Finally, distrust of funding sources or scientists limits any council's effectiveness.

Another review of similar studies by Leach and Pelkey also identified a few factors that were applicable to watershed council governance and confirmed the research previously discussed. Sixty percent of the studies they examined indicated that managerial assets such as funding and effective leaders were crucial to the success of a watershed council (Leach & Pelkey, 2001). Leach and Pelkey suggested that a skilled facilitator or coordinator should be

hired to lead the council instead of giving this responsibility to a member of the technical staff. Such technical personnel often lack the time, neutrality, training, and experience necessary to adequately perform as a leader. In addition, 43% of the studies looked at suggested that interpersonal assets, meaning "participants who are cooperative and committed to the process, and who trust the other members of the partnership," are also a key factor for success. The authors suggested that the presence of neutral facilitators, clear process rules, and unimpaired sharing of data or information can help to foster this partnership.

The main goal of extant research was to assist in the understanding of the factors that influence the effectiveness of a watershed council. By utilizing this research, we were able to identify several governance structure variables that may have an impact on watershed council effectiveness. We were able to assess the effect of the variables using a variety of data collection methods.

3.0 Methodology

The overall goal of this project was to aid in the creation of a watershed council within the Río Espiritu Santo Watershed with the assistance of the U.S. Forest Service. To accomplish this task, we conducted a study to answer four primary research questions that we developed from our background research:

1) Study the most frequent challenges faced by watershed councils and determine if budget size or funding sources had an impact on the frequency of reported challenges,

2) Examine the common activities that watershed councils perform in their communities and how the time spent on these activities can be affected by budget size,

3) Evaluate the perceived effectiveness of watershed councils and define any potential effects that budget size, time spent on different types of activities, funding sources, or frequency of reported challenges have on perceived effectiveness,

4) Gauge the community interest in the development of a watershed council and the best methods of community outreach for the Río Espiritu Santo Watershed Council.

These questions were answered using a variety of methods. First, we interviewed several officials of existing watershed councils in Massachusetts. Second, we sent an online survey to other existing watershed council officials in order to gather information from a larger population of sources. Third, we interviewed interested individuals that had been previously identified by the U.S. Forest Service as potential stakeholders. Fourth, we created and distributed a survey to members of the community surrounding the Río Espiritu Santo Watershed using a contact list also provided by the U.S. Forest Service. We then analyzed the results using a variety of statistical methods, including single-sample t-tests, two-sample t-tests, ANOVA tests, and regression analyses. This analysis enabled us to create several deliverables

for the U.S. Forest Service and the Río Espiritu Santo Watershed Council, including a Rapid Watershed Assessment, a draft of a charter, a blog detailing council activities, and a Restoration and Community Development Assessment.

3.1 Watershed Council Official Interviews & Survey

In order to gain an understanding of the challenges encountered by watershed councils, the activities undertaken by these councils, and the factors that make these councils effective, information was gathered from officials of existing watershed councils on their experiences with running such organizations. This information supplemented the prior research on watershed council governance structure, activities, and finances reviewed in Section 2.4. This information aided in the recommendation of an appropriate governance structure and a set of best practices for the council. This section was divided into two distinct data collection methods. The first consisted of in-depth in-person interviews with available watershed council officials in the Massachusetts area. Since conducting an in-depth interview with individuals who are not local would have been difficult, the second part of this section consisted of the development of an online survey. This survey was then administered to other, non-local watershed council officials throughout the U.S.

3.1.1 Watershed Council Official Interviews

To gain in-depth information about how watershed councils operate, three Massachusetts based watershed council officials were interviewed both in-person and by phone. The Secretary and the Executive Director of the Massachusetts Watershed Coalition, and the Executive Director of the Lake Wickeboag Preservation Association were all contacted

and they all agreed to be interviewed. Each interview lasted approximately 30-45 minutes. The specific questions used for these interviews can be found in Appendix A: Background on Rapid Watershed Assessments

Information Included in a Rapid Watershed Assessment

RWAs are not the most specific or targeted method of gathering data as can be seen in Figure 4, the NRCS "Planning Continuum". RWAs do, however, provide invaluable information in different forms. In general, RWAs contain two major components: a watershed resource profile and an assessment matrix.

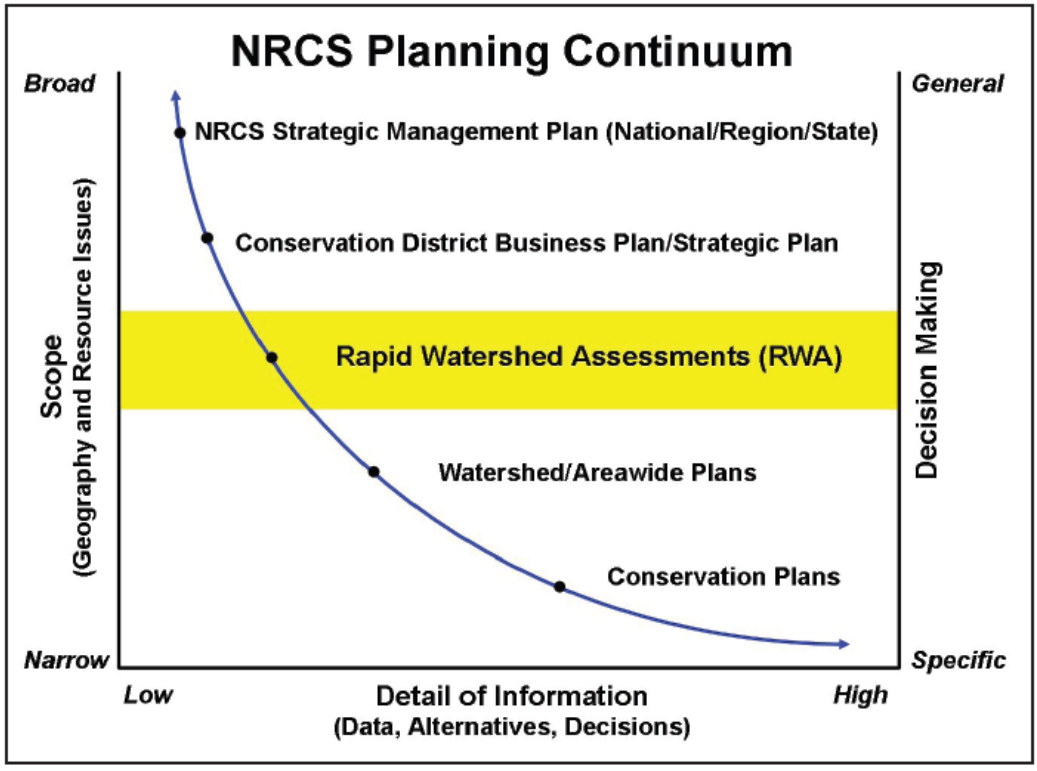

Figure 19: NRCS Planning Continuum - (United States Department of Agriculture, 2007)

A watershed resource profile is a summary of the most readily available data about a watershed and its resources. According to the USDA and NRCS report entitled “Rapid Watershed Assessments”, these data include:

- A general description of the location, size, and political units associated with the watershed,
- Physical description including land use/land cover, precipitation/climate, common resource areas, stream flow data, land capability class, etc.,
- Known resource concerns,
- Census and social data,
- Status and history of resource conservation in the watershed,
- References and data sources (United States Department of Agriculture, 2007).

The second section of a RWA is the Assessment Matrix. This section contains a number of tables that summarize the resource conditions and their related maintenance costs, conservation opportunities, resource concerns, and potential funding sources for conservation implementation. The tables that make up the Assessment Matrix, provided by the USDA and NRCS, are a Current Condition Table, a Future Conditions Table, and a Summary Table. The Current Conditions Table details the current level of conservation activity in the watershed. The Future Conditions Table identifies appropriate conservation practices to deal with primary resource concerns. Finally, the Summary Table summarizes the various costs associated with the resource management systems described in the previous tables (United States Department of Agriculture, 2007).

Benefits of a Rapid Watershed Assessment

RWAs have a number of key benefits. They are a quick, effective, and inexpensive method of gathering information that can then be used in decision making processes. The amount of detail included in a RWA is low enough as to not require the time commitment that more in depth studies require, while still providing a substantial amount of information. Other benefits of RWAs include:

- Provide a preliminary source of information for standard environmental evaluations,
- Determine if there is a need for further detailed analysis or watershed studies,
- Identify if there are infrastructure needs,
- Address multiple concerns and objectives of landowners and communities,
- Enhance established local and state partnerships,
- Enable landowners and communities to decide on the best mix of NRCS programs and other funding sources to meet their resource concerns (United States Department of Agriculture, 2007).

Appendix B: Watershed Official Interview Questions. In order to accomplish our goals for these interviews, a variety of areas concerning the governance structure and operation of watershed councils were targeted in the interview. Based on our background research, these areas were:

- The formation of a watershed council and the initial/principal stakeholders,
- The gathering and management of watershed council funds, including annual budgets,
- Major activities and accomplishments performed by watershed councils to improve the environment,
- Governance structure of watershed councils, including stakeholder composition and non-profit status,
- Potential challenges encountered by watershed councils and strategies for overcoming such obstacles,
- Methods and strategies for involving the community in environmental preservation.

3.1.2 Watershed Council Official Survey

The main objective for this survey was the same as for the interviews described above: to gain an understanding of the factors that enable a watershed council to function effectively. The specific questions used in this survey can be seen in Appendix C: Web-Based Survey to Watershed Council Officials. Many questions used were modeled after, and adapted from questions administered by The Network of Oregon Watershed Councils in their Fall 2012 Council Survey (Gordon, 2013). Based on our background research, questions were asked that pertain to:

- The formation of a watershed council and the initial/principal stakeholders,
- The gathering and management of watershed council funds, including annual budgets,
- Major activities and accomplishments performed by watershed councils to improve the environment,
- Governance structure of watershed councils, including stakeholder composition and profit/non-profit status,
- Potential challenges encountered by watershed councils and strategies for overcoming such obstacles,
- Methods and strategies for involving the community in environmental preservation,
- Effectiveness of the watershed council overall and in a variety of specifically targeted areas.

In order to ensure a high response rate for the survey, the length of the survey was limited to 16 questions and personalized invitations were created for each individual taking the survey. In addition, most of the questions on the survey utilized a seven point Likert scale which made the survey easier for the respondents. Before distributing the survey, a version was implemented as a web-based survey using Qualtrics software, and then tested on a senior staff member at the U.S. Forest Service and two WPI faculty supervisors. Based on this feedback, the survey was revised for clarity. After distributing the survey, two reminders were sent on a weekly basis to each individual that had yet to respond. All of these strategies ensured that the response rate was above the expected rate of 20% (Kaplowitz, Hadlock, & Levine, 2004).

To ensure that the anonymity of the individuals was maintained, a method was devised to separate the identifying questions from the survey questions using the survey software Qualtrics. Two on-line surveys were created, the first with the identifying questions and the second with the remainder of the survey questions. When the survey was distributed to the respondents, they were provided with the link to the survey with the identifying questions. When they completed the first survey, the software automatically redirected them to the beginning of the second survey. By using this two survey method, two completely separate reports were created by the on-line data collection tool, serving to keep the identifying information and the remaining information unlinked.

In order to locate individuals that were willing to provide information for the survey, we conducted an on-line search and identified the websites of several U.S. watershed councils. These websites were searched for contact information, specifically e-mail addresses. Individuals who make decisions for each watershed council, such as Executive Board Members and Executive Directors were specifically targeted. A total of 111 people representing 88 separate watershed councils were identified. Although a convenience sampling method was used to determine the contacts for the survey, the recipients encompassed a variety of geographical areas within the U.S., including the Pacific Northwest, the Northeast, the Midwest, and the Southeast.

3.2 Initial Stakeholder Interviews

A major part of the project involved interviewing the initial stakeholders that had been identified by Pedro Rios and his team at the U.S. Forest Service. It was important to examine

each stakeholder's opinions individually in order to gain a full understanding of their expectations for the council, their individual areas of expertise, and to determine the appropriate governance structure to address the issues that were documented in the RWA. The specific questions used in these interviews can be seen in Appendix D: Interview to Initial Stakeholders. Based on our background research, questions were asked pertaining to the following areas:

- The individual's area of expertise as well their reason for wanting to be part of the Río Espiritu Santo Watershed Council,
- Environmental issues that the individual recognized in the Río Espiritu Watershed that the council should address,
- Potential programs or activities the individuals had considered for the council that would benefit the environment,
- Methods and strategies to engage the community of Río Grande and create an interest in environmental conservation,
- Potential challenges the individuals felt the council could encounter during its development and operation,
- Other contacts that the individual believed would be interested in participating in the Río Espiritu Santo Watershed Council.

These interviews were designed to be administered in both English and Spanish to facilitate interviews with non-English speakers. One of the student team members is a native Spanish speaker, or hispanophone, which assisted in conducting the interviews with individuals

who did not speak English as well as translating their responses. An extensive list of potential contacts was provided by the U.S. Forest Service which was eventually reduced to the key stakeholders. Each of these individuals was then contacted with the goal of scheduling interviews. However, there were individuals that were unavailable to conduct interviews or did not respond during our two months on-site in Puerto Rico. Follow-up e-mails were sent to these individuals with varying levels of success. The notes taken during the interviews were examined by one team member that identified the most common responses. This process was done independently and then approved by the other team members.

3.3 Surveying the Community

Community involvement is an extremely important aspect of watershed councils and their governance. Since watershed councils are usually volunteer-based organizations, they require input and support from the members of the community in order to be successful. The specific questions in this survey can be seen in Appendix E: Survey to Puerto Rican Community. Based on our background research, the online community survey included questions on:

- Environmental issues that the individual recognized in the Río Espiritu Watershed that the council should address,
- Potential programs or activities the individuals had considered for the council that would benefit the environment,
- Methods and strategies to engage the community of Río Grande and create an interest in environmental conservation,

- The municipality in which the respondent resided and the community group with which the respondent most identified (Academia, Non-Government Organization (NGO), Federal Government, State Government, Municipality Government, and Private Citizen),
- The respondent's knowledge of watersheds and watershed councils,
- The likeliness of the respondent to participate in various functions of a watershed council.

Several factors were considered during survey development, including survey length, wording and selection of a representative subject pool. The survey length was targeted such that it could be completed by most subjects in less than 15 minutes. Since the subjects were Puerto Rican residents (primarily hispanophones), the web survey was converted to the Spanish language by a hispanophone team member prior to its distribution. One survey question recorded the municipality of residence of each subject, permitting comparison of results from those residing within the Río Grande municipality to those residing elsewhere. A response rate of approximately 20% was anticipated, which would result in an expected 90 survey responses (Kaplowitz et al., 2004).

In addition to the data collected, a section was appended to the survey in which interested community members could disclose their contact information while being unlinked from their survey responses. In this way, interested respondents could be kept apprised of the status of the proposed watershed council.

In administering the survey to the community, there were a number of important factors we considered. The first step was to determine contact information we could use to solicit subjects

via a targeted e-mail. A convenience sampling method was the most appropriate method for this survey because the U.S. Forest Service provided us with an extensive mailing list of community members. This contact list was reduced to 534 individuals from the Río Grande municipality as well as the other municipalities of Puerto Rico. Upon sending the surveys to these individuals, approximately 80 e-mails were sent back and deemed undeliverable resulting in a total usable sample size of 454 individuals.

3.4 Rapid Watershed Assessment

To achieve a greater understanding of the ecosystem within the Río Espiritu Santo Watershed, a basic Rapid Watershed Assessment (RWA) was performed. Guidance was provided by the U.S. Forest Service in the form of several reports that detailed the format and structure of a RWA, as well as examples of previous RWAs. Existing information on the Río Espiritu Santo Watershed gathered from several sources was analyzed and consolidated into the RWA. The main topics of the RWA were land use, hydrology, and species inhabiting the watershed. The land use section of the RWA consists of data regarding how the land within the watershed is currently being used, and describes this use in terms of categories such as: forest, industrial, agricultural, high and low density residential, and public and recreation. This information was gathered from two reports from the Río Grande municipality, the “Plan Territorial del Municipio de Río Grande” and the “Plan de Usos de Terrenos” (Municipio Río Grande, 2010; Oficina de Gobernador Gobierno Puerto Rico, 2011). The hydrology of the Río Espiritu Santo was also researched. This research included data from the United States Geological Survey and the Environmental Protection Agency on the general quality of the

water, along with its flow patterns and drainages. A list of the species that inhabit the watershed was compiled from information gathered in the "Rio Espiritu Santo Upper Watershed Level 1 Assessment," a document by the Centro para la Conservacion del Paisaje on the ecology of the watershed.

From these sources of information as well as data from the initial stakeholder interviews, several key environmental issues within the watershed were identified and discussed at length. This RWA helped to define the concerns and goals of the proposed watershed council.

3.5 Drafting Watershed Council Charter

The creation of a charter for the Río Espiritu Santo Watershed Council was made possible by a thorough analysis of the collected data. Data from the interviews and surveys of existing watershed council officials attempted to link watershed council governance structure to perceived watershed council effectiveness. The goals of the council were largely determined by data obtained from the RWA, the initial stakeholder interviews, and the community survey. The charter was framed using these data as well as observations of existing charters from various watershed councils (Coast Fork Williamette, 2013; Long Tom Watershed Council, 1998; LWC Board, 2000; Powder Basin Watershed Council, 2006; Walla Walla Basin Watershed Council, 2013). The draft charter we created for the Río Espiritu Santo Watershed Council includes a mission statement for the council, a preliminary governance structure, and bylaws.

3.6 Developing Google Blog

The purpose of creating the Google blog was to create a method to share information about the Río Espiritu Santo Watershed Council and its activities. Our sponsor at the U.S. Forest Service requested that a Google blog be created instead of an official website because such a website could not be added to the U.S. Forest Service website due to budget and logistical constraints at the time of this project. This also allows the council to maintain its independence from individual member organizations such as the U.S. Forest Service. The blog was designed to distribute information about the Río Espiritu Santo Watershed Council to all of the interested stakeholders as well as the community at large.

The purpose of this blog was to present the technical and social aspects of the council's projects in an innovative way so visitors will be actively engaged by the information. We created posts for the blog that covered an introduction to the Río Espiritu Santo Watershed Council in addition to several posts about the specific data from our project. A timeline that details all of the accomplishments of this project was also posted. The timeline was important because it allowed the initial stakeholders to understand what the project had already accomplished and how they can use the data upon the completion of the project. We also included several "gadgets" on the blog that allow visitors to perform various actions, such as subscribing to the blog, translating the content, and sharing posts from the blog on social media websites.

3.7 Restoration and Community Development Assessment

To further assist in the development of the goals for the watershed council, a Restoration and Community Development Assessment (RCDA) was also performed. While the RWA focused on the environmental issues within the watershed, the RCDA focused on potential ways to address such problems. Using the results of research into watershed councils, suggestions from the initial stakeholder interviews, and suggestions from the community survey, we compiled a list of several potential activities for the Río Espiritu Santo Watershed Council. The RCDA contains three major sections: Recommended Restoration Activities, Recommended Community Development Activities, and Recommended Contacts for Río Espiritu Santo Watershed Council. These sections identified common suggested activities for both restoration and community development purposes. After identifying these activities, we also considered how some of the most common activities could be planned and hosted. The Recommended Contacts section was developed using contact information given to us through either the initial stakeholder interviews or the community survey.

4.0 Survey and Interview Findings

We gathered data from a variety of methods to assist in the creation of recommendations for the Río Espiritu Santo Watershed Council. These methods included:

- Watershed Council Official Interviews
- Watershed Council Official Survey
- Initial Stakeholder Interviews
- Community Survey

The watershed council official survey was conducted by sending an online survey to watershed council officials from various locations in the United States. Of the 107 individuals that were sent the survey, 44 replied. These responses represented 37 different councils, which resulted in a council response rate of 44.2%. From the 44 surveys that were received, 7 were unused in the analysis because they contained no responses, leaving 37 usable survey responses which yielded a response rate of 34.5%. In the watershed council official survey, respondents were asked to rate the effectiveness of their watershed council on the seven point Likert scale described in Section 4.3 in several effectiveness categories. The survey data were then sorted by the "Overall Effectiveness" and separated into three categories. Survey responses with an overall effectiveness of 4 or 5 were labeled "Somewhat Effective", responses with an overall effectiveness of 6 were labeled "Effective", and responses with an overall effectiveness of 7 were labeled "Very Effective".

Throughout our time in Puerto Rico, 16 interviews were conducted with initial stakeholders that had been previously identified by the U.S. Forest Service. These individuals represented a diverse collection of businesses, government agencies, academic institutions, NGO's, and private citizens.

The final data collection method used in the project was a survey of community members. This survey was distributed online using a contact list provided by the U.S. Forest Service. One hundred eleven responses were received. From the 111 surveys that were received, 11 were blank, leaving 100 usable surveys and yielding an overall response rate of 22.0%. Also, 56 individuals provided their contact information that was inserted into the RCDA.

4.1 Watershed Council Challenges

The watershed council official survey asked respondents to rank the top three challenges for their watershed council. From these ranking data, a points system was used, which assigned 3 points to a ranking of 1, 2 points to a ranking of 2, and 1 point to a ranking of 3. These points could then be summed to determine a final "score" for each challenge. Figure 6 below shows the score for the challenges from all respondents. Council challenges that were not listed in the survey (e.g., coded as "Other) received a score of 23.

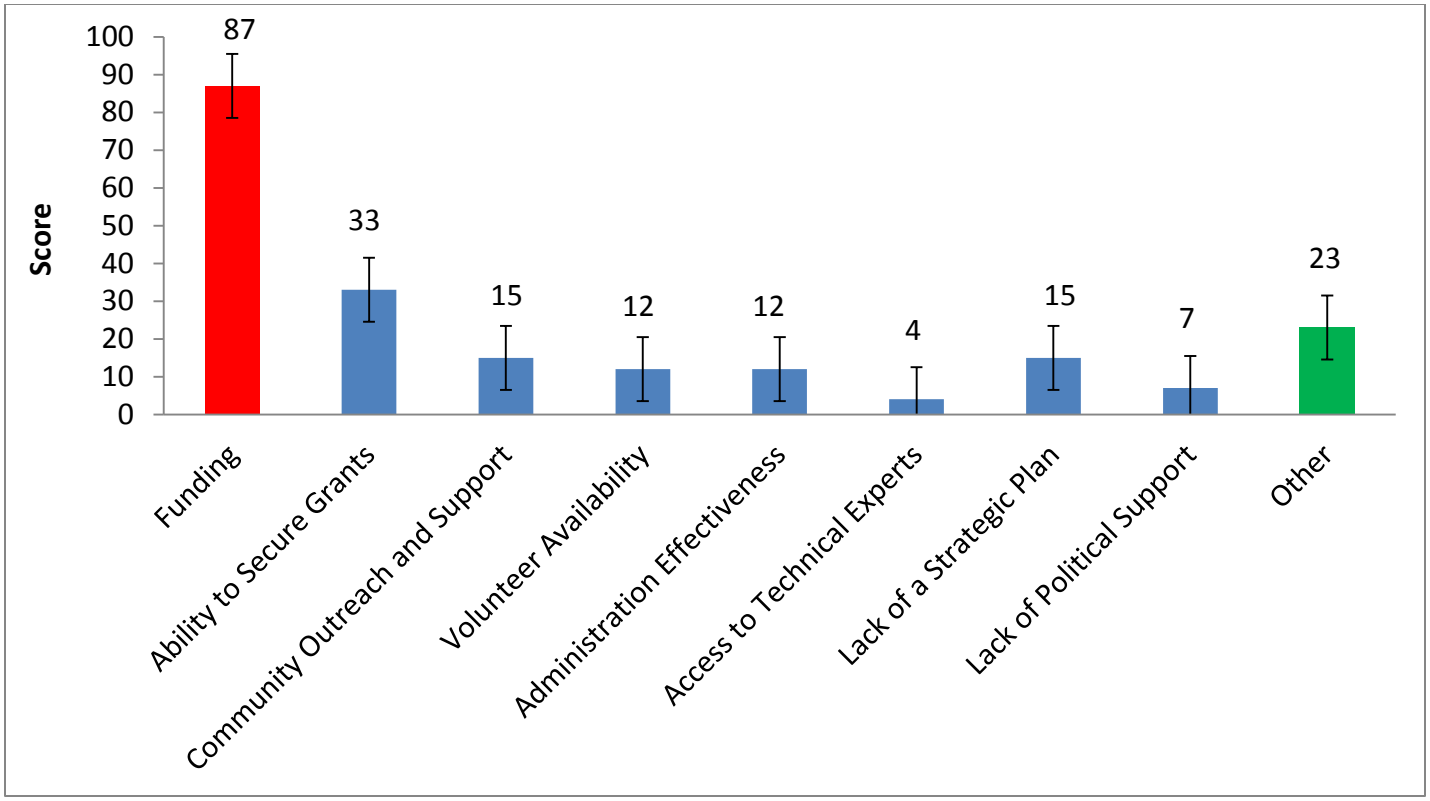

Figure 6: Score (standard error) of Watershed Council Challenges – n = 37

As can be seen in the data in Figure 6, the most common challenge to watershed councils was "Funding", with a score of 87. This challenge was followed by "Ability to Secure Grants" which had a score of 33. In addition, all of the individuals that were interviewed mentioned funding as a major challenge for their watershed council. These data suggest that a major problem for watershed councils is gathering the necessary funds to conduct their programs and activities. One individual that was interviewed suggested that a way to overcome this challenge is to not focus on individuals with significant financial resources to offer, but rather to focus fundraising efforts on individuals with a passion for the environment. The interviewed individual suggested that people with a connection to the environment the council is trying to protect are much more willing to assist in funding a project.

To determine if there was a relationship between funding sources and watershed council challenges, 40 regressions were performed with the five funding sources from question 5 as the independent variables, and the eight challenges from question 6 as the dependent variables. Of these regressions, two were statistically significant while not being adjusted for multiple comparisons. The independent and dependent variables for these regressions, as well as their p-values, R^2 values, and signs of the coefficients are displayed in Table 2 below. All referenced questions are from the watershed council official survey and can be found in Appendix C: Web-Based Survey to Watershed Council Officials. For the complete regression data, please reference Table 15, Table 16, and Table 17 in Appendix F: Regression Tables from Watershed Council Official Survey.

Independent	Dependent	P-value	R^2	Coefficient
Funding-"State Grants"	Challenges-"Funding"	0.0129	0.1640	+
Funding-"General Membership"	Challenges-"Administration Effectiveness"	0.0492	0.1061	+

Table 2: Regressions with Challenges as the Dependent Variable and P-value <0.05

As detailed in Table 2, we observed a positive relationship between the score associated with state grants as a funding source and the score of funding as a watershed council challenge explaining 16.4% of the variance in the score of funding as a challenge. All of the regression data suggest that as the number of individuals who identify "State Grants" as a funding source increases, the number of individuals who identify "Funding" as a challenge also increases. At first glance, this relationship may seem unlikely, but a possible explanation for this relationship is that as watershed councils rely more on the funding provided by state grants, they must work

harder to ensure that the grants are secured. Due to this extra work required to obtain funding, these councils may be more likely to see funding as a challenge.

Also shown in Table 2, there exists a positive relationship between the score associated with general membership as a funding source and the score of administration effectiveness as a watershed council challenge explaining 10.6% of the variance in the score of administration effectiveness as a challenge. These regression coefficients imply that as watershed councils rely more on the funding from membership dues, the administration must spend more of its time ensuring these dues are collected, which may lead the council to rank "Administration Effectiveness" as a challenge. Another possible explanation for this relationship is that the increase in "General Membership" as a funding source could imply that there is an increase in the number of general members. This increase may result in an increase in identifying "Administration Effectiveness" as a challenge because there are more members for the administration to manage. These regressions support the descriptive result that funding is the major challenge for watershed councils.

4.2 Watershed Council Activities

As part of the watershed council official survey, respondents were asked to describe the amount of time their watershed council spends on certain types of activities by assigning each type of activity a percentage value that totaled 100%. As described in Figure 7, the activity that watershed councils spend the most time on is "Restoration and Action" with an average percentage of 33%. This indicates that most councils place significant effort into activities that fulfill their original goals, rather than other work like fundraising or administration. A potential

explanation of this is that a council's main purpose is to conserve and restore the environment. Therefore, it is logical that a substantial amount of time is spent on these types of activities. This hypothesis is supported by our review of watershed council websites conducted in our background research. "Monitoring and Research" is the activity with the least percentage of time spent with an average percentage of 10%.

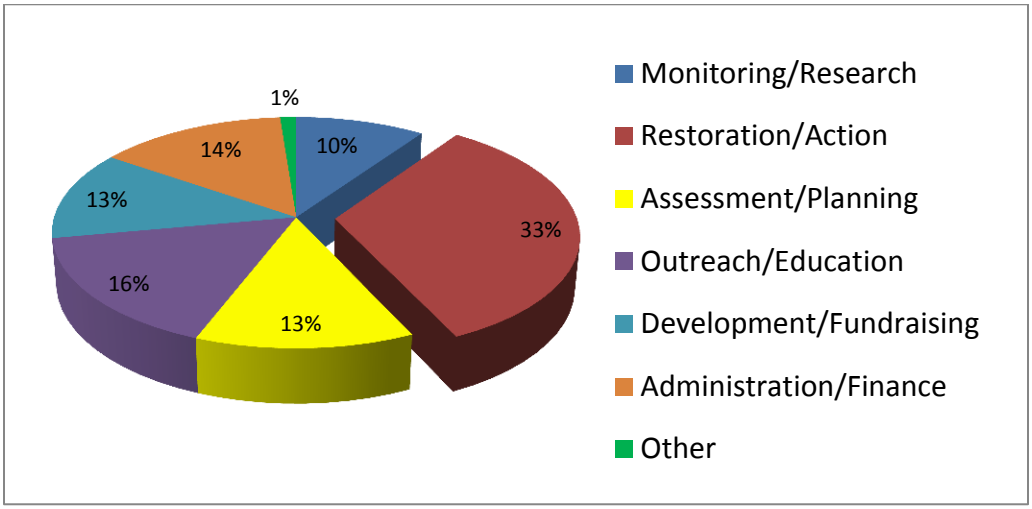

Figure 7: Watershed Council Activities – n = 37

To determine if there was a relationship between watershed council budget and time spent on certain types of activities, six regression analyses were performed. A regression was performed for each type of watershed council activity (excluding "Other"), with budget as the independent variable. Of the six regressions performed, two of them were statistically significant ($p<0.05$), as shown in Table 3. For the complete regression data, please reference Table 14 in Appendix F: Regression Tables from Watershed Council Official Survey.

Independent	Dependent	P-value	R^2	Coefficient
Budget	Activities – "Restoration/Action"	0.0244	0.1531	+
Budget	Activities – "Outreach/Education"	0.0447	0.1238	-

Table 3: Regressions with Activities as Dependent Variable and P-value <0.05

As detailed in Table 3, we observed a positive relationship between budget and time spent on restoration and action activities explaining 15.3% of the variance in the time spent on restoration/action activities. This relationship could be explained by the fact that as a council's budget expands, the council is more likely to spend time on restoration/action activities. Also observed in Table 3 was a negative relationship between budget and time spent on outreach and education activities explaining 12.4% of the variance. A potential explanation for this relationship is that as a watershed council's budget expands, they may focus their efforts on large activities rather than the small, less expensive activities that could be classified as outreach and education.

4.3 Watershed Council Effectiveness

The watershed council official survey used a seven point Likert scale to gauge the perceived effectiveness of the respondents' councils. On this scale a 1 was rated as "Very Ineffective" and a 7 was rated at "Very Effective" with a 4 being rated "Neutrally Effective". Figure 8 below shows the mean results for all respondents in all five effectiveness categories. T-tests were performed on the various categories of effectiveness to determine if the mean responses were statistically different than "Neutrally Effective". The results of these tests can be seen in Table 4 below. Through these T-tests we determined that all of the categories except for "Fundraising" were significantly higher than "Neutrally Effective".

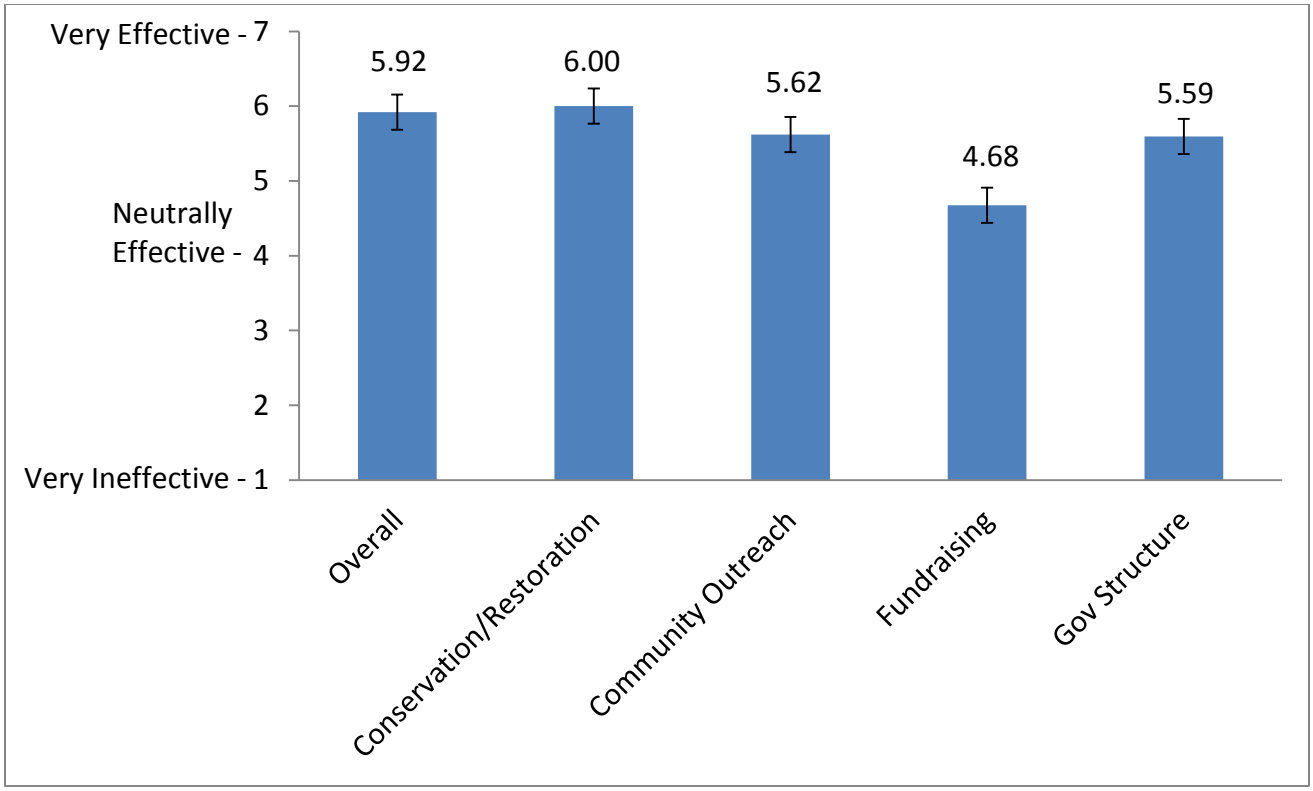

Figure 8: Mean Perceived Effectiveness (standard error) of Surveyed Watershed Councils – n = 37

Effectiveness Category	Overall	Conservation /Restoration	Community Outreach	Fundraising	Governance Structure
T-Value	4.509989279	4.636596135	3.901845186	1.186993214	3.513653162
P-Value	5.1355E-05	3.43248E-05	0.000339051	0.241900833	0.001072535

Table 4: T-Test Results for Watershed Council Perceived Effectiveness compared to "Neutral"

Figure 8 shows that "Conservation/Restoration Effectiveness" has a mean rating of "Effective". This rating suggests that watershed council officials believe that the conservation and restoration activities their respective councils conduct are successful in accomplishing the council goals. This suggests that since these activities are effective, the council must spend a significant amount of time planning and supervising these activities. This interpretation is supported by data from Section 4.3 that state that, on average, 33% of a council's time is spent on "Restoration and Action".

The lowest rated category for watershed council perceived effectiveness was "Fundraising Effectiveness" which was rated as being "Neutrally Effective". We performed a two-sample t-test to determine if "Fundraising Effectiveness" was significantly lower than the next lowest effectiveness category, "Governance Structure Effectiveness" (t-value = 3.87, (p-value) = 0.00024). These data suggest that fundraising is a major issue for many watershed councils and must be addressed by the Río Espiritu Santo Watershed Council. This observation is supported by data from Section 4.5.2 which state that "Funding" is the most common challenge among watershed councils with a score of 87.

Figure 9 and Figure 10 below show a pie chart for the "Somewhat Effective" and "Very Effective" watershed council categories. The budgets of the watershed councils that make up the "Somewhat Effective" category were all between $0 and $150,000, with 50% of them being in the lowest possible budget category. On the contrary, the budgets of the councils in the "Very Effective" category range from $50,000-$400,000, with 50% being over $200,000. There is also evidence of a statistically significant difference between the average budget of "Somewhat Effective" and "Very Effective" councils (t-value = 4.84, (p-value) = 0.000513).

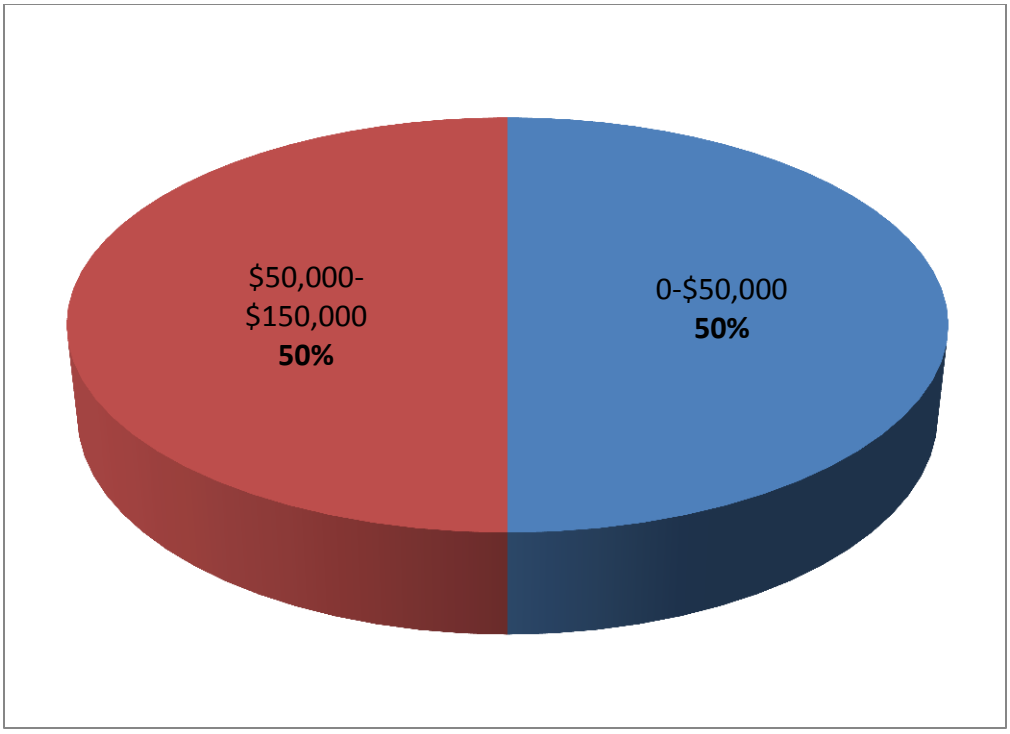

Figure 9: Budgets of Watershed Councils (Somewhat Effective) – n = 8

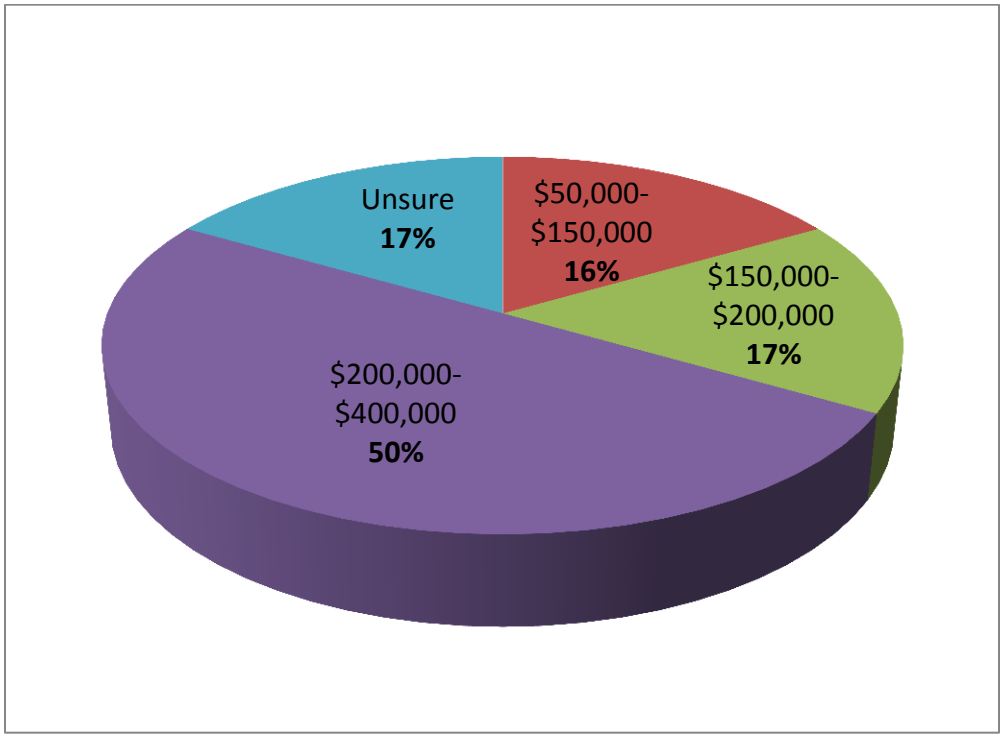

Figure 10: Budgets of Watershed Councils (Very Effective) – n = 6

Figure 11 and Figure 12 below show the percentage of watershed councils in both the "Neutrally Effective" and "Effective" categories that indicated having the various stakeholder groups as a part of their watershed council. These graphs show the respondents' watershed councils as having stakeholders from a variety of groups, regardless of their perceived effectiveness. As detailed in Table 5, there was no evidence of a significant difference between the percentage of neutrally effective and effective councils that contained the specified stakeholder groups.

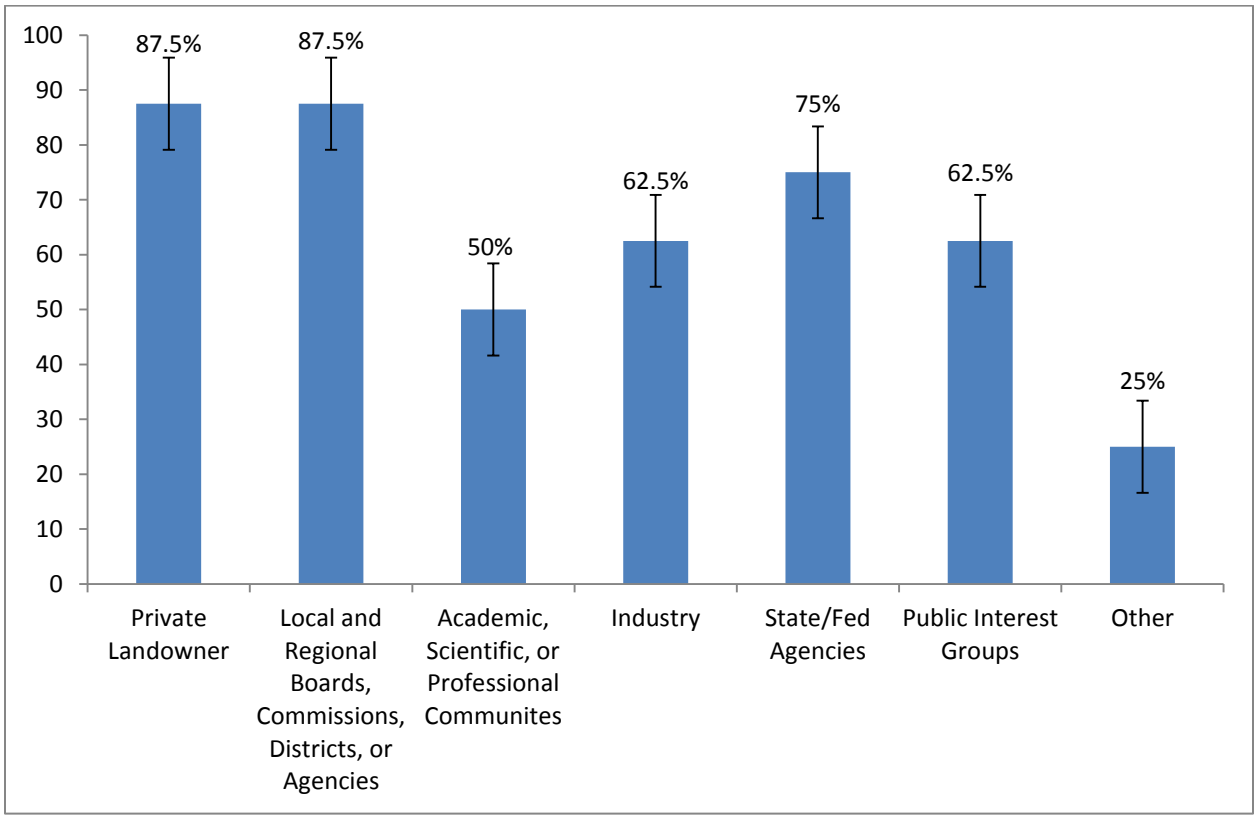

Figure 11: Percentage of Watershed Councils (standard error) with Certain Stakeholder Groups (Somewhat Effective Councils) – n = 8

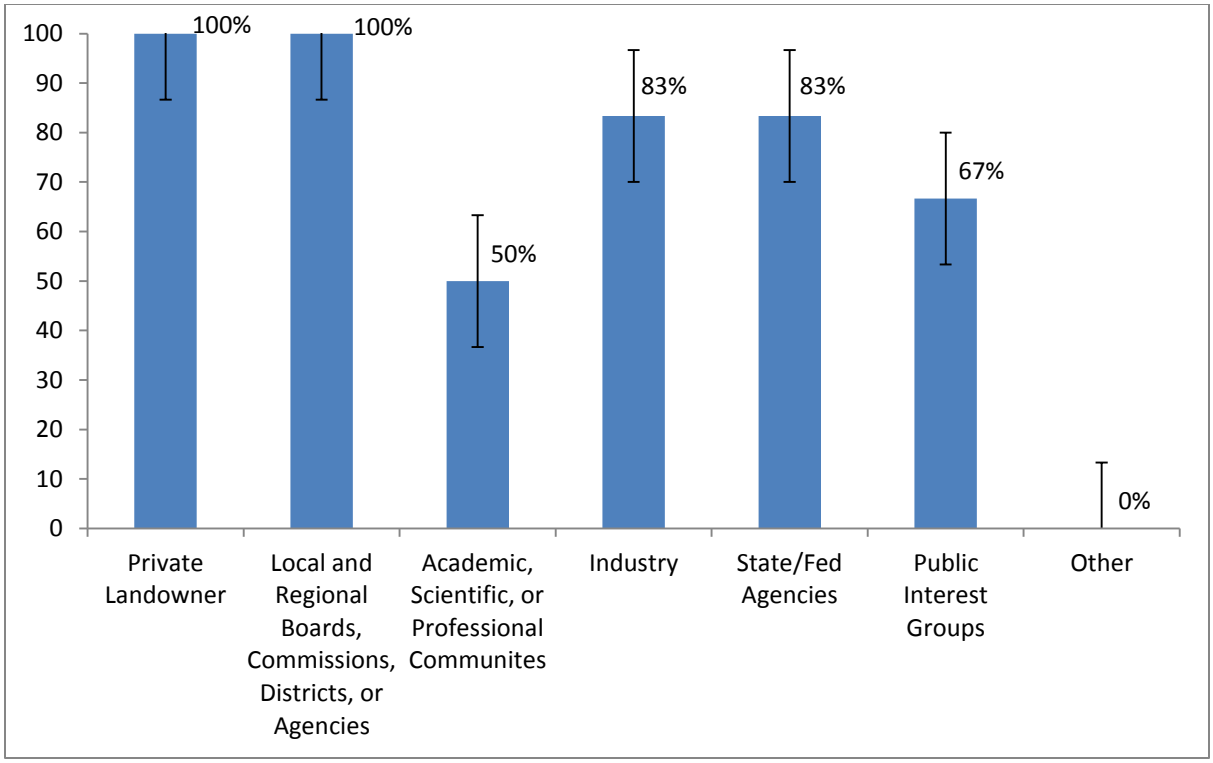

Figure 12: Percentage of Watershed Councils (standard error) with Certain Stakeholder Groups (Very Effective Councils) – n = 6

Stakeholder Group	Private Landowner	Local and Regional Agencies	Academic	Industry	State/Fed Agencies	Public Interest Groups
T-Value	0.86	0.86	0	0.81	0.35	0.15
P-Value	0.41	0.41	1	0.43	0.73	0.88

Table 5: T-Test results for Watershed Council Stakeholder Groups

To determine if there was a relationship between certain characteristics of watershed councils and perceived effectiveness, 24 regressions were performed. The first five regressions used budget data from question 4 as the independent variable and the five effectiveness categories from questions 9-13 as the dependent variables. The other 19 regressions were performed with the six activity categories from question 7, the five funding sources from question 5, and the eight challenges from question 6 as independent variables and "Overall Effectiveness" as the dependent variable. All referenced questions are from the watershed

council official survey and can be seen in Appendix C: Web-Based Survey to Watershed Council Officials. For the complete regression data, please reference Table 8 and Table 11 in Appendix F: Regression Tables from Watershed Council Official Survey.

Of the regressions performed, three were statistically significant. Table 6 below shows the independent and dependent variables of these regressions, as well as their p-values, R^2 values, and whether the coefficient is positive or negative. No adjustments were made for multiple comparisons.

Independent	Dependent	P-value	R^2	Coefficient
Budget	Effectiveness-"Overall"	0.00007	0.3200	+
Budget	Effectiveness-"Conservation/Restoration"	0.0106	0.1984	+
Activities-"Restoration/Action"	Effectiveness-"Overall"	0.0252	0.1352	+

Table 6: Regressions with Effectiveness as the Dependent Variable and P-value <0.05

As detailed in Table 6, we observed a positive relationship between budget and overall effectiveness as well as conservation/restoration effectiveness explaining 32.0% and 19.8% of the variance in effectiveness, respectively. A potential explanation for this relationship is that as budget increases, it allows more money to be spent on activities that accomplish the goals of the council, thus giving the council a higher perceived effectiveness. The third regression in Table 6 shows a positive relationship between the percentage of time spent on restoration and action activities and overall perceived effectiveness that explains 13.5% of the variance. This relationship can be potentially explained because a majority of the council's goals revolve around restoration and action activities, so as more of them are completed, more goals are achieved. As more goals are achieved, the perceived effectiveness of the council increases.

4.4 Community Outreach

4.4.1 Descriptive Analysis

In the community survey, a seven point Likert scale was used to assess the respondent's likeliness to participate in the Río Espiritu Santo Watershed Council in eight categories (see questions 7-14 in Appendix E: Survey to Puerto Rican Community). On this scale a one was rated as "Very Unlikely" and a seven was rated at "Very Likely" with a four being rated "Neutral". Figure 13 below shows the mean results for all respondents in all categories. The red bar on the right of Figure 13, labeled "Overall Willingness", is a mean of the average values for each of the eight activities and is valued at "Somewhat Likely". T-tests were conducted on these data to determine if the average willingness of the community to participate in the eight activities was significantly higher than "Neutral". The data for these t-tests can be seen in Table 7 below.

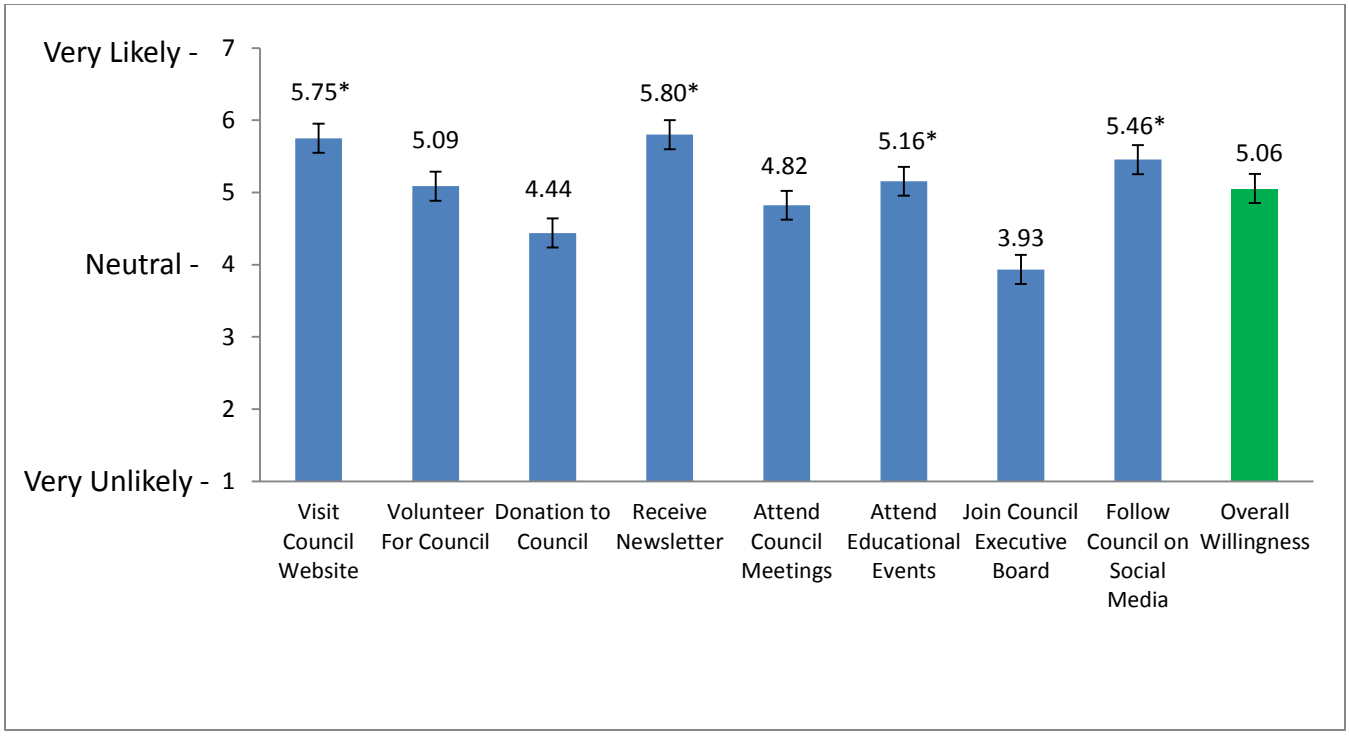

Figure 13: Mean (standard error) Willingness of Community to Participate in Watershed Council – n = 100

Area	Visit Website	Volunteer	Make Donation	Receive Newsletter	Attend Meeting	Attend educational event	Attend Educational Event	Follow on Social Media
T-Value	2.91	1.79	0.66	3.62	1.33	2.16	0.10	2.18
P-Value	0.41	0.004	0.077	0.514	0.0004	0.184	0.921	0.032

Table 7: T-Test of Community Willingness to Participate in a Watershed Council compared to "Neutral"

According to the data, the community is "Somewhat Likely" to participate in a watershed council overall. However, certain activities such as "Visit Council Website", "Receive Newsletter", and "Follow Council on Social Media" are rated higher than "Neutral". A possible explanation for this result is that these activities do not require much time, money, or commitment on the part of the community.

4.4.2 Comparison of Overall Willingness by Municipality

A portion of the research conducted was also used to determine if there was a statistically significant difference between the overall willingness of community members within the municipality of Río Grande and community members within the other municipalities of Puerto Rico to participate in the Río Espiritu Santo Watershed Council. Río Grande was specifically selected as the test municipality because the Río Espiritu Santo Watershed lies in this municipality. Figure 14, below, shows the overall willingness of the respondents from Río Grande and the respondents from other municipalities. There is no evidence that the overall willingness of Río Grande residents to participate in the council is different from that of residents of other municipalities (t-value = 1.64, (p-value) = 0.104).

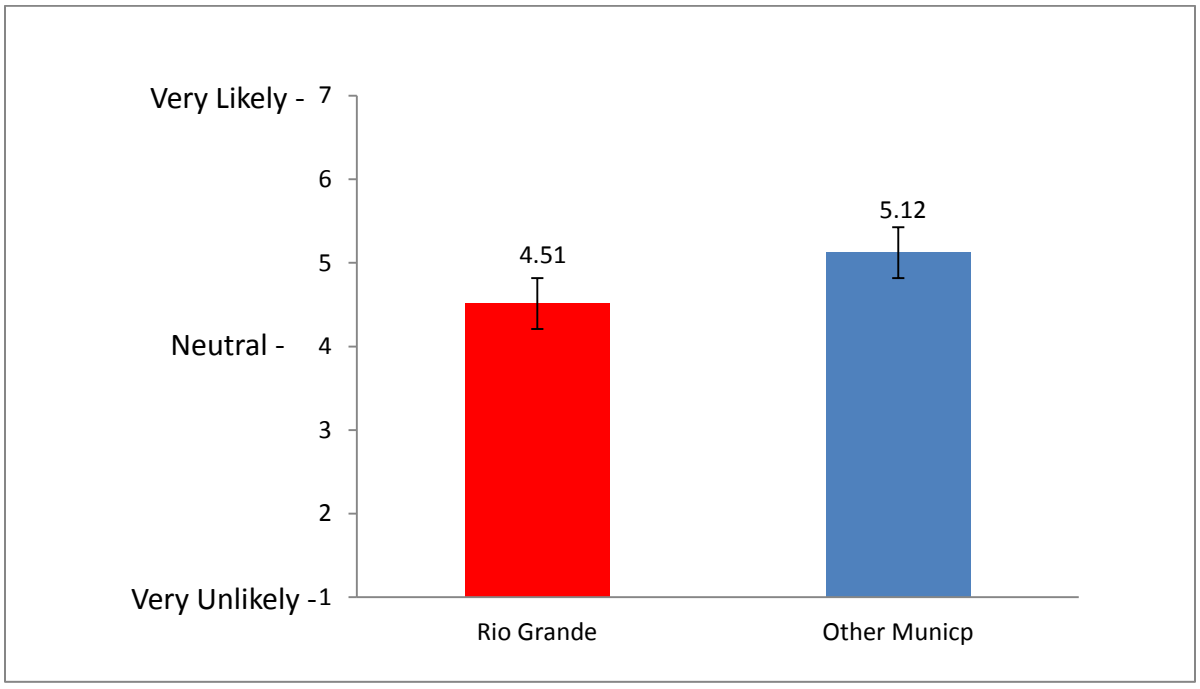

Figure 14: Overall Willingness (standard error) Sorted by Municipality Councils – n = 100

4.4.3 Comparison of Overall Willingness by Community Group

The data were also examined to determine if a statistically significant difference in overall willingness existed between different community groups. These community groups were: academia, NGO, industry, federal government, state government, municipality government, and private citizens. Figure 15 below shows the "Overall Willingness" of the various community groups. According to an ANOVA test, ($f = 0.48$, $p = 0.82$) there is no evidence that the overall willingness of the various community groups to participate in the council are significantly different.

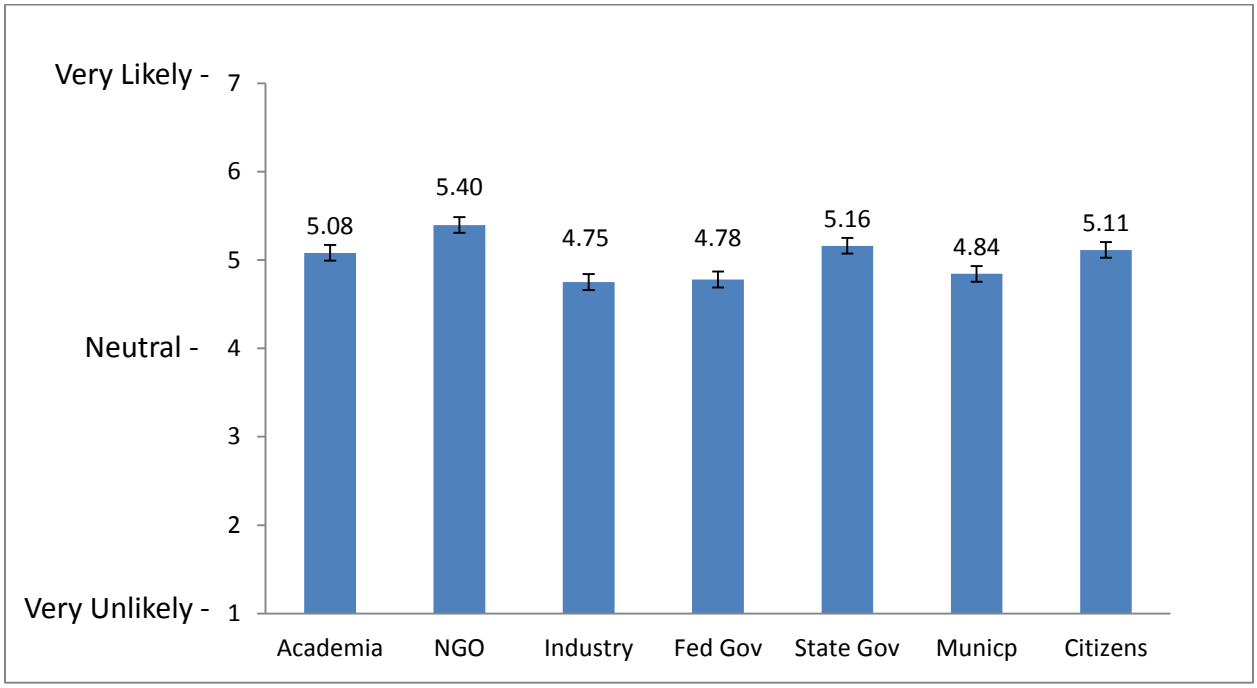

Figure 15: Average Willingness (standard error) Sorted by Community Group – n = 100

4.4.4 Community Outreach Activities

In addition to the survey data on community involvement, data were also acquired from the initial stakeholder interviews. These data were centered on strategies that the council could employ to effectively involve the community. The major themes that the majority of the interviews conveyed were the promotion of the watershed council, education, and finding community leaders.

According to 11 out of the 16 of the individuals that were interviewed, the most important way to involve the community in a watershed council is to make the community feel that their ideas and concerns are being addressed. Those individuals repeatedly stated that the community will not invest their time into the watershed council if they feel that it offers them no tangible benefit on an individual level. According to those interviewed, a method to ensure that the values of the community agree with the values of the watershed council is to conduct a public values forum. This forum would allow community members to voice their concerns about the environmental health of the area and allow the watershed council to establish a set of priorities and action items based on what the community conveys to them. This forum would also reduce the possibility of the watershed council establishing an agenda that did not match the agenda of the community.

One of the major challenges facing the council, however, is that the prevailing values of the community may not be aligned with the goal of environmental restoration and conservation. A way to combat this attitude, as suggested through the interviews, is through education. Of the 16 individuals interviewed, 12 suggested that education was the best way to

engage the community. Of the individuals interviewed, 25% suggested educating children was the best method for educating the community as a whole. By educating children directly within their schools about how their actions affect the environment and how they can help conserve the environment as a whole, the watershed council can directly reach parents and attempt to change the prevailing attitude of disinterest with environmental conservation.

Another way to get the community involved, as suggested through the interviews, is to locate community leaders and convince them to further the watershed council's agenda among the individuals they represent. The initial stakeholders interviewed suggested that the community is more likely to take action when it is endorsed by a community leader rather than an outside source, such as the watershed council. As suggested by the interviews, the major community leaders within most Puerto Rican communities are the various churches that service most of the population. If the watershed council can reach out to church leaders and gain their support, 25% of the initial stakeholders interviewed believed the support of the community will soon follow.

4.5 Supplemental Analysis

4.5.1 Watershed Council Governance Structure

4.5.1.1 Budget

In the watershed council official survey, respondents were asked to report their annual budget by selecting one of four budget ranges. Figure 16: **Budgets of Watershed Councils** below shows the reported budgets for the responding watershed councils. Of the councils surveyed, 42%

reported having budgets of $200,000-$400,000 while only 25% of councils reported having a budget of $0-$50,000.

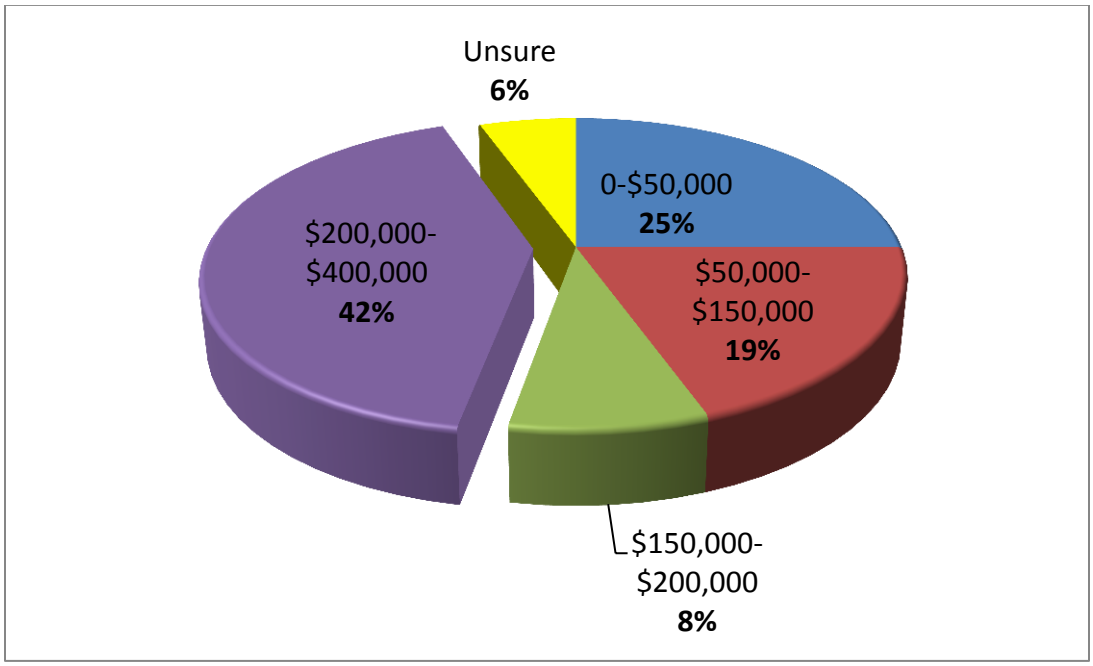

Figure 16: Budgets of Watershed Councils – n = 37

4.5.1.2 Stakeholder Groups

In the watershed council official survey, respondents were asked to select all of the stakeholder groups that were represented in their council. Respondents were allowed to select more than one group. Figure 17 shows the percentage of watershed councils that contain each of the stakeholder groups. Of the watershed councils surveyed, 16.2% reported having a stakeholder group that was not listed. Of the councils surveyed, 97.3% of the respondents listed having private landowners as a part of their watershed council. According to Figure 17, the stakeholder group with the least representation is “Public Interest Groups” with a 62.2% representation.

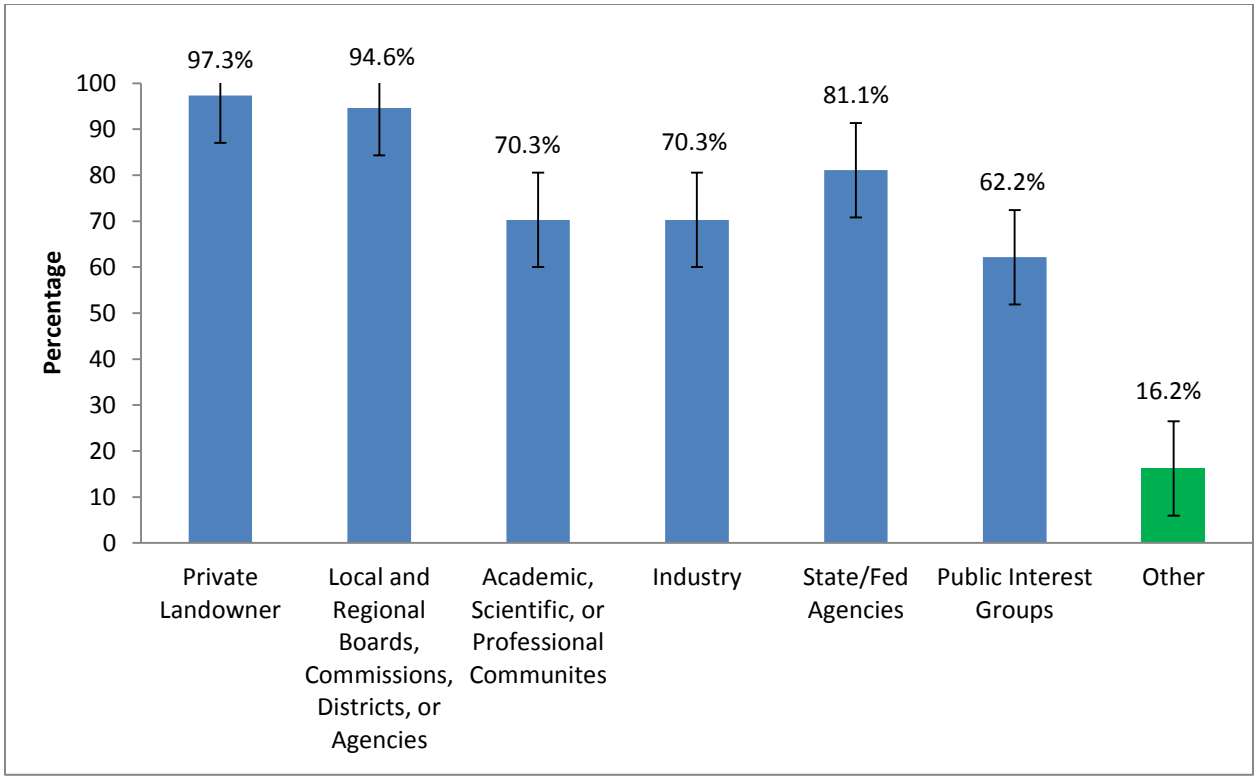

Figure 17: Percentage of Watershed Councils (standard error) Containing Stakeholder Groups – n = 37

4.5.1.3 501(c)(3) Designation

Of the responding watershed councils, 83% were organized as a not for profit under section 501(c)(3) of the IRS code. A possible explanation for this result is that having a 501(c)(3) designation enables a council to apply for tax-exempt status and increases the possibility of receiving federal or state grants.

4.5.2 Watershed Council Funding Sources

The watershed council official survey asked respondents to rank the top three funding sources for their watershed council. From these ranking data, a points system was used, which assigned 3 points to a ranking of 1, 2 points to a ranking of 2, and 1 point to a ranking of 3. These points were then summed to determine a final "score" for each funding source. Figure 18

below shows the score for all funding sources. We removed all responses identifying state grants as a funding source from the "Other" category and created a new variable called "State Grants".

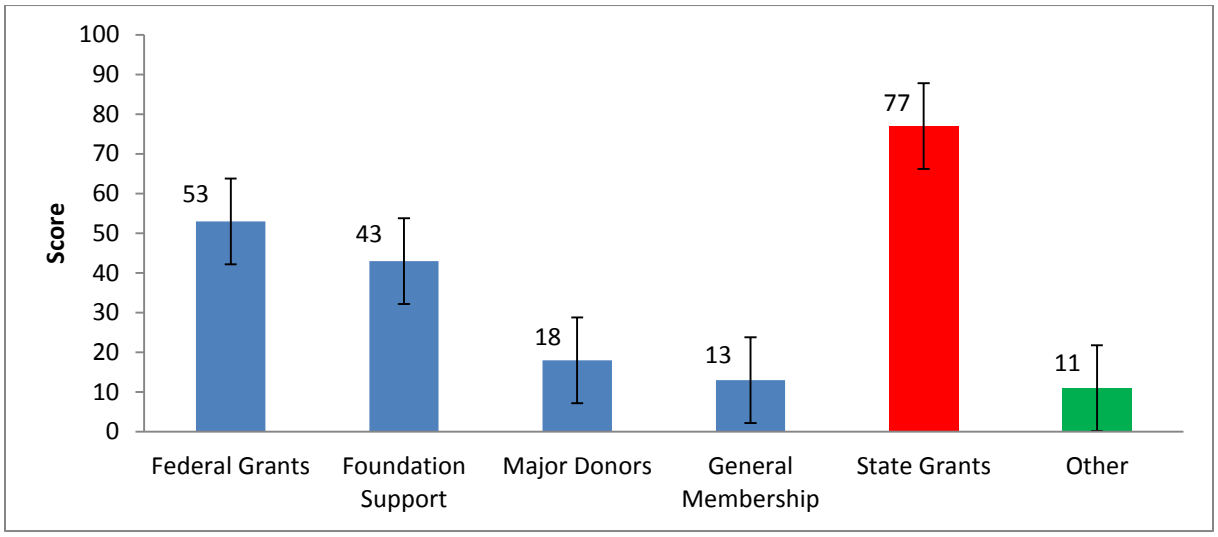

Figure 18: Score (standard error) of Watershed Council Funding Sources – n = 37

The data that are presented in Figure 18 show that "State Grants" are the largest overall source of funding for the watershed councils with a score of 77. "Federal Grants" closely follows with a score of 53. These data were also supported through data gathered from the watershed council official interviews, in which state and federal grants were mentioned as major funding sources. A potential explanation for these results could be because these grants represent large amounts of capital that can be used to fund a variety of activities and projects. However, as one individual indicated in an interview, while grants are a common funding source for most councils, they are not consistent, reliable sources of funding because there is no guarantee of continued support.

Another observation that can be made from the data in Figure 18 is that "Major Donors" and "General Membership" are two of the lowest rated sources of funding, with scores of 18

and 13 respectively. This score implies that watershed councils do not draw a significant amount of their funding from individual donations. These scores could be due to the fact that in order to receive individual donations, watershed councils must spend time and resources to locate and convince individuals to donate to their council. There is also a possibility that an individual, when contacted, will not donate to the watershed council. This hypothesis is supported by data from the community survey where individuals were asked how likely they would be to make a donation to a watershed council. The mean response to this question was "Neutral", as can be seen in Section 4.4.1.

4.5.3 Environmental Issues

The community survey asked respondents an open response question about what they perceived as environmental issues in their respective municipalities. From these data, the responses from individuals who lived in the Río Grande municipality could be further analyzed. It is important to note that even though only 10 out of 100 survey respondents identified themselves as a part of the Río Grande municipality, a wide variety of environmental issues were identified. Some of these issues concerned lack of education on environmental issues, the damming of the Río Espiritu Santo, erosion, and misuse of the river.

The first issue identified within the open responses involves the lack of education concerning environmental issues. If individuals visiting or living in the Río Espiritu Santo Watershed do not understand how their actions impact the environment, there is no incentive for these individuals to curb their pollution of the environment. This principle also extends to urban developers who construct along or near the banks of the river. According to ten of the 16

individuals we interviewed, some of these developers, likely due to their lack of education on environmental issues, have no regard for the environmental impact of their actions.

In 2000, a water intake pipe was installed in the Río Espiritu Santo to collect water from the river to supply to the surrounding communities. In order to supply this water, a 2.5 m tall dam was installed that created a 450 m^2 pool of water (Roghair, Nuckols, & Whalen, 2001). However, the damming of the Río Espiritu Santo was identified as an issue in both the community survey and the Initial Stakeholders Interviews. According to three of the 16 the individuals we interviewed, this dam is particularly harmful to the Río Espiritu Santo because it obstructs the natural migration patterns of some of the native fish that use the river as a habitat. Because the fish are not able to swim upstream, they are forced to find other, less suitable locations for their reproduction. This change results in a significant decrease in the fish population of the Río Espiritu Santo.

For any watershed, erosion can become a major issue if allowed to occur without any attempts to curb its effects. As stated in Background Section 2.3.2.2, erosion creates sedimentation which can have a negative impact on the health of a river. According to the individuals interviewed, erosion is a major problem in the Río Espiritu Santo Watershed. The naturally occurring mangroves that grow on the banks of river help prevent some erosion, but in urban areas, these mangroves are usually destroyed. In addition, in agricultural areas, the trampling of the landscape by cows and other agricultural animals contributes to the heavy erosion found in the watershed. The sedimentation caused by this erosion has had a drastic

negative impact on both the fish population and the quality of the coral reefs located at the mouth of the river.

A majority of the individuals that were interviewed, 13 out of the 16, talked extensively about how community members or businesses are misusing the environment of the Río Espiritu Santo Watershed. As an example given by certain sources, illegal poaching is a major problem and has drastically reduced the fish population in the river. In addition, certain businesses are constructing on parts of the land that should be protected. However, enforcement of these rules does not occur. Seven of the 16 individuals that were interviewed suggested that this may be due to corruption on some levels of the government, but there is no hard evidence to support those claims.

Another significant observation from these data concerns the backgrounds and motivations of each of the individuals from whom information was obtained. Individuals surveyed and interviewed had a variety of backgrounds and represented a variety of interests. Even though each individual had a different motivation for wanting the environment preserved, all 16 individuals not only identified the need for environmental conservation, but also were in relative agreement on the specific issues that need to be addressed.

4.5.4 Community Knowledge

These data were acquired through two questions in the community survey that asked specifically about whether or not the respondent understood the concepts of a watershed and a watershed council (see questions 4 and 5, respectively, in Appendix E: Survey to Puerto Rican

Community). Overall, 98% of respondents knew the definition of a watershed, but only 43% of respondents knew the definition of a watershed council.

A potential reason for these data on watershed knowledge is that the contact information was taken from a list that the U.S. Forest Service had of community members. If these individuals were on a list, they previously had contact with the U.S. Forest Service. This fact may imply that the individuals on the list have a higher education then the rest of the community with regards to knowledge of environmental terms and issues. This explanation suggests that the data for this question may not represent the knowledge base of the overall community.

For these data on watershed council knowledge, we compared the responses based on the community group the respondent identified with in question 3 of the community survey in Appendix E: Survey to Puerto Rican Community. Of the community groups labeled “Academia”, “Federal Government”, “State Government”, and “Municipality” an average of 51.3% of respondents understood the definition of a watershed council, but out of the community groups labeled “NGO”, “Industry”, and “Private Citizen” only an average of 30.56% respondents understood this definition. On average, the academia/governmental group had a better understanding of the watershed council definition than the second group (t-value = 8.33, p-value = 0.0004). A potential explanation for this difference is that individuals within academia or government have access to different, more varied information, articles, and reports than individuals in the other groups.

4.6 Creation of Project Deliverables

To create the various project deliverables, we had to compile and analyze the data from our five data collection methods. One of these methods, the RWA, was the first of the seven deliverables that we produced for this project. The remaining six deliverables were the draft of the watershed council charter, the RCDA, the Google blog based website, the project presentation, the project poster, and the discussion of an ideal watershed council.

5.0 Project Deliverables

5.1 Rapid Watershed Assessment

The Rapid Watershed Assessment (RWA) briefly describes the Río Espiritu Santo Watershed, and includes information on the land use, hydrology, species, and habitat status and trends of the watershed as a whole. The United States Forest Service will use this document in the development of the Río Espiritu Santo Watershed Council to explain the environmental status of the watershed to the community or interested parties. We believe that the RWA will be a useful tool for the U.S. Forest Service in the development of the Río Espiritu Santo Watershed Council, and will also be a resource for the established council to use if necessary. The RWA also aided in the development of the remaining project deliverables described below. The full Rapid Watershed Assessment can be seen in Appendix G: Rapid Watershed Assessment.

5.2 Río Espiritu Santo Watershed Council Charter Draft

Based on our reviews of multiple watershed council charters, we divided the charter into multiple sections in order to cover all aspects of watershed council governance structure. The charter draft contains ten articles that cover the following areas:

1) Mission Statement
2) Geographic Area Description
3) Purpose

4) Vision

5) Objectives

6) Organization

7) Membership

8) Meetings

9) Decisions

10) Amendments

This charter draft will be used by the US Forest Service and the initial stakeholders of the project as a guide for the development of the official charter of the Río Espiritu Santo Watershed Council. The full charter draft, including recommendations, can be seen in Appendix I: Draft of Watershed Council Charter.

5.3 Restoration and Community Development Assessment

A Restoration and Community Development Assessment (RCDA) was also created for the use of the Río Espiritu Santo Watershed Council. The Recommended Restoration Activities section contains a description of the most commonly suggested restoration activities including improvement of infrastructure, increasing enforcement of regulations, and clean-up activities. The Recommended Community Development Activities section follows a similar format, and contains descriptions of educational activities and a public values forum. The Recommended Contacts section contains the contact information of 79 people that have expressed an interest in the council.

We expect that the RCDA will be an extremely useful tool for the Río Espiritu Santo Watershed Council after it is established. The council will be able to use this deliverable to immediately begin official actions and activities without having to use valuable time brainstorming new ideas. The full RCDA, with the contact list redacted for the purposes of anonymity, can be seen in Appendix J: Restoration and Community Development Assessment.

5.4 Google Blog

A Google blog was created for the use of the U.S. Forest Service in informing the initial stakeholders of the Río Espiritu Santo Watershed Council and the community of the Río Espiritu Santo Watershed about the project and its status. The information posted to this blog during the project came from the various deliverables that have been previously described. The blog was used to record the accomplishments of the project thus far and will be used further by the U.S. Forest Service and initial stakeholders in the development of the Río Espiritu Santo Watershed Council.

Once officially established, the Río Espiritu Santo Watershed Council will be able to utilize this blog as the framework for the creation of the official watershed council website. Having a guide for their website already developed will hopefully be a great asset for the Río Espiritu Santo Watershed Council in their efforts to quickly launch the official council website. A screenshot of the Google blog can be seen in Appendix K: Google Blog.

5.5 Final Project Presentation

We created the final presentation by compiling all of our work and results from the project into a concise PowerPoint presentation. We delivered this presentation to the staff at the U.S. Forest Service, as well as the initial stakeholders of the Río Espiritu Santo Watershed Council. The slides for this presentation can be seen in Appendix L: Final Presentation.

5.6 Development of the Río Espiritu Santo Watershed Project Poster

The poster was created based on a project poster template provided by Worcester Polytechnic Institute. The poster includes background information on watershed councils and their importance, along with specific information about our project. This information includes a flow chart of the various stages of our project, the accomplishments of the project thus far, and the reasons why the support of the community is required. Contact information for the individuals in charge of the continued development of the council are also included, but have been redacted from this report for the purposes of anonymity. The project poster will ideally enable the US Forest Service and other initial stakeholders of the project to better present the watershed council to the community at large. This poster was designed to be utilized at two large community events as a promotional tool for the project. These events included the Leatherback Turtle Festival at Luquillo Beach on April 13th and the El Yunque Forest Clean-Up Day on April 20th. The full project poster can be seen in Appendix H: Project Poster.

5.7 Discussion of the Ideal Watershed Council

We created a series of recommendations for the governance structure and activities of the ideal watershed council by combining our survey and interview results with our prior research on watershed councils. These recommendations contain a series of attributes that, based on our research and findings, the ideal watershed council should possess. These recommendations will be used by the initial stakeholders of the Río Espiritu Santo Watershed Council in the initial governance of the council.

6.0 Discussion

As mentioned above, the final deliverable we produced for the initial stakeholders of the Río Espiritu Santo Watershed Council was the discussion of the ideal watershed council. These recommendations were made based on our background research and findings from the surveys and interviews of watershed council officials, the interviews of initial stakeholders of the project, and survey to the community.

6.1 Ideal Watershed Council Governance Structure

Using the data acquired from our research, we have been able to identify several characteristics of the governance structures of effective watershed councils. According to watershed council officials interviewed, the ideal watershed council should have a charter that contains both the mission statement of the council as well as bylaws and regulations that determine the governance structure of the council. This recommendation is supported by some of the background research in Section 2.4 where "Vision" is suggested as one of the seven effectiveness factors of watershed councils (Smith & Gilden, 2002)

According to the three watershed council officials interviewed, typical executive boards contain 10-14 members. According to the officials we interviewed, this range is ideal because it is large enough that responsibilities can be effectively assigned but is small enough that it can still be managed efficiently. Selecting the best individuals to be a part of the executive board is also crucial according to some of our background research. The quality of three of the seven effectiveness factors of watershed councils, specifically "Leadership", "Trust", "Social Networks", are determined exclusively by the individuals on the executive board (Smith &

Gilden, 2002). Most watershed councils also contain executive positions within their executive boards. According to our research, these positions typically include:

- President/Council Chair
- Vice President/Council Vice Chair
- Executive Director
- Treasurer
- Secretary
- Committee Chairs

According to the research done in Section 2.4.3.2, most watershed councils contain one or more committees that were focused on a specific area of watershed management. This division of labor allows the council to complete its work more efficiently. These committees are usually led by a committee chair that sits on the Executive Board and distributes work among the members of the committee. Some of the typical committees that watershed councils have are as follows:

- **Search Committee** – Designed to identify new potential members of the watershed council and recruit them to the council
- **Technical Committee** – Made up of mostly scientists or people with knowledge of environmental issues. Designed to deal with the environmental issues in the watershed and develop solutions to them
- **Outreach Committee –** In charge of all the council's community outreach programs including newsletters, websites, and education

According to our data, there is a direct relationship between budget size and perceived overall effectiveness and perceived effectiveness of conservation/restoration activities. This relationship can be corroborated with data from the watershed council official interviews and supports research from Section 2.4.4 where Smith and Gilden listed “Capital” as one of the seven effectiveness factors of a watershed council (Smith & Gilden, 2002).

From our research, we found no significant difference between the percentage of councils that were made up of certain stakeholder groups (See Table 5). It is suggested, however, that the ideal watershed council be made up of, “20 percent each from industry and the environmental community, 15 percent each from professional organizations and academia, and 10 percent each from local, state, and federal government” (Griffin, 1999).

In our results, it was determined that 83% of watershed councils had received a 501(c)(3) designation. This designation means that under the IRS Tax Code, these councils are classified as a non-profit organization. By having this designation, watershed councils are able to apply for a tax-exempt status and are eligible for special state and federal grants to receive funding for their projects. Considering that in our results, “State Grants” was rated as the highest source of funding, we recommend that the ideal council apply for and be recognized as a 501(c)(3) organization soon after its creation. In addition, because a plurality of councils surveyed identified “Ability to Secure Grants” as a challenge, our ideal council would have a professional grant writer on staff. This grant writer would be hired for a specific period of time, and could thereafter be responsible for securing a certain percentage of their own salary for future years.

6.2 Ideal Watershed Council Activities

Based on our data on watershed council activities, we can determine that a council will most likely spend a majority of its time on restoration/conservation activities. In fact, we determined that there is a direct relationship between the amount of time spent on restoration and conservation activities and the perceived overall effectiveness of the council. Further, there is also a direct relationship between budget and the amount of time spent on restoration and conservation activities. Therefore, the ideal watershed council should work to increase its budget, thereby increasing the time spent on restoration/conservation activities which according to our research, increases the perceived effectiveness.

We also observed an inverse relationship between budget size and time spent on outreach and education. This relationship could suggest that a watershed council must be careful to not get so involved in the larger, usually more expensive conservation and restoration projects, that they lack the time to spend on community outreach activities. Because the community is a major factor in watershed management, it would be ill-advised to alienate them in such a manner.

One of the major activities the ideal Río Espiritu Santo Watershed Council could undertake is the improvement of the infrastructure of the area. A suggestion we received as part of the results in Section 4.4.4 was to implement a subterranean water withdrawal system similar to that on the Río Mameyes that will decrease the impact of dams on wildlife. In order to improve the infrastructure of the river, however, the council would need the support of the agencies that maintain the infrastructure, such as Autoridad de Acueductos y Alcantarillados

(AAA) and the Río Grande Municipality. However, according to our research, achieving this partnership may be difficult as the average willingness of the community groups these entities are a part of (industry and municipality government) is “Somewhat Likely”.

In addition to infrastructure improvement, the ideal Río Espiritu Santo Watershed Council should focus on empowering community members to oppose the disregard for environmental regulations in the area. According to our results in Section 4.5.3, there appear to be certain organizations or individuals that ignore these regulations in order to perform construction near the banks of the Río Espiritu Santo. According to the data from our stakeholder interviews, these individuals are not reprimanded for their actions because the current method of enforcement is inefficient. Several individuals suggested that the Río Espiritu Santo Watershed Council should focus on increasing the enforcement of these regulations. For example, the council could work towards the establishment of a buffer zone around the banks of the river that would prevent construction within a set distance of the river. This project would have to be done in conjunction with the Puerto Rican Government which based on the research in Section 4.4.3 may be possible due to the fact that the “State Government” community group had an average willingness rating of “Somewhat Willing”.

According to our research, the ideal Río Espiritu Santo Watershed council should implement clean-up programs that remove trash and other debris from the landscape, such as a river clean-up day. This activity could be similar to the forest clean-up day held by the U.S. Forest Service in El Yunque. Community members from around the island could visit the river and help the council remove trash from the banks, with a potential prize for the individual or group that removes the most trash by weight. This activity could also be tied into community

development activities such as a community barbeque gathering or educational programs. According to our research in Section 4.3, there is a direct relationship between time spent on restoration/action activities and overall effectiveness. Therefore, by spending a lot of time on activities like clean-up days, the council can potentially increase its effectiveness.

Another activity the ideal watershed council should focus on is education. According to our research in Section 4.4.1, the community is “Somewhat Willing” to attend educational events hosted by the council. In terms of education, there are many different topics that the council could focus on. According to the results discussed in Section 4.4.4, in order to attract as many individuals as possible, these topics should cover a wide range of areas while still retaining an environmental focus. These themes could include:

- History of the Río Espiritu Santo
- Importance of the Río Espiritu Santo
- Strategies for everyday sustainability
- Environmental impact of construction
- Environmental regulations
- Benefits of sustainable development

Education could also be conducted through schools in order to educate children on environmental issues. According to individuals interviewed, both the Department of Agriculture and Bahia Beach Resort have well established programs that work with middle and high school students to educate them on ecological preservation strategies. These programs also encourage the students to participate in restoration programs such as the beach clean-up day at the Bahia

Beach Resort. The 4H program, which is designed for youth to be able to solve local issues, also has a strong presence in the area according to one of our sources. Students can apply the knowledge gained through these activities within their families to further educate the community on environmental issues.

In addition to educational events, the ideal Río Espiritu Santo Watershed Council should host a public values forum. According to 11 out of the 16 individuals we interviewed, hosting a public values forum would be an ideal community outreach event. The purpose of this forum will be to gather community input on the environmental issues that members of the community encounter through their daily lives. This forum will be instrumental in developing the agenda and priorities of the council, and will also make the community more involved in the council, as they will now feel that the council is addressing issues that the community feels are important. In order to gather community support from the very beginning of the council, it is recommended that this forum be one of the first activities sponsored by the Río Espiritu Santo Watershed Council. It is also recommended that this event is well-publicized and significant effort is put into making sure it is attended by many community members.

6.3 Limitations

As with any data analysis, we encountered certain limitations through our data collection and analysis methods. When the effectiveness data from questions 9-13 in our watershed council official survey (see Appendix C: Web-Based Survey to Watershed Council Officials) from the individual respondents are considered, only 7 out of the 185 data points were rated below “Neutrally Effective”. This unusual skewing of the data towards high values is potentially a result of individuals perceiving their council effectiveness as higher than should be

reported. This skewing of the data could also be due to a "self-selection bias", meaning individuals could have been more likely to answer our survey if they had positive responses. If this inflated reporting is the reason why the data are unusual, then the data do not accurately depict the effectiveness of the watershed councils represented. However, if it is assumed this bias is universal, then any statistical tests performed to attempt to correlate these data with other variables are still relevant.

Our community survey was subject to similar types of limitations. Because our contact list was generated from a mailing list developed by the U.S. Forest Service, the individuals that received the survey have previously volunteered their contact information. This fact may imply that these individuals possess a certain inclination towards participating in environmental projects. This implication may mean that our data on the willingness of the community to participate in a watershed council could be skewed upwards.

The main limitation for our data analysis is that in attempting to find relationships between certain variables and watershed council perceived effectiveness, we ran upwards of 84 regression analyses. The large number of regressions performed implies that there is a higher chance that some of the relationships we determined to be statistically significant may be simply a random result.

6.4 Conclusions

The major goal of our project was to assist the U.S. Forest Service in the development of the Río Espiritu Santo Watershed Council. This goal was accomplished by collecting and analyzing data on challenges faced by watershed councils, the different activities these councils

perform, various factors of council effectiveness, and the interest of the Puerto Rican community in a watershed council. These data were collected using a series of surveys and interviews to watershed council officials, initial stakeholders, and the community at large. By analyzing these data, we were able to determine several factors that influence watershed council effectiveness, including budget and the time spent on restoration and conservation activities. Furthermore, we determined the overall willingness of the community of Puerto Rico as well as showed that there is no statistically significant difference between the willingness of individuals to participate based on their municipality or their community group. Using these and other results, we produced a series of deliverables designed to help the initial stakeholders develop and operate the council, culminating in a discussion of the ideal watershed council. Using the information provided in the deliverables, the initial stakeholders should be able to meet and officially establish themselves as the Río Espiritu Santo Watershed Council.

Appendices

Appendix A: Background on Rapid Watershed Assessments

Information Included in a Rapid Watershed Assessment

RWAs are not the most specific or targeted method of gathering data as can be seen in Figure 4, the NRCS "Planning Continuum". RWAs do, however, provide invaluable information in different forms. In general, RWAs contain two major components: a watershed resource profile and an assessment matrix.

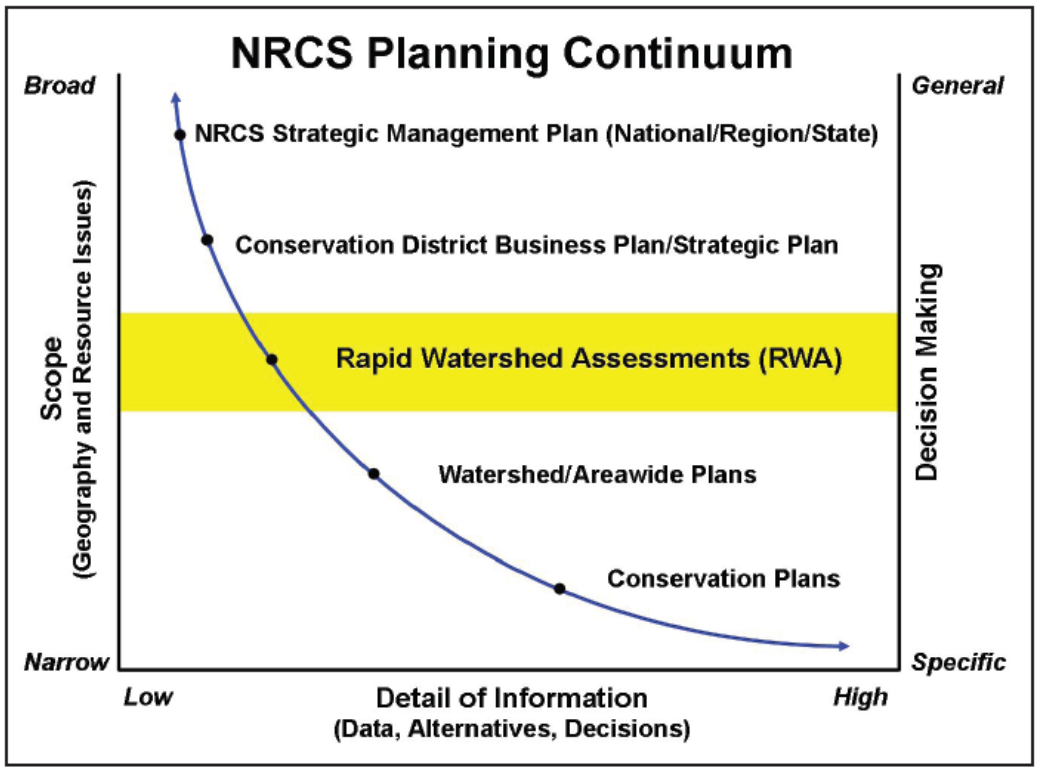

Figure 19: NRCS Planning Continuum - (United States Department of Agriculture, 2007)

A watershed resource profile is a summary of the most readily available data about a watershed and its resources. According to the USDA and NRCS report entitled “Rapid Watershed Assessments”, these data include:

- A general description of the location, size, and political units associated with the watershed,
- Physical description including land use/land cover, precipitation/climate, common resource areas, stream flow data, land capability class, etc.,
- Known resource concerns,
- Census and social data,
- Status and history of resource conservation in the watershed,
- References and data sources (United States Department of Agriculture, 2007).

The second section of a RWA is the Assessment Matrix. This section contains a number of tables that summarize the resource conditions and their related maintenance costs, conservation opportunities, resource concerns, and potential funding sources for conservation implementation. The tables that make up the Assessment Matrix, provided by the USDA and NRCS, are a Current Condition Table, a Future Conditions Table, and a Summary Table. The Current Conditions Table details the current level of conservation activity in the watershed. The Future Conditions Table identifies appropriate conservation practices to deal with primary resource concerns. Finally, the Summary Table summarizes the various costs associated with the resource management systems described in the previous tables (United States Department of Agriculture, 2007).

Benefits of a Rapid Watershed Assessment

RWAs have a number of key benefits. They are a quick, effective, and inexpensive method of gathering information that can then be used in decision making processes. The amount of detail included in a RWA is low enough as to not require the time commitment that more in depth studies require, while still providing a substantial amount of information. Other benefits of RWAs include:

- Provide a preliminary source of information for standard environmental evaluations,
- Determine if there is a need for further detailed analysis or watershed studies,
- Identify if there are infrastructure needs,
- Address multiple concerns and objectives of landowners and communities,
- Enhance established local and state partnerships,
- Enable landowners and communities to decide on the best mix of NRCS programs and other funding sources to meet their resource concerns (United States Department of Agriculture, 2007).

Appendix B: Watershed Official Interview Questions

Thank you for taking the time to speak with us. We are students at Worcester Polytechnic Institute conducting research into the development of a Watershed Council in the Río Espiritu Santo Watershed in Puerto Rico. While your answers to the following questions will help in that endeavor, your answers will always remain confidential. Any information we collect that is identifying in any way will be separated from your answers.

1. In what year was your council founded?
2. What were the major environmental problems that brought your watershed council together?
3. How did the initial stakeholders locate each other and begin working together? If you do not know, do you anyone who does?
4. Is your council a designated 501 (c) (3) non-profit organization?
5. What is your council's annual operating budget?
6. Do you have a council coordinator? If so, is the current council coordinator a hired employee, a contractor, or a volunteer organization?
7. Approximately how long has the current council coordinator served in that position?
8. How many total full time equivalent staff and contract employees currently work for your council?
9. What activities/projects does your Council conduct in your Watershed in each of the following areas?
    a. Restoration
    b. Outreach, Education, Media Production

c. Fundraising

10. What are the sources of funding for your watershed council?

11. How many members serve on your Executive Board and what are the officer titles on that board?

12. What is the makeup of the stakeholders on your watershed council? (i.e. business owners, environmental groups, government individuals, etc.)

13. What are the greatest challenges your council faces in accomplishing its objectives?

14. What are some of the major accomplishments of your watershed council?

15. Do you have any documents (Charter, Business Plan, etc.) that you could share with us to assist in the development of a watershed council?

16. Do you have a website for your watershed council?

17. If so, who is the target audience for your website?

18. What information does your watershed council put on its website? Is that information sufficient?

19. How do other organizations and community members perceive your organization?

Thank you very much for your time. If you are interested in the results of our analysis please contact yunque@wpi.edu.

Appendix C: Web-Based Survey to Watershed Council Officials

Thank you for taking the time to fill out this survey. We are students at Worcester Polytechnic Institute conducting research into the development of a Watershed Council in the Río Espiritu Santo Watershed in Puerto Rico. While your answers to the following questions will help in that endeavor, your answers will always remain confidential. Any information we collect that is identifying in any way will be separated from your answers.

1. What is the name of the watershed council you represent?
2. What is your position on your watershed council?
    a. President/Council Chair
    b. Vice President/Council Vice Chair
    c. Treasurer
    d. Secretary
    e. None
    f. Other (Please Specify
3. Is your council a 501 (c) (3) non-profit organization?
    a. Yes
    b. No
    c. Unsure
4. What is your council‘s annual operating budget?
    a. 0-$50,000
    b. $50,000-$150,000

c. $150,000-$200,000

d. $200,000 $400,000

e. Unsure

5. Which of the following funding sources play a role in supporting your council's operations? Please rank the TOP THREE funding sources with the numbers "1" (top), "2" (second) and "3" (third).

    a. Federal Grants

    b. Foundation support

    c. Major Donors

    d. General Membership

    e. Other (Please Specify)

6. What are the greatest challenges your council faces in accomplishing its objectives? Please rank the TOP THREE funding sources with the numbers "1" (top), "2" (second) and "3" (third).

    a. Funding

    b. Ability to Secure Grants

    c. Community Engagement and Perception

    d. Volunteer Availability

    e. Capacity for administration

    f. Access to technical experts

    g. Lack of strategic plan

    h. Lack of political support (national, state, or local level)

    i. Other (please specify)

7. Approximately what percent of your council’s total staff time is dedicated to the following program areas? Responses must TOTAL 100%

a. Monitoring and Research

b. Restoration and Action

c. Assessment and Planning

d. Outreach and Education

e. Development and fundraising

f. Administration and finances

g. Other (Please Specify)

8. What is the makeup of the participants in your watershed council? Please check all that apply:

a. Private Landowners

b. Local and regional boards, commissions, districts, or agencies

c. Academic, scientific, or professional communities

d. Industry

e. State and federal agencies

f. Public interest groups

g. Other (please specify)

(For questions 9-13) On a scale of 1 to 5 with 1 being "Very Ineffective" and 5 being "Very Effective", please rate the effectiveness of the following items regarding your watershed council:

9. Overall watershed council
10. Conservation and restoration efforts
11. Connection with the community
12. Fundraising efforts
13. Governance Structure

14. How did the initial stakeholders locate each other and begin working together?

15. What are some of the major accomplishments of your Watershed Council?

16. What are the most important environmental issues within your watershed?

Thank you very much for your time. If you are interested in the results of our survey please contact yunque@wpi.edu.

Appendix D: Interview to Initial Stakeholders

English Version:

Thank you for taking the time to speak with us. We are students at Worcester Polytechnic Institute conducting research into the development of a Watershed Council in the Río Espiritu Santo Watershed in Puerto Rico. While your answers to the following questions will help in that endeavor, your answers will always remain confidential. Any information we collect that is identifying in any way will be separated from your answers.

1. How long have you been working with the Forest Service?
2. How did you and the Forest Service begin working together?
3. What is your area of expertise/profession?
4. Describe your role in your organization?
5. What are your major responsibilities?
6. Why do you want to be involved in the Río Espiritu Santo Watershed Council?
7. What role(s) will you be willing to play in this council?
8. What concerns do you have about the current environmental status of El Yunque?
9. What areas for improvement have you observed?
10. What are some accomplishments that you want the watershed council to achieve?
11. How will you measure the success of the watershed council?
12. What sources, if any, can you identify for the funding of the watershed council?
13. If you were to receive unlimited funding for this council, what would you want to see the council accomplish?

14. How much knowledge do you have about watershed councils?

Thank you very much for your time. If you are interested in the results of our analysis please contact yunque@wpi.edu.

Spanish Version:

Gracias por tomarse el tiempo para hablar con nosotros. Somos estudiantes de Worcester Polytechnic Institute que estamos realizando una investigación en el desarrollo de una Asamblea de Cuenca del Río Espíritu Santo en Puerto Rico. Aunque sus respuestas a las siguientes preguntas nos ayudaran en esta tarea, sus respuestas permanecerán confidenciales. Cualquier información que recopilemos y sea de identificación en alguna manera será separada de sus respuestas.

1. ¿Cuánto tiempo ha estado trabajando con el Servicio Forestal?
2. ¿Cómo usted y el Servicio Forestal empezaron a trabajar juntos?
3. ¿Cuál es su área de especialización/profesión?
4. Describa la función que desarrolla en su organización
5. ¿Cuáles son sus responsabilidades principales?
6. ¿Por qué desea participar en esta Asamblea de Cuenca del Río Espíritu Santo?
7. ¿Qué rol (s) estaría usted dispuesto a tomar en esta asamblea?
8. ¿Qué preocupaciones tiene usted acerca del estado actual del medio ambiente de El Yunque?
9. ¿Qué áreas para mejorar ha observado?

10. ¿Cuáles son algunas metas que desea que la Asamblea de Cuenca del Río Espíritu Santo logre?
11. ¿Cómo usted mediría el éxito de la asamblea de Cuenca?
12. ¿Qué fuente, si alguna, puede identificar para la financiación de la asamblea de Cuenca?
13. Si usted recibiría fondos ilimitados para esta asamblea, ¿qué le gustaría ver a la asamblea lograr?
14. ¿Cuánto conocimiento tiene usted acerca de una asamblea de Cuenca?

Muchas gracias por tomar de su tiempo. Si estás interesado en los resultados de nuestro análisis puede contactarnos a Yunque@wpi.edu.

Appendix E: Survey to Puerto Rican Community

English Version:

Thank you for taking the time to fill out this survey. We are students at Worcester Polytechnic Institute conducting research into the development of a Watershed Council in the Río Espiritu Santo Watershed in Puerto Rico. While your answers to the following questions will help in that endeavor, your answers will always remain confidential. Any information we collect that is identifying in any way will be separated from your answers.

1. What environmental issues do you see or recognize in your geographical area?
2. What municipality do you live in?
3. What group of people or organizations do you most identify with?
    a. Academia
    b. NGO
    c. Industry
    d. Federal Government
    e. State Government
    f. Municipality
    g. Other (Please Specify)
4. Do you know what a "Watershed" is?
5. Do you know what a watershed council is?
6. What social media sites do you participate in? Please check all that apply
    a. Facebook

b. Twitter

c. Google+

d. MySpace

e. Blogspot

f. LinkedIn

g. Other (Please specify)

- A watershed is a specifically defined area of land in which all water flows to the same point
- A watershed council is a community driven organization created for the purpose of ecosystem preservation and community education regarding the watershed and its conservation

(For questions 7-14) Using the above information, please rate your likelihood of performing the following actions if a watershed council in the El Yunque area was created, on a scale of "Not Likely" to "Extremely Likely".

7. Visit the watershed council website to learn about restoration and conservation activities in the area
8. Volunteer your time to help in restoration or conservation activities
9. Make a donation to the watershed council *Please note that by responding to this question, you are not committing to making a donation.*
10. Sign up to receive a watershed council newsletter
11. Participate in community meetings of the watershed council
12. Attend educational events held by the watershed council

13. Join the Executive Board of the watershed council
14. Follow the watershed council activities on social media websites (i.e. Facebook, Twitter, etc.)

15. If you are interested in knowing more about watershed and watershed councils or being part of a watershed council in the El Yunque area, please place your contact information below (name, telephone #, email). This information is for the sole purpose of the governance of a new watershed council. Your name WILL NOT be associated with your answers to the questions above.

    - Name:
    - Telephone # :
    - Email Address:

Thank you for your time. If you are interested in the results of our survey, please contact yunque@wpi.edu.

Spanish Version:

Gracias por tomarse el tiempo para llenar esta encuesta. Somos estudiantes de Worcester Polytechnic Institute que estamos realizando una investigación en el desarrollo de una Asamblea de Cuenca del Río Espíritu Santo en Puerto Rico. Aunque sus respuestas a las siguientes preguntas nos ayudaran en esta tarea, sus respuestas permanecerán confidenciales.

Cualquier información que recopilemos y sea de identificación en alguna manera será separada de sus respuestas.

1. ¿Qué problemas (ecológicos, de seguridad, etc.) usted ve en el área de El Yunque?
2. ¿En que municipalidad usted reside?
3. ¿Con que grupo de personas o organizaciones usted se identifica?
    a. Academia
    b. ONG
    c. Industria
    d. Gobierno Federal
    e. Gobierno del Estado
    f. Municipalidad
    g. Otro (Por favor especificar)
4. ¿Sabe usted lo que significa el término “Cuenca”?
5. ¿Sabe usted lo que es una asamblea de cuenca?
6. ¿Cuáles son los medios sociales en los que usted participa? Por favor, marque todas las que apliquen.
    a. Facebook
    b. Twitter
    c. Google+
    d. MySpace
    e. Blogspot

f. LinkedIn

g. Otros (Por favor especificar)

- Una cuenca es un área específicamente definida de la tierra en la que toda el agua fluye hacia el mismo punto.
- Una asamblea de cuenca es una organización impulsada por la comunidad creada con el fin de preservar los ecosistemas y proveer educación para la comunidad con respecto a la cuenca y su conservación.

(Para las preguntas 5-12) Utilizando la información anterior, por favor califique la probabilidad de realizar las siguientes acciones si una asamblea de cuenca en el área de El Yunque fuera creada. En una escala de "improbable" a "extremadamente probable."

7. Visitar la red (website) de la asamblea de cuenca para aprender acerca de la restauración y actividades de conservación en el área.
8. Ofrecer su tiempo de voluntario para ayudar en las actividades de restauración y/o conservación.
9. Hacer una donación a la asamblea de cuenca *Por favor tenga en consideración que al contestar esta pregunta usted no está comprometiéndose a hacer una donación.*
10. Registrarse para recibir un boletín de noticias de la asamblea de cuenca.
11. Participar en las reuniones de la comunidad de la asamblea de cuenca.
12. Atender a los eventos educativos realizados por la asamblea de cuenca.
13. Unirse a la junta directiva de la asamblea de cuenca.

14. Seguir las actividades de la asamblea de cuenca en la red (websites) de medios sociales (Facebook, Twitter, etc.)
15. Si usted está interesado en saber más acerca de las cuencas y las asambleas de cuenca o quiere ser parte de una asamblea de cuenca en el área de El Yunque, por favor, coloque su información de para contactarlo/a. El único propósito de esta información es para la creación de la estructura de la nueva asamblea de cuenca. Su nombre no se asociará con sus respuestas a las preguntas anteriores.
    - Nombre:
    - # Teléfono :
    - Correo electrónico:

Muchas gracias por tomar de su tiempo. Si estás interesado en los resultados de nuestra encuesta puede contactarnos a Yunque@wpi.edu.

Appendix F: Regression Tables from Watershed Council Official Survey[1]

Independent	Dependent	P-value	R^2	Coefficient
Budget	Effectiveness- "Overall"	0.00007	0.3200	+
	Effectiveness- "Conservation/Restoration"	0.0106	0.1984	+
	Effectiveness- "Community Outreach"	0.8702	0.0009	+
	Effectiveness- "Fundraising"	0.9715	0.0000	-
	Effectiveness "Governance Structure"	0.5847	0.0101	+

Table 8: Regression Table for Watershed Council Budget as it Affects Perceived Effectiveness

Independent	Dependent	P-value	R^2	Coefficient
Activities-"Monitoring/Research"	Effectiveness- "Overall"	0.7032	0.0042	-
Activities-"Restoration/Action"		0.0252	0.1352	+
Activities-"Assessment/Planning"		0.1389	0.0615	-
Activities-"Outreach/Education"		0.2735	0.0342	-
Activities-"Development/Fundraising"		0.8392	0.0012	+
Activities-"Administration/Finances"		0.8268	0.0014	+

Table 9: Regression Table for Watershed Council Activities as they Affect Overall Perceived Effectiveness

Independent	Dependent	P-value	R^2	Coefficient
Funding- "Federal Grants"	Effectiveness- "Overall"	0.7879	0.0021	+
Funding- "Foundation Support"		0.8931	0.0005	-
Funding- "Major Donors"		0.1892	0.0487	-
Funding- "General Membership"		0.2372	0.0397	-
Funding- "State Grants"		0.4973	0.0133	+

Table 10: Regression Table for Watershed Council Funding Sources as they Affect Overall Perceived Effectiveness

[1] Significant regressions are marked with shaded row

Independent	Dependent	P-value	R^2	Coefficient
Challenges- "Funding"	Effectiveness-"Overall"	0.4817	0.0142	-
Challenges- "Securing Grants"		0.5362	0.0110	-
Challenges- "Community Outreach/Support"		0.8731	0.0007	+
Challenges- "Volunteer Availability"		0.7422	0.0031	-
Challenges- "Administration Effectiveness"		0.7795	0.0023	+
Challenges- "Access to Technical Experts"		0.7289	0.0035	-
Challenges- "Lack of Strategic Plan"		0.3045	0.0301	-
Challenges- "Lack of Political Support"		0.8445	0.0011	-

Table 11: Regression Table for Watershed Council Challenges as they Affect Overall Perceived Effectiveness

Independent	Dependent	P-value	R^2	Coefficient
Funding- "Federal Grants"	Budget	0.1480	0.0685	+
Funding- "Foundation Support"		0.6659	0.0063	+
Funding- "Major Donors"		0.7421	0.0037	-
Funding- "General Membership"		0.0852	0.0955	-
Funding- "State Grants"		0.8481	0.0012	+

Table 12: Regression Table for Watershed Council Funding Sources as they Affect Watershed Council Budget

Independent	Dependent	P-value	R^2	Coefficient
Challenges- "Funding"	Budget	0.2772	0.0392	+
Challenges- "Securing Grants"		0.5022	0.0151	+
Challenges- Community Outreach/Support		0.1222	0.0778	-
Challenges- "Volunteer Availability"		0.4407	0.0199	-
Challenges- "Administration Effectiveness"		0.5023	0.0151	+
Challenges- "Access to Technical Experts"		0.1811	0.0588	-
Challenges- "Lack of Strategic Plan"		0.8365	0.0014	-
Challenges- "Lack of Political Support"		0.3493	0.0292	-

Table 13: Regression Table for Watershed Council Challenges as they Affect Watershed Council Budget

Independent	Dependent	P-value	R^2	Coefficient
Budget	Activities- "Monitoring/Research"	0.2328	0.0456	+
	Activities- "Restoration/Action"	.0244	0.1531	+
	Activities- "Assessment/Planning"	0.2451	0.0433	-
	Activities- "Outreach/Education"	0.0447	0.1238	-
	Activities-"Development/Fundraising"	0.4331	0.0199	-
	Activities- "Administration/Finances"	0.4763	0.0165	+

Table 14: Regression Table for Watershed Council Budget as it Affects Average Watershed Council Activities

Independent	Dependent	P-value	R^2	Coefficient
Funding- "Federal Grants"	Challenges- "Funding"	0.2184	0.0430	-
Funding- "Foundation Support"		0.3454	0.0255	+
Funding- "Major Donors"		0.2993	0.0307	+
Funding- "General Membership"		0.4393	0.0172	-
Funding- "State Grants"		0.0129	0.1640	+
Funding- "Federal Grants"	Challenges- "Securing Grants"	0.3562	0.0244	+
Funding- "Foundation Support"		0.7630	0.0026	+
Funding- "Major Donors"		0.0812	0.0843	+
Funding- "General Membership"		0.4324	0.0177	-
Funding- "State Grants"		0.9077	0.0004	+

Table 15: Regression Table for Watershed Council Funding Challenges and Securing Grants Challenges as they Affect Watershed Council Funding Sources

Independent	Dependent	P-value	R^2	Coefficient
Funding- "Federal Grants"	Challenges- "Community Outreach/Support"	0.1305	0.0641	-
Funding- "Foundation Support"		0.3417	0.0259	-
Funding- "Major Donors"		0.7846	0.0022	+
Funding- "General Membership"		0.2114	0.0442	+
Funding- "State Grants"		0.9013	0.0004	-
Funding- "Federal Grants"	Challenges- "Volunteer Availability"	0.0963	0.0770	-
Funding- "Foundation Support"		0.7378	0.0032	-
Funding- "Major Donors"		0.2877	0.0322	-
Funding- "General Membership"		0.7998	0.0019	+
Funding- "State Grants"		0.1587	0.0559	-
Funding- "Federal Grants"	Challenges- "Administration Effectiveness"	0.2189	0.0429	+
Funding- "Foundation Support"		0.3298	0.0271	-
Funding- "Major Donors"		0.7190	0.0037	-
Funding- "General Membership"		0.0492	0.1061	+
Funding- "State Grants"		0.8678	0.0008	+

Table 16: Regression Table for Watershed Council Community Outreach/Support Challenges, Volunteer Availability Challenges, and Administration Effectiveness Challenges as they Affect Watershed Council Funding Sources

Independent	Dependent	P-value	R^2	Coefficient
Funding- "Federal Grants"	Challenges- "Access to Technical Experts"	0.9020	0.0004	-
Funding- "Foundation Support"		0.1438	0.0600	-
Funding- "Major Donors"		0.9600	0.0001	-
Funding- "General Membership"		0.7893	0.0021	+
Funding- "State Grants"		1.0000	0.0000	0
Funding- "Federal Grants"	Challenges- "Lack of Strategic Plan"	0.5402	0.0108	+
Funding- "Foundation Support"		0.3157	0.0287	-
Funding- "Major Donors"		0.8971	0.0005	+
Funding- "General Membership"		0.5576	0.0099	+
Funding- "State Grants"		0.7691	0.0025	+
Funding- "Federal Grants"	Challenges- "Lack of Political Support"	0.0491	0.1061	+
Funding- "Foundation Support"		0.7436	0.0031	-
Funding- "Major Donors"		0.4913	0.0136	-
Funding- "General Membership"		0.6098	0.0075	+
Funding- "State Grants"		0.1414	0.0608	-

Table 17: Regression Table for Watershed Council Access to Technical Experts Challenges, Lack of Strategic Plan Challenges, and Lack of Political Support Challenges as they Affect Watershed Council Funding Sources

Rapid Watershed Assessment of the Río Espiritu Santo Watershed

By: Diego Adrianzen, Samuel Naseef, Alexander Verrelli

El Yunque National Forest

U.S. Forest Service

Worcester Polytechnic Institute

March 2013

Assessment

In order to establish the status and trends of the Río Espiritu Santo Watershed, the following procedures were performed:

Identification of Study Area

The area of interest is defined by a geographical intersection of the Río Espiritu Santo Watershed with the boundaries of Barrio Jimenez, where the river originates, and the mouth of the river. The Río Espiritu Santo Watershed contains 67.78 square miles of land. One of the main tributaries of the Río Espiritu Santo is Río Grande. Río Grande and Río Espiritu Santo unite North of PR-3 and then flow into the Atlantic Ocean. The Río Espiritu Santo Watershed will be referred to as the study area in the rest of this Rapid Watershed Assessment Map 1 below shows the study area as the blue shaded area labeled Cuenca Río Espiritu Santo.

Data Gathering and Manipulation

Data was gathered through a variety of methods. Using reports such as the “Espiritu Santo Upper Watershed Level 1 Assessment” and the” Río Espiritu Santo Watershed Reforestation Project Report by the Centro para la Conservacion del Paisaje”, we were able to learn about the ecology of the watershed. We researched the land use of the area using the “Plan Territorial del Municipio de Río Grande” and the “Plan de Usos de Terrenos” reports. Hydrology data was obtained from the United States Geological Survey (USGS) and the Environmental Protection Agency (EPA). Finally, by interviewing residents of the watershed, as well as scientists who conduct research in the area, we were able to identify several key environmental issues within the watershed.

Map 1: Study Area

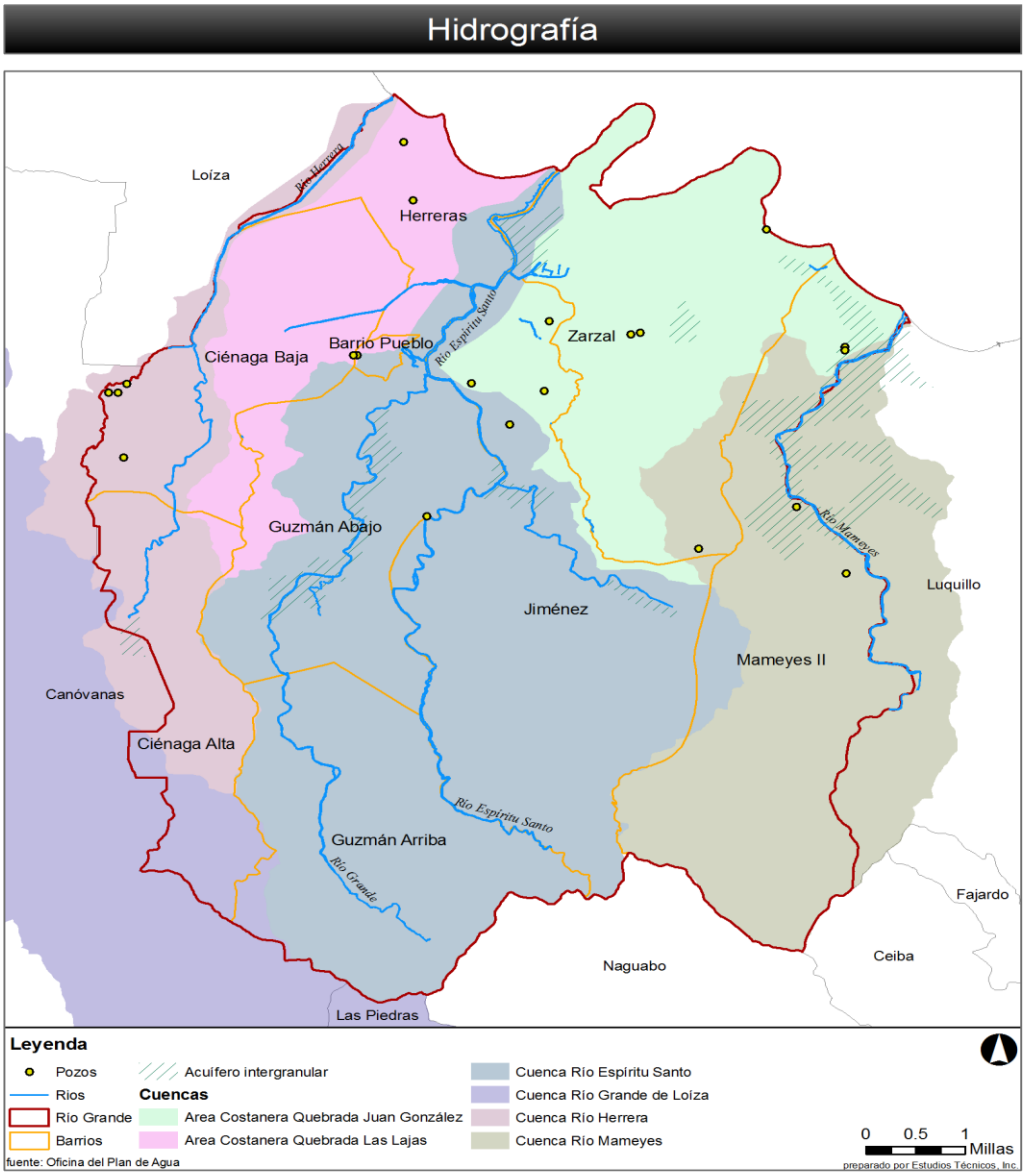

Figure 20: Río Espiritu Santo Watershed – (Municipio Río Grande, 2010)

Ecological Model Development and Analysis

A. Land Use: Land Use data was obtained from Plan Territorial del Municipio de Río Grande, and Plan de Usos de Terrenos. This data was used to show the different types of soils in the Río Grande Municipality as well as identify the different ecological sectors of Río Grande.

B. Hydrology: Hydrology data was obtained from the United States Geological Survey, Environmental Protection Agency, and the Plan Territorial del Municipio de Río Grande . This data was used to determine water quality measurements as well as set up the environmental model of the area.

C. Plant and Animal Species: Espiritu Santo Upper Watershed Level 1 Assessment contained a list of all species residing in the upper area of the Río Espiritu Santo Watershed. This list was adapted for this report.

D. Areas of Concern: Areas of concern were determined by first touring the watershed and identifying the main features along the river. Through interviews with locals of the area as well as scientists who work in the area, a series of problems was identified.

Social Model

A. Population: Population data was obtained from the U.S. Census Bureau. The total population of the Río Grande Municipality according to the 2010 census is 54,304 individuals.

B. Land Use Categories: The land within the Río Espiritu Santo Watershed is used for a variety of purposes. These include forest reserves, forest, natural, high density residential, and low density trade and services.

C. Infrastructure: A large part of the infrastructure within the Río Espiritu Santo is the collection stations for the Associacion de Acueductos y Alcantarillados (AAA). These collection stations can be found mainly in the form of dams scattered throughout the river. With the construction of PR-3 through the Río Grande municipality, additional infrastructure has been added surrounding the Río Espiritu Santo, such as bridges and small businesses.

Results

Land Use

Geographical Framework

The Río Grande Municipality is part of the Río Espiritu Santo Watershed. This municipality has a territory of 157.50 square kilometers. The Río Espiritu Santo is a major watershed with an area of 67.86 square kilometers. As reported in the census of 2000, the population of Río Grande is 52,477 people. Río Grande is composed of nine different neighborhoods: Cienaga Alta, Cienaga Baja, Guzman Abajo, Guzman Arriba, Herreras, Jimenez, Mameyes, Río Grande Pueblo and Zazal. Te following table identifies the classification of soils in the Río Grande Municipality (Municipio Río Grande, 2010).

Classification of Soils in Río Grande				
Soil		Territorial Extension		
Classification	Definition	Km^2	Cuerdas	Proportion
Urban Soil	Lands that have the necessary infrastructure for the activities that are performed in these areas and that are comprised in areas consolidated by the buildings	9.64	2,453.00	6.1%
Urban Soil Road	Land space used as primary and secondary roads	5.01	1,275.71	3.2%
Developable Soil	Land that could be developable based on the necessity to accommodate the urban growth of the municipality in 8 years. This classification has two categories: Programmed Developable Soil and Not Programmed Developable Soil	0.88	223.51	0.6%
Rustic Soil	Land that needs to be protected of the urbanization process for its agricultural value, livestock, natural, recreational areas for being risk areas for security and the public health. Also for not being needed to meet the expectations of urban growth in 8 years. This includes the categories of common rustic soil and protected rustic soil.	141.96	36,117.81	90.1%
Total		157.50	40,070.03	100.0%

Table 18: Classification of Soils in Río Grande - (Municipio Río Grande, 2010)

Agricultural Areas

In 2007, the Río Grande municipality had 78 farms which is a loss of 155 acres (22%) from 2002 when there were 100 farms in the municipality. It is important to notice that municipalities such as Luquillo and Naguabo had increases in the number of farms of 100% and 31% respectively. This shows that the lands in Río Grande, which had previously been used for agriculture, are now being utilized for the development of urban infrastructure. This permanent

change in the way this soil is used has caused many neighboring lands to be affected. These changes have also restricted the opportunity for expansion of agricultural development in the area (Oficina de Gobernador Gobierno Puerto Rico, 2011).

Río Espiritu Santo Natural Reserve

The Natural Reserve of the Río Espiritu Santo is located in the Río Grande municipality inside the watershed of Río Espiritu Santo, and occupies an area of approximately 19.8 square kilometers. From these, 10.1 square kilometers are part of the maritime area, 3.71 square kilometers constitute the lands of Punta Picua and 6 square kilometers comprise the Río Espiritu Santo.

The area has a great value as a habitat for 15 coral species, 14 crab species, 58 bird species, as well as the 60 species that are in the Río Espiritu Santo. The major types of plants that grow in the area are hydrophytes which are plants that can tolerate the conditions of flooded lands (Oficina de Gobernador Gobierno Puerto Rico, 2011).

Agricultural Areas

The following graph shows some municipalities, including the Río Grande municipality which contains the Río Espiritu Santo. The purpose of this table is to portray the different uses of the land in each municipality. In the table we see that about half of the Río Grande municipality is taken up by the El Yunque National Forest. The Río Espiritu Santo flows north starting in Barrio Jimenez, which is located in El Yunque. After the river flows out of forest land, it reaches a high density residential area that contains other public and recreation sections (Oficina de Gobernador Gobierno Puerto Rico, 2011).

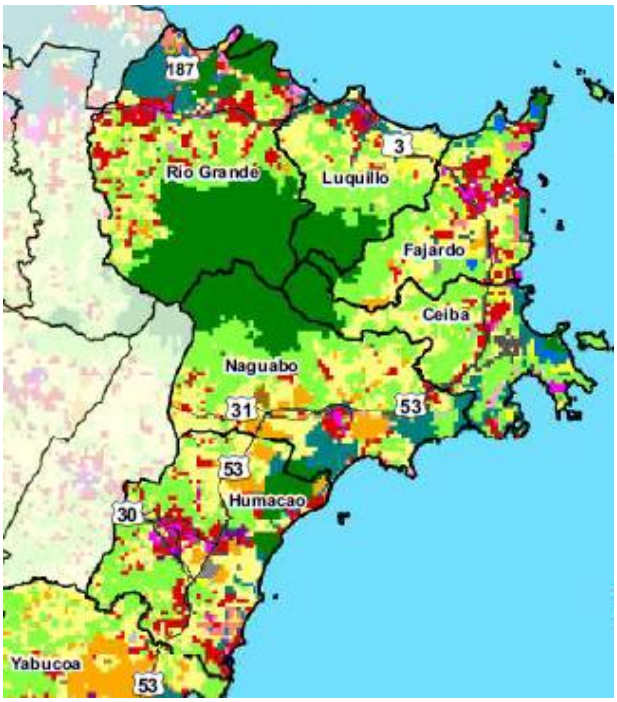

Figure 21: Municipality Land Use - (Oficina de Gobernador Gobierno Puerto Rico, 2011)

Hydrology

There are four main rivers that originate in the mountains of the Río Grande Municipality. These rivers are: Río Herrera, Río Grande, Río Espiritu Santo and Río Mameyes.

Rio Espiritu Santo which flows through Río Grande and originates in Barrio Jimenez starts at an elevation of approximately 740 meters above sea level. This river then flows for about 19.2 km through the Río Grande municipality, until reaching the Atlantic Ocean. The Río Espiritu Santo Watershed, within which the river flows, has an area of 67.78 square miles.

Data from the Environmental Quality Board (JCA) points out that the Río Espiritu Santo Watershed does not fulfill several parameters of water quality, namely surfactants, fecal

coliform and turbidity. Pollution sources identified in the Río Espiritu Santo are: communities without wastewater systems, confined animal companies, and glitches in the system of collection. However, this river meets the standards for secondary contact recreation and as a source for drinking water. To achieve compliance with the standards of primary contact and the preservation and propagation of wildlife, it was considered necessary to develop and implement standards for Total Maximum Daily Load in all these parameters. This river has sections that are considered navigable in the mouth and estuary, covering 368.51 acres. According to JCA, possible sources of contamination of the estuary are communities with no municipal sewer systems (Municipio Río Grande, 2010).

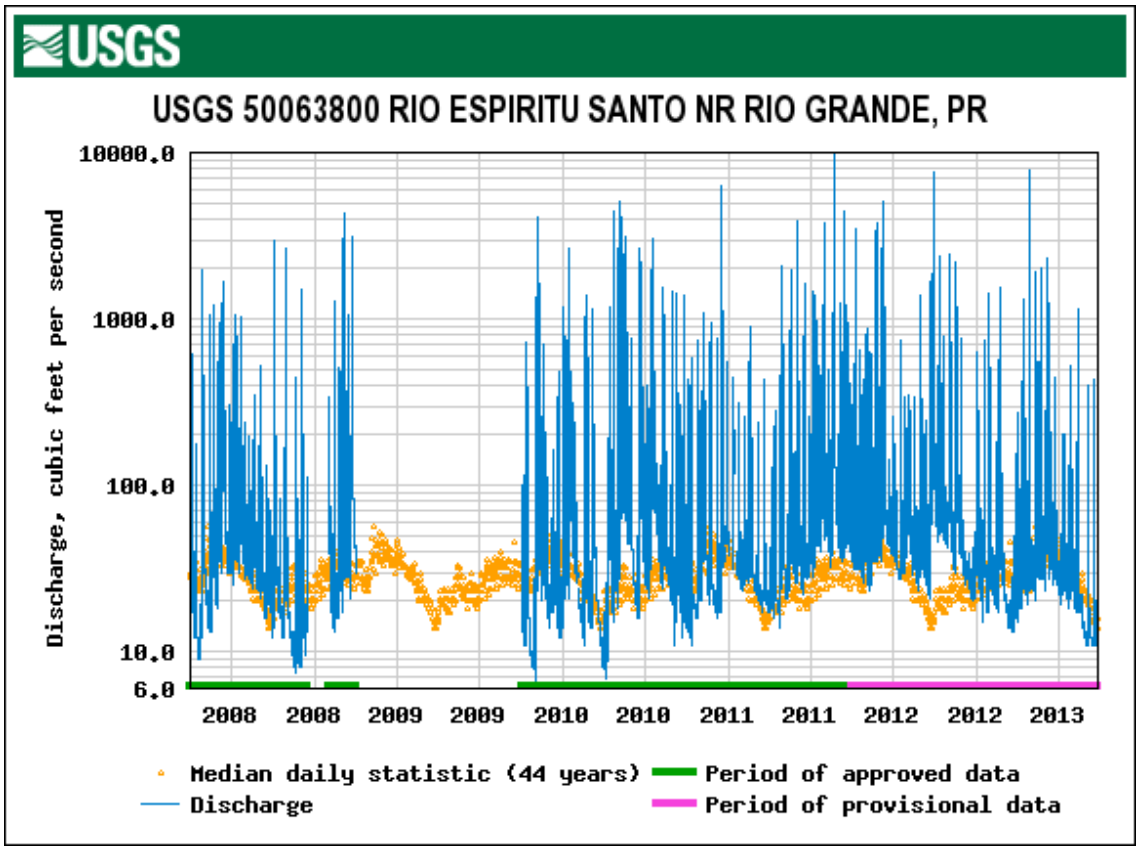

Figure 22: USGS Data showing discharge of the Río Espiritu Santo from 2008-Present - (United States Geological Survey, 2013a)

Water Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Discharge, Cubic ft. per second	51.6	49.3	69	66	76.6	43.7	51.8	37.3	42.4	52.7	41	50.7	98.6	54.2

Water Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Discharge, Cubic ft. per second	67.7	64.6	52.1	49.5	68.8	62.6	66.4	74.6	81	70.2	45.8	47.2	52	21.6

Water Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010
Discharge, Cubic ft. per second	61.3	71.3	76.7	75.2	83.8	38.3	60.5	45.4	84.2	66.9	63.3	40.3	56.8	83

Table 19: USGS Data on annual average discharge of the Río Espiritu Santo - (United States Geological Survey, 2013a)

Datetime	Water Temperature	Instantaneous Discharge	Dissolved Oxygen	pH, water, unfltrd field	Ammonia water, unfltrd	Phosphorus,water, unfltrd	Total coliform, M-Endo, immed	Fecal coliform,M-FC 0.7u MF
	deg C	ft3/s	mg/L	units	as N	as P	100 mL	100 mL
3/15/2005 12:35	25.1	12	8.1	7.6	0.02	0.01	320	60
5/17/2005 12:20	23.9	111	8.6	6.7	0.04	0.03	514	800
7/18/2005 11:50	28.1		7.3	6.6			3200	880
8/24/2005 11:51	25.6	29	7.2	7.6	0.04	0.01		4400
11/15/2005 12:10	24.5	67	8.5	7.1	0.04	0.05	80	60
2/9/2006 11:30	22.2	42	9.1	7.5	0.04	0.01	720	160
5/16/2006 9:05	25.8	22	8.7	8	0.02	0.020	2030	950
8/16/2006 15:45	27.7	87	7.9	7.6	0.04	0.020	5800	640
11/13/2006 14:55	24.9	30	8.3	7.5	0.04	0.013	2400	3400
2/1/2007 12:00	23	17	8.4	8.2	0.02	0.007	1160	99
5/3/2007 9:15	22.9	83	8.9	7.2	0.03	0.011	3000	580
8/8/2007 12:05	25.6	82	8.3	7.3	0.02	0.027	8820	3200
1/29/2008 9:30	21.2	41	9.3	7.5	0.04	0.009	860	750
3/3/2008 14:45	22.9	163	8.9	7.2	0.04	0.092	80000	3400
5/14/2008 8:45	25.3	10	8.2	7.7	0.04	0.009	2230	1200
8/6/2008 12:50	28.6	26	7.6	7.6	0.04	0.01	630	140
11/13/2008 10:45	23.6	106	8.2	7.5	0.04	0.064	21000	5600
2/10/2009 13:30	23.2	50	9	7.8	0.04	0.019	3800	1200
5/27/2009 10:30	25.2	39	8.5	7.8	0.04	0.007	1400	300
8/13/2009 11:15	24.8	288	8.5	7.4	0.04	0.03	21000	2100
12/4/2009 9:35	23.9	20	8.6	7.9	0.04	0.008	2900	430
3/11/2010 14:30	23	150	8.7	7.6	0.02	0.132	78000	46000
3/22/2010 9:00	24.1	25	8.5	7.9	0.04	0.008	1000	150
5/26/2010 12:30	25.6	62	8.4	7.7	0.04	0.013	4600	500
8/20/2010 8:35	25.5	32	8.4	7.3	0.04	0.008	2700	270
12/2/2010 13:20	23.1	19	9.6	8.2	0.02	0.006	1200	230
2/23/2011 9:40	20.9	35	9.3	7.7	0.02	0.008	1200	170
5/27/2011 8:00	24.9	30	8.5	7.7	0.02	0.007	2200	130
8/24/2011 9:45	23.6	431	8.7	6.7	0.03	0.055	7700	470
11/10/2011 8:00	23.5	33	8.6	7.5	0.02	0.023	2500	410
2/21/2012 9:15	21.3	26	9.2	7.6	0.02	0.007	1200	220
5/16/2012 10:45	26.1	40	8.7	7.7	0.02	0.007		
8/16/2012 14:15	28.7	46	8.2	7.9	0.02	0.022	5900	2000
11/28/2012 9:30	23.3	31	8.8	7.3	0.02	0.011	1600	270
AVERAGE	24.45882353	69.24242424	8.520588235	7.532352941	0.02125	0.023322581	6156.814815	2671.392857

Table 20: USGS and EPA data on Water Quality of the Río Espiritu Santo - (United States Geological Survey, 2010)

Species

The Río Espiritu Santo Watershed contains a wealth of biodiversity in its animal species. These species include both aquatic and terrestrial animals, some of which are considered indicator species for El Yunque. Table 4 through Table 8, taken from the "Espiritu Santo Upper Watershed Level 1 Assessment" outline the numerous species of fauna found in the Río Espiritu Santo Watershed (El Yunque National Forest & US Forest Service, 2011).

	Scientific Name	Common Name
1	*Amazona vittata*	Puerto Rican Parrot
2	*Accipiter striatus striatus*	Sharp-shinned Hawk
3	*Buteo playpterus brunnescens*	Broad-winged Hawk
4	*Dendroica angelae*	Elfin woods Warbler
5	*Dendroica caerulescens*	Black-throated blue Warbler
6	*Anolis gundlachi*	Yellow-bearded Anole
7	*Eleutherodactylus hedricki*	Tree-hole Coquí
8	*Eleutherodactylus locustus*	Warty Coquí
9	*Eleutherodactylus unicolor*	Burrow Coquí
10	*Sicydium plumieri*	Goby
11	*Agonostomus monticola*	Mountain mullet
12	*Macrobrachium carcinus*	Freshwater river shrimp
13	*Stenoderma rufun*	Native Fruit Eating Bat

Table 21: Indicator Species - (El Yunque National Forest & US Forest Service, 2011)

Aquatic Species		
Scientific Name	**Common Name**	**Source**
Shrimps		
Atya innocuous	GataChica, Chágara	Kwak et al. 2007
Atya lanipes	Chágara Giradora	Kwak et al. 2007 Species List Upper Espiritu Santo Watershed
Atya Scabra	Guábara	Species List Upper Espiritu Santo Watershed
Macrobrachium carcinus	Camarón Viejo	Kwak et al. 2007 Species List Upper Espiritu Santo Watershed
Macrobrachium heterochirus	Camarón tigre	Kwak et al. 2007 Species List Upper Espiritu Santo Watershed
Macrobrachium faustinum	Coyuntero	Species List Upper Espiritu Santo Watershed
Xiphocaris elongate	Chiripi, salpiche	Kwak et al. 2007 Species List Upper Espiritu Santo Watershed
Crab		
Epilobocerasi nuatifrons	Buruquena	Kwak et al. 2007 Species List Upper Espiritu Santo Watershed

Table 22: Aquatic Species - (El Yunque National Forest & US Forest Service, 2011)

Other Fauna reported in the study area	
Class Reptilia	
Scientific Name	**Common Name**
Trachemys stejnegeri stejnegeri	Jicotea
Anolis evermani	Puerto Rican emerald anole
Anolis krugi	Upland Grass Anole, Olive Bush
Anolis gundlachi	Yellow-chinned Anole
Alsophis portoricensis	Puerto Rican Racer
Class Amphibia	
Rana catesbeiana	American Bullfrog
Bufo marinus	Cane Toad, Marine Toad
Eleutherodactylus coqui	Coquí Común
Filum Mollusca	
Neritina (Vitta) virginea	Neritina
Tarebia (Thiara) granifera	Thiaridsnail
Caracolus (Pleurodonte) caracolla	
Caracolus (Pleurodonte) marginella	Marginella Caracolus Snail
Nenia tridens	
Polydontes (Parthena) acutangula	Yellow Land Snail, Acute-angled Polydontes
Gaeotisni grolineata	Puerto Rican Green Ear-snail
Platysuccinea portoricensis	
Polydontes (Granodomus) lima	Raspy Nipple Snail
Veronicella portoricensis	Sietecueros, Babosa
Phylum Arthropoda Suborder Myriapoda	
Scolopendras sp	Canopies, Alarcon
Anadenobolus (Orthocricus) arboreus	Gongolí arboreo
Class Arachnidan	
Deinopis lamia	
Leucage regnyi	Silver Spider
Cyrtopholis portoricae	Greater Puerto Rican Tarantula
Gasteracantha cancriformis	Spiny-backed orb weaver, crab spider
Phrynus longipes	Whip spider

Table 23: Other Fauna Reported in Río Espiritu Santo Watershed - (El Yunque National Forest & US Forest Service, 2011)

Forest interior birds	
Scientific Name	**Common Name**
Vereo altiloquus	Black-whiskered vireo
Patagioenas squamosa	Scaly-naped pigeon
Coereba flaveola	Bananaquit
Tiaris bicolor	Black-faced grassquit
Surothera vieilloti	Lizard cuckoo
Zenaida aurita	Zenaida dove
Spinalis portoricensis	Puerto Rican spindalis
Chlorostilbon maugaeus	Puerto Rican emerald
Turdus plumbeus	Red-legged thrush
Patagioenas leucocephala	White-crowned pigeon
Megascops nudipes	Puerto Rican screech-owl
Loxigilla portoricensis	Puerto Rican Bullfinch
Margarops fuscatus	Pearly-eyed thrasher
Myiarchus antillarum	Puerto Rican flycatcher
Petrochelidon fulva	Cave swallow
Amazona vittata	Puerto Rican parrot

Table 24: Forest Interior Birds - (El Yunque National Forest & US Forest Service, 2011)

Scientific Name	Common Name	Location
Noctilio leporinus	Murcielago Pescador	Loiza
Pteronotus parnellii	Murcielago Bigotudo Mayor	Rio Grande / El Verde Field Station
Eptesicus fuscus	Murcielago Ali-oscuro	Rio Grande / El Verde Field Station
Erophylla sezekorni	Murcielago de las Flores	Rio Grande / El Verde Field Station
Lasiurus borealis	Murcielago rabi-peludo	Rio Grande / El Verde Field Station
Monophyllus redmani	Murcielago Lenguilargo	Rio Grande / El Verde Field Station
Pteronotus quadridens	Murcielago Bigotudo Menor	Rio Grande / El Verde Field Station
Stenoderma rufun	Murcielago Frutero Nativo	Rio Grande / El Verde Field Station
Brachyphylla cavernarum	Murcielago Hocico de Cerdo	Rio Grande / El Verde Field Station
Artibeus jamaicensis	Murcielago Frutero Comun	Rio Grande / El Verde Field Station
Molossus molossus	Murcielago de Techos	Luquillo

Table 25: Bat Species - (El Yunque National Forest & US Forest Service, 2011)

Habitat Status and Trends

The Río Espiritu Santo Watershed is divided into two distinct sections, the upper watershed and the lower watershed. The upper watershed consists of land that is owned by the U.S. Forest Service and considered part of the El Yunque National Forest, while the lower watershed consists of the land beyond the limits of the forest, also known as “off-forest land”. These two sections, although both part of the Río Espiritu Santo Watershed, are subjected to different conditions and warrant separate concern.

The upper basin of the Río Espiritu Santo Watershed appears to be in a relatively constant and healthy condition. Its status as part of the El Yunque National Forest means that the U.S. Forest Service manages this section of land, ensuring the stability of the region. The main area of concern within the Río Espiritu Santo Watershed lies with the off-forest land. This area includes urban development and industry surrounding Puerto Rico Highway 3 (PR-3), as well as residential areas, pastures, and floodplains. The watershed ends at the northern coast of the island, at the mouth of the Río Espiritu Santo. As shown in Figure 4, taken from Google Earth, there are two beachfront resorts, The St Regis Bahia Beach Resort and The Gran Meliá Golf Resort Puerto Rico, which occupy the coast surrounding the mouth of the Río Espiritu Santo (Google Inc., 2009).

Figure 23: Mouth of the Río Espiritu Santo - (Google Inc., 2009)

There are a number of concerns within the Río Espiritu Santo Watershed, mostly regarding the lower basin. These issues are mainly focusing around the pressure of urban development isolating the forest and the ever present threat of invasive species (El Yunque National Forest & US Forest Service, 2011). It also appears that there is a general lack of respect for the environment from the community at large. The banks of the Río Espiritu Santo, specifically where it is crossed by PR-3, are littered with garbage and other, larger refuse can be found in the river itself.

The community of the Río Espiritu Santo Watershed, along with other invested individuals, has conveyed several problems in the area, including poaching, erosion, and the environmental mentality of the neighboring resorts. In the Río Espiritu Santo, fish poaching is a serious issue, and has almost removed the fish population from the river entirely. The lack of a healthy fish population severely diminishes the health of the river, along with its overall value as a public natural reserve for recreationalists and tourists. Erosion is also an extremely serious issue in the Río Espiritu Santo, and the excess sediment produced in the river is a threat to the

adjacent coral reef. This erosion has multiple causes, including the cattle inhabiting the pastures and floodplains surrounding the river. These livestock, when they drink from the river, loosen the soil on the banks of the river. This sediment is then washed down the river and expelled into the ocean, which suffocates the coral reef at the estuary of the river. The most important issue expressed by the community in the health of the natural reserve of the Río Espiritu Santo is the impact of the two resorts located at the mouth of the river. These resorts need to be environmentally conscious of their impact on the Río Espiritu Santo, as well as on the rest of the natural reserve.

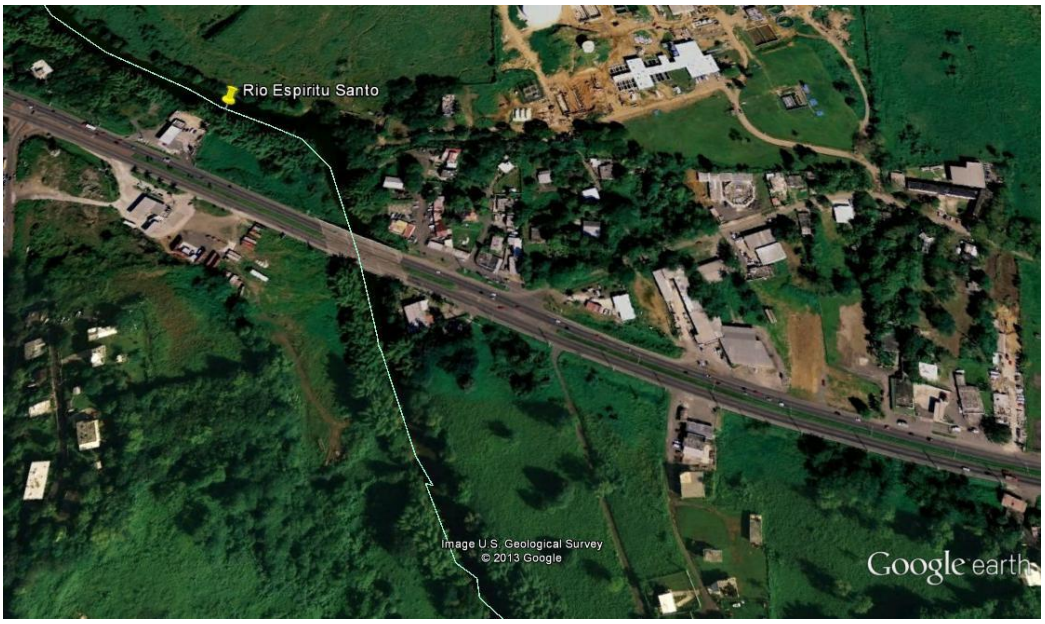

Figure 24: PR-3 Crossing the Río Espiritu Santo - (Google Inc., 2009)

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Appendix H: Project Poster

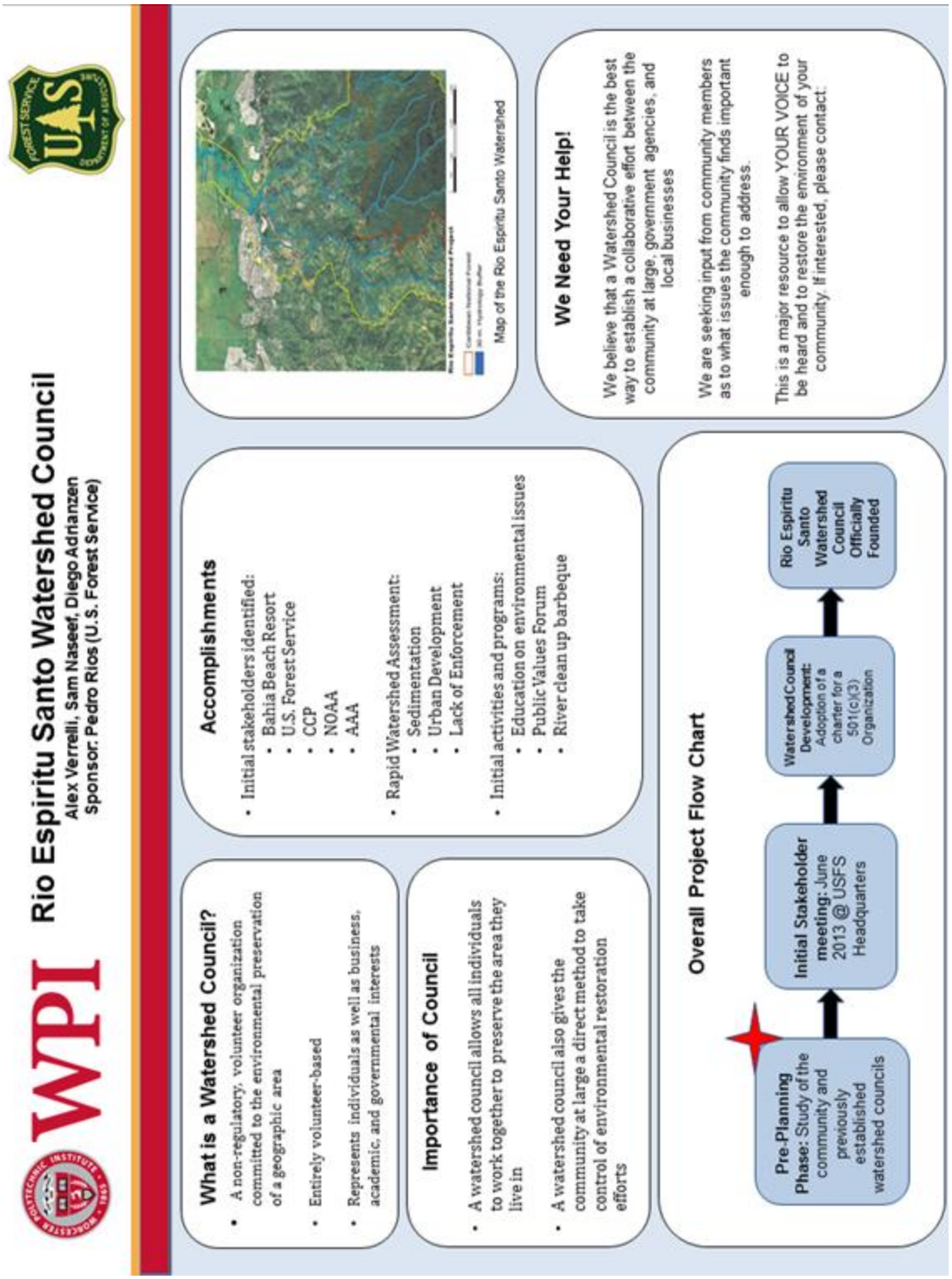


Figure 25: Project Poster

Appendix I: Draft of Watershed Council Charter

The Charter of the

Río Espiritu Santo Watershed Council

Prepared by students of Worcester Polytechnic Institute through an Interactive Qualifying Project from March 9th to May 3rd, 2013

Submitted to the United States Forest Service upon completion of project on May 3rd, 2013

Article I. Mission Statement

The Río Espiritu Santo Watershed Council is committed to the protection, restoration and enhancement of the health of the Río Espiritu Santo Watershed in accordance with all applicable laws and regulations.

Article II. Geographic Area Description

The geographic area managed by the Río Espiritu Santo Watershed Council consists of both the upper on-forest land and lower off-forest land sections of the Río Espiritu Santo Watershed.

Article III. Purpose

The Río Espiritu Santo Watershed Council will provide opportunities for any individual invested in the Río Espiritu Santo Watershed to cooperate in promoting the health of the watershed and educating the community in its economic and social benefits.

Article IV. Vision

A healthy and sustainable watershed that ensures high water quality and remains a natural habitat for wildlife and plants while recognizing the needs of the community it serves.

Article V. Objectives

1. To educate members of the community on environmental issues and strategies for sustainability
2. To facilitate community involvement in the actions of the council
3. To seek input from the community on environmental issues of the Río Espiritu Santo watershed
4. To measure and improve the water quality of the Río Espiritu Santo
5. To preserve the habitats of the various plants and animals that reside within the watershed
6. To ensure the enforcement of environmental regulations as they apply to both individuals and business interests
7. To evaluate and improve the environmental impact of water sequestration infrastructure

Article VI. Organization

Executive Board

- Size of the Executive Board- Could be anything, 10-12 is recommended
- Positions on the Executive Board- **President**, **Vice President**, **Secretary**, **Treasurer**, PR Chair, Technical Chair, Past President, Events Chair, Recruitment Chair, Education Chair, Executive Director (only if paid staff are hired)
- Duties of the Officers
- Term Length- Could be 1-3 years, 2 years is recommended
- Method of Election- Majority vote of those present at specified meeting (See Article IX for procedure)
- Filling an Open Position- If a position is left open, it can be filled by a majority vote at the next council meeting (See Article IX for election procedures)

Committees

List of Possible Committees:

- **Recruitment Committee**- Run by the Recruitment Chair. Designed to seek out new members for the council
- **Education Committee**- Run by the Education Chair. Designed to organize and run all educational programs and events as well as determine curriculum of events. May also apply to internal education.

- **Technical Committee**- Run by the Technical Chair. Designed to create and review technical documents and projects for the council
- **Events Committee**- Run by the Events Chair. Designed to organize and host all events put on by the council.
- **Specific Event Committee**- A committee designed to organize and host a single large, annual event. May be more than 1 committee for multiple events
- **Community Outreach Committee**- Run by the PR Chair. Designed to involve the community in council and keep public informed of council activity

Article VII. Membership

There are three (3) levels of membership: General Public, Active Members, and Executive Board

The General Public will be allowed to attend meetings, be allowed to make comments during the Public Forum sessions during meetings (See Article VIII), but will NOT have a vote for Executive Board officers or in Executive Board Decisions

Active Members will be allowed to attend meetings, be allowed to make comments during the Public Forum sessions during meetings (See Article VIII), will have a vote for Executive Board officers, but will NOT have a vote in Executive Board decisions

The Executive Board will be required to attend meetings, and will have a vote for Executive Board officers or in Executive Board Decisions

To be eligible to receive "Active Member" status, an individual must be a participating member of at least one committee. To be eligible for a committee, an individual must have attended at least two (2) meetings and have the approval of the Committee Chair

To be eligible to participate in Executive Board elections, an individual must have "Active Member" status

Although it is NOT SUGGESTED, some councils charge membership dues as a part of fundraising. However, our research has shown that people are less likely to get involved if they have to pay dues and councils that rely on dues for funding are not as effective. Charging membership dues IS NOT RECOMMENDED, but is an option

Article VIII. Meetings

Meetings should follow Robert's Rules of Order

- **Meeting Times:** Watershed Council should define a set meeting time at the first meeting. If a regular meeting time cannot be established, focus on establishing a meeting frequency and schedule meetings well in advance.
- **Meeting Locations:** Meeting locations could rotate based on availability. Recommended locations include:
    - Churches
    - Community Centers
    - Catalina Service Center
- **Frequency of Meetings:** Important to establish meeting frequency. Frequency could be weekly, biweekly, monthly
- **Attendance Requirements:** Attendance requirements vary by membership status (Please see Article VII)
- **Meeting Structure:**
    - Call Meeting to Order
    - Reports
        - President
        - Vice President
        - Treasurer
        - Secretary
        - Committee Leaders
    - Public Forum for "General Public" and "Active Members" (20 minutes minimum is recommended)
    - Old Business
    - New Business
    - Close Meeting

Article IX. Decisions

All Executive Board decisions will be voted on solely by the Executive Board. Robert's Rules of Order should be followed for all voting procedures

Executive Board elections will be voted on by both the Executive board and the Active Membership. Robert's Rules of Order should be followed for all election procedures.

Council needs to define a quorum for itself. A quorum must be achieved in order to vote on any action. For Executive Board votes, a 2/3 quorum is recommended. For Active Membership and Executive Board votes, a majority quorum is recommended

Article X. Amendments

Section 1: The Council must define specific rules for the amendment of this charter after its adoption. It is recommended that a 2/3 vote of Executive Board Members be required to pass an amendment.

An alternate method requires two rounds of voting. The first is to approve the motion of making a change to the charter and requires a majority vote. The second is to approve the specific amendment and requires a 2/3 vote.

Section 2: The executive board shall review the Charter at the conclusion of each year to ensure that the Charter still represents the purpose and reflects the values of the Río Espiritu Santo Watershed Council.

Appendix J: Restoration and Community Development Assessment

Restoration and Community Development Assessment for the Río Espiritu Santo Watershed Council

By: Diego Adrianzen, Samuel Naseef, Alexander Verrelli

El Yunque National Forest

U.S. Forest Service

Worcester Polytechnic Institute

May 2013

Purpose

The purpose of this document is to provide the Río Espiritu Santo Watershed Council a list of potential Restoration and Community Development activities that could be conducted once the council is established. These activities were developed from ideas suggested by community members, as well as initial stakeholders. These ideas are supplemented by a list of potential contacts that have either expressed interest in the Río Espiritu Santo Watershed Council or were recommended as a critical contact by potential stakeholders.

In order to achieve their goal of environmental restoration and conservation, the Río Espiritu Santo Watershed Council must conduct multiple activities focused on restoration. Using information provided by scientists in the area, potential stakeholders, and a survey to the community, a list of possible restoration activities was created. It is important to note, however, that these activities are only based on issues identified by individuals who are already focused on environmental conservation. In order to gain a full understanding of the environmental issues within the watershed, the Río Espiritu Santo Watershed Council must seek the input of the community at large.

In order to empower the individuals of a community and provide them with the skills required to be able to positively affect the environment, it is necessary to conduct activities designed for community development. In order to receive community support for environmental conservation, the initial stakeholders must be able to work with the community to develop a set of goals that is in line with the values of the community. This can be accomplished by allowing the community to voice their concerns about the environment and incorporating those ideas into the agenda of the council. This document will provide specific

methods to get the community involved as well as specific activities for community development. By implementing these ideas, the Río Espiritu Santo Watershed Council will be able to successfully receive community support for any project they decide to undertake.

Recommended Restoration Activities

Using data obtained from a survey to the community and interviews with potential stakeholders, some specific restoration activities were identified. These activities were divided into three major categories: Improvement of Infrastructure, Increasing Regulation Enforcement, and Clean-Up Activities. By improving infrastructure within or around the river, the council can drastically reduce pollution and erosion within the river, as well as improve water quality. Also, by increasing the enforcement of environmental regulations, the damage to the watershed currently being caused by violations of these regulations will be abated. Finally, the purposes of clean-up activities are to improve the aesthetic and environmental quality of the landscape while also involving the community.

Improvement of Infrastructure

In order to improve the infrastructure of the river, the council will need the support of the agencies that maintain the infrastructure, such as Autoridad de Acueductos y Alcantarillados and the Río Grande Municipality. One potential activity for infrastructure improvement is the creation of green bridges that would allow wildlife to safely cross major roadways, such as PR-191 and PR-3. Another suggestion is to implement a subterranean water withdrawal system similar to that on the Río Mameyes that will decrease the impact of dams on wildlife. The dams that currently block migration of native fish and shrimp and by implementing an underground system, some of these dams could be removed.

Increasing Regulation Enforcement

Currently, there are a series of regulations in place that are designed to protect the watershed from unnecessary litter or destruction. However, there are certain organizations or individuals that ignore these regulations in order to perform construction near the banks of the Río Espiritu Santo. The main issue with this is that these individuals are not reprimanded for their actions because the current method of enforcement is inefficient. Several individuals suggested that the Río Espiritu Santo Watershed Council should focus on increasing the enforcement of these regulations. For example, the council could work towards the establishment of a buffer zone around the banks of the river that would prevent construction within a set distance of the river. However, this process would be long and would require major political support.

Clean-Up Activities

One of the simplest methods for environmental conservation is the implementation of clean-up programs that remove trash and other debris from the landscape. In terms of the Río Espiritu Santo Watershed Council, one of the major suggestions from the community and stakeholders was the creation of a River Clean-Up Day. This activity could be similar to the Forest Clean-Up Day held by the U.S. Forest Service in El Yunque. Community members from around the island could visit the river and help the council remove trash from the banks, with a potential prize for the individual or group that removes the most trash by weight. This activity could also be tied into community development activities such as a community barbeque gathering or educational programs.

Other Restoration Activities

In addition to the three major categories described above, there were a few activities that were suggested that should be reported. The first is the potential establishment of a place in the El Portal Visitor Center within El Yunque where visitors can report potential environmental issues as well as suggest possible restoration activities. This may take some of the burden off of the council to continually develop new ideas. It was also suggested that council should establish a program or activity that involves the planting of trees within the watershed in order to further reforestation efforts.

Recommended Community Development Activities

The major purpose of hosting community development activities is to keep the community involved in the watershed council and to be able to inform them about the progress and successes of council activities. The most prominent issue, however, is that for the community to get involved, there must be a tangible benefit for them as individuals. One of the main ways to combat this is to ensure the community has a voice in the decision making process. It is important that the community and the council be united in their efforts and vision, which can be achieved by utilizing community input to determine the initial goals and activities of the council. It is also vital to gain the support of community leaders in the watershed such as churches and community centers. These alliances will not only give the council resources such as meeting space and capital, but will also enable the council to more effectively pursue their agenda among community members.

The strategies described above can be executed through a variety of activities that were suggested by community members and initial stakeholders. While the individuals interviewed had different areas of expertise, most of them were able to agree that certain types of activities would be effective at garnering community support. These ideas were divided in two separate sections: education and public values forum.

Education

In terms of education, there are many different topics that the council could focus on. In order to attract as many individuals as possible, these topics must cover a wide range of areas while still retaining an environmental focus. These themes could include:

- History of the Río Espiritu Santo
- Importance of the Río Espiritu Santo
- Strategies for everyday sustainability
- Environmental impact of construction
- Environmental regulations
- Benefits of sustainable development

Education could also be conducted through schools in order to educate children on environmental issues. Currently, both the Department of Agriculture and Bahia Beach Resort have well established programs that work with middle and high school students to educate them on ecological preservation strategies. These programs also encourage the students to participate in restoration programs such as the Beach Clean-Up Day at the Bahia Beach Resort. The 4H program, which is designed for youth to be able to solve local issues, also has a strong

presence in the area. Through the education gained in these kinds of activities, students can apply their knowledge within their families to further educate the community on environmental issues.

Public Values Forum

In addition to educational events, the Río Espiritu Santo Watershed Council should also consider hosting a public values forum. The purpose of this forum will be to gather community input on the environmental issues that members of the community encounter through their daily lives. This forum will be instrumental in developing the agenda and priorities of the council. It will also make the community more involved in the council, as they will now feel that the council is addressing issues that the community feels are important. In order to gather community support from the very beginning of the council, it is recommended that this forum be one of the first activities sponsored by the Río Espiritu Santo Watershed Council. It is also recommended that this event is well-publicized and significant effort is put into making sure it is attended by many community members.

Other Community Development Activities

In addition to the education of the community and a public values forum, several other community development activities were suggested by community members or initial stakeholders. The first of these is offering free tours of the Río Espiritu Santo through local tour companies, during which the history and the importance of the river will be explained. Second, the community could volunteer to sell merchandise to tourists during large events in the El Yunque National Forest or other surrounding areas. These could include but would not be limited to apparel, artwork, and electronic material about the Río Espiritu Santo or the

landscape in general. This kind of activity not only helps to fund council activities, but is an easy activity for the community to get involved in. Also, by creating a newsletter about the council, the community can be easily made aware of the council and its activities. Large audiences can also be reached through media coverage of events, either by television, radio or social media.

Recommended Contacts for Río Espiritu Santo Watershed Council

General Contacts:

- Amigos del Corredor
- Amigos del Yunque
- Amigos del Río Espiritu Santo
- Sociedad Ambiente Marino
- U.S. Corps of Engineers
- Asociacion de Pescadores
- Autoridad de Tierra
- Junta de Planificacion
- DNER
- Town Hall
- Sierra Club

Appendix K: Google Blog

Rio Espiritu Santo Watershed Council

Welcome to the Rio Espiritu Santo Council Blog site! Here, we hope you will share stories about the Rio Espiritu Santo Watershed history, people, wildlife, weather and other daily events. We are particularly interested in your river observations!

Friday, April 26, 2013

WPI Project Details

From January 10th to May 3rd we worked with the U.S. Forest Service on the Pre-Planning Phase of their Rio Espiritu Santo Watershed Council Project. In order to gather data, we conducted two surveys; one of existing U.S. based Watershed Council Officials, and one of community members throughout Puerto Rico. In addition, we interviewed 16 Initial Stakeholders for the project. Using the data from these methods, we created several deliverables for the council to utilize:

The Rapid Watershed Assessment (RWA) detailed the current environmental health of the watershed and will allow the council to determine what areas need improvement.

The Restoration and Community Development Assessment (RCDA) brainstormed potential restoration and community development activities that the council could undertake.

The Project Poster described the methods and results of our project, as well as the overall timeline for the Rio Espiritu Santo Watershed Council Project. This poster was used at the Leatherback Turtle Festival on April 13th and the El Yunque Forest Clean-Up Day on April 20th to promote the council.

Rio Espiritu Santo Slideshow

Contact:

Pedro Rios:

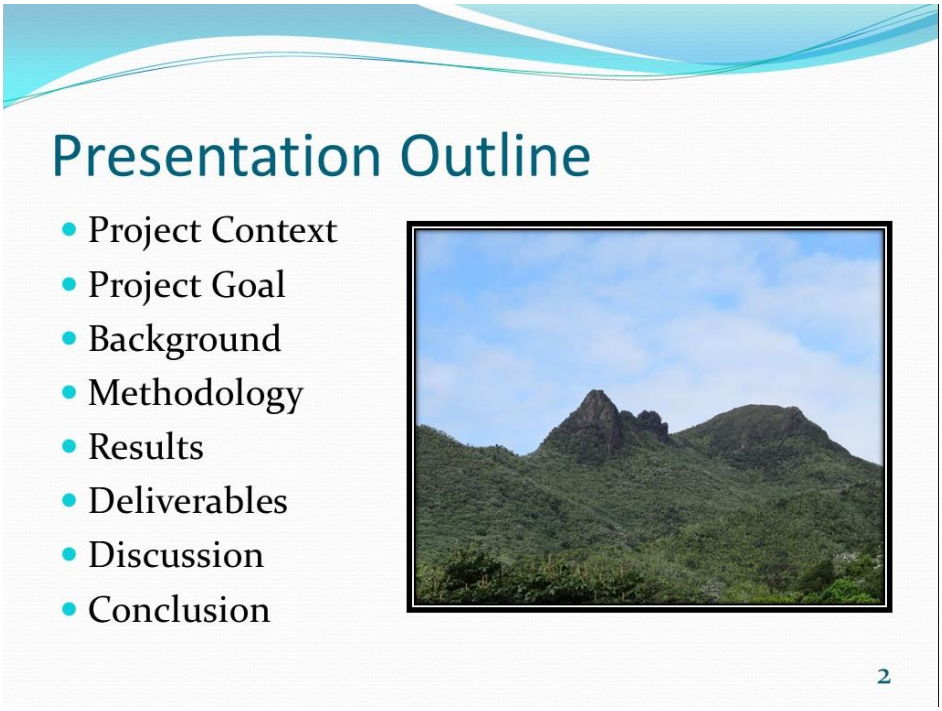
787-549-0080

prios@fs.fed.us

Marcela Cañon:

787-957-1509

Appendix L: Final Presentation



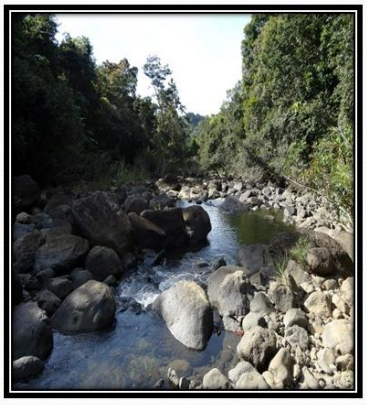
Project Context

- Declining health of the global environment
- Environmental preservation and management
- Without proper management decline will continue
- Preservation is primarily supported on large, national scales

3

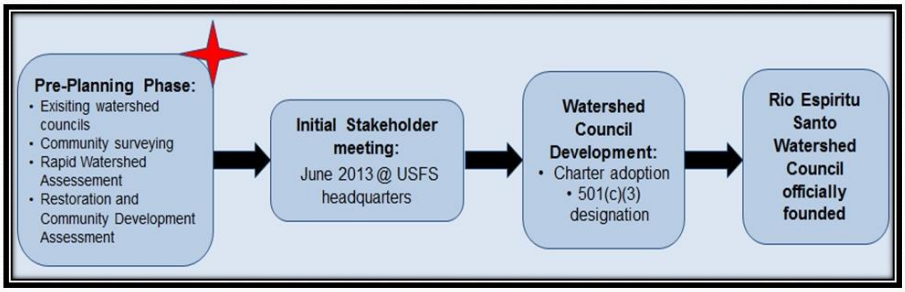
Project Goal

- Aid the U.S. Forest Service in the development of the Río Espiritu Santo Watershed Council.
  - Give the Río Espiritu Santo community a forum to voice their environmental concerns.
  - Educate the community in ecological preservation practices.
  - Improve the environmental health of the area.



4

Overall Project Timeline



5

Watershed Councils

- Non-governmental regulatory agencies made up of various stakeholders
- Focused on one local watershed
- Grew out of desire for more rapid, tailored response to needs of individual watershed

6

Governance Structure Samples

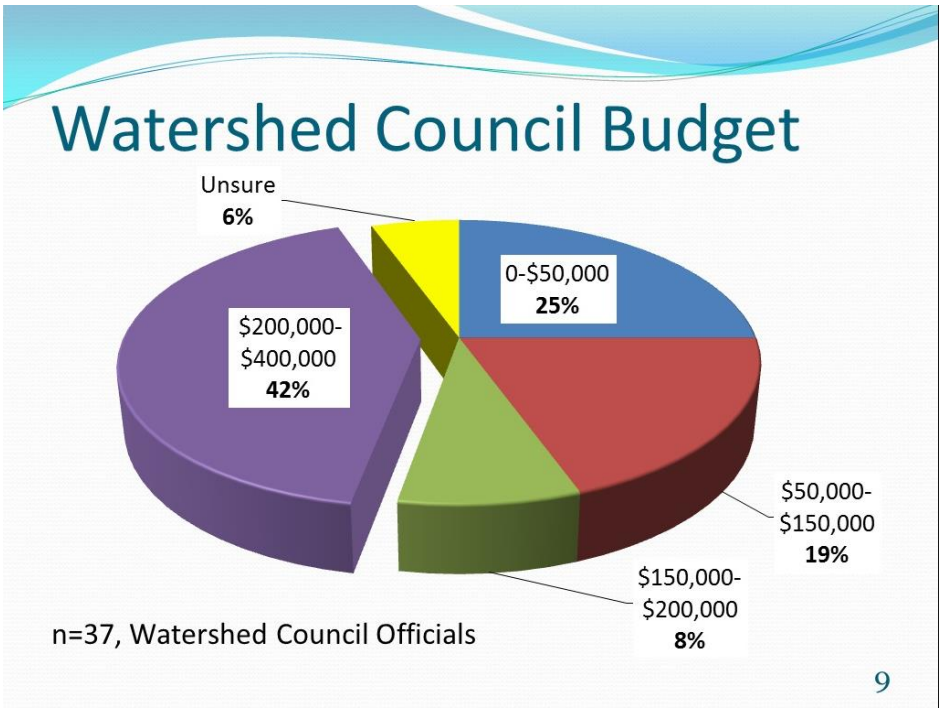
	Luckiamute Watershed Council, OR	Powder Basin Watershed Council, OR	Long Tom Watershed Council, OR	Coast Fork Williamette Watershed Council, OR
Term Length	1 Year	3 Years	4 Years	2 Years
Election Method	Popular election	Appointment by county court	Popular election	Volunteer
Number of Members	12	10	14	8
Number of Officers	3	3	5	4
Officer Positions	• Council Chair • Treasurer • Secretary	• Council Chair • Council Vice Chair • Treasurer	• Council Chair • Council Vice Chair • Council Past Chair • Treasurer • Secretary	• Council Chair • Council Past Chair • Treasurer • Secretary

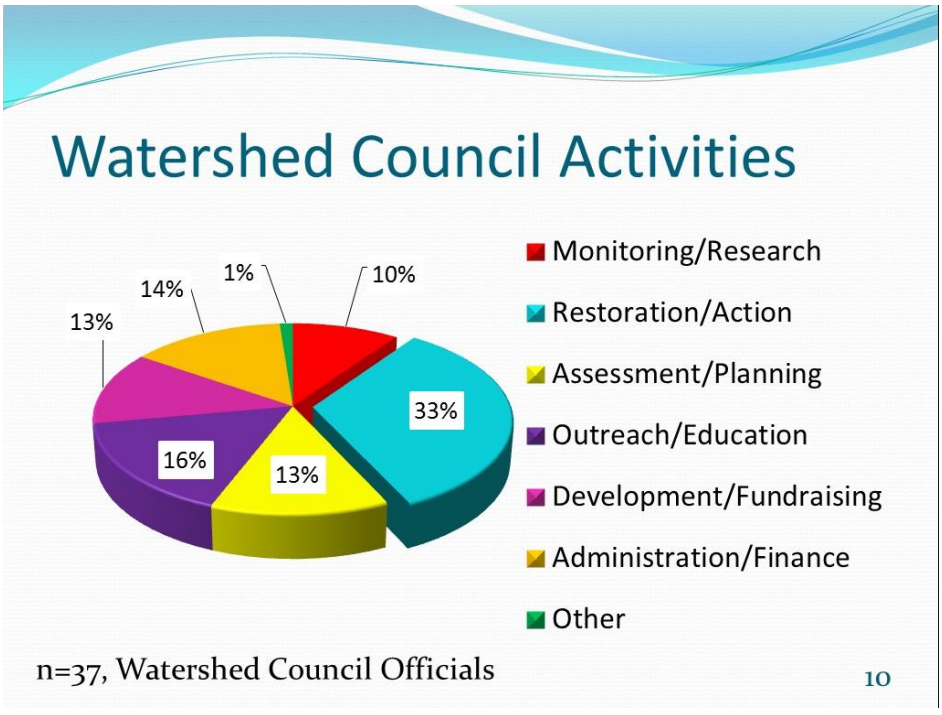
7

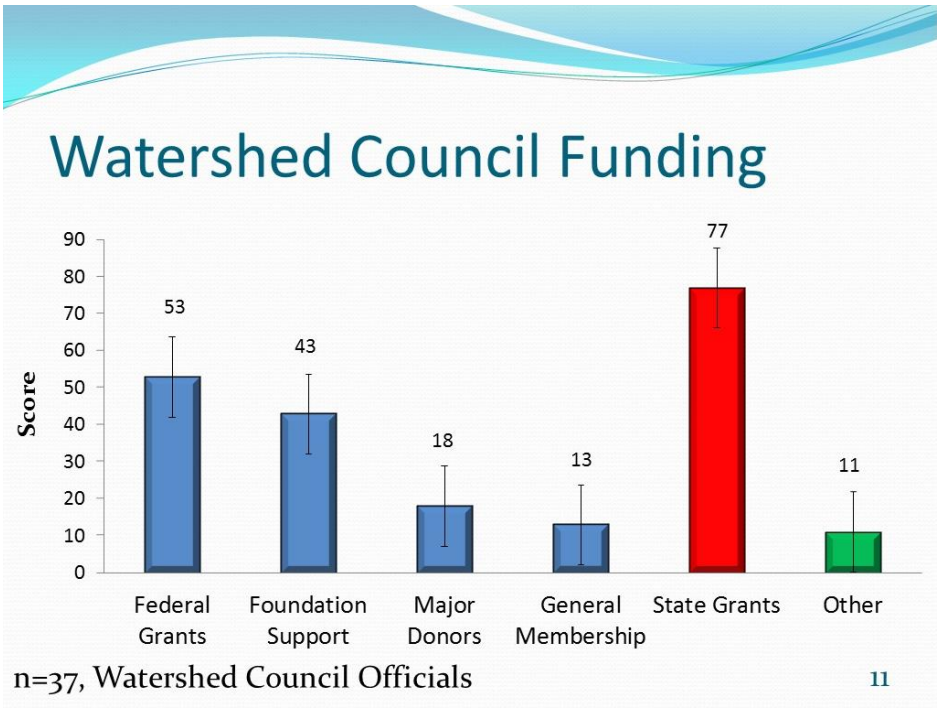
Methodology

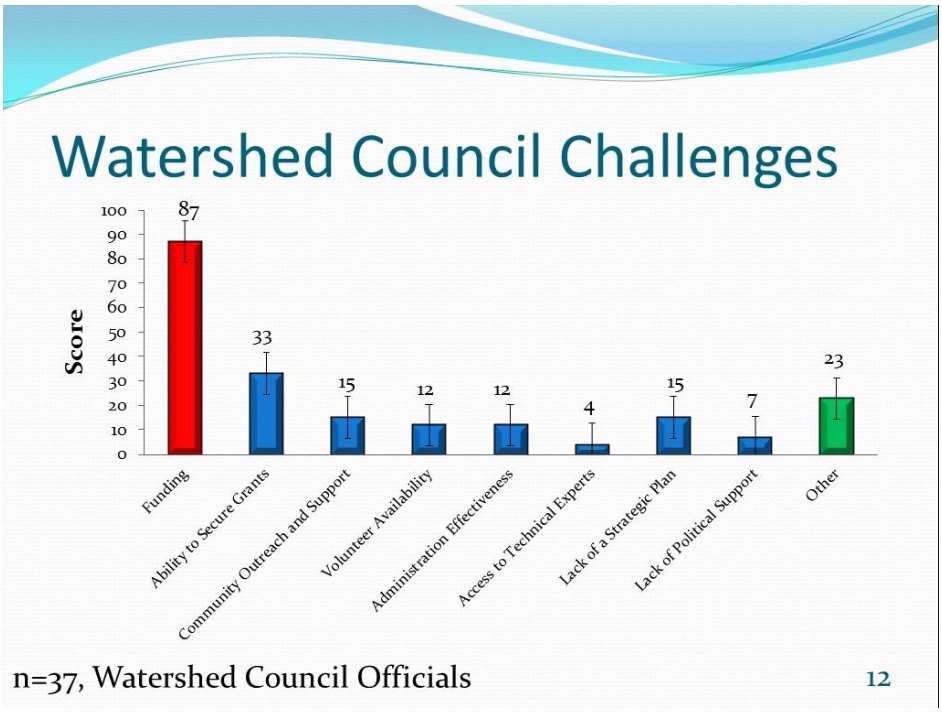
- Interviews and on-line survey to watershed council officials (n=3, n=37)
- Interview to initial stakeholders (n=16)
- On-line survey to general community(n=100)
- Rapid Watershed Assessment (RWA)
- Restoration and Community Development Assessment (RCDA)
- Developed Google blog

8


Watershed Council Budget
Unsure
6%
0-$50,000
25%
$200,000-
$400,000
42%
$50,000-
$150,000
19%
$150,000-
$200,000
8%
n=37, Watershed Council Officials
9


Watershed Council Activities
1%
10%
14%
13%
33%
16%
13%
Monitoring/Research
Restoration/Action
Assessment/Planning
Outreach/Education
Development/Fundraising
Administration/Finance
Other
n=37, Watershed Council Officials
10


Watershed Council Funding
Score
90
80
70
60
50
40
30
20
10
0
53
43
18
13
77
11
Federal Grants
Foundation Support
Major Donors
General Membership
State Grants
Other
n=37, Watershed Council Officials
11


Watershed Council Challenges
Score
100
90
80
70
60
50
40
30
20
10
0
87
33
15
12
12
4
15
7
23
Funding
Ability to Secure Grants
Community Outreach and Support
Volunteer Availability
Administration Effectiveness
Access to Technical Experts
Lack of a Strategic Plan
Lack of Political Support
Other
n=37, Watershed Council Officials
12

Challenge Regressions

Independent	Dependent	P-value	R^2	Coefficient
Funding- "State Grants"	**Challenges-** "Funding"	0.0129	0.1640	+
Funding- "General Membership"	**Challenges-** "Administration Effectiveness"	0.0492	0.1061	+

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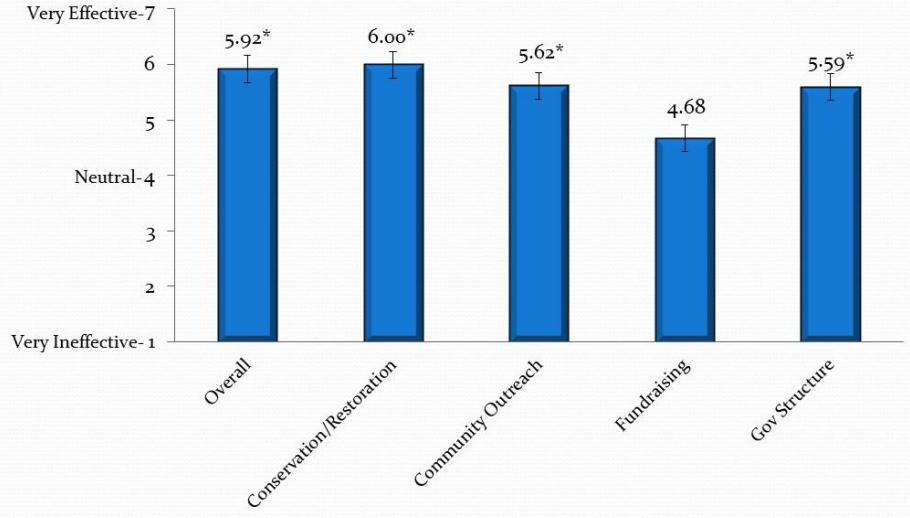
Watershed Council Effectiveness



n=37, Watershed Council Official Survey

14

Drivers of Watershed Council Effectiveness

Independent	Dependent	P-value	R^2	Coefficient
Budget	**Effectiveness-** "Overall"	0.00007	0.3200	+
Budget	**Effectiveness-** "Conservation/Restoration"	0.0106	0.1984	+
Activities- "Restoration/Action"	**Effectiveness-** "Overall"	0.0252	0.1352	+

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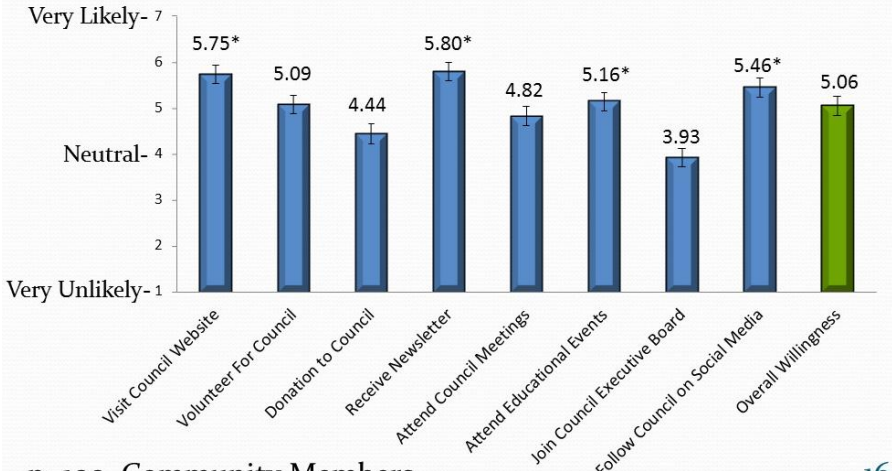
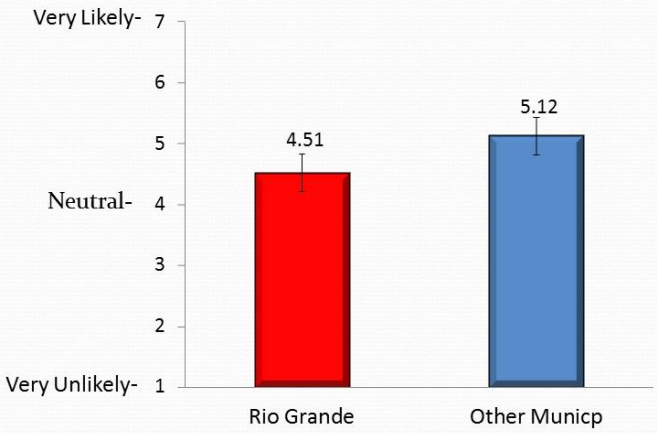
Community Willingness



n=100, Community Members

16

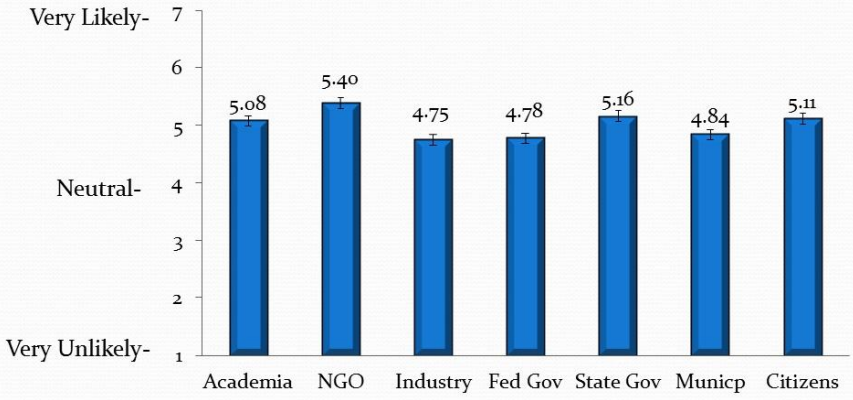
Municipality Willingness



n=100, Community Members

17

Citizen Group Willingness



n=100, Community Members

18

Environmental Issues

- Lack of education
- Damming
- Erosion
- Misuse

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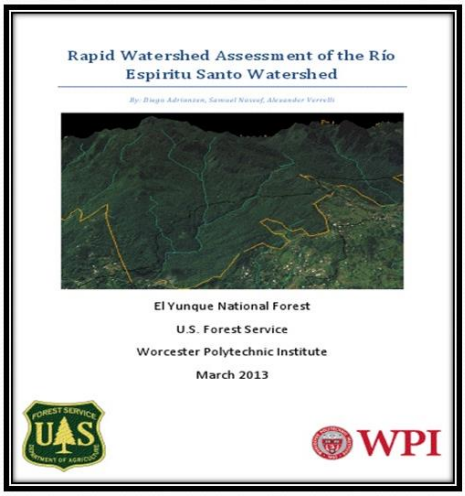
Deliverables

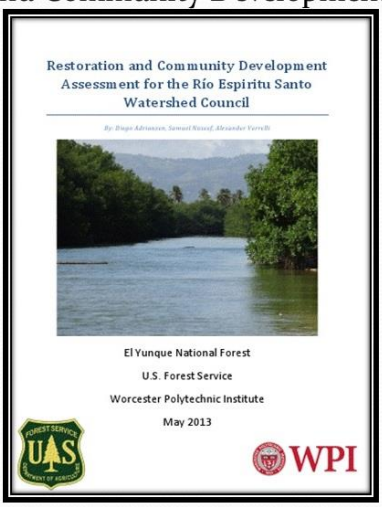
Rapid Watershed Assessment



20

Deliverables

Restoration and Community Development Assessment


Restoration and Community Development Assessment for the Río Espiritu Santo Watershed Council

By: Diego Adrianzen, Samuel Nassif, Alexander Verrelli

El Yunque National Forest

U.S. Forest Service

Worcester Polytechnic Institute

May 2013

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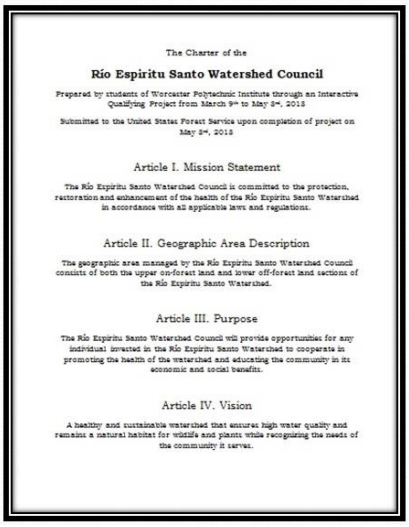
Deliverables

Charter draft


The Charter of the

Río Espiritu Santo Watershed Council

Prepared by students of Worcester Polytechnic Institute through an Interactive Qualifying Project from March 9th to May 8th, 2013

Submitted to the United States Forest Service upon completion of project on May 8th, 2013

Article I. Mission Statement

The Río Espiritu Santo Watershed Council is committed to the protection, restoration and enhancement of the health of the Río Espiritu Santo Watershed in accordance with all applicable laws and regulations.

Article II. Geographic Area Description

The geographic area managed by the Río Espiritu Santo Watershed Council consists of both the upper on-forest land and lower off-forest land sections of the Río Espiritu Santo Watershed.

Article III. Purpose

The Río Espiritu Santo Watershed Council will provide opportunities for any individual invested in the Río Espiritu Santo Watershed to cooperate in promoting the health of the watershed and educating the community in its economic and social benefits.

Article IV. Vision

A healthy and sustainable watershed that ensures high water quality and remains a natural habitat for wildlife and plants while recognizing the needs of the community it serves.

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Deliverables

Google blog

Rio Espiritu Santo Watershed Council

Welcome to the Rio Espiritu Santo Council Blog site! Here, we hope you will share stories about the Rio Espiritu Santo Watershed history, people, wildlife, weather and other daily events. We are particularly interested in your river observations!

Friday, April 26, 2013

WPI Project Details

From January 10th to May 3rd we worked with the U.S. Forest Service on the Pre-Planning Phase of their Rio Espiritu Santo Watershed Council Project. In order to gather data, we conducted two surveys; one of existing U.S. based Watershed Council Officials, and one of community members throughout Puerto Rico. In addition, we interviewed 16 Initial Stakeholders for the project. Using the data from these methods, we created several deliverables for the council to utilize:

The Rapid Watershed Assessment (RWA) detailed the current environmental health of the watershed and will allow the council to determine what areas need improvement.

The Restoration and Community Development Assessment (RCDA) brainstormed potential restoration and community development activities that the council could undertake.

The Project Poster described the methods and results of our project, as well as the overall timeline for the Rio Espiritu Santo Watershed Council Project. This poster was used at the Leatherback Turtle Festival on April 13th and the El Yunque Forest Clean-Up Day on April 20th to promote the council.

We also created a draft of a charter for the Rio Espiritu Santo Watershed Council containing the Mission Statement and proposed bylaws.

Rio Espiritu Santo Slideshow

Contact:

Pedro Rios:
787-549-0080
prios@fs.fed.us
Marcela Cañon:
787-957-1509
marcela@bahiabeachpuertorico.com

Blog Archive

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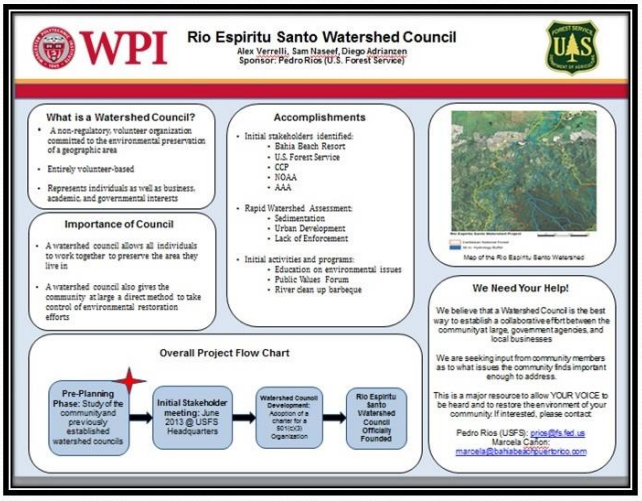
Deliverables

Project poster



WPI

Rio Espiritu Santo Watershed Council

Alex Verretti, Sam Naseef, Diego Adrianzen
Sponsor: Pedro Rios (U.S. Forest Service)

What is a Watershed Council?

- A non-regulatory volunteer organization committed to the environmental preservation of a geographic area
- Entirely volunteer-based
- Represents individuals as well as business, academic, and governmental interests

Importance of Council

- A watershed council allows all individuals to work together to preserve the area they live in
- A watershed council also gives the community at large a direct method to take control of environmental restoration efforts

Accomplishments

- Initial stakeholders identified:
  - Bahia Beach Resort
  - U.S. Forest Service
  - CCP
  - NOAA
  - AAA
- Rapid Watershed Assessment:
  - Sedimentation
  - Urban Development
  - Lack of Enforcement
- Initial activities and programs:
  - Education on environmental issues
  - Public Values Forum
  - River clean up barbeque

Map of the Rio Espiritu Santo Watershed

We Need Your Help!

We believe that a Watershed Council is the best way to establish a collaborative effort between the community at large, government agencies, and local businesses

We are seeking input from community members as to what issues the community finds important enough to address.

This is a major resource to allow YOUR VOICE to be heard and to restore the environment of your community. If interested, please contact:

Pedro Rios (USFS): prios@fs.fed.us
Marcela Cañon:
marcela@bahiabeachpuertorico.com

Overall Project Flow Chart

Pre-Planning Phase: Study of the community and previously established watershed councils → Initial Stakeholder meeting: June 2013 @ USFS Headquarters → Watershed Council Development: Adoption of a charter for a 501(c)(3) Organization → Rio Espiritu Santo Watershed Council Officially Founded

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Ideal Watershed Council Structure

- Charter with well-defined mission statement and bylaws
- Executive board of 10-14 members
- Committees focused on specific tasks
- 501(c)(3) designation
- Hiring of a grant writer

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Ideal Watershed Council Activities

- Infrastructure improvement
- Clean-up days
- Educational events
- Public values forum

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Conclusions

- Deliverables will give the initial stakeholders the following:
  - Current watershed conditions
  - Attributes of effective watershed councils
  - Challenges they should expect to encounter
  - Options and recommendations for governance structure
  - Potential activities to undertake
- Aid the initial stakeholders in officially forming the Rio Espiritu Santo Watershed Council

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Acknowledgments

We would like to thank the following people:

The U.S. Forest Service employees, especially Pedro Rios, Benjamin Fuentes, Bruce Drapeau, Anastacio Gomez, and Orlando Carrasquil

Bahia Beach Resort, especially Marcela Cañon and Ashley Perez

Worcester Polytechnic Institute, especially our advisors Professors Ted Clancy and Fabienne Miller, as well as Professor Susan Vernon-Gerstenfeld

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Questions/Comments

25

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