Evaluating Effectiveness of the Signage and Other Markings for Gudiance and Warning Placed by OCN

An Interactive Qualifying Project submitted to the faculty of
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Abstract

Despite warnings against dangers in the water, swimmers are continuing to drown at Puerto Rican beaches. The goal of our project was to improve maritime safety through warning signage and the education of beachgoers. Using resources at the Department of Natural and Environmental Resources, we evaluated high-risk areas and used interviews to determine how well swimmers comprehend the dangers. Based on the analysis on the information we gathered, we made recommendations to better educate the public. The recommendations, along with a database, will ideally improve maritime safety in Puerto Rico.

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Contents

Figures

Executive Summary

Drowning is the third-leading cause of accidental deaths worldwide, causing approximately 390,000 fatalities each year (World Health Organization, 2013). Drownings occur in every coastal region of the world and Puerto Rico is no exception, with 363 recorded drownings between 1999 and 2010 (Morales Muñoz, 2013). Both locals and tourists visit Puerto Rico's beaches every year. Unfortunately, the chance that a person drowns increases if they are poorly informed of the dangers.

To determine methods of keeping beachgoers safe, we, a team of Worcester Polytechnic Institute students, analyzed potential causes for drowning incidents in Puerto Rico, investigated how well the public is informed of beach dangers, and worked to reduce the number of deaths in the future. Our team chose three aspects to focus on during our time in Puerto Rico: the environmental hazards of beaches, the information provided to beachgoers, and public awareness on dangers and signage at beaches.

We divided our project into two categories: the main environmental dangers that increase the chances of drowning (such as rip currents, strong waves, and rocks) and the main social causes of drownings, or means that beachgoers endanger themselves (such as ignorance of conditions, intoxication, and negligence).

The goal of our project was to improve maritime safety through warning signage and the education of beachgoers. The project had the following three objectives:

1. Analyze effectiveness of warnings in terms of signage characteristics

2. Examine dangers and safety precautions at beaches to determine the most likely causes of drownings

3. Determine the public's knowledge and understanding of hazards and signage at beaches

The team studied eighteen different beaches; eleven of which are considered high-risk. At each beach, we noted the locations of the signs relative to beachgoers as well as the symbols and languages used to convey messages. Further investigation showed what environmental factors make each beach safe or dangerous. Interviewing beachgoers and the lifeguards helped complete the objective of gathering data on public understanding of the dangers and signage at beaches.

The data provided evidence that the signage at the beaches could be improved. Our reconnaissance showed that people would commonly enter beaches away from areas where signs are posted. Only 64% of signs at dangerous beaches, and 36% of signs at safe beaches, appeared to be effective.

Overall, the interviews showed that the majority of the public was not observing the signs. Based on the surveys, the team observed four important statistics about how well people are informed of beach dangers:

- Approximately 51% of beachgoers at dangerous beaches did not notice the signs when they visited the beach. This shows that the signage is not currently an effective method of communication.
- When asked about rip currents, the largest danger at the beach in terms of the number of yearly rescues and drownings, 65% of people were not adequately informed about what rip currents are or how to escape them. This puts them at risk to drown if caught in a rip current.
- Roughly 23% of beachgoers at high-risk beaches would attempt to rescue a person in danger, which could put them at risk to drown as well.
- According to the interviews, about 61% of beachgoers believed that people are not well informed of hazards at the beach, which shows that much improvement can be made.

These statistics show that beachgoers are not noticing the signage and are not properly informed.

The main reasons for more drownings at high-risk beaches are features such as rocks and strong currents, but improved signage can mitigate these risks. Beachgoers are not noticing the signs due to various factors, such as poor placement, vandalism, language barriers, or inconspicuousness. The signage should better inform the beachgoers of dangers at the beach.

RECOMMENDATIONS

Signs

- We recommend using spray-paint resistant coating to cover all signs.

- We recommend rip current escape signs be placed at all beaches.

- We recommend the same sign be placed on both sides of double-sided signs to increase the likelihood that people will see the message.

- We recommend signs be improved in many different ways: location, color, and size. Also, a future project team to determine their effectiveness.

- We recommend using a color-coded flag system at high-risk beaches to indicate how dangerous the water is.

Specific Beaches

- We recommend changing the signs used at Playa Jobos.

- We recommend adding more signs to Ocean Park Beach.

- We recommend adding a sign to the boating side of Crashboat Beach indicating where the swimming area is located.

- We recommend placing "strong current" signs at the relevant areas of La Pared.

Miscellaneous

- We recommend creating and distributing pamphlets to the public that warn about beach dangers.

- We recommend lifeguards complete "daily activity reports" to document any occurrences at the beach.

- We recommend buying cameras with GPS ability to document all signs.

- We recommend fines be given to violators of prohibited swimming areas.

Chapter One: Introduction

As temperatures increase, many people travel to beaches all around the world to enjoy the warm sun, soft sand, and refreshing water. When people go to the beach, they expect to have an enjoyable time and to be safe. Maritime safety issues make it difficult to stay out of harm's way. "Maritime safety" refers to decreasing the chance of accidents associated with the water. It refers to both the organisms that live in the ocean as well as people who are performing activities in the water, such as swimming or boating. Although ocean life plays a major part in maritime safety, this project focused on the safety of humans.

With average temperatures in the high 80s, the warm weather in Puerto Rico makes it an ideal location for locals and tourists to enjoy the beaches (Rivera, 1998). Over the last few years, there have been a substantial number of drowning victims in Puerto Rico, with 363 reported incidents in the last decade (Morales Muñoz, 2013). Although specific data do not exist on exactly which precautions are being taken, the lack of education of beachgoers on hazards in the water is a possible cause of the drownings.

The Department of Natural and Environmental Resources (DNER)[1] of Puerto Rico established a project and offered their resources and time for us, a team of Worcester Polytechnic Institute (WPI) students. The project was intended to improve maritime safety in Puerto Rico and consolidate information for the use of the DNER and any other governmental agencies. The DNER needed to know the cause of the accidents in order to improve maritime safety. Rip currents, rocks, and strong waves may be making the water dangerous, which results in an increase in drownings. Also, irresponsible beachgoers who are intoxicated or not watching their children could also contribute to accidental maritime deaths.

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[1] Spanish name – Departamento de Recursos Naturales y Ambientales (DRNA)

Inadequate education is potentially a main cause of these drowning incidents. Improving public awareness on the hazards people face at the beach may help to decrease the number of accidents that occur. For example, beachgoers may observe a rip current sign but not understand what a rip current is. In addition, they may also not know how to recognize when they are caught in one and what steps to take to escape. We also investigated if people know whom to call in the event of witnessing a swimmer being dragged out to sea by a rip current.

The goal of our project was to improve maritime safety through warning signage and the education of beachgoers. A problem that the team faced was that there was limited information available on the main causes of drownings. Our team did not know the extent of the drowning problem because the records of maritime accidents in Puerto Rico are poorly organized. We began by identifying the most dangerous and safest beaches on the island. We investigated safety precautions currently in place at the most dangerous beaches and observed precautions at safer beaches to see how they were different. In the areas that have warnings, we needed knowledge pertaining to the public's awareness of oceanic hazards as well as any misunderstandings the public has of information which is currently conveyed. This information was used to make proper recommendations about how to warn beachgoers of dangers more effectively.

We visited eleven high-risk sites to discover what safety precautions are used and how beachgoers are educated on the different hazards the water poses. This information allowed us to collect data on what dangers people need to be more aware of and how to educate them. During these visits, the team surveyed and interviewed locals and tourists to determine how the public is interpreting the information. Using these results, we provided recommendations on ways the public can be warned about the dangers in the water more effectively. Our team created a

preliminary database that can be accessed by the DNER to organize the drowning records and

help prevent drownings in the future.

Chapter Two: Background

This chapter outlines necessary information required to understand the depth of the maritime safety issue in Puerto Rico. It provides an overall discussion of demographics of the drowning victims, beach characteristics, social and environmental causes of drownings, psychology of warnings, and marine education.

DROWNING AS A WORLDWIDE PROBLEM

Worldwide, drownings account for 7% of all injury-related deaths. With approximately 390,000 drownings every year, it is the third leading cause of accidental deaths worldwide. An estimated 96% of all reported drownings occur in low-to-middle income countries. However, this number may be lower than reality because it is estimated that many deaths in low-income countries are never reported. With 84 countries considered lower-middle or low income, drowning is a serious problem in the world (World Health Organization, 2013; World Bank, 2013).

DEMOGRAPHICS OF VICTIMS

Drowning is a very serious issue in Puerto Rico. From 1999-2010, there have been 363 reported deaths due to maritime drowning (Morales Muñoz, 2013). The demographics of the victims range from all ages, as seen in the adapted chart below.
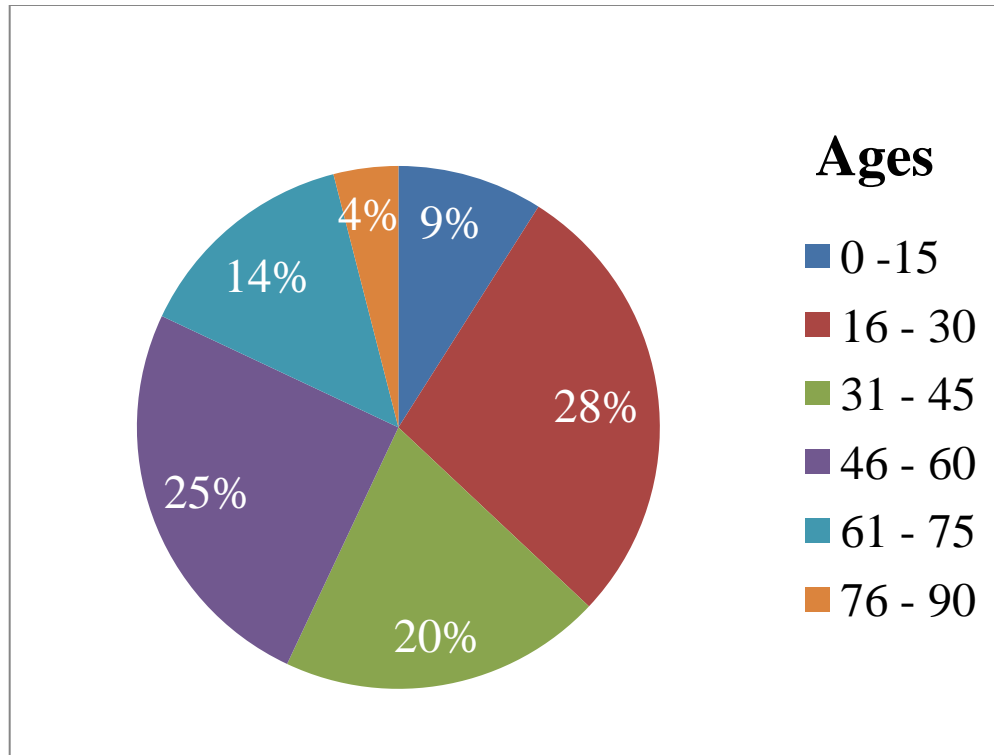
Figure 1: Percentage of Total Drowning Victims from 2005-2010 (Morales Muñoz, 2013)

The labels on the right represent the different age groups. The largest group affected is between 16 and 30 years of age. This range consists of college students and other young adults who have the freedom and time to go to the beach, especially during summer vacations. They most likely make up the majority of the people who attend beaches; hence they have the highest percentage of total deaths. Another unfortunate fact is that 9% of all victims were under the age of 15. These children may have died because a parent or guardian did not watch over them properly. The vast majority of the drowning victims were also male, making up 91.1% (Morales Muñoz, 2013). From these statistics, it is likely that males between the ages 16 and 30 make up the preponderance of the total drownings.

The time and location of the incidents is also important to note because 79.4% of the accidents occur during the afternoon (Morales Muñoz, 2013). Most people go to the beach during the afternoon while the sun is out, so it makes sense that most of the fatalities happen

during this time period. The adapted chart below shows the breakdown of the number of deaths per month from 2005 to 2010 in Puerto Rico:

Number of Drowning Victims
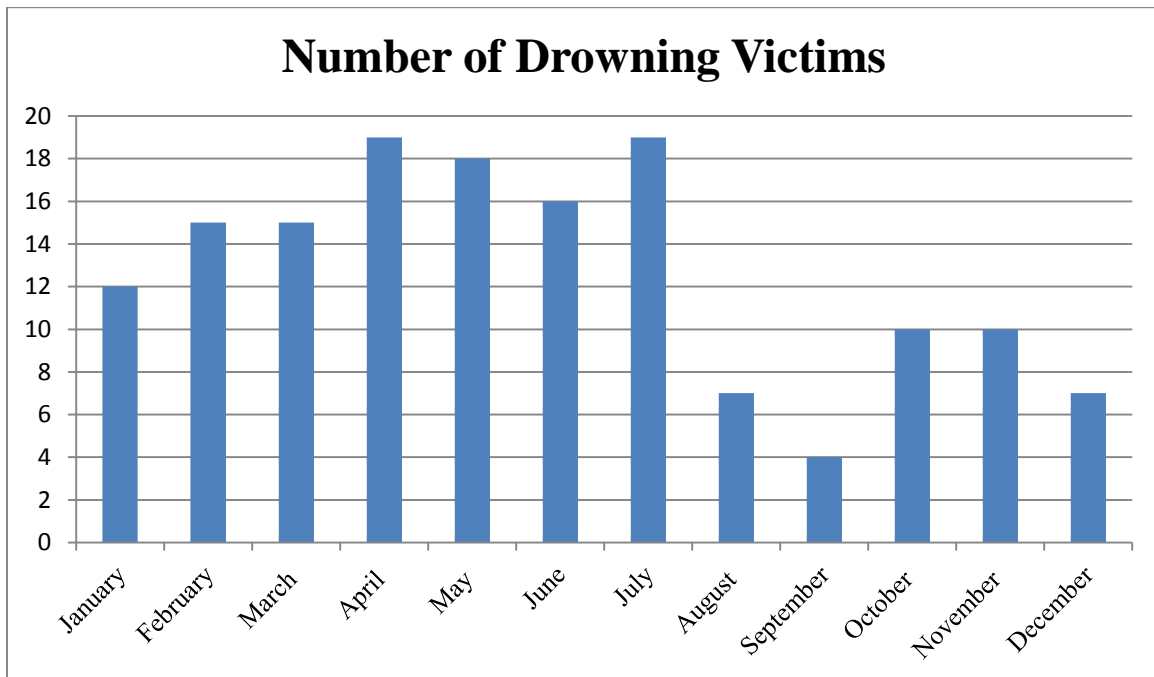
Figure 2: Number of Drowning Deaths in Puerto Rico from 2005-2010 (Morales Muñoz, 2013)

As shown above, the majority of drowning calamities transpire during the summer months, between April and July. A possible explanation for this is that the temperatures during the summer in Puerto Rico are the warmest, with averages in the high 80s (Rivera, 1998). People take advantage of the weather and go to the beach. Many students are also on summer vacation, giving them more time to visit the ocean. Because of the rise in individuals who go to the beach, it is logical that the number of accidents would also rise. The decrease in deaths from August to December is possibly due to the students' return to school. Public schools in Puerto Rico start the first week of August so students do not have as much time to enjoy the ocean and vacationers return to their homes at this time of year. In addition, the rainy season in the later months of the year, along with a drop in temperatures, discourages swimmers from going to the beach. The winds also intensify during the winter months, further discouraging people from visiting beaches.

Even though fewer people go to the beach, 46% of all drowning deaths occur in the winter (Morales Muñoz, 2013).

BEACH CHARACTERISTICS

Information can be obtained by looking at characteristics of a beach, especially the sand grains and waves. Although the differences in size and shape of the grains are only noticed when carefully analyzed, the knowledge gained shows a lot about the characteristics of the beach, including the minerals in the sand, power of the incoming waves, and the strength of the current out to sea.

Sand and Waves

In Puerto Rico, the most abundant minerals that exist in the sand are quartz and calcium carbonate, although mixtures of magnetite, ilmenite, feldspar, and magnesium also make up some of the sand grains (Morelock, J., Carrera, C., Grove, K., & Trumbull, J, 1978; Benes, 1988). Due to the history of Caribbean volcanoes, many igneous rock or other dark minerals are also prevalent. Other material comes from skeletal structures of long deceased sea creatures, such as mollusks (Morelock, J., Carrera, C., Grove, K., & Trumbull, J, 1978).

All of the materials named above have been eroded and morphed throughout the earth's history through constant abrasions with waves. The size and shape of the sand grains reflect the power of the incoming waves and the strength of the current pulling out to sea. Smaller sand grains have been continuously pulverized by strong waves, slowly reducing their size. This is also prevalent in the amount of sand present in the water because waves are more likely to carry small sand grains as opposed to large grains. A higher amount of sand in the water shows that the sand grains are comparatively small and that the waves break with a high amount of power (Benes, 1988; Anderson, 2004). Waves approaching the beach will deposit sand onto the beach,

carry sand into the ocean, or erode the existing material; changing the size and shape of the sand and the beach itself. The diagram of the wave velocity and particle size, or the Hjulstrom Diagram, is shown below:
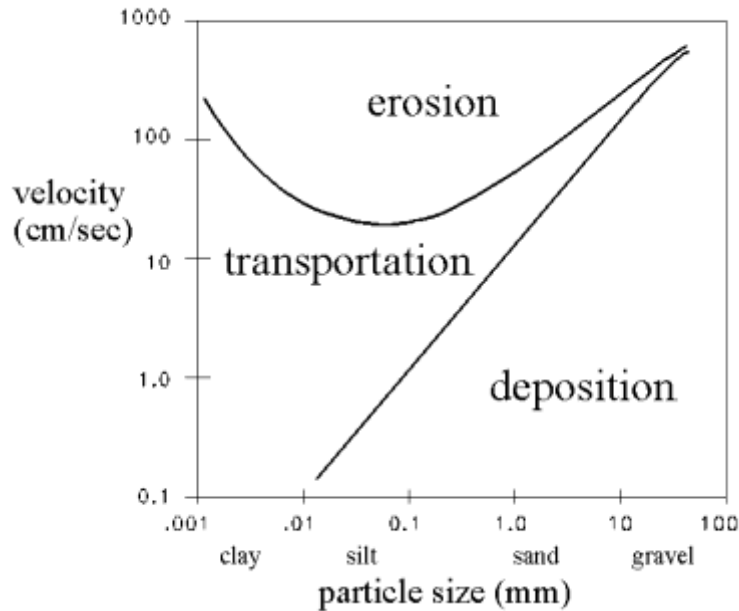
Figure 3: Hjulstrom Diagram

Rip Current Characteristics

Rip currents, mistakenly called rip tides, are a constant threat to beachgoers and account for a large portion of drownings (Dalrymple, 2011). These currents are uneven backwash after a wave has reached shore. They are generally about 10-25 meters across, travel approximately 100 meters out to sea, and travel perpendicular to the shore in most cases (Dalrymple, 2011). However, rip current sizes vary greatly and could be much larger or smaller than these values. These currents can be found with average swells; waves only about three feet above the water can generate strong rip currents.

Rip currents should not be confused with rip tides and undertow. Although rip currents are often called rip tides, rip tides are actually present in offshore inlets where the tides affect the small width of the inlets more aggressively. Undertow occurs when the water at the surface is pulled to the bottom and returns to the ocean underneath the incoming waves. (Leatherman, 2011).

Longshore Currents

Winds and swells can alter the direction that a wave is traveling. When waves move towards a beach without being completely perpendicular to the shoreline, they create a current that flows parallel to the coast, known as a longshore current. More often than not, coastlines have these currents moving parallel to the beach. Longshore currents are dangerous because they can push swimmers into rip currents or into deeper water if they are on a sandbar (National Weather Service Weather Forecast Office, 2009). Swimmers can ensure that they are not pulled a significant distance by longshore currents by regularly checking their distance from an onshore location, such as where they left their belongings on the beach (National Weather Service Weather Forecast Office, 2013). A diagram of a longshore current can be found below.
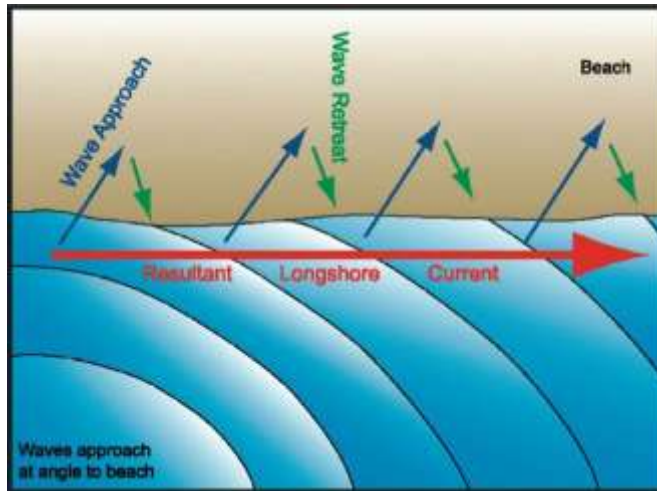
Figure 4: Diagram of a Longshore Current (Geocaching, 2013)

Shorebreaks

A shorebreak is a wave that breaks close to or directly on the shore, increasing the difficulty of leaving the waters for beachgoers (SportsDictionary, 1998). Shorebreaks are dangerous to beachgoers; these waves do not break similar to regular waves and can cause serious injury if a swimmer is caught in one. The wave's power can throw people around in shallow water and cause swimmers to collide with the beach or rocks.

ENVIRONMENTAL CAUSES OF DROWNING

The environmental causes of accidental drowning can be out of the beachgoer's control but the risks can be mitigated with better knowledge of the swimming conditions.

Weather Related

To understand the environmental factors, a study was done on five of the most dangerous beaches in Puerto Rico. These are: Marriott Condado (in front of Marriott, Condado), Mar Chiquita, Balneario La Monserrate en Luquillo, Vacía Talega and Jobos shown below:

Figure 5: Five of the Most Dangerous Beaches in Puerto Rico

Most of the dangerous beaches are on the northern side of the island because of the rough

Atlantic Ocean pounding the coast (Morales Muñoz, 2013). The northern portion of the island

also has many rivers that empty into the ocean. As the rainy season arrives, the rivers overflow

and cause the ocean levels to rise, making the water more dangerous for swimmers as well.

People drown in these areas because of rip currents, high and strong waves, and rocks. Puerto

Rico also lies in the trade wind belt, as seen below (Morales Muñoz, 2013):
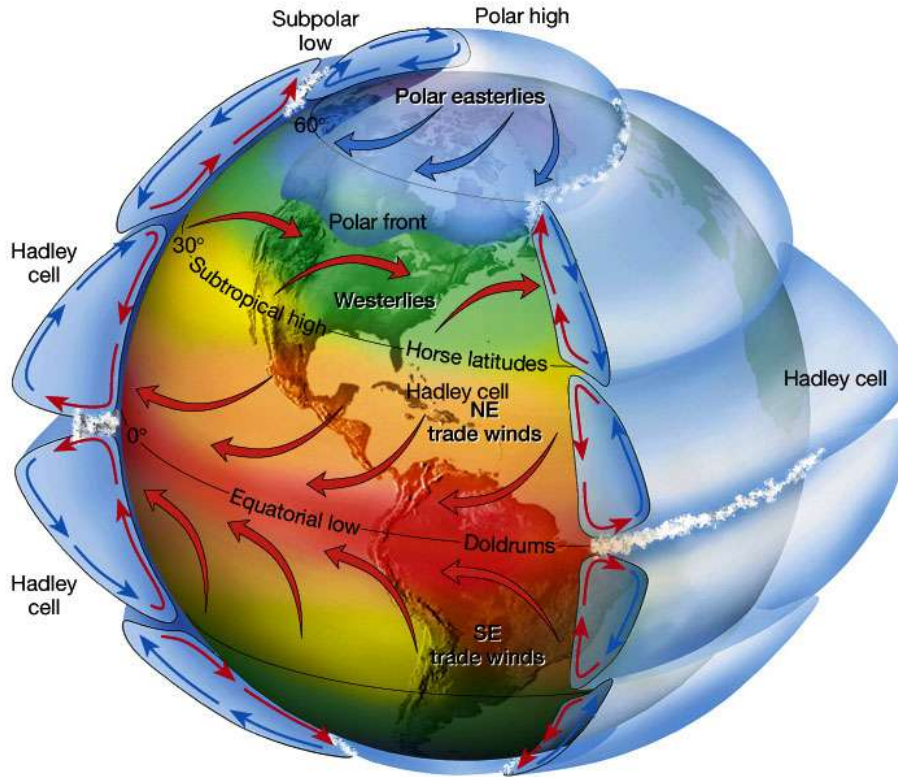
Figure 6: Trade Wind Belt

This causes the waves to become stronger, endangering the swimmers. Strong winds can cause waves to reach between three to four meters in height and collide with the beach every 12 to 20 seconds. It can take up to 12 hours for waves to return to normal heights (Morales Muñoz, 2013).

The rip currents are especially dangerous in Mar Chiquita because of its geomorphology. Most of the beach is encircled by rocks so all the water is flushed through one spot during the transition between tides, which intensifies all existing rip currents at the beach (Morales Muñoz, 2013).

PLAYA MAR CHIQUITA MANATI 2010

Figure 7: Aerial View of Mar Chiquita

The rocks at Jobos are not only dangerous for ocean users, but for the rescuers as well. If first responders are necessary, it is hard for them to get around the rocks and the nearest hospital is 20 minutes away (Morales Muñoz, 2013). The Playa Marriott Condado is different because it has a wave blocker to reduce the size and intensity of the waves but this makes the rip currents significantly stronger (Morales Muñoz, 2013). These environmental factors are out of human control, but if the public is properly warned of the dangers, some deaths may be prevented in the future.

Rip Currents

There are a large number of deaths due to drowning in rip currents every year because many swimmers are unaware of the procedure to safely reach shore once a rip current has taken them out to sea. Since rip currents can pull somebody out over 100 meters, as explained in a previous section, it is very difficult to make it back to shore. If swimmers try to swim against the rip current, they will tire very quickly and make no progress against the current. This is one of the main causes of drowning because people tend to panic when caught. To escape a rip current,

swimmers must swim parallel to the coast until they are no longer being pulled out to sea and then swim directly back to shore (Leatherman, 2011). Rip currents are more dangerous than rip tides and undertow because it is more complicated to escape from one. A picture of a rip current in San Juan, Puerto Rico is shown below. The rip current is the cloud of sand that is being pulled out into the ocean.

Figure 8: Rip Current in San Juan, Puerto Rico (photo by John Fletemeyer)

SOCIAL CAUSES OF DROWNING

Social factors contribute to why people drown. The *social causes* refer to the ways individuals endanger themselves in the water, as opposed to environmental explanations. According to a recent survey of lifeguards in Puerto Rico (Morales Muñoz, 2013), the social causes of why most people drown are: ignorance of swimming conditions, drunkenness, negligence by parents or friends, inability to swim, and lack of lifeguards. Drunkenness impairs decision-making abilities, slows reaction times, and hinders cognitive processing. Because of the effect alcohol has on inner ear balance, it may cause a person in distress to swim downwards

instead of to the surface (The Coroner's Prevention Unit, 2011). Negligence by guardians can result in accidental drowning of children. Lack of swimming ability not only endangers children but adults as well because people who travel too far into the water put themselves at risk of not being able to swim back to shore. People may need lifeguards, but under the rules set up by the National Park Company of Puerto Rico[2], lifeguards are only required at the eleven resort beaches on the island (Morales Muñoz, 2013).

Many factors, such as ocean levels, wind speed, and the times of high and low tides, contribute to the hazards (Morales Muñoz, 2013). If the water levels rise and the wind is or has been blowing hard, large waves are bound to occur (Schember, 1998). This makes the beach dangerous because people can be knocked down and dragged out by rip currents. Knowing when the tides change can also make beachgoers safer because as the tides change from high to low, rip currents are intensified, further endangering swimmers (Morales Muñoz, 2013).

PSYCHOLOGY OF WARNINGS

Warnings are designed to prevent accidents from occurring. They help to reveal hazards and dangers that may not be prevalent to people in the area. Warnings are intended to create enough "fear" so that a person who understands the warning will avoid a dangerous activity (Green, 2004). If people are aware of a potential threat, they are more inclined to avoid that danger. It is impossible for a person to circumvent a danger that he or she is unaware of. However, people do not always heed warnings and may find themselves in trouble because of it.

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[2] Spanish name – Compañia de Parques Nacionales

Figure 9: Warning Sign Telling Beachgoers of Strong Currents Present in the Area

Why Warnings Are Sometimes Ignored

Despite a warning against it, a person may proceed to perform a dangerous activity, such as swimming in a prevalent rip-tide area or drinking too much alcohol near the ocean. People may ignore a warning if they believe that the risks presented by the activity are smaller than the rewards of performing the activity (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999). There are multiple factors that affect whether a person is likely to heed a warning or continue to ignore it. The two main contributors to a person's chance of heeding a warning are familiarity with the situation or activity and if he or she feels pressured to perform the action (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999).

Familiarity:

Familiarity and experience are key contributors that can cause a person to ignore a suggestion from a warning. If a person is very familiar or experienced with an activity, he or she is more likely to ignore a precaution against it (Wogalter, Dejoy, Laughery, Ebrary Academic, &

EnvironetBase, 1999). For example, if people have experience swimming in a specific area and they see a warning that says it is dangerous to swim there because of conditions, then they are more likely to ignore the warning than swimmers who do not have experience in the area. A person who is familiar with an activity may feel as though he or she will be able to perform successfully, no matter the danger. The same theory applies to a certain location. If there are two swimmers of equal ability at a beach and one swimmer has swum there many times while the other has never swum there, the swimmer more familiar with the area is less likely to heed any warnings about the dangers at that beach. Whether or not that swimmer is safer depends on the actual dangers in question. A rip current, which is nearly unpredictable, is dangerous to anyone, but the more familiar swimmer might be more careful about avoiding a coral reef than someone who is less familiar with the area (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999).

If someone is experienced and familiar with an activity, it becomes more "automatic" to him or her. People tend not to think about what they are doing or worry about whether or not they will succeed. When a person performs a task in automatic mode, he or she is less likely to notice or pay attention to warnings against the activity (Green, 2004). As a result, the person is more likely to perform the activity despite the dangers.

Cost of Compliance:

If someone feels time, social, or cost pressure to pursue an activity, he or she may decide to ignore any warnings against the activity (Green, 2004). Time, social, or cost pressures affect what is known as the "cost of compliance," which is defined as what a person has to lose by heeding a warning (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999). If a library has signs that tells patrons not to use their cell phones but has a small room on each floor

that allows the cell phones to be used, people are very likely to heed the warnings because the cost of compliance is very low. People can simply walk a very short distance and use their cell phones there (Green, 2004). This example shows a low cost of compliance, because it is very easy to heed this type of warning without too much interruption of what a person wants to do. If a warning at a beach suggests that beachgoers should not swim there, that can have a high cost of compliance because the beachgoers will have to move to a different beach and that beach could be a long distance away. Social pressure is also a potential cause to ignore warnings, as people have drowned in waters that they were not able to swim in because they felt pressured to enter the water by their peers (Joe & Frank, 2012).

Improving the Heeding of Warnings

There are many ways to improve the percentage of people that heed a given warning. To make a person more likely to listen to a warning, it is important that the message is easy to see as well as easy to interpret (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999). These conditions are particularly true if the warning is a sign. Warning signs have a specific location as well as an appearance. The appearance of a sign is used to convey a message to the people who view it.

An effective warning:

1. Is visible. If there is insufficient lighting or the warning is poorly placed, people will not see the warning and therefore will be unable to follow it (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999). An attention-grabbing word such as "Danger" or "Caution" can also help the warning attract the attention of people in the area.

2. Is easy to interpret. If the warning is in a language that viewers do not understand or if it uses unfamiliar terminology, then the warning is useless. A picture can be used if finding a well-known language proves to be difficult. Also, the color scheme of the sign must make it easily readable as well as make any pictures clear (Wogalter, Dejoy, Laughery, Ebrary Academic, & EnvironetBase, 1999).

The characteristics of signs can greatly impact the effectiveness of how well warnings are noticed and followed. These warnings can be used to educate people on the dangers present at any given location, such as a beach. Education of beach dangers is vital in preventing accidents.

MARINE EDUCATION

There have been very few case studies done in the area of education of beachgoers on the risks of going to the beach. One study in Australia, which has similar issues to Puerto Rico, showed that rip currents are the main cause of maritime rescues and drownings. With rip currents being a paramount danger at the beach, only 40% of college students recognized the dangers of rip currents and what they are. About 20% of people surveyed gave an accurate description of how to identify a rip current, which included the two most common ways to point out a rip current, according to the Surf Life Saving Queensland (Surf Lifesaving Queensland, 2013). A group of beachgoers was shown a picture of a beach with rip currents; 60% of the group stated that they would swim in or near the rip currents because the water looked calm (Ballantyne, Carr, Hughes, 2005). The same survey included a questionnaire on lifeguards and the knowledge of the group on where lifeguards were present. The study proved that most people associated red, yellow, and lifesaving equipment with lifeguards; a correct association (Ballantyne, Carr, Hughes, 2005). This suggestion shows that people know whether there are lifeguards at the beach they are at, making the beach safer.

These surveys have their limitations as they are centered on Australia, but they do provide insight into an area that has not been investigated thoroughly. However, these studies support the hypothesis that there are misconceptions with rip currents, such as their appearance. The information gained from the background provided our team with enough knowledge to further the steps to complete our project.

Chapter Three: Methodology

The goal of our project was to improve maritime safety through warning signage and the education of beachgoers. We analyzed the precautionary measures currently in place and recommended ways that the government can better warn the public of dangers. Our goal was pursued through the following objectives:

- Examine dangers and safety precautions at beaches to determine the most likely causes of drownings

- Analyze effectiveness of warnings in terms of signage characteristics

- Determine the public's knowledge of hazards and signage at beaches

The DNER provided us with a list of high-risk beaches and low-risk beaches. High-risk beaches had the most drownings while low-risk beaches had the fewest.

SAFETY PRECAUTIONS AND BEACH ANALYSIS

Signage was a focus of the project because signs are the primary source of conveying information to beachgoers. The signs have numerous features that affect how likely beachgoers are to abide by them. Color scheme, visibility, and clarity are the main characteristics (See Background – Psychology of Warnings) that influence how effective signs are at warning beachgoers. We collected data on where the signs are positioned on the beach and the languages the signs are written in. It was also important to observe any pictures on the signs because pictures can be understood by people of different backgrounds if they represent objects that are well-known, such as waves symbolizing ocean water. Some symbols are shown on the signs below:

Figure 10: Signs using well-known symbols

At each beach, two team members (Blanchard and Rutfield) conducted the signage and

beach analysis through pictures and observations. Upon arrival, pictures were taken to recreate

the layout of the beach. Also, our team recorded the GPS coordinates so the area could be

analyzed and documented more easily. After the borders of the region were identified, GPS

coordinates and pictures were taken at each warning sign. Also, our team looked for any flags

that displayed if swimming was allowed or if there were dangerous conditions in the water.

Later, we returned to these pictures to determine if precautions were deemed effective or not.

To determine the signs' effectiveness, we established a protocol. The team created a short list of guidelines that a well-located and well-positioned sign would follow:

- The sign can be seen from an entrance, where beachgoers settle, or near the danger presented

- The sign only faces the ocean if an obstacle is behind it

- The sign faces an open area

We created a table comparing "effective" signs and "ineffective" signs. "Ineffective" signs had one or more of the following characteristics:

- The sign is not well-located and well-positioned based on the guidelines listed above

- It is written in only one language

- The view of the sign is obstructed by trees, rocks, or other objects

- The sign is too faded to be understood from a distance

- Some of the lettering or pictures on the sign had fallen off or are too small

- Parts of the sign appear to be missing

- Graffiti, stickers, or damage make some of the writing or pictures difficult to see

"Effective" signs did not have any of the characteristics above, showing that they could be easily read by most beachgoers. We observed which signs had pictures, checked if the pictures represented a danger accurately, and used interviews to discover if the symbols displayed were easy for beachgoers to understand. This information was organized into a table sorted by beach and message conveyed. The final table can be seen in (Figure 14: Effectiveness of Signs) the Results chapter of this report.

Following the documentation of the signs, we surveyed the beach for features that could affect the safety of beachgoers. We searched for the following dangers at beaches: any rock

formations, large waves, and rip currents. Our team noted the locations and sizes of the rock

formations that could pose problems to swimmers. We also noted the approximate size of the

waves and confirmed the results through buoys that recorded the exact height of the waves at that

location, found through the Caribbean Coastal Ocean Observing System (CARICOOS). The

group also looked for lifeguards and buoys demarcating a swimming area that improve maritime

safety.

When the signage and safety of the beaches were analyzed, the team compared the results

of the safe and dangerous beaches. We compared the quality of the signage at each beach, the

amount of signage, whether buoys and lifeguards were used, and the dangers associated with

each beach. This made any differences between the beaches' signage and features more apparent

and helped the team find potential reasons the high-risk beaches are more dangerous.

DETERMINING PUBLIC KNOWLEDGE

We interviewed individuals on whether or not they have knowledge of the various

dangers that exist in the water. Our group interviewed both Puerto Rican residents and tourists to

acquire perspectives from multiple views. We interviewed 73 people across 18 beaches, with 40

local Puerto Ricans and 33 tourists.

In the interviews, we used a semi-standardized structure. This structure gave us easily

comparable answers, but also unplanned answers that showed personal experience. Using a semi-

structured interview ensured that we stayed on topic with our questions. However, we were also

able to delve into specific subjects with the person when the situation presented itself.

César Benoit conducted talks with locals and Spanish speakers because of his fluency in

Spanish, while George Williamson conducted interviews with English speakers and tourists. The

interviews were generally fast—less than 5 minutes each on average. To gather information on

the interviewee's background, we began with asking how often they came to the beach, where they were from, and their swimming capability. Second, the team asked if they saw the signs and followed up with questions on their understanding of the signs. Then, we asked about their knowledge on rip currents and what to do in case of an accident on the beach. The questions on rip currents included general knowledge such as how to identify and escape a rip current. These questions provided us with the public's understanding of the largest danger at the beach and they proved whether or not the interviewee knew about rip currents. Finally, we asked whether or not they checked the tides and the weather prior to visiting the beach to determine if the interviewee went to the beach with any knowledge of how dangerous the waves and currents were. The last question asked about the person's belief of whether or not the public knows about the dangers at the beach. The full interview is found in Appendix C. The team also interviewed two lifeguards at beaches as well as the Director of the Lifeguards Unit for Puerto Rico. This interview allowed us to see the actions and knowledge of beachgoers from the lifeguards' perspective. The interview for the director can be found in Appendix C. We analyzed the answers obtained through the interviews to draw our conclusions.

Analysis

We tabulated the data obtained from the interview process. The semi-standardized structure of the interview, where most questions could be answered with a yes or no, allowed for an easy tallying of some of our results. We used the following categories to record the interviewees' responses.

- **Frequency**
  - Often - This indicates the interviewee goes to the beach at least once a week
  - Vacation - The interviewee does not frequent the beach (mostly vacation)

- **Signs Noticed**

  - Yes - The interviewee noticed the safety signs in the area

  - No - The interviewee did not notice the safety signs in the area

- **Signs understood**

  - Yes - The interviewee understood the signs

  - No - The interviewee could either not see or not understand the signs due to either a language barrier or confusion

- **Swimming Capability**

  - Yes - The interviewee feels comfortable with his/her swimming ability

  - No - The interviewee does not feel comfortable with his/her swimming ability

- **Knowledge on Rip Currents**

  - Yes - The interviewee identified what a rip current is **and** how to escape safely

  - No - The interviewee could not identify a rip current and explain how to escape one

- **Rescue**

  - Call - The interviewee said they would call for help; the police if a lifeguard was not present

  - Save - The interviewee said they would attempt to save the victim themselves

- **Weather**

  - Yes - The interviewee checks the weather and tides before going to the beach

  - No - The interviewee does not check the tides and weather before going to the beach

- **Public is Aware**

  o Yes - The interviewee believes the public is aware of the dangers at the beach

  o No - The interviewee believes the public is unaware of the dangers at the beach

After these were tallied and put into tabular form we determined correlations and

analyzed the answers to complete the objective of understanding the public's knowledge.

Chapter Four: Results and Analysis

The team analyzed the safety measures, physical characteristics, and public opinion at each beach we visited. During these visits, we discovered that many areas on the north shore of Puerto Rico are very dangerous to beachgoers. Although these areas may be designated beaches for people to enjoy, they are not necessarily safe. The Atlantic Ocean pounds the north coast with rough waves and strong currents; on the contrary, the Caribbean Sea on the southern coast of Puerto Rico is much calmer. The high volume of tourists that venture to the north, particularly San Juan and Carolina, resort to using these unsafe beaches rather than safe beaches that may be further away.

HIGH-RISK BEACHES

Our team visited 11 beaches that we considered high-risk areas: La Playa de Aviones, La Poceta de Piñones, Ocean Park, Último Trolley, Crashboat Beach, Jobos Beach, La Pared Beach, Mar Chiquita Beach, La Poza del Obispo, Isla Verde Beach, and Marriott Condado Beach. Complete analyses of these high-risk beaches can be found in Appendix D.

All 11 high-risk beaches had many similar characteristics that made them dangerous; most of which were the physical characteristics of the beaches themselves. Since all of these beaches are in areas of the coast that are particularly dangerous, the wave heights and currents were especially noticeable. Every beach had strong rip currents that could cause serious problems for swimmers. The larger, more frequent waves commonly cause stronger rip currents. After a period of large, frequent waves, the water is quickly returned to the ocean through very strong currents not noticeable to the average beachgoer (65% of interviewees were unable to define and identify a rip current, as seen in Figure 17: Swimming Capability and Rip Current Knowledge). This is the reason strong rip currents occur where the water appears calm; the rip

currents drag the majority of the water near shore back into the ocean so waves are generally

smaller.

Another similar characteristic among many of these high-risk beaches are rock

formations. Some of these beaches have structures that could cause serious injury or death if

swimmers collide with them. Also, rip currents can be created when water funnels through the

rocks into tight spaces. At La Poceta, the large wave breaker splits the sea and the swimming

area, but in a time of very high swells, this wave breaker disappears under the water level.

Figure 11: Wave Breaker at La Poceta

Any strong currents would drag a swimmer straight into this formation. The same occurs

at La Poza del Obispo and Jobos. Both beaches have very large rock configurations that pose

serious threats to beachgoers who are not taking the necessary precautions. At Mar Chiquita,

there is a cross on the rocks as evidence of someone already losing a life.

Figure 12: Cross Atop a Rock at Mar Chiquita

These rock structures are just one aspect that makes these beaches high-risk, but they are a very serious problem if people do not use caution when venturing into the water. At the beaches with rock structures on the left and right of the swimming area (Último Trolley, Jobos, Mar Chiquita, La Poza del Obispo), the longshore currents can possibly drag the swimmers to the sides, parallel to the shore. Swimmers will generally not notice these currents because they will be focused on the water away from shore. However, beachgoers could be severely injured if carried into these rocks by strong waves.

Another factor that affects the safety at the beaches is wave-breakers, such as those at Marriott Condado and La Poceta. These are large, manmade rock structures intended to decrease the size and strength of incoming waves. Although they are generally effective at reducing the size and strength of waves, the breakers significantly increase the strength of rip currents. When the waves hit the structures, the flow of water continues to shore, parallel to the breakers. The rip currents in these areas intensify because the flow of water quickly changes directions after the water reaches shore.

LOW-RISK BEACHES

An important step in finding the main causes that make the previously mentioned beaches dangerous is comparing them to the seven beaches that are generally considered low-risk because of fewer drownings and rescues. Six of these beaches are balnearios, or resort beaches, and the last is a continuation of a high-risk area. They are: Balneario Seven Seas, Balneario de Caña Gorda, Balneario de Boquerón, Balneario Cerro Gordo, Balneario Punta Salinas, Balneario la Monserrate, and Costa Azul, a continuation of La Pared Beach. Complete analyses of these safer beaches can be seen in Appendix E.

These seven beaches had many similarities, but also many differences. They varied from the high-risk beaches in multiple ways as well. Of the six balnearios, five of them are Blue Flag certified. This means that they are very safe and meet several other criteria; a more detailed description of Blue Flag can be found in Appendix A. However, although they are considered safe, it is not necessarily due to lifeguards, signage, or buoys. All of the balnearios had lifeguards stands, but there were only lifeguards present during our visits to Seven Seas, La Monserrate, and Cerro Gordo. Also, the danger level and number of people present at each beach was so low that there may have not been any need for lifeguards. Nonetheless, despite each beach having multiple lifeguard stands, not all had a lifeguard present.

It was speculated that these beaches are safer because of the number and quality of signs warning beachgoers of certain dangers. However, the number of signs present and quality of the signs had no direct correlation to the safety of the beach. Balneario Seven Seas had the highest number of signs, although all the signs were only in a small stretch of this very long beach. Costa Azul, on the other hand, had no warning signs and Caña Gorda contained one sign that simply stated the basic rules of the beach. However, these beaches had so little danger that signs would

have been irrelevant. If there were any rocks in the water, every beach would have stated this danger in some way, whether by a generic sign or a sign unique to the particular beach. Caña Gorda, Boquerón, Punta Salinas, and Cerro Gordo contained small rock formations that would not injure beachgoers unless in times of strong swells, which were not likely at these beaches. Below are two variations of the signs, and a more detailed description is included in Appendix E.

Figure 13: Slippery Rock Signs

All of the low-risk beaches had buoys to mark designated swimming areas, which prevented beachgoers from entering deeper waters. La Monserrate, Punta Salinas, and Cerro Gordo, however, were the only beaches that had signs pointing to the swimming area. At the other beaches, swimmers would have to understand what the buoy lines meant without actually seeing a sign. However, the buoy lines are very simple and the consistencies of buoy lines at beaches make them an easily understood concept. In addition, a rope connects all of the buoys to show that there is a limit to the swimming area.

LOW-RISK VS. HIGH-RISK BEACHES

Our team found that the differences in signage and environmental hazards vary from beach to beach, and vary even more from low- to high-risk. Some of the most dangerous beaches

have a high number of signs warning the beachgoers of dangers and some of the very safe beaches have minimal or zero signs warning beachgoers. Through our analysis, the majority of low-risk beaches have fewer warning signs than the dangerous beaches, as seen in the spreadsheet below, which shows the total number of signs on each beach that our team visited and the total number of "effective" signs. In this spreadsheet, beaches that were considered low-risk are italicized. A sign was deemed effective after going through the protocol explained in the Methodology chapter. We tabulated that 46% of people notice signs and deemed 55% of all warning signs effective. From these calculations, our team concluded that signage plays a significant role in warning the public of hazards because people are not observing signs and putting themselves at risk. These statistics show that signs are not placed in relevant locations and are not legible enough to effectively warn beachgoers. Although the signage may affect safety, the main factors that make these beaches dangerous or safe are their physical characteristics.

Signs	No Swimming		Strong Currents		Flag Definitions		Dangerous Shorebreak		No Swimming past Buoys		Don't Pass		Rip Current Escape Instructions	
Is the Sign Effective?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Condado	2		2	2	2		1	2						
Crashboat									1					
Playa Jobos				2			1	1				1		
La Poza del Obispo			1				1							1
Mar Chiquita			1				1							
Último Trolley									1					
La Pared			1				2							1
Isla Verde									1	1				
Ocean Park			1	1										
La Poceta de Piñones							5							
La Playa de Aviones	1		1	1			1							
Balneario Cerro Gordo						3								
Balneario de Caña Gorda						1								
Coast Azul														
Balneario la Monserrate					1	1								
Balneario Seven Seas					1	1			1	1				
Balneario de Boquerón						2								
Balneario Punto Salinas						2								
Total of each sign	3	0	7	6	2	12	12	3	4	2	0	1	0	2
% each sign good condition	100		54		14		80		67		0		0	

Figure 14: Effectiveness of Signs

Signs	Rocks		No Diving		Lifeguard is Absent		Swimming Area		Total Signs for Beach	Total in Good Condition	% in Good Condition
Is the Sign Effective?	Yes	No	Yes	No	Yes	No	Yes	No			
Condado									11	5	45
Crashboat									1	1	100
Playa Jobos									5	1	20
La Poza del Obispo	1								4	3	75
Mar Chiquita	1								3	3	100
Último Trolley		1							2	1	50
La Pared									4	3	75
Isla Verde					1		1	2	6	3	50
Ocean Park									2	1	50
La Poceta de Piñones	3								8	8	100
La Playa de Aviones									4	3	75
Balneario Cerro Gordo	1						2		6	3	50
Balneario de Caña Gorda						1			2	0	0
Coast Azul									0	0	No signs
Balneario la Monserrate									2	1	50
Balneario Seven Seas	2		1						7	5	71
Balneario de Boquerón		2							4	0	0
Balneario Punto Salinas								2	4	0	0
Total of each sign	8	3	1	0	1	1	3	4			
% each sign good condition	73		100		50		43				
Total of all signs	75										
Total in good condition	41										
% all signs good condition	55										
Total dangerous beach signs	50										
% good signs dangerous	64										
Total safe beach signs	25										
% good signs at safe beaches	36										

Figure 15: Effectiveness of Signs

The physical factors, such as waves, currents, and rock formations, are the primary reasons that there are differences in safety at the beaches. From our team's reconnaissance and interviewing, high-risk beaches have environmental factors that are not present at low-risk beaches (See Appendices D and E for detailed information gathered at the beaches). The Balnearios all had very small waves and weak current, indicating that the danger level is very low in these areas. Although the low-risk beaches had fewer signs, they are much safer because the dangers are minimal. The dangers at high-risk beaches are much more severe, so the precautions authorities take to warn beachgoers of dangers only play a small role. Many of the highest-risk beaches, such as Aviones or La Pared, simply had much larger waves and stronger currents than the safest beaches.

At many beaches, the signs were in locations away from the shoreline and main entrances. This makes it unlikely that beachgoers will notice them. Many beaches had multiple entrances for beachgoers; almost all of which did not have warning signs. From our reconnaissance, we noticed that many beaches had entrances in which a person could enter without seeing any signs. More signs at beaches may cause people to heed the warnings because there is more emphasis on each danger and people would actually observe the signs. The locations of signs should also be in a more visible area instead of behind the region where beachgoers gather. Signs in the middle of beaches would better portray the dangers present at the beach.

PUBLIC AWARENESS

To determine public knowledge of dangers at the beach, the team interviewed both Puerto Ricans and tourists at the beaches visited. Our surveys included 55% people who live in Puerto Rico; the remaining were tourists from the mainland United States, with the exception of two

people from Brazil and two people from Australia. The following areas of the interview helped

us achieve our objective of determining the public's knowledge on the hazards and the signage at

the beach. The interview (attached in Appendix C) asked specific questions on signage,

swimming capability, rip currents, accident situations, whether the beachgoers check the weather

and tides, and their belief on the public's awareness.

Sign Awareness

	Signs Noticed		Signs Understood	
	Yes	*No*	*Yes*	*No*
Ocean Park	1	3	1	3
Último Trolley	1	0	1	0
La Poceta de Pinones	0	2	0	2
Playa Aviones	1	0	1	0
La Pared	4	3	4	3
Mar Chiquita	8	0	8	0
La Poza Del Obispo	2	0	2	0
Playa Jobos	4	12	4	12
Isla Verde	3	1	1	3
Crashboat	1	5	1	5
Condado	2	2	1	3
Total for Dangerous Beaches	27	28	24	31
Percentages	Yes 49%		Yes 44%	
Balneario Caña Gorda	4	5	4	5
Balneario de Boquerón	1	5	1	5
Balneario 7 Seas	2	2	0	4
Cerro Gordo en Vega Alta	1	1	1	1
Total for Safe Beaches	8	13	6	15
Percentages	Yes 38%		Yes 29%	
Total	35	41	30	46
Percentages	Yes 46%		Yes 39%	

Figure 16: Public Awareness of Signs

Signage at the beach is generally missed according to the 54% of interviewees stating

they did not notice the signs (51% of beachgoers at dangerous beaches). The reason for this may

be that signs are not placed in ideal locations; 55% of all signs are considered effective through

the protocol explained in the Methodology. If the signs are hidden behind trees, away from the beachgoer area, or not placed near entrances, people can easily miss them. Also, the signs may not attract the attention of the public. They should have a distinctive color scheme to catch the beachgoers' attention. The interviews also demonstrate that more people noticed and understood signs at the dangerous beaches, with 49% of interviewees noticing the signs and 44% seeing and understanding them. At the low-risk beaches, 38% saw the signs and 29% saw them and understood their meanings. Given our small sample size, the difference between the percentages is statistically insignificant. However, it appears that more people notice the signs at dangerous beaches than safe beaches. Also, the number of people who see and understand the signs is very close to the number of people who see them. This fact shows that understanding the signs is not as severe a problem as noticing them. This data agrees with the analysis of beaches.

Swimming Capability and Rip Current Knowledge

	Swimming Capability		Knowledge on Rip current	
	Yes	*No*	*Yes*	*No*
Ocean Park	2	2	1	3
Último Trolley	0	1	0	1
La Poceta de Pinones	2	0	0	2
Playa Aviones	0	1	0	1
La Pared	7	0	3	4
Mar Chiquita	8	0	7	1
La Poza Del Obispo	2	0	0	2
Playa Jobos	15	1	4	12
Isla Verde	3	1	4	0
Crashboat	1	5	0	6
Condado	3	1	4	0
Total for Dangerous Beaches	43	12	23	32
Percentages	Yes 78%		Yes 42%	
Balneario Caña Gorda	5	4	2	7
Balneario de Boquerón	2	3	0	6
Balneario 7 Seas	3	1	0	4
Cerro Gordo en Vega Alta	2	0	1	0
Total for Safe Beaches	12	8	3	17
Percentages	Yes 60%		Yes 15%	
Total	55	20	26	49
Percentages	Yes 73%		Yes 35%	

Figure 17: Swimming Capability and Rip Current Knowledge

The majority of the interviewees, 73%, stated they were comfortable swimming in the ocean. Despite this, 65% of interviewees at all beaches stated that they did know either how to identify and escape a rip current. These two numbers show that most people think they can swim in the ocean but most do not know what a rip current is. This is a major problem because rip currents are a serious issue in Puerto Rican waters. According to our interviews, more people knew how to swim at the high-risk beaches versus the low-risk beaches, with 78% and 60% respectively. From the interviews, the percentage of people at the dangerous beaches who knew what a rip current was and how to escape one was more than twice that of the safer beaches.

Although both percentages are low, 42% for high-risk and 15% for low-risk, this exhibits that

beachgoers at dangerous beaches are more knowledgeable on rip currents.

Opinions in Times of Emergency

	Rescue	
	Call	*Save*
Ocean Park	3	1
Último Trolley	1	0
La Poceta de Pinones	0	2
Playa Aviones	1	0
La Pared	4	3
Mar Chiquita	6	2
La Poza Del Obispo	2	0
Playa Jobos	14	2
Isla Verde	0	4
Crashboat	6	0
Condado	4	0
Total for Dangerous Beaches	**41**	**14**
Percentages	**Call 75%**	
Balneario Caña Gorda	6	3
Balneario de Boquerón	6	0
Balneario 7 Seas	4	0
Cerro Gordo en Vega Alta	1	0
Total for Safe Beaches	**17**	**3**
Percentages	**Call 85%**	
Total	**58**	**17**
Percentages	**Call 77%**	

Figure 18: Opinions in Times of Emergency

We also questioned the interviewees on what their actions would be in the case of an

emergency in the ocean, such as a possible drowning. At the dangerous beaches, 25% of people

said they would try to save the person in trouble themselves. At the low-risk beaches, 85% of

people claimed they would call the lifeguard for help in the case of an emergency. More people

would call for help at the low-risk beaches with lifeguards present because lifeguards are not

present at the high-risk beaches. According to our interviews, beachgoers are less inclined to endanger themselves if a trained individual could more effectively save the person in danger.

Weather Knowledge Prior to Visiting the Beach

	Weather	
	Yes	*No*
Ocean Park	1	3
Último Trolley	0	1
La Poceta de Pinones	0	2
Playa Aviones	1	0
La Pared	4	3
Mar Chiquita	2	5
La Poza Del Obispo	2	0
Playa Jobos	14	2
Isla Verde	2	2
Crashboat	2	4
Condado	2	2
Total for Dangerous Beaches	**30**	**24**
Percentages	**Yes 56%**	
Balneario Caña Gorda	2	7
Balneario de Boquerón	6	0
Balneario 7 Seas	2	2
Cerro Gordo en Vega Alta	1	1
Total for Safe Beaches	**11**	**10**
Percentages	**Yes 52%**	
Total	**41**	**34**
Percentages	**Yes 55%**	

Figure 19: Knowledge of Weather

We also asked the interviewees if they check the weather to determine if they would be aware of the swimming conditions. When surveyed, 55% said they checked the forecast and the remaining interviewees estimated the weather conditions. The weather can have a serious effect on wave size and strength of currents, so knowledge of weather conditions prior to entering a beach can help prevent possible drownings.

Opinion on Public Awareness

	Public is Aware	
	Yes	*No*
Ocean Park	2	2
Último Trolley	0	1
La Poceta de Pinones	0	2
Playa Aviones	1	0
La Pared	0	3
Mar Chiquita	0	8
La Poza Del Obispo	0	2
Playa Jobos	8	8
Isla Verde	4	0
Crashboat	3	3
Condado	4	0
Total for Dangerous Beaches	**22**	**29**
Percentages	**Yes**	**43%**
Balneario Caña Gorda	2	7
Balneario de Boquerón	2	4
Balneario 7 Seas	2	2
Cerro Gordo en Vega Alta	0	2
Total for Safe Beaches	**6**	**15**
Percentages	**Yes**	**29%**
Total	**28**	**44**
Percentages	**Yes**	**39%**

Figure 20: Public Opinion on Each Other

When asked if interviewees thought the majority of people knew about dangers at the beach, 61% believed that most people did not have knowledge of the dangers of the beach. This is very similar to the percentage of people who do not know what a rip current is, which is 65%. At the dangerous beaches, a higher percentage of people interviewed believed that the general public does not know about the dangers of the beach with 57%, compared to 71% at low-risk beaches.

INVESTIGATION OF SAFETY PROTOCOLS

Lifeguards are usually the first to respond to maritime emergencies and have a major impact on beach safety. The team investigated the safety protocols lifeguards complete by interviewing the director of the Lifeguards Unit, Mr. Augusto Gigante. We asked him questions on what the requirements are for lifeguard certification, what equipment lifeguards have available, and what recommendations he had to improve beach safety. To receive certification, all Puerto Rican lifeguards must complete the program designed by the United States Lifesaving Association, which includes a 500 meter swim, at least 40 hours of training, CPR training, and first aid training (The United States Lifesaving Association , 2011). Another requirement includes knowledge on how to escape a rip current; not theoretically, but practically as well. In order to obtain the hands-on experience, trainees are placed into rip currents and must escape. The ability to escape a rip current is an important skill because they are responsible for many drownings and rescues in Puerto Rico. There are also 42 National Park Company (NPC) certified lifeguards on the island, but many more that specific municipalities finance. The NPC has their lifeguards stationed only at balnearios, of which there are only 11 on the entire island. The combination of having at least three lifeguards at each balneario, and having few environmental hazards makes these beaches very safe. Five beaches that our team visited have been awarded Blue Flag status. A more detailed description of Blue Flag certification can be seen in Appendix A.

Mr. Gigante also gave us information on what equipment lifeguards possess. Gear the NPC provides lifeguards includes: a rescue tube and board, spinal board, whistle, defibrillator, and a mask for CPR, which are standard at every balneario. In addition, Boquerón and la Monserrate have an ambulance ready in case of serious emergency. Boquerón also has an

infirmary on site. Additionally, some other balnearios have jet skis ready in case of an emergency, such as a rip current pulling a swimmer too far offshore. This basic equipment alone does not suffice, especially at the beaches that do not have jet skis and ambulances.

Mr. Gigante also made some suggestion that he felt would improve beach safety. The first of which is that more lifeguards are needed. He suggested that the number of lifeguards at beaches should depend on the size of the beach and the number of visitors. He mentioned that in the United States, the rules say a lifeguard should be stationed every 200 meters. Some of the local surfers also realized the shortage of lifeguards and took the necessary certification courses so they could save lives in their community. In La Pared, a surfer beach in Luquillo, the municipality even bought them jet skis to use in case of an emergency. Lifeguards are extremely important because they can respond to drownings the fastest. Local police claim their accident response time is 15 minutes but usually take longer, according to Mr. Gigante and some local residents. Neither the NPC nor the DNER have a record of drownings or rescues. This makes it difficult for the Lifeguard Unit to request funding and grants for more and better equipment. A possible solution for this might be to require lifeguards to present supervisors with a daily report on activities, such as any rescues or other problems in the water.

In order to acquire a different perspective, the team interviewed two lifeguards at Balneario la Monserrate and Balneario Seven Seas. We asked them the main causes of drownings and how the drownings can be prevented. In both cases, they stated that drunkenness, negligence by parents, health issues, and lack of swimming ability were the main causes of the bulk of the rescues and drownings.

As stated in the Background chapter, intoxicated individuals are more likely to partake in unsafe swimming habits that put themselves at risk. The negligence by parents also plays a major

role. The two lifeguards we interviewed indicated that parents let their children run free around the beach because they feel that it is the lifeguard's job to watch their children as they play dominoes or drink with friends. Natural ailments, such as heart attack or stroke, have also led to some rescues and deaths in the ocean. The lifeguards also mentioned that many local Puerto Ricans do not know how to swim. Some men try to challenge themselves and impress others by swimming to the buoys that designate the swimming area. This leads to many rescues because the swimmer gets nervous or tired and needs immediate assistance. Many parents cannot teach their children how to swim because they cannot swim themselves. Currently, there is no commonwealth-wide school requirement forcing children to learn how to swim, so many do not get the opportunity.

When asked how these incidents could be prevented or mitigated, both lifeguards responded with better education and equipment. Holding swimming lessons at the beach or public pools can reduce the number of total victims. It could also help stop the cycle of inability to swim that currently exists in families. In addition, education on beach dangers such as rip currents and strong waves may cause individuals to reconsider taking a dangerous risk. The lifeguards also lack the necessary equipment to properly protect the beachgoers. Both only had a flotation device, whistle, spinal board, and first aid kit. They do not even have radios to communicate with each other and are forced to resort to cell phones and hand signals.

There is also a lack of respect by the beachgoers toward the lifeguards. One lifeguard described an incident in which he told a beachgoer that dogs were not permitted to walk on the beach. The beachgoer responded with hostility and the incident quickly escalated; the lifeguard was forced to call the local authorities who arrived 20 minutes later. When they finally arrived, they resolved nothing and simply told everyone to stop arguing. Once the officers departed, the

angry beachgoer continued to ignore the lifeguard. This exemplifies the general lack of respect

towards the people who make sure others are safe, and the inability to enforce the rules. A better

educated public, better equipment for lifeguards, and a more effective method of enforcing laws

would help reduce the number of maritime accidents.

Chapter Five: Conclusions and Recommendations

From the data that our team gathered through beach analysis and interviews, we concluded that there are few factors that affect beach safety. Although signage is present at almost all sites, the overall percentage of "effective" warning signs at safer beaches is lower than that at dangerous beaches and the total number of signs per beach is lower at the safe beaches. Also, the percentage of people that notice the signs is lower at safe beaches than dangerous beaches. This shows that signage is not a determining factor in making a beach dangerous; however, signage can improve safety of a beach.

Overall, signage is ineffective at warning the beachgoers of dangers. People are not noticing the signs that are currently in place at beaches around the island because they are not in ideal locations and do not attract the attention of beachgoers. Although signage is not what differentiates high-risk beaches from low-risk beaches, more effective signage can better improve the safety at the most dangerous sites. The percentage of "effective" signs at high-risk beaches (64%) shows that there can be improvement. Having more signs in better locations would emphasize the dangers more, meaning there would be a better chance for beachgoers to take note. This would likely prevent beachgoers from putting themselves in danger and may reduce the number of drownings at high-risk sites.

The environmental factors themselves are the main reason for drownings in certain areas and not others. The safest beaches are in locations that do not have dangerous conditions, such as large waves or strong currents. The most dangerous beaches, Marriott Condado, La Pared, and the beaches in Loiza, have significant rip currents and large waves. Authorities cannot change the beaches' environmental characteristics.

Interviews showed that people did not notice the signs and do not know what rip currents are. This indicates that beachgoers do not know the dangers associated with strong currents and the main form of teaching them is not sufficient. With these data, we can assume that informing the public of the dangers of the beach is a reasonable step. With these conclusions we have assembled the following recommendations:

SIGNS

1. **We recommend using spray-paint resistant coating to cover all signs.**

   The coating is readily available at many hardware stores and is relatively cheap. It would take some time to coat each individual sign but many last for years.

2. **We recommend rip current escape signs be placed at all beaches.**

   These signs should be placed in area where they are easily seen. These signs will cost money and will take time to erect but will be instrumental in teaching the public about rip currents. An example of a sign can be seen below:

Figure 21: Rip Current Escape Sign

3. **We recommend the same sign be placed on both sides of a double-sided sign to increase the likelihood that people will see the message.**

When a sign is double-sided, people may not see both sides because they may assume that both sides portray the same message. However, on many Puerto Rican beaches, double-sided signs show two different warnings. People are less likely to miss messages if the same warning is put on both sides.

4. **We recommend signs be improved in many different ways: location, color, and size. Also, a future project team to determine their effectiveness.**

   i) Signs should be placed no more than 100 meters apart and near entrances where beachgoers are likely to see them.

   ii) Some of the signs are brown with white writing and do not stand out. They should be more conspicuous and in colors such as white with black writing, or in any other bright color that will grab the attention of beachgoers. Along with being more attractive to the eye, the message still needs to be portrayed effectively.

   iii) Larger signs would also help with visibility because they will be more attractive to people and will be seen from further away. Signs that are 1.00 meters x 0.75 meters in size will be more effective than most current signs.

   iv) A possible IQP could include designing new signs and surveying the public to determine if the new signs are more effective than the ones currently in place.

5. **We recommend using a color-coded flag system at high-risk beaches to indicate how dangerous the water is.**

   Creating a flag system defined in both in English and Spanish, similar to those at the balnearios, will help warn beachgoers of dangers because they are more noticeable than a sign might be. For beaches where swimming is not permitted because of natural geomorphologic structures, a permanent red flag should be placed along with a sign

explaining it. For the other beaches, volunteers from the areas nearby can be recruited and instructed to raise certain flags depending on the weather conditions.

INDIVIDUAL BEACHES

1. **We recommend changing the signs used at Playa Jobos.**

   Playa Jobos had the worst signage of the dangerous beaches with four of five signs having poor quality. Three signs that are faded or have too much graffiti should be replaced; while a fourth sign warning of "dangerous shorebreaks" should be moved to a more visible area. Completely replacing signs may cost the DNER money, but could greatly increase the effectiveness of the signs on this beach.

2. **We recommend adding more signs to Ocean Park Beach.**

   Ocean Park is a relatively long beach with several entrances, but it only has two signs (warning beachgoers of strong currents), making it unlikely that beachgoers will see them. One or two more signs positioned near entrances from the street should help to tell beachgoers about the strong currents.

3. **We recommend adding a sign to the boating side of Crashboat Beach indicating where the swimming area is located.**

   Crashboat Beach is separated into two areas: one area for swimming and the other for boating. Unfortunately, the picnic tables and volleyball courts are on the boating side of the beach so people tend to swim in that area. Signs need to be put up that clearly indicate which section of the beach is for swimming. These signs would best be added at the front of the parking lots so beachgoers see them as they enter.

4. **We recommend placing "strong current" signs to the relevant areas at La Pared.**

La Pared is one of the more dangerous beaches in Puerto Rico. A volunteer first responder stated that there have been 282 rescues at La Pared since 2007 and that most of those people were in danger because of rip currents. However, in the entire stretch of the beach at La Pared, only one "strong current" sign is present. In addition, the section of the beach past the rock wall is an open entrance from the street where people can enter where they please. Due to this and the dangers presented at La Pared, signs should be placed at a maximum distance of 75 meters from each other so all visitors are able to view the signs. Also, rip current escape plans should be placed on all signs, if feasible.

MISCELLANEOUS

1. **We recommend creating and distributing pamphlets to the public that warn about beach dangers.**

   To increase awareness about rip currents, one of the largest dangers in the ocean, the team recommends that pamphlets be given out to the public. The pamphlets should include how to identify possible rip currents at the beach and how to escape a rip current if caught in one. The brochures could be given to hotels, making them available to tourists. Another efficient place for the distribution of pamphlets would be the newly implemented cigarette disposal areas, which have been successful in their usage. Implementation of pamphlets would cost money to print and locate areas for them. They could be ignored or go unnoticed by the public just as signs do, but this would be a good complement to signs to increase beach awareness. An issue with working with the hotels is the hotel management may see passing out pamphlets on the dangers of the ocean as a threat to business, causing them to have no interest.

2. **We recommend lifeguards complete "daily activity reports" to document any occurrences at the beach.**

   Currently, the United States Lifesaving Association (USLA) and the DNER do not have any records of rescues or drownings. If lifeguards completed "daily activity reports" every day when their work was finished, the organizations would have complete records of the day-to-day operations and occurrences at the beaches where lifeguards are present. The lifeguards could drop these forms in a type of locked box in the lifeguard stand where they would be taken by a lifeguard official weekly for documentation. These records could be used to persuade the government to give the DNER and the USLA additional funding by providing evidence of continuing problems at the beaches.

3. **We recommend buying cameras with GPS ability to document all signs.**

   A camera with the ability to record GPS coordinates exportable to computers would be useful for the database and its later versions. The Olympus Stylus TG2 is an excellent choice due to its shock-proof, water-proof, and dust-proof design. The GPS coordinates can be recorded with the picture to improve ease of entering values into the database. Poor signage can be the result of accidents in the water and this camera is one part of a healthy database that will help keep signs in good condition. This version can be purchased for $330-$400.

4. **We recommend fines be given to violators of prohibited swimming areas.**

   A $50 fine should be given out to individuals who swim in non-designated swimming areas. This includes swimming outside of marked buoy lines and beaches where swimming is not allowed. Fines would be given out by lifeguards and police officers.

WHAT WE LEARNED

1. **Technology can greatly help with the organization of government agencies.**

   Government agencies have to gather data on a large population of people and places. Puerto Rico, for example, creates and maintains records on over three million living citizens as well as visitors and people who have passed away. Technology can help the government organize this information through the use of databases. Government agencies may also have to communicate with various parts of the region they govern. Technology can make this communication much faster with electronic mail and mobile telephones. These technologies make communicating with other parts of the agency much more efficient.

2. **Even with increases in science, technology, and knowledge of the coast, drowning is still a serious problem.**

   With the recent increase in technology, one could assume that the unneeded deaths of civilians in the ocean would decrease with the speed of knowledge being shared. Technology has no effect on drowning prevention at this time, while there are some ways the public can be reached. Cell phones and other forms of communication are not being used to inform the public of the dangers presented at the beaches, such as strong currents. Drowning is still very much so a societal issue where education of these dangers is key to prevent beachgoers from entering unsafe water.

3. **Steps that the government takes to prevent drownings are not as effective as desired because people will ignore them.**

   At many beaches, it is obvious that people ignore the warning signs in place. Although signage can be improved at many beaches and people are not noticing the signs, many

precautions are ignored. At Marriott Condado, there are signs and flags that show swimming is completely prohibited at the beach. However, many people still swim in the water despite the forbiddance. Also, lifeguards stated that they are ignored even though they are trying to make the beach safer for everybody. These two small examples show that often people will do what they desire, despite any steps that the government or different agencies have in place. The DNER can improve beaches with as many signs or precautions that they feel are necessary; however, the responsibility is on the beachgoers to heed these warnings.

4. **Interviewees' knowledge was very similar among Puerto Ricans and tourists.**
   Independent of ethnic background, both locals and tourists had similar knowledge on beach safety. Although the majority of people in both groups felt they could swim well, they did not understand what a rip current is and how to escape one. They also did not notice the signs but were able to understand them when they did. This reflects not only the Puerto Ricans' lack of understanding of beach dangers, but also some of the tourists that visit the island as well. A better job needs to be done on educating the locals and visitors as well.

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Appendix A

SAFETY CERTIFICATIONS

Many areas primarily use signage to inform individuals of dangers at the beach. In addition, certifications have been created in order to show the public which beaches have the safest conditions. The two main certifications are Blue Wave (U.S.) and Blue Flag (primarily international). Puerto Rico uses Blue Flag certifications for many of their balnearios.

Blue Wave

Due to the enjoyment that people receive from beaches, the ways that the coast is protected has become a more serious topic. Blue Wave is a rare certification that American beaches can garner in recognition of their increased steps taken to protect the environment. Many citizens put cleanliness as one of the top reasons they choose a specific beach, which is why the Blue Wave Campaign was created by the Clean Beaches Council (McLeod, Evans; 2005). Blue Wave certified beaches meet specific requirements in these fields: water quality, beach conditions, beach hazards, services, habitat conservation, public education, and erosion management. If a beach has proven its worth and received this certification, a Blue Wave flag is flown to show users its prestige.

Blue Flag

In order to assure citizens that beaches are as safe as possible, many countries have adopted Blue Flag Certification. This is an honor given to beaches by the Foundation of Environmental Education and the Blue Flag Coordination. Blue Flag is the most internationally known and respected certification that a beach can earn (Blue Flag, 2013). Using an international set of guidelines is effective because the owners of eligible beaches understand exactly what

precautions to take in order to receive the accolade. Although this is not a recognized certification in the continental United States, Blue Flag operates in 46 countries and commonwealths around the world, including Puerto Rico. Due to the rigorous criteria and need for continued excellence, this certification is very difficult to receive. In order to obtain the Blue Flag certification, beaches must meet criteria in four main aspects: environmental education, water quality, environmental management, and beach safety.

Environmental Education:

Educating citizens has proved its importance in creating a strong base for marine safety. Citizens must be made aware of different methods to keep the beaches clean and the water quality as high as possible. To complete this criteria, at least five educational events must be held to promote beach safety in order to achieve and uphold Blue Flag status (Blue Flag, 2013). Also, all educational values must be posted or made aware to the public to further ensure that the citizens understand how to maintain a safe beach.

Water Quality:

The second criterion that a beach must meet to gain Blue Flag recognition is water quality and its level of pollution. The organization has a way to test for the amount of pollution in the bathing water. The quality of water is determined through water samples, which are always taken from a location where the most bathers swim for the most accurate results (Blue Flag, 2013). If water quality was determined in a location where there are no swimmers, results would be skewed because human-related impacts on the environment would not be factored in.

Environmental Management:

The third criterion that the beaches must show sufficiency is environmental management. Beaches and their surrounding areas must be clear of any type of litter, and also must obey different rules on how waste is dealt with. In addition, natural phenomenon, such as algae or plankton formation, must be left to thrive (Blue Flag, 2013). Dumping harmful chemicals into the water will violate the criteria. In Puerto Rico, one of the main environmental factors that affects a Blue Flag award are the coral reefs. The reefs would need to be protected in order to meet Blue Flag level of excellence because they have a large role in tourism. People from around the world go to Puerto Rico to snorkel at the reefs.

Safety:

The last of the four components of a certified Blue Flag beach is the safety. All beaches that have Blue Flag certification have lifeguards, although the number of lifeguards varies from beach to beach based on size. The lifeguard must also have emergency first-aid gear at all times.

In addition to human safety, every beach must have environmental management plans in case any pollution arises (Blue Flag, 2013). This is directly related to the environmental management portion of the Blue Flag requirements. With emergency plans in place, it is easier to control the pollution levels and always have a high water quality.

In addition to achieving the certification, beaches must maintain Blue Flag level of excellence. Starting this year in 2013, if a beach loses its Blue Flag certification, they must meet the required standards for the following four years in order to be eligible for recertification (Blue Flag Beaches). This ensures that the beaches' excellence will be maintained year after year.

Appendix B

DATABASE MANUAL

This database is used to document drowning incidents and signage at beaches. It is contained in a shared folder.

LAYOUT

The database is a system of folders and subfolders. The main folder is labeled "Database." Inside this folder is two separate folders, one called "Database" and one called "Pictures." Each of these subfolders contains further subfolders, each of which is a municipality. In turn, these subfolders all have their own subfolders, each of which represents a different beach within the municipality. Within the "Pictures" subfolder, the beach folders contain photos of signs at the beaches. In the "Database" subfolder, the beach folders contain two Microsoft Excel documents, one for signage and one for drownings. Each sheet in a signage document represents a different sign and each sheet in a drowning document represents a different incident.

The diagram below shows how these folders are organized:
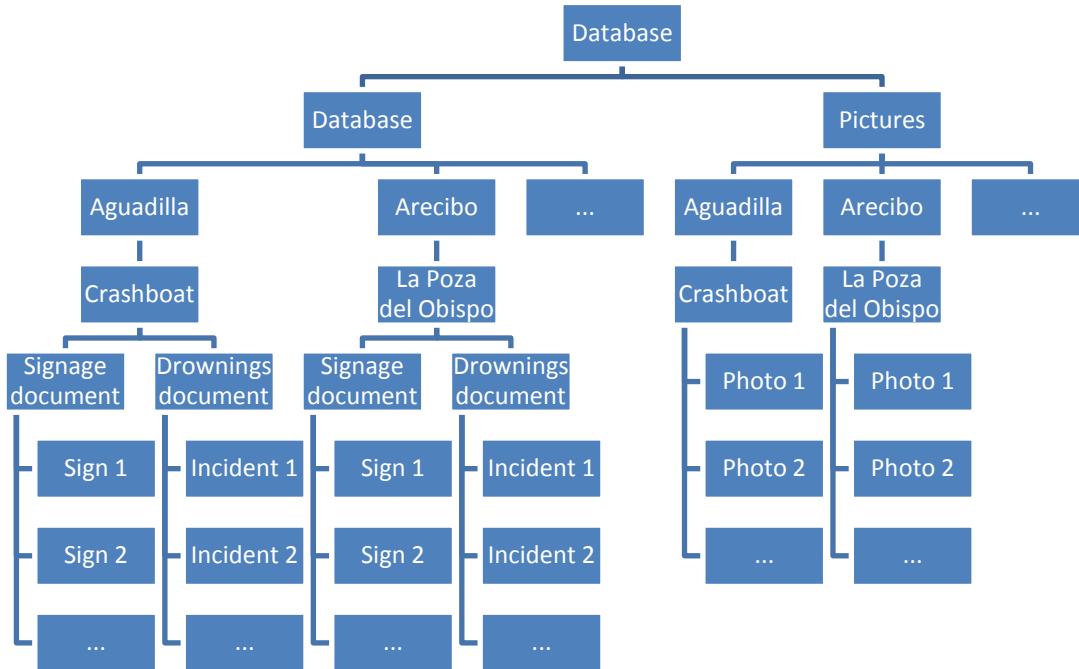
VIEWING INFORMATION ON A SIGN

To view information on a particular sign, the user must know which beach the sign is located as well as the beach's municipality. To access the information:

1. Double-click on the main "Database" folder.
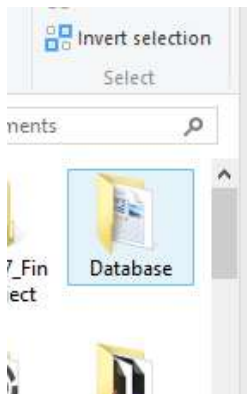
2. Double-click on the "Database" subfolder.
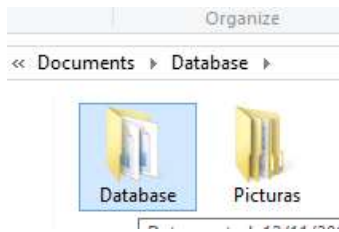
3. Double-click on the subfolder with the beach's municipality.

4. Double-click on the subfolder with the beach's name.

5. Open the "Signage" document.

6. Find the Excel Sheet that represents the sign the user is looking for. The user can scroll

   through and view the different sheets using the arrows and tabs at the bottom of the excel

   document.
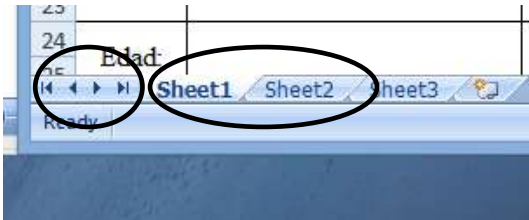
VIEWING INFORMATION ON A DROWNING INCIDENT

To view information on a particular drowning incident, the user must know which beach

the incident occurred as well as the beach's municipality. To access the information:

1. Double-click on the main "Database" folder.

2. Double-click on the "Database" subfolder.

3. Double-click on the subfolder with the beach's municipality.

4. Double-click on the subfolder with the beach's name.

5. Open the "Reporte de Ahogamiento" document.

6. Find the Excel Sheet that represents the incident the user is looking for. The user can
   scroll through and view the different sheets using the arrows and tabs at the bottom of the
   excel document.
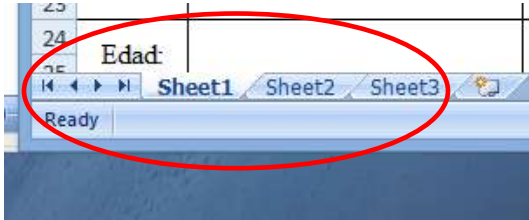
CREATING A NEW MUNICIPALITY OR BEACH

In order to create a new municipality or beach, the user must add a new folder. To create
a new folder:

1. Navigate to where the folder should be located.

2. Right click on the window away from the icons.

3. In the menu that appears, go to New and click "New Folder."

4. Type in the name of the municipality or beach that folder represents.

5. Click away from the folder. If the folder is a municipality and the user wants to add a
   beach to it, continue to steps 6 and 7.

6. Double-click on the newly-created folder.

7. Repeat steps 2-5 to create a beach.

ADDING AN EXCEL SPREADSHEET

If a new beach is created in the Database subfolder, it will require one Excel document for drownings and one for signage. To create the documents for a beach:

1. From the main "Database" folder, double-click on the Database subfolder and click "Plantilla de Reporte de Letreros" only once.

2. Press Ctrl and C simultaneously (Copy).

3. Navigate into the new beach's folder.

4. Press Ctrl and V simultaneously (Paste). The "Plantilla de Reporte de Letreros" document should appear in the folder.

5. Right-click the document and click "Rename."

6. Rename the document "Letreros."

7. Repeat steps 1-5 with the document "Reporte de los Ahogos" and rename it as "Reporte de Ahogamiento."

ADDING A TEMPLATE TO AN EXCEL DOCUMENT

Each sign and drowning incident has its own Excel sheet within an Excel document. To add a template to a document:

1. Navigate to and open the Excel Document.

2. Ensure that none of the sheets are blank. If one is, continue to step 5.

3. Use the left and right arrows next to the sheet tabs to scroll to the rightmost sheet. To the right of it this icon will appear:
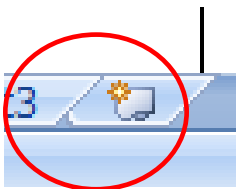
4. Click that icon and a new sheet will appear.

5. Click on the new sheet.

6. Navigate to the Database subfolder within the Database's main folder.

7. Open "Reporte de los Ahogos" if adding a sheet to "Reporte de Ahogamiento" OR open

   "Plantilla de Reporte de Letreros" if adding a sheet to "Letreros"

8. Click within the document that was just opened.

9. Press Ctrl and A simultaneously.

10. Press Ctrl and C simultaneously.

11. Go back to the document that the user is adding a sheet to.

12. Click the most upper-left cell of the new sheet.

13. Press Ctrl and V simultaneously.

14. Fill in the information as needed.

15. Right-click on the tab for the sheet.

16. Rename the sheet.
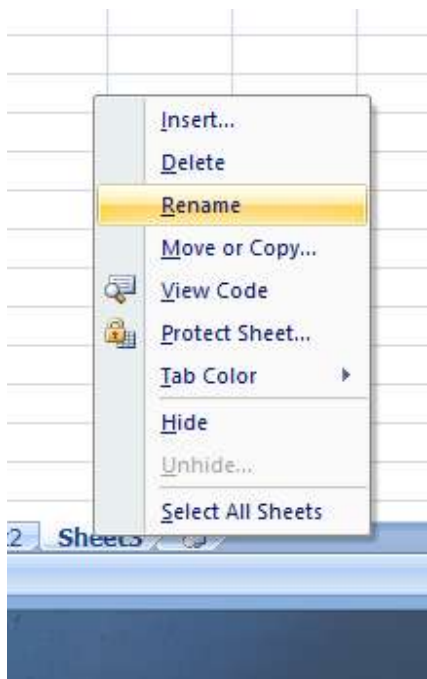
RENAMING A SHEET

The current protocol for renaming a sheet in a "Letreros" document is to name it after the sign it represents followed by the smallest number that has not yet been used. For example: The third "Oleaje Fuerte" sign at a beach will be named "Oleaje Fuerte 3" while the first one is named "Oleaje Fuerte 1."
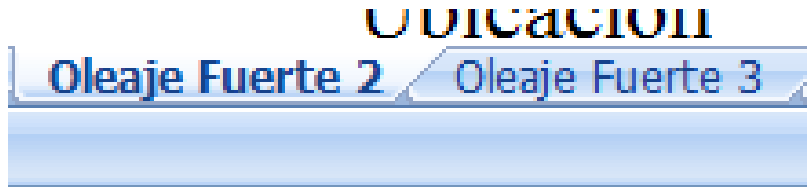
The protocol for renaming a sheet in a "Reporte de Ahogamiento" document is to name it after the victim.

NAMING AND ORGANIZING PICTURES

The pictures of the individual signs are organized in subfolders within the "Pictures" subfolder, first by municipality and then by beach.

The names of the photos are created with the following protocol:

Type of Sign_Number_Beach_Municipality_Date photographed

If there are multiple signs in a picture, they are renamed:

Type of Sign_Number-Type of second Sign_Number_Municipality_Date photographed

In this code, the number of the sign is the same as the number in the sign's sheet name.

The following tables show the codes for types of signs, municipalities, and beaches:

Type of Sign:

Area de Bañista	AB
Compañia de Parques Naturales	CPN
Corrientes Fuertes	CF
Definicion de las banderas	DB
No Bañista	NB
Oleaje Fuerte	OF
Peligroso Area Rocosa	PR
Prohibido Arrojar	PA
Prohibido por ley nadar fuera del area de boyas	PB
Reglas de la Playa	RP
Resbala Area Rocosas	AR

Beach:

Aviones	AV
Balneario de Boquerón	BO
Balneario Caña Gorda	CG
Balneario Cerro Gordo	CE
Balneario la Monseratte	MO
Balneario Punta Salinas	PS
Balneario Seven Seas	SS
Costa Azul	CO
Crashboat	CB
Isla Verde	IV
Jobos	JO
Mar Chiquita	MC
Marriott Condado	CN
Ocean Park	OP
La Pared	PA
La Poceta de Piñones	PP
La Poza del Obispo	PO
Último Trolley	UT

Municipality:

Aguadilla	AG
Arecibo	AR
Cabo Rojo	CR
Carolina	CA
Fajardo	FA
Guánica	GU
Isabela	IS
Loíza	LO
Luquillo	LU
Manatí	MA
San Juan	SJ
Toa Baja	TB
Vega Alta	VA

Example:

Based on this code, a photo taken November 12, 2013 of the second sign labeled "Area de Bañista" at Marriott Condado in San Juan would be labeled AB-2_CO_SJ_12-11-13. "AB" represents "Area de Bañista," "CO" represents "Marriott Condado," "SJ" represents "San Juan," and 12-11-13 is the date the picture was taken.

These codes are also in the document "código de las picturas" which is located in the main Database folder. Users can add codes for new beaches, signs, and municipalities in this document.

RIP CURRENT SAFETY MANUAL

Don't get caught, Follow these recommendations to stay safe in the water

Identifying a Rip Current:

Rip currents usually follow a series of large waves. They look calm in comparison to the surrounding waves with little or no sea foam. The area will have a large amount of sediment (sand) in the water and will appear to be column-like.

D.N.E.R.

Rip Currents at the Beach:
The Unknown Danger

Department of Natural and Environmental Resources

Rip Currents & Their Dangers

Rip currents, mistakenly called rip tides, are a constant threat to beachgoers and account for a large portion of drownings. These currents are uneven backwash after a wave has reached shore. They are generally about 10-25 meters across, travel approximately 100 meters out to sea, and travel perpendicular to the shore in most cases. These currents can be found with average swells; waves only about three feet above the water can generate strong rip currents. Rip currents should not be confused with rip tides and undertow.

http://www.erh.noaa.gov/er/akq/marine/rip.php

How to Escape a Rip Current

The following steps to escape from a rip current are simple and will save energy to return to shore safely:

1) **Don't fight the current and swim straight back**

2) **Swim parallel to shore until you have escaped the current**

3) **Swim directly back to shore**
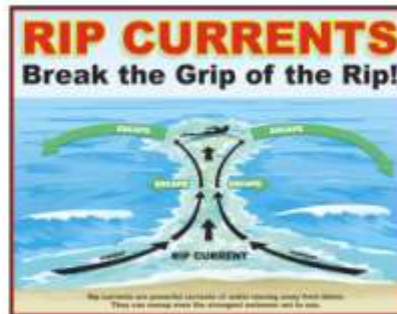
Rip Current Statistics

- Nearly 80% of all rescues at the beach are due to rip currents

- Rip currents can reach up to 3 m/s, the average speed of an Olympic swimmer

- There are over 100 deaths per year in the U.S. due to rip currents

- The strength of rip currents is proportional to wave height. Stay away from big waves!

Tips to Stay Safe:

1. Check the currents and tides before going to the beach to avoid strong currents

2. Look for signs as you walk on to beaches; stay away from beaches with no swimming signs and warnings

3. Watch children to make sure they are safe in the water

Appendix C

INTERVIEW WITH BEACHGOER

Outline of an interview with a beach user:

Good morning/afternoon, we are students from Worcester Polytechnic Institute in Massachusetts and are conducting a study on how to improve water safety. We would like to ask you a few questions about beach safety.

1. Is it okay if we conduct the interview in English? If you feel more confortable, we can also conduct the interview in Spanish.

    (If yes, ask if it is okay if we conduct the interview in English. If the person says no, Cesar Benoit will conduct the interview in Spanish.)

2. How often do you come to this beach? Do you visit any other beaches? Please mention which ones.

3. Did you notice any safety signs or warning flags when you entered the beach today?

    (If so, ask them to point out where the signs were)

4. Do you understand what the signs mean (if they have symbols on it, what language are they in)? (If yes, ask them to interpret the signs)

5. Do you think the safety signs need any improving?

    (If yes, ask what recommendations they may have for improving the signs. If not, continue to question 7.)

6. Do you enjoy swimming at beaches or do you generally stay out of the water?

    (If they swim, ask how experienced they are at swimming.)

7. How you heard or know about rip currents/rip tides?

> (If yes, ask what they know. If no, briefly describe what a rip current is and the dangers of one.)

8. Are you aware if rip currents are prevalent to this beach? (Question will vary if we have previous knowledge of wave size at the specific beach. May also ask about long-shore currents)

9. Can you identify what a rip current looks like or when it is occurring?

10. Do you know what steps to take if caught in a rip current?

> (If yes, continue to question 12. If no, describe the procedure: swim parallel to the beach until he or she is out of the rip current and then swim back to the beach.)

> Based on the structure of the beach, we will ask about other dangers that may exist, such as rock formations, shorebreak, wave height, strong currents)

11. How would you react if you saw somebody in trouble in the water?

12. Do you know whom to contact in case of an emergency at the beach?

> (If yes, ask whom they would contact. If no, inform the person of the best way to get in touch with emergency services.)

13. Do you check the weather reports before going to the beach?

14. Do you think that most people are aware of dangers at the beach?

> (If yes, conclude interview. If no, ask ways that they believe would be the best way to alert more people.

Marine Safety: Interview Answers			
Language	English	Spanish	Other
Frequency of Visit			
Other Beaches?			
Signage Noticed			
Understanding of the Signs			
Do You Think there are Ways to Improve Signage			
Swimming Capability			
Knowledge on Ripcurrent			
Knowledge on Specific Beach			
Identification of a rip current			
Rescue Response(what to do/who to call)			
Do they check the Weather			
Interviewer(s)			
Date			
Beach			
Tourist or Native			
Weather			
Time of Day			

Figure 22: Interview Answer Sheet

INTERVIEW WITH HEAD LIFEGUARD

1. What are the requirements in achieving lifeguard certification?

2. Is there a method in deciding whether a beach needs a lifeguard?

3. How many lifeguards are there in San Juan? On the island?

   (Based on the number of lifeguards, ask if there should be more)

4. What do lifeguards do when beachgoers are performing risky behaviors?

   (Do they warn the beachgoers to stop or just keep a close eye on the beachgoer?)

5. What is the procedure that a lifeguard goes through in the event of an emergency in the water?

6. What equipment is available to a lifeguard in the event of an emergency in the water?

7. If an accident is occurring and emergency services are called, who arrives?

8. Are there any records of rescues or deaths?

Appendix D

HIGH-RISK BEACHES

Crashboat Beach – Municipality of Aguadilla

Signs:

This beach is split into a swimming area and a boating area by an old pier in the middle.

On the left of the pier, there is a large sign that clearly marks "swimming area."

Figure 23: Swimming Area Sign at Crashboat

However, people entering on the right side would not notice this sign due to its location. The

sign is also not facing the parking lot where people would be entering from. Shown below is a

view of the left side of the beach and a blank wall for signs. The right and left side are separated

by a small bridge.

Figure 24: Empty Board at Crashboat

Apart from the swimming area sign and a tsunami zone sign (which is on every beach and in most residential areas around the island), there are no warning signs at Crashboat.

Dangers and Observations:

Figure 25: Pier at Crashboat Beach

Due to the configuration of the beach, the only glaring danger is the pier in the middle. During heavy swells or simply larger waves, the pier could become a serious problem for swimmers. Another problem is that many people were swimming on the boaters' side of the pier anyway. This could be a problem for swimmers if any boats came into the area. Also, the rip currents were significantly stronger on the boaters' side of the pier. The water was very calm on the swimmers' side, with constant waves less than one foot. However, the wind speed during the time of our team's visit was 2 mph, so wind could possibly play a role at Crashboat that we did not observe.

La Poza del Obispo – Municipality of Arecibo

Signs:

This beach had a parking lot as the only likely entrance so everybody should have a clear look at the warning signs. This beach had three signs to warn beachgoers of potential dangers. All three signs were located at the edge of the beach facing towards the parking lot and were written in both English and Spanish. One sign warned beachgoers about strong currents and had a picture of a swimmer in water. The other two signs were next to this sign. One told beachgoers to be careful about dangerous shorebreaks and had a picture of a person being knocked over by a wave. Directly below that sign was a small notice instructing beachgoers about how to escape a rip current. This sign had a brief diagram to help explain its message. The writing on the sign was very small but still portrayed the message well.

Figure 26: Warning Signs at La Poza del Obispo

Dangers and Observations:

La Poza del Obispo contained large rock and ledge formations to the left that could pose a problem in times of strong swells and large waves. The strong currents could have easily pulled swimmers out into rock formations.

Figure 27: Waves and Rock Formations at La Poza del Obispo

Also, the waves came very frequently which caused constant rip currents, even though waves only measured between 3 and 5 feet. If the waves were larger, the rip currents that were produced would cause very serious problems with the rock formation. The wind speed during the time of our visit was also around 11 miles per hour. In times of more wind, this beach would become significantly more dangerous.

Isla Verde Beach – area of Isla Verde in the Municipality of Carolina

Signage:

There was a line of buoys around the swimming area. There was a sign written in English and Spanish instructing beachgoers to not swim past the buoys because it was against the law. The sign had some graffiti on it which made it more difficult to read. Also, the word "Warning" was written in English and Spanish but some of the English letters were missing. The sign faced parallel to the coast and was positioned near the center of the beach. It also had a picture of a person swimming with the buoy line next to him and a diagonal slash went through the picture.

Figure 28: Damaged Sign at Isla Verde

A second sign had the rules of the beach written in both English and Spanish. The sign was near the edge of the beach and was facing a direction parallel to the shoreline. The sign was large compared to other signs and had a light blue background with white writing. Two signs marked the edges of the swimming area showing arrows that pointed toward the swimming area with a

caption that read "Swimming Area" in Spanish only. The signs also said that kayaks, boats, surfboards, and motorboats were not allowed in the swimming area.

Figure 29: Swimming Area Sign at Isla Verde

One of these signs had some graffiti on it but the sign was still legible. There was another sign that prohibited swimming past the buoys that was located on the right side of the beach. This sign was identical to the other sign that instructed swimmers not to pass the buoys, except that it was in much better condition with no graffiti and the word "Warning" had all letters in both languages. The sign was angled toward where beachgoers were. There were many entrances but the signs could be noticed easily as beachgoers head toward the beach.

Dangers and Observations:

On the day of our team's visit to Isla Verde, there were high winds at speeds of 10-15 miles per hour. The waves that were breaking at shore varied from 2-3 feet and 5-7 feet depending on the location on the beach. The currents these waves produced were generally small although the waves were sometimes larger. The currents would not cause a serious problem at this beach unless waves were significantly higher. There were also large amounts of sand and seaweed in the water, meaning the waves broke with high amounts of power. The marked swimming areas were also split in two because of a path for jet skis to enter the ocean. This could pose a problem if people are not paying attention to the marked swimming areas.

Figure 30: Jetski Area at Isla Verde

Jobos Beach – Municipality of Isabela

Signs:

There are multiple entrances at Jobos, but there are only two signs. The signs may not be in an area where the beachgoers notice them. Many of the people on the beach were not near the

locations of the signs. The first is a large warning sign written only in Spanish with a very large

hole in it, as seen in the picture below.

Figure 31: Damaged Sign at Jobos

There is also a generic "strong currents" sign in both English and Spanish. This sign will only

portray the message if beachgoers know how serious strong currents can be. There was also a

private entrance to the beach in which there were no signs.

Dangers and Observations:

On the right side of Jobos, there is a very large rock formation and even rocks along

much of the shore, shown below.

Figure 32: Large Rock Formation at Jobos

Most of the visitors come from the left side of the beach, so the rocks to the right pose no problems to them. Also, most of the swimmers stayed away from the rocky areas. There was also a sandbar in the water, which could be dangerous to swimmers during larger swells because it may give them a false sense of security. The sandbar is shown below.

Figure 33: Sandbar at Jobos Beach

The large waves at the beach would break at the sandbar, while other waves that broke at shore were consistently 1-2 feet high. Many of the people also settled down in locations where there were attractions, such as the bar or under palm trees. The bar could pose a problem because alcohol hinders capabilities and thought processes to beachgoers, which in turn may cause swimmers to make dangerous decisions in the water.

La Playa de Aviones – area of Piñones in the Municipality of Loiza

Signs:

At this beach, there was little information for the beachgoers. At the main entrance of the beach, a large, unique sign welcomed people to Aviones. There were multiple pictures on the sign designating multiple rules of the beach, including that swimming is not allowed at Aviones. The only people allowed in the water at this beach are surfers, as seen below in the sign.

Figure 34: Playa de Aviones Main Entrance Sign

There were multiple small entrances to the beach from the street where beachgoers could enter in which there were no signs, apart from the main entrance above. If somebody entered through one of these smaller entrances, the important information would not be known by the person. At Aviones, there are two other signposts. However, at one post, the sign is completely removed so it is unknown what that sign displayed. The other post has two signs, one displaying that there is a "dangerous shorebreak," which is conveyed through a picture and is in both English and Spanish. The other sign shows large waves but is only written in Spanish. These signs are shown below.

Figure 35: Dangerous Shorebreak Sign

Dangers and Observations:

Our team visited this beach on a day where the average wind speed was measured at 18 miles per hour, the highest wind speed at any beach during the period of beach visits. The effect the wind had on the waves was very noticeable, with common swells over 10 feet crashing every few seconds. The waves carried a large amount of material, including seaweed, high amounts of sand, logs, and larger rocks that could cause injury. These large waves did not break near shore, but the power they had carried so far that most of the noticeable beach had disappeared. They also caused severely strong rip currents that would drag any swimmers out to sea. Although the amount of wind on this particular day may skew our observations of Aviones, the large waves must always be prevalent because there is no swimming allowed at any time at this beach. Waves are shown below.

Figure 36: Large Waves at Aviones

La Poceta de Piñones – area of Piñones in the Municipality of Loiza

Figure 37: Slippery Rock Sign at La Poceta

Signs:

At La Poceta, there are no main entrances to the beach. A major road is located directly next to the beach, where most people park and simply walk onto the beach. There is a small area of rocks, a sidewalk, and a barrier that separate the beach from the road. However, this area of rocks is dangerous so there are many signs that display "slippery rock area," as seen above. These signs are double sided, saying "slippery rock area" on the side facing the road, and "dangerous shorebreak" facing the beach.

Figure 38: Dangerous Shorebreak Sign at La Poceta

There are effective pictures on both sides of the sign and give the information in both English and Spanish. The signs are also separated enough to not overload the beach, but also close enough so people entering at any entrance will notice them.

Dangers and Observations:

There is a large wave breaker at La Poceta that separates most of the water from the rest of the ocean, as shown in the picture below. The side of the wave breaker closest to shore is very calm, where most swimmers would be. However, the side of the ocean gets continuously pounded by large waves.

Figure 39: Wave Breakers at La Poceta

The area of the beach not separated by the wave breaker sees continuous strong waves and strong rip currents. The wind speed on the day our team visited La Poceta was 13 miles per hour, a considerable speed; this added to the size and power of the waves. If the wave breaker did not exist at all, this would be a very dangerous beach because of the size of the waves. On a trip to another beach on a later day, our team passed this beach and observed such strong swells and tide level where the wave breaker was not visible. This could cause serious problems to any person in the water at the time because the rip currents would be so strong that a person would most likely be pulled out and slammed into the wave breaker.

La Pared Beach – Municipality of Luquillo

Signs:

Figure 40: Beach and Concrete Wall at La Pared

This beach is very long, with one main entrance to the far right and a long concrete wall that separates the road/sidewalk from the beach. At the end of the concrete wall, there are no determined entrances to the beach, so any beachgoer can simply walk on. In the entire analyzed area, there were only two signs. On the edge of the cell, there is a "strong currents" sign in both English and Spanish with a picture. There is also a pole that has two signs on it. The first is a sign that designates a "dangerous shorebreak" on the beach. The other is an escape plan for a swimmer caught in a rip current.

Figure 41: Dual Signs at La Pared

This is especially important at La Pared because of the dangers the beach poses. A talk with a

local safety volunteer also stated that he wished more beaches had these escape plans because

many people do not know the steps to take if caught in a rip current. A better view of the escape

plan is shown below, with a picture and written in both English and Spanish.

Figure 42: Rip Current Escape Plan at La Pared

The man also commented on how the size of the signs affected how many people actually read them and wished that they were much larger. However, due to there being no determined entrances in this side of the beach, it would be very easy to completely miss seeing these signs, no matter the size.

Dangers and Observations:

In the talk with the local volunteer, our team learned that there have been 282 rescues at La Pared since 2007, almost all of which from rip currents. This is a very serious problem.

Although the wind was a low 4 miles per hour and the waves were a relatively small 2-3 feet

consistently, the rip currents were very significant.

Figure 43: Consistent Waves at La Pared

The strong rip currents as well as the dangerous shorebreak make this the dangerous beach it is.

These rip currents were not small, frequent ones that simply pull towards the sea with little force;

they produced clouds of sand in the water that make it easy to notice rips. Apart from the rock

formation to the far right of the beach, there are no physical features that would pose a threat to

beachgoers. This is also considered a "surfer beach" due to the normal size and consistency of its

waves. This could cause a problem for swimmers as well because surfers could cause accidents

with them and rip currents could pull them further out to sea. The combination of strong currents

and waves make this beach one of the most dangerous on the island.

Mar Chiquita Beach – Municipality of Manatí

Signs:

This beach had a number of signs to warn beachgoers of various dangers. All the signs were facing the parking lot, which wrapped around the perimeter of the beach. One of the signs warned beachgoers of slippery rocks. The sign was in both English and Spanish and had a picture of a person slipping on a ledge. It was located near the edge of the beach facing the beachgoers and was parallel to the shoreline.

Figure 44: Slippery Rock Sign at Mar Chiquita

Another sign warned beachgoers about strong currents and was positioned in the middle of the beach facing away from the water. The sign was in English as well as Spanish and had a picture of a swimmer.

Figure 45: Strong Currents at Mar Chiquita

A third sign was located on the opposite side of the beach warning about the dangerous shorebreak. Its picture showed a person being knocked over by a wave. It was difficult to predict where people will enter the beach from because they could have parked anywhere around the beach. Fortunately, a small parking lot was located on the right side of the beach, which made it the most likely entrance.

Dangers and Observations:

While the current at this beach was very strong, most of the force of the currents was blocked by rocks and only a small inlet allowed water to pass through into the main beach area. The waves break early and there are many rocks in the area around the shore, as seen below.

Figure 46: Rocky Shore at Mar Chiquita

However, the waves were still large even through the small inlet. These rocks could pose serious problems if rip currents were any stronger. The currents could pull swimmers out straight into the rocks, which makes this a very dangerous beach.

Marriott Condado – Municipality of San Juan

Signs:

Marriott Condado is a long stretch of beach located directly behind the La Concha Renaissance Resort and the Marriott resort in the Condado area of San Juan. It had the higher number of signs out of the beaches our team visited; however, the danger level at Marriott Condado is very high so more signs are needed. Next to La Concha Renaissance, there is a sign that states absolutely no swimming allowed in the area.

Figure 47: Sign at Condado defining Flag colors and No Swimming sign

Also, a red flag flies behind the resort to signal no swimming, as well as signs explaining what the flag colors mean. There is also a flag and sign behind the Marriott resort, which also states no swimming is allowed. In the stretch of beach in between the two resorts, there are "dangerous shorebreak" and "strong currents" signs which are in ideal locations; however, the "dangerous shorebreak" sign is damaged with graffiti. Also, people entering through the area in between the two resorts would not see any warning signs.

Dangers and observations:

On the edge of the shore behind La Concha Renaissance, a large rock formation is present that multiple people swim near. Also, behind the Marriott resort, a large wave breaker is present to decrease the size of waves.

Figure 48: Wave Breaker at Marriott Condado

This also intensifies rip currents, however. Waves continuously rose between 7-10 feet during our visit (although the wind was minimal), which caused very strong rip currents. In the water, there are many random areas of large rocks that are not visible from shore. These rocks and the strong rip currents make it one of the most dangerous beaches on the north coast of Puerto Rico.

Ocean Park – Municipality of San Juan

Signs:

In the stretch of beach that our team analyzed, there are various routes from the hotels and streets that people can enter the beach. Out of all the entrances that are available to beachgoers, there are only two signs warning of dangers at the particular beach, although one is at an entrance. As with most of the northern coast of Puerto Rico, Ocean Park has very strong currents. The two signs both display "strong currents" in English and Spanish, as well as a picture of a current. However, these signs are back away from shore, under trees, in areas that are most likely only viewable if beachgoers are specifically looking for signs.

Figure 49: Strong Current Sign at Ocean Park

One positive aspect of these signs is that they are double sided. There is also a section of poles where the sign has been removed and not been replaced. If a new sign is put up, it would be easier to warn the beachgoers of certain dangers.

Dangers and Observations:

The dangers at Ocean Park are not extensive. The stretch of beach is long and has no noticeable rocks that could pose threats to beachgoers. The only danger found at this beach was the rip currents, which are still a very serious problem. Our team visited this beach on a fairly windy day, with average wind speeds of 16 miles per hour. Because of this, waves varied. Most were generally smaller, around 5 feet high, with occasional large waves that could have

measured up to 10 feet. When these larger waves would hit shore, noticeable rip currents followed. These currents were very strong and could easily be seen by observers who have knowledge of rip currents. However, unless beachgoers were very far out into the water, they would have no trouble reaching shore after a rip current.

Último Trolley Beach – Municipality of San Juan

Figure 50: Entrance to Último Trolley Beach

Signs:

Último Trolley is located next to a road that runs parallel for the duration of the stretch of

beach. Although there is a small wall separating the sidewalk from the sand, people can enter the

beach at any point. There is a main entrance with a large "no swimming past buoys" sign. The

sign is written in English and Spanish and also has a picture. However, this picture can be easily

confused with a "no swimming" sign if glanced at quickly. A better picture would more easily

convey this message and avoid any confusion. The sign is very large compared to signs at other

beaches and can be seen from any entrance to the beach. Also, there is a large rocky area to the

right edge of the beach, seen through the trees in the picture below.

Figure 51: Rocky Shore at Último Trolley

A "slippery rock area" sign sits on top of the rocks and can be seen from any area close to it. It also conveys its message in English and Spanish with a picture.

Dangers and Observations:

The first observation at this beach is that there are buoys in the water marking the allowed swimming area. This means that beachgoers are in the most danger if they pass the buoys, although the buoys are several hundred feet into the water.

Figure 52: Buoy Line at Último Trolley

There was a large amount of sand and seaweed, which means that waves and currents are strong

enough to keep material off the beach, as seen in the picture above and the picture below.

Figure 53: Seaweed in Water at Último Trolley

The wind speed on the day our team visited the beach was measured at 16 miles per hour, which caused consistent waves of over 8 feet. This caused very strong rip currents, even after waves that were smaller in comparison. Also, the rocks off on the east edge of the beach could pose problems for any swimmers that venture near them. The strong currents may cause longshore currents that would push swimmers east toward these rocks.

Appendix E

LOW-RISK BEACHES

Balneario de Boquerón – Municipality of Cabo Rojo
Signs:

There are many entrances to the Balneario, which is a very safe beach. This beach is Blue Flag certified. There are two overall "rules of the beach" signs which discuss many things. One sign is in only Spanish and is covered in graffiti; the other is in both English and Spanish.

Figure 54: Rules of the Beach Sign at Boquerón

There is also a sign telling about the Blue Flag program and what criteria the beach must meet. Along with the overall rules, there are two signs that display "danger, rocky areas" that are only written in Spanish.

Figure 55: Rocky Area Sign at Boquerón

This is a problem if people do not understand Spanish because the rocks could pose a serious

problem if swimmers are near them. Lastly, there is a sign displaying what the color of each flag

means. The Spanish side of the sign is clear but the English side is completely unreadable. Some

signs are also missing letters and are not very noticeable in the location they are in.

Figure 56: Badly Damaged Sign at Boquerón

Figure 57: Damaged Sign at Boquerón

Dangers and Observations:

Since this is a Blue Flag certified beach, there are not many dangers. There is a very

small pier that would not pose a serious threat because the waves are so small, averaging 1-2

feet. The rocks near the sign would only cause problems during times of very strong waves,

which would not be a problem due to the location of the Balneario. There were also no

noticeable rip currents on the beach which may be another reason that it is Blue Flag certified for

its safety. Our team noted the lifeguard stations, but there were no lifeguards on the beach at the

time of our visit, although it was within the normal lifeguard hours. There were also buoys

marking the swimming area.

Figure 58: Lifeguard Stand at Boquerón

Balneario Seven Seas – Municipality of Fajardo

Signs:

At this beach, the signs were prevalent, as with all Balnearios. Signs such as "swimming behind buoy lines is prohibited," "no diving," and "slippery rock area" were in good locations at the beach, all places in relevant locations for the dangers present. The number of signs at Seven Seas was also greater than that of any other Balneario that our team visited.

Figure 59: No Swimming Beyond Buoys at Seven Seas

Signs for flags were present but no flags were being flown at the time the team was at the beach. Three lifeguard stands were located in good places on the beach. Signs showing beachgoers that this is a Blue-Flag certified beach were at the entrances. The buoys were all at their designated locations; these were the limit for swimmers to travel out into the ocean.

Figure 60: Buoy Lines at Seven Seas Beach

Dangers and Observations:

There were rocks at the beach, but they were easily seen by the public. Signs informing swimmers of the rocks were near the rocks, improving the safety in those areas. Our team visited this beach on a day where the average wind speed was measured at 2 miles per hour. The waves were an average of 1 foot tall and produced small rip currents that were of no danger to swimmers.

Balneario de Caña Gorda – Municipality of Guánica

Signs:

This is a relatively short beach and since it is a balneario, it is very safe. The only sign on the beach is a simple "rules of the beach" sign, which is given in both English and Spanish. On the other side of this sign, it displays what the colors of the flags mean, however only in Spanish.

Figure 61: Rules Sign at Caña Gorda

Figure 62: What Each Flag Means at Caña Gorda

There are no other danger or warning signs anywhere on the beach.

Dangers and Observations:

Although the beach is very safe, the shore is rocky to the right side. However, the rock formation is small and would not cause any problems to beachgoers. The area is very well marked with buoys demarcating the allowed swimming area, with small rocks around it.

Figure 63: Marking Buoy at Caña Gorda

The wind was also 5-10 miles per hour but only caused waves that were consistently 1-2 high. There were constant rip currents at Caña Gorda but the small size of the waves would not make this a problem. On the beach, there were lifeguard stands with flags that would denote if there was a lifeguard on duty at the time, although a lifeguard would most likely seldom be needed.

There was also a speaker system at the beach that would be used in the case of any emergencies.

Overall, this is a very safe beach.

Balneario la Monserrate – Municipality of Luquillo

Signs:

The only flags on the beach were the flags on the lifeguard stands. There was a bulletin board in the middle of the beach facing away from the ocean that defined what each flag color represented and was written in Spanish and English. The board also defined a Blue Flag beach in both languages. The sign was located in the middle of the beach. Another sign indicated the edge of the Blue Flag beach zone. It had a small picture of a blue flag and had English and Spanish writing.

Figure 64: Blue Flag Beach Limit Sign at La Monserrate

There was also a third sign behind the sign indicating the end of the zone but all the paint had

faded or been removed so the sign was completely illegible. Buoys were used to mark the

swimming area. There were a number of ways to enter the beach which made predicting the most

likely entrance difficult.

Dangers and Observations:

Since this beach is Blue Flag certified, it is very safe. Although there were frequent

waves, they rarely reached higher than a foot; they would not cause serious problems for

swimmers. Also, there were constant small rip currents that would not be able to pull swimmers

away from shore.

Figure 65: Small Rip Current at La Monserrate

There are lifeguards present at this beach from 8:30 a.m. to 5:00 p.m. in case of emergencies,

which would most likely not be needed because the risk level is so low. One issue that may occur

at this beach is that kayaks may enter the swimming area, although the marking buoys would generally keep kayakers away from the swimmers.

Costa Azul Beach – Municipality of Luquillo

Signs:

This beach is considered a safe, or low-risk, beach and does not have any signs warning beachgoers of dangers. The only signs prevalent are those displaying "rules of the beach," such as the no littering policy, which were covered in graffiti.

Figure 66: Graffiti-Covered Sign at Costa Azul

Buoys also marked the designated swimming area for beachgoers. Although this is a continued stretch of La Pared Beach in Luquillo, it runs perpendicular to its counterpart and does not receive the same wave power as La Pared. The need for signs at Costa Azul is much less than that of La Pared.

Dangers and Observations:

During our visit, the wind blew at a low speed of 4 miles per hour creating waves that reached 1-2 feet in height. Small rip currents could be seen in the water but nothing of any significant magnitude. Rocks could also be seen in the ocean but since they were flat, they did not present a serious hazard to swimmers unless in the time of very strong swells, which did not seem likely at this beach.

Figure 67: Very Small Waves at Costa Azul Beach

Balneario Punta Salinas – Municipality of Toa Baja

Signs:

This location had many signs and flags to communicate with beachgoers about dangers in the water. There were three lifeguard stands, each with a flag. Two of the flags were red while one was yellow. The stand with the yellow flag was on the side of the beach and was the only one with a lifeguard. A sign on each end of the beach indicated where the swimming area was using an arrow that pointed towards the swimming area. These two signs also forbade kayaks, boats, surfers, and motor boats. The part of the sign that said "Area for Swimmers" was in Spanish only, while the rest of these signs were in English and Spanish, using a circle with a line through it to indicate that the activity in the picture is forbidden. The sign is shown below.

Figure 68: Swimming Area Sign at Punta Salinas

There was also a sign in the middle of the beach that defined what each flag color represented. This sign was completely in Spanish and was facing a direction parallel to the shoreline. There was also a very faded sign facing the water that prohibited floats from being used in the ocean. Directly beneath that was a sign, facing the same direction, indicating that glass, pets, and floats were not allowed at the beach.

Figure 69: Faded Sign & Warning Sign at Punta Salinas

The last sign, which was facing a direction parallel to the shoreline, indicated that part of the swimming area was a Blue Flag beach. Buoys are used to mark the edges of the swimming area. There were multiple small entrances to the beach.

Dangers and Observations:

Since this beach is Blue Flag certified, it is considered very safe. There were consistent very small rip currents that would not pose a problem to beachgoers. The waves at Punta Salinas were consistently 2-3 feet high, so the rip currents were not strong.

Figure 70: Small Rip Current at Punta Salinas

The wind was also not noticeable during the time of our team's visit. During a time of heavy swells, however, the rip currents would be much stronger. There were also rocks to the right of the beach and along the shore in that area. The only possibility that these rocks would pose a problem is if beachgoers were behaving poorly because the formations are small and very noticeable. There was also a lifeguard present at this beach.

Balneario Cerro Gordo – Municipality of Vega Alta

Signs:

On this beach, there was a lifeguard stand with a yellow flag. The swimming area had one sign at each end that says "Swimming Area, " but only in Spanish. The sign also had an arrow pointing toward the side of the sign that was the swimming area. This sign also used pictures to indicate that kayaks, boats, surfing, and motorboats were banned from the swimming area. The rules and forbidden activities were listed in both Spanish and English while using a circle with a line through it to indicate that the activity was not allowed. There was also a sign facing the beach at the edge of the water warning beachgoers that the area around it was rocky. The sign was small and was written in both English and Spanish. The top of the sign said "Danger" but only in Spanish.

Figure 71: Rocky Area Sign at Cerro Gordo

There was a sign indicating in both Spanish and English that part of the beach was a Blue Flag beach. There was a sign facing the ocean that defined what each flag color represented, but the

sign was only in Spanish. Buoys were used to mark the edges of the swimming area. This beach had a few pathways leading to it, so it had multiple possible entrances.

Dangers and Observations:

Since this beach is Blue Flag certified, it is very safe. There was also a lifeguard present at this beach for added security. This beach had a rocky patch in the middle of the swimming area near the shore, which was very noticeable because there was a sign denoting the rocky area. Although the waves were consistently between 3-5 feet, which are higher than most Blue Flag certified beaches, the rip currents produced were very small. The currents posed no problems to swimmers because they were not strong enough to be able to pull people away from shore.

Figure 72: Small Current at Cerro Gordo

Appendix F

Puerto Rico B13 - Marine Safety - Beach Report		
Municipality:		**Beach:**
Description of the Cell Observed (i.e. Between two hotels or coordinates)		
Signage (attach files or pictures)		
Flags		
Signs		
Explanation of Dangers		
Location of Signs		
Dangers Presented		
Beach Information		

Sand		Waves	
Grain Size		Height	
Roundess		Power*	

Other Observations		

*using h^2 where h is height and relative to 1 ft wave

Time at beach	Start-	End-
	Date-	
Weather		

Appendix G

BEACH MAPS

Each sign is denoted by the red marks. The outermost marks of each beach are the region limits as defined by our team.

Aguadilla – Crashboat

Figure 73: Crashboat Beach Map

1. Swimming Area Sign

Arecibo – La Poza del Obispo

Figure 74: La Poza del Obispo Beach Map

1. Slippery Rocks
2. Strong Current/Dangerous Shorebreak/Rip Current Escape Plan

Cabo Rojo – Balneario De Boquerón

Figure 75: Boquerón Beach Map

1. Rules of the Beach
2. Rules of the Beach
3. Danger Rocky Area
4. Danger Rocky Area

Carolina – Isla Verde

Figure 76: Isla Verde Beach Map

1. No Swimming Past Buoy Lines
2. Rules of Beach
3. Swimming Area Sign
4. Swimming Area Sign
5. No Swimming Past Buoy Lines

Fajardo – Balneario Seven Seas

Figure 77: Seven Seas Beach Map

1. No Swimming Past Buoy Lines
2. No Diving
3. Slippery Rocks
4. Slippery Rocks

Guánica – Balneario Caña Gorda

Figure 78: Caña Gorda Beach Map

1. Rules of the Beach

Isabela – Jobos

Figure 79: Jobos Beach Map

1. Sign with Large Hole
2. Dangerous Shorebreak
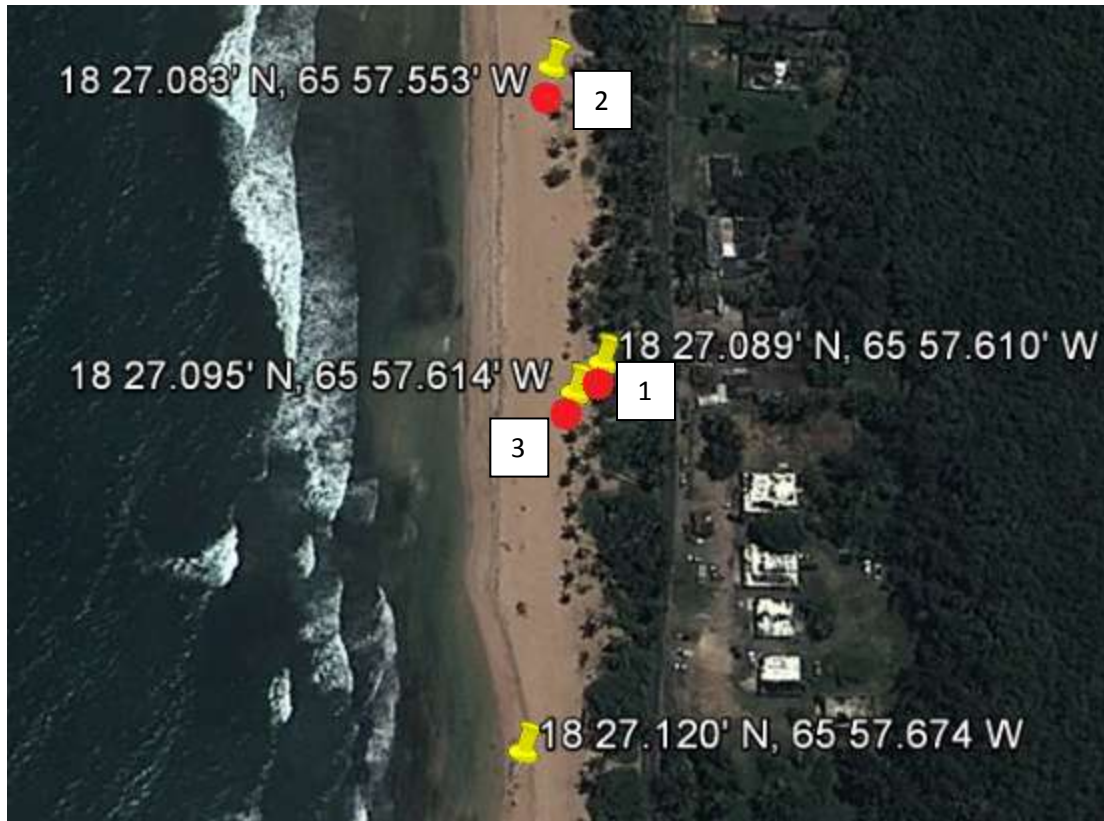3. Strong Currents

Loiza – Aviones

Figure 80: Aviones Beach Map

1. Welcome/Warning Sign
2. Sign Post with Missing Sign
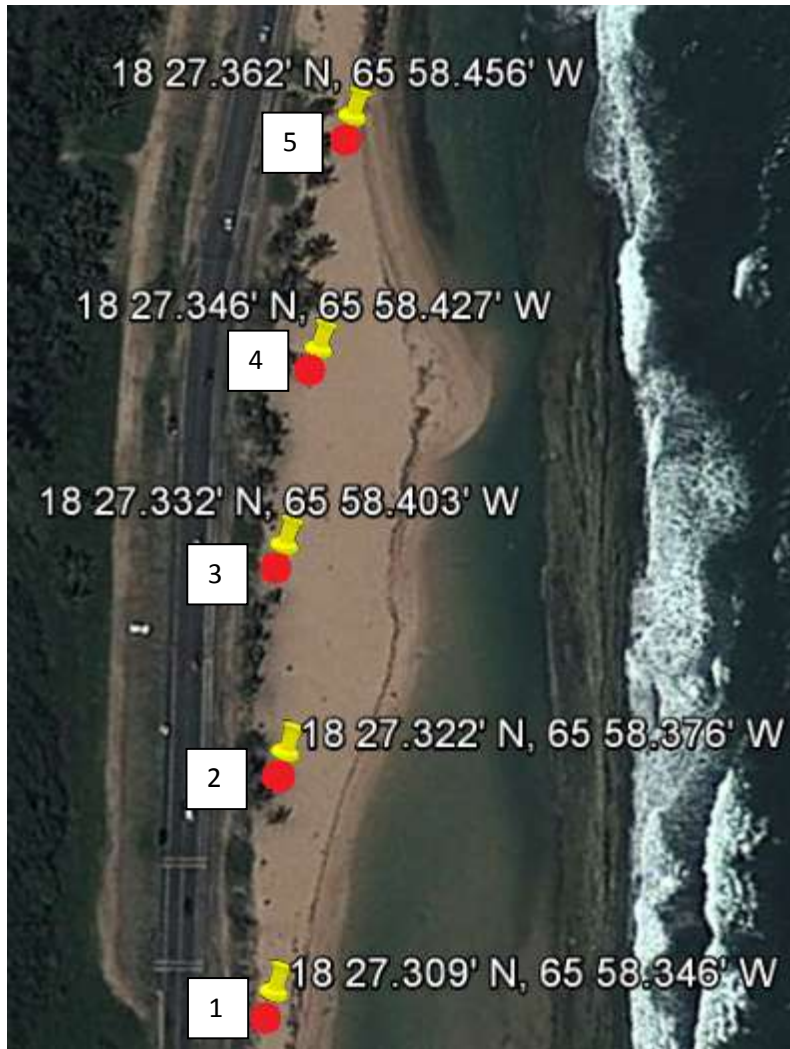3. Dangerous Shorebreak

Loiza – La Poceta

Figure 81: La Poceta Beach Map

1. Dangerous Shorebreak
2. Dangerous Shorebreak
3. Dangerous Shorebreak/Slippery Rocks
4. Dangerous Shorebreak/Slippery Rocks
5. Dangerous Shorebreak/Slippery Rocks

Luquillo – Balneario La Monserrate

Figure 82: La Monserrate Beach Map

1. Swimming Area Sign

Luquillo – Costa Azul

Figure 83: Costa Azul Beach Map

No Signs Present

Luquillo – La Pared

Figure 84: La Pared Beach Map

1. Strong Currents
2. Dangerous Shorebreak/Rip Current Escape Plan

Manatí – Mar Chiquita

Figure 85: Mar Chiquita Beach Map

1. Slippery Rocks
2. Strong Currents
3. Dangerous Shorebreak

San Juan – Marriott Condado

Figure 86: Marriott Condado Beach Map

1. Dangerous Shorebreak
2. No Swimming In This Area
3. Strong Currents-placed on Rocks
4. Explanation of flag (Flags adjacent to sign)
5. Explanation of flag (Flags adjacent to sign)
6. Dangerous Shorebreak
7. Strong Currents
8. Explanation of flag (Flags adjacent to sign)

San Juan – Ocean Park

18 27.299' N, 66 03.697' W

18 27.274' N, 66 03.658' W

3

18 27.270' N, 66 03.551' W

2

18 27.268' N, 66 03.438' W

1

18 27.270' N, 66 03.418' W

Figure 87: Ocean Park Beach Map

1. Signpost with Missing Sign
2. Strong Currents
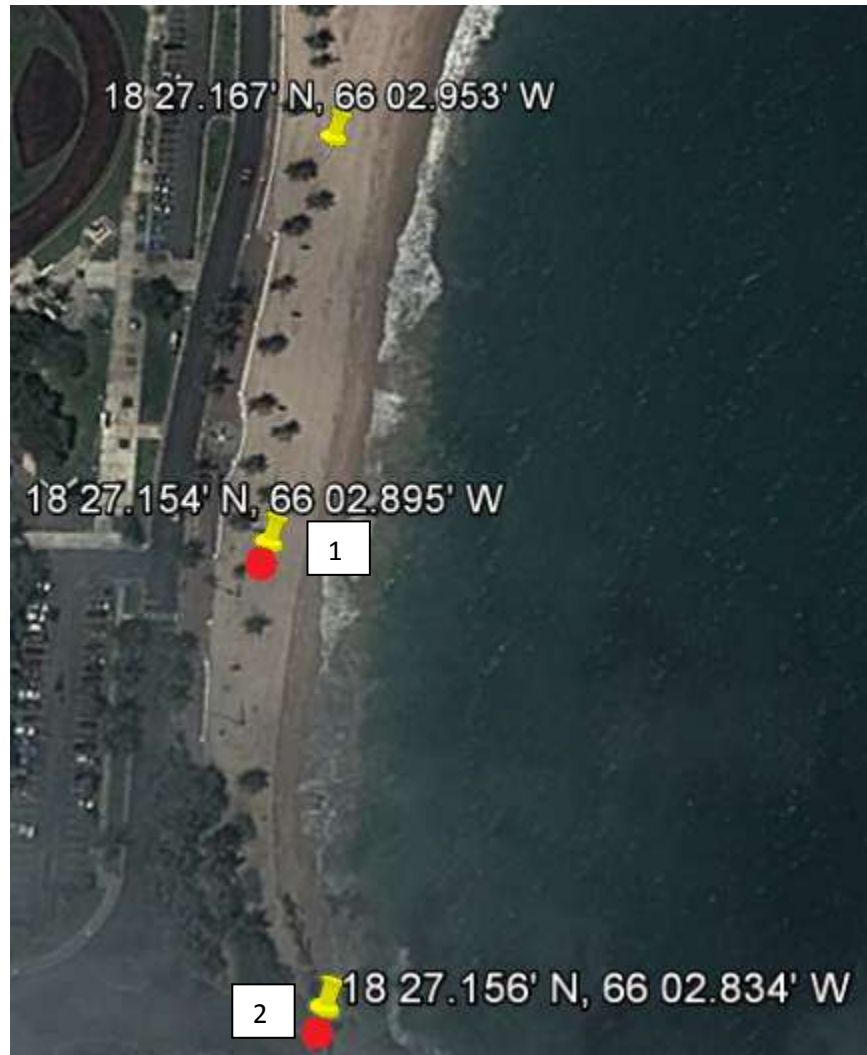3. Strong Currents

San Juan – Último Trolley

Figure 88: Último Trolley Beach Map

1. No Swimming Past Buoy Lines
2. Slippery Rocks

Toa Baja – Balneario Punta Salinas

Figure 89: Punta Salinas Beach Map

1. Swimming Area Sign
2. Explanation of Flags
3. Inflatables Prohibited
4. Swimming Area Sign
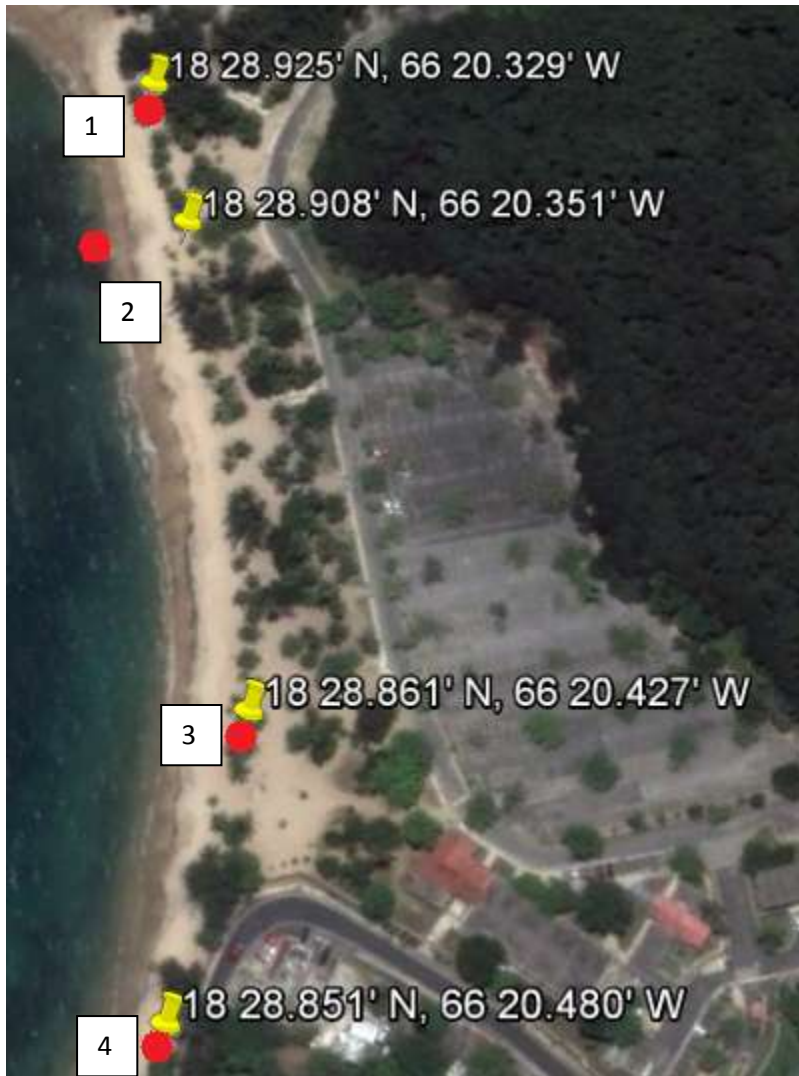
Vega Alta – Balneario Cerro Gordo

Figure 90: Cerro Gordo Beach Map

1. Swimming Area Sign
2. Danger Rocky Area-in the water
3. Explanation of Flags
4. Swimming Area Sign