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BIOLOGICAL CORRIDORS: PROMOTING AND MAINTAINING BIODIVERSITY IN PUERTO RICO

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This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of the Department of Natural and Environmental Resources or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be constituted as a working document by the reader.

Abstract

This project is prepared for Puerto Rico's Departamento de Recursos Naturales y Ambientales (DRNA). Background research, interviews, on-site visitations, and a detailed analysis of digitized maps made it possible for the IQP team to recommend where and how the DRNA should establish biological corridors to unite state forests in Puerto Rico. The corridors will increase biodiversity within the forests and help combat deforestation on the island. The project will lead to a better public understanding of corridors and the necessity of conserving Puerto Rico's natural heritage.

Authorship

This IQP is the product of an equal and significant effort by the entire project team. All group members took an active role in its development throughout the course of the project. Primary authorship of certain sections of the report, however, should be noted in order to give proper credit to those involved.

The Literature Review contained equal contributions from all project members. Matthew Kling's preliminary research focused on deforestation and fragmentation and their effects on the ecosystem. The section dealing with different methods of conservation used globally and reasoning behind using biological corridors in this project was the effort of Christopher Greene. Jayne McAlary was responsible for research on the aspects of biological corridors, including criteria for development and case studies. Richard Kuzsma's sections dealt with the economic considerations, different land acquisition methods, ArcView™, and reforestation. Kling and McAlary were also responsible for the background on the target forests.

The entire group made contributions to the rest of the project. The Methodology was primarily written by Kuzsma and Greene. McAlary and Kling were the primary authors of the Results and Analysis and the Conclusions and Recommendations. Kling was also responsible for all ArcView™ graphics found in this project. The entire group participated in the editing and formatting of the project.

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Executive Summary

In accordance with Law 1277 (2000), the Puerto Rico Departemento de Recursos Naturales y Ambientales (DRNA), the Department of Natural and Environmental Resources (DNER), is required to delineate two biological corridors to unite six state forests. The forests to be connected are the Maricao, Susúa and Guánica State forests in the southwestern part of the island and the Toro Negro, Pueblo de Adjuntas and Guilarte State forests in the central region of Puerto Rico.

The goals of this project were to establish these corridors with accompanying buffer zones, to use digitized ArcView™ maps to show where these delineations were, to prioritize tracts of land based on their ecological value, and to educate the public about Law 1277 (2000) and other conservation programs that may apply to them.

Our biological corridor designs meet the outlined requirements set by the DRNA. When established, the corridors would fully connect the forests within each region. These corridors have been delineated on digitized maps using ArcView™, a geographical information system software package. In addition, they fulfill the stipulations of Law 1277 (2000).

The design for each corridor was based on background research and follows a well-defined methodological procedure. We adhered to the guidelines of Professors Fleury and Brown's Framework for the Design of Wildlife Corridors (1997). The corridor designs also met all habitat requirements for the intended target species, a method adapted from Professor Jack Ahern's study (1995).

While accomplishing the principle goal of delineating two biological corridors, we achieved accompanying goals as well. Since obtaining all the land included in the

corridor simultaneously was infeasible, we prioritized lands by ecological value so the DRNA could acquire high priority lands first. We also identified property tax numbers for all properties within the corridors. From the tax numbers, we collected contact information for landowners and tax-assessed values for their land.

The cost of creating the entire corridor system is estimated at $38.3M. This result was based upon the tax-assessed values of properties within the corridor and the market values of seven appraised lands. The corridors cover a total area of 8,863 acres, or 3,587 hectares, and encompass 644 properties.

In order to properly educate the community and receive feedback from those affected, we designed a brochure and questionnaire to be distributed by the DRNA. The brochure colorfully describes the corridor, its purpose, and its possible effects in terms that can be understood by those not knowledgeable in the field of biological corridors.

Our delineated biological corridors will greatly benefit both the overall ecosystem and residents of Puerto Rico. By partially defragmenting lands via corridors, biodiversity increases at a relatively low cost and lowers the likelihood of extinction for many endangered species. The preserved forests provide a healthier and more aesthetic environment for people in neighboring communities. Puerto Rican citizens can take pride knowing that their natural heritage is better preserved.

CHAPTER 1 - INTRODUCTION

Increasing development in Puerto Rico has caused massive deforestation (Aide, 1998). Rosa (2000) explains that in 1940, only 6 percent of Puerto Rico's land area was covered by forest. Through the efforts of conservationists and environmentalists, more than 30 percent of the land is currently under forest cover. A high population density coupled with a large percentage of privately owned forested lands have raised concern about future forest use. To ensure that wildlife and plant life are preserved, efforts to conserve forests must continue.

In response to a new conservation law, Puerto Rican Law 1277 (2000), the Department of Natural and Environmental Resources (DNER), or in Spanish, el Departamento de Recursos Naturales y Ambientales (DRNA), has sponsored this project to help conserve six state forests, or in Spanish bosques estatales, in Puerto Rico. The project involved the delineation of two biological corridors. One corridor was designed to unite the Maricao, Susúa, and Guánica State Forests. The other corridor was designed to unite the Toro Negro, Guilarte, and Pueblo de Adjuntas State Forests. Our main goal was to delineate the two corridors and to establish buffer zones using digitized maps. Lands were prioritized by their ecological value. To help the DRNA acquire the corridor region, individual properties within the corridor were identified by their municipal tax numbers. These tax numbers provided us with access to tax-assessed values that were used in land acquisition cost estimation.

In order to delineate the two biological corridors, we researched the flora and fauna of the forests. We analyzed various geographical information system (GIS) map layers using ArcView™ software. These layers included factors important to delineating a corridor such as land topography, watersheds, location of target species, and tax property numbers. In conjunction with the data collected, we used Fleury and Brown's Framework for the Design of Wildlife Corridors to assist us in determining the most suitable location for the corridors and their buffer zones. We designed a mail survey intended for distribution to private landowners who might be affected by the corridors. The survey was written to understand landowners' reactions to the project and to learn how they might be willing to participate in the land acquisition process. Upon receiving the survey results, the DRNA would then analyze the data. Accompanying our survey was a brochure to educate the public about corridors, relevant conservation legislation, land acquisition mechanisms available to the DRNA, and the economic incentives for conservation. We obtained landowner contact information in order to distribute the surveys and brochures. Our analysis of the benefits, disadvantages, and optimal locations of the proposed corridors is included in the final results. Also, a detailed cost estimate of the corridor lands accompanies the report. We intend that the DRNA will use the project recommendations to establish the necessary biological corridors between the forests.

An Interactive Qualifying Project (IQP) examines the effects of technology on society. Through the completion of the IQP, students become aware of how their work affects society. The project provided a method for educating society on the impact biological corridors may have on private landowners and nearby residents. This project also added to the literature regarding corridor development and may help other researchers or governing bodies that choose to undertake corridor development. Ideally, corridors built based upon the project's recommendations will help preserve ecosystems within six state forests of Puerto Rico. This project meets the requirements of an IQP by combining the engineering design of biological corridors with the social and environmental implications of the corridors.

CHAPTER 2 - BACKGROUND AND LITERATURE REVIEW

2.1 Introduction to the Background and Literature Review

The following is a review of the existing literature required for our IQP group to complete and understand the problem with which we have been presented. As explained in the Introduction, Chapter 1, our report focuses on the delineation of two biological corridors to unite the Maricao, Susúa, and Guánica forests in the southwest and the Toro Negro, Guilarte, and Pueblo de Adjuntas forests in the center of Puerto Rico. In order to determine what areas of land best suit our needs for delineating the corridors and determining the buffer zones required, we include the following topics.

We first discuss deforestation and fragmentation, emphasizing the role each plays in Puerto Rico. We include the different methods of conservation that currently exist to help reverse the effects of deforestation and fragmentation. Then we discuss why the use of corridors has been chosen over other methods.

Since creating two biological corridors is the main focus of our report, our research relies heavily on the study of corridors and why they are used. This review provides a detailed discussion of biological corridors, including specific criteria for the establishment of biological corridors and case studies of previous corridors. It then examines both the positive and negative effects that corridors have on the environment around them.

Other effects of biological corridors are discussed. We examine the possible economic impact that may result from the implementation of them. This review also discusses the social impact of creating corridors, including who will be affected and how they might react. In addition, to ensure that our project complies with local and federal laws, we discuss relevant legislation concerning the implementation of corridors and the guidelines provided by the DRNA.

2.2 Deforestation

According to Rosa (2000), in the middle of the twentieth century, Puerto Rico was considered to be one of the most heavily deforested areas of the world, as only 6 percent of its land was under forest cover. It has recovered somewhat and today 32 percent of its land is under forest cover. However, 82 percent of this forested land is privately owned and is constantly being threatened by increasing pressures for development. There are enormous pressures for development in Puerto Rico because it is one of the most densely populated regions of the world. Therefore, new land is constantly needed for commercial and agricultural purposes.

It is commonly accepted that humans alter their surrounding land in order to increase its economic value. This alteration can result in massive deforestation when large sections of forest are cut down or cleared, generally for agricultural or commercial use. According to Dobson (1996), another well-accepted fact is that deforestation is directly linked to human population expansion, agricultural development, and the need for economic development (See Figure 2.1 and Figure 2.2).

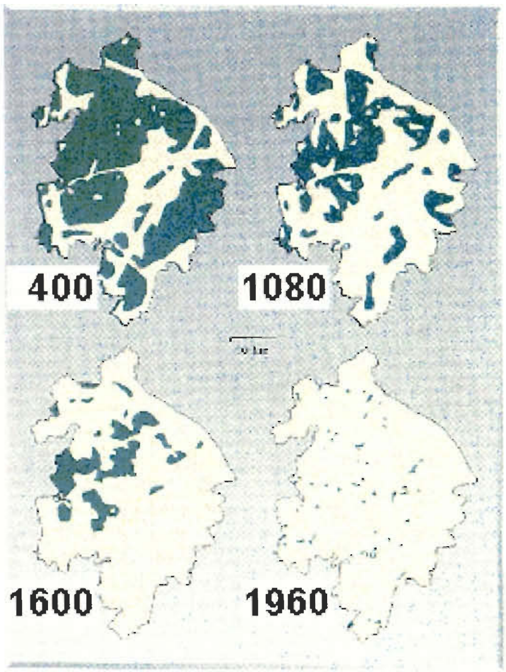


Figure 2.1 The change in England's forest cover from 400 AD to 1960
(Dobson, 1996)

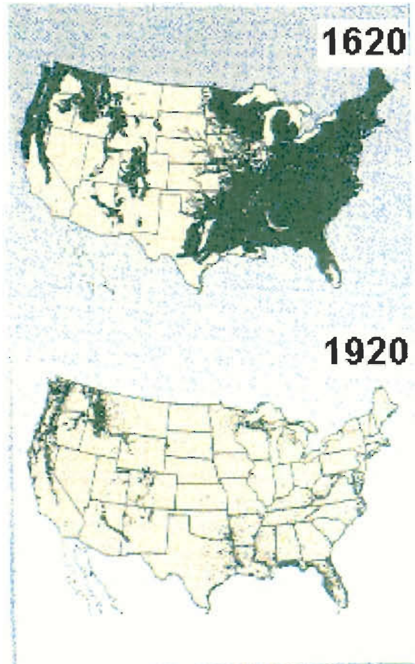


Figure 2.2 The change in US forest cover from 1620 to 1920
(Dobson, 1996)

In order for humans to develop land, they must first deforest the desired area, thus evicting the encompassed wildlife. Soule (1986) and Dobson (1996) agree that agriculture is a main cause of deforestation, especially in tropical locations. Slash and burn agriculture, mainly used in tropical areas, occurs when farmers cut down and burn a forested area in order to increase the fertility of the land. According to Dobson (1996), one problem caused by this type of agriculture is that the land remains fertile only for a few years at most, after which the farmers must move to a different area and repeat the process. It is because of slash and burn agriculture that deforestation rates have become very alarming in tropical areas. In the tropical Americas, between 1980 and 1985, 66 percent of tropical forests were transformed into agricultural lands, and 34 percent of those agricultural lands were transformed into degraded wastelands (Dobson, 1996).

Another type of agriculture that contributes to deforestation in tropical areas is the production of sun-grown coffee. Unlike shade-grown coffee farms that require plentiful vegetation to grow, farms that harvest sun coffee strip land of all existing flora. Sun coffee farmland leaves the soil highly vulnerable to erosion due to increased exposure to wind and rain. Most soil on a sun coffee farm is depleted of nutrients after five years and coffee can no longer grow there; farmers must then move to new land to remain productive (Beverly Yoshioka, personal communication, 2001).

Soule (1986) states that there are other causes of deforestation, although not as destructive as agriculture and with short-lived effects. Natural phenomena such as tree falls, windstorms, hurricanes, and fires cause short-term disturbances in forests, opening up gaps in normally covered areas. Pollution, although not directly linked to deforestation, also has had many effects on different environments throughout the world.

Road construction is a major contributor to deforestation (Olander, Scatena, and Silver, 1998). Roads can have direct and indirect effects on surrounding vegetation and animals. Directly related to the construction of roads is habitat destruction. Indirectly related to road construction are pollution, landslides, and the introduction of exotic species of plants and animals.

Dobson (1996) states that it is not by coincidence that the rates of deforestation closely resemble the rates of human expansion in the twentieth century. Most experts, he says, agree that if current deforestation rates stay the same, the majority of all tropical forests will disappear by the middle of the twenty-first century.

2.2.1 Tropical Regions

Tropical regions of the world are extremely rich in the number of species of plants and animals that occupy them. According to Bolen and Robinson (1995), there are almost 3 million species of plants and animals throughout the tropical regions of the world, whereas temperate regions contain less than half that number. Because many tropical regions are being threatened by deforestation, Bolen and Robinson (1995) also state that nearly half of all species on earth are also threatened with extinction. Their conclusion is obvious: as a result of all the deforestation, the Earth's most biologically dense areas are being devastated at a rapid rate.

Most recently in Puerto Rico, the administration under newly-elected Governor Calderdón is pushing for an increase in agricultural production throughout the island. More food is being imported due to an increase in abandoned farms on the island; therefore, the Agriculture Department is offering incentives to farmers to produce agricultural products such as dairy products and plantains. In fact, $5 million of the $11 million in incentives slated into Puerto Rico's budget next year is going to the island's coffee industry (Kantrow, 2001). Considering the detriments of sun-grown coffee mentioned earlier, this can have disastrous effects on Puerto Rico's ecosystem. The push for more agriculture will increase the demand for pastureland and cropland, most likely resulting in increased deforestation rates in Puerto Rico over the next few years (Kantrow, 2001).

2.3 Fragmentation

Fragmentation is a direct cause of humans developing land in or near forests and can be a result of deforestation. Fragmentation occurs when large natural habitats are split up into smaller fragments (See Figure 2.3).

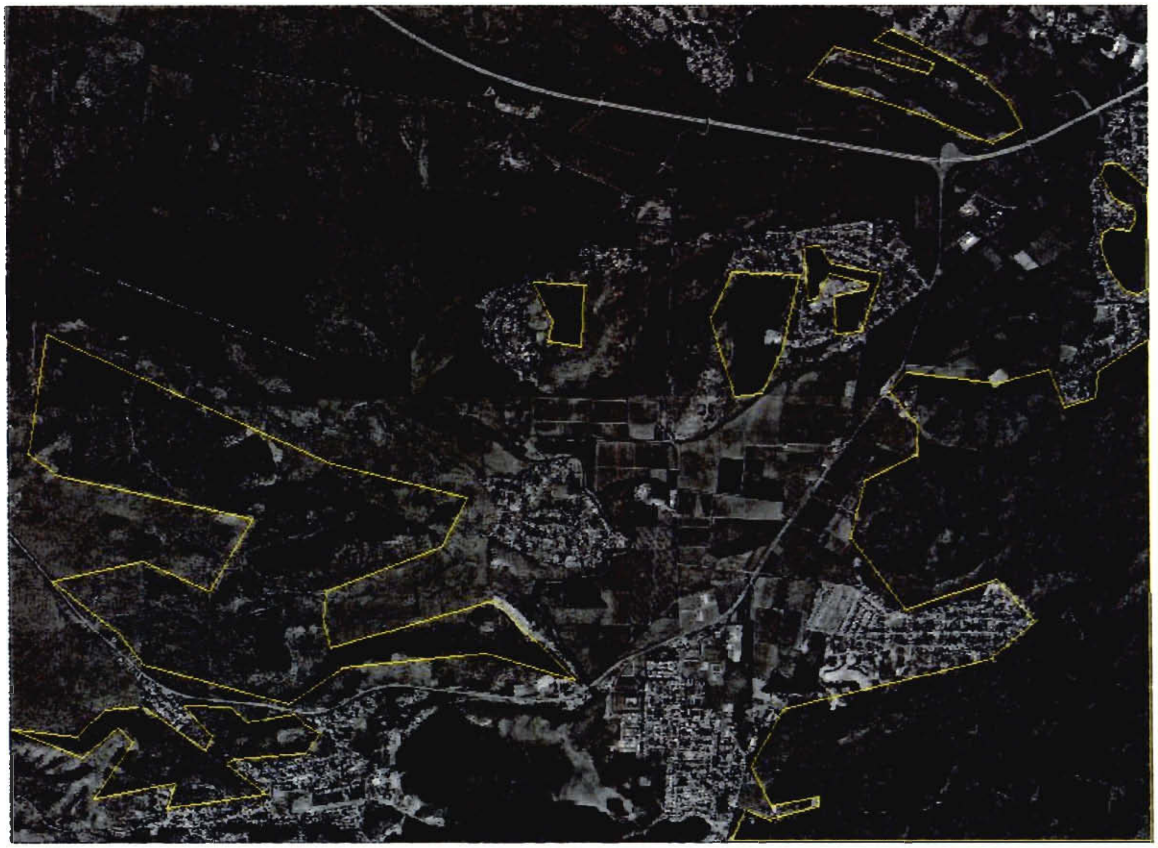


Figure 2.3 Fragmentation in Guánica
Fragmentation is illustrated by the separation of forests, outlined in yellow, by agricultural and housing development in Guánica, Puerto Rico (Digital OrthoPhoto, USGS, 1995).

Soule (1986) explains the two key components of fragmentation. The first is reduction in total habitat area, which affects population sizes and extinction rates. The second is redistribution of the remaining area into disjoint sections which affects species dispersal and immigration rates. The result is that fragmentation causes higher death rates and lower populations; it isolates species and stops movement of species between habitats.

2.3.1 The Effect of Fragmentation on Home Ranges

Fragmentation can have many effects on ecosystems depending on the types of species involved. Bolen and Robinson (1995) and Dobson (1996) agree that a large effect of fragmentation is that habitats become smaller than the home ranges required by many species to survive. Dobson (1996) gives examples of certain animals and their required home ranges. For example, mountain lions require a home range of 400 square kilometers to survive. Birds such as woodpeckers require anywhere between 30 to 50 square kilometers to survive. A specie will ultimately become extinct without a suitable home range. Dividing or fragmenting a specie's home range may make it impossible for it to traverse separate areas or habitats. Especially if it requires multiple habitats, the specie will not be able to hunt and locate its prey (Dobson, 1996). Bolen and Robinson (1995) add that inbreeding reduces gene pools and that specie richness declines. According to Soule (1986), the extinction of many land birds of Barro Colorado Island, Panama can be attributed to fragmentation and the reduction in the size of the home ranges required by these birds.

2.3.2 Effect of Forest Edge

When a continuous habitat is transformed into a number of smaller habitats, the overall "edge" of the habitat is increased. Sharon Collinge (1996) states that "edge" is the area around a forest that is adjacent to an altered physical environment or any cleared areas. The number of species in the edge of a habitat is less than the interior, mainly because there are different types of vegetation, soil, and amounts of protection offered. When the edge of a habitat is increased or changed by fragmentation, the type of wildlife present and the type of vegetation that grows there will ultimately change. However, Soule (1986) states that there are a number of species that can survive in edges such as deer, squirrels, raccoons, and dogs, but edges have a strong negative impact on many other species contained within the interior of a habitat.

Soule (1986) explains that the areas between fragmented habitats, or the edges of a habitat, tend to favor species that are harmful to those within the fragments, causing the populations of many species to drop. Theobald, Miller, and Thompson (1997) agree with

Soule, stating that fragmentation causes a build up of smaller predators that will feed on wildlife long after many natural predators can no longer be sustained. According to Soule (1986), the effect that this has on many habitats is a chain reaction in which initially only one species may be affected, but in the end many species are affected. These chain reactions can lead to what Soule calls "secondary extinctions" in which entire communities are depleted.

2.3.3 Island Biogeography

Also closely related to fragmentation is the idea of island biogeography, which Soule (1986), Bolen and Robinson (1995), Collinge (1996), and Dobson (1996) believe can be used to explain the effects of fragmentation on ecosystems. Island biogeography uses the theory that the number of species on an island represents a balance between the processes of immigration and extinction. This balance depends mainly on the size of the island and its separation from animal species that are likely colonists, but it can also depend on the inhabitants' dispersal abilities or population densities (Soule, 1996). By treating separate habitat fragments as islands, Dobson (1996) states that experts have been able to conclude that if the total area of a habitat decreases, then the number of species present decreases. Therefore, the species that require larger habitats will be lost sooner than others. In terms of fragmentation, this would imply that smaller fragments sustain fewer species than larger fragments (See Figure 2.4). Also, species that require larger habitats may not survive in smaller fragments.

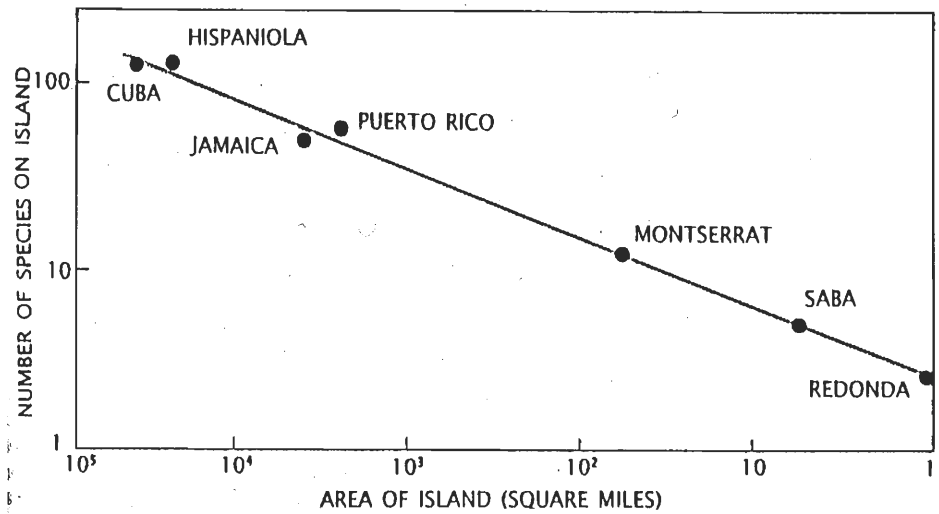


Figure 2.4 Number of species versus land area on islands
(Bolen & Robinson, 1995)

2.3.4 Effects of Fragmentation

Fragmentation does not affect all species equally. Depending on the physical landscape and the type of species present, fragmentation can either have very little effect or it can be devastating. It is because of this uncertainty that Dobson (1996) states it is very hard to see the results of fragmentation on habitats, not only because the effects of fragmentation vary greatly from habitat to habitat, but also because many of the full effects cannot be seen until many years have passed. According to Soule (1986), if most of a habitat has already been destroyed, then any further fragmentation should be avoided at all costs. Further fragmentation will indefinitely cause a rapid loss of species, thus altering the biodiversity (See Glossary) of the habitat. According to many experts, fragmentation is the leading cause in the reduction of biodiversity. Because fragmentation and deforestation are a constant threat to the biodiversity of the Earth's most abundant areas, many experts believe it has become necessary to implement conservation measures throughout the world.

2.4 Methods of Conservation

Conservation of the world's forests is a major concern for the welfare and well-being of future generations. Three main ways of preserving the Earth's forest resources are through **Error! Not a valid link.**, biological corridors, and regionalizing.

The most common and easily recognized preservation method is the government-protected forest. One type of protected forest, a national park, is left materially unaltered by human exploitation and occupation. As explained by Pearl and Weston (1989), the government having jurisdiction over the national park must take steps to prevent or eliminate exploitation or occupation in the area. A protected forest is a tract of land partitioned by the government and protected against human development. Views on this method are contrasting. One view is that huge tracts of land are preserved for future generations to enjoy. However, an effect of this conservation method is that mankind has come to see forests as having a boundary. One side of the boundary is civilization and mankind; the other side is wildlife. Since the boundary of the park protects wildlife from a certain degree of human development, a psychological boundary is often formed in the minds of humans in relation to conserving wildlife. This is a psychological boundary that leads people to believe they can use the land outside of the parks' boundaries carelessly. It is because of this that Kevin Van Tighem, a park interpreter quoted by Weston and Pearl (1989), believes that national parks have not reminded people to use the land frugally. However, many have become complacent with the current state of conservation because of national parks. Furthermore, Van Tighem states that in many cases national parks add to fragmentation and have become a symptom of the conservation problem (1989).

The problem of fragmentation encourages the development of biological corridors, another form of conservation. A biological corridor is a tract of land that connects two separate ecosystems or forests. They provide the wildlife with a method of traveling between the separate habitats without having to encounter mankind and developed lands. The corridor is defined based on two components of species behavior: the frequency of species' movement and distribution of the species' movement throughout the habitat (Bunnell and Johnson, 1998). Due to fragmentation, artificial and natural corridors between remaining habitat patches may become increasingly important in facilitating species' movement. (Mace, et. al, 1998).

To help aid the different methods of conservation, some countries are starting to use computer programs and mapping software to make visual pictures of the surrounding ecosystems. These countries then use these maps to identify land regions. The Biogeoclimatic Ecosystem Classification (BEC) system is used in British Columbia by foresters to divide the land by climate into biogeoclimatic (See Glossary) zones (MacKinnon et al., 1992). These zones are then further divided into sub-zones according to vegetation. Each sub-zone is an ecosystem comprised of a portion of the landscape and the life in it (Bunnell and Johnson, 1998). By utilizing this system of divisions, foresters are able to see what areas require conservation.

Another method of conservation focuses on reintroducing species that may have previously disappeared from an ecosystem, sometimes leading to the complete restoration of an entire habitat. Reconstructing ecosystems not only reestablishes a single organism, but also helps restore the whole plant and animal community in its ancestral habitat (Weston and Pearl, 1989).

Still other methods focus on the economic aspects of conservation. These methods work to make conservation more economical for people so that they will be more willing to conserve the natural resources. Certification and eco-labeling programs in recent years are encouraging more sustainable timber harvesting (French, 2000). These processes allow people to harvest timber for a living, while maintaining biodiversity. Promoting the trade of non-timber products such as nuts, rubber, and spices is another conservation strategy that focuses on the economic alternatives to timber harvesting (French, 2000). This strategy uses renewable portions of the forest for trade and economic incentives. Therefore, it saves trees that are not easily replaced.

Another method of dealing with conservation is through a program established by the Environmental Protection Agency (EPA). This program, called Green Communities, is designed to aid communities in the United States and its territories in creating conservation projects. This program consists of an application process to become a green community and a toolkit to help guide the organizers of these programs. The toolkit includes a five-step program to implement the conservation project and over 1,000 links to various helpful web sites on local sustainability and environmental protection (Green Communities, 2001).

2.5 Biological Corridors

A biological corridor is loosely defined, in the ecological context, as a linear landscape element of flora indigenous to the area connecting patches of similar native flora (Collinge, 1996). They are also known as wildlife corridors, conservation corridors, or greenways. They are intended to provide linkages and facilitate movement of plants and animals between habitat fragments (Collinge, 1996; Fleury & Brown, 1997; Ahern, 1995). Much literature has been written on the advantages, disadvantages, design, and effects of biological corridors. Special consideration has to be given to tropical wildlife corridors because of their unique ecological structure (Laurance, S. & Laurance, W., 1999).

2.5.1 Potential Advantages and Disadvantages of Biological Corridors

There are many arguments supporting and opposing the establishment of biological corridors into ecosystems. Those who have discussed the merits of biological corridors are in agreement that generalizations derived from theory cannot be applied universally (Noss, 1987; Simberloff & Cox, 1987). Another common ground for the conservation biologists involved in this debate is their shared interest in maintaining and promoting biodiversity (Noss, 1987).

There are many potential advantages to preserving wildlife through the establishment of biological corridors. Perhaps the most evident is a corridor's intended function, which is to reverse the effects of habitat fragmentation by increasing connectivity (Noss, 1987). The increased connectivity would ideally promote emigration from one reserve to another. This would ultimately help to increase or maintain species diversity, increase population sizes of particular species, decrease extinction probability, and prevent inbreeding depression by promoting a greater genetic exchange over time (Noss, 1987; Ahern, 1995).

In addition to these positive results, there are some species-specific advantages of biological corridors. According to Noss (1987), for many wide-ranging species that do not function well in small, fragmented habitats, corridors provide increased foraging and roaming area. He further notes that for species that are dependent on escape-cover from predators, corridors can offer reasonable shelter and protection that will aid in their flight. He also comments that corridors can provide alternate refuge from catastrophic events and large disturbances. Their presence would decrease the likelihood of urban sprawl, abate pollution, and possibly provide recreational activities (Noss, 1987; Burger, 2000).

There are also several detrimental effects of biological corridors that must be considered. In addition to its beneficial outcomes, increased connectivity can have harmful consequences. It could make possible the spread of epidemic diseases and insect pests. Also, the introduction of exotic and other unwanted species into the reserve is made possible by connectivity, resulting in outbreeding depression (Simberloff et al., 1992; Noss, 1987). Outbreeding depression is caused when animals that have adapted to their surrounding environment are introduced to animals not familiar with the local ecosystem. This results in gene complexes that are no longer locally adaptive and that are potentially harmful to the species' survival rate. Simberloff and Cox (1987) believe the most destructive result of corridors is facilitating the spread of fire and other disastrous events or consequences. Corridors also increase exposure of animals to humans, domestic animals, and predators. If a corridor were sufficiently narrow, it is likely that hunters would exploit it by stationing themselves in areas that are particularly vulnerable for animals (Simberloff & Cox, 1987). The same is true for predators of these animals. Also, a corridor can facilitate disease among wildlife and domesticated animals that carry diseases not found in their respective environments (Simberloff & Cox, 1987).

An important concern to many is that the successfulness of corridors has not been well analyzed, since such a study would be difficult; thus, the benefits of corridors are theoretical (Simberloff et al., 1992). For that reason, their effectiveness is unknown in relation to nature conservation (Lindemeyer & Nix, 1993). Cost effectiveness is also an issue among conservationists. Some argue that the cost to purchase, maintain, and protect corridors could be better spent on other conservation strategies such as creating a preserve (Simberloff et al., 1992).

2.5.2 Methods and Criteria for Designing Corridors

Few conservation biologists or landscape ecologists have attacked the problem of creating a methodology to assist designers in creating corridors (Fluery and Brown, 1997). However, Hellmund defined a flexible model for the design of wildlife corridors in 1993 on which Fleury and Brown (1997) later expanded and named the Framework for the Design of Wildlife Corridors (FDWC). Included within it is a detailed description of the basic criteria of a biological corridor. The Abiotic-Biotic-Cultural (ABC) method allows for the consideration of not only the environmental aspects of the landscape, but also the cultural aspects as well (Ndubisi, DeMeo, and Ditto, 1995). Professor Jack Ahern noted the indicator species method for establishing a wildlife corridor. With this method, he incorporated the needs of property owners (Ahern, personal communication, 2001). It also must be noted that tropical corridors have specific needs because of their unique ecological make-up.

The Framework for the Design of Wildlife Corridors (FDWC) was accepted in December of 1996 as a method for establishing corridors and was published in 1997 in the Journal of Landscaping and Urban Planning (See Appendix F). Fleury and Brown (1997) comment on the steps taken to establish and implement corridor site designs. Its primary focus is on ecological, rather than social, corridor usage. That is to say wildlife movement, not human recreation, is the center of attention. They first indicate that data on target species and landscape inventory be taken. Then they use the collected data to set up minimum criteria for the corridor that should be met. They define critical corridor attributes as matrix, patch, network connectivity, barrier, length, width, edge, structure, and composition, each of which, in most cases, is specific to the species (See Glossary).

The matrix is the environmental context in which a patch of land is located. It defines the physical environment and the associated functions of the landscape (Ahern, 1995). For example, many corridors are developed in what can be stated as an agricultural matrix if the surrounding area is used for farming. Certain species need specific features in the matrix, such as the presence of a water source, trees, or food supply, without which the corridor would be treacherous for the species and ultimately useless (Fleury & Brown, 1997).

Patches are the area of land to be connected by corridors. Circular patches are better than rectangular ones because they protect their inner resources better. Also, those aligned perpendicular to the migratory direction have been proven more effective than those aligned parallel because they "catch" species rather than facilitate movement (Fleury & Brown, 1997).

The degree to which all the nodes of the system are connected is known as connectivity in the landscape. High network connectivity promotes movement of animals between multiple patches in order to minimize low population in a particular patch. It also minimizes barriers such as roads and prevents any catastrophic event that could destroy a single-travel corridor (Fleury & Brown, 1997).

Any barrier that inhibits the movement of species in a corridor is undesirable, since it would inherently lower the quality of the corridor. Fleury and Brown (1997) note that roads are the most common cause of a barrier and sometimes the most destructive.

Their general conclusion is that any discontinuity within the composition of a corridor should be avoided.

According to Fleury and Brown (1997), corridor length is a very species-specific criterion, as its maximum size is determined by mortality and speed of the target species. They agree that a common guideline to follow is the shorter the corridor, the higher likelihood of its success. However, specie use is also a major factor. For example, a suitable corridor for a quick animal such as a deer might seem too long and treacherous to a turtle because it would present a high chance of mortality. Therefore, the corridor would not facilitate turtle movement and would be useless to that species.

Width is also a species-specific attribute and perhaps the most important, because a corridor must be wide enough to provide shelter, nesting, and feeding opportunities. However, it must also be thin enough to prevent wandering and promote movement through the corridor (Fleury & Brown, 1997). The species' survival rate can be directly related to the width of a corridor (See Figure 2.5).

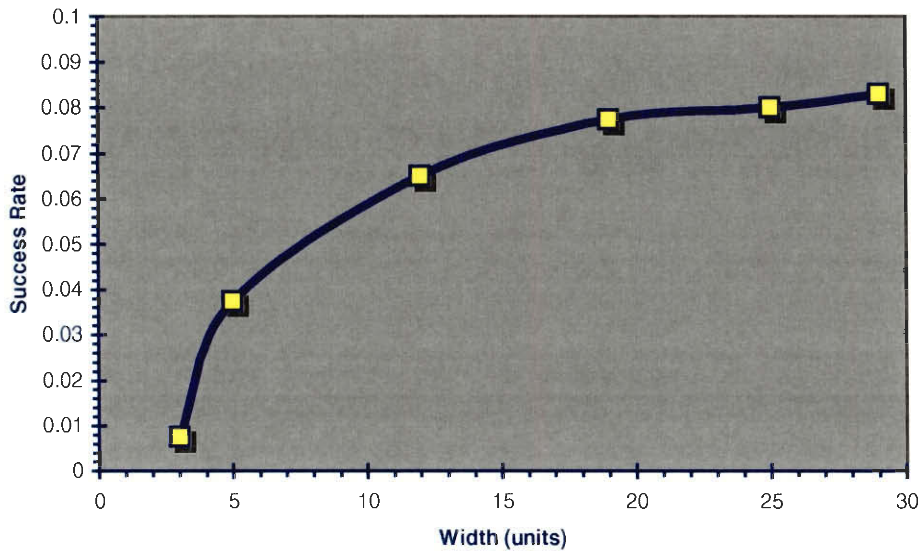


Figure 2.5 Width of corridor vs. species success rate
(adapted from Fleury & Brown, 1997)

An edge, as stated before, is defined as an outer band in which species and vegetative composition differ greatly from the interior of the patch or corridor. The goal of outlining a corridor is to decrease edge effects as much as possible since animals, especially larger ones, are hesitant to pass through these areas because of the composition change (Fleury & Brown, 1997).

Fleury and Brown (1997) feel that it is also very important to take into account the number of layers of vegetation present in a corridor because this will ultimately affect its quality. Therefore, they included this as another criteria taken into account in their FDWC. They believe that the more diverse in plant life the corridor is, the more species it will benefit. Layers include grasses, small shrubs, tall shrubs, and a mixture of trees (Fleury & Brown, 1997).

They also identify the term "composition" as the types of flora required to enhance corridor quality. Food and shelter requirements must be provided in the corridor for an animal. Hence this criterion is species specific. For example, it is unlikely that a frog could pass through a corridor if there was no water source present, because water is a crucial habitat attribute for it.

Another method of delineating biological corridors is the Abiotic-Biotic-Cultural, or ABC, strategy proposed by Dorney in 1976 and described by Ndubisi, DeMeo, and Ditto (1995). It is similar to the FDWC method in that it first suggests that an inventory of abiotic and biotic (See Glossary) attributes should first be taken. This method differs from the FDWC in that it also takes into account the cultural relationship of the forests with respect to human activities.

The ABC method contains four levels that represent increasing stages of data incorporation. Level I includes data collection on ABC resources. At Level II, this data is organized so that a comparison of natural and cultural values can take place. Next, Level III includes the usage of maps of ABC significance being integrated to summarize the total ecological significance of the landscape. Lastly, Level IV combines the ecological significance with policies and guidelines of agencies or landowners. After conducting a case study in Walton County, Georgia, Ndubisi, DeMeo and Ditto (1995) determined that the ABC method would need to be modified for each individual situation. They also believe that emphasis should be placed on resource availability, local ecological characteristics, and public opinion.

A method for establishing corridor attributes that Ahern (1995) notes is known as the indicator species method in which a species is chosen to represent the greater number of species present in a particular ecosystem. The species is chosen on the basis of several key characteristics, mainly high intolerance to fragmentation, specific habitat requirements, and extensive home range. Though this method is commonly used in wildlife research, it has been criticized because it does not deal with species competition or their different responses to habitat change.

There are not many published studies on the potential use of corridors by tropical wildlife. Tropical forests are unique in that they have structural, floristic and climatic characteristics unlike other forests. They also support more species with specialized habitat and dietary requirements than temperate forests according to Laurance and Laurance (1999). They note that species present in tropical landscapes are more sensitive to edge habitat changes, and therefore they require wider corridors than temperate forests. They further state that in order to support these vulnerable species, a corridor that is comprised of a primary forest untouched by humans is the most fitting for countering fragmentation. They also believe it is imperative that there be continuity throughout the corridor, for most tropical species cannot tolerate any form of barriers or breaks (Laurance & Laurance, 1999).

2.5.3 Case Studies

In 1990, a research project took place by the Department of Landscape Architecture and Regional Planning at the University of Massachusetts at Amherst in conjunction with the Massachusetts Audubon Society in Central Massachusetts. The objective was to establish a wildlife corridor uniting the Quabbin Reservoir and Wachusett Mountain Reservation.

This project utilized an indicator species approach to planning the corridor in which species are selected to represent the larger specie population in the ecosystem

(Ahern, 1995). The Audubon Society recommended the river otter and the fisher as the indicator species in this study. They were selected because of their intolerance to fragmentation, specific habitat requirements, and their extensive home range (Ahern, 1995).

Another unique strategy that this project utilized was that of creating two scenarios that each addressed distinct problems. The first, named "Otter Max", was based solely on the needs of the target species and presented the most suitable corridor design to facilitate their movement (See Figure 2.6).

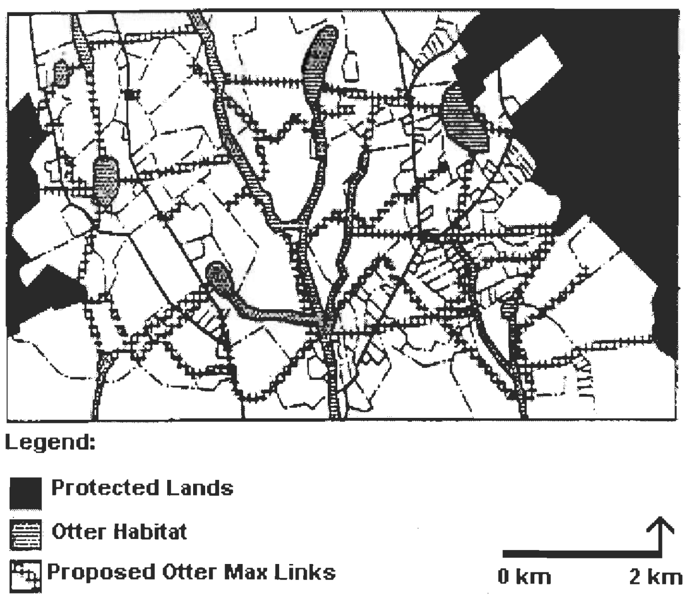


Figure 2.6 Otter Max scenario
(Ahern, 1995)

The second presented a means of connecting the two reserves with the least encroachment onto privately owned lands, and thus it was named "Least Property Impact" (See Figure 2.7).

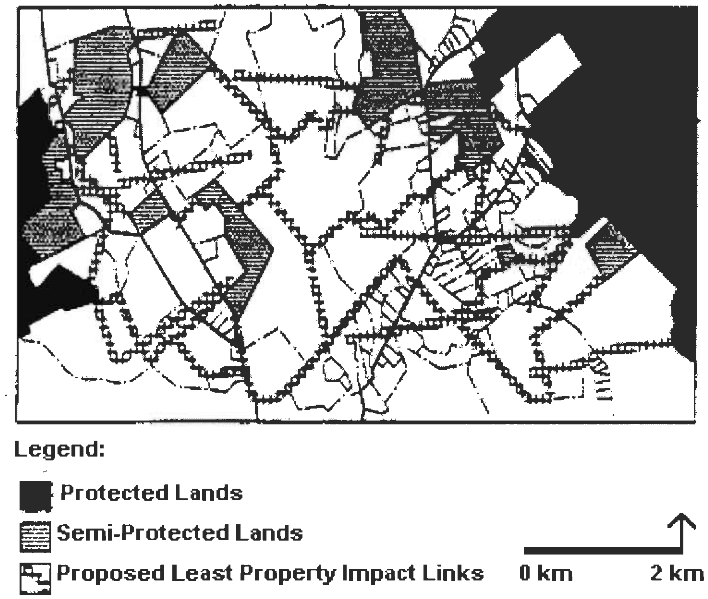


Figure 2.7 Least Property Impact scenario
(Ahern, 1995)

The scenarios' designs varied greatly and neither served as a proposal for an actual corridor. According to Ahern (1995), one method of creating a non-partial compromise of the two designs would be to digitally combine them using a geographical information system (GIS). However, this corridor was not introduced into the environment and it acted only as an example in theory. Nonetheless, it successfully presented a method of planning greenways by keeping both the target species and affected citizens in mind.

Southwestern Ontario was used as an example for the applicability of the Framework for the Design of Wildlife Corridors (FDWC). Fleury and Brown (1997), the persons responsible for the creation of FDWC, conducted this study. Included in their FDWC is an outline of the specific needs of each species guild in their previously defined criteria. The target species for this study included squirrels, mice, rabbits, and deer. Squirrels and mice fell in the "small mammal" guild. Rabbits were considered medium mammals, and deer were considered large mammals. Other guilds included in the FDWC but not considered in this study are insects, reptiles and amphibians, and birds.

Fleury and Brown (1997) comment that small mammals, to which length is a major factor due to a higher likelihood of mortality, do not generally pass through a corridor longer than 50 meters. Width, an issue to medium and large animals, should be greater than three rows of trees. These and other minimum criterion were compiled to define a basic set of requirements for the each of the proposed corridors. After evaluating the available land, these requirements were used to identify corridor locations.

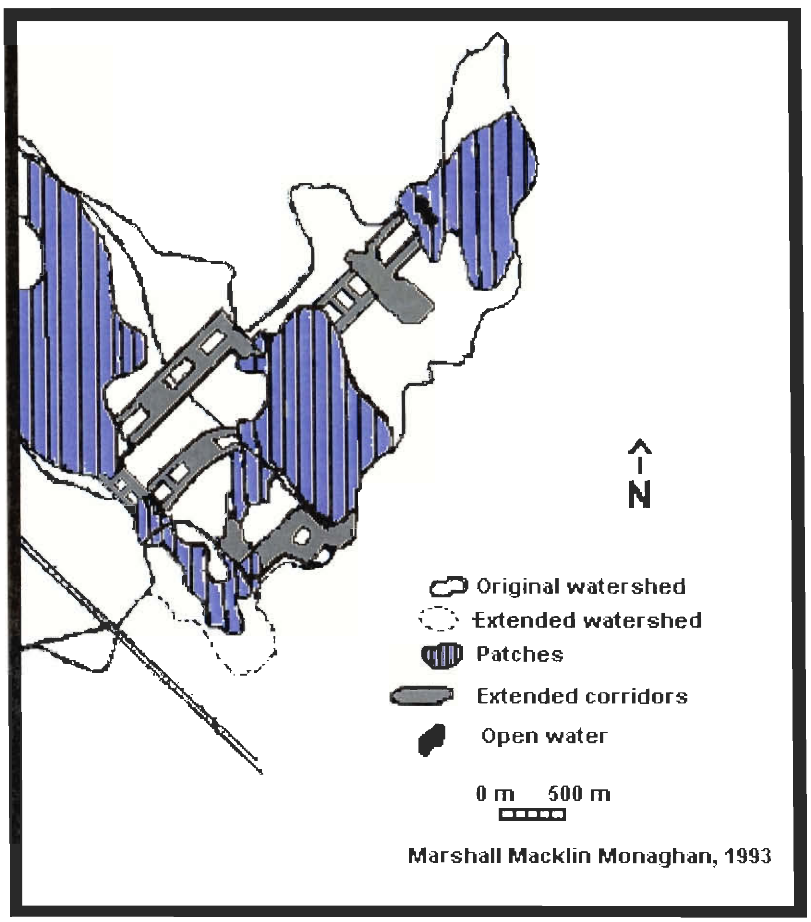


Figure 2.8 Proposed corridors in southwestern Canada
(adapted from Fleury & Brown, 1997)

After delineating and analyzing each of the six proposed corridors (See Figure 2.8) in this study, they concluded that the FDWC was a successful means of designing a wildlife corridor and is a very valuable tool for landscape architects. They also state that the success is theoretical; the corridors have not been physically introduced into the environment. Fleury and Brown (1997) conclude that the results of most studies of this nature are theoretical.

The final case study presented is better described as a field experiment designed to test the theory behind biological corridors. The study tries to verify that increased connectivity equals increased biodiversity. This experiment took place in North Central Colorado in a grassy prairie (See Figure 2.9). Findings were published in 1998.

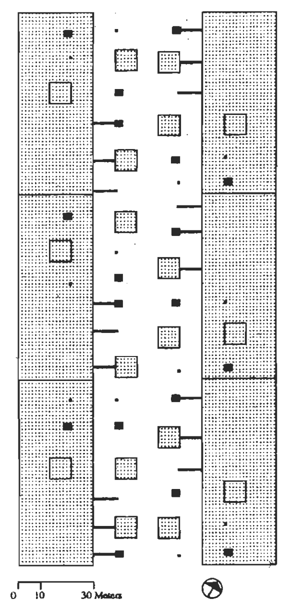


Figure 2.9 Experimental design of field study for fragment size and connectivity
(Collinge, 1998)

Collinge (1998) used insects as her target species. She artificially created grassy patches and corridors by mowing and treating surrounding areas. She formed differently sized plots, labeling them large, medium, and small, and connected some of them to a much larger untreated area. She tagged each of the insects in order to account for species loss and recolonization. Species loss was defined as the disappearance of an insect from a plot or corridor. Recolonization is the arrival of an insect to a plot. The experiment took place by releasing insects into the corridor and monitoring movement over a four-day period.

After analyzing collected data on insect movement, it was concluded that corridors decreased species loss and increased colonization in only medium plots. These results suggest that smaller fragments would not benefit from the implementation of biological corridors. Therefore, she suggests that for smaller patches resources should be devoted to increasing patch size rather than connectivity. She also states that her results lead her to believe larger patches serve as their own ecosystem; corridors are not necessary to combat fragmentation because their effects are not felt by the species. She notes that, in applying these findings to real corridors and patches, the size should be relative to the target species' size and specific needs. Nonetheless, this experiment provides some of the first field evidence of the effectiveness of biological corridors (Collinge, 1998).

2.6 Targeted Forests

Puerto Rico contains an abundance of biological diversity scattered throughout its many types of forests. According to the USGS and the DNER, there are six different forest classifications, each noted for their many different plant and animal species. These types of forests are subtropical rain forests, lower montane rainforests, lower montane wet forests, subtropical wet forests, subtropical moist forests, and subtropical dry forests (See Figure 2.10).

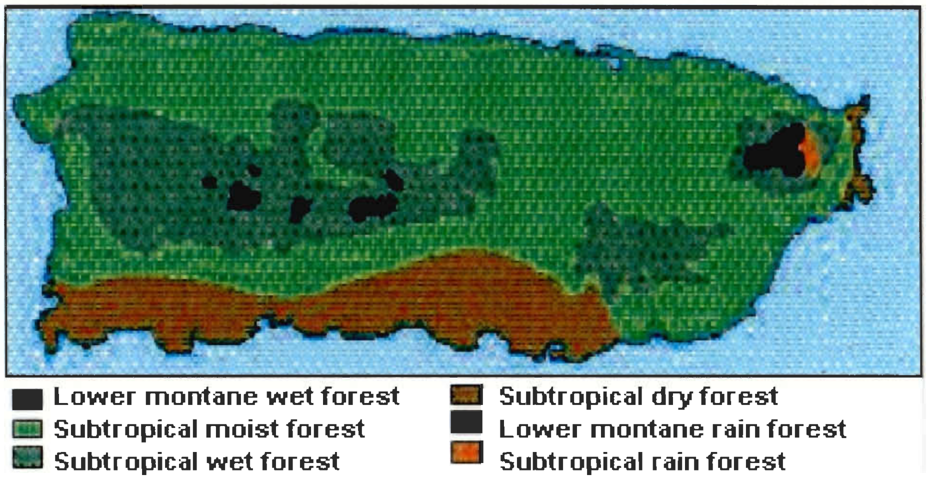


Figure 2.10 Forest classifications of Puerto Rico
(USGS website, http://biology.usgs.gov/)

Rosa (2000) adds another type of forest classification, transitional tabonuco forests, which are found in between dry forests and wet forests. The forests that are involved in delineating the two biological corridors can be found in the dry, transitional tabonuco, moist, and wet forest regions of Puerto Rico. The following information about the flora and fauna specific to each forest comes from Silander (1986) and personal communication with the USGS (2001).

2.6.1 Guánica, Susúa, and Maricao Forests

The corridor that will connect Guánica, Susúa, and Maricao State Forests will span four different forest classifications, which include dry, transitional tabonuco, moist, and wet forests. Guánica Forest is the largest subtropical dry forest in Puerto Rico. It is located in the southwest portion of Puerto Rico in the municipalities of Guánica, Yauco, and Guayanilla in two separate sections. Susúa Forest is located north of Guánica in the municipalities of Yauco and Sabana Grande. This area spans both the dry and moist forest regions which classifies it as a transitional tabonuco forest. Maricao Forest is located just to the northwest of Susúa in the municipalities of Mayagüez, San Germán, Maricao, and Sabana Grande. This area spans the subtropical wet, subtropical moist, and lower wet forest regions. (See Figure 2.11 and Figure 2.12)

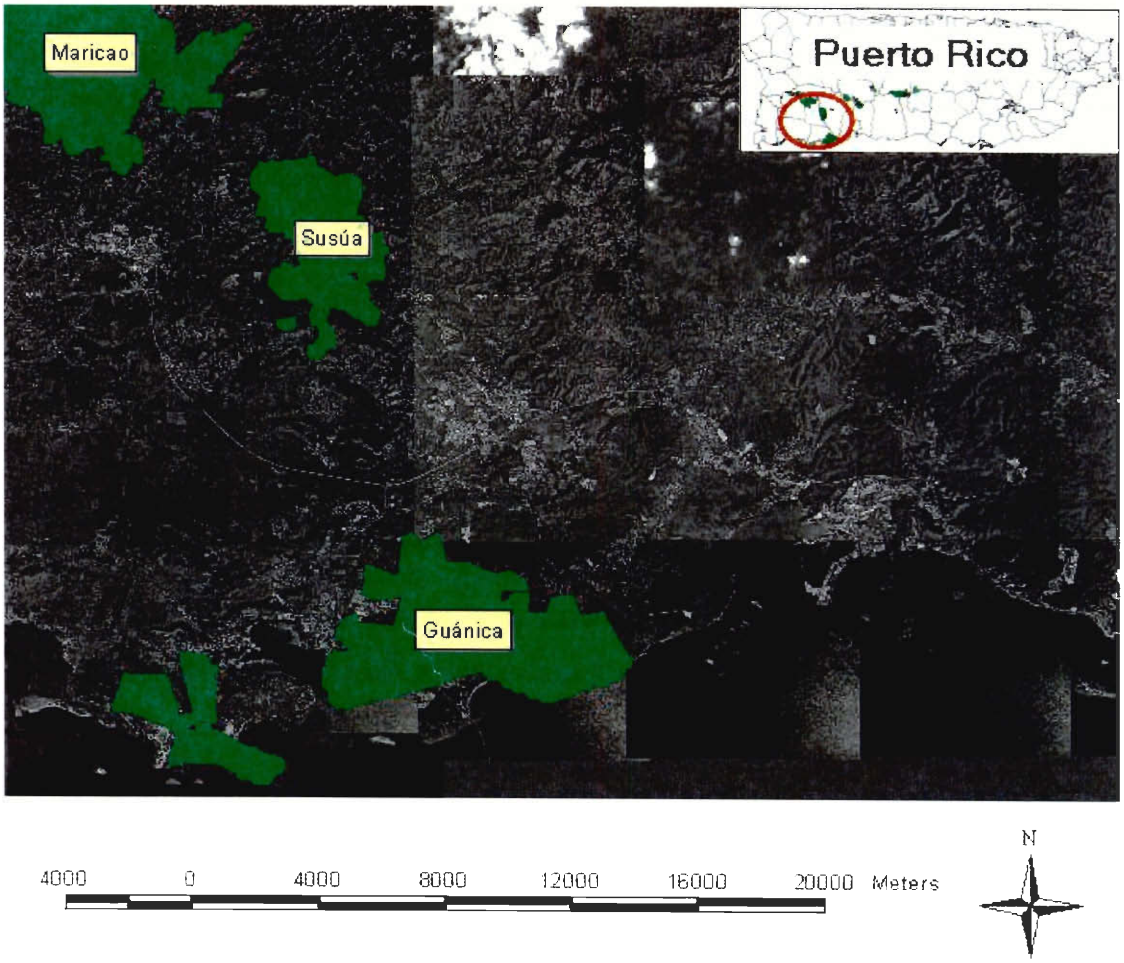


Figure 2.11 Aerial view of Maricao, Susúa, and Guánica
(Orthographic Photograph, USGS, 1995)
The different shading on photographs results from patching different photographs together

Figure 2.12 Panoramic view of Maricao, Susúa, and Guánica
(Photographed by Kuzsma, 2001)

According to the DRNA, Maricao has three conditions that are unique to the forests of Puerto Rico (Jiménez, Vidal, & Padrón, 1998). The first is its climate, which is found in less than three percent of the island. It receives an annual rainfall of 2,396 mm, and its average temperature is 72 degrees Fahrenheit, or 21 degrees Celsius. The second unique feature is its serpentine soil, which allows for rapid runoff of water. The third unique feature is that Maricao has been virtually untouched and is in pristine condition.

This corridor will encompass some of the most diverse habitats found on the island of Puerto Rico. Guánica Forest contains over 700 plant species, out of which forty-eight are endangered and sixteen are endemic, and forty bird species, out of which nine are endemic (Canals & Vidal, 1998). Susúa is home to 157 species of trees of which eighteen are rare or endangered, forty-four bird species, out of which one is endangered, seven species of amphibians, and seven species of reptiles (Cordero, 1998). Maricao is considered to be one of the most diverse areas of the Island in terms of plant species, as it contains 1,141 species of plants, out of which 128 are endemic to Puerto Rico and 23 are found only there (Jiménez, Vidal, & Padrón, 1998). Maricao is also home to 60 species of birds, out of which 29 are endemic.

One of the endangered species of birds that is found within Guánica, Susúa, and southern Maricao is the Guabairo, or Puerto Rican Nightjar (*Caprimulgus noctitherus*). It is a nocturnal bird, about robin-size. It survives on flying insects that it captures by hopping from perch to perch. The Guabairo is found only on the island of Puerto Rico in the dry limestone forests along southwestern coast. It is most abundantly found in the deciduous forests, evergreen forests, and plantations of the Guánica Forest. The Guabairo's habitat is also based upon the lack of nest or chick predators, specifically the mongoose, feral cat, and the recently introduced Rhesus Monkeys. The US Fish and Wildlife Service believes that the survival of the Guabairo is dependent on the conservation of this habitat and adjacent privately owned land (Vilella, 1991).

2.6.2 Guilarte, Pueblo de Adjuntas, and Toro Negro Forests

Guilarte, Pueblo de Adjuntas, and Toro Negro State Forests also are to be united by a corridor. These forests lie mainly in the subtropical and lower montane wet regions of central Puerto Rico. Guilarte, a subtropical wet forest, is located in the municipalities of Adjuntas, Guayanilla, Peñuelas, and Yauco. Two-thirds of Toro Negro lies within the lower montane wet forest region, while the rest of the area is classified as a subtropical wet forest. It is located in the municipalities of Orocovis, Jayuya, Ponce, Juana Díaz, y Ciales. Adjuntas Forest is a lower montane forest located in the Adjuntas and Utuado municipalities. See Figure 2.13 for locations of all three forests.

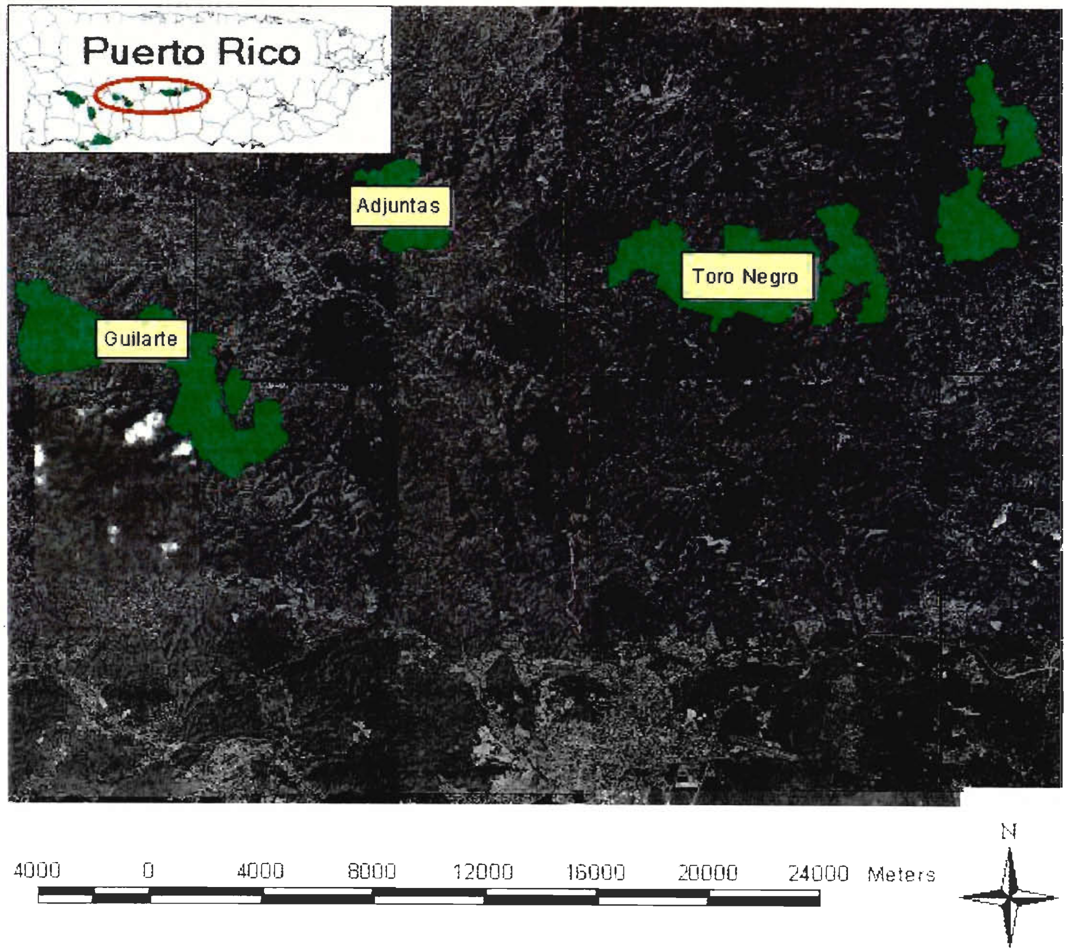


Figure 2.13 Aerial view of Guilarte, Adjuntas, and Toro Negro Forests
(Orthographic Photo, USGS, 1995)

The areas within these three forests are home to many species of flora and fauna. One can find within Guilarte 105 different species of trees, of which 29 are endemic to the island (Padrón, Reyes, & Vidal, 1998). Toro Negro contains 160 species of trees, of which 40 are endemic (Román, 1998). It is also home to 30 species of birds, including six endemic and two endangered species, and 20 species of reptiles and amphibians (Román, 1998). Adjuntas is a recent State Forest for which species information is not readily available.

In addition to the abundance of wildlife in the area, conservation of Guilarte and surrounding areas is important for protecting many watersheds that border the forest. Gerardo Hernández, Area Coordinator for Toro Negro and Adjuntas State Forests, explained during an interview (2001) that watersheds exist throughout the three forests. A watershed is an area of land that permits water runoff into a lake or river at the basin ("Putting Together a Watershed," 2001). A watershed efficiently provides inexpensive water to towns surrounding the basin. Expanding the watershed forest cover has the benefit of diversifying wildlife. Disturbances in these watersheds can have disastrous effects on the outlining areas, including a decrease in water quality and an increased possibility of flooding (DRNA, 1998).

One endangered species of bird that is found within Toro Negro, Guilarte, and Pueblo de Adjuntas Forests is the Falcón de Sierra, or Puerto Rican Sharp-shinned Hawk (*Accipiter striatus)*. It is a small hawk, measuring approximately eleven to thirteen inches long. The habitat of the Sharp-shinned Hawk is that of the lower montane and subtropical wet forests. It chooses to nest in areas in which there is a closed canopy and dense forest cover. Large breeding populations of twenty-five to thirty birds, are known to be present in the Toro Negro and Guilarte forests. The US Fish and Wildlife Service notes that the most likely cause of their population decline is the species' high intolerance to human disturbances in combination with the increase of roads, recreational facilities and public usage in the forests.

Another endangered species of bird that is possibly present in these forests is the Guaraguao de Bosque, or Puerto Rican Broad-winged Hawk (*Buteo platypterus)*. Like the Sharp-shinned Hawk, it is relatively small, measuring only 15.5 inches long. It is colored a dark chocolate brown. Extant populations are restricted to montane habitats of three forests, Río Abajo Forest, Carite Forest, and the Caribbean National Forest. However, there have been sightings in many other montane areas, including Pueblo de Adjuntas and Toro Negro. In addition, Haydeeliz Meléndez Burgos, Biologist at Toro Negro, has personally seen the Broad-winged Hawk within the forest and strongly believes that populations do in fact exist there (personal communication, 2001). Like many endangered animals, its current endangered status has been attributed to road construction, increased timber foresting, and increased recreational facilities and human disturbance. In 1992, the last census of Broad-winged Hawks yielded an estimated population of only 125 hawks throughout Puerto Rico (Delannoy, 1997). Delannoy (1997) suspects that the population has been about this size for roughly a hundred years. He suggests that because of this the Broad-winged Hawks' population may also be suffering from low genetic diversity.

2.7 Economic Considerations

Economic incentives for forest conservation could include increased forest tourism, recreation, tax breaks for landowners, a healthier water supply, and income from minor forest products including fruits, oils, fiber, and medicines. Nature tourism, or "ecotourism," could be a very promising economic opportunity. A report by the World US Wildlife Fund cited the benefits of ecotourism in Mexico, Ecuador, and several other Latin American countries (Boo, 1990). The report commented that ecotourism can help diversify an economy, provide local employment, and is a relatively open market. Recreation and tourism can serve as a way of garnering public support for developing corridors (Burger, 2000). Fishing and other water-related activities are compatible with preserving the ecosystem if controlled and managed properly (Burger, 2000).

Not all studies agree that nature tourism is beneficial. For example, Vail and Hultkrantz (2000) explain that the forests of Dalarna, Sweden and Maine, USA are not well suited for ecotourism. Tourism would not help the economies in those locations for either the long or short run. There would be a lower amount of goods that are not related to recreation produced in and around the ecotourist regions. Other problems would arise such as congestion and environmental degradation from inconsiderate tourists. Vail and Hultkrantz also believe that smaller producers of recreational goods would face unfair competition from larger producers.

Some preserved forestlands that would otherwise be used for logging purposes can hold value in non-wood products. Peters, Gentry, & Mendelsohn (1989) are cited in Dixon (1990) to report that three times more total revenues were generated in a rich Amazon forest in Peru by exploiting valuable non-timber forest products than by developing the land. In Economics of Protected Areas, Dixon (1990) concludes from Peters et al's report that Peru would yield $1,000 per hectare for commercial timber, but $6,330 per hectare for fruit and latex collection every year.

Sometimes the cost of a corridor does outweighs its ecological benefit. Simberloff (1992) explains that Florida's Conservation and Recreation Lands (CARL) acquisition program rejected a proposal to connect the Eglin Air Force Base with two other forests via a biological corridor. The CARL found that the $5 million cost of the corridor did not outweigh the benefit to the few species of birds whose survival might be improved.

Ahern (personal communication, 2001) explains three economic strategies for protecting land. One strategy is to buy the deed to a landowner's property. This provides for maximum control over the property, but it is also very expensive. A less expensive but also less reliable method is voluntary forest management by the landowners themselves. A compromise for these two strategies is to purchase easements. The owner sacrifices certain rights to his property, but still owns the land. The conservation group sets up paid or voluntary clauses in the landowner's deed to maintain conservation in the region. Lastly, Ahern explains that since quantifying the value of scenic beauty or wildlife is not easy, justifying the cost of land acquisition for conservation purposes is also difficult.

2.8 Land Acquisition

The methods available to the DRNA for acquiring land are important to understanding the full effect the corridors will have on the affected landowners. Several laws exist to support the DRNA with their land acquisition attempts. Under the authority of these laws, the DRNA implements several mechanisms when acquiring lands. The impact of land acquisition on landowners can be drastic or negligible.

2.8.1 Legislation

There are five laws in Puerto Rico that provide the DRNA with mechanisms or impetus for acquiring land. Law 150 (1988), "Natural Heritage Law," gives the DRNA funds for acquiring, restoring, and managing areas of natural value. Law 195 (1998), "Reforestation Law," gives the Secretary of the DRNA the power to acquire areas of natural value through donations or purchasing. Under Law 133 (1975), "Forest Law," the Secretary of the DRNA can also acquire any parcel of land whose location, physical characteristics, topography or geography may be especially important for forest conservation efforts. This includes acquiring land in order to develop and protect watersheds, protect against erosion in highly susceptible areas, and develop areas by the forest administration for recreation or other purposes. The Secretary can acquire or rent property containing lakes or lands necessary for the establishment of biological reserves under Law 70 (1976), "Wildlife Law."

Law 1277 (2000) of Puerto Rico entitled "The Law to Unite the State Forests of Maricao, Susúa, Guánica, Toro Negro, Guilarte and Pueblo de Adjuntas" orders the DRNA to establish the biological corridors. Rossana Vidal, a land acquisition expert with the DRNA, finds Law 1277 unclear as to whether the DRNA should expropriate land for the corridor or not (personal communication, 2001). One part of Law 1277 explains that land titles should not be an obstacle when acquiring the corridor land. However, another part of the law orders the DRNA to devise economic incentives that will encourage affected landowners to sell their properties.

2.8.2 Mechanisms

Forcing landowners to sell their properties because of conservation is not a compromise between the government and its people. New conservation legislation in the 1970s in the United States provoked intense disagreement with landowners who believed the laws were unjustified intrusions on their property rights (Meinzen-Dick & Wiebe, 1998). Instead of forcing landowners to give up property rights for conservation purposes, an alternative is to create incentives for landowners to voluntarily to give up partial land rights. This strategy is commonly referred to as "partial interest acquisition." The Wetlands Reserve Program, for example, is an incentives-based program that entices wetlands property owners to give up some cultivation rights in exchange for a small payment from the US government (Luzar & Diagne, 1999). However, there are still the costs of ongoing monitoring to ensure partial property rights are being respected (Meinzen-Dick & Wiebe, 1998).

As explained in a presentation on land acquisition strategies by Serrano and Vidal (2000), the DRNA has many mechanisms for acquiring land. The most effective strategy for protecting lands is buying the land titles outright. This method is not always viable because of insufficient funds. In situations where the landowner does not want to sell or is not in agreement with a compensation value for the land, the DRNA can expropriate (See Glossary) their land. Under Law 133 (1975), the DRNA can expropriate land proven to have significant conservation value. The DRNA offers a reasonable compensation for the expropriated land, basing the price of the land off its market value.

When the DRNA does not have all available funds for a land purchase, a contract may be written between the DRNA and the involved landowner to rent the land for a period of time. In this strategy, the landowner retains the title to his or her land and obtains some economic benefits from it. Sometimes the contract includes an option to lease then buy the land outright.

The DRNA sometimes receives property donations. In cases where the landowner is interested in protecting his own land but also retaining the title to the land, an agreement may be signed with the DRNA to give full power to the DRNA to manage the property.

Conservation easements or partial interest acquisitions are also mechanisms used by the DRNA to acquire forests. Under this mechanism, a landowner gives up certain rights to his or her land in exchange for money from the DRNA. The landowners accede rights that will benefit conservation of their forests.

The DRNA can also mitigate the exchange of lands of lesser ecological value for lands of higher ecological value. For example, the DRNA might exchange an area of coastline important to developers with a valuable forestland from a private landowner. Sometimes a third party might be involved if the DRNA does not have any land of its own to exchange.

The Secretary of the DRNA can classify private lands as auxiliary forests if the lands cover more than five acres in a continuous area and are dedicated exclusively to the production and development of forests. The landowner does not have to pay taxes over property on an auxiliary forest. A disadvantage to this program is that it is entirely voluntary. The landowner can withdraw his land from auxiliary status at any time for the cost of back taxes on the land. This program, known as the "Auxiliary Forest" program, is designated under Law 133 (1975), "Forest Law."

There are two other ways in which the DRNA can acquire lands. The "usofructo" land acquisition mechanism involves a contract between a landowner and the DRNA in which the landowner gives up all rights to the land except the title to it. Also, under section 16 of the Natural Heritage Law, the Secretary of the DRNA can ask the government to transfer the title or management of public areas to the DRNA.

2.8.3 Social Impacts

Building biological corridors to conserve wildlife will have a significant impact on society. Private landowners of forested lands would be heavily affected by the delineation of corridors and accompanying buffer zones. When the Forest Legacy program was initiated to conserve specific forest areas of Puerto Rico, three meetings were held with affected private forest landowners. Rosa reports (2000) that all participating landowners highly approved of implementation of the program. The landowners also recommended tax break incentives and financial and technical assistance with the reforestation process.

Unlike the affected private landowners mentioned in Rosa's study, there exist people who are not in favor of conservation efforts. Bryant (2000) cites a study in the Philippines about a government initiative in 1992 to conserve biodiversity in the country. Claiming their ancestral domain rights were being violated by the initiative, the indigenous people of the Philippines reacted negatively (TFCI, 1998). One landowner involved with the initiative said, "We do not need outsiders to lead in protecting our territory since we have long kept it protected." Another believed that outsiders were arrogant to argue that "western" science was superior to local knowledge (Bryant, 2000).

2.9 Reforestation

Developed regions within the corridors will have to be reforested to provide adequate habitats for the wildlife. The Reforestation Guide for Watersheds of Puerto Rico (DRNA, 1998) suggests methods for reforesting lands. Reforestation should begin on lands near already forested lands. Trees that take root quickly should be grown near livestock barriers. On lands with a high slope, trees with deep roots can best help prevent erosion. To conserve water, trees should not be planted closer than 10 meters from intermittent sources of water, 20 meters from perennial sources of water, and 30 meters from canals. All trees should be planted along the topographical contours of the land. The guide also lists some species of tree that should be used to reforest areas of different soils.

The reforestation guide also explains when to reforest different regions (DRNA, 1998). The southwest corridor should be reforested between August and October, except in the far south where reforestation should occur between September and October. The central corridor can be reforested between May and November.

2.10 ArcView™, a Geographical Information System

ArcView™ is a geographic information system (GIS) that can be used to create maps from quantifiable data (See Figure 2.14).

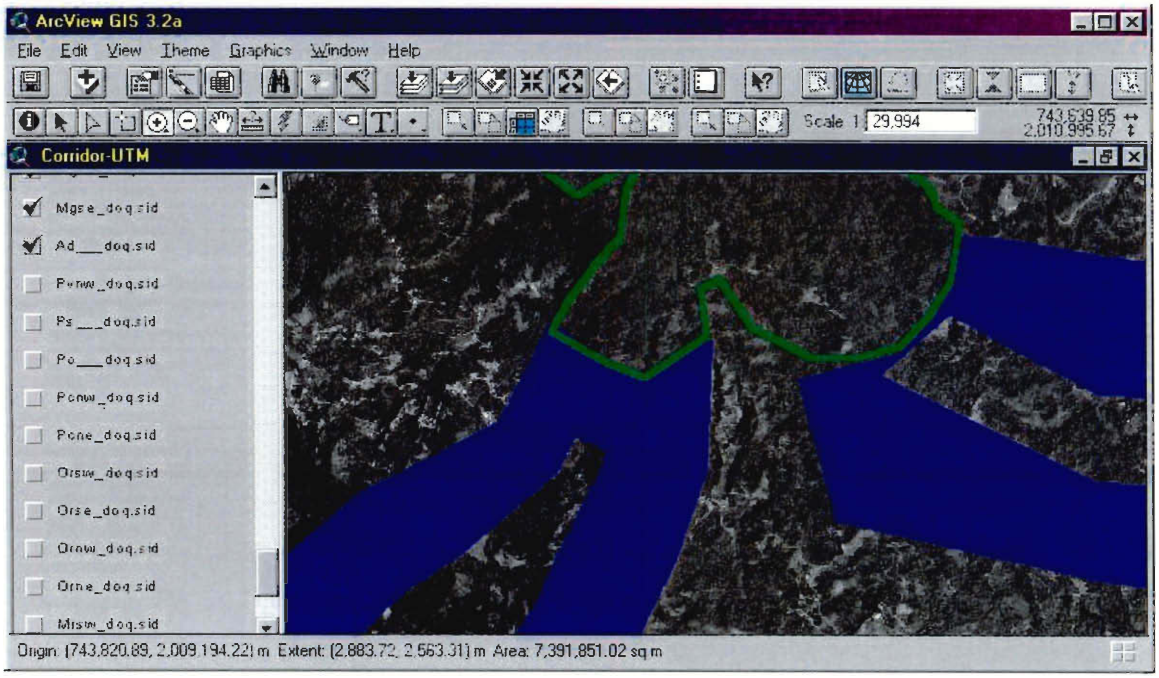


Figure 2.14 Screen shot of ArcView™ version 3.2a by ESRI, Inc.

ArcView™ data is compiled into layers that can be superimposed over each other to present more meaningful data. As illustrated in Figure 2.15, three different layers, wells, homes, and streets, can be layered upon one another to create a more comprehensive layer.

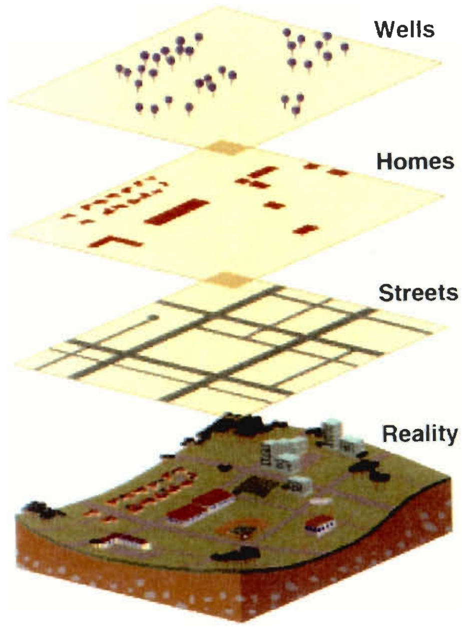


Figure 2.15 Illustration of sample GIS layers
(Lang, 1998)

ArcView™ is one of our primary methodological tools used for delineating the biological corridors.

CHAPTER 3 - METHODOLOGY

The primary objective of this project was to present the DRNA with a complete design of biological corridors to increase the biodiversity of Puerto Rico's forests, combat the effects of deforestation and fragmentation, and satisfy the stipulations of Law 1277 (2000). The corridors were designed to unite the forests of Guánica, Susúa, and Maricao in the southwest and Guilarte, Pueblo de Adjuntas, and Toro Negro in the center of Puerto Rico.

There were other objectives associated with delineating the corridor that were completed during this project. It was necessary to prioritize tracts of land involved in the final corridor design so that the DRNA could use its budgeted funds effectively. In addition, a method for calculating the estimated cost of the final corridors had to be designed.

We changed our original goal from creating a less socially-intrusive corridor towards educating the public about our project. By taking this approach, our corridors retained their optimal ecological design. We explain how we acquired contact information for all private landowners within the corridors so that an informational brochure and survey could be distributed. An explanation for how the DRNA can interpret the survey is also included.

3.1 Data Collection

The first stage of our methodology was the collection of data relevant to our project. We conducted interviews with five forest managers, one of whom is an area coordinator for both Adjuntas Forest and Toro Negro. At a forest in each corridor we held general information sessions with a resident biologist. Also instrumental in our data collection process was the information gathered from interviews with two biologists at the US Fish and Wildlife Service and a hydrologist at the US Geological Survey. We interviewed a land acquisition expert at the DRNA and held weekly informational meetings with our liaison Daniel Galán, the Director of Forest Management of the DRNA. We also visited four of the six forests to obtain a visual first-hand account of the regions with which we were working. The following sections detail the process of our data collection.

3.1.1 Interviews with Forest Managers, Biologists, and Other Professionals

We conducted structured one-on-one interviews with five forest managers. They were Wetsy Cordero from Susúa, Ruben Padrón from Guilarte, Miguel Canals from Guánica, Adrian Muñiz from Maricao, and Gerardo Hernández, the Area Coordinator for the Toro Negro and Adjuntas forests. The questions we asked the forest managers focused on relevant flora and fauna, potential target species, land ownership and development near the forests, conflicts with the affected landowners, economic incentives within the corridor regions, and the forest managers' concerns about the corridor. For interview questions and responses, see Appendix C.

The forest managers convened together at the DRNA for our structured individual interviews. Galán organized an informal group meeting with all of them in which we could direct questions that might pertain to all their respective forests. The individual interviews were more beneficial to our study but the group discussion helped us to determine target species for two connected forests. Other questions focused on understanding what wildlife species could especially benefit from the corridors.

At the DRNA, Galán, Rossana Vidal, Biologist and land acquisition expert, Alexis Dragoni, ArcView™ expert, and Wendy Boneta, Biologist, provided background information and tools necessary to complete the project. In a general information session, Rossana Vidal explained the land acquisition mechanisms available to the DRNA. She also clarified the confusing Spanish portions of the corridor law, Law 1277 (2000). We discussed our current findings almost daily with Wendy. As a biologist, she gave us further background information on relevant flora and fauna of the corridor regions. Dragoni gave us the software and map layers required to digitize maps and delineate the corridors.

We interviewed Susan Silander, a Botanist at the US Fish and Wildlife Service, to acquire maps with locations of target species for the corridors. Also at the US Fish and Wildlife Service, we interviewed Beverly Yoshioka, a Wildlife Biologist. We learned from the forest manager interviews that sun-grown coffee causes deforestation and could be a threat to our target species. Therefore, our interview with Beverly focused on the detriments of this agriculture, where it is prominent, and how it differs from the cultivation of shade-grown coffee.

An informal phone conversation with Carlos Conde, a hydrologist at the US Geological Survey, revealed that Conde had delineated a corridor between Maricao, Susúa, and Guánica. Along with Wendy Boneta from the DRNA, we visited Conde to compare corridor designs. We acquired Conde's paper on the corridor and some maps of his final delineation.

To confirm our hypothesis about good target species for the central corridor (See Methodology Section 3.2.1), we held a general information session with Haydeeliz Meléndez, the resident biologist at Toro Negro. The purpose of the information session was to obtain the opinion of another biologist about our choice of target species and to identify any other species that might benefit from the corridor. We also wanted to confirm that our endangered target species had been sighted in the area.

José Silva, Biologist at Guánica State Forest, showed us an aerial map of the corridor region between Guánica and Susúa. We examined the map with him and discussed the possible options for corridor delineations for the southwestern corridor.

3.1.2 Forest Visitations

We visited four of the six forests for which we delineated the corridors. Maricao and Guilarte could not be visited due to time constraints. Forest managers there expressed their preferred corridor delineations and pointed them out on a map. In some cases, we viewed their preferred corridor locations directly along the landscape. The visits helped us to examine land development and geographical features between the forests. We took photographs of the corridor regions for reference. Any barriers that existed within the corridor were seen up close. As stated in Methodology Section 3.1.1, we conducted general information sessions with biologists José Silva and Haydeleez Mendeléz at Guánica and Toro Negro, respectively.

3.2 Determining Critical Corridor Attributes

Most critical attributes of the corridor were dependent on the habitat requirements of the target species. For example, we found the required vegetation for the corridor by examining the habitats of target species. Other attributes were identified by the guidelines outlined in Fleury and Brown's Framework for the Design of Wildlife Corridors. These attributes are matrix, network connectivity, barrier, length, width, edge, structure, and composition (See 2.5.2).

3.2.1 Identifying Target Species

Through information gathered from the interviews and background reading, we identified several possible target species for the corridors. More than one target specie could be chosen, as long as each met a specific set of requirements. The target specie requirements defined by Ahern (1995) are as follows:

- It has high intolerance to human disturbances and fragmentation
- Its existence in an area indicates that all of the surrounding habitat is intact and healthy
- It has an extensive home range
- It is on the higher end of the food chain, preferably an upper-level carnivore

We also felt it was important for the target species to have clearly defined habitat requirements so that we could follow composition throughout the corridor. It also seemed logical for the target species to have suitable habitats on both ends of the corridor; species that pass through the corridor should be able to survive in the connected forest.

According to Ahern (personal communication, 2001), a well-chosen target specie should be intolerant to human disturbances and fragmentation. This is because biological corridors benefit species that are found in the interior of forests, not in developed or fragmented areas. The specie should also be sensitive to habitat changes; therefore, its existence in a particular area confirms that the surrounding habitat is healthy and intact. Ahern (1995) also states that the target species should have an extensive home range. This is due to the likeliness the species will use a corridor in an effort to extend its foraging area. It is also important that the target specie be considered high-level with respect to the food chain. Therefore, if that specie is present, the existence of “lower-level” wildlife needed to support the chain is affirmed. Another critical characteristic of a target species is that its habitat requirements be clearly defined. Without knowing the detailed living conditions the specie requires, it would be impossible to determine where to place a corridor to suit its needs. Also, it is important that its required habitat is present at both ends of the corridor, thereby increasing the likelihood of species usage.

3.3 Designing the Corridors in ArcView™

As explained in the Literature Review Section 2.10, ArcView™ is a GIS tool that can assist us with drawing maps and delineating corridor regions. The DRNA provided us with ArcView™ software and various map layers, or shapefiles. These shapefiles included watersheds, land use and development, forest locations, hydrology, roads, topography, soils, and high resolution aerial and satellite photos. Considering all the criteria that the corridors must satisfy, we chose these layers as the most instrumental for mapping the corridors. Also, through discussions with Alexis Dragoni, ArcView™ expert at the DRNA, we learned which layers were available to us, the accuracy of the data presented in the layers, and which layers might provide the most benefit for designing our corridors.

To analyze the data contained in each ArcView™ shapefile, we used gap analysis, a process that consists of collecting data, compiling the data into GIS maps, and then layering these maps to view certain patterns and relationships (Dobson, 1996). By using this method we were able to visualize easily the most suitable areas of land for delineating the corridors.

It was necessary for us to create a layer of target species locations. To make the corridor more effective, we could possibly delineate the corridor around the highest concentration of the species. We obtained maps from Silander at the US Fish and Wildlife Service that marked the sightings of our target species throughout the corridors and connected forests. We used this data to create a digitized map layer in ArcView™ showing the sightings of these species.

We determined the preliminary corridor design for the forests of Guánica, Susúa, and Maricao by examining the layers containing sightings of target species, land usage, hydrology, and soils. The first step in the preliminary design was to mark all areas between the forests that were categorized as lightly forested and densely forested in the land usage map. The next step was to mark all areas of similar soil between the forests using the soil maps. Next, we used the hydrology map to mark rivers that pass between the forests, which could serve as possible pathways for the corridors. We then combined the map layer showing target specie location with each of the previous layers to determine critical areas and habitats. Lastly, a layer connecting all of these critical areas and habitats was created to serve as our preliminary corridor delineation. To our design we applied any remaining critical corridor attributes as determined by our target species' requirements and by Fleury and Brown's FDWC (See Literature Review Section 2.5.2).

The process for delineating the corridor between Toro Negro, Adjuntas Forest, and Guilarte was similar to that used to delineate Guánica, Susúa, and Maricao, but with some fundamental differences. Since the protection of watersheds (See Glossary) is important in the central forests, we focused on tracing the corridor around watershed boundaries. The distance between the forests was also too long for an effective corridor (See Results and Analysis Section 4.3), so we delineated a large patch encompassing a watershed between each forest. Then we continued with the same process used for establishing the southwest corridor. We superimposed land usage, vegetation, soil, hydrology, topography, and target species locations layers to factor necessary areas and habitats in our corridor design.

3.3.1 Identifying Property Tax Numbers within the Corridors

Once the preliminary corridor design was complete, we created another layer consisting of property delineations throughout the corridor regions. Maps denoting property numbers were acquired at the Centro de Recaudación Ingresos Municipales (CRIM). Pedro Rivera, an administrative assistant at the DRNA, scanned the maps into a computer as monochrome bitmap images (See Glossary). The bitmaps were then cropped and positioned into ArcView™ using the Quick and Dirty Image Referencing (QDIR) tool. QDIR allows the ArcView™ user to manually position a picture into a layer. We superimposed the digitized property maps onto our existing corridor delineations to spot necessary properties.

We manually created a spreadsheet of all property numbers that the corridor touched (See Appendix B). The CRIM also provided us with tax-assessed values, acreage, and contact information for landowners of the identified properties (See Appendix E). These values were included in the property numbers spreadsheet.

3.3.2 Summarizing the Final Corridor Design

We summarized the final corridor attributes in a table listing corridor attributes, the desired result, and the actual design result. The following attributes are listed in the table: matrix, network, barriers, length, width, shape, structure, species benefited, areas conserved, target species suitability, land value. For attribute definitions, refer to the Glossary or Section 2.5.2 of the Literature Review.

If the corridor met or exceeded all of the minimum requirements, then it would be considered functionally acceptable. If the corridor did not meet one or more of the minimum requirements, we would include an explanation of why each requirement was not met and the how the corridor's functionality would be affected.

3.3.3 Prioritizing Lands

Since it may be impossible for the DRNA to acquire all lands included in the corridor immediately, it was necessary to prioritize lands based on ecological value. Lands that met all requirements for the target species took highest priority. See Conclusions and Recommendations Section 5.2.4 for reasoning behind the type of habitat chosen. Lands that required reforestation or did not have important corridor attributes as outlined in the FDWC took lower priority.

We developed a process in ArcView™ to identify high, medium, and low priority lands for all corridors. ArcView™ tools and processes that were instrumental in manipulating layers to arrive at the prioritized property layers are explained in Appendix G. In the southwest corridor, we identified high priority lands as those containing desirable soils and dense forest cover. Medium priority lands had either desirable soils or dense forest cover. Remaining lands were considered to have the lowest priority. The central corridor followed the same priority method as the southwest corridor. However, watersheds played an important role in the central corridor delineation (See Results and Analysis Section 0). Because of this, watersheds were labeled with the absolute highest priority. Properties within the watershed were then subdivided into low, medium, and high priorities as in the rest of the corridors.

Finally, we identified property tax numbers for the prioritized lands using the same process for identifying tax numbers as the entire corridor. (See Appendix B). By superimposing the prioritized lands layer over the CRIM properties layer, we could list property numbers and their corresponding priorities.

3.4 Estimating the Cost of the Corridors

The market value of delineated corridor lands cannot be exactly determined without individually appraising all properties within the corridor. According to Daniel Galán at the DRNA (personal communication, 2001), a professional land appraisal takes approximately two months and can cost several hundred dollars depending on the size of the plot. Approximately 600 properties would have to be appraised within the corridors. Since appraising all the lands would take longer than the time allotted for the project, an alternative approach was taken.

To approximate the value of the corridors, we referred to appraised values of seven lands purchased by the DRNA within the last two years (See Appendix D). The sample of seven lands was not picked randomly; they were the only seven lands near the corridors for which the DRNA had copies of their appraisals and tax-assessed values.

We were given the market value V_{market} and tax-assessed value V_{tax} of the seven appraised lands around the corridors. The V_{tax} of any property can be obtained from the CRIM given the property's tax identification number. We determined the error between V_{tax} and V_{market} of each property with the following equation:

$$\%_{error} = (V_{market} - V_{tax}) / V_{market}$$

We then found the average $\%_{error}$ for all seven properties and used this value as the constant V_{tax} to V_{market} error.

Next, we gathered property tax numbers for all lands within the corridor region. The CRIM then gave us all tax-assessed values V_{tax} and acreage $A_{property}$ for each property. We applied the following formula to each property to arrive at an estimated market value E_{market} for each property:

$$E_{market} = V_{tax}/(1-\%_{error})$$

Finally, to obtain the cost for each corridor, we solved the following proportion for the estimated corridor value, $E_{corridor}$, given the total corridor acreage, $A_{corridor}$:

$$\Sigma E_{market} / E_{corridor} = \Sigma A_{property} / A_{corridor}$$

3.5 Identifying Social Conflicts and Optimal Land Acquisition Mechanisms by Surveying Landowners

Initially, we wanted to arrive at a land compromise between the DRNA and private landowners should the DRNA have to acquire their property. Our original approach was to interview approximately twenty-five landowners from a random selection of properties within the corridors. In each interview, we intended to first explained briefly our project in Spanish with the help of a translator. We then planned on presenting the subject with a survey asking several questions regarding their sentiments about the possible implementation of a biological corridor on their land. The questions, written in Spanish, would be presented to them to be answered in written form while we waited for their response. We then planned on analyzing the responses to determine the most popular land acquisition method, which landowners did not want to participate at all in conservation, public awareness of the corridor law, and how landowners planned on using their land in the future.

However, in our attempt to interview landowners, we discovered that we could not interview a large enough sample to identify any trends in the results. We acquired a list of all private landowner contacts late in the project phase (See Appendix E). Due to time constraints and limited transportation availability, we were able to interview only two landowners. The questionnaire and the two responses from it can be found in Appendix H. With only two completed interviews, we could not identify which land acquisition mechanisms would be most pleasing to the most landowners. Furthermore, we could not identify properties owned by landowners unwilling to sell for conservation. Therefore, our corridor design could not be adjusted for private landowner sentiments.

3.5.1 Adjusting the Survey for a Mailing

Although we could not accomplish our original goal of delineating a corridor that would satisfy both ecological and landowner desires, we still wanted to provide the DRNA with a method for acquiring results from our survey. We adjusted portions of the content and layout of the survey so that the results could be more easily analyzed and quantified by the DRNA. The final survey can be found in Appendix I; a full method for analyzing it can be found in Appendix J.

We designed a mail survey for many reasons, all of which are identified in Dillman & Salant (1994). Mail surveys require few resources, are easier to conduct than telephone or face-to-face surveys, and do not require professionals to analyze the data. Because an interviewer does not have to be present when the respondent fills out the survey, fewer people are required and more time can be spent on the survey analysis. Responses from the mailings do not have to be analyzed as immediately as other survey methods. Respondents might also be more encouraged to give personal responses because they are not faced with an unknown interviewer and they can answer the questionnaire at their leisure in their own home. The results from the mail survey could be less biased than the results of a personal interview; the respondent will not try to give answers that the interviewer wants to hear. The main drawback to the survey is that landowners might not respond or send incomplete responses.

3.5.2 Educating the Landowners with a Brochure

Surveyed landowners should be aware of biological corridors and their effects to give educated and accurate responses to the questions. Neither of the two landowners we interviewed knew about Law 1277 (2000) or the purpose of biological corridors. We found that an expert on biological corridors at the US Geological Survey also was not aware of the recent corridor law. At least three professionals at the DRNA including the resident land acquisition expert agreed that the majority of the public is not aware of the corridor law, biological corridors, land acquisition practices, and incentives for conservation.

We concluded, therefore, that the public was not aware of many aspects of the corridors. If our survey were to yield educated results, our survey population should first be made aware of the project. Therefore, we created an informational brochure to accompany the survey and impart the information described above (See Appendix I). An explanation of Law 1277 (2000), proposed corridor locations, and a brief discussion of biological corridors were fundamental aspects of the project explained in the brochure. We also included ways in which conservation benefits wildlife and humanity and explained the increasing deforestation problem within Puerto Rico. Private landowners also had to learn about the benefits of using their land for conservation. In order to eliminate any ambiguity over the power of the DRNA to take private lands, a list of land acquisition mechanisms available to the agency was explained in the brochure.

The brochure was designed with the knowledge of the audience in mind. Information was written clearly, concisely and with as little technical information as possible. Time was also spent making the eye-catching brochure visually appealing, easy to follow, and quick to read.

CHAPTER 4 - RESULTS AND ANALYSIS

The following chapter illustrates all final corridor delineations and explains in detail how we arrived at each design. For the corridor designed to unite Guánica, Susúa, and Maricao State Forests in the southwest region, we identified the target species chosen, discussed geographical influences, and justified the final corridor delineation. We separated the resulting maps for the Guánica to Susúa corridor from the Susúa to Maricao corridor for more clarity. For the central corridor designed to unite Guilarte, Adjuntas, and Toro Negro State Forests in central Puerto Rico, we again indicated the target species chosen, identified geographical influences, and justified the corridor delineation. The central corridor region is separated into two results sections: the Guilarte to Adjuntas corridor and the Adjuntas to Toro Negro corridor. Following our corridor results, we explain the full analysis behind our estimated cost for all corridor properties. Lastly, we conclude the report with an explanation of how we intend to educate the community about corridors.

Results from our interviews can be found in Appendix C. The full listing of property tax numbers and assessed values is located in Appendix B.

4.1 Southwestern Corridor Region

The corridor uniting Guánica, Susúa, and Maricao Forests improves the ecosystem of the forests and surrounding areas by conserving approximately 2,600 acres of land. This increases the available roaming, foraging, and living space for many different species of fauna, including those that are endemic or endangered. Within these three forests, there are approximately fifty to sixty species of bird, thousands of plant species, and numerous amphibians and reptiles that would most likely benefit from the corridor. Some of these species include the Guabairo, or Puerto Rican Nightjar (*Caprimulgus noctitherus*), the Pájaro Carpintero, or Puerto Rican Woodpecker (*Melanerpes portoricensis*), the Aura Tiñosa, or Turkey Vulture (*Cathartes aura*), and the Siguana de Rabo Azul, or Blue Tail Iguana (*Ameiva wetmorei*). For more advantages to implementing a corridor, refer to Literature Review Section 2.5.1.

4.1.1 Target species

In order to choose the most suitable target species for this corridor, we first consulted the forest managers of the involved forests. The consensus from our individual interviews with each (See Appendix C) was that the Guabairo, or Puerto Rican Nightjar, was the most suitable target specie for the area. The forest managers' basis for this choice was that it is located in all three forests and its habitat is representative of the majority of the species found in the forests. A picture of this specie can be seen in Figure 4.1.

Figure 4.1 The Guabairo (Puerto Rican Nightjar), target specie for the southwest corridor
(DRNA, 2001)

The corridor was designed with high consideration for the requirements of birds. Birds have longer home ranges than reptiles and amphibians within the forests. They can assist with seed dispersal, thus contributing to the reforestation process of acquired lands. As noted by Conde (1996), some endemic Puerto Rican bird species such as the Puerto Rican Bullfinch (*Loxigilla portoricensis*), Puerto Rican Pewee (*Contopus portoricensis*) and Puerto Rican Vireo (*Vireo latimeri*) avoid flight over open areas. These species can especially benefit from a continuous vegetative corridor.

We confirmed that the Guabairo was a suitable target species by comparing it to the characteristics outlined in the Methodology Section 3.2.1. Its endangered status is indicative of its high intolerance to habitat changes, human disturbance, and fragmentation. Also, in comparison to other species, it has an extensive home range, measuring about five hectares, which is about 12 acres (Vilella, 1995). An extensive home range, as stated in Methodology Section 3.2.1, is an important characteristic for a target species because it is more likely to use the corridor to expand its foraging and living area.

The Guabairo is not considered an upper-level carnivore; it survives mainly on insects. Although the main habitat of the Guabairo is the dry forest, it can be found in moist forests as well. Its habitat consists of birds and small reptiles. For this reason, we considered the Guabairo representative of the higher-level fauna in this region.

The Guabairo possesses very clearly defined habitat requirements. It prefers the dry limestone forests that have a closed-canopy, dense cover, and little human disturbance (Vilella & Zwank, 1992). These findings are supported by a map of Guabairo sightings by Vilella obtained from the US Fish and Wildlife Service.

Vilella's sightings were primarily in Guánica Forest and Susúa Forests in areas characteristic of the habitat that Villella described. They are represented by red dots in Figure 4.2.

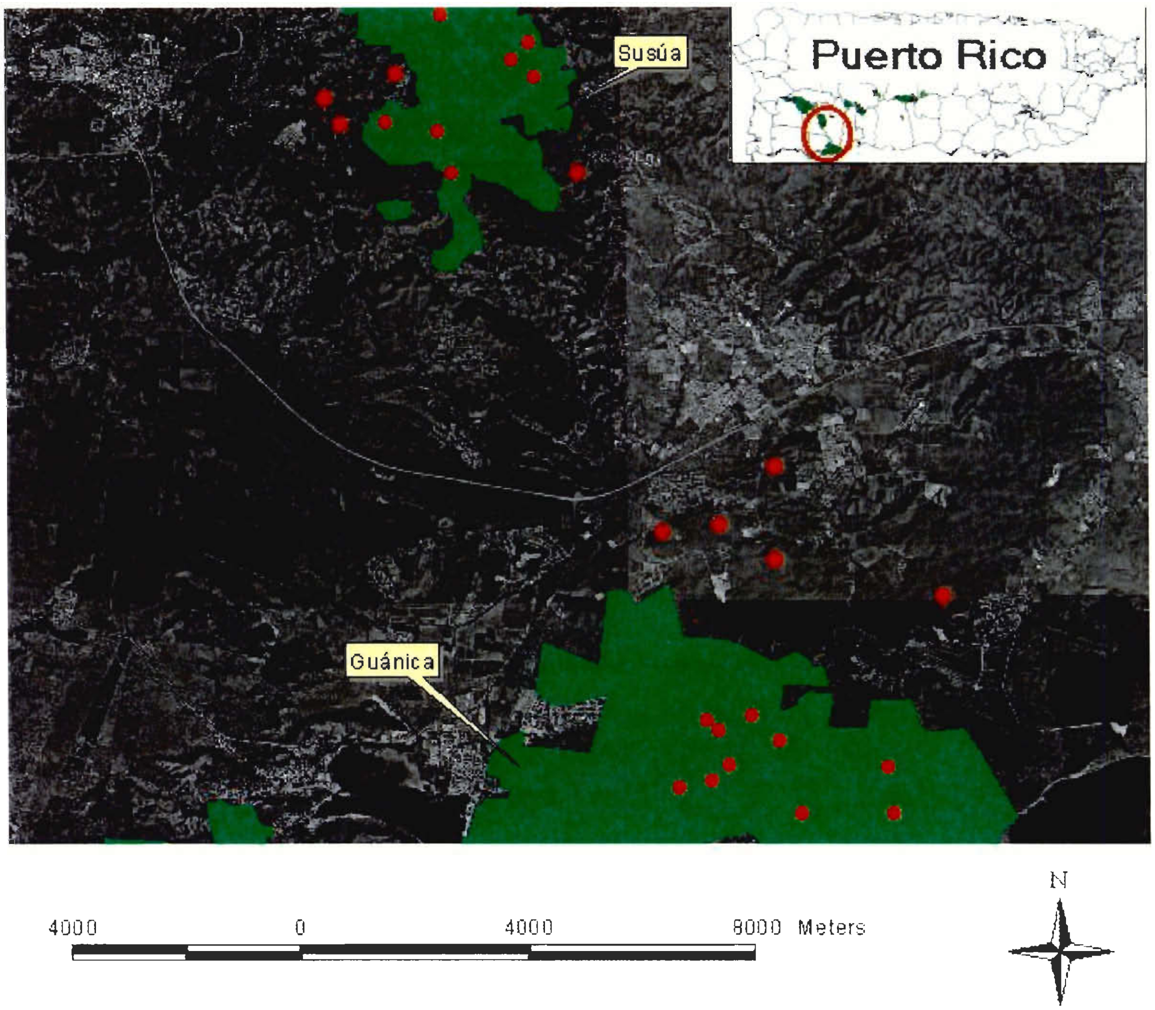


Figure 4.2 Locations of the Guabairo (characterized by red dots) between Susúa and Guánica

The sightings were in both forests; however, there were none in the developed area between them. Therefore, designing a corridor that was based on the species locations between the forests was not possible. However, the maps did provide us with visual confirmation that the Guabairo would greatly benefit from the corridor; it would give them access to another suitable habitat region. There were also some Guabairo sightings in the areas surrounding southern Maricao Forest (See Figure 4.3).

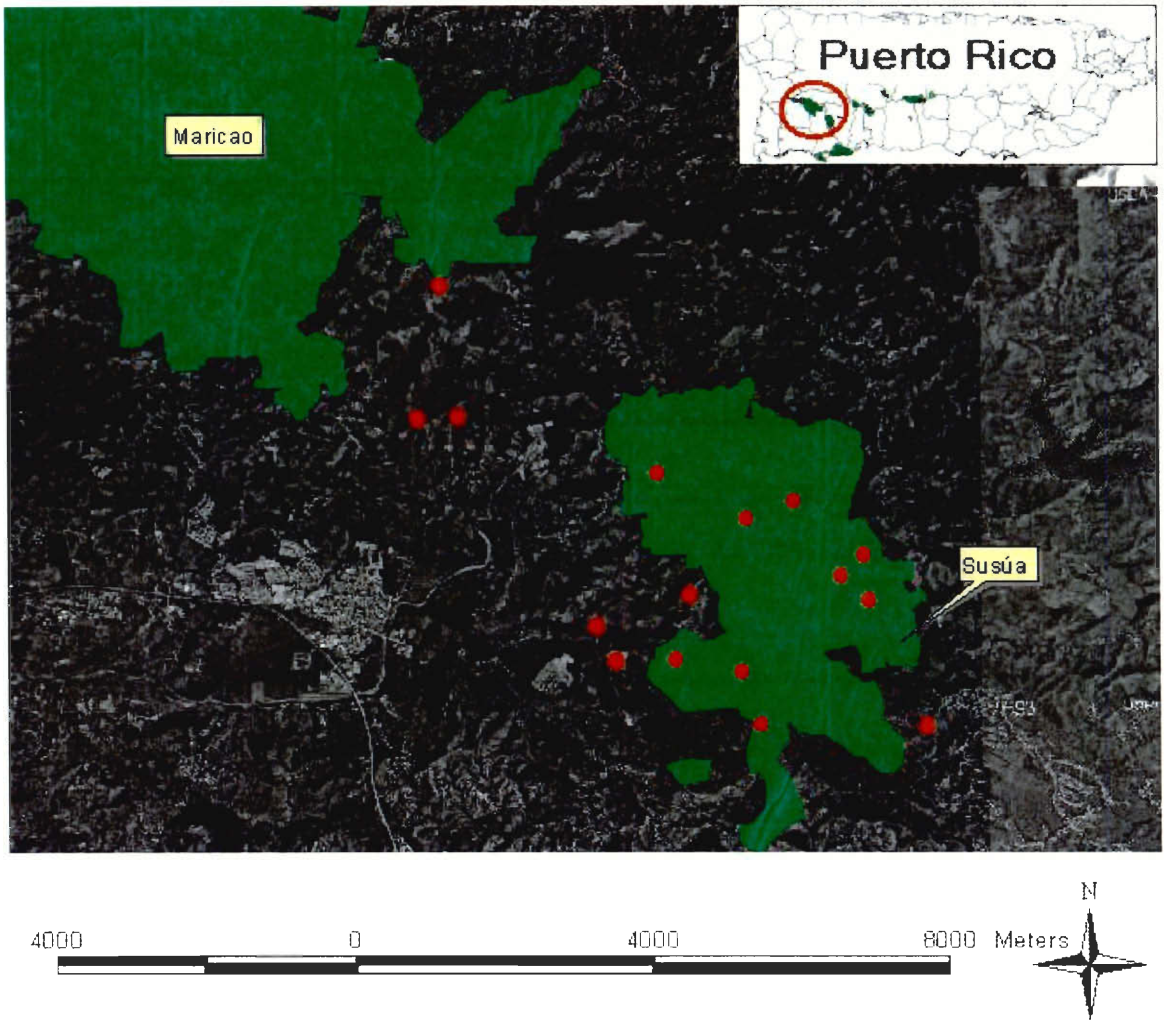


Figure 4.3 Locations of the Guabairo (characterized by red dots) between Susúa and Maricao

The consensus from the group discussion with the forest managers (See Appendix C) was that some Guabairos were found within Maricao as well, not just the southern outskirts, despite the lack of sightings in Villella's study.

Having identified the Guabairo as the best target species for the corridor, we could determine species-specific corridor requirements as outlined in Fleury and Brown's Framework for the Design of Wildlife Corridors. Vilella (1995) attached radio transmitters to two Guabairos to measure their distance traveled. During one movement, one Guabairo was found to move a maximum of 270 meters. The other moved a maximum of 360 meters in one movement. These movements are a determining factor for the width of the corridor. The corridor should be no smaller than 300 meters wide to accommodate the Guabairo. If the corridor is too narrow, there is a higher chance of human contact and the Guabairo might not enter the corridor. However, to facilitate movement properly, the corridor should not be much wider than the distance the Guabairo moves at one time. This way, the Guabairo would be more apt to move through the corridor safely rather than wander. Wandering would increase the likeliness of mortality.

4.1.2 Geographical influences between Guánica and Susúa

The region that lies between Guánica and Susúa Forests is heavily developed in both the agricultural and residential context. Agriculture in the area consists of low crops that do not provide adequate tree and brush cover for most animal species. Residential development is concentrated directly to the north of Guánica Forest in the town of Guánica. Due to this heavy development, there are various roads and highways in the area. The highway of most concern in regards to corridor delineation is Route 2 which is a busy four-lane highway having a concrete divider that splits the landscape from east to west (See Figure 4.4).

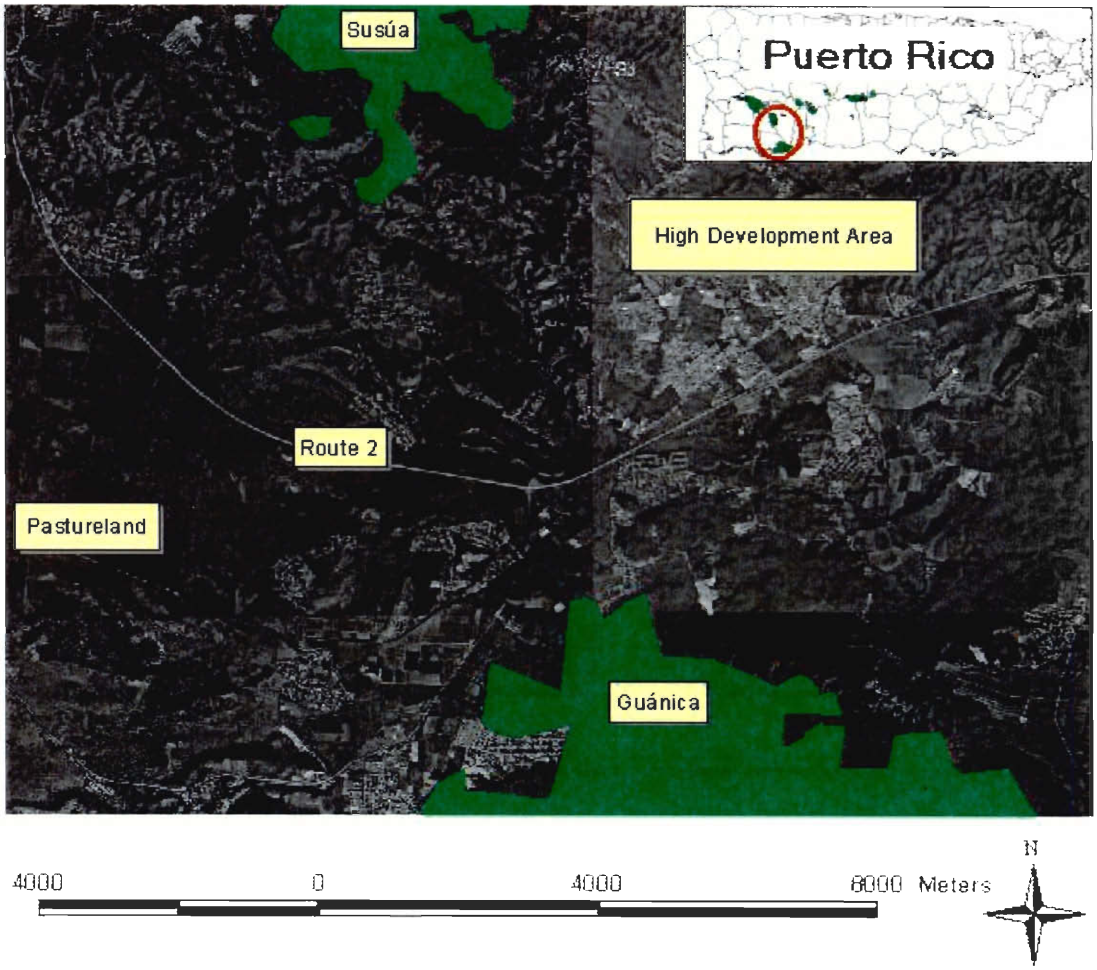


Figure 4.4 Development between Susúa and Guánica
(Orthographic Photo, USGS, 1995)

José Silva, Biologist at Guánica Forest, recommended that we follow the Río Loco river when delineating the corridor (personal communication, 2001). Delineating the corridor along a river will provide the least-expensive land acquisition. The DRNA controls all land within 5 meters on both sides of all rivers in Puerto Rico (Dragoni, personal communication, 2001). Since a river provides a natural corridor through barriers such as roads, following the Río Loco between Guánica and Susúa is a logical approach (See Figure 4.5).

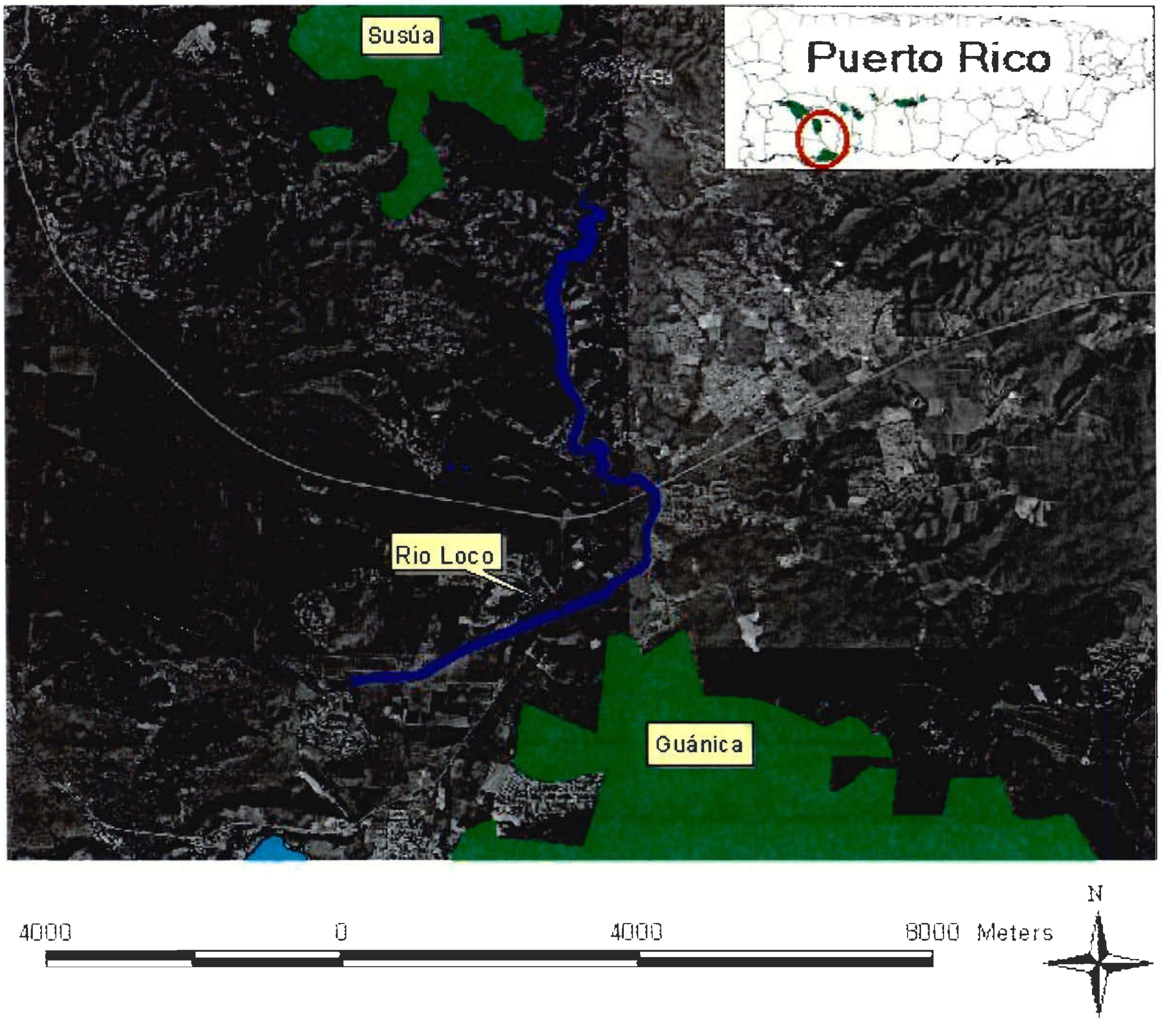


Figure 4.5 The Río Loco from Susúa towards Guánica
(Orthographic Photo, USGS, 1995)

According to a proposal to establish a corridor between Guánica, Susúa, and Maricao by Carlos Conde (1996), a riparian corridor, or a corridor that follows a river zone, was the most cost-effective approach to delineating the southwest corridor. Connectivity should remain constant on at least one side of the river because many species do not move efficiently if they have to cross the river (Conde, 1996).

The Río Loco runs south from Susúa to approximately .5 km north of Guánica where it turns southwest from Guánica Forest. Since the river does not touch Guánica Forest, a strictly riparian connection between the two forests is impossible. Close, small patches of land or a strip of continuous land should be placed between the north end of Guánica and the Río Loco. The species will likely utilize these small patches to reach either forest because they will not want to leave the forest cover provided by the corridor.

To keep a lower overall cost for the acquired corridor lands, care should be taken to avoid urban areas in the final corridor delineation (Conde, 1996). Urban areas are generally more expensive to acquire and utilize in corridor delineation because they have development, utilities, and roadways. Lands with a lot of development also must be reforested. Areas of dense forest cover are ideal for the corridor. Agricultural regions are also an option because they are generally less expensive than highly developed properties.

Corridor 2 Region: Susúa – Maricao

There is little room for development between Maricao and Susúa Forests. The forests lie only 2200 meters apart at their closest point. Therefore, most of this area has only small communities or no development at all. Agriculture is also limited. Much of this land is covered with dense forest. There are areas of high development in the vicinity, mainly to the south of Maricao and to the west of Susua. However, in developing the corridor, these areas were avoided easily and did not present a barrier. (See Figure 4.6)

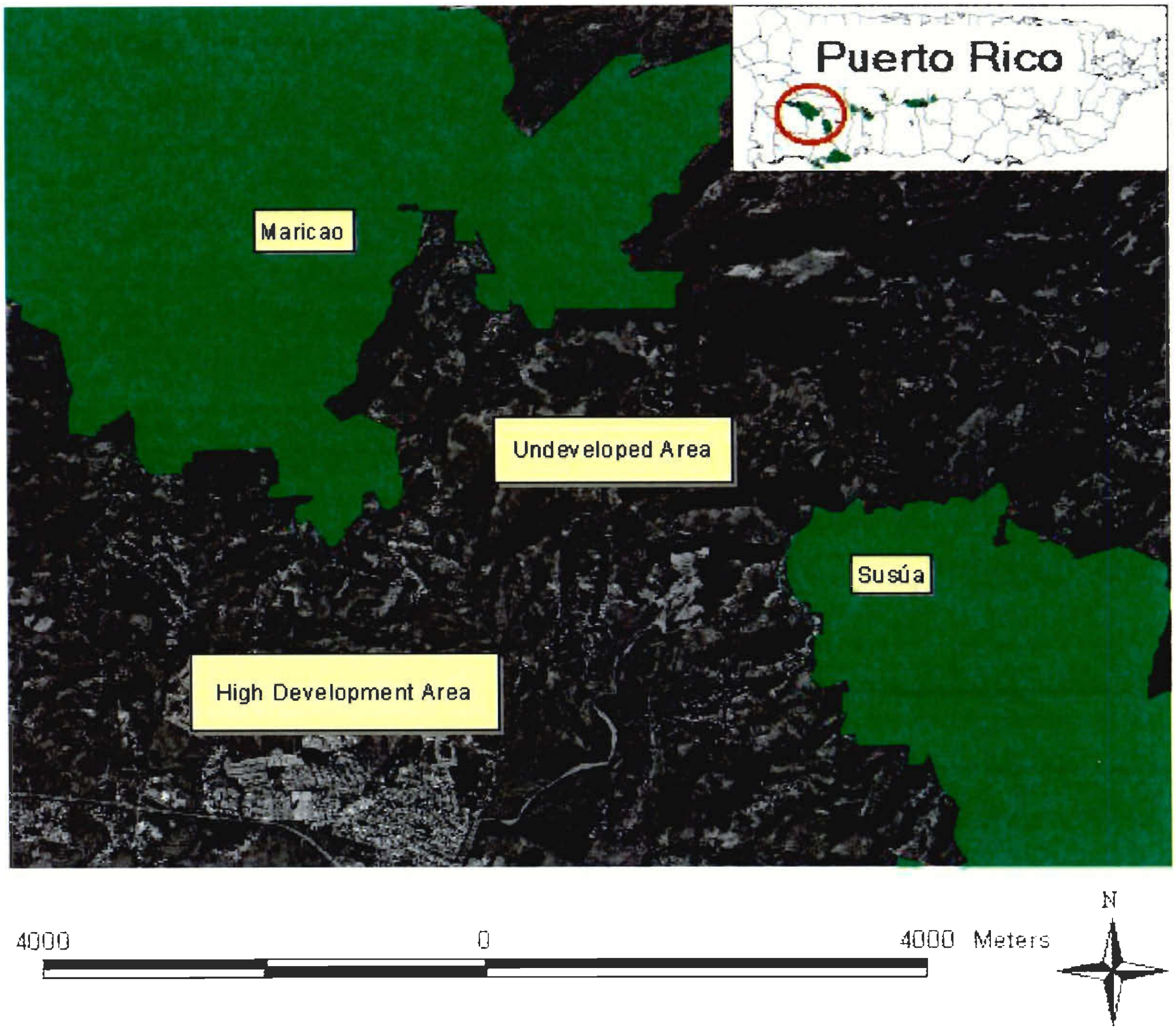


Figure 4.6 Aerial view of development between Maricao and Susúa

4.1.3 Corridor Design and Justifications

Utilizing multiple GIS layers, we compiled a corridor design for the southwest corridors using ArcView™. For a full discussion of ArcView™, refer to Literature Review Section 2.10 and Methodology Section 3.3.

Corridor 1: Guánica – Susúa

We began our process of delineating the biological corridor connecting Guánica and Susúa State Forests, Corridor 1, by first identifying the general area of concern. This region lies directly between the two forests, as seen in Figure 4.7. This was further analyzed for suitability by utilizing Arc™ layers for land usage, soil types, and the location of the Río Loco.

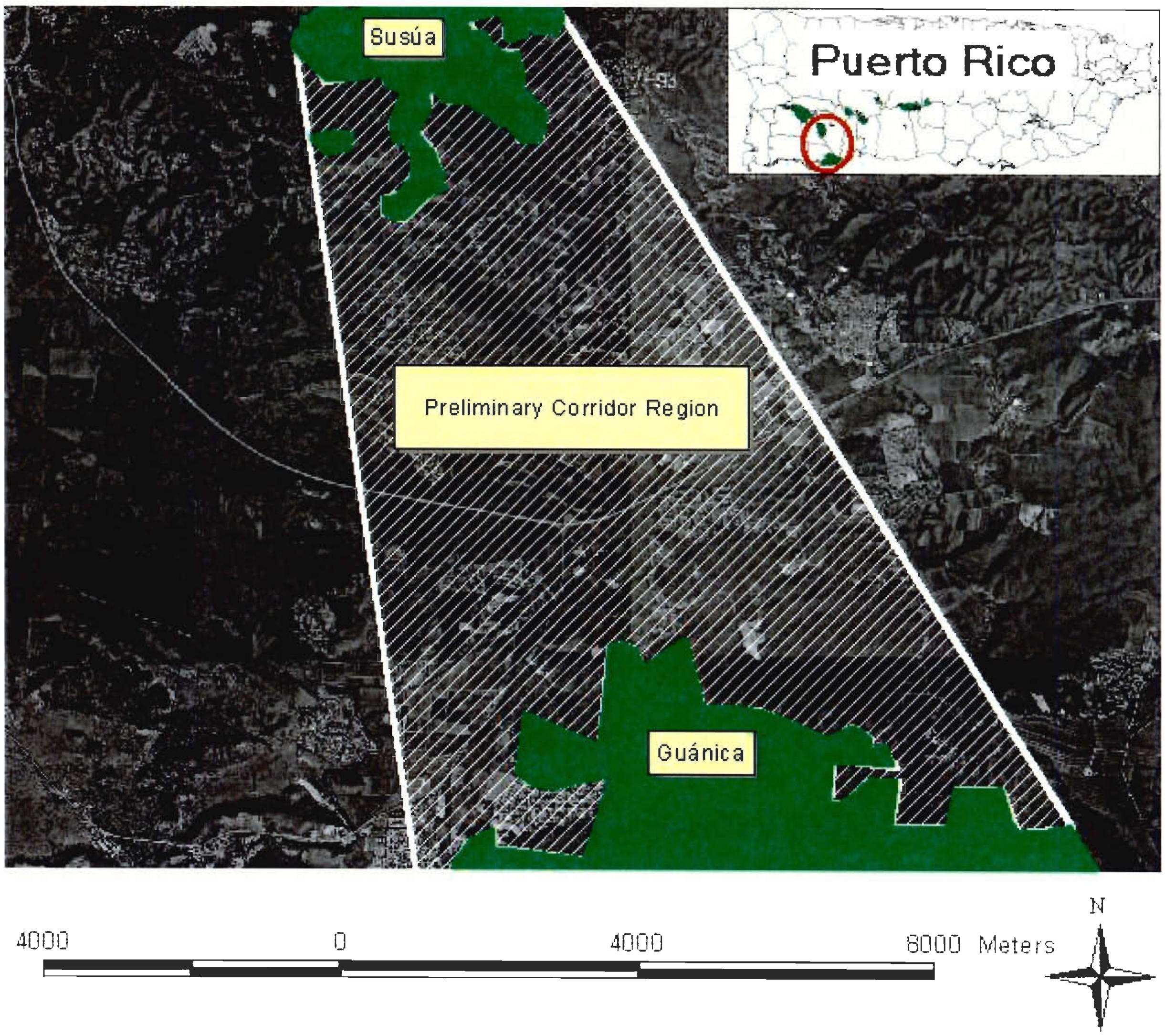


Figure 4.7 Potential corridor region for Guánica and Susúa

Ideally the corridor would pass through areas of highly forested areas. However, as seen in Figure 4.8, there were little areas of such vegetation.

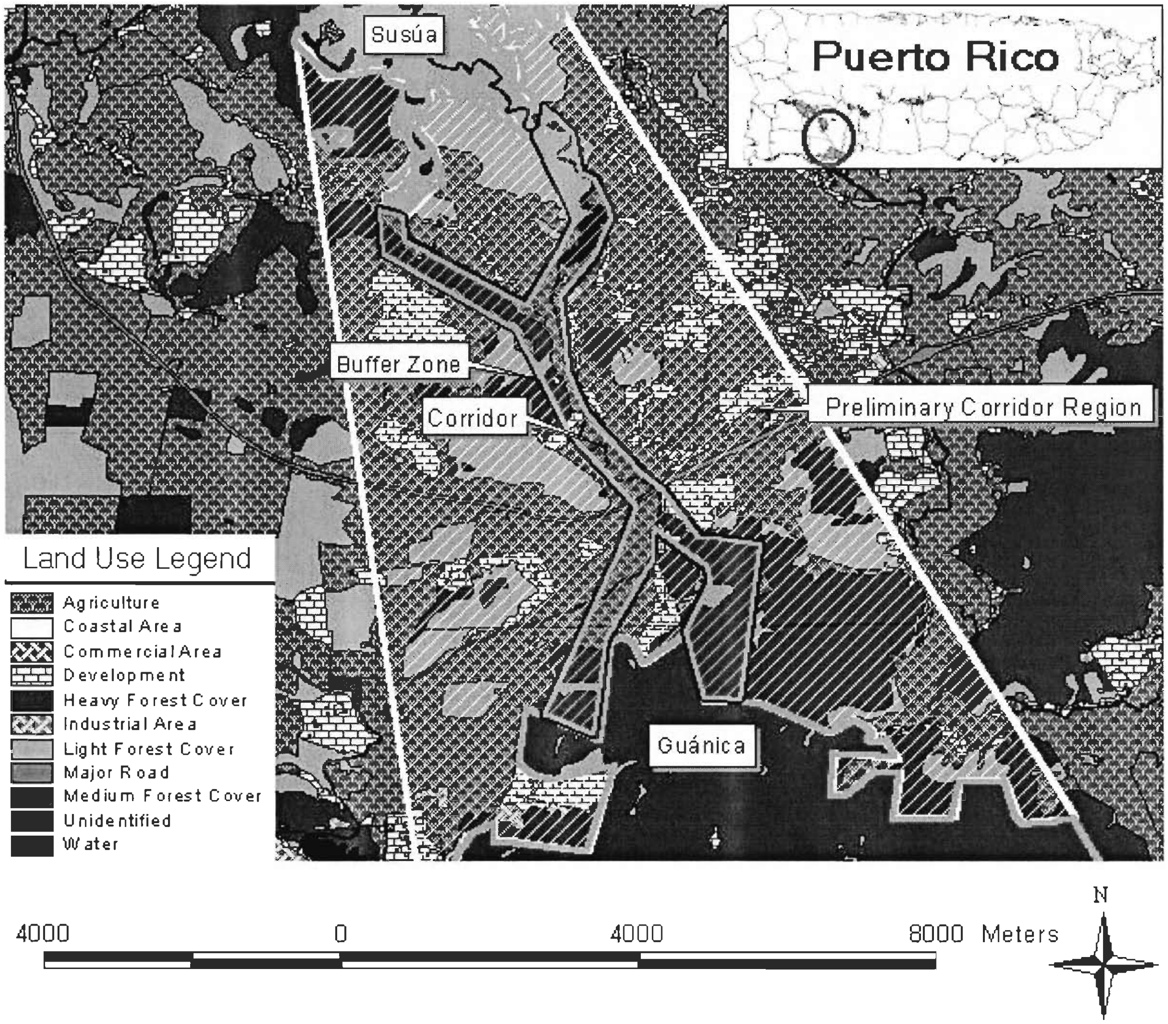


Figure 4.8 Guánica to Susúa corridor layered over land use

Therefore, we shifted focus to connect areas that had patches of forested land or little development. Also, areas utilized for pasture and crops were considered because natural reforestation is more likely there than in urbanized areas. This is also evident in Figure 4.8. The areas shaded red were avoided whenever possible because they represented forms of urban development. The final corridor design, shaded in green, primarily consists of dense woodland, bushes and shrubs, cropland, and pastureland.

According to the habitat requirements and sightings of our target species, the Guabairo, the corridor needed to encompass areas of dry limestone or serpentine soil. Limestone soil and serpentine soil, represented in khaki in Figure 4.9, are the soils primarily utilized by the types of vegetation found in Susúa and Guánica Forests.

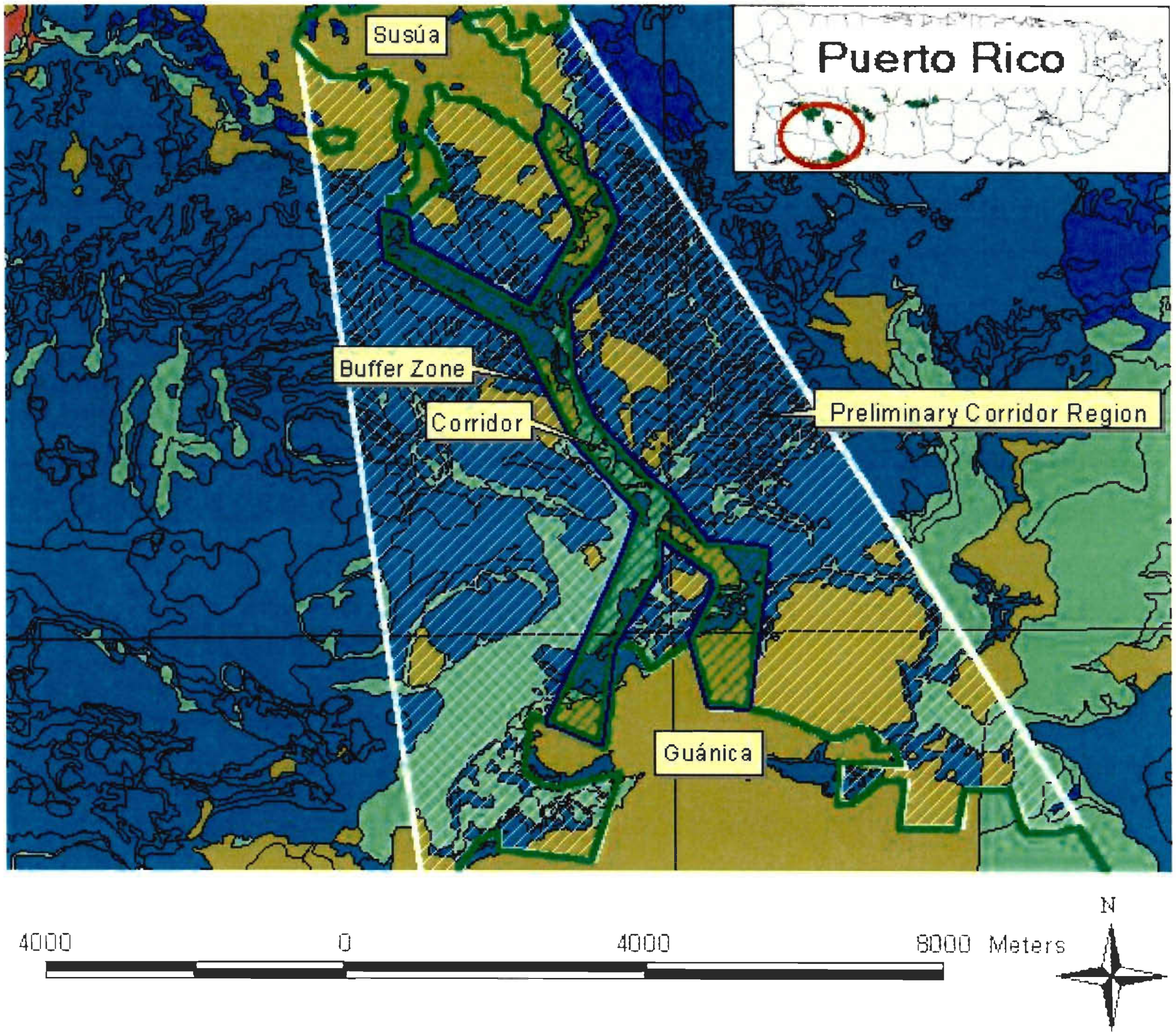


Figure 4.9 Guánica to Susúa corridor layered over soils

Creating a design that included only limestone soil proved an impossible task; therefore, areas of different soils were utilized when necessary.

As mentioned previously, a corridor design that followed the Río Loco is most beneficial both ecologically and economically. The Río Loco provides a path for the fauna to traverse past treacherous highways. Without the underpass provided by the Río Loco, Route 2 would present an almost impassable barrier. It also includes land already owned by the DRNA that could cut down land acquisition costs. Our corridor followed the Río Loco through the central area of the region, mainly on the western side, which had less development than the east side of the river (See Figure 4.10).

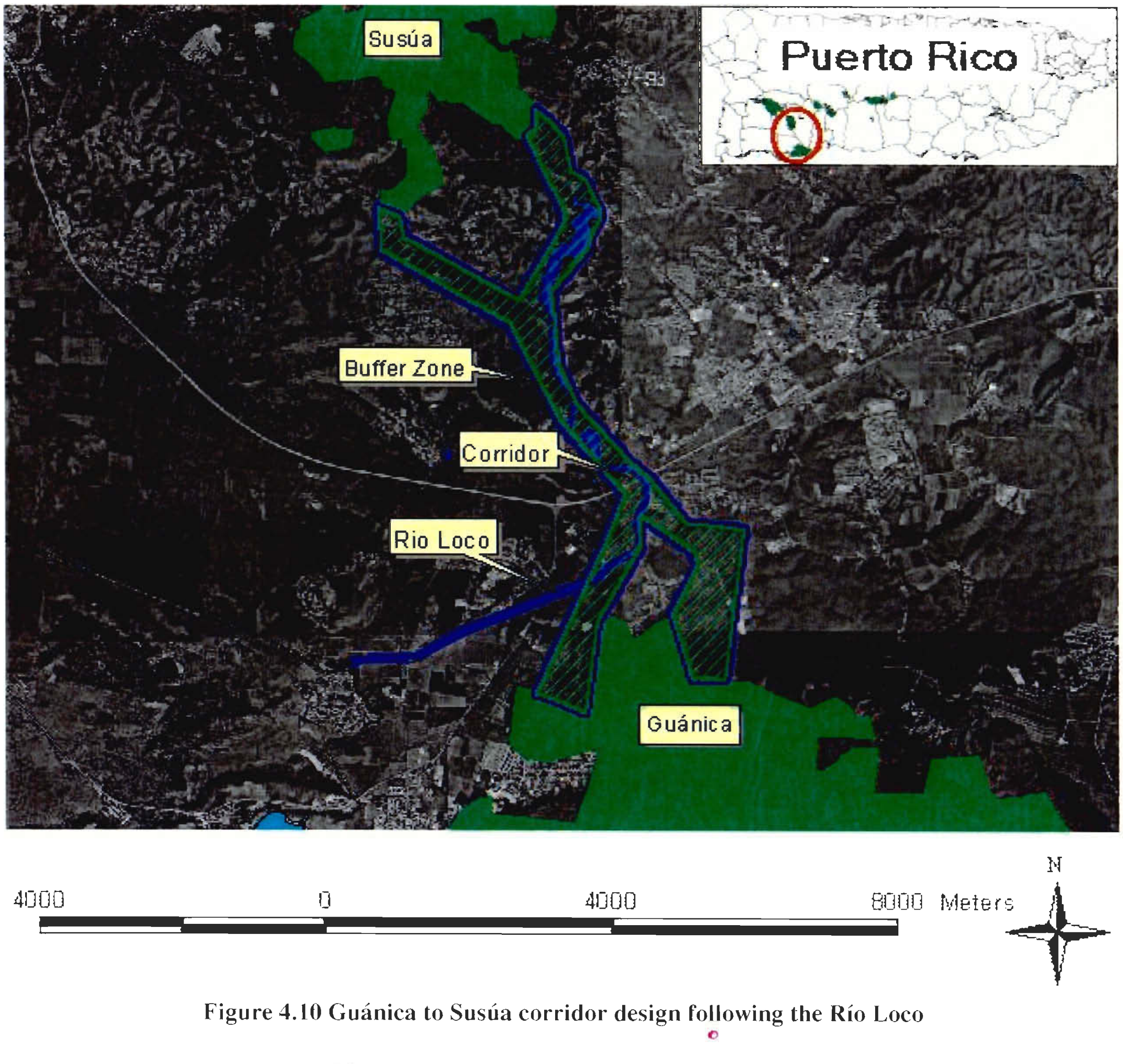


Figure 4.10 Guánica to Susúa corridor design following the Río Loco

Table 4.1 lists the desired attributes and design results for Corridor 1. The attributes were based on habitat requirements of the Guabairo and basic ecological principles.

Table 4.1 Guánica to Susúa corridor results

Attribute	**Desired Result**	**Actual Design Result**
Matrix (Land usage)	Dense or moderately dense forested land	Primarily dense forest land, bushes and shrubs, cropland, and pastureland
Network	High network connectivity, multiple entrances and exits	2 entrances, 2 exits
Barriers	None	Highway and roads, with underpasses
Length	Shortest distance between the forests is 6.3 km	7.2 km minimum length, 9 km maximum
Width	300 m plus a 50 m buffer zone on each side equals 400 meters	Corridor ranges from 360m to 930m, including buffer zone
Shape	Straight, no high degree angles	One approximately 90º angle (southwest leg). The rest of the corridor is acceptable.
Buffer	50 meters both sides	Buffer is 50 meters from both sides
Species benefited	All that are found in both Susua and Guanica	Avifauna in Susúa and northern Guánica will benefit most.
Area conserved	Minimum area could be 620 acres	1943.5 acres with multiple paths
Target Species Suitability	All habitat requirements are met for the Guabairo	All requirements met. The corridor was designed around its needs.
Land cost	Lowest economic value, easily acquirable	We tried to avoid developed lands whenever possible. Estimated cost: $7.722 million (See Section 4.4).

The final design of the Guánica – Susúa Corridor (See Figure 4.11) met nearly all of our desired results.

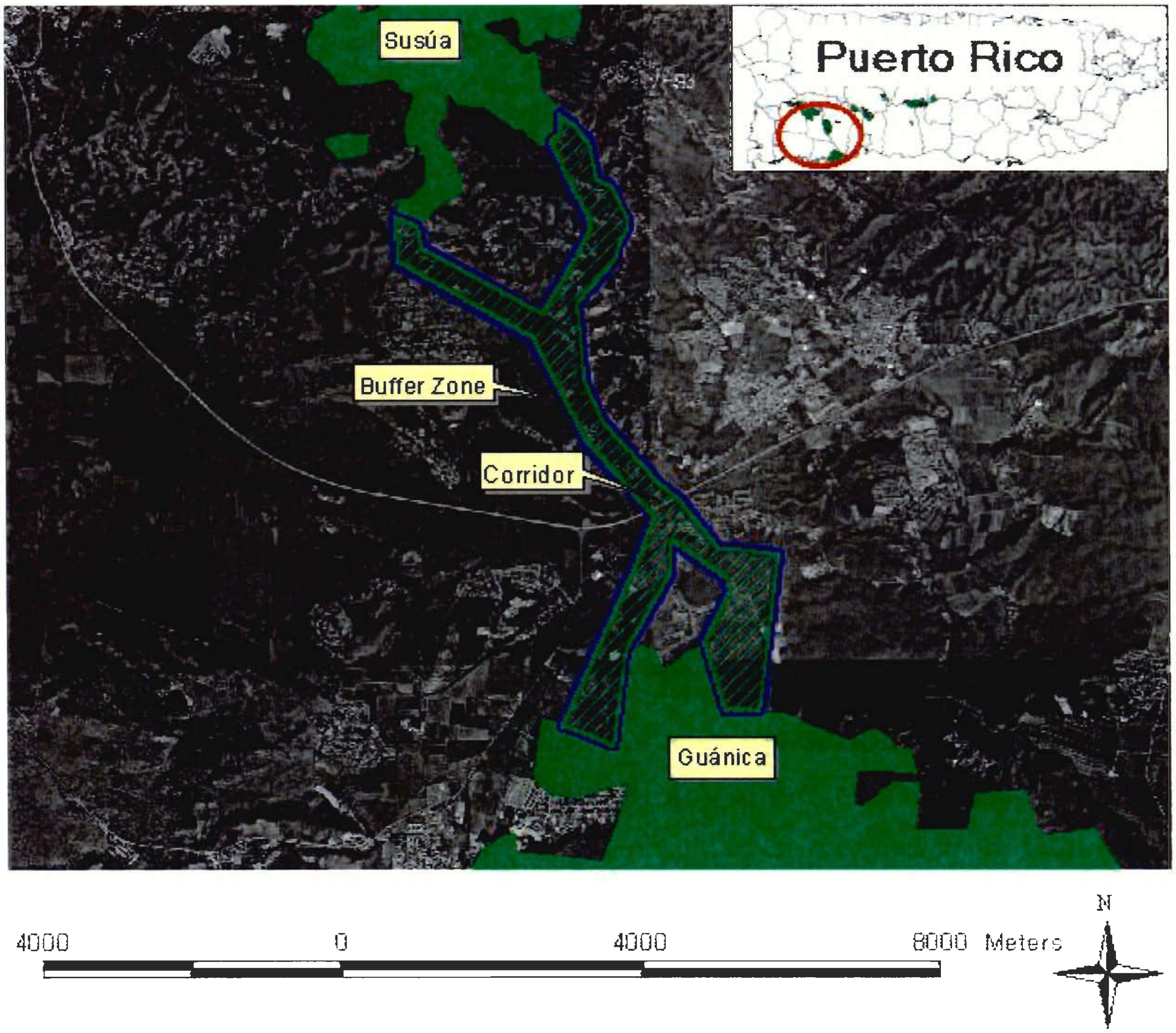


Figure 4.11 Guánica to Susúa final corridor design based on ecology

See Conclusions and Recommendations Section 5.2.4 for prioritized properties and recommended land acquisition mechanisms within the corridor. The main concern with this corridor is that it is too long. Small mammals will not pass through a corridor longer than 50 meters (Fleury & Brown, 1997). Avifauna can travel farther, but it is recommended that a patch be established in the middle of the corridor large enough for the target species to inhabit. Another concern is the approximate 90° angle located in the southeast leg of the corridor. Fleury & Brown (1997) state that angles of this magnitude can increase edge effects and thus inhibit the species' movement. See Recommendations

Section 5.2.1 for suggestions to combat the long length of the corridor and the sharp corridor turn.

Corridor 2: Susúa – Maricao

The first step of delineating a corridor to unite Susúa and Maricao was to identify the general area that would include our final corridor. This area is shaded in white in Figure 4.12.

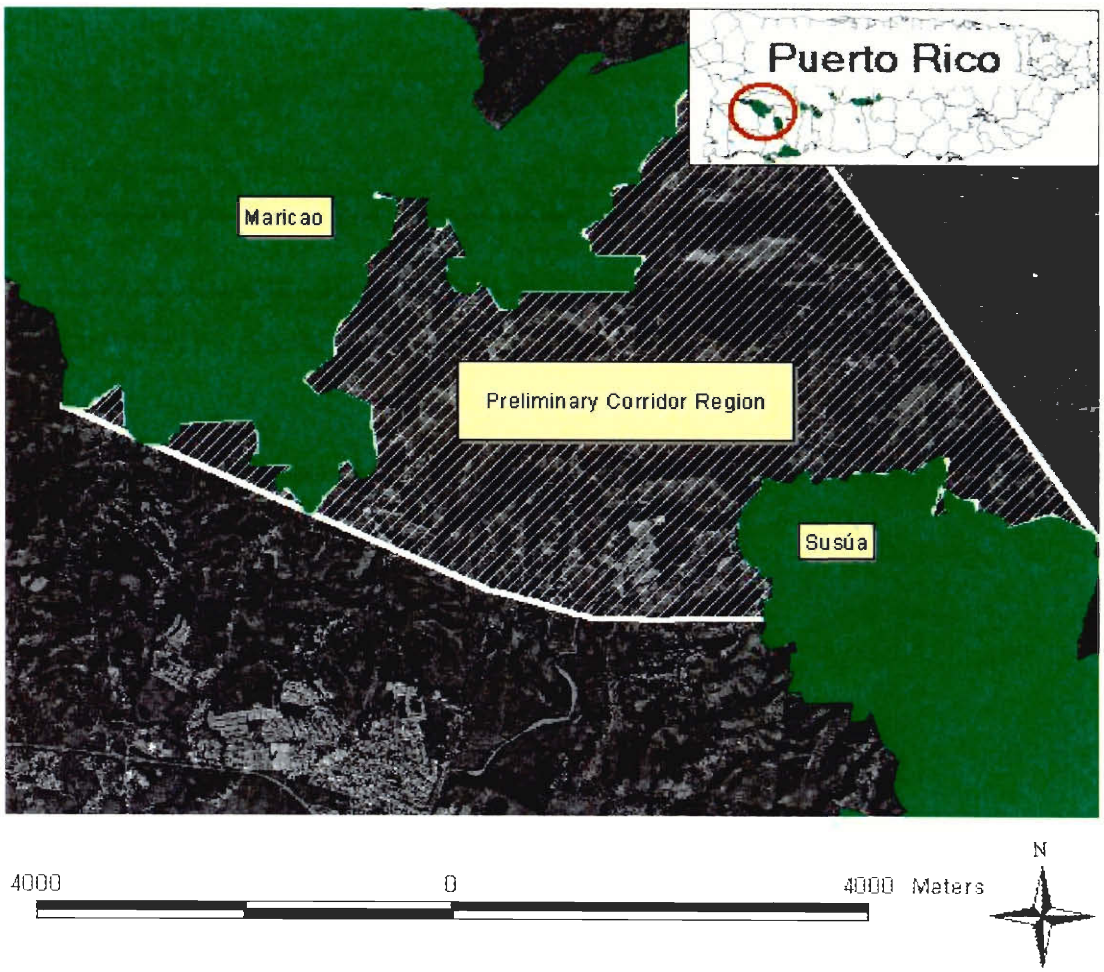


Figure 4.12 Susúa and Maricao potential corridor region

We analyzed the area further by utilizing several ArcView™ layers: land usage, soil type, and topography.

Unlike Corridor 1, the area between Maricao and Susúa contained almost no urban or agricultural development. Since dense woodland is abundant in this area, connecting the forest via these areas was a fairly easy task. However, it was necessary to utilize some grassy or pastureland areas to fully connect the forests with a corridor of appropriate width (See Figure 4.13).

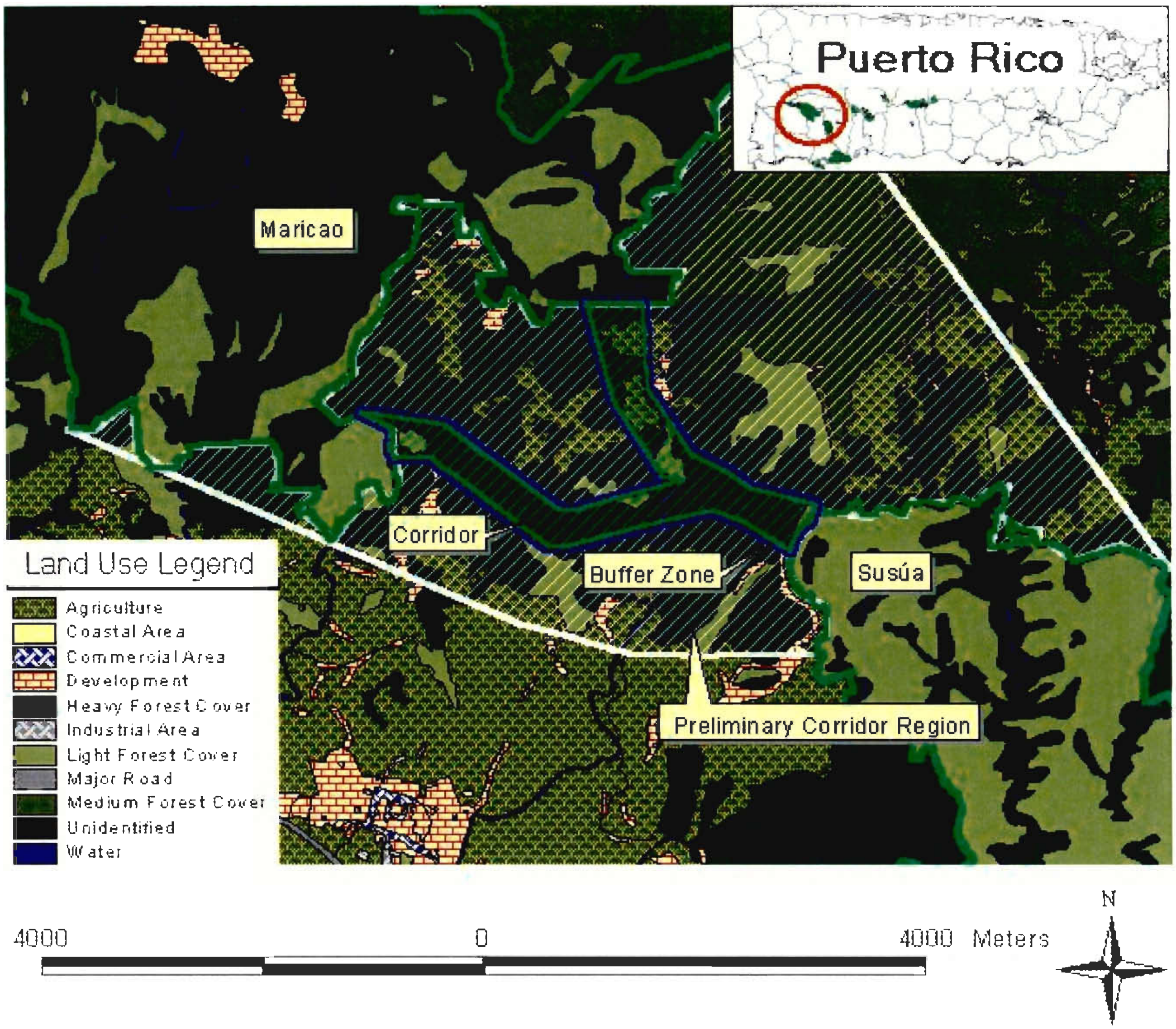


Figure 4.13 Susúa to Maricao corridor layered over land use

Sightings of the Guabairo in the Maricao and Susúa region were limited to not only densely forested regions, but also to regions with serpentine soil. Therefore, the most appropriate corridor for our target species would utilize areas of these soil types. Serpentine soil is abundant in Maricao and northern Susúa; hence, it was easy to delineate a corridor through regions of serpentine soil. Other types of soil were included in the corridor if necessary (See Figure 4.14).

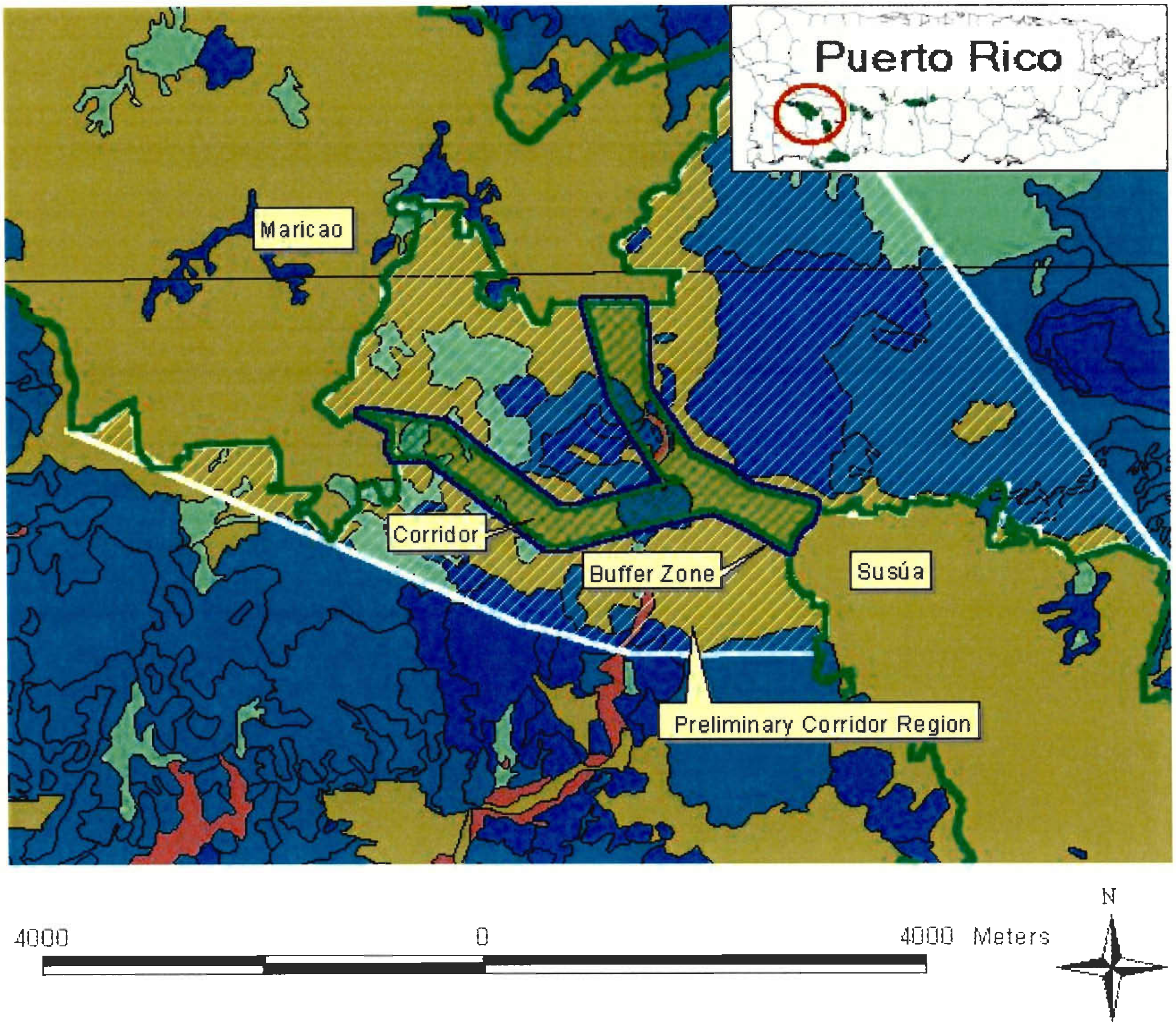


Figure 4.14 Susúa to Maricao corridor layered over soils

Error! Reference source not found. lists the desired attributes for Corridor 2, based on habitat requirements of the Guabairo and basic ecological principles, and the final design attributes.

Table 4.2 Susúa to Maricao corridor results

Attribute	Desired Result	Actual Design Result
Matrix (Land usage)	Dense or moderately dense forested land	Majority located within a dense forest region
Network	High network connectivity, multiple entrances and exits	1 exit, 2 entrances
Barriers	None	None
Length	Shortest distance between the forests is 2.2 km	The corridor stretches between 2.6 km and 4.3 km
Width	400 meters	420 m to 620 m
Shape	Straight, no high degree angles	The corridor makes no sharp turns
Buffer	50 meters on both sides	50 meters on both sides
Species benefited	All that are found in both Susúa and Guánica	No species will be negatively affected by the corridor
Area conserved	217 acres is the smallest possible area	665.1 acres, including both paths
Target Species Suitability	All habitat requirements are met for the Guabairo	All requirements for the Guabairo have been met.
Land cost	Lowest economic value, easily acquirable	Few developed lands are included in the delineation. Estimated cost: $2.523 million (See Section 4.4).

The final design of Corridor 2 (See Figure 4.15) met nearly all of our desired results.

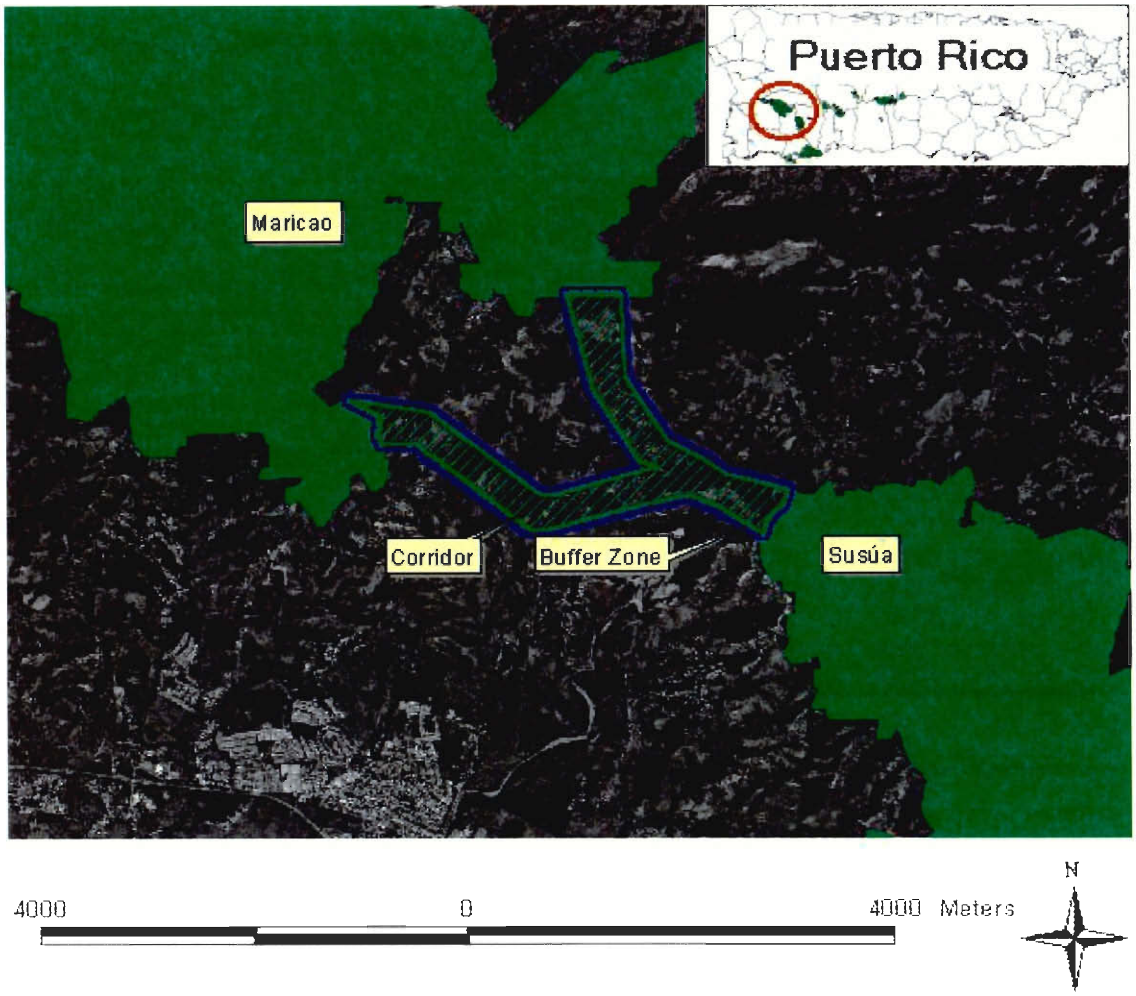


Figure 4.15 Susúa to Maricao corridor design based on ecological value

We did not feel that since the corridor length was less than 5 kilometers, it was not a concern. See Recommendations section 5.2.4 for prioritized properties and recommended land acquisition mechanisms within the corridor.

4.2 Central Corridor Region

The corridor that is designed to unite the Guilarte State Forest, Adjuntas Forest, and Toro Negro State Forest in central Puerto Rico has significantly different attributes and presents unique concerns from the corridor in the southwest. The corridor covers approximately 6,300 acres, a much greater total area than the other corridor. As explained by Toro Negro Forest Manager Gerardo Hernández (personal communication, 2001), two important reasons for conservation in central Puerto Rico are the protection of endangered species and preservation of watersheds (See Glossary). Except for scattered sun-grown coffee plantations, development between the forests is minimal. The major concern with constructing the corridors is its length. Guilarte and Adjuntas are approximately 7 kilometers apart at their closest point and Toro Negro and Adjuntas are approximately 6 kilometers apart at their closest point. Larger patches of forest should be acquired along the corridor to provide a stable habitat for species that will not move the full distance between forests. (See Figure 4.16)

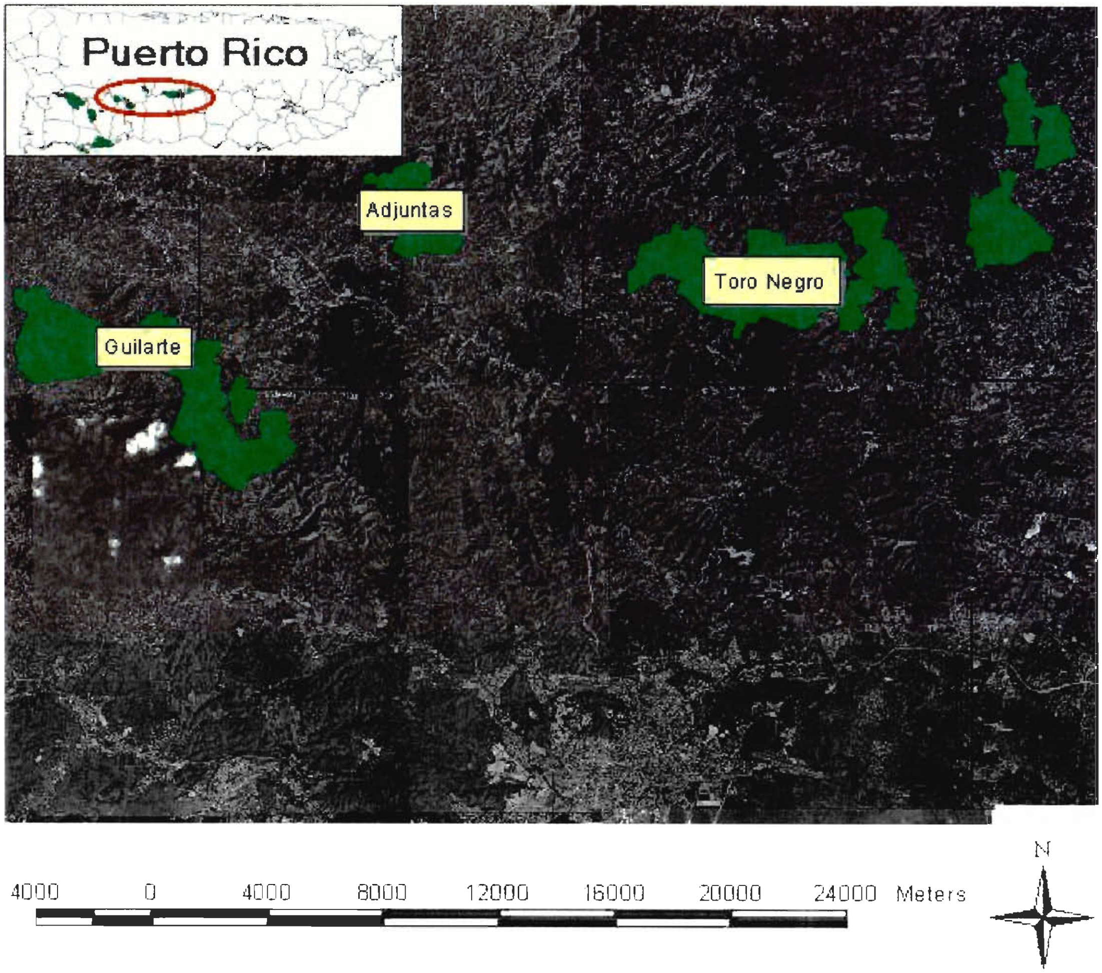


Figure 4.16 Aerial view of Guilarte, Adjuntas, and Toro Negro

4.2.1 Target species

Like in the southwest corridor, we focus on birds as target species for the central corridor. In order to support our tentative decision of again using birds as target species, we consulted Haydeeliz Meléndez, Resident Biologist at Toro Negro Forest (See Appendix C for interview transcripts). She agreed that establishing a corridor with attributes conducive to the needs of birds was the best approach in designing our corridor in this region. Birds are more likely to utilize a corridor than a reptile or amphibian because of their extensive home ranges. Also, they help in seed dispersal and reforestation. We had an informal discussion with Botanist Susan Silander at the US Fish and Wildlife Service in which she mentioned that the Falcón de Sierra (See Figure 4.17) and the Guaraguao de Bosque (Figure 4.18) could possibly each be used as a representative for the majority of species in the central corridor.

Figure 4.17 Falcón de Sierra (Sharp-shinned Hawk)
(DRNA, 2001)

Figure 4.18 Guaraguao de Bosque (Broad-winged Hawk)
(DRNA, 2001)

Further research led us to believe that both species indeed possessed the characteristics of a good target specie as outlined in Methodology section 3.2.1. Both are endangered species highly intolerant to fragmentation and, as stated in the Literature Review section 2.6.2, the most likely cause of their low populations is increased road construction and other human disturbances. The home ranges of the Guaraguao de Bosque and Falcón de Sierra are 101.5 acres and 369.4 acres, respectively (Rivera, 1997). These home ranges are substantially larger than the southwestern corridor target species, the Guabairo, and larger than most of the other species in the area, excluding other hawks.

Both the Guaraguao de Bosque and the Falcón de Sierra are considered high-level carnivores. The Falcón de Sierra primarily survives on smaller birds, including the Puerto Rican Bullfinch and the Puerto Rican Tanager (Delannoy & Cruz, 1999). The Guaraguao de Bosque preys on frogs, lizards, mice, and birds (Rivera, 1997). Neither one has any major predators. They are endangered mainly because of deforestation and parasitism.

According to Rivera (1997) and Delannoy (1997), the specific habitat characteristics of the Guaraguao de Bosque and the Falcón de Sierra have not been identified. Ongoing research to determine these attributes has been recommended by Rivera (1997) in order to increase the species populations. However, it is known that they prefer closed canopy, dense forest cover. The Guaraguao de Bosques prefers subtropical wet or moist forest; the Falcón de Sierra prefers lower montane and subtropical wet forests. These habitat preferences are supported by sightings by Delannoy retrieved from the US Fish and Wildlife Survey. Falcón de Sierra and Guaraguao de Bosque sightings are represented by yellow dots in Figure 4.19 and Figure 4.20, respectively.

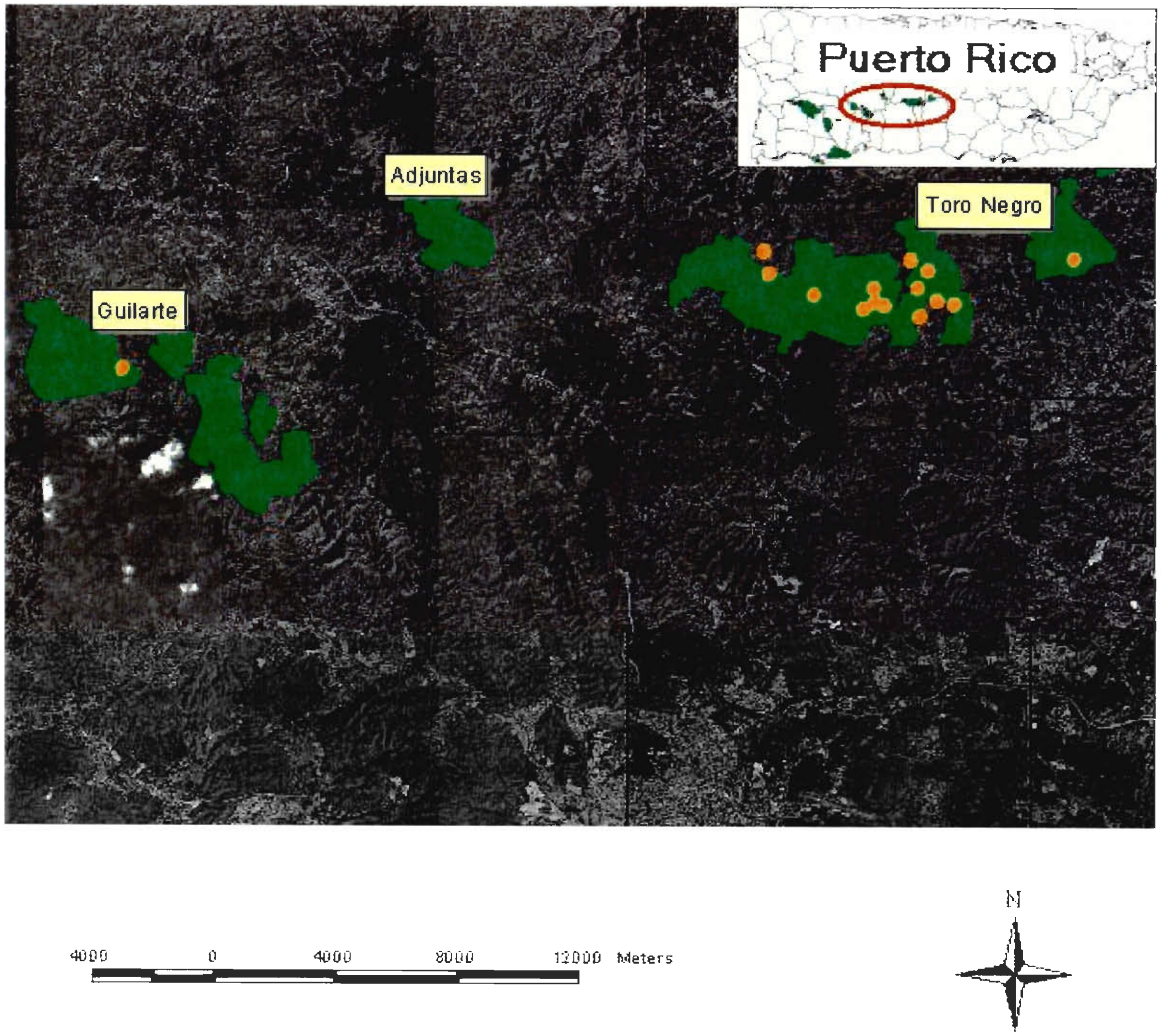


Figure 4.19 Falcón de Sierra sightings (in yellow) within the central forests

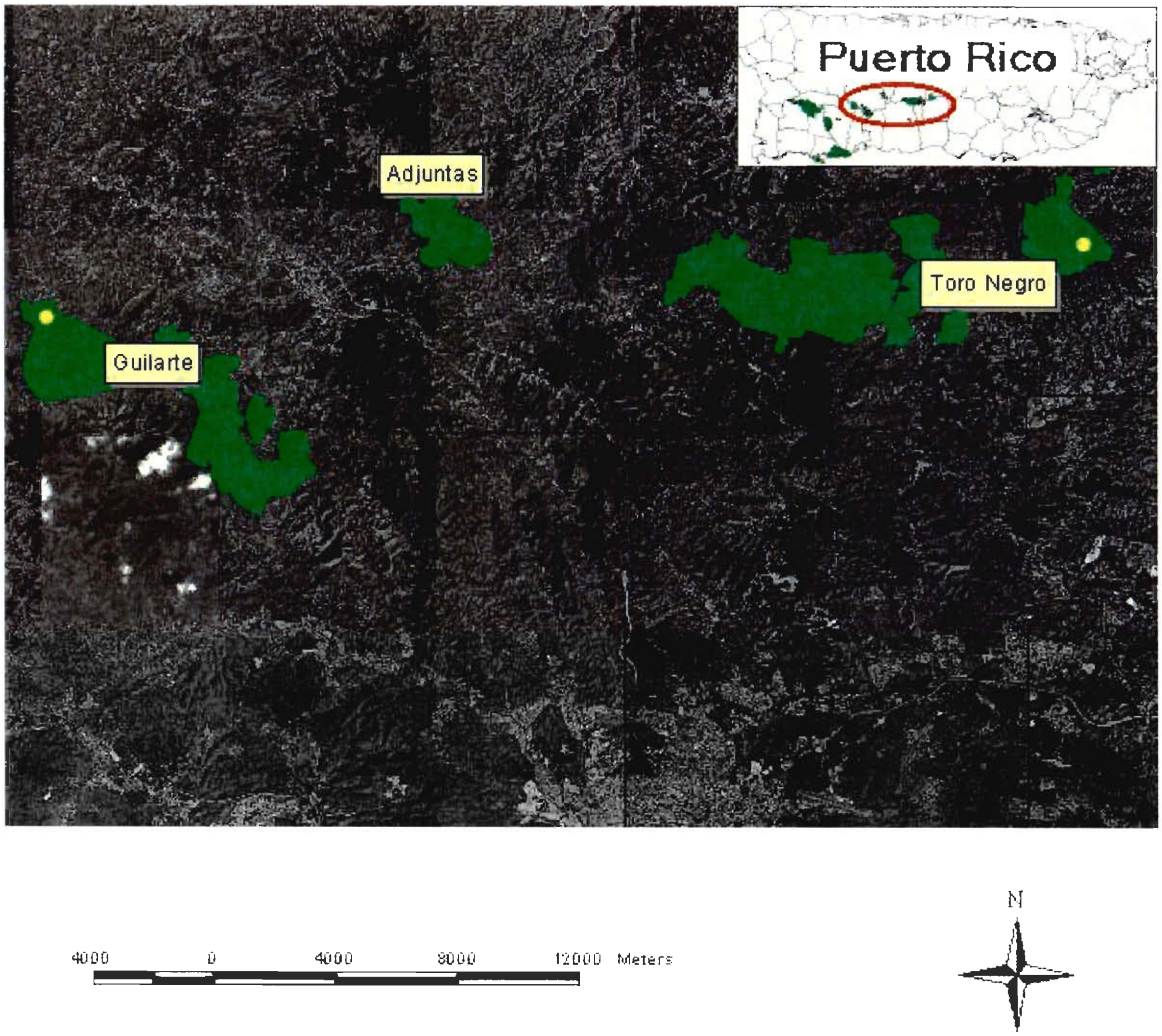


Figure 4.20 Guaraguao de Bosque sightings (in yellow) within the central forests

The sightings of both species were not as evenly distributed as the Guabairo. Furthermore, the sightings of the Guaraguao de Bosque were rare in this region. There were only two confirmed sightings. One was in western Guilarte, the other in eastern Toro Negro. Despite the lack of sightings, we believe that this area between the sightings has potential for Guaraguao inhabitation because of similar landscape characteristics. Therefore, we felt that the Guaraguao would benefit from the corridor. Sightings for the Falcón de Sierra were concentrated in Toro Negro. There was also one sighting in

Guilarte, though population there has been estimated at 25 hawks (Delannoy, 1997). Additionally, there were many sightings in Maricao Forest to the west of Guilarte. Like the Guaraguao de Bosque, the Falcón de Sierra would benefit from the corridor because it would connect areas that it is known to inhabit, extending its available home range and perhaps increasing biodiversity.

In order to justify the width of our corridor, we searched for information similar to Vilella's study of the Guabairo. Though some studies exist, we were unsuccessful in finding one that included documentation of maximum distance either species would move in a singular movement. Therefore, we could not base our width on this factor like in the southwestern corridor region. We then decided that we could base our width on the home ranges of the species. The home range of the Guaraguao de Bosque, as mentioned above, is about 100 acres. The diameter of a circle of this area is 713 meters. The home range of the Falcón de Sierra is about 369 acres. The diameter of a circle of this area is 1380 meters. We concluded that in order to properly facilitate movement, the corridor should be of a width smaller than the diameter of the home range. Therefore, the hawk would not have an area suitable for nesting and inhabiting and would be more apt to move through the corridor rather than wander. For the Guaraguao de Bosque, this desired width would be about 600 to 650 meters. The Falcón de Sierra would need a width of about 1200 to 1300 meters. We desired a corridor width that would accommodate both species; however, the difference in each species' requirement was too broad.

Implementing a high degree of network connectivity could combat this problem. We decided that delineating two corridors of a desired width of 600 meters each would account for both species' needs. The Guaraguao de Bosque, an extremely local resident, would be able to utilize one of the corridors because a singular corridor would meet its required width. The Falcón de Sierra is less local and flies at heights of a maximum of 200 meters above canopy (Delannoy & Cruz, 1988). It may perhaps utilize the corridor because the combined width of the two parallel corridors would be about its required width of 1300 meters. Though this reasoning is completely theoretical, we believe that it is the best available basis for our corridor width.

4.2.2 Geographical influences

There is very little agricultural or residential development between the forests. Scattered small communities are present in the landscape. The largest strip of residential areas outlines Pueblo de Adjuntas to the southwest (See Figure 4.21).

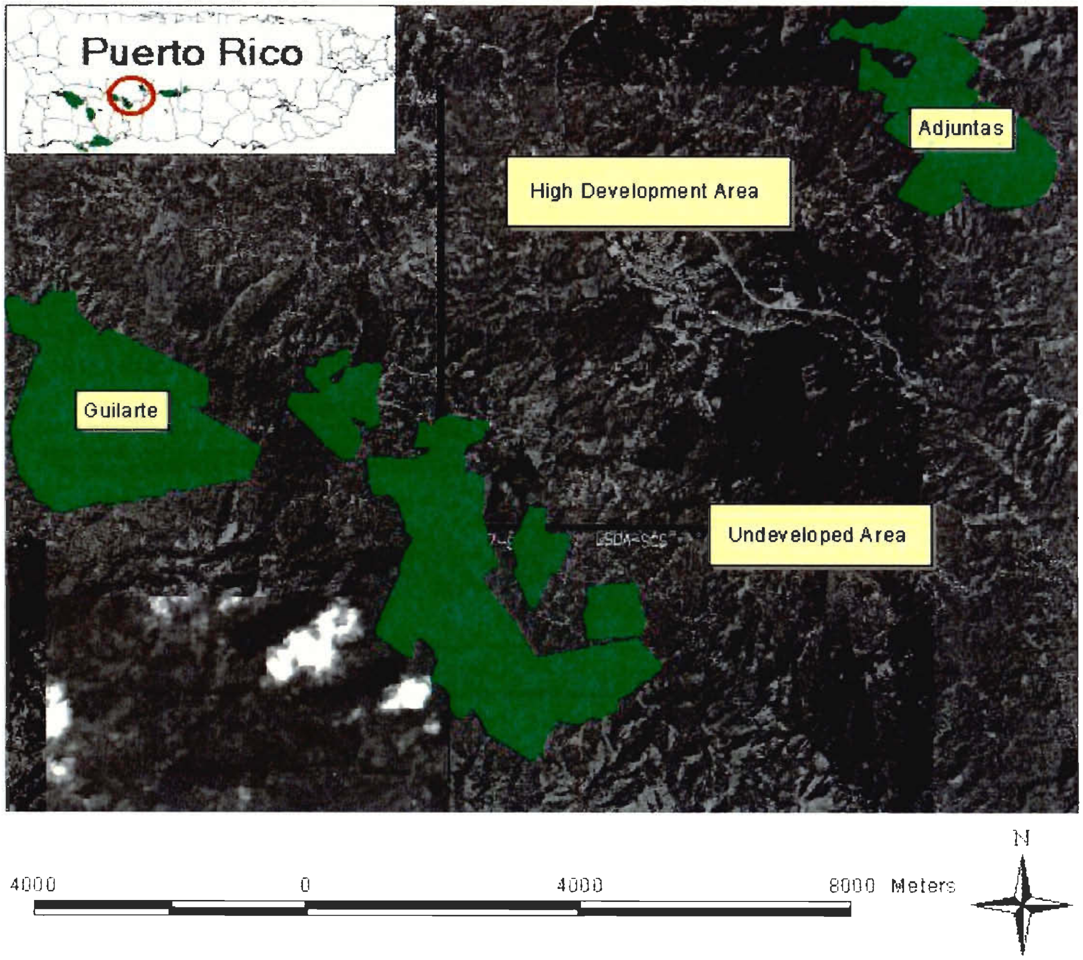


Figure 4.21 Development between Guilarte and Adjuntas

There is also some substantial residential development to the north of Toro Negro (See Figure 4.22).

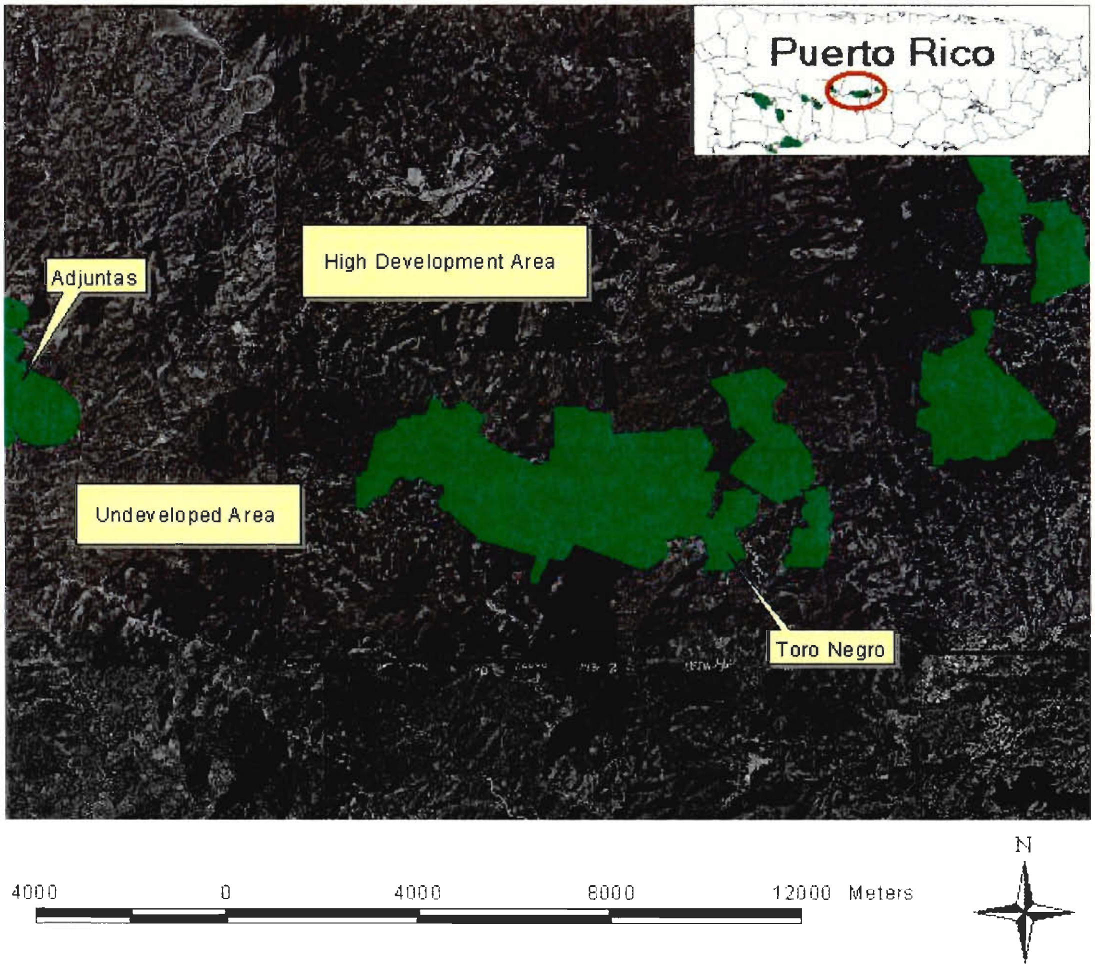


Figure 4.22 Development between Toro Negro and Adjuntas

Small patches of resident communities outline Guilarte Forest to the west as well. In comparison to the southwest corridor, the density of these communities is relatively less concentrated and was not considered a substantial obstacle when delineating the corridor. Avoiding these areas when delineating the corridor, however, was considered ideal because of the target species' high intolerance to human disturbance.

First-hand observation of the forests and aerial photographs of the areas made it abundantly clear that the most common and destructive crop in the region surrounding the central forests is sun coffee (See Figure 4.23).

Figure 4.23 Deforestation due to sun-grown coffee agriculture within the central corridor

As stated in the Literature Review Section 2.2, sun-grown coffee is highly destructive to the ecosystem because it leaves the soil depleted of nutrients and susceptible to erosion. Our ArcView™ layers showed much shade coffee agriculture between the forests. Shade coffee requires forested area for growth and is not as detrimental to the ecosystem as sun coffee. However, the land use layers showing coffee agriculture were dated 1977; there is a possibility that many of the shade coffee plantations were abandoned shortly after their appearance.

4.2.3 Corridor Design and Justifications

We established our corridor design for the central corridor by compiling and analyzing several GIS layers in ArcView™.

Corridor 3: Guilarte – Adjuntas

The distance separating these forests was of great concern initially. As stated by Fleury and Brown (1997), a corridor that is too long for the intended species would prove useless; species would probably not use a long corridor because of a higher chance of mortality. In order to counter this problem, we believed it necessary to utilize a large watershed patch of land within the corridor. Using a GIS map layer, we identified several watersheds in the area. The most suitable due to its central location and larger size is outlined and shaded in blue in Figure 4.24.

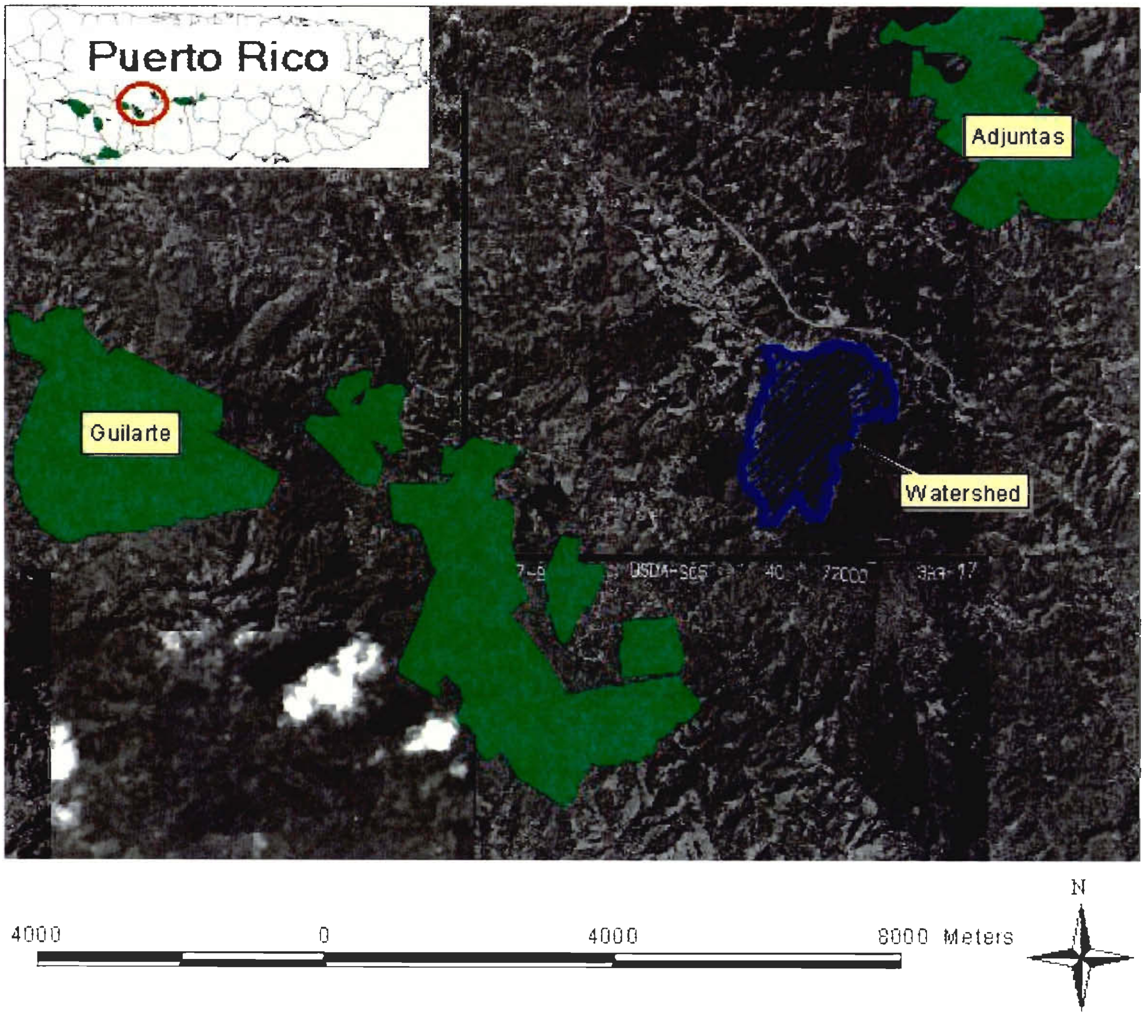


Figure 4.24 Watershed between Guilarte and Adjuntas

With this watershed region in mind, we then identified the general area with which we would be working in order to create the most suitable corridor. This general area is shaded in Figure 4.25.

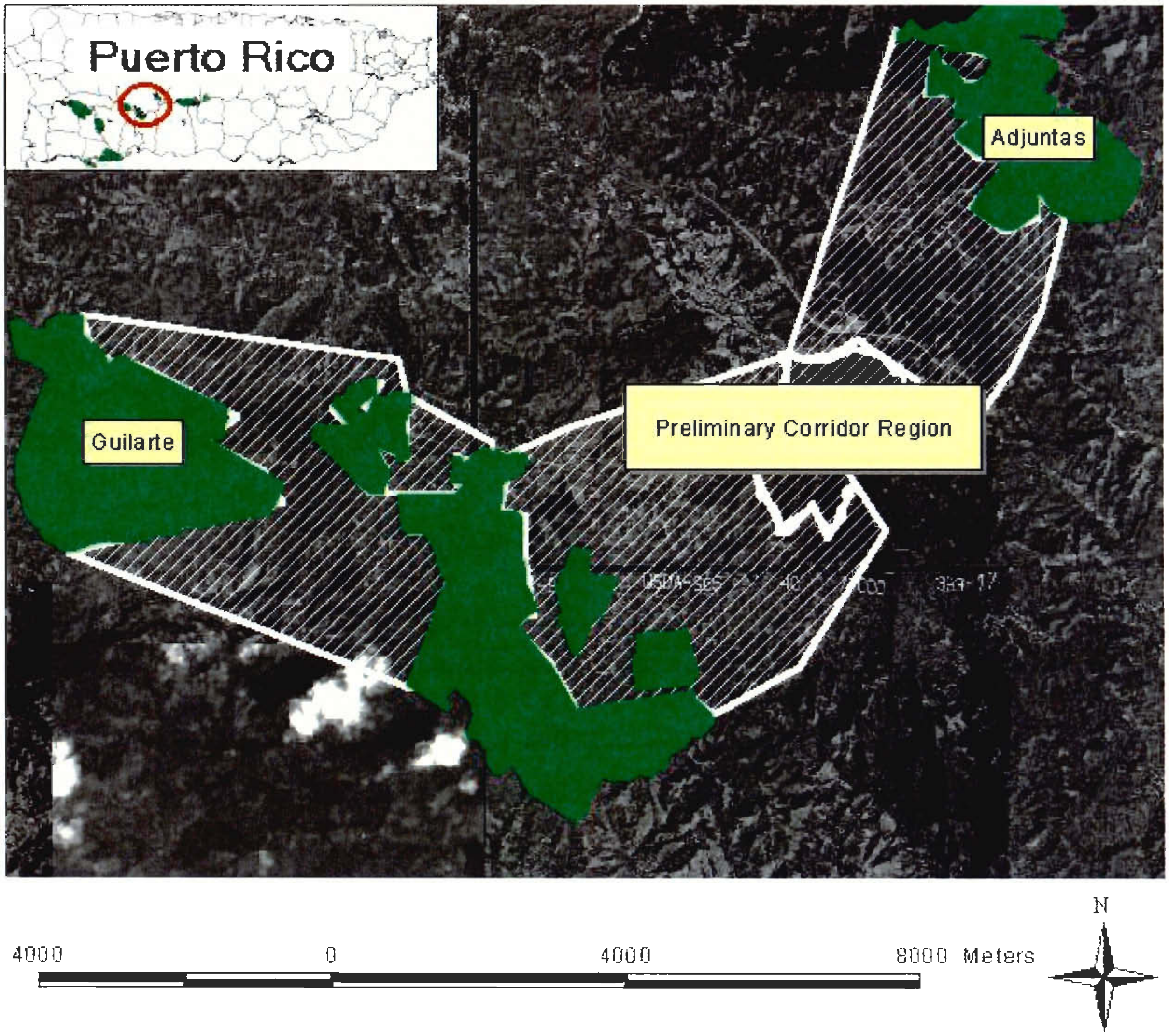


Figure 4.25 Corridor Region between Guilarte and Adjuntas

In order to find the regions most conducive to the target species, we overlaid several ArcView™ layers: land usage, soil types, and topography.

Much of the region lying between Guilarte and Adjuntas is labeled on the ArcView layer as "coffee cropland," indicated by the shaded green region in Figure 4.26.

However, orthographic aerial photos and first-hand visual observation made us realize

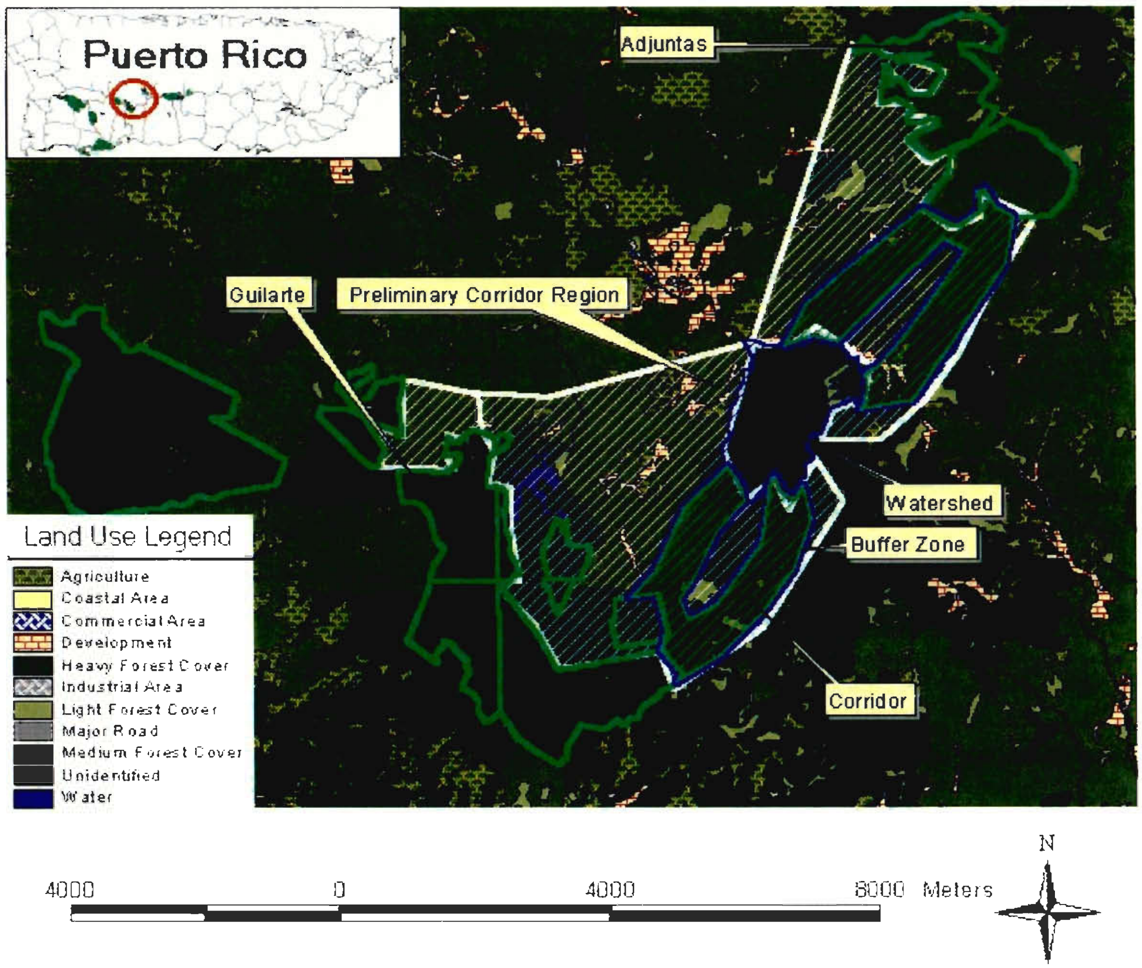


Figure 4.26 Guilarte to Adjuntas corridor layered over land use

that much of this cropland had been abandoned and naturally reforested. In addition, shade coffee is much less detrimental to the ecosystem since it requires medium forest cover. This made the majority of the region very suitable for corridor delineation. Therefore, we primarily used dense woodland and the secondary forest that resulted from the abandoned cropland in our delineation.

The type of soil within a region dictates the types of vegetation that grows there. The soil represented by blue in Figure 4.27 is a clay that is more moist than the soil represented with the green shading.

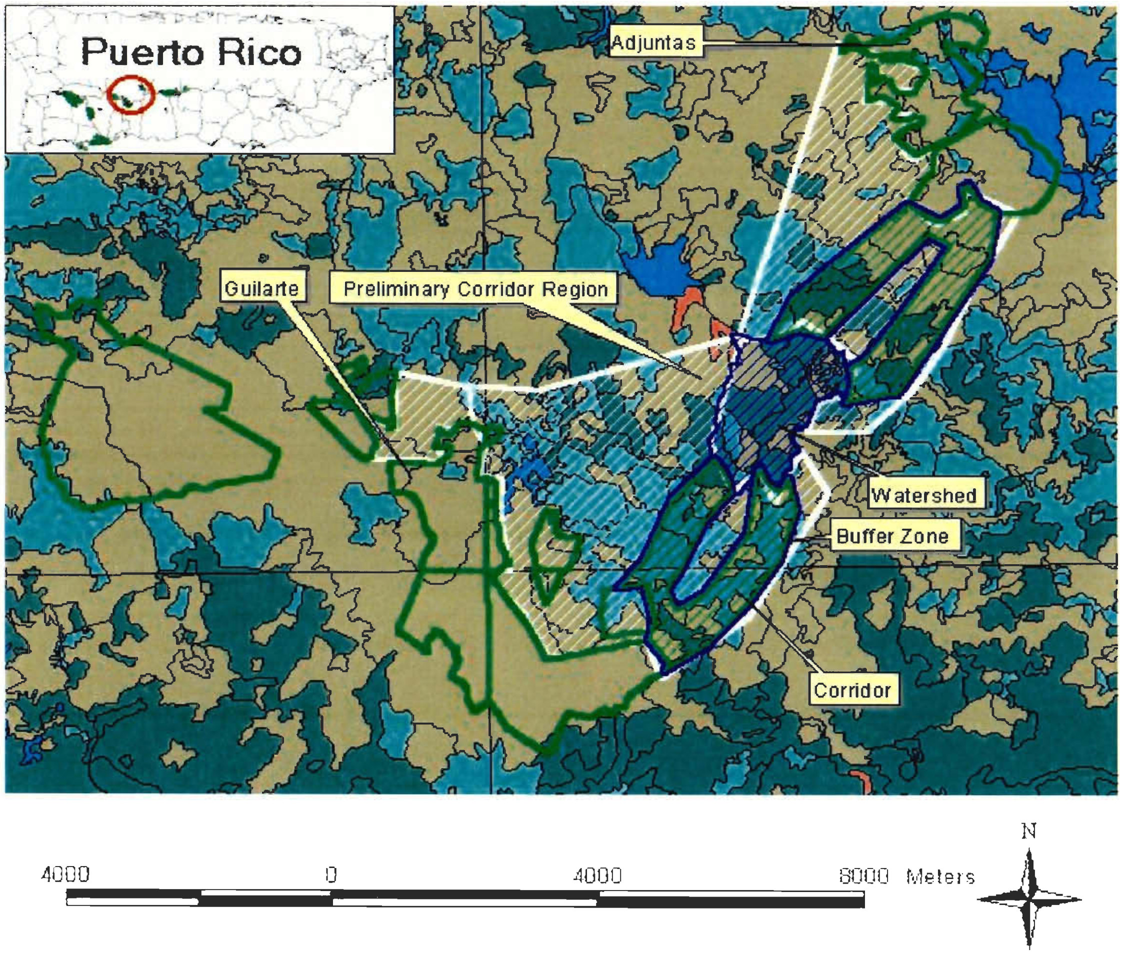


Figure 4.27 Guilarte to Adjuntas corridor layered over soils

Since both of the forests have soil that is represented by blue, connecting the forests with land that contains this type of soil was desirable. However, it was sometimes necessary to utilize the lands with the dryer clay.

The region between Guilarte and Adjuntas Forests is very mountainous. High slopes may be too treacherous for many species to traverse. Therefore, we felt it necessary to maintain a similar elevation throughout the corridor. Areas of high elevation are shaded darker than lower elevations in Figure 4.28.

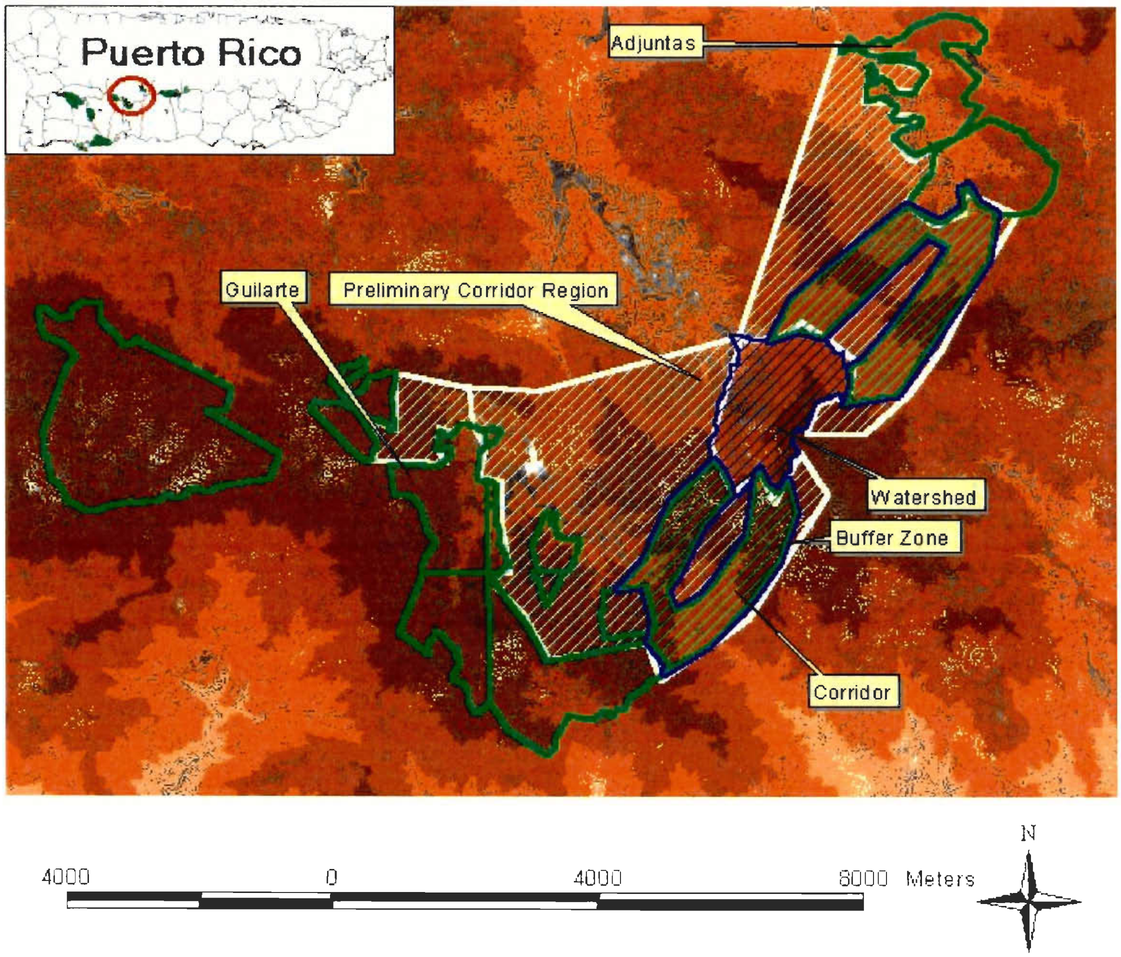


Figure 4.28 Guilarte to Adjuntas corridor layered over topography

We attempted to encompass only areas of relatively high elevation whenever possible.

The following Table 4.3 lists the desired attribute for Corridor 3, based on habitat requirements of the sharp-shinned and Broad-winged Hawks, basic ecological principles, and the final design attributes.

Table 4.3 Guilarte to Adjuntas corridor results

Attribute	Desired Result	Actual Design Result
Matrix (Land usage)	Dense or moderately dense forested land	Mostly heavy and medium forest cover, some light forest cover
Network	High network connectivity, multiple entrances and exits	2 paths, with a middle patch
Barriers	None	None
Length	7 km is the shortest length possible	The corridor stretches between a maximum of 8.7 km and a minimum of 7.3 km (incl. middle patch)
Width	650 meters (incl. buffer)	600-700 meters (incl. buffer)
Shape	Straight, no high degree angles	Relatively straight, with some curvature
Buffer	50 meters on both sides	50 meters on both sides
Species benefited	All that are found in both Susúa and Guánica	None negatively affected
Area conserved	1124.3 acres is the smallest possible area	2985.3 acres, including patch
Target Species Suitability	All known habitat requirements are met for both target species	All known habitat requirements are met for both target species
Land cost	Lowest economic value, easily acquirable	Not much development within the corridor. Estimated cost: $8.42 million (See Section 4.4).

The final design of Corridor 3 satisfied the majority of the desired results. As mentioned before, the length of the corridor could have been an issue. However, we included a patch in the center of the corridor in order to tackle this. An illustration of the final design for Corridor 3 uniting Guilarte and Adjuntas Forest is below in Figure 4.29.

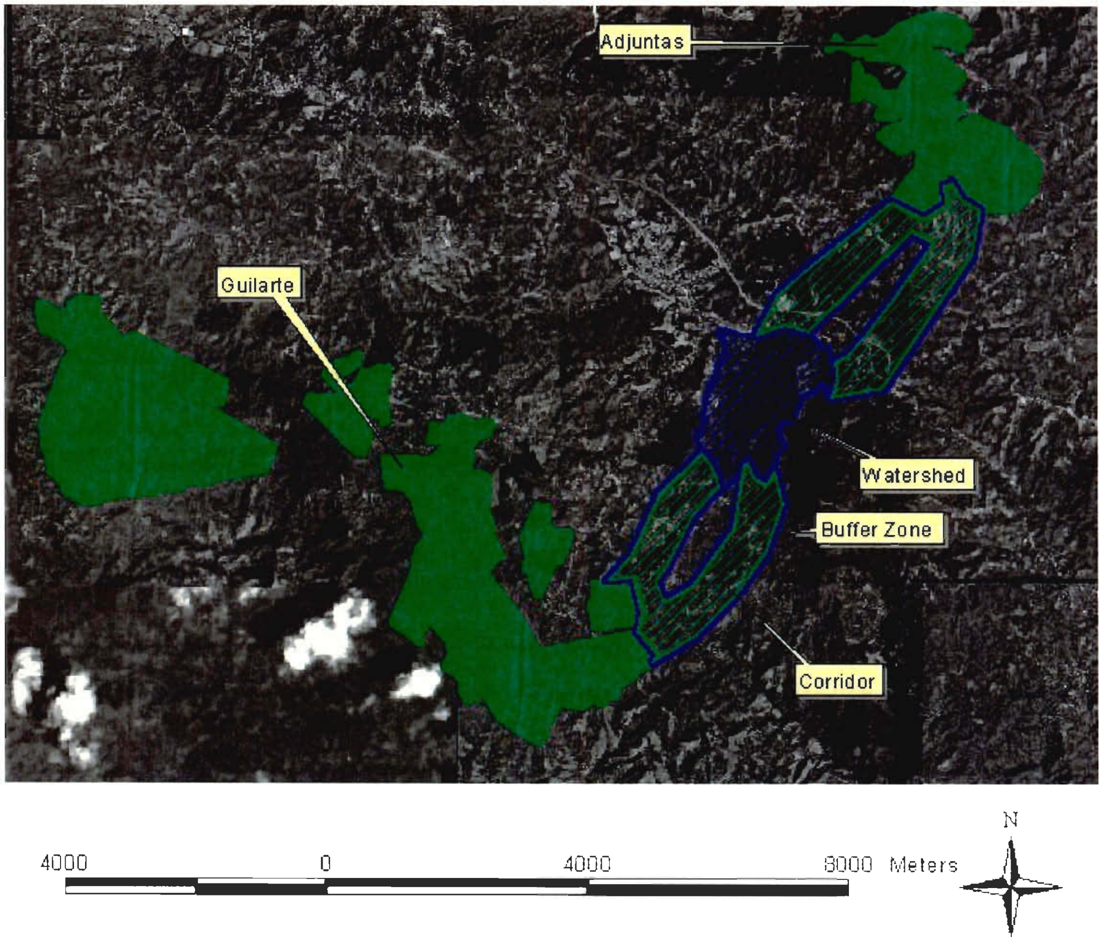


Figure 4.29 Final corridor design for corridor designed to unite Guilarte and Adjuntas

Corridor 4: Adjuntas Forest – Toro Negro

Like Corridor 3, the distance between Adjuntas and Toro Negro was of concern in the preliminary stages of corridor design. We again felt it necessary to utilize a large patch of land to combat this problem. We identified several watersheds in the area and chose the most suitable one based on location and size. The watershed chosen to be included in the corridor is shaded in white in Figure 4.30.

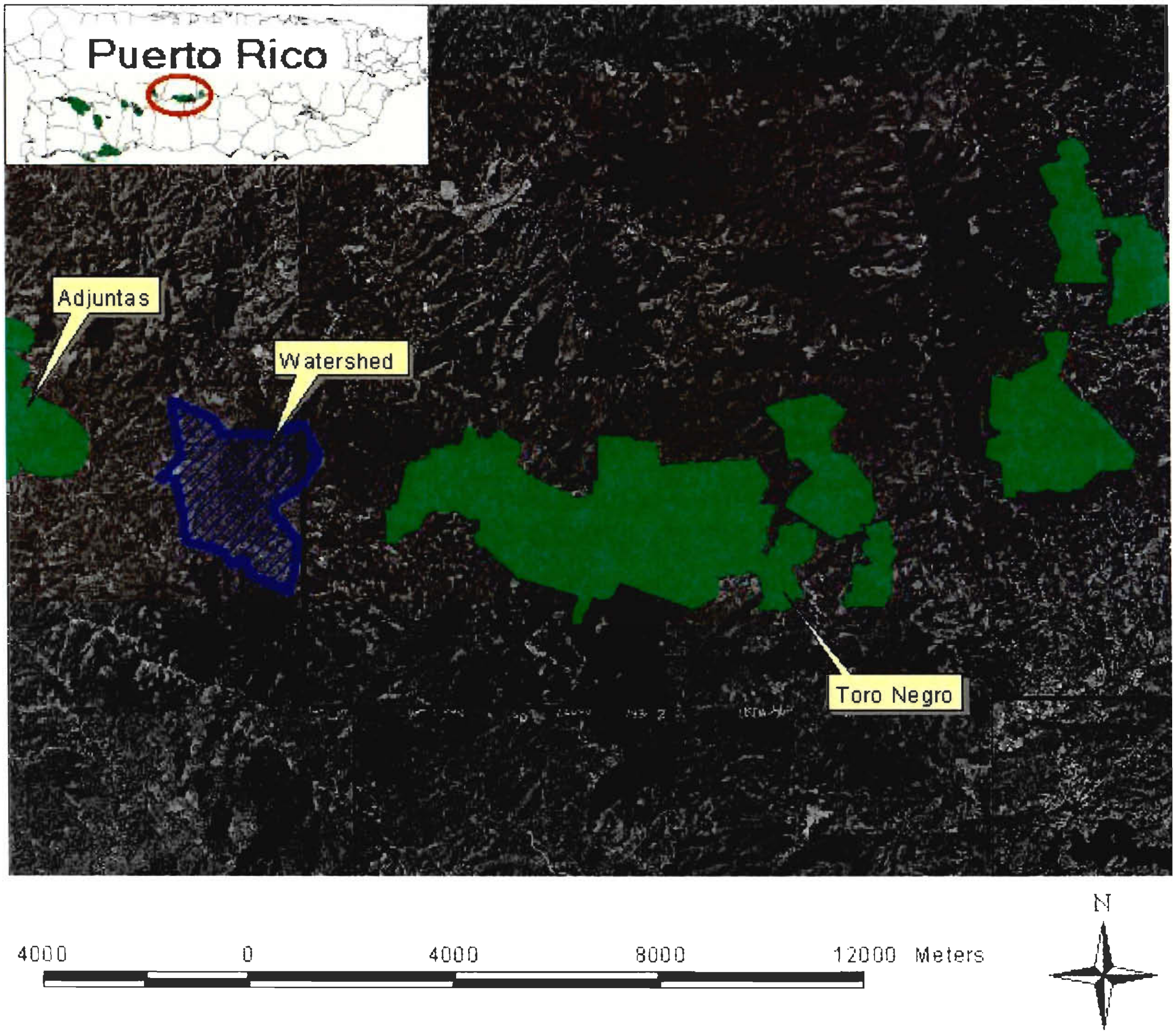


Figure 4.30 Watershed between Toro Negro and Adjuntas

We identified the general area with which we would be dealing, keeping in mind the watershed mentioned above. This general area is shaded in white in Figure 4.31.

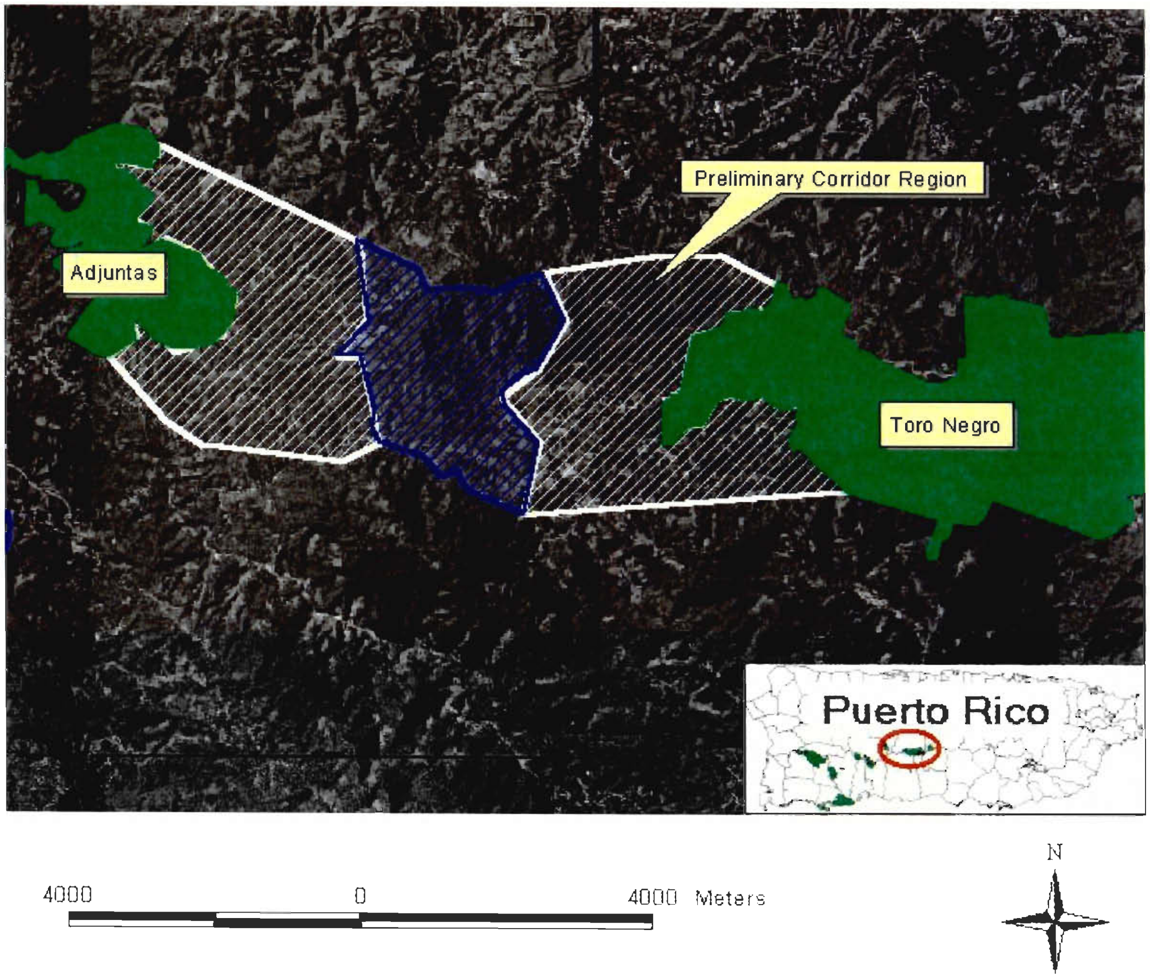


Figure 4.31 Potential corridor region between Adjuntas and Toro Negro

We then utilized many ArcView™ layers to find the best location for our corridor that was conducive to the target species' habitat requirements.

The region between Adjuntas and Toro Negro is well forested. Some areas are listed as coffee cropland. However, as stated before, shade coffee cropland is suitable for use in corridor delineations. There are also scattered pasturelands and grassy regions which were avoided whenever possible. We again primarily utilized forested land or cropland in our delineation (See Figure 4.32)

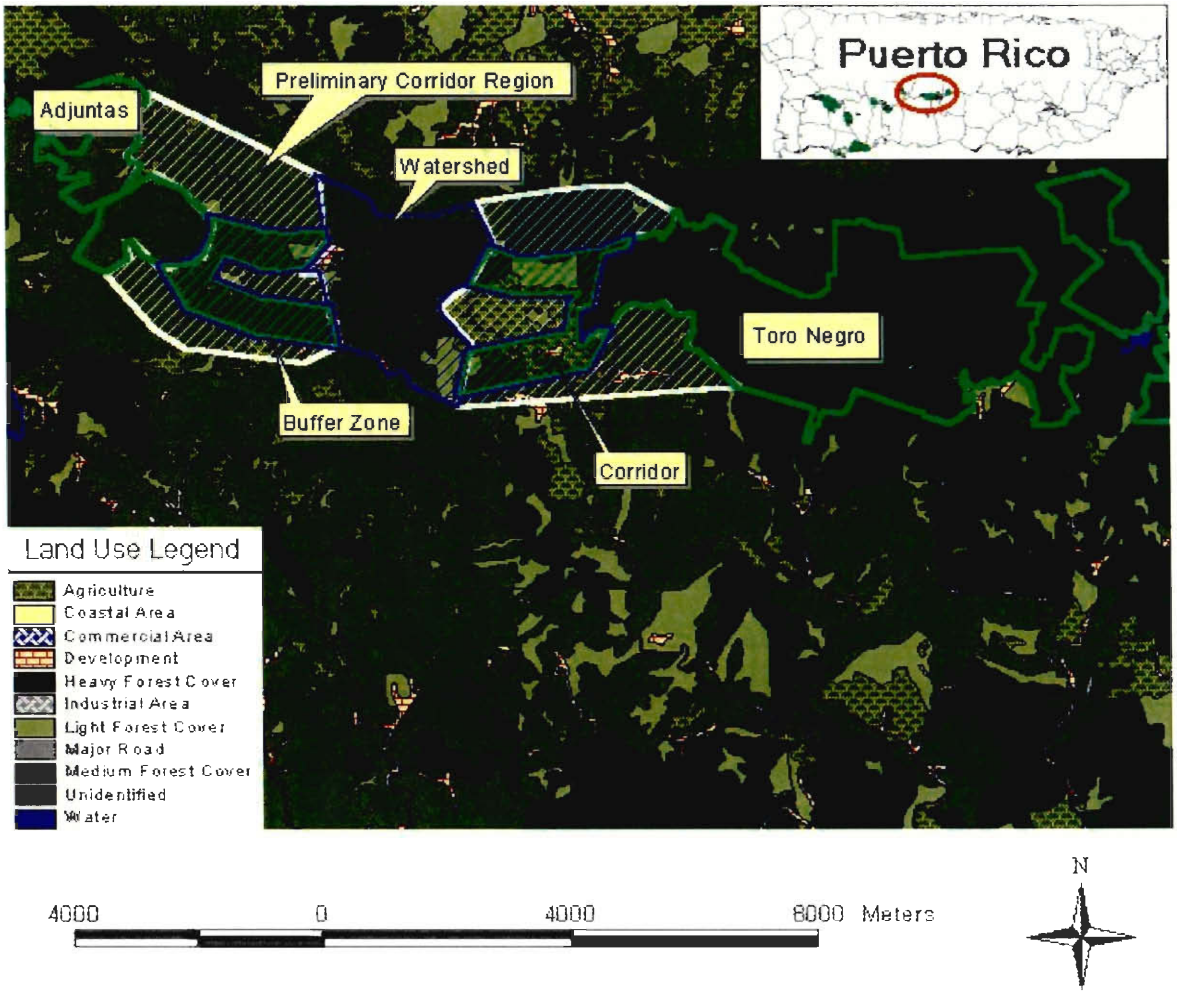


Figure 4.32 Toro Negro to Adjuntas corridor layered over land use

It was desirable for the forests to be joined utilizing soil of similar type and hydration so that the vegetation that grew there would also be similar. The soil within the two forests is mainly a moist clay, represented in blue in Figure 4.33.

However, between the forests this was not the case and it was somewhat difficult to connect the corridors utilizing this clay. Therefore areas of other type of soils were used when necessary.

Because of the mountainous region between Adjuntas and Toro Negro, it was necessary to attempt to delineate a corridor via regions of similar elevation. As seen in

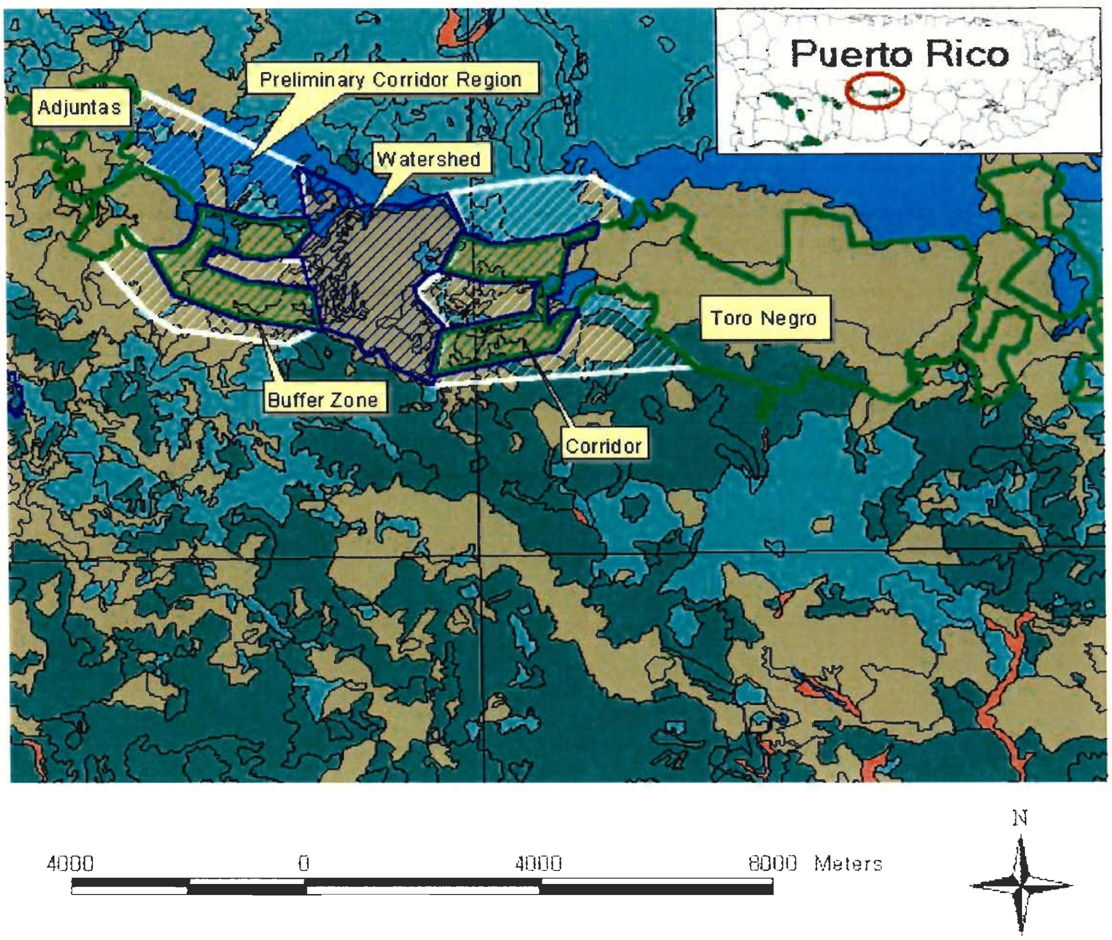


Figure 4.33 Toro Negro to Adjuntas corridor layered over soils

Figure 4.34, the corridors are mainly within darker regions within Toro Negro, and lighter regions between the watershed and Adjuntas.

The following Table 4.4 lists the desired attribute for Corridor 4, based on habitat requirements of the sharp-shinned and Broad-winged Hawks and basic ecological

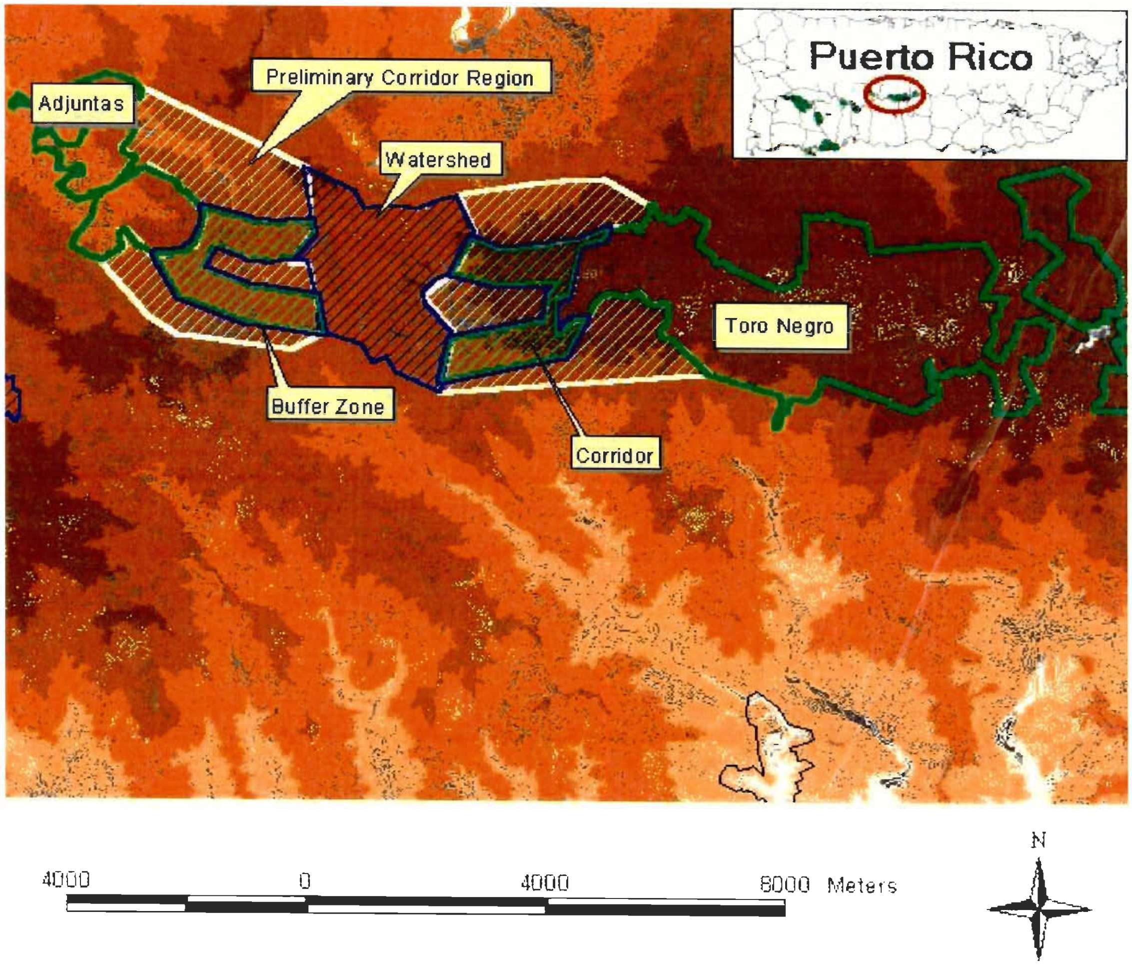


Figure 4.34 Toro Negro to Adjuntas corridor layered over topography

principles, and the final design attributes.

Table 4.4 Toro Negro and Adjuntas corridor results

Attribute	Desired Result	Actual Design Result
Matrix (Land usage)	Dense or moderately dense forested land	Mostly Heavy and Medium forest cover, some light forest cover and some pastureland
Network	High network connectivity, multiple entrances and exits	Two paths, and a patch to combat length
Barriers	None	None
Length	6 km is the minimum distance	Ranges from 7700 m to 6300 m (with patch)
Width	650 meters with buffer	700 m with buffer
Shape	Straight, no high degree angles	Relatively straight, some curvature
Buffer	50 meters on both sides	50 meters on both sides
Species benefited	All that are found in both Susúa and Guánica	None negatively affected by the corridor
Area conserved	963.7 acres is the smallest possible area	3268.5 acres, including patch
Target Species Suitability	All known habitat requirements are met for the target species	All known habitat requirements are met for the target species
Land cost	Lowest economic value, easily acquirable	Developed land is avoided throughout most of the corridor region. Estimated cost: $19.63 million (See Section 4.4).

The final design of Corridor 4 satisfied nearly all of our desired results with the introduction of the patch in the center of the corridor. This patch was introduced, as mentioned before, to combat the length between the forests.

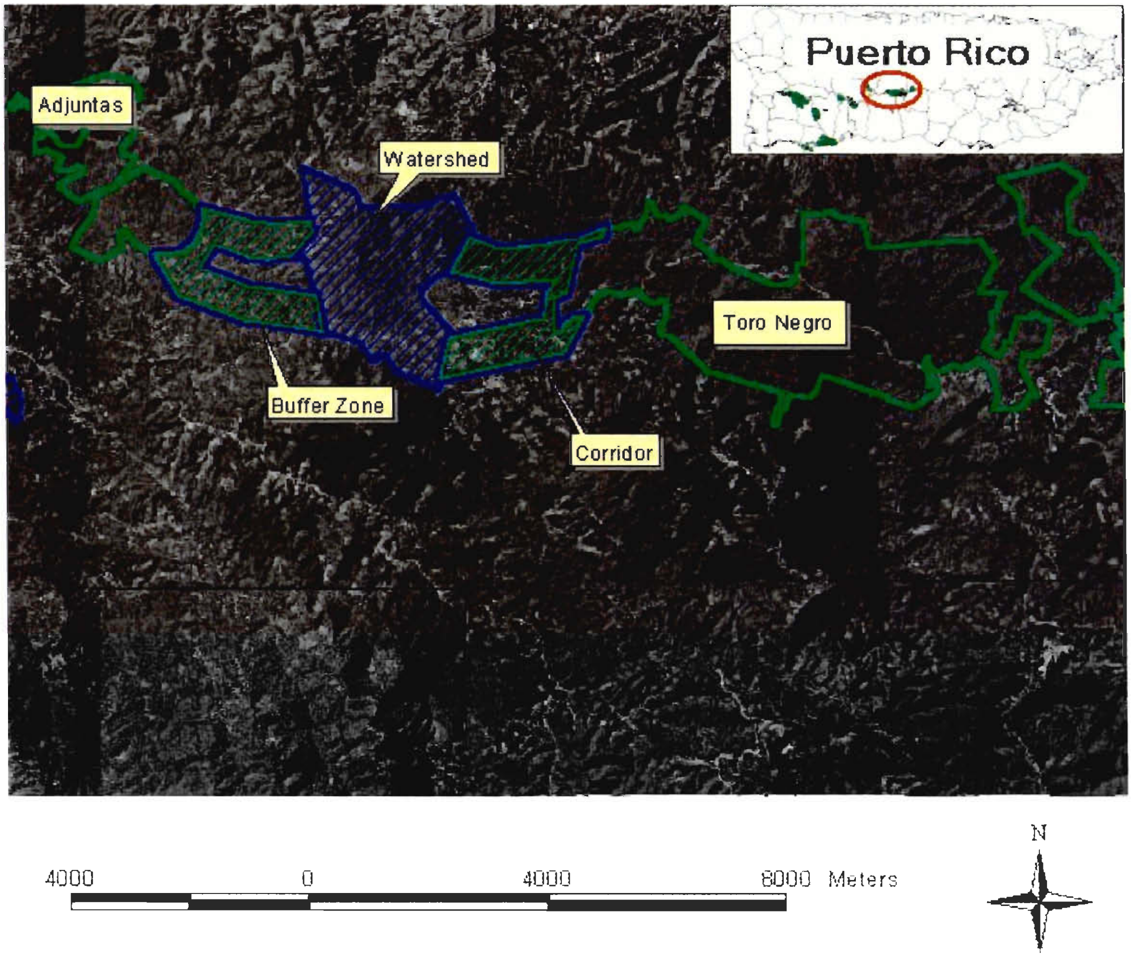


Figure 4.35 Corridor between Toro Negro and Adjuntas

4.3 Final Corridor Delineations

See the following Figure 4.36 for the delineations of all corridors. For a detailed discussion, refer to Conclusions Section 5.1.

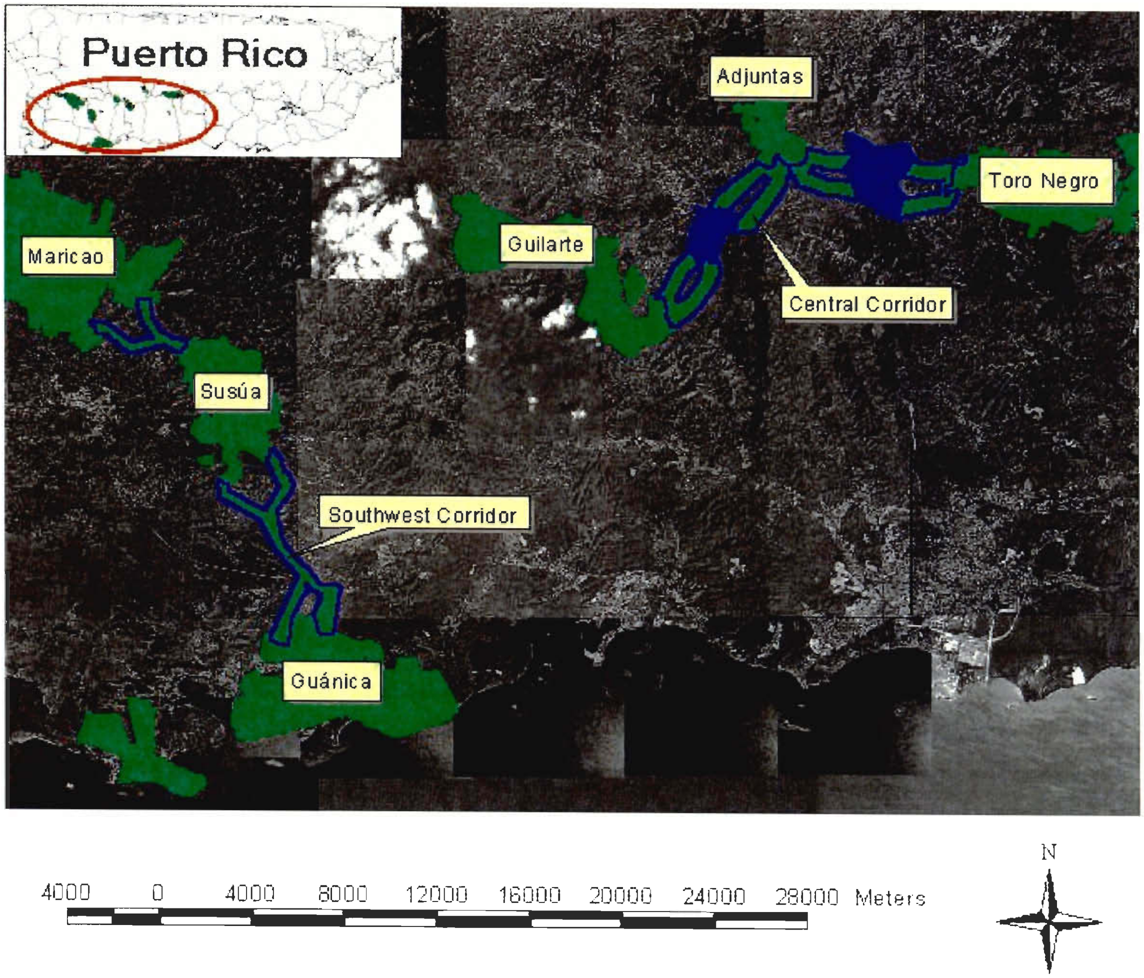


Figure 4.36 Final corridor delineations for all forests

4.4 Estimated Land Value

To calculate an estimated cost for the corridors, we first collected market values for seven appraised lands (See Appendix D) near or within the corridors. We compared these market values to their corresponding tax-assessed values as defined by the CRIM. We found that the average error between the tax-assessed values and market values was 0.9785748 +/- 2.54%.

Next, we collected acreage and tax-assessed values from the CRIM for properties within the corridors (See Appendix B). The CRIM was able to provide us with information about 60 percent of all 644 properties for which we requested information. Of the 384 properties for which the CRIM could collect data, 346 of them contained both acreage and tax-assessed values. Having 54 percent of all desired properties, we calculated an average per-acre tax-assessed value for each corridor (See Table 4.5)

Table 4.5 Estimated Market Values for Corridors and Watersheds

Corridor			Acreage	Per-acre Tax-Assessed Value	Estimated Market Value
Guánica to Susúa			1943.5	$ 87.41	**$ 7,721,666.87**
	High Priority		530.31	$ 87.41	$ 2,106,960.20
	Medium Priority		601.58	$ 87.41	$ 2,390,121.10
	Low Priority		811.61	$ 87.41	$ 3,224,585.57
Susúa to Maricao			665.1	$ 83.46	**$ 2,523,078.28**
	High Priority		460.85	$ 83.46	$ 1,748,249.32
	Medium Priority		171.64	$ 83.46	$ 651,121.87
	Low Priority		32.61	$ 83.46	$ 123,707.09
Guilarte to Adjuntas			2985.4	$ 62.07	**$ 8,422,667.76**
	Watershed		784.57	$ 61.44	$ 2,191,029.88
		High Priority	228.68	$ 61.44	$ 638,623.34
		Medium Priority	552.82	$ 61.44	$ 1,543,833.11
		Low Priority	3.07	$ 61.44	$ 8,573.44
	Remaining corridor		2200.83	$ 62.29	$ 6,231,178.96
		High Priority	1004.49	$ 62.29	$ 2,843,998.38
		Medium Priority	1124.34	$ 62.29	$ 3,183,327.99
		Low Priority	72	$ 62.29	$ 203,852.59
Adjuntas to Toro Negro			3268.5	$ 132.15	**$ 19,632,746.22**
	Watershed		1574.62	$ 88.10	$ 6,305,464.25
		High Priority	1265.89	$ 88.10	$ 5,069,174.87
		Medium Priority	303.19	$ 88.10	$ 1,214,104.80
		Low Priority	5.54	$ 88.10	$ 22,184.57
	Remaining corridor		1693.88	$ 205.65	$ 15,833,493.57
		High Priority	1188.52	$ 205.65	$ 11,109,655.81
		Medium Priority	458.14	$ 205.65	$ 4,282,450.20
		Low Priority	47.22	$ 205.65	$ 441,387.56
				Total Cost:	**$ 38,300,159.12**

For the central corridors, we also calculated average per-acre tax-assessed values for watershed and non-watershed lands. From our corridor layers in ArcView™, we determined the total area of each corridor, including separate areas for watersheds and prioritized lands. Finally, we applied the equations defined in the Methodology Section 3.4 to arrive at the totals given in Table 4.5. Applying the standard error for the tax-assessed to market value constant, the total given could vary from $37,327,335.08 to $39,272,983.16.

CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Our biological corridor designs met the outlined requirements set forth by the DRNA. When established, they will fully connect the forests within each region. These corridors have been delineated on digitized maps. In addition, they fulfill the stipulations of Law 1277 (2000).

Each corridor could not be designed without compromising certain corridor attributes. In many cases, the composition of the corridor became secondary to its shape, length or width because straight, short and uniformly wide corridors are the most effective (Fleury & Brown, 1997). The composition of the corridor was also compromised for low development land or riparian zones. This is especially true for the Guánica to Susúa region where land is the most expensive. Furthermore, highly developed regions had to be avoided because the high cost they would incur to the DRNA. Lastly, it was not possible to design a corridor that had continuous vegetation, common soil types, and similar topography throughout. Therefore, we had to compromise some compositional elements for others in order to maximize composition as a whole.

Although the corridor designs are ecologically beneficial and fulfill all of the stipulations set forth by the DRNA, we believe that it is possible to improve upon their design to increase effectiveness. For example, the central forests are internally fragmented and attempts should be made to defragment them.

The total estimated market value for all corridors was \$38.3M. We only had appraisal values for seven lands around the corridors; therefore, the estimations are less accurate than desired. Also, since our error adjustment for the CRIM tax-assessed values to the estimated market values was an average for lands throughout all six forests, the total estimated market value for all corridors is likely to be more accurate than the estimated market value for each individual corridor.

Because of increasing deforestation and development in the corridor regions, we concluded that areas containing the best types of soil, vegetation, and topography should be acquired first. This will ensure that pristine forest regions are preserved. It was also concluded that regions containing either good soils, or good vegetation should be acquired second. Regions of high-quality soil can be easily reforested, and areas of dense vegetation will serve as good habitat for species that utilize the corridor.

Many private landowners will be affected by our corridor designs because the DRNA must acquire the land involved in their establishment. In order to help the DRNA determine the best methods for acquiring land, we designed a questionnaire to be given to private landowners. However, in order to have the landowners form educated responses to the questionnaire, we concluded that an educational brochure about the project should be distributed along with it.

5.2 Recommendations

We present to the Departamento de Recursos Naturales y Ambientales (DRNA) the following recommendations. Discussion of their reasoning follows.

- Make efforts to improve the corridors effectiveness by:
    - Introducing a patch of land as part of Corridor 1. It should be vertically centered in the corridor, circular in shape, and no less than 1190 m.
    - Expanding the size of Guánica Forest to the northeast.
    - Defragmenting Guilarte and Toro Negro Forests

- Distribute a survey along with the brochure
- Acquire lands of highest ecological value first by buying titles
- Appraise all properties contained within the corridor
- Create a corridor management plan and appoint a Corridor Manager
- Use this project as a starting point for future corridor development

5.2.1 Improving Corridor Effectiveness in the Southwestern Corridor Region

We recommend that a patch of land be introduced as part of Corridor 1 to combat the negative effects of its length. Corridor 1, which would unite Guánica and Susúa Forests, was noted in Results and Analysis section 5.* to be longer than the desired result. However, it was impossible to shorten the length of the corridor because the forests were too far apart from each other. In addition, efforts to find a suitable area to place a patch of land to combat the effects of a long corridor proved to be impossible; there were no large areas of forestland or pastureland that could potentially be reforested. However, we believe that creating such a patch would still be very beneficial to the wildlife, and efforts to acquire and create a suitable piece of land should continue. We recommend that the patch be vertically centered in the corridor, circular in shape, and be no less than 1190 meters in diameter to provide for 11 acres of home range for the target specie. See Figure 5.1 for a recommended patch.

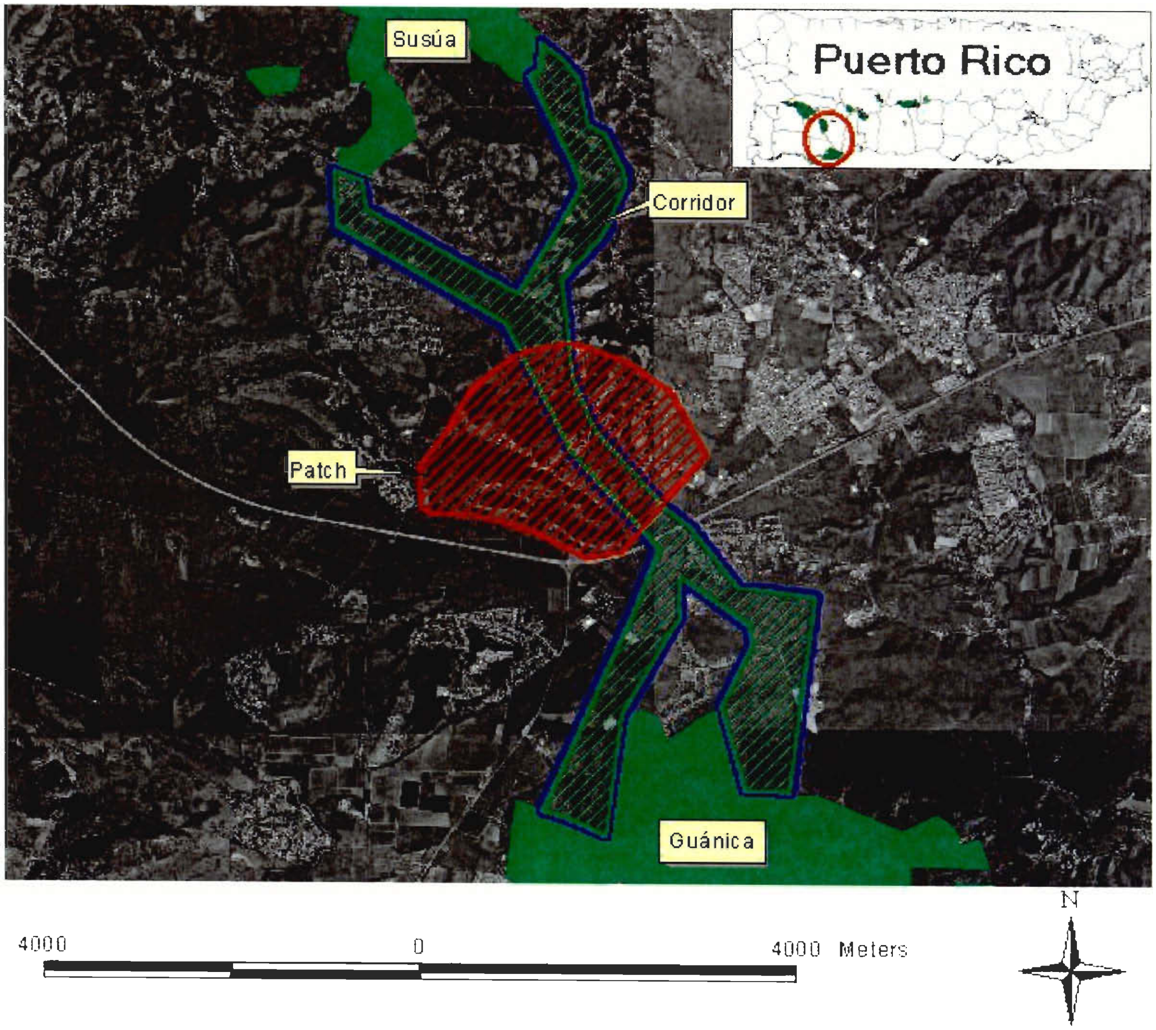


Figure 5.1 Recommended patch within Guánica to Susúa corridor

Another recommendation we have for improving the effectiveness of this corridor is to expand the size of Guánica Forest to the north. There is a substantial portion of well-forested area to the north of Guanica Forest.

If this area were to be acquired by the DRNA, it would not only combat the extreme length of the corridor, but also the high degree angle located on the southeastern leg of the corridor noted in Results and Analysis section 4.1.3 (See .

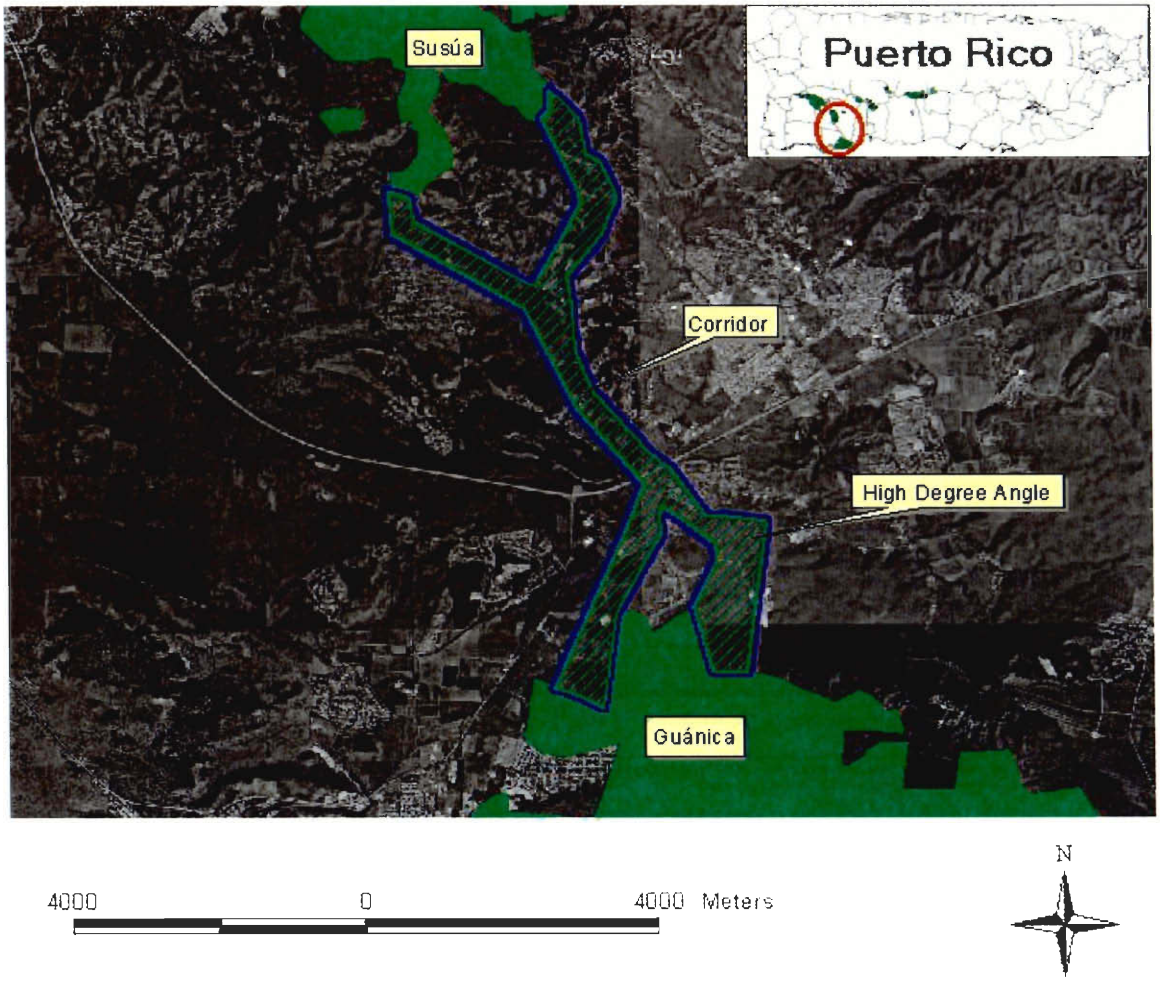


Figure 5.2 High-degree angle in southeastern leg of corridor between Susúa and Guánica

The angle could amplify the edge effect (See Glossary) in that portion and inhibit species movement. By acquiring this land, the angle becomes virtually non-existent. In addition, extending the protected forested areas would only benefit this unique ecosystem in general.

This rationale can be applied to all six forests involved in the project scope. By increasing the size of each forest when possible, the issue with length is addressed. Length is a problem because, as mentioned in Results and Analysis, it increases the likelihood of species mortality. Therefore, a shorter corridor is most effective. This issue spans both corridor regions and can continuously be improved upon by increasing forest size.

5.2.2 Improving Corridor Effectiveness in the Central Corridor Region

We strongly recommend that the DRNA make a substantial effort to defragment Guilarte and Toro Negro Forests (See Figure 5.3 and Figure 5.4).

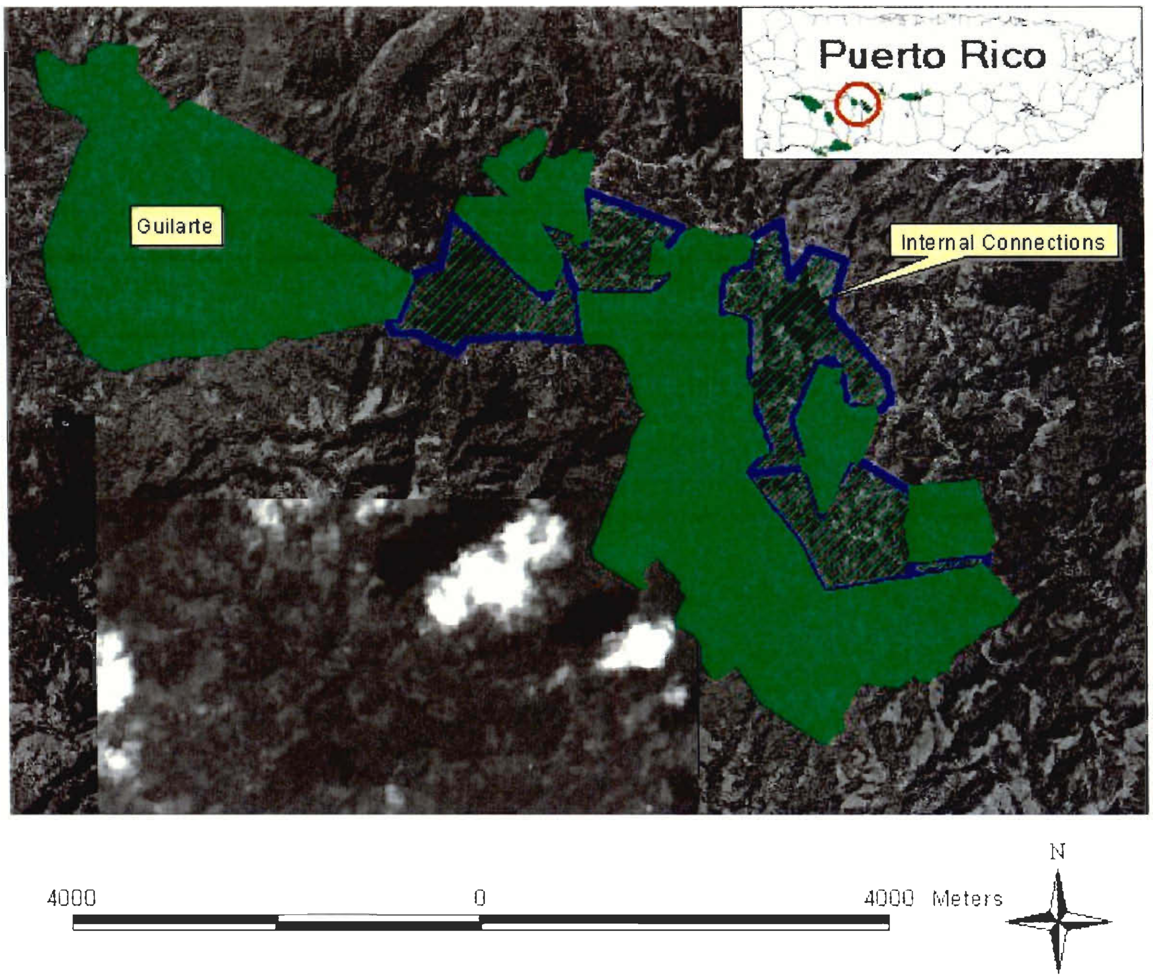


Figure 5.3 Areas to acquire in order to defragment Guilarte

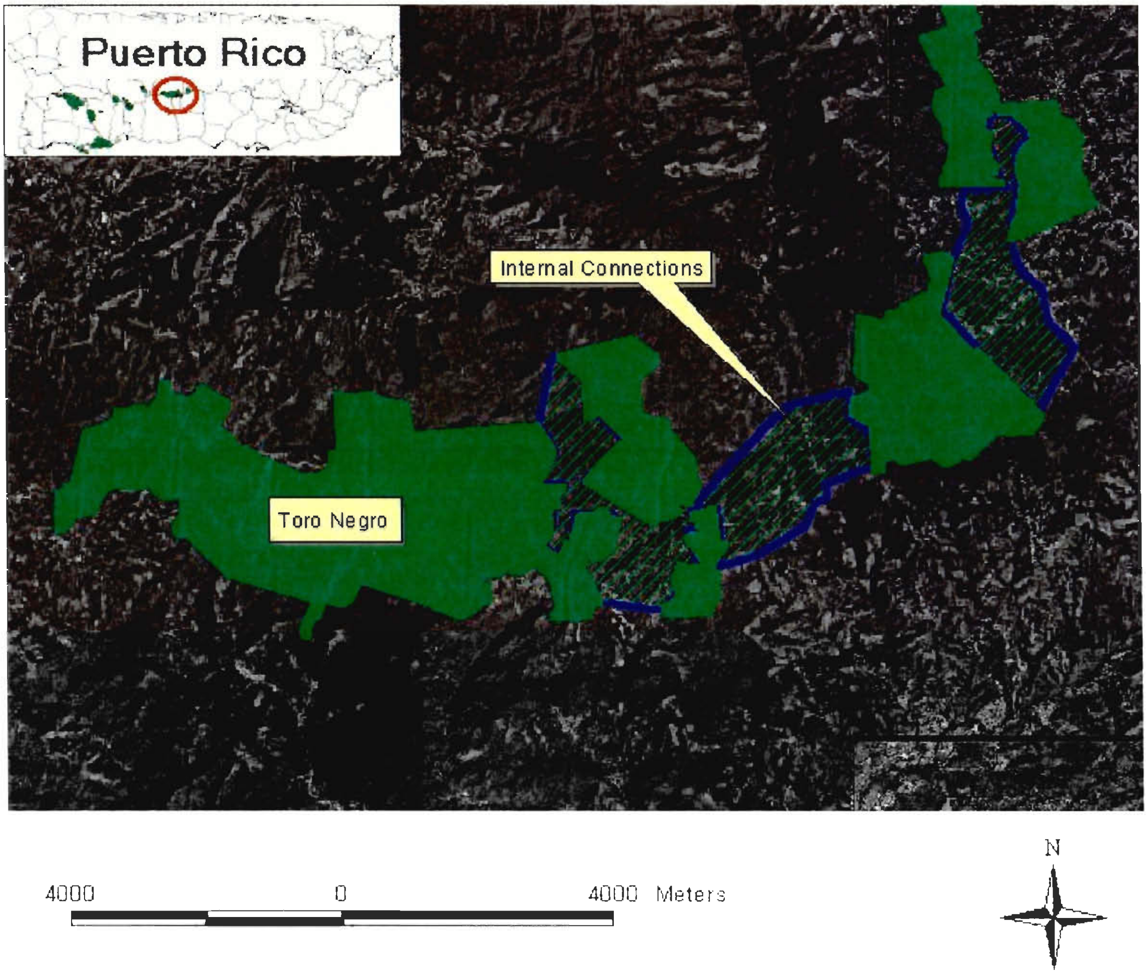


Figure 5.4 Areas needed to defragment Toro Negro

Both the Guilarte and Toro Negro are highly fragmented forests. Though the areas lying between the forest fragments are currently under forest cover, increasing developmental pressures and private ownership could lead to deforestation of these areas. Fragmentation within these forests could have potential negative effects on the functionality of the corridor. If the connected regions are small and isolated themselves, their patch size may prove inadequate for species survival. Species with larger home ranges would suffer greatly if they sought refuge in a small patch and were unable or unwilling to travel to a larger area of conserved forest. Acquiring the lands between the forests' sections would ensure that the disastrous effects of fragmentation would not be noticed within the forests.

5.2.3 Education and Feedback from Affected Citizens

To help the DRNA understand public sentiment about the law and the conservation programs in which they prefer to participate, we recommend a survey be distributed along with the brochure. It is important to educate the community about the importance of conservation, especially the benefit of biological corridors. It is also fair that the public be aware of the options available to them should they want to participate in the conservation effort. A public that is aware of the project might be more willing to volunteer their lands to conservation programs like the auxiliary forest program. We have included a sample brochure and survey in Appendix F.

5.2.4 Prioritized Properties and Land Acquisition

In order to make informed decisions regarding land acquisitions, the DRNA asked that we prioritize land in the corridor regions based on their ecological value. This is due because the DRNA may not have the funds available to them to buy all the land at once and needs to know which lands are in the most pristine condition. Lands in pristine condition would serve as a foundation for the corridor.

The regions shown in red in Figure 5.5, Figure 5.7, Figure 5.8 and Figure 5.8 are lands that should be acquired first.

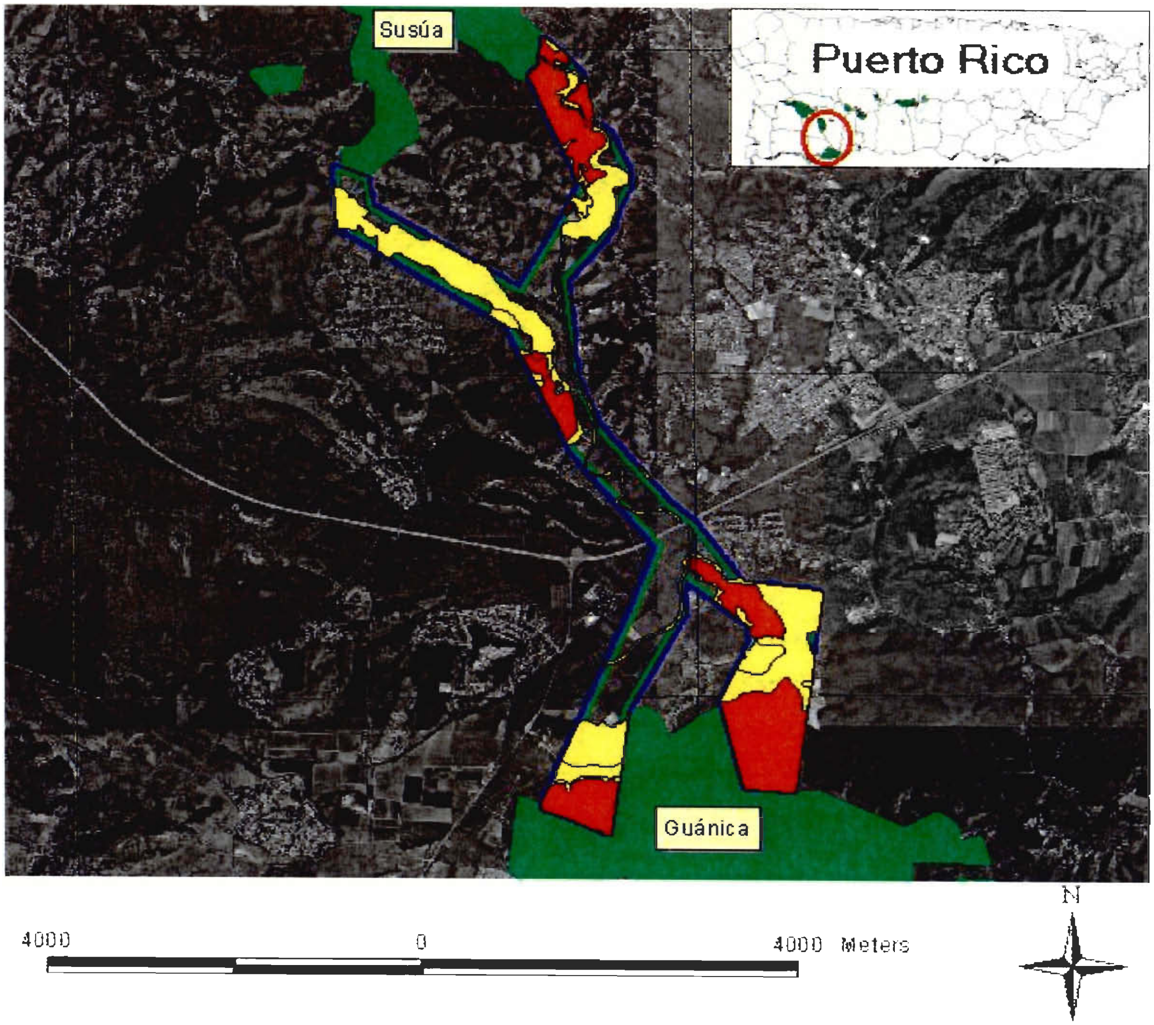


Figure 5.5 Prioritized lands between Guánica and Susúa
High priorities are in red; medium priorities are in yellow

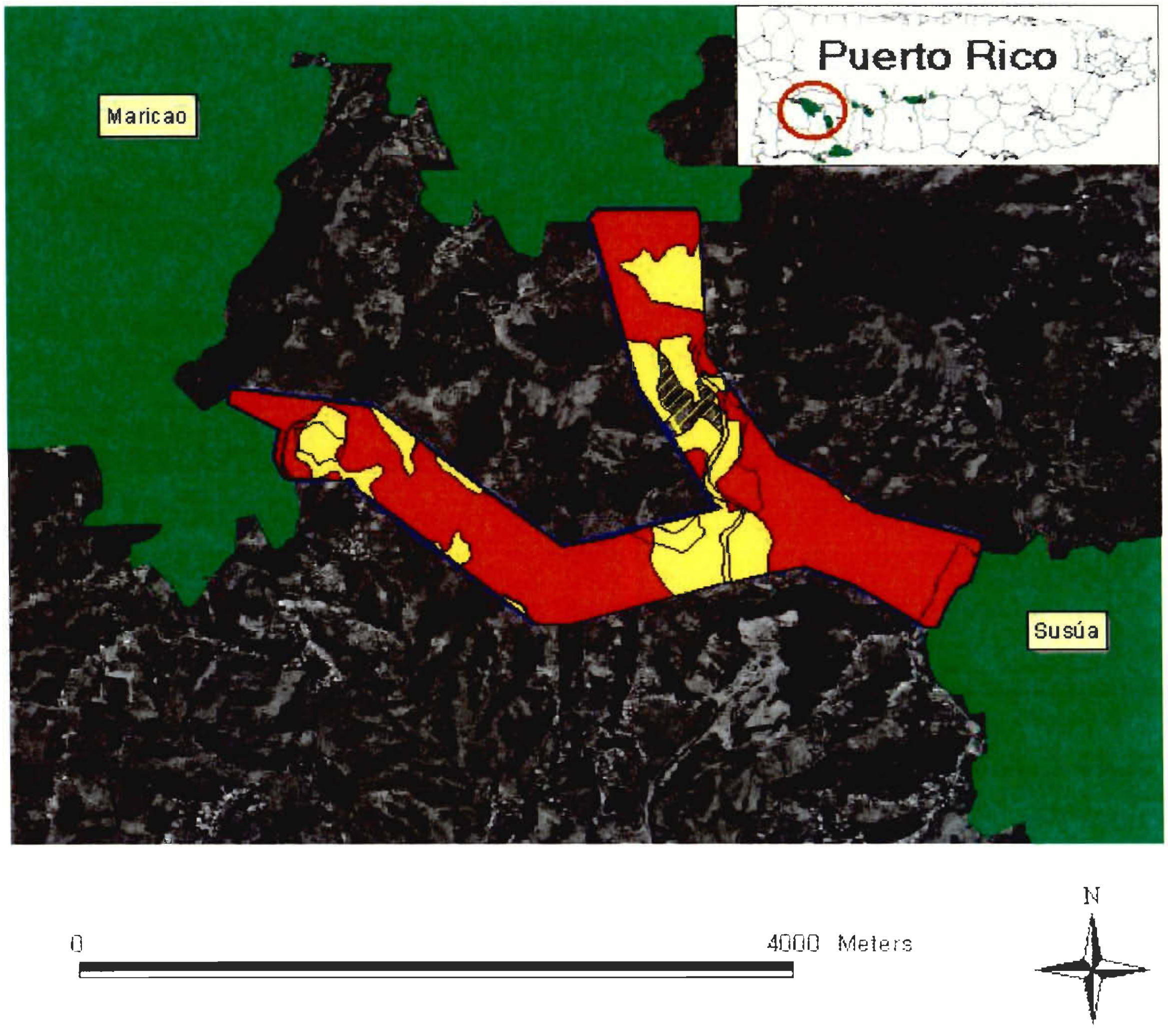


Figure 5.6 Prioritized lands between Maricao and Susúa
High priorities are in red; medium priorities are in yellow

Containing limestone and serpentine soil, dense forest cover, and low development, the forests indicated in red have habitats highly conducive to the Guabairo. The yellow areas are second priority, containing almost all habitat requirements for the Guabairo.

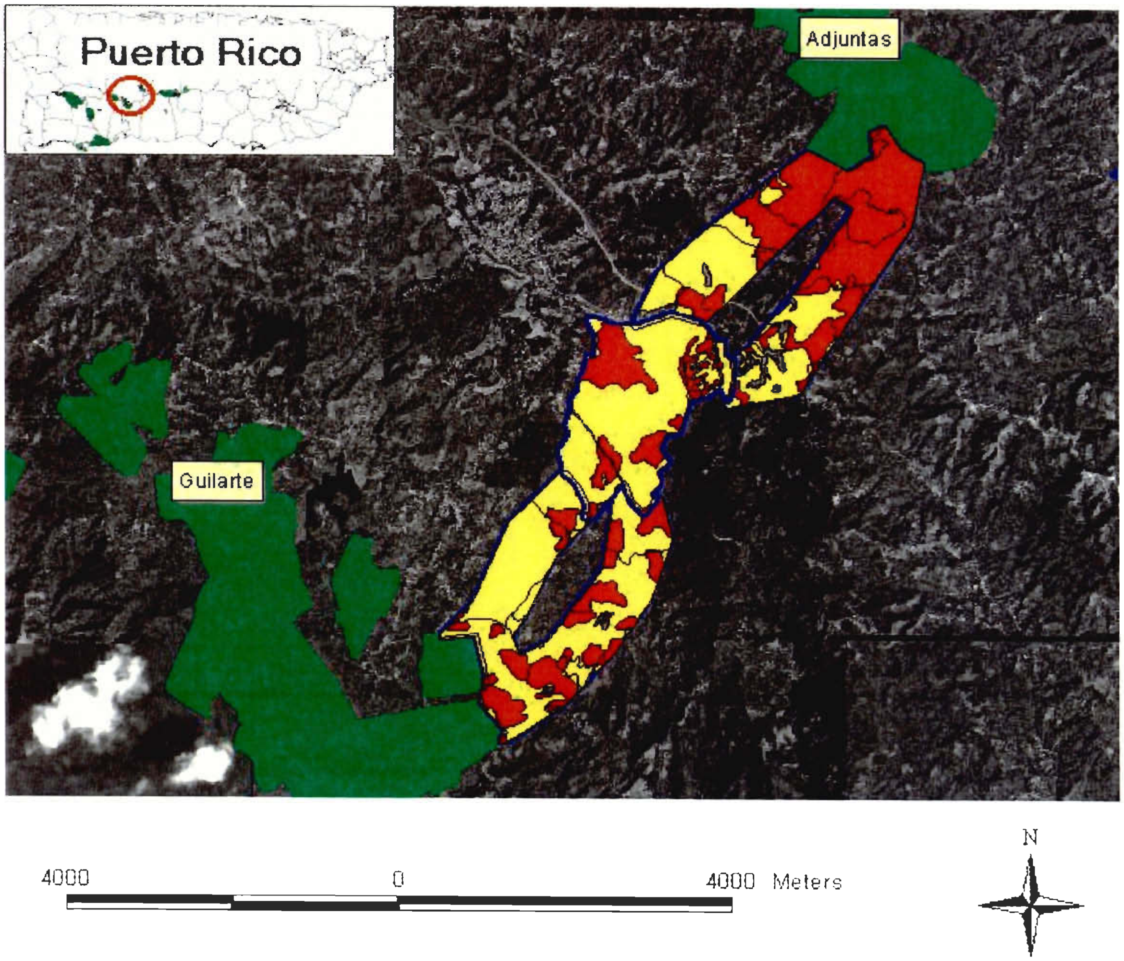


Figure 5.7 Prioritized lands between Guilarte and Adjuntas
High priorities are in red; medium priorities are in yellow

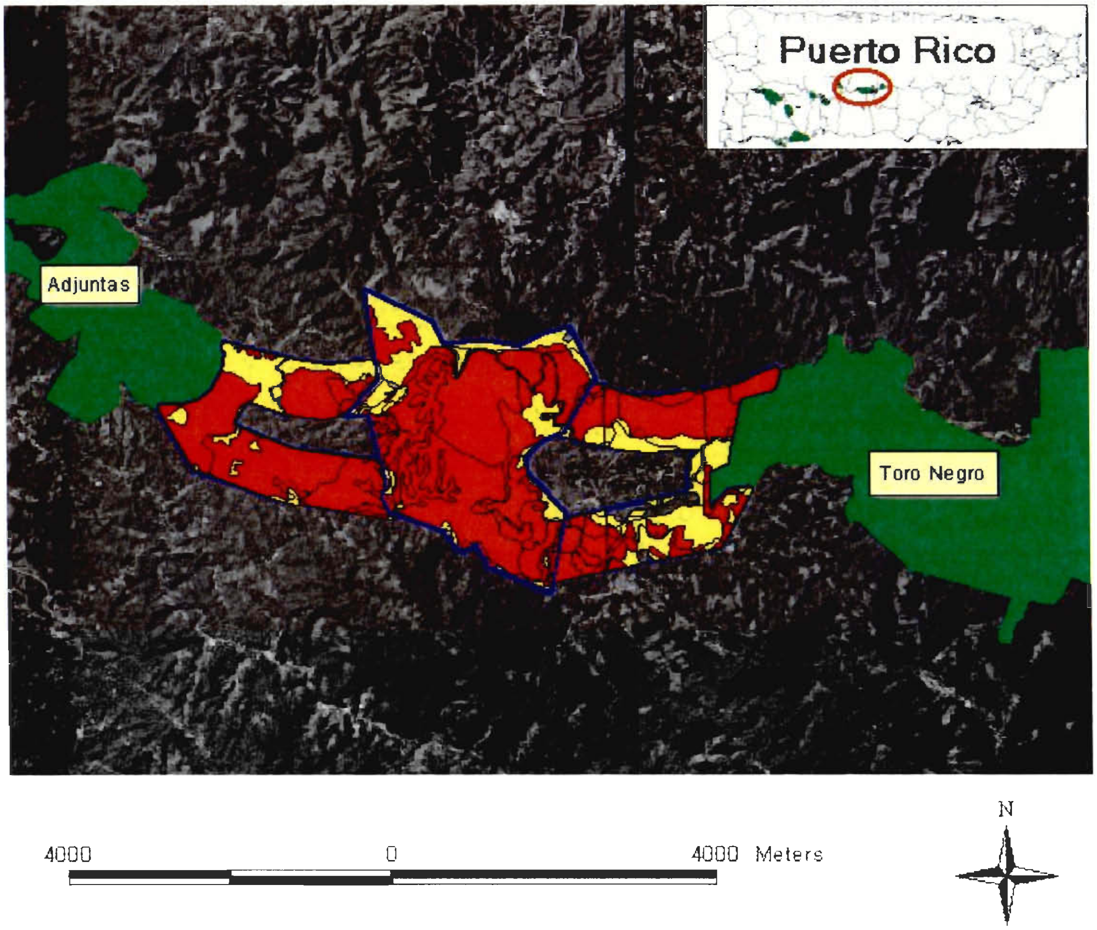


Figure 5.8 Prioritized lands between Adjuntas and Toro Negro
High priorities are in red; medium priorities are in yellow

The lands highlighted in red are high priority, containing habitat conducive to the needs of the target species: dense forest and appropriate topography.

The lands highlighted in the maps above are those that we recommend the DRNA attempt to acquire first. They provide the most suitable landscape for corridor establishment. Though they are fragmented portions of land themselves, in this primary stage of corridor development they will serve as the backbone for future corridor expansion. They will also offer the species "stepping stones" to move from forest to forest. With a stepping stone, an animal may navigate from piece to piece of small land before arriving at the end of the corridor. Though we believe that these stepping stones may not be the most effective method of facilitating wildlife movement, we realize that financial constraints may leave this as the only available option for the DRNA at the present time.

We recommend buying the titles to the highest priority lands because they are critical to the success of the corridor. In areas of lower priority, encourage landowners to participate in the auxiliary forest program until their land can be fully acquired. Conservation easements might be a viable acquisition mechanism especially for properties that reside along the edge of the corridor. By utilizing the brochure described in the previous section, landowners may contact the DRNA and express how they might volunteer their land.

5.2.5 Cost Estimate Improvement

The market value estimate for the corridors could be better estimated. Appraising more lands to determine a better tax-assessed value to market value discrepancy would lead to a more accurate result. Acquiring tax-assessed values for the properties for which no tax value is given would also better define the result. Eventually, we recommend that the DRNA should obtain appraisals for all properties contained within the corridor.

5.2.6 Reforestation Process

As mentioned in Results and Analysis, the Guánica to Susúa corridor region is very developed. Therefore, after acquiring the land, much of it will be in need of reforestation to offer a suitable living habitat for many species (See Figure 5.9).

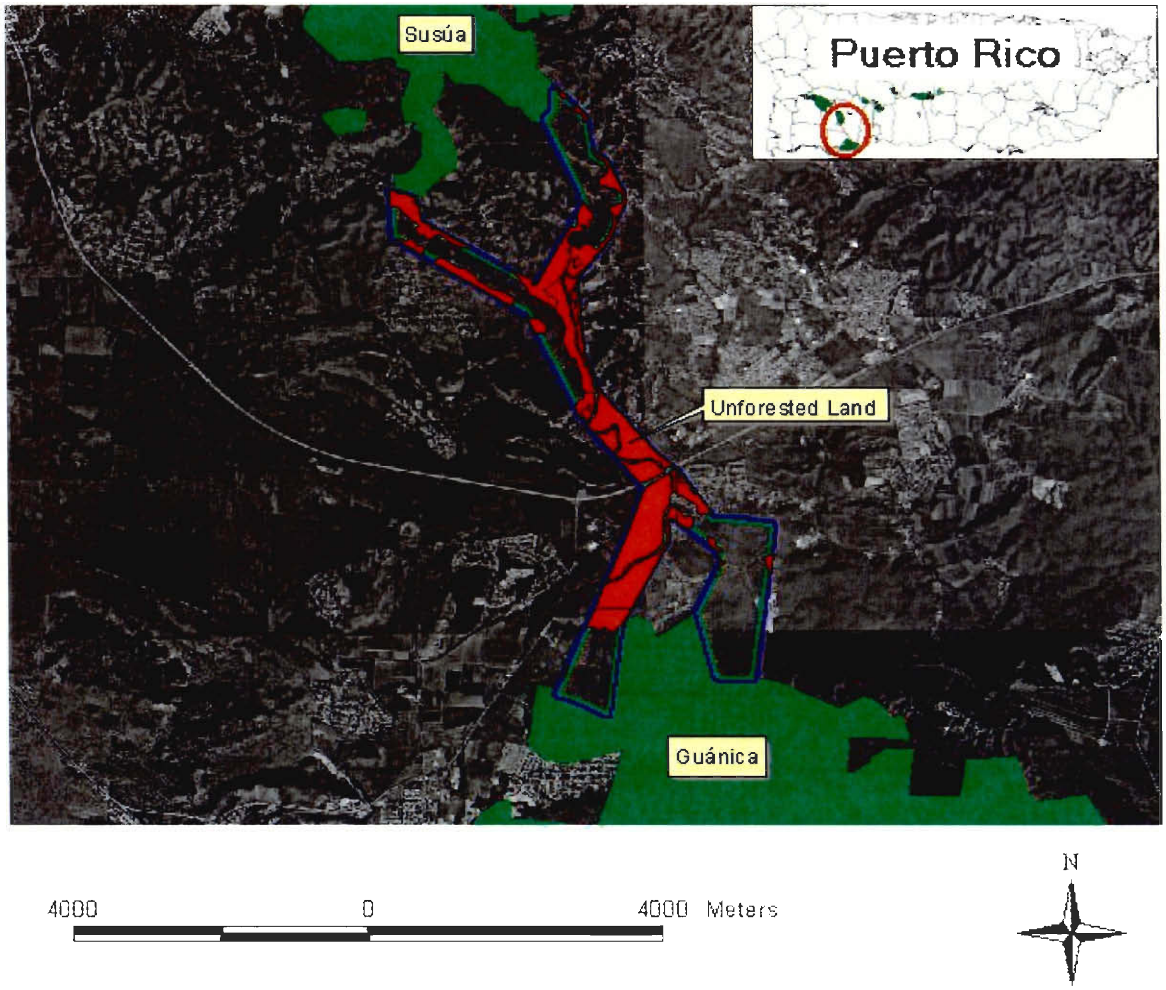


Figure 5.9 Recommended lands to reforest between Guánica and Susúa

Reforestation is explained in the Literature Review Section 2.9. More detailed information about reforestation can be found in The Guide to Reforesting Watersheds in Puerto Rico (DRNA, 1998).

5.2.7 Corridor Management

Once established, the biological corridors will be new lands in need of appropriate management and maintenance. We firmly recommend the DRNA should hold responsibility for the management of the corridors. The corridors will require general forest management, such as surveillance and reforestation, in order to become and remain effective. We respect the DRNA's judgement in appointing officials, specifically a Corridor Manager, to accomplish this.

In addition to customary forest management, there are a few critical aspects specific to biological corridors that must be the responsibility of the appointed Corridor Manager. It is imperative that the Corridor Manager constantly monitor the corridor and surrounding areas for forest fires. Forest fires can spread rapidly from forest to forest having disastrous effects; therefore, prompt action against their expansion is crucial. Monitoring animal movement is also important. Because corridors cannot serve as a permanent habitat for many larger species, ensuring proper movement is taking place between forests is an important aspect of corridor management. It is also important that the Corridor Manager continuously monitor the corridor buffer zones for encroaching development. Development that would threaten the functionality of the corridor and integrity of the ecosystem should be halted before any serious damage is done to the area.

5.2.8 Future Corridor Development

We firmly recommend that DRNA continuously make efforts to connect other forests via biological corridor. We believe that the corridors we have designed in this project serve as a starting point for many other corridor projects in Puerto Rico. Continually connecting forests via biological corridors is an effective way of combating the devastating effects of deforestation and fragmentation.

The area between the forests of Tres Picachos and Toro Negro is an excellent region to consider for corridor development. It is currently under much forest cover, so land would be less expensive than in a developed region. Conservation of this region is important for many species including the Broad-winged and Sharp-shinned Hawk. The preservation of valuable watersheds can also be accomplished by conserving forestland between these two forests. Establishing a corridor here would essentially create a large continuous forested area expanding across four state forests and five municipalities.

Another area to consider for corridor establishment is between Guilarte and Susúa Forests. Though this region is larger than any of the regions we dealt with in our delineations, the distance can be combated with the inclusion of multiple patches, similar to the central corridor region. Accomplishing this would be more difficult than creating a Tres Picachos to Toro Negro corridor. However, it would unite both the southwestern and central corridor regions and establish a network of six or seven forests. This plan could have great benefits for the ecosystem.

Continuously creating and establishing more corridors throughout the island would greatly increase biodiversity and species survival rate. More corridors would also ensure a more balanced and stable ecosystem. We recommend that an effort be made to eventually unite all of the state forests in Puerto Rico. We believe that this is a feasible accomplishment that would conserve numerous species of plants and animals.

APPENDIX A - Mission and Organization of the Departamento de Recursos Naturales y Ambientales

Mission: To develop, manage, and conserve Puerto Rico's natural resources, in order to maintain an ecologically sustainable society.

About the DRNA

The Departamento de Recursos Naturales y Ambientales (DRNA), or in English, the Department of Natural and Environmental Resources (DNER), encompasses a number of different subdivisions, including the Corporate Development of Mineral Resources, Administration of Matters and the Division of Forestry, Environmental Planning, Scientific Research, Environmental Management, and Natural Resources Protection. Organizational charts can be seen in Figure A1 and Figure A2. The DNR, now the DNER, was created on June 20, 1972 as the Department of Natural Resources under Law 23 of the Commonwealth of Puerto Rico. This law established the DNR to be responsible for the operational phase of the Commonwealth's public policy regarding conservation. The DNER supervises coastal and mineral resources, wildlife, forests, fishing, hunting, solid waste, wells and underground water extraction, and hazardous waste policies (Valdés, 2000).

Objectives of the DRNA

The DRNA is responsible for the protection and preservation of Puerto Rico's most valuable natural resources. It provides administrative direction, coordination and assistance with the programs of the Administration and Conservation of Water and Mineral Resources, Administration and Conservation of Living Resources, Regional Coordination of Conservation of Natural Resources, and the Coastal Zone Bureau. The DRNA provides education to citizens in order to increase their awareness of environmental problems. The Administration attempts to meet its objectives by educating citizens, issuing permits for mines and fisheries, and monitoring the use of water and land resources. By issuing permits, the DRNA is not only able to raise funds, but it is also able to limit the number of citizens who can use the island's resources.

Administration and Funding

The Secretary of DRNA, Carlos M. Padín, directs the operations of the Department. Our liaison, Daniel Galán, is the Director of Forest Management Division for the DRNA. For funding, the Department relies primarily on money from the Commonwealth but also acquires income from permits and licenses (See Figures A1 and A2, for more organizational information).

Project to Agency Relationship

Our IQP involves the creation of biological corridors between adjacent forests of Puerto Rico that will help preserve and protect the environment within them. By helping to sustain ecological stability, our project is consistent with the mission of the DRNA. If satisfactory, our results will be used to establish corridors to preserve the wildlife and plant life of the united forests.

Forest Management Division

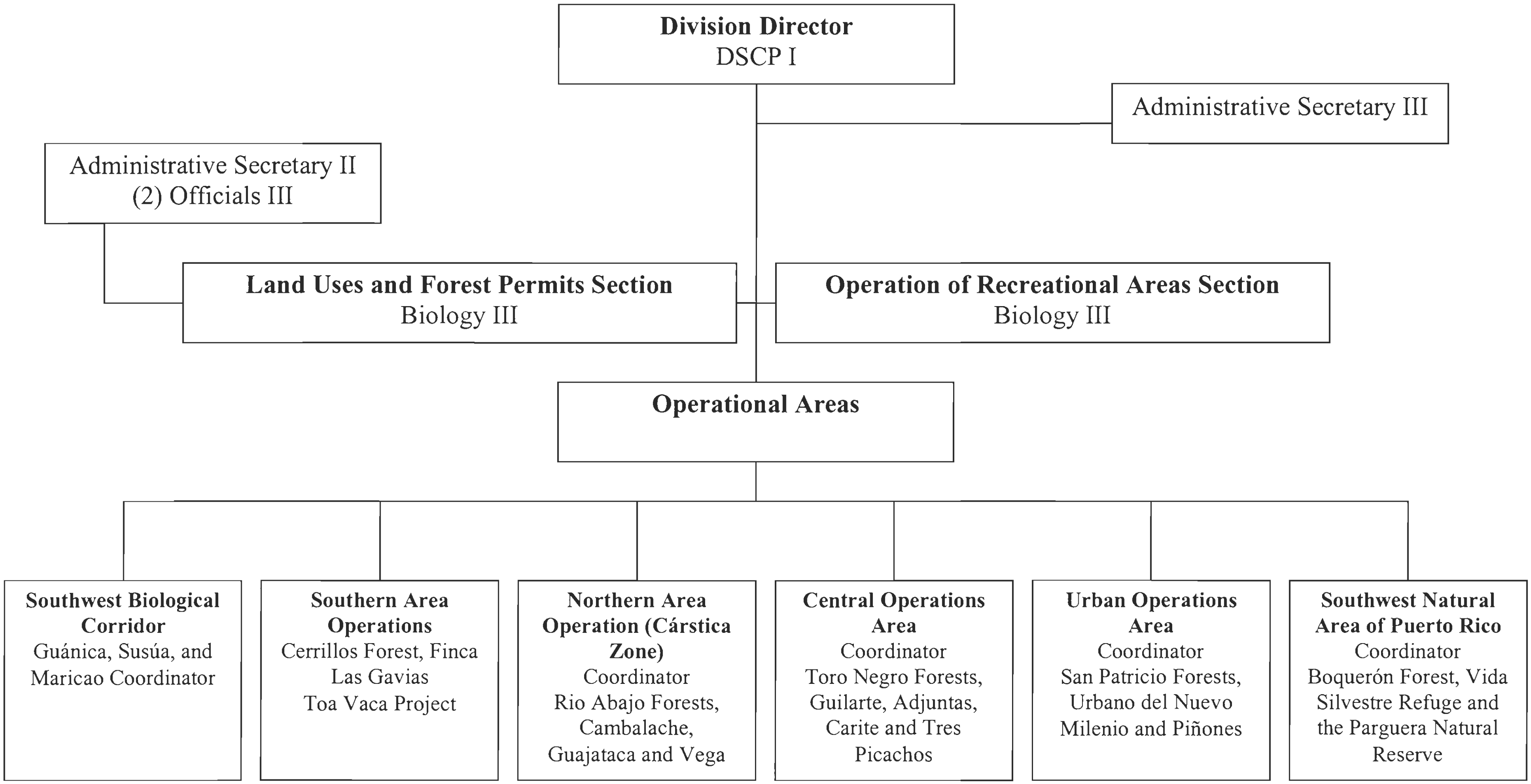


Figure A1 – Forest Management Division

Division of Forest Services

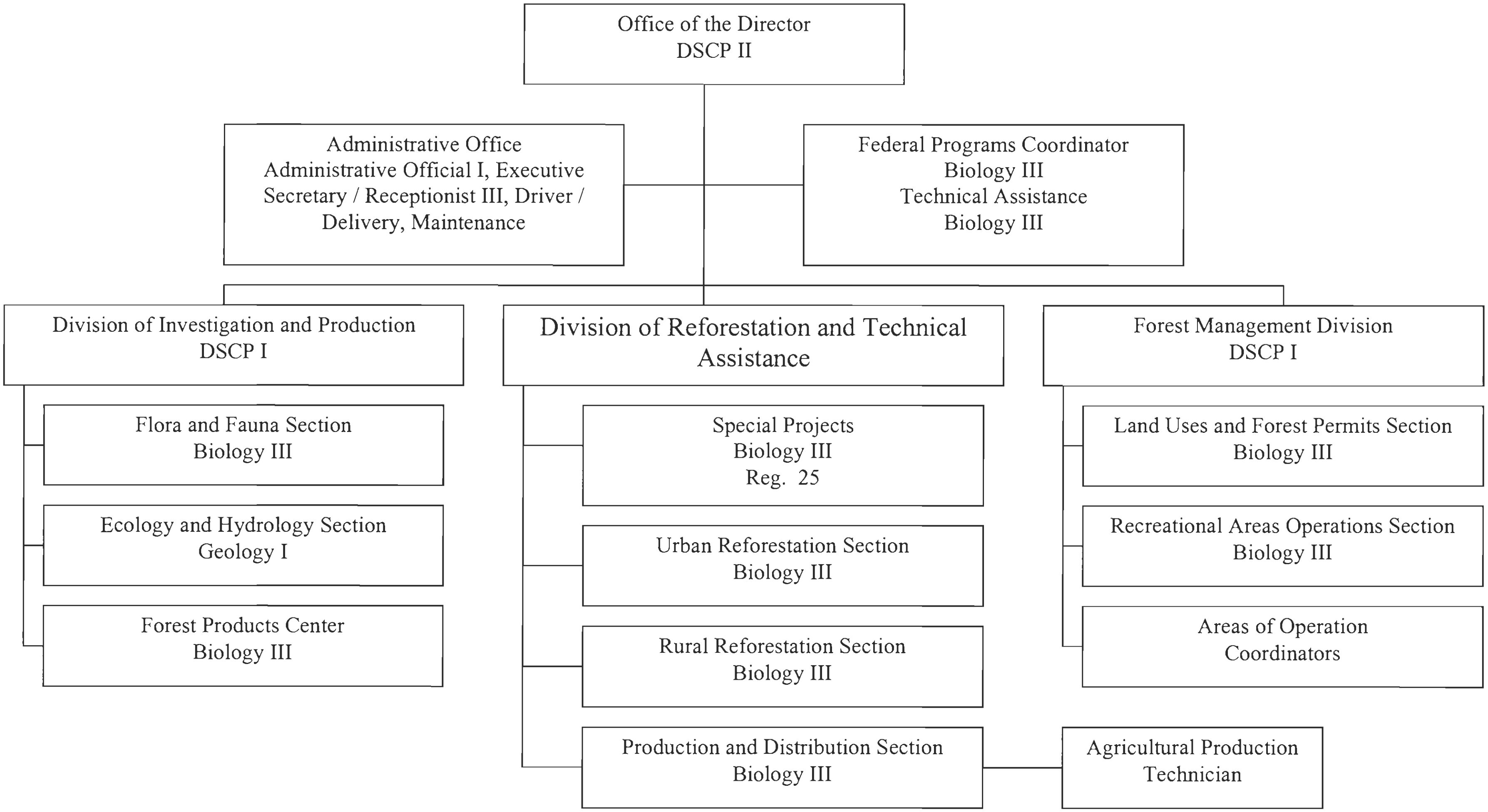


Figure A2 – Division of Forest Services

APPENDIX B – Property Information

Property Information

Information acquired from the CRIM (2001)

Guánica to Susúa

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
360-000-004-02							
360-000-004-03	39,355	10.00	9.72	$200.00	$1,980.00	$2,180.00	224.18
360-000-004-45	1,617,473	411.00	399.68	$6,410.00	$0.00	$6,410.00	16.04
360-000-005-01	616,529	156.66	152.34	$5,010.00	$100.00	$5,110.00	33.54
360-000-005-34							
384-000-004-09	842,188	214.00	208.10	$21,150.00	$0.00	$21,150.00	101.63
407-000-004-04							
407-000-005-05							
408-000-001-01							
408-000-001-02	1,326,250	337.00	327.72	$10,700.00	$620.00	$11,320.00	34.54
408-000-001-02	1,074,380	273.00	265.48	$4,760.00	$1,000.00	$5,760.00	21.7
11 properties	5,516,175	1,401.66	1,363.05	$48,230.00	$3,700.00	$51,930.00	$38.10

Guánica to Susúa

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
360-000-003-19	44,431	11.29	10.98	$360.00	$0.00	$360.00	32.79
360-000-003-21							
360-000-003-22	63,754	16.20	15.75	$540.00	$4,960.00	$5,500.00	349.12
360-000-003-53							
360-000-003-55							

Guánica to Susúa

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
360-000-003-57	84,612	21.50	20.91	$1,010.00	$3,090.00	$4,100.00	196.1
360-000-005-45	55,096	14.00	13.61	$470.00	$140.00	$610.00	44.81
360-000-005-46	107,044	27.20	26.45	$980.00	$640.00	$1,620.00	61.25
360-000-005-46	0	0.00	0.00	$0.00	$2,080.00	$2,080.00	
360-000-005-47							
360-000-009-08							
360-000-009-12	303,030	77.00	74.88	$1,880.00	$0.00	$1,880.00	25.11
360-000-009-16	2,436,049	619.00	601.95	$510.00	$0.00	$510.00	0.85
360-000-009-16	146,045	37.11	36.09	$3,000.00	$0.00	$3,000.00	83.13
360-000-009-16	36,993	9.40	9.14	$1,320.00	$7,550.00	$8,870.00	970.35
360-000-009-16	0	0.00	0.00	$0.00	$2,450.00	$2,450.00	
360-000-009-20							
360-000-009-21							
360-000-009-23							
360-000-009-33	82,645	21.00	20.42	$990.00	$0.00	$990.00	48.48
360-000-009-55							
360-000-009-56							
360-000-009-57							
360-000-009-64							
360-000-009-72							
360-000-009-76	237,623	60.38	58.72	$1,360.00	$0.00	$1,360.00	23.16
360-000-009-83							
360-000-009-90							
360-000-009-91	7,871	2.00	1.94	$20.00	$0.00	$20.00	10.28
360-000-009-93	80,244	20.39	19.83	$160.00	$0.00	$160.00	8.07
360-000-009-95							

Guánica to Susúa

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
360-000-010-13							
360-000-010-15	14,876	3.78	3.68	$380.00	$0.00	$380.00	103.38
360-000-010-19	71,232	18.10	17.60	$1,340.00	$2,200.00	$3,540.00	201.12
360-000-010-42							
360-000-010-58							
360-000-010-75	1,965	0.50	0.49	$230.00	$4,040.00	$4,270.00	8794.12
360-000-010-77	153	0.04	0.04	$40.00	$2,600.00	$2,640.00	69829.63
360-000-010-83							
360-000-010-89	2,555	0.65	0.63	$30.00	$1,730.00	$1,760.00	2787.98
384-000-004-11	5,864	1.49	1.45	$150.00	$0.00	$150.00	103.52
384-000-004-11	0	0.00	0.00	$0.00	$6,270.00	$6,270.00	
384-000-004-25							
384-000-005-01	82,645	21.00	20.42	$1,530.00	$320.00	$1,850.00	90.59
384-000-005-31	17,316	4.40	4.28	$530.00	$0.00	$530.00	123.87
384-000-005-31	0	0.00	0.00	$0.00	$6,300.00	$6,300.00	
384-000-005-31	0	0.00	0.00	$0.00	$3,720.00	$3,720.00	
384-000-005-31	0	0.00	0.00	$0.00	$6,980.00	$6,980.00	
384-000-005-31	0	0.00	0.00	$0.00	$5,480.00	$5,480.00	
384-000-005-31	0	0.00	0.00	$0.00	$5,260.00	$5,260.00	
384-000-005-41	500	0.13	0.12	$210.00	$3,410.00	$3,620.00	29299.88
384-000-005-53	1,614	0.41	0.40	$1,874.00	$4,388.00	$6,262.00	15703.68
384-000-005-54	0	0.00	0.00	$0.00	$8,070.00	$8,070.00	
384-000-005-55							
384-000-005-56	0	0.00	0.00	$0.00	$240.00	$240.00	
384-000-005-56	0	0.00	0.00	$0.00	$2,110.00	$2,110.00	
384-000-005-56	0	0.00	0.00	$0.00	$610.00	$610.00	

Guánica to Susúa

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
384-000-005-56	359,662	91.39	88.87	$36,570.00	$870.00	$37,440.00	421.28
384-000-005-77	0	0.00	0.00	$0.00	$0.00	$0.00	
59 properties	4,243,819	1,078.35	1,048.65	$55,484.00	$85,508.00	$91,422.00	$134.45

Guánica to Susúa

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
360-000-003-39	20,071	5.10	4.96	$130.00	$3,580.00	$3,710.00	748.06
360-000-003-56							
360-000-003-70	1,820	0.46	0.45	$290.00	$4,040.00	$4,330.00	9629.44
360-000-004-31	106,257	27.00	26.26	$470.00	$1,270.00	$1,740.00	66.27
360-000-009-28	0	0.00	0.00	$0.00	$7,452.00	$7,452.00	
360-000-009-34	43,290	11.00	10.70	$650.00	$210.00	$860.00	80.4
360-000-009-42							
360-000-009-43							
360-000-009-80	101,023	25.67	24.96	$710.00	$0.00	$710.00	28.44
360-000-009-81	24,006	6.10	5.93	$670.00	$0.00	$670.00	112.95
360-000-009-82	9,052	2.30	2.24	$110.00	$0.00	$110.00	49.18
360-000-009-84	12,751	3.24	3.15	$740.00	$0.00	$740.00	234.87
360-000-009-85	11,255	2.86	2.78	$720.00	$0.00	$720.00	258.88
360-000-009-86	24,006	6.10	5.93	$870.00	$0.00	$870.00	146.66
360-000-009-87	101,063	25.68	24.97	$730.00	$0.00	$730.00	29.23
360-000-009-88	10,862	2.76	2.68	$570.00	$0.00	$570.00	212.37
360-000-009-89	22,590	5.74	5.58	$860.00	$0.00	$860.00	154.07
360-000-010-12	0	0.00	0.00	$0.00	$3,442.00	$3,442.00	

Guánica to Susúa

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
360-000-010-16							
360-000-010-18	39,355	10.00	9.72	$240.00	$46,280.00	$46,520.00	4783.78
360-000-010-20	69,854	17.75	17.26	$950.00	$190.00	$1,140.00	66.04
360-000-010-32							
360-000-010-43							
360-000-010-45	0	0.00	0.00	$0.00	$1,520.00	$1,520.00	
360-000-010-53							
360-000-010-59	983	0.25	0.24	$150.00	$6,140.00	$6,290.00	25908.68
360-000-010-60							
360-000-010-61							
360-000-010-97	3,555	0.90	0.88	$850.00	$2,000.00	$2,850.00	3243.96
360-000-010-97	1,100	0.28	0.27	$390.00	$6,400.00	$6,790.00	24980.69
384-000-004-10	2,005	0.51	0.50	$300.00	$0.00	$300.00	605.53
384-000-004-10	0	0.00	0.00	$0.00	$7,380.00	$7,380.00	
384-000-004-22							
384-000-005-30							
408-000-001-03							
35 properties	604,898	153.70	149.47	$10,400.00	$89,904.00	$80,510.00	$671.06

Guánica to Susúa

Tax-assessed cost for all properties:	$223,862.00
Total acreage for all properties	2,561.16
Per-acre tax-assessed total cost	$87.41

Susúa to Maricao

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
311-000-004-20							
311-000-004-22							
311-000-004-34							
311-000-004-37							
311-000-005-08	192	0.05	0.05	$1,920.00	$610.00	$2,530.00	53271.43
311-000-009-08	233,373	59.30	57.67	$1,390.00	$60.00	$1,450.00	25.14
311-000-010-01							
311-000-010-02							
311-000-010-03	131,838	33.50	32.58	$450.00	$0.00	$450.00	13.81
311-000-010-07	11	0.00	0.00	$120.00	$0.00	$120.00	44148.49
311-000-010-12	638,095	162.14	157.67	$7,260.00	$0.00	$7,260.00	46.04
311-000-010-34	78,709	20.00	19.45	$330.00	$0.00	$330.00	16.97
311-000-010-55							
311-000-010-56							
312-000-001-01							
312-000-001-19	149,547	38.00	36.95	$810.00	$330.00	$1,140.00	30.85
312-000-001-20	428,375	108.85	105.85	$1,150.00	$80.00	$1,230.00	11.62
312-000-001-22							
312-000-001-24							
312-000-001-30	30,697	7.80	7.59	$190.00	$7,300.00	$7,490.00	987.46
312-000-001-31	5	0.00	0.00	$120.00	$0.00	$120.00	95597.12
312-000-006-18	560,331	142.38	138.46	$3,610.00	$0.00	$3,610.00	26.07
22 properties	2,251,172	572.02	556.26	$17,350.00	$8,380.00	$25,730.00	$46.25

Susúa to Maricao

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
311-000-004-16							
311-000-004-17							
311-000-004-18	1,965	0.50	0.49	$40.00	$8,230.00	$8,270.00	17032.18
311-000-004-19							
311-000-004-21							
311-000-004-50	44,235	11.24	10.93	$220.00	$0.00	$220.00	20.13
311-000-005-09	125,935	32.00	31.12	$110.00	$130.00	$240.00	7.71
311-000-009-05							
311-000-010-08							
311-000-010-09	11,806	3.00	2.92	$60.00	$0.00	$60.00	20.57
311-000-010-10							
312-000-001-27	432,900	110.00	106.97	$540.00	$60.00	$600.00	5.61
312-000-001-40	1,527	0.39	0.38	$260.00	$4,180.00	$4,440.00	11767.61
312-000-006-01	116,883	29.70	28.88	$510.00	$0.00	$510.00	17.66
312-000-006-02							
15 properties	735,251	186.83	181.68	$1,740.00	$12,600.00	$14,340.00	$78.93

Susúa to Maricao

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
311-000-005-02	326,643	83.00	80.71	$620.00	$40.00	$660.00	8.18
311-000-010-33	70,838	18.00	17.50	$260.00	$200.00	$460.00	26.28
311-000-010-62	8,028	2.04	1.98	$110.00	$28,650.00	$28,760.00	14497.42
312-000-001-26							

Susúa to Maricao

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
4 properties	405,510	103.04	100.20	$990.00	$28,890.00	$29,880.00	$298.20

Susúa to Maricao

Tax-assessed cost for all properties:	$69,950.00
Total acreage for all properties	838.15
Per-acre tax-assessed total cost	$83.46

Guilarte to Adjuntas

Watershed Properties

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-003-09	1,992,483	506.29	492.34	$28,820.00	$0.00	$28,820.00	58.54
290-000-004-02	9,839	2.50	2.43	$200.00	$10,230.00	$10,430.00	4290.19
290-000-004-06	77,135	19.60	19.06	$670.00	$0.00	$670.00	35.15
290-000-004-08	27,548	7.00	6.81	$290.00	$12,740.00	$13,030.00	1914.16
290-000-004-09	409,288	104.00	101.13	$2,670.00	$210.00	$2,880.00	28.48
290-000-004-19	44,667	11.35	11.04	$780.00	$990.00	$1,770.00	160.36
290-000-004-20	47,698	12.12	11.79	$960.00	$2,470.00	$3,430.00	291.02
290-000-004-26	2,058	0.52	0.51	$620.00	$1,730.00	$2,350.00	4621.66
290-000-004-27	25,895	6.58	6.40	$300.00	$0.00	$300.00	46.88
290-000-004-28	25,620	6.51	6.33	$240.00	$0.00	$240.00	37.91
290-000-005-43	59,032	15.00	14.59	$620.00	$2,390.00	$3,010.00	206.35
290-000-005-86							
290-000-008-08	510,941	129.83	126.25	$2,240.00	$450.00	$2,690.00	21.31

Guilarte to Adjuntas

Watershed Properties

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-008-36							
290-000-008-37							
290-000-008-39							
290-000-009-45	1,574,183	400.00	388.98	$5,400.00	$0.00	$5,400.00	13.88
17 properties	4,806,387	1,221.30	1,187.66	$43,810.00	$31,210.00	$75,020.00	$63.17

Guilarte to Adjuntas

Watershed Properties

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-003-14	25,344	6.44	6.26	$150.00	$0.00	$150.00	23.95
290-000-003-87							
290-000-004-05	112,161	28.50	27.71	$1,010.00	$120.00	$1,130.00	40.77
290-000-004-17	141,677	36.00	35.01	$1,250.00	$0.00	$1,250.00	35.71
290-000-004-22	27,706	7.04	6.85	$260.00	$0.00	$260.00	37.98
290-000-004-23	25,738	6.54	6.36	$240.00	$0.00	$240.00	37.74
290-000-004-24	12,593	3.20	3.11	$200.00	$0.00	$200.00	64.27
290-000-004-25	12,751	3.24	3.15	$160.00	$0.00	$160.00	50.78
8 properties	357,969	90.96	88.45	$3,270.00	$120.00	$3,390.00	$38.32

Guilarte to Adjuntas

Watershed Properties

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-003-88							
290-000-004-01							

Guilarte to Adjuntas

Watershed Properties

Low Priority Properties

CRIM ID	Meters^2	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
2 properties						$0.00	

Guilarte to Adjuntas

Watershed Properties

Tax-assessed cost for all properties:	$78,410.00
Total acreage for all properties	1,276.11
Per-acre tax-assessed total cost	$61.44

Guilarte to Adjuntas

High Priority Properties

CRIM ID	Meters^2	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
266-000-005-56	187,446	47.63	46.32	$1,750.00	$3,666.00	$5,416.00	116.93
266-000-009-16	0	0.00	0.00	$0.00	$0.00	$0.00	
266-000-009-46	26,092	6.63	6.45	$280.00	$4,010.00	$4,290.00	665.39
266-000-010-07							
266-000-010-08	82,645	21.00	20.42	$690.00	$60.00	$750.00	36.73
266-000-010-09							
266-000-010-14							
266-000-010-15	78,709	20.00	19.45	$870.00	$150.00	$1,020.00	52.44
266-000-010-30							
266-000-010-31	287,288	73.00	70.99	$3,220.00	$0.00	$3,220.00	45.36
266-000-010-34							
266-000-010-42							
266-000-010-43	98,701	25.08	24.39	$1,560.00	$0.00	$1,560.00	63.96

Guilarte to Adjuntas

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
266-000-010-44							
266-000-010-45							
266-000-010-47							
267-000-001-27							
267-000-001-31	11,806	3.00	2.92	$270.00	$0.00	$270.00	92.55
267-000-001-32	110,193	28.00	27.23	$1,730.00	$0.00	$1,730.00	63.54
267-000-001-50	397,481	101.00	98.22	$5,940.00	$1,230.00	$7,170.00	73
267-000-001-50	681	0.17	0.17	$230.00	$0.00	$230.00	1366.45
267-000-001-51							
267-000-001-53							
267-000-006-01							
267-000-006-02	335,183	85.17	82.82	$6,340.00	$7,950.00	$14,290.00	172.54
267-000-006-03	19,677	5.00	4.86	$380.00	$3,030.00	$3,410.00	701.32
267-000-006-03	0	0.00	0.00	$0.00	$240.00	$240.00	
267-000-006-04							
267-000-006-06							
267-000-006-07							
267-000-006-09							
267-000-006-10							
267-000-006-27	116,096	29.50	28.69	$1,160.00	$80.00	$1,240.00	43.22
267-000-006-28							
267-000-006-29							
267-000-006-30							
267-000-006-31							
267-000-006-32							
267-000-006-32							

Guilarte to Adjuntas

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-006-33							
267-000-006-33							
267-000-006-34	154,664	39.30	38.22	$1,090.00	$80.00	$1,170.00	30.61
267-000-006-34							
267-000-006-35	70,484	17.91	17.42	$680.00	$3,649.00	$4,329.00	248.56
267-000-006-35							
267-000-006-38	267,178	67.89	66.02	$4,340.00	$0.00	$4,340.00	65.74
267-000-006-41							
267-000-006-42							
267-000-006-43							
267-000-006-47							
267-000-006-48							
267-000-006-52	45,769	11.63	11.31	$1,010.00	$7,060.00	$8,070.00	713.55
267-000-006-52	0	0.00	0.00	$0.00	$3,650.00	$3,650.00	
290-000-005-03	0	0.00	0.00	$0.00	$3,100.00	$3,100.00	
290-000-005-03	0	0.00	0.00	$0.00	$320.00	$320.00	
290-000-005-03	155,451	39.50	38.41	$2,280.00	$540.00	$2,820.00	73.41
290-000-005-41	259,740	66.00	64.18	$2,430.00	$650.00	$3,080.00	47.99
290-000-005-48	507,359	128.92	125.37	$5,010.00	$0.00	$5,010.00	39.96
290-000-005-63	1.000	0.25	0.25	$730.00	$5,200.00	$5,930.00	23998.38
290-000-005-75	1,232	0.31	0.30	$460.00	$6,780.00	$7,240.00	23776.77
290-000-008-05							
290-000-008-09							
290-000-008-10	19,677	5.00	4.86	$90.00	$60.00	$150.00	30.85
290-000-009-11							
290-000-009-12							

Guilarte to Adjuntas

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-009-44							
315-000-002-04	141,677	36.00	35.01	$530.00	$140.00	$670.00	19.14
315-000-002-05							
315-000-002-06	38,961	9.90	9.63	$150.00	$2,840.00	$2,990.00	310.58
315-000-002-12	94,451	24.00	23.34	$650.00	$7,150.00	$7,800.00	334.21
315-000-002-15							
315-000-002-16							
315-000-002-28							
315-000-003-04	85,793	21.80	21.20	$620.00	$270.00	$890.00	41.98
315-000-003-04	822,511	209.00	203.24	$4,550.00	$180.00	$4,730.00	23.27
315-000-003-10							
315-000-003-11							
315-000-003-12							
315-000-003-16							
315-000-003-20	1,027,194	261.01	253.82	$3,870.00	$740.00	$4,610.00	18.16
315-000-003-21							
315-000-003-22							
315-000-003-23							
315-000-003-24							
315-000-003-26	29,516	7.50	7.29	$230.00	$100.00	$330.00	45.25
315-000-004-05	145,612	37.00	35.98	$360.00	$0.00	$360.00	10.01
315-000-004-27							
315-000-004-38	25,266	6.42	6.24	$224.00	$0.00	$224.00	35.88
88 properties	5,645,534	1,434.53	1,395.01	$53,724.00	$62,925.00	$109,339.00	$83.62

Guilarte to Adjuntas

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
266-000-009-13	59,032	15.00	14.59	$470.00	$0.00	$470.00	32.22
266-000-009-14	299,095	76.00	73.91	$3,420.00	$1,880.00	$5,300.00	71.71
266-000-009-15	3,935	1.00	0.97	$450.00	$2,417.00	$2,867.00	2948.22
266-000-009-17	11,806	3.00	2.92	$170.00	$0.00	$170.00	58.27
266-000-009-18	3,286	0.84	0.81	$820.00	$0.00	$820.00	1009.84
266-000-009-19							
266-000-009-20	5,785	1.47	1.43	$80.00	$220.00	$300.00	209.86
266-000-009-22							
266-000-009-33	0	0.00	0.00	$0.00	$0.00	$0.00	
266-000-009-49	23,613	6.00	5.83	$260.00	$0.00	$260.00	44.56
266-000-009-50	11,806	3.00	2.92	$128.00	$4,361.00	$4,489.00	1538.72
266-000-009-54	27,548	7.00	6.81	$240.00	$0.00	$240.00	35.26
266-000-010-13							
266-000-010-17	15,742	4.00	3.89	$60.00	$350.00	$410.00	105.4
266-000-010-25							
266-000-010-28	55,214	14.03	13.64	$770.00	$0.00	$770.00	56.44
266-000-010-28	0	0.00	0.00	$0.00	$4,300.00	$4,300.00	
266-000-010-28	14	0.00	0.00	$770.00	$0.00	$770.00	222106.01
266-000-010-29	69,382	17.63	17.14	$750.00	$0.00	$750.00	43.75
266-000-010-33	86,580	22.00	21.39	$750.00	$410.00	$1,160.00	54.22
266-000-010-41	70,287	17.86	17.37	$760.00	$0.00	$760.00	43.76
290-000-005-06	0	0.00	0.00	$0.00	$2,922.00	$2,922.00	
290-000-005-07	62,967	16.00	15.56	$650.00	$320.00	$970.00	62.34
290-000-005-09							
290-000-005-10							
290-000-005-11							

Guilarte to Adjuntas

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-005-51	157,497	40.02	38.92	$1,780.00	$0.00	$1,780.00	45.74
290-000-005-55							
290-000-005-65	2,622	0.67	0.65	$700.00	$8,860.00	$9,560.00	14758.26
290-000-005-65	2,476	0.63	0.61	$700.00	$8,860.00	$9,560.00	15624.57
290-000-005-85	550	0.14	0.14	$232.00	$0.00	$232.00	1708.1
290-000-007-25							
290-000-007-27							
290-000-007-65	86,265	21.92	21.32	$870.00	$140.00	$1,010.00	47.38
290-000-007-67							
290-000-007-79							
290-000-008-07							
290-000-008-31							
290-000-008-32							
290-000-008-45							
290-000-008-46	118,064	30.00	29.17	$710.00	$360.00	$1,070.00	36.68
290-000-008-50							
290-000-008-51	61,865	15.72	15.29	$230.00	$0.00	$230.00	15.05
290-000-008-53	22,904	5.82	5.66	$180.00	$0.00	$180.00	31.8
290-000-008-54							
290-000-008-55	7,871	2.00	1.94	$130.00	$0.00	$130.00	66.84
290-000-008-56	8,894	2.26	2.20	$50.00	$4,440.00	$4,490.00	2043.01
290-000-008-57	19,677	5.00	4.86	$100.00	$0.00	$100.00	20.57
290-000-008-57	0	0.00	0.00	$0.00	$4,600.00	$4,600.00	
290-000-008-58	3,896	0.99	0.96	$20.00	$0.00	$20.00	20.77
290-000-008-59	16,608	4.22	4.10	$100.00	$0.00	$100.00	24.37
290-000-008-60	82,999	21.09	20.51	$1,720.00	$0.00	$1,720.00	83.87

Guilarte to Adjuntas

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
290-000-008-61	16,962	4.31	4.19	$280.00	$8,200.00	$8,480.00	2023.25
290-000-009-04							
290-000-009-05							
290-000-009-06							
290-000-009-08							
290-000-009-10							
290-000-009-13							
290-000-009-14	11,806	3.00	2.92	$30.00	$0.00	$30.00	10.28
290-000-009-15							
290-000-009-16							
290-000-009-17							
315-000-002-07							
315-000-002-08							
315-000-002-11							
315-000-002-13							
315-000-002-14							
315-000-003-01							
315-000-003-02							
315-000-003-03							
315-000-003-05							
315-000-003-06	12,987	3.30	3.21	$50.00	$40.00	$90.00	28.05
315-000-003-07	137,741	35.00	34.04	$620.00	$0.00	$620.00	18.22
315-000-003-08							
315-000-003-09							
315-000-003-15							
315-000-004-06							

Guilarte to Adjuntas

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
78 properties	1,577,779	400.91	389.87	$19,050.00	$52,680.00	$59,908.00	$183.98

Guilarte to Adjuntas

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
289-000-003-01	1,058,638	269.00	261.59	$3,920.00	$200.00	$4,120.00	15.75
289-000-003-21	197,363	50.15	48.77	$870.00	$0.00	$870.00	17.84
289-000-004-28							
289-000-004-30	196,773	50.00	48.62	$1,120.00	$0.00	$1,120.00	23.03
289-000-004-31	196,773	50.00	48.62	$1,410.00	$0.00	$1,410.00	29
289-000-005-02	773,318	196.50	191.09	$2,930.00	$120.00	$3,050.00	15.96
289-000-005-03	11,806	3.00	2.92	$80.00	$0.00	$80.00	27.42
289-000-005-04	11,846	3.01	2.93	$140.00	$380.00	$520.00	177.65
289-000-005-05	3	0.00	0.00	$80.00	$380.00	$460.00	620531.5
289-000-005-06							
289-000-005-07							
289-000-005-08							
289-000-005-09							
289-000-005-10	11,806	3.00	2.92	$60.00	$0.00	$60.00	20.57
289-000-005-11	9,052	2.30	2.24	$50.00	$0.00	$50.00	22.36
289-000-005-63	49,193	12.50	12.16	$420.00	$180.00	$600.00	49.36
289-000-005-67	51,161	13.00	12.64	$515.00	$1,849.00	$2,364.00	187
289-000-005-68	23,613	6.00	5.83	$303.00	$2,171.00	$2,474.00	424.01
289-000-008-02	1,483,668	377.00	366.61	$4,490.00	$2,160.00	$6,650.00	18.14
289-000-008-07	196,773	50.00	48.62	$1,400.00	$0.00	$1,400.00	28.79

Guilarte to Adjuntas

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
289-000-008-08	314,837	80.00	77.80	$1,150.00	$0.00	$1,150.00	14.78
289-000-008-09	314,837	80.00	77.80	$1,360.00	$0.00	$1,360.00	17.48
289-000-009-01	27,548	7.00	6.81	$180.00	$0.00	$180.00	26.44
289-000-009-01	295,946	75.20	73.13	$1,090.00	$2,540.00	$3,630.00	49.64
289-000-009-02	184,967	47.00	45.71	$830.00	$0.00	$830.00	18.16
289-000-009-02	377,804	96.00	93.36	$1,590.00	$30.00	$1,620.00	17.35
289-000-009-03	197,560	50.20	48.82	$520.00	$0.00	$520.00	10.65
289-000-009-04	197,166	50.10	48.72	$1,660.00	$0.00	$1,660.00	34.07
290-000-001-30	25,580	6.50	6.32	$470.00	$40.00	$510.00	80.68
290-000-001-31	11,019	2.80	2.72	$51.00	$3,025.00	$3,076.00	1129.69
290-000-001-32							
290-000-001-33	15,742	4.00	3.89	$119.00	$1,645.00	$1,764.00	453.49
290-000-001-34							
290-000-001-44	43,290	11.00	10.70	$240.00	$120.00	$360.00	33.65
290-000-001-60							
290-000-001-64	36,403	9.25	9.00	$230.00	$380.00	$610.00	67.81
290-000-001-65							
290-000-005-02	454,152	115.40	112.22	$4,800.00	$8,800.00	$13,600.00	121.19
290-000-006-08	554,900	141.00	137.12	$3,200.00	$240.00	$3,440.00	25.09
290-000-006-12	0	0.00	0.00	$0.00	$1,450.00	$1,450.00	
290-000-006-12	0	0.00	0.00	$0.00	$410.00	$410.00	
290-000-008-16							
315-000-001-01							
315-000-001-05	11,806	3.00	2.92	$60.00	$0.00	$60.00	20.57
315-000-001-08	105,982	26.93	26.19	$580.00	$0.00	$580.00	22.15
315-000-001-09	108,461	27.56	26.80	$510.00	$0.00	$510.00	19.03

Guilarte to Adjuntas

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
315-000-001-13	14,482	3.68	3.58	$123.00	$0.00	$123.00	34.37
315-000-001-14	11,334	2.88	2.80	$98.00	$0.00	$98.00	34.99
315-000-001-15	4,211	1.07	1.04	$36.00	$0.00	$36.00	34.6
315-000-001-16	6,100	1.55	1.51	$53.00	$0.00	$53.00	35.16
315-000-001-17	10,862	2.76	2.68	$93.00	$0.00	$93.00	34.65
315-000-001-22	3,148	0.80	0.78	$27.00	$0.00	$27.00	34.71
315-000-001-23	0	0.00	0.00	$0.00	$0.00	$0.00	
315-000-002-22	65,329	16.60	16.14	$530.00	$0.00	$530.00	32.83
315-000-002-23							
315-000-002-24							
315-000-002-25	98,386	25.00	24.31	$470.00	$40.00	$510.00	20.98
315-000-002-27	74,774	19.00	18.48	$410.00	$0.00	$410.00	22.19
315-000-003-25							
315-000-011-03							
60 properties	7,838,413	1,991.74	1,936.87	$38,268.00	$26,160.00	$62,568.00	$33.26

Guilarte to Adjuntas

Tax-assessed cost for all properties:	$231,815.00
Total acreage for all properties	3,721.75
Per-acre tax-assessed total cost	$62.29

Adjuntas to Toro Negro

Watershed Properties

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-003-23							
267-000-003-25							
267-000-003-42	7,871	2.00	1.94	$290.00	$1,000.00	$1,290.00	663.27
267-000-003-42	32,153	8.17	7.94	$810.00	$250.00	$1,060.00	133.42
267-000-004-11	373,081	94.80	92.19	$5,210.00	$930.00	$6,140.00	66.6
267-000-004-13	451,397	114.70	111.54	$4,200.00	$600.00	$4,800.00	43.03
267-000-004-15	67,887	17.25	16.77	$1,230.00	$1,300.00	$2,530.00	150.82
267-000-004-21	59,032	15.00	14.59	$430.00	$0.00	$430.00	29.48
267-000-004-22	202,165	51.37	49.95	$2,210.00	$0.00	$2,210.00	44.24
267-000-005-08							
267-000-005-33							
267-000-008-29							
267-000-008-31							
267-000-008-33							
267-000-009-02	936,639	238.00	231.44	$9,230.00	$0.00	$9,230.00	39.88
267-000-009-03	149,547	38.00	36.95	$1,490.00	$390.00	$1,880.00	50.88
267-000-009-04	0	0.00	0.00	$1,340.00	$80.00	$1,420.00	
267-000-009-05	133,806	34.00	33.06	$1,400.00	$1,610.00	$3,010.00	91.04
267-000-009-05	0	0.00	0.00	$0.00	$0.00	$0.00	
267-000-009-09	1,462	0.37	0.36	$440.00	$0.00	$440.00	1217.96
267-000-009-10							
267-000-009-17							
267-000-009-18							
267-000-009-19							
267-000-009-20	59,032	15.00	14.59	$510.00	$590.00	$1,100.00	75.41
267-000-009-21	19,677	5.00	4.86	$200.00	$3,790.00	$3,990.00	820.61

Adjuntas to Toro Negro

Watershed Properties

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-009-25							
267-000-009-30	13,026	3.31	3.22	$710.00	$600.00	$1,310.00	406.98
267-000-009-31	19,677	5.00	4.86	$200.00	$0.00	$200.00	41.13
267-000-009-32	19,677	5.00	4.86	$200.00	$2,990.00	$3,190.00	656.07
267-000-009-34	19,677	5.00	4.86	$200.00	$7,949.00	$8,149.00	1675.97
267-000-009-35	0	0.00	0.00	$0.00	$5,185.00	$5,185.00	
267-000-009-36							
267-000-009-37	19,677	5.00	4.86	$200.00	$0.00	$200.00	41.13
267-000-009-40							
267-000-009-41	3,935	1.00	0.97	$20.00	$0.00	$20.00	20.57
267-000-009-48							
267-000-009-50	728	0.18	0.18	$260.00	$0.00	$260.00	1446.29
267-000-009-51	728	0.18	0.18	$260.00	$0.00	$260.00	1445.5
267-000-009-56	21,606	5.49	5.34	$760.00	$0.00	$760.00	142.36
267-000-009-57	22,314	5.67	5.51	$560.00	$0.00	$560.00	101.56
267-000-010-01	4,927,194	1,252.00	1,217.51	$50,780.00	$20,210.00	$70,990.00	58.31
268-000-006-01	521,842	132.60	128.95	$7,230.00	$1,160.00	$8,390.00	65.07
291-000-005-01	10,075	2.56	2.49	$200.00	$7,690.00	$7,890.00	3169.34
291-000-005-02							
291-000-005-03	11,806	3.00	2.92	$150.00	$1,580.00	$1,730.00	593
291-000-005-04	0	0.00	0.00	$230.00	$1,560.00	$1,790.00	
291-000-005-05							
291-000-005-24	59,032	15.00	14.59	$1,050.00	$10,299.00	$13,153.00	901.71
291-000-005-25	6,454	1.64	1.59	$110.00	$8,590.00	$8,700.00	5455.16
291-000-005-52	19,677	5.00	4.86	$160.00	$0.00	$160.00	32.91
291-000-005-53	418	0.11	0.10	$200.00	$3,310.00	$3,510.00	34016.08

Adjuntas to Toro Negro

Watershed Properties

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
52 properties	8,191,293	2,081.41	2,024.07	$92,470.00	$81,663.00	$167,542.00	$86.92

Adjuntas to Toro Negro

Watershed Properties

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-003-26	1,544,786	392.53	381.72	$25,550.00	$0.00	$25,550.00	66.93
267-000-003-26	13,892	3.53	3.43	$200.00	$0.00	$200.00	58.26
267-000-003-50	7,871	2.00	1.94	$140.00	$5,020.00	$5,160.00	2653.09
267-000-004-10							
267-000-004-12	177,292	45.05	43.81	$1,340.00	$4,620.00	$5,960.00	136.05
267-000-004-25							
267-000-004-26	59,032	15.00	14.59	$440.00	$0.00	$440.00	30.16
267-000-009-23	3,935	1.00	0.97	$50.00	$3,820.00	$3,870.00	3979.63
267-000-009-24	1	0.00	0.00	$30.00	$3,380.00	$3,410.00	13800080.94
267-000-009-26							
267-000-009-27	1,965	0.50	0.49	$20.00	$5,540.00	$5,560.00	11450.9
267-000-009-29							
291-000-005-21							
291-000-005-47							
14 properties	1,808,774	459.61	446.95	$27,770.00	$22,380.00	$50,150.00	$112.21

Adjuntas to Toro Negro

Watershed Properties

Tax-assessed cost for all properties:	$217,692.00
Total acreage for all properties	2,471.02
Per-acre tax-assessed total cost	$88.10

Adjuntas to Toro Negro

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-002-13	228,257	58.00	56.40	$2,400.00	$420.00	$2,820.00	50
267-000-002-13	90,516	23.00	22.37	$530.00	$140.00	$670.00	29.96
267-000-002-14							
267-000-002-15							
267-000-002-16	11,806	3.00	2.92	$60.00	$580.00	$640.00	219.38
267-000-002-19	181,031	46.00	44.73	$1,580.00	$130.00	$1,710.00	38.23
267-000-002-22	273,908	69.60	67.68	$2,570.00	$3,340.00	$5,910.00	87.32
267-000-003-04							
267-000-003-05	11,806	3.00	2.92	$60.00	$580.00	$640.00	219.38
267-000-003-05	12,987	3.30	3.21	$64.00	$2,387.00	$2,451.00	763.77
267-000-003-06							
267-000-003-07							
267-000-003-08							
267-000-003-09							
267-000-003-10							
267-000-003-11							
267-000-003-13							
267-000-003-14							
267-000-003-15	12,987	3.30	3.21	$240.00	$580.00	$820.00	255.52

Adjuntas to Toro Negro

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-003-16							
267-000-003-17	11,806	3.00	2.92	$181.00	$7,404.00	$7,585.00	2599.96
267-000-003-18	11,806	3.00	2.92	$80.00	$580.00	$660.00	226.23
267-000-003-20							
267-000-003-21	12,987	3.30	3.21	$200.00	$600.00	$800.00	249.29
267-000-003-22							
267-000-003-24							
267-000-006-07	55,096	14.00	13.61	$680.00	$180.00	$860.00	63.17
267-000-006-09	212,515	54.00	52.51	$3,950.00	$110.00	$4,060.00	77.32
267-000-006-42	0	0.00	0.00	$210.00	$0.00	$210.00	
267-000-007-01	236,128	60.00	58.35	$2,090.00	$0.00	$2,090.00	35.82
267-000-007-02							
267-000-007-03							
267-000-007-04							
267-000-007-05							
267-000-007-06	11,019	2.80	2.72	$80.00	$590.00	$670.00	246.06
267-000-007-07	12,200	3.10	3.01	$90.00	$590.00	$680.00	225.57
267-000-007-08							
267-000-007-09	12,987	3.30	3.21	$90.00	$590.00	$680.00	211.9
267-000-007-10	12,593	3.20	3.11	$170.00	$590.00	$760.00	244.23
267-000-007-11	12,987	3.30	3.21	$90.00	$550.00	$640.00	199.43
267-000-007-12							
267-000-007-17	34,199	8.69	8.45	$2,010.00	$0.00	$2,010.00	237.85
267-000-007-18							
267-000-007-19	12,987	3.30	3.21	$90.00	$640.00	$730.00	227.48
267-000-007-20	12,987	3.30	3.21	$80.00	$670.00	$750.00	233.71

Adjuntas to Toro Negro

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-007-21	11,806	3.00	2.92	$80.00	$670.00	$750.00	257.08
267-000-007-22							
267-000-007-23							
267-000-007-24	11,806	3.00	2.92	$90.00	$670.00	$760.00	260.51
267-000-007-25	47,226	12.00	11.67	$320.00	$0.00	$320.00	27.42
267-000-007-26							
267-000-007-27							
267-000-007-28							
267-000-007-31							
267-000-007-32	11,806	3.00	2.92	$80.00	$0.00	$80.00	27.42
267-000-007-33	11,806	3.00	2.92	$110.00	$0.00	$110.00	37.71
267-000-007-34	11,806	3.00	2.92	$110.00	$0.00	$110.00	37.71
267-000-007-35	37,229	9.46	9.20	$2,130.00	$0.00	$2,130.00	231.54
267-000-007-36	77,135	19.60	19.06	$1,770.00	$3,200.00	$4,970.00	260.75
267-000-007-38	25,974	6.60	6.42	$210.00	$0.00	$210.00	32.72
267-000-007-49	34,829	8.85	8.61	$2,040.00	$0.00	$2,040.00	237.04
267-000-008-11							
267-000-008-17							
267-000-008-30	3,935	1.00	0.97	$300.00	$8,415.00	$8,715.00	8961.88
267-000-008-32							
267-000-008-36	12,987	3.30	3.21	$90.00	$580.00	$670.00	208.78
267-000-008-41	19,677	5.00	4.86	$110.00	$8,960.00	$9,070.00	1865.39
267-000-008-42	78,709	20.00	19.45	$570.00	$50.00	$620.00	31.88
267-000-008-43	78,709	20.00	19.45	$640.00	$0.00	$640.00	32.91
267-000-008-48							
267-000-008-49	3,935	1.00	0.97	$30.00	$5,450.00	$5,480.00	5635.24

Adjuntas to Toro Negro

High Priority Properties

CRIM ID	Meters ^{2}	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-008-50							
267-000-008-51	48,288	12.27	11.93	$550.00	$0.00	$550.00	46.09
267-000-008-54	78,040	19.83	19.28	$420.00	$0.00	$420.00	21.78
267-000-008-55	11,806	3.00	2.92	$70.00	$0.00	$70.00	23.99
267-000-008-55	1,451	0.37	0.36	$410.00	$8,570.00	$8,980.00	25041.21
267-000-008-56	19,677	5.00	4.86	$220.00	$4,480.00	$4,700.00	966.63
267-000-008-57	220,386	56.00	54.46	$3,470.00	$0.00	$3,470.00	63.72
267-000-008-58	284,612	72.32	70.33	$3,590.00	$12,690.00	$16,280.00	231.49
268-000-001-18							
268-000-001-22							
268-000-001-23							
268-000-001-24							
268-000-002-16							
268-000-006-03							
268-000-006-07	34,357	8.73	8.49	$290.00	$35,080.00	$35,370.00	4166.32
268-000-006-08	30,618	7.78	7.57	$210.00	$0.00	$210.00	27.76
268-000-006-09	31,484	8.00	7.78	$180.00	$250.00	$430.00	55.27
268-000-006-14	21,645	5.50	5.35	$210.00	$4,190.00	$4,400.00	822.66
268-000-006-16							
268-000-006-17	29,516	7.50	7.29	$350.00	$1,670.00	$2,020.00	276.96
268-000-006-20							
268-000-006-21	4,329	1.10	1.07	$50.00	$0.00	$50.00	46.74
268-000-006-36	7,832	1.99	1.94	$70.00	$350.00	$420.00	217.03
268-000-007-01	6	0.00	0.00	$260.00	$0.00	$260.00	175367.6
268-000-007-02							
268-000-007-03							

Adjuntas to Toro Negro

High Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
268-000-007-05	21,645	5.50	5.35	$330.00	$90.00	$420.00	78.53
268-000-007-08	169,225	43.00	41.82	$560.00	$80.00	$640.00	15.31
268-000-007-23							
268-000-007-35	171,350	43.54	42.34	$1,110.00	$280.00	$1,390.00	32.83
268-000-007-36							
268-000-007-39							
268-000-007-40	6,179	1.57	1.53	$2,830.00	$2,000.00	$4,830.00	3163.58
268-000-007-45							
268-000-007-47							
292-000-001-02	55,490	14.10	13.71	$450.00	$520.00	$970.00	70.74
292-000-001-05	35,419	9.00	8.75	$230.00	$0.00	$230.00	26.28
292-000-001-06	37,426	9.51	9.25	$230.00	$120.00	$350.00	37.85
292-000-001-08							
292-000-001-47							
292-000-001-68	50,256	12.77	12.42	$410.00	$700.00	$1,110.00	89.38
112 properties	3,336,011	847.68	824.33	$42,775.00	$120,316.00	$162,881.00	$197.85

Adjuntas to Toro Negro

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-002-12	82,645	21.00	20.42	$530.00	$240.00	$770.00	37.71
267-000-002-17	177,096	45.00	43.76	$1,070.00	$0.00	$1,070.00	24.45
267-000-002-21	61,000	15.50	15.07	$510.00	$0.00	$510.00	33.84
267-000-003-03							
267-000-007-30							

Adjuntas to Toro Negro

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-007-37	95,238	24.20	23.53	$2,560.00	$0.00	$2,560.00	108.78
267-000-008-45	78,709	20.00	19.45	$2,040.00	$920.00	$2,960.00	152.19
268-000-001-19							
268-000-006-04	27,548	7.00	6.81	$320.00	$3,140.00	$3,460.00	508.29
268-000-006-05	32,349	8.22	7.99	$310.00	$0.00	$310.00	38.78
268-000-006-06	38,174	9.70	9.43	$440.00	$50.00	$490.00	51.95
268-000-006-10	39,355	10.00	9.72	$330.00	$180.00	$510.00	52.44
268-000-006-15	33,688	8.56	8.32	$290.00	$0.00	$290.00	34.84
268-000-006-18	4,723	1.20	1.17	$80.00	$0.00	$80.00	68.56
268-000-006-18	24,793	6.30	6.13	$270.00	$60.00	$330.00	53.86
268-000-006-19	3,935	1.00	0.97	$60.00	$0.00	$60.00	61.7
268-000-006-22							
268-000-006-25	460	0.12	0.11	$410.00	$0.00	$410.00	3607.06
268-000-006-26	2,051	0.52	0.51	$1,230.00	$9,720.00	$10,950.00	21603.01
268-000-006-27	1,400	0.36	0.35	$950.00	$0.00	$950.00	2746.14
268-000-006-28	1,400	0.36	0.35	$950.00	$6,990.00	$7,940.00	22951.96
268-000-006-29	1,410	0.36	0.35	$940.00	$8,320.00	$9,260.00	26577.81
268-000-006-30	1,440	0.37	0.36	$960.00	$0.00	$960.00	2697.96
268-000-006-31	1,951	0.50	0.48	$1,190.00	$0.00	$1,190.00	2468.09
268-000-006-32	2,798	0.71	0.69	$1,510.00	$0.00	$1,510.00	2184.23
268-000-006-33	1,905	0.48	0.47	$1,180.00	$5,370.00	$6,550.00	13914.69
268-000-006-34	54	0.01	0.01	$1,800.00	$5,300.00	$7,100.00	532788.92
268-000-006-35	1,500	0.38	0.37	$990.00	$3,620.00	$4,610.00	12437.61
268-000-006-58	2,133	0.54	0.53	$1,260.00	$0.00	$1,260.00	2390.19
268-000-007-26	86,580	22.00	21.39	$350.00	$0.00	$350.00	16.36
292-000-001-10							

Adjuntas to Toro Negro

Medium Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
292-000-001-65	39,355	10.00	9.72	$320.00	$0.00	$320.00	32.91
32 properties	843,690	214.38	208.48	$22,850.00	$43,910.00	$66,760.00	$320.23

Adjuntas to Toro Negro

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-004-07	21,251	5.40	5.25	$200.00	$0.00	$200.00	38.09
267-000-004-07	214,246	54.44	52.94	$5,010.00	$0.00	$5,010.00	94.63
267-000-004-14	317,631	80.71	78.49	$2,970.00	$4,000.00	$6,970.00	88.81
267-000-004-23	19,677	5.00	4.86	$150.00	$0.00	$150.00	30.85
267-000-006-07	55,096	14.00	13.61	$680.00	$180.00	$860.00	63.17
267-000-006-09	212,515	54.00	52.51	$3,950.00	$110.00	$4,060.00	77.32
267-000-006-12	166,470	42.30	41.13	$3,050.00	$4,259.00	$7,309.00	177.68
267-000-006-42	0	0.00	0.00	$210.00	$0.00	$210.00	
267-000-006-49	3,935	1.00	0.97	$760.00	$0.00	$760.00	781.53
267-000-007-29							
267-000-007-44	395,238	100.43	97.66	$11,460.00	$0.00	$11,460.00	117.34
267-000-007-48	239,551	60.87	59.19	$1,580.00	$0.00	$1,580.00	26.69
267-000-007-54	26,210	6.66	6.48	$1,670.00	$0.00	$1,670.00	257.85
267-000-007-59	22,590	5.74	5.58	$430.00	$2,100.00	$2,530.00	453.25
267-000-007-60							
267-000-007-61							
267-000-008-01	11,806	3.00	2.92	$90.00	$580.00	$670.00	229.66
267-000-008-03							
267-000-008-04	11,806	3.00	2.92	$90.00	$100.00	$190.00	65.13

Adjuntas to Toro Negro

Low Priority Properties

CRIM ID	Meters²	Cuerdas	Acres	Land Cost	Structural Cost	Tax-Assessed Cost	Per Acre Cost
267-000-008-05							
267-000-008-10							
267-000-008-13	12,987	3.30	3.21	$90.00	$580.00	$670.00	208.78
267-000-008-15							
267-000-008-18	12,987	3.30	3.21	$110.00	$740.00	$850.00	264.87
267-000-008-38	11,413	2.90	2.82	$360.00	$5,670.00	$6,030.00	2138.21
267-000-008-38	0	0.00	0.00	$0.00	$7,550.00	$7,550.00	
267-000-008-47	27,548	7.00	6.81	$750.00	$0.00	$750.00	110.18
267-000-008-53	19,717	5.01	4.87	$190.00	$3,272.00	$3,462.00	710.59
268-000-001-20							
291-000-005-50	6,021	1.53	1.49	$450.00	$7,899.00	$8,349.00	5611.45
292-000-001-04							
292-000-001-48	1,548	0.39	0.38	$570.00	$5,750.00	$6,320.00	16526.68
292-000-001-51	1,301	0.33	0.32	$450.00	$0.00	$450.00	1400.31
292-000-001-59	2,484	0.63	0.61	$700.00	$3,930.00	$4,630.00	7543.7
292-000-001-69							
35 properties	1,814,029	460.94	448.25	$35,970.00	$46,720.00	$74,930.00	$184.47

Adjuntas to Toro Negro

Tax-assessed cost for all properties:	$304,571.00
Total acreage for all properties	1,481.05
Per-acre tax-assessed total cost	$205.65

After late changes to the final corridor designs, some new property numbers were excluded from the list of property numbers sent to the CRIM for tax information. The numbers of these properties are listed below.

Table B.1 New properties between Guilarte and Adjuntas

266-000-009-22	267-000-006-32	290-000-007-67
266-000-010-14	267-000-006-32	290-000-007-79
266-000-010-25	267-000-006-33	290-000-008-31
266-000-010-34	267-000-006-33	290-000-008-32
266-000-010-45	267-000-006-34	290-000-008-45
266-000-010-47	267-000-006-35	290-000-008-50
267-000-001-27	267-000-006-41	290-000-009-04
267-000-001-51	267-000-006-42	290-000-009-10
267-000-006-06	267-000-006-43	315-000-003-01
267-000-006-07	290-000-003-87	315-000-003-02
267-000-006-09	290-000-005-09	315-000-003-03
267-000-006-10	290-000-005-11	315-000-003-15
267-000-006-28	290-000-005-55	315-000-003-16
267-000-006-29	290-000-007-25	315-000-004-06
267-000-006-30	290-000-007-27	315-000-004-27
267-000-006-31		

Table B.2 New properties between Adjuntas and Toro Negro

267-000-006-42	268-000-007-23	291-000-005-21
267-000-007-02	268-000-007-39	291-000-005-47
267-000-007-04	268-000-007-45	292-000-001-10
267-000-007-18	268-000-007-47	292-000-001-47
268-000-001-24		

APPENDIX C – Interview Transcripts

Forest Managers – Interview Questions
3/13/2001

Below are the questions asked to each forest manager in individual interviews held on March 13, 2001 at the Department of Natural and Environmental Resources, Forest Management Division Office.

Introduction (briefly explain what we are doing here and the corridors)
What is your name? What forest do you manage?

Flora and fauna
Target species. What are the target species that will be saved by the corridors?
What species might be hurt by the corridor?

Land ownership
Who owns the land through which the corridors might be delineated?
Are the landowners unwilling to sell their land?
Are there any other perceivable problems that might occur when purchasing the land?

Do you have contact information about the landowners for us so that we might interview them?
What conservation work has been done between the forests already?
What other conservation workers might be involved with the corridor design? For example, biologists, landscape planners, or community groups.

Economic
Can recreation and nature tourism be implemented within the corridors without affecting the primary purpose of the corridor?
What are some minor forest products of economic value within the corridor regions?
Can you comment on any natural economic benefits of the land?

Conclusion
Do you have any major concerns about the corridors? For example will it affect ecotourism in the area? What are your expectations of us and of the project?
Do you have any final questions or comments for us?

Notes from Forest Managers Interviews
3/13/2001

Group Discussion

We met with representatives for the six forests. We learned of some key species upon which we could focus for our corridor design. One such specie was the Nightjar or, in Spanish, Guabairo. It is a good indicator specie for Guanica, Susúa, and Maricao because it is located in all three forests, though it is located more in Guanica and Susúa. The U.S. Fish and Wildlife Service should have information on the Nightjar and other possible key species mentioned during the meeting. It was agreed that the Nightjar would be the best key specie. We were also told about the Michigan group that has a lot of information on the minimum requirements to maintain biodiversity. They also know a lot about the type of forests we studied. The contact at the Michigan Group is Peter Murphy (murphyp@pilot.msu.edu, 517-355-4686).

Wetsy Cordero – Forest Manager for Susúa State Forest

1. Flora, fauna, and target species:

Susua is a transitional, dry and moist forest altogether. There is not much timber available. Some possible target species to save include the Guabairo, the ayar, and an amphibian called *amieva wetmorei*. A species of plant which is important to the region economically is the *thrinax morrisii*, or palma de petate.

The corridor will not endanger any animal species because there are no big mammals between the forests to prey upon them.

2. Land ownership:

Two municipalities that comprise Susua are Sabana Grande and Yauco. Cordero can provide us the names and phone numbers of private landowners when we arrive at the site.

Some problems might arise when buying land. Landowners may resist because they use land for grazing. Landowners will ask for too much money. There will most likely be more resistance from landowners going north from Susúa to Maricao

Urutia is a good buy for the DNER because of the lake there. The Urutia forest owners are possibly willing to sell. Recreational fishing can occur there if the owners are interested.

No other conservation work has been done in the area.

3. Economic incentives within the corridor:

Only scientific investigations are preferred in the corridor. The craft of palma de petate (www.maripilli.com) is an important economic benefit to Susúa.

4. Concerns about the corridor:

There are no concerns about corridors, but there are concerns about resistance from landowners. Incentive programs and partnerships exist between the government and private landowners to help with land acquisition.

5. Final comments:

Some valuable resources in the area include the University of Puerto Rico, Mayaguez campus, and the Interamericana University, San German and San Juan campus.

Ruben Padrón – Forest Manager for Guilarte State Forest
Padrón has 18 years of experience as forest manager of Maricao. He has 3 years of experience as forest manager of Guilarte.

1. Flora, fauna, and target species:

The Guabairo can be found in Maricao, along with the endemic guaraguao, the falcon de sierra, the chorosa, and the calandría. He does not expect any species will be hurt by the corridor. There are no big mammals in the area, only humans. The forest is fragmented into seven pieces.

2. Land ownership:

He can get the names of all landowners when we visit. There will be problems buying land for this corridor. There are new people who want a lot of money for their land.

3. Economic incentives within the corridor:

Before Padrón was in charge of the forest, there was agriculture and timber logging permitted, but not anymore. He only wants the corridor to be used for conservation, not for recreation.

4. Concerns about the corridor:

Generally, he thinks the corridor is a good idea.

5. Final comments:

An existing conservation effort in the area is the conservation of watersheds. The watersheds give healthy water to many towns. The government benefits from them. There are aqueducts and lakes for the watersheds. There was not a lot of interest in conservation until recently. He has set up the connections with the community groups and universities regarding conservation. Some contact regarding conservation developments include Professor Gabil at Interamericana University, San German campus and Juan Ricart at Catolica University at Ponce.

The new coffee agriculture is destroying the land. The forest is very fragmented. He recommended a specific tract of land that the DNER buy because the bank owns it now. Nobody else wants the land. It has ecological value.

Miguel Canals – Forest Manager for Guánica State Forest

1. Flora, fauna, and target species:

2. Land ownership:

There is a lot of government owned land. This could lead to potential problems with land acquisition, for example can the DRNA expropriate from other government agencies. Land Administration is one government agency that owns land in Guánica, they do not want to sell to the DRNA because they would rather sell to developers to make more money. This land is very important to obtain.

Franco is a key developer in the Guanica area who wants to sell land for commercial uses such as hotel/resort development.

In Guanica there is a lot of land that is managed by the DNER but is not owned by the DNER, it is extremely desirable to acquire this land.

3. Economic incentives within the corridor:

There is a lot of recreation in Guanica, almost 300,000 visitors per year. Tourists come to visit the beaches, visit mangrove forests, see birds, see the coral reefs, and go scuba diving. These activities all take place on the coast, therefore, the inner sections of the forest are not disturbed and a corridor should not be affected by recreational activities.

4. Concerns about the corridor:

Miguel's major concern is with facilitating the spread of forest fires through the corridor. Maricao has a lot of forest fires that could possibly spread to Guanica. He is also concerned with the strength of the law. He thinks we should look into that further if we are actually going to have the backing to take all the land.

Adrian Muniz – Forest Manager for Maricao State Forest
Muniz has spent 2.5 years as a forest management official for Maricao. Most of his work concerned forest recovery after Hurricane George.

1. Flora, fauna, and target species:

The Puerto Rican Elephant Woods Warbler might extend to the Susua into the dry forest. The Puerto Rican Emerald Hummingbird is abundant in all three forests. It could be a possible indicator species. The Thouinia tree might be found in Maricao, Susúa, and Guánica.

Watershed protection is very important in Maricao.

2. Land ownership:

3. Economic incentives within the corridor:

4. Concerns about the corridor:

5. Final comments:

See Padrón and Canals about Maricao because of their extensive experience.

Gerardo Hernández – Forest Manager for Toro Negro and Central Operations Area Coordinator for Toro Negro, Adjuntas, and Tres Picachos forests.

1. Flora, fauna, and target species:

There are similar species among all three forests. Red-tailed hawks and tabonuco trees are common species among Toro Negro, Guilarte, Tres Picachos, and Adjuntas forests. There are three main reasons for conserving Toro Negro: endangered species, watersheds, and recreational areas.

2. Land ownership:

There is no fragmentation within Adjuntas and the Tres Picachos forests, but Guilarte and Toro Negro are fragmented into many pieces. Agriculture and wastelands exist within the forest fragments.

The community has interests in conservation and protecting Toro Negro. Gerardo believes private landowners will be receptive to the corridor effort. Many people in the area want to protect the region. The DRNA should know exactly how much land will be necessary to acquire and specifically what the advantages of the acquired lands are. Landowners would most likely opt for conservation easements because they might not want to volunteer all their land.

Gerardo sees importance in relating to the community the purpose of the corridors. Explain the new law.

3. Economic incentives within the corridor:

There are many scenic views. The highest point of Puerto Rico lies in the Toro Negro forest. An indigenous food restaurant serves 10,000 people per month in the summer.

4. Concerns about the corridor:

The distance between the forests is large, even though the forests are very similar in climate and other attributes.

One problem at Toro Negro is the new sun coffee agriculture between the forest fragments that is destroying vegetation and landscape. Poorly managed ecotourism is also an issue in Toro Negro.

5. Final comments:

The Taller de Arte y Cultura del Pueblo de Adjuntas is a community group that manages the Adjuntas forest.

Notes from General Information Sessions with Resident Biologists

Haydeeliz Meléndez – Biologist at Toro Negro specializing in Environmental Science

Meléndez concurred with our previous research and discussions with forest managers that the Guaraguao de Bosque and Falcón de Sierra would be two good target species for the corridor between Toro Negro and Adjuntas forests. She explained that the Guaraguao de Bosque is slightly larger and stronger than the Falcón de Sierra. We explained that literature from the US Fish and Wildlife Service (Rivera, 1994) cited no resident populations of the Guaraguao de Bosque in Toro Negro. However, Haydeeliz has confirmed its existence visually in the Toro Negro forest. If we need more information about the Falcón de Sierra, we can contact José Román Soto, a forest manager at Guajataca (872-1045).

We discussed the feasibility of using reptiles as target species, specifically the lagarto grande (*anolis cuvieri*) and Puerto Rican boa (*Culebra corredora*). Meléndez explained that the reptiles, being smaller than birds, would not move as far through the corridor. Also, birds are important in seed dispersal.

José Silva – Biologist at Guánica State Forest

Silva pointed out on a map of Guánica and Susúa that a good path for our corridor to follow would be along the Río Loco. He also showed us a land usage map indicating urban, rural, agricultural, and industrial areas. When visiting Guánica, Silva showed us first-hand the Río Loco and regions through which our corridor might pass.

APPENDIX D – Appraised Lands

Table D.1 Appraised Lands

Property Tax Number	Relevant Corridor	Size (acres)	Total Appraisal	Appraisal (per acre)	Date Appraised	Tax-assessed Value	CRIM % Error	
408-000-008-12-998	Guanica to Susua	139.2976	$ 348,200.00	$ 2,499.68	11/99	$ 2,740.00	0.99213	
407-000-009-14-000	Guanica to Susua	83.3736	$ 308,500.00	$ 3,700.21	11/99	$ 2,170.00	0.99297	x
408-000-007-02-001	Guanica to Susua	63.8440	$ 127,700.00	$ 2,000.19	11/99	$ 590.00	0.99538	
269-000-008-02-001	Toro Negro to Adjuntas	87.00	$ 69,600.00	$ 800.00	2/99	$ 1,620.00	0.97672	
292-000-004-01-901	Toro Negro to Adjuntas	262.00	$ 105,000.00	$ 400.76	1/99	$ 4,450.00	0.95762	
262-000-009-04-901	Maricao to Susua	300	$ 255,000.00	$ 850.00	4/99	$ 11,940.00	0.95318	
290-000-006-08	Guilarte to Adjuntas	136.7023	$ 191,400.00	$ 1,400.12	8/00	$ 3,440.00	0.98203	
						Average Market Error:	**0.9785748**	
							+/- 2.54%	

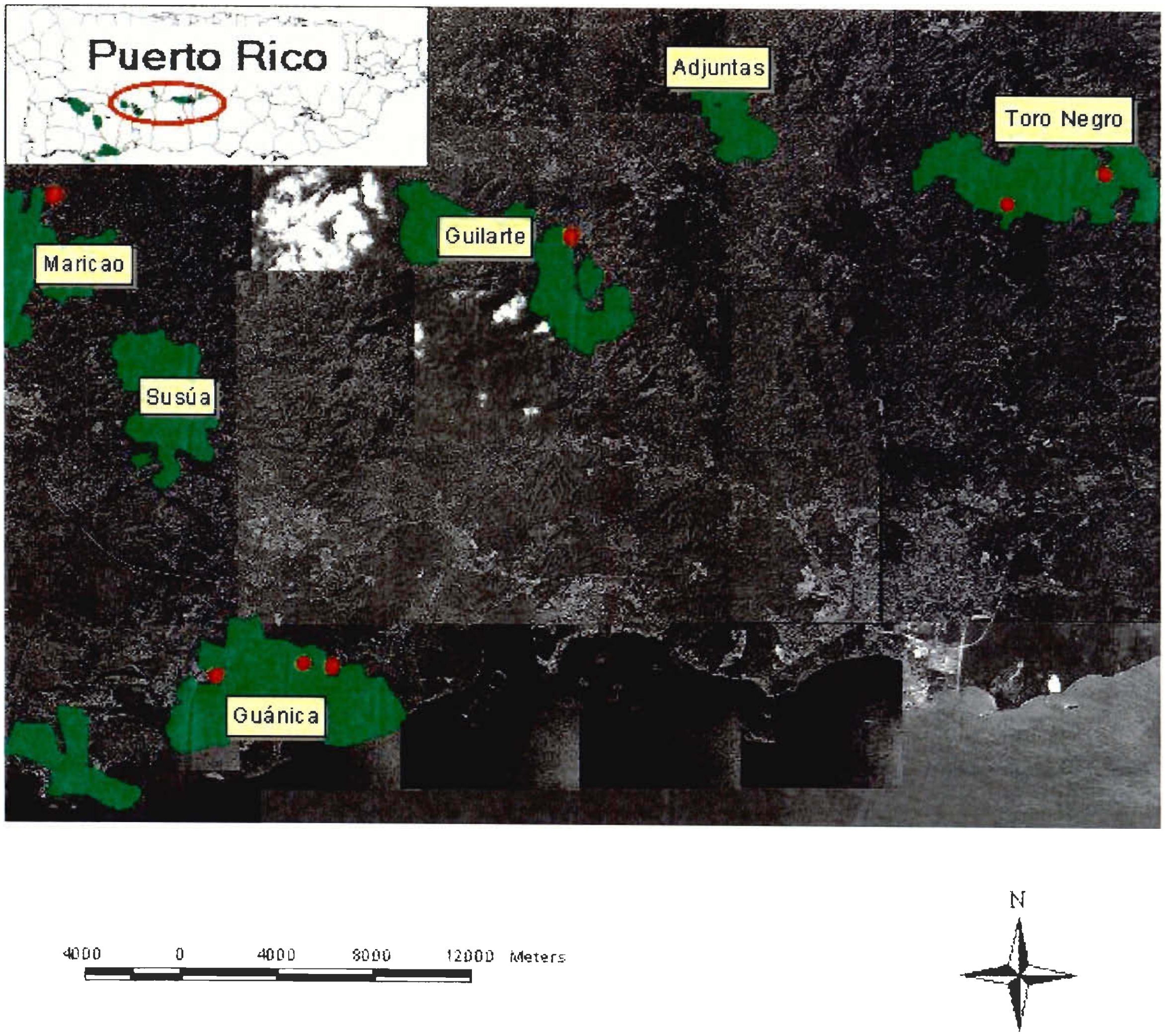


Figure D1 Locations of appraised properties (in red)

APPENDIX E – Landowner Contact Info

Landowner Contact Information

Information acquired from the CRIM (2001)

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
ADMINISTRACION DE TERRENOS	BO LA PICA			JAYUYA	267-000-003-26
ALBINO RIVERA ALFONSA		CARR0139	BO ANON	PONCE	268-000-006-36
ALICEA LARACUENTE VICENTE	BO VEGAS ARRIBA			ADJUNTAS	267-000-006-49
APONTE CARATINI JAIME	BO SALTILLO			ADJUNTAS	290-000-008-10
APONTE CARATINI JAIME	BO RUCIO		PENUELAS	PE\UELAS	315-000-003-04
APONTE CARATINI JAIME	BO SALTILLO			ADJUNTAS	315-000-003-04
APONTE PEREZ JULIO			BO SALTILLO	ADJUNTAS	266-000-009-33
ARROYO LOPEZ JOSE A	HM 7 ROAD #0521		BO VEGAS ARRIBA	ADJUNTAS	267-000-006-35
ARROYO RODRIGUEZ LUIS ENRIQUE	BO BUEN CONSEJO			UTUADO	267-000-007-35
BAEZ BONILLA FELIX	BO SUSUA BAJA			YAUCO	384-000-005-56
BAEZ ORTIZ JUAN	BO LA TORRE			SABANA GRANDE	360-000-003-39
BALLESTER COLON JORGE A	BO VEGAS ARRIBA			ADJUNTAS	267-000-006-38
BALLESTER COLON JUAN	BO CONSEJO		P R	UTUADO	267-000-003-26
BANCO DE LA VIVIENDA	BO JAUCA			JAYUYA	267-000-004-11
BANCO POPULAR DE PR	BO LA PICA			JAYUYA	267-000-009-23
BARNES VELEZ JUAN A	BO ANON			PONCE	268-000-006-28
BARTOLOMEI LEON HIRAM		CARR0511	SEC LA CARMELITA	PONCE	268-000-007-40
BATISTA HERNANDEZ MANUEL	BO ANON			PONCE	268-000-006-09
BATISTA HERNANDEZ MANUEL				PONCE	292-000-001-06
BATISTA HERNANDEZ MANUEL				PONCE	268-000-006-10
BATISTA HERNANDEZ MANUEL	BO ANON			PONCE	292-000-001-05
BECERRA NAZARIO AIDA G	BO SUSUA			SABANA GRANDE	360-000-009-34
BIANCHI ARVELO JOSEFINA				JAYUYA	267-000-009-27
BLASINI RIVERA ANTONIO	BO ANON			PONCE	268-000-006-29
BONILLA LOPEZ VICENTE				ADJUNTAS	267-000-006-09
BONILLA LOPEZ VICENTE				ADJUNTAS	267-000-006-09
BONILLA RIVERA MARIA	BO SUSUA ALTA			YAUCO	360-000-010-77

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
BUSIGO CIFRE DONALD	BO RINCON			SABANA GRANDE	312-000-001-20
BUSIGO CIFRE DONALD	BO RINCON			SABANA GRANDE	312-000-001-19
BUSIGO CIFRE DONALD	TABONUCO			SABANA GRANDE	312-000-001-31
CABAN TORRES MARTIN	HM 9 ROAD #0123		BO SALTILLO	ADJUNTAS	290-000-005-06
CAMACHO PASARELL RUBEN I				UTUADO	267-000-008-56
CANDELARIO SANTIAGO EMILIO	BO SUSUA			SABANA GRANDE	360-000-003-57
CARABALLO MONTALVO FELIX SUCN			BO VEGAS ARRIBA	ADJUNTAS	266-000-010-33
CARABALLO PAGAN JOSE	BO SALTILLO			ADJUNTAS	290-000-006-12
CARABALLO RODRIGUEZ EFRAIN				ADJUNTAS	266-000-010-28
CARABALLO RODRIGUEZ TOMAS			BO SALTILLO	ADJUNTAS	290-000-005-75
CARABALLO SANTIAGO	BO SUSUA BAJA			YAUCO	384-000-005-41
CARTER DOUGLAS GARY R				PONCE	268-000-006-33
CASIANO CRUZ EMILIO	BO SUSUA BAJA			YAUCO	384-000-005-56
CASIANO CRUZ EMILIO	BO SUSUA BAJA			YAUCO	384-000-005-31
CASIANO ESMERALDA	BO SUSUA BAJA			YAUCO	384-000-005-31
CASIANO LUGO LUIS E			BO.SUSUA BAJA	YAUCO	360-000-010-12
CASTRO CINTRON LUIS	BO SAN PATRICIO			PONCE	267-000-008-49
CASTRO RUIZ CALIXTO	BO GARZAS			ADJUNTAS	289-000-005-10
CASTRO RUIZ CALIXTO	BO GARZAS			ADJUNTAS	289-000-005-03
CASTRO RUIZ CALIXTO				ADJUNTAS	289-000-005-04
CASTRO TORMOS JOSE A		CARR0511	BO ANON CARMELITA	PONCE	268-000-006-07
CHEVERE HEREDIA FRANCISCO	HM 1 ROAD #0143		BO REAL ANON	PONCE	268-000-006-34
CITRON EXPORT INC	B/ VEGAS ARRIBA			ADJUNTAS	267-000-001-50
CITRON EXPORT INC			CARR 521 BO VEGAS ARRIBA	ADJUNTAS	267-000-001-31
CITRON EXPORT INC	B/ VEGAS ARRIBA			ADJUNTAS	267-000-006-02
CIUDAD EL SALTO INC	BO RINCON			SABANA GRANDE	311-000-010-34
CIUDAD EL SALTO INC	BO RINCON			SABANA GRANDE	311-000-010-03
CIUDAD EL SALTO INC	BO RINCON			SABANA GRANDE	311-000-010-09
CIUDAD EL SALTO INC	BO RINCON			SABANA GRANDE	311-000-010-12
CIUDAD EL SALTO INC	BO RINCON			SABANA GRANDE	311-000-010-33
COLL VILLARONGA MIGUEL	BO ANON			PONCE	268-000-006-32

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
COLON ALUSTIZA FERNANDO L	BO CONSEJO			UTUADO	267-000-008-45
COLON MEDINA PEDRO				JAYUYA	267-000-009-21
COLON RANGEL PEDRO		CARR0143	BO SAN PATRICIO	PONCE	267-000-008-55
CORTES JUAN	BO CONSEJO			UTUADO	267-000-008-36
CORTES MARTINEZ ZULMA	HM 3 ROAD #0518		BO GARZAS	ADJUNTAS	290-000-001-31
COTTON CARLOS J	BO SALTILLO			ADJUNTAS	290-000-005-41
CRUZ MANUEL C/O ADONIS GONZALE	BO VEGAS ABAJO			ADJUNTAS	267-000-002-13
CRUZ NEGRON JOSE	BO ANON			PONCE	292-000-001-02
CRUZ ORTIZ DELLANIL	BO RUCIO		PENUELAS	PE\UELAS	315-000-004-05
CRUZ ROSARIO SERRANO	HM 7 ROAD #0143		BO. LA PICA	JAYUYA	267-000-009-35
CRUZ SERRANO MANUEL	BO CONSEJO			UTUADO	267-000-008-18
CRUZ SOTO MANUEL			P R	UTUADO	267-000-002-13
CRUZ TORRES JULIO	BO ANON			PONCE	268-000-006-04
CRUZ TORRES JULIO	BO ANON			PONCE	268-000-006-17
CRUZ TORRES JULIO	BO ANON			PONCE	268-000-006-18
CUMMINGS ASSOCIATES INC/O HENRY		CARR0140	BO JAUCA	JAYUYA	267-000-004-21
DE JESUS CHOMPRE ADALBERTO		CARR0139	ANON CARMELITA	PONCE	292-000-001-59
DE PORRAS CASTILLO HECTOR RUIZ			BO VEGAS ARRIBA PARCELA 3	ADJUNTAS	267-000-007-34
DE PORRAS CASTILLO HECTOR RUIZ			PARCELA 2 BO VEGAS ARRIBA	ADJUNTAS	267-000-007-33
DE PORRAS CASTILLO HECTOR RUIZ			PARCELA 1 BO VEGAS ARRIBA	ADJUNTAS	267-000-007-32
DEL VALLE RIVERA PABLO	BO ANON			PONCE	268-000-007-35
DIAZ PACHECO ANGEL L	CARR 518		BO SALTILLO	ADJUNTAS	315-000-002-22
ECHEVARRIA MALDONADO RAMON	PARCELA 2 LA PICA			JAYUYA	267-000-009-31
ESCOBALES SANTIAGO JUAN FELIPE				ADJUNTAS	267-000-006-52
ESCOBALES SANTIAGO JUAN FELIPE				ADJUNTAS	267-000-006-52
ESPINET PAGAN JULIO	HM 4 ROAD #0143		BO ANON CARMELITAS	PONCE	268-000-007-26
FEDERAL BANK OF BALTIMORE	BO VEGAS ARRIBA			ADJUNTAS	266-000-010-28
FELICIANO LUIS ARMANDO	COM LAS PALOMAS			YAUCO	384-000-005-54
FELICIANO RIVERA JUAN J	HM 1 ROAD #0388		BO SALTILLO	ADJUNTAS	315-000-002-06
FELICIANO SANTIAGO PRIMITIVO	B/ VEGAS ARRIBA			ADJUNTAS	267-000-006-03
FELICIANO SOTOMAYOR JOSE M	HM 7 ROAD #0518		BO. LAGO GARZAS	ADJUNTAS	290-000-001-33

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
FERNANDINI TORRES ROBERTO				ADJUNTAS	290-000-008-46
FIGUEROA ALICEA BARTOLOME	BO SALTILLO			ADJUNTAS	290-000-005-51
FIGUEROA AVILES JOSE A				ADJUNTAS	290-000-009-45
FIGUEROA MENDOZA EUNICE A			NORZAGARAY #22	UTUADO	267-000-003-05
FIGUEROA RODRIGUEZ JOSE F	HM 1 ROAD #0010		BO SALTILLO	ADJUNTAS	290-000-005-85
FIGUEROA SUAREZ JOSE LIUD	HM 0 ROAD #0010		BO SAN PATRICIO	PONCE	292-000-001-48
FUCHS ROBERT J				PONCE	268-000-007-05
GALARZA OTERO MIGDALIA				JAYUYA	267-000-009-30
GALARZA RIVERA AMELIA				ADJUNTAS	266-000-009-54
GARCIA IDALIA ANTONIA				ADJUNTAS	290-000-004-17
GARCIA TORRES AVELINO	BO ANON			PONCE	268-000-006-06
GERARDINO MEDINA WILLIAM	PARCELA 7 LA PICA			JAYUYA	267-000-009-34
GONZALEZ BORRERO CRUZ	BO GARZAS			ADJUNTAS	289-000-005-11
GONZALEZ MARTINEZ LUIS ANTONIO	BO SUSUA BAJA			YAUCO	384-000-005-77
GONZALEZ MU\IZ BALDRAMINA	BO SUSUA BAJA			YAUCO	384-000-005-56
GONZALEZ PEREZ FELIX	BO SUSUA			SABANA GRANDE	384-000-004-09
GONZALEZ SANTIAGO HECTOR L				ADJUNTAS	267-000-002-21
GONZALEZ TORRES EDWIN R				ADJUNTAS	267-000-006-27
GRAU VDA OLIVIERI ANA DEL	BO SUSUA			SABANA GRANDE	360-000-009-12
GRILLASCA FERNANDO				ADJUNTAS	290-000-004-19
GUZMAN FERRER VICENTE	BO CONSEJO			UTUADO	267-000-007-24
GUZMAN FERRER VICENTE	CASA C 896 PARC 2		BO CONSEJO	UTUADO	267-000-007-21
HACIENDAS DON MAYO C/O HECTOR	BO SALTILLO			ADJUNTAS	290-000-005-02
HERNANDEZ PADILLA ALEJANDRO	BO ALMACIGO BAJO			YAUCO	360-000-005-45
HERNANDEZ RAMOS MARGARITA	BO ALMACIGO BAJO			YAUCO	360-000-005-46
HERNANDEZ VARGAS ANDRES				JAYUYA	267-000-004-14
HNAS RODRIGUEZ MENENDEZ ETAL	BO GUILARTE			ADJUNTAS	289-000-003-01
HOTEL EL CAFETAL INC	BO SUSUA ALTA			YAUCO	360-000-010-18
IRIZARRY DELGADO ALCIDES				UTUADO	267-000-002-16
IRIZARRY MALDONADO JOSE J	BO VEGAS ARRIBA			ADJUNTAS	267-000-006-34
IRIZARRY RODRIGUEZ IGNACIO	BO SUSUA BAJA			YAUCO	384-000-005-01

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
IRIZARRY RODRIGUEZ JUAN	B/ VEGAS ARRIBA			ADJUNTAS	267-000-002-12
JONES VENERO DANIEL				ADJUNTAS	267-000-007-59
JORDAN HOYOS CARMELO	BO VEGAS ARRIBA			ADJUNTAS	266-000-009-13
JOSE ANTONIO SOTO TORRES	HM 0 ROAD #0388		BO JAGUAS	PE\UELAS	315-000-002-27
LARACUENTE RAMON Y MARIO C/O E	BO SALTILLO			ADJUNTAS	315-000-002-04
LARACUENTE VEGA MACARIO	CARR 139 NO 05		BO ANON	PONCE	268-000-006-14
LECTORA HARRY	BO ANON			PONCE	268-000-006-31
LEGNER KURT			REAL ANON	PONCE	268-000-006-05
LEMONS MORRIS	BO TABONUCO			SABANA GRANDE	311-000-005-09
LEON SOTOMAYOR JOSE RAFAEL				ADJUNTAS	266-000-010-41
LOPEZ LUCIANO GUADALUPE	BO CONSEJO			UTUADO	267-000-003-42
LOPEZ NEGRON MARIA M	BO SALTILLO			ADJUNTAS	290-000-005-48
LOPEZ RIVERA ALFONSO AMOS	BO LA PICA			JAYUYA	267-000-004-22
LOPEZ RODRIGUEZ GENOVEVA	BO JAUCA			JAYUYA	267-000-004-23
LOPEZ SERRANO CRUZ	HM 8 ROAD #0364		BO RINCON POZO	SABANA GRANDE	312-000-001-30
LOUBRIEL VIDAURE JORGE				PONCE	268-000-006-19
LUCCA TORRES JULIO	BO RUCIO		PENUELAS	PE\UELAS	315-000-003-20
LUCIANO CRUZ CONFESOR	BO VEGA ARRIBA			ADJUNTAS	267-000-001-32
LUCIANO VELEZ EFRAIN				ADJUNTAS	266-000-010-31
LUGO LOPEZ DORA	BO SUSUA BAJA			YAUCO	384-000-005-31
LUGO LOPEZ REINALDO	BO SUSUA BAJA			YAUCO	384-000-005-31
LUGO RAMIREZ JUAN	BO BARINA			YAUCO	408-000-001-02
LUGO RAMIREZ JUAN	BO SUSUA BAJA			GUANICA	408-000-001-02
MALAVET RODRIGUEZ HECTOR J	BO ANON			PONCE	268-000-006-30
MALDONADO SANTIAGO JOSUE			BO VEGAS ARRIBA	ADJUNTAS	266-000-009-50
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-14
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-23
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-16
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-15
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-22
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-17

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
MARCUCCI ANGEL SUCN			BO SALTILLO VACAS KM 6.6	ADJUNTAS	315-000-001-13
MARTI RIVERA PEDRO	BO CONSEJO			UTUADO	267-000-007-07
MARTINEZ RIVERA DORIAN				JAYUYA	267-000-009-32
MARTINEZ SANTIAGO HIRAM				JAYUYA	291-000-005-53
MARTINEZ SANTIAGO SYLVIA		CARR0139	ANON CARMELITA	PONCE	291-000-005-50
MASSOL JUAN C			BO SALTILLO	ADJUNTAS	290-000-008-55
MASSOL NIEVES ANDRES S	SECT CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-61
MASSOL NIEVES MONSERRATE			BO SALTILLO	ADJUNTAS	290-000-008-57
MASSOL NIEVES OLIMPIA	SECTOR CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-56
MATTEI DE LUCCA FRANCISCO				ADJUNTAS	290-000-003-09
MATTEI REYES JOAQUINA	BO LA PICA			JAYUYA	267-000-009-51
MATTEI REYES JOAQUINA	BO LA PICA			JAYUYA	267-000-009-41
MATTEI REYES JOAQUINA	BO LA PICA			JAYUYA	267-000-009-50
MEDINA ORTIZ JOSE NOEL	CARR NO 2 KM 226 7		BO SUSUA ALTA	YAUCO	360-000-010-89
MENDEZ MENDEZ MIGUEL	BO SALTILLO			ADJUNTAS	266-000-009-20
MERCADO FULGENCIO	BO SANTANA			SABANA GRANDE	311-000-004-50
MERCADO IRIZARRY JOSE				JAYUYA	267-000-008-38
MERCADO ROSARIO NELSON	BO CONSEJO			UTUADO	267-000-007-19
MERCADO ROSARIO NELSON	BO CONSEJO			UTUADO	267-000-007-20
MIGNUCCI PLAZA JIMMY G	BO VEGAS ARRIBA			ADJUNTAS	267-000-006-03
MIRO VELEZ CRUZ MARIA C/O NOEL E.	BO VEGAS ARRIBA			ADJUNTAS	267-000-007-01
MOJICA PEGITAMY LUZ MARIA	BO SANTANA			SABANA GRANDE	311-000-009-08
MOLINA RODRIGUEZ JOSE	BO VEGAS ARRIBA			ADJUNTAS	267-000-006-12
MONSEGUR SANABRIA MANUEL	BO RINCON			SABANA GRANDE	312-000-006-18
MONTALVO RODRIGUEZ JOSE A	BO ANON			PONCE	268-000-006-08
MONTANER ORAMA ANTONIO	BO PASO PALMAS		P R	UTUADO	267-000-004-07
MONTANER ORAMA ANTONIO	BO JAUCA			JAYUYA	267-000-004-07
MONTANER ORAMA SALVADOR	BO JAUCA			JAYUYA	267-000-004-13
MONTIJO CRUZ GASPAR	BO CONSEJO			UTUADO	267-000-008-30
MORALES COLON ROBERTO			BO ANON LOTE 3	PONCE	291-000-005-03
MORALES PIEVES DAMIAN A	CARR 518 SEC OLIMPIA		BO SALTILLO	ADJUNTAS	290-000-003-14

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
MORALES RAMOS MILAGRO	BO RUCIO		PENUELAS	PE\UELAS	315-000-003-26
NAZARIO CORREA ALLAN	BO CONSEJO			UTUADO	267-000-007-36
NEGRON JUAN	BO CONSEJO			UTUADO	267-000-007-09
OLIVIERI GRAU ADELA G			BO GUILARTE	ADJUNTAS	289-000-009-04
OLIVIERI GRAU ADELA GEORGINA	PARC F BO SUSUA ALTA			YAUCO	360-000-009-82
OLIVIERI GRAU ADELA GEORGINA	PARC G BO SUSUA ALTA			YAUCO	360-000-009-87
OLIVIERI GRAU CARLOS E	PARC E		BO SUSUA ALTA	YAUCO	360-000-009-91
OLIVIERI GRAU CARMEN M	HM 8 ROAD #0368		PARC B BO SUSUA ALTA	YAUCO	360-000-009-88
OLIVIERI GRAU CARMEN M				ADJUNTAS	289-000-003-21
OLIVIERI GRAU CARMEN MARIA	REMANENTE PARC C		SUSUA ALTO	SABANA GRANDE	360-000-009-93
OLIVIERI GRAU EUGENIA G	PARC I BO SUSUA ALTA			YAUCO	360-000-009-81
OLIVIERI GRAU EUGENIO G			BO GUILARTE	ADJUNTAS	289-000-009-03
OLIVIERI RODRIGUEZ JOSE A				ADJUNTAS	289-000-009-01
OLIVIERI RODRIGUEZ JOSE A				GUAYANILLA	289-000-009-01
OQUENDO MALDONADO NAZARIO	BO CONSEJO		P R	UTUADO	267-000-002-17
OQUENDO MALDONADO NAZARIO	BO CONSEJO			UTUADO	267-000-002-22
OQUENDO SOTO JOSE				UTUADO	267-000-003-50
ORTIZ ALICEA DANIEL			CONSEJO	UTUADO	267-000-008-04
ORTIZ IRIZARRY JOVITA	BO RINCON			SABANA GRANDE	311-000-010-62
ORTIZ QUI&ONES JOSE				GUAYANILLA	289-000-008-02
ORTIZ SANTANA GERMAN			YAUCO	ADJUNTAS	289-000-005-02
ORTIZ SANTANA PORFIRIO				ADJUNTAS	290-000-001-30
PADILLA MORALES CARMEN C			BO GARZAS	ADJUNTAS	289-000-005-05
PADRO BATTISTINI RUBEN	BO SUSUA			SABANA GRANDE	360-000-009-16
PADRON BATTISTINI RAUL	BO SUSUA ALTA			YAUCO	360-000-009-16
PADRON BATTISTINI RAUL	BO SUSUA			SABANA GRANDE	360-000-009-16
PADRON BATTISTINI RUBEN	BO SUSUA ALTA			YAUCO	360-000-009-16
PAGAN ALICEA JOSE M	HM 7 ROAD #0121		BO SUSUA ALTA	YAUCO	360-000-010-75
PAGAN CUEVAS LUIS ENRIQUE	BO VEGAS ARRIBA			ADJUNTAS	266-000-010-28
PARAMOUNT FINANCE CORP	BO ALMACIGO BAJO			YAUCO	360-000-005-46
PEREZ ALBINO SALATHIEL			BO SALTILLO	ADJUNTAS	290-000-005-65

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
PEREZ CRESPO FERNANDO				JAYUYA	267-000-003-42
PEREZ CRESPO JOAQUIN	BO CONSEJO			UTUADO	267-000-007-11
PEREZ CRESPO MOISES		CARR0143	BO SAN PATRICIO	PONCE	267-000-008-54
PEREZ LOPEZ RAQUEL	BO ANON			PONCE	268-000-006-25
PEREZ MANGUAL RAFAEL A			VEGAS ARRIBA	ADJUNTAS	267-000-006-42
PEREZ MANGUAL RAFAEL A			VEGAS ARRIBA	ADJUNTAS	267-000-006-42
PEREZ RODRIGUEZ JORGE	HM 2 ROAD #0526		BO. GARZAS JUNCOS	ADJUNTAS	289-000-005-68
PEREZ SEDA EDUARDO	BO SUSUA ALTA			YAUCO	360-000-004-03
PLUGES OSORIO LYDIA				ADJUNTAS	290-000-005-03
PLUGES OSORIO LYDIA		CARR0010	BO SALTILLO	ADJUNTAS	290-000-005-03
PORTALATIN MEDINA WILLIAM	HM 0 ROAD #0010		BO SALTILLO	ADJUNTAS	290-000-005-63
QUI\ONES CESAR AUGUSTO				PONCE	268-000-006-35
QUILINCHINI CARLOS A DR				ADJUNTAS	290-000-005-43
RAMOS GUZMAN EDUARDO	HM 9 ROAD #0391		BO RUCIO,SECTOR CERROTE	PE\UELAS	315-000-004-38
RAMOS LUGO MARIA H	BO SALTILLO VACAS		KM 6 6	ADJUNTAS	315-000-001-05
REYES AGOSTINI CESAR L			BO NORZAGARAI	UTUADO	267-000-003-17
REYES MATTEI JOAQUINA	BO LA PICA			JAYUYA	267-000-009-09
RIBAS RIVERA JOSE LUIS				ADJUNTAS	266-000-010-29
RIOS APONTE AUGUSTO			BO GARRAZ	ADJUNTAS	289-000-009-02
RIOS APONTE AUGUSTO	BO SALTILLO			ADJUNTAS	290-000-006-08
RIOS APONTE AUGUSTO	BO BARREAL		PENUELAS	PE\UELAS	289-000-009-02
RIOS AUGUSTO	BO GARZAS			ADJUNTAS	290-000-006-12
RIOS NIEVES ALCIDES	SECTOR CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-60
RIVERA ALCOVER JUAN A	BO SALTILLO			ADJUNTAS	290-000-004-02
RIVERA BONILLA JOSE AMADOR			BO SUSUA BAJA	YAUCO	360-000-010-15
RIVERA CANDELARIO MARIA C	BO SUSUA BAJA			YAUCO	384-000-005-31
RIVERA FLORES RAMON	HM 0 ROAD #0364		BO RINCON	SABANA GRANDE	312-000-001-40
RIVERA JUSTINIANO	BO CONSEJO			UTUADO	267-000-003-21
RIVERA NIEVES BLAS	SEC CIENEGAS		BO SALTILLO	ADJUNTAS	315-000-002-12
RIVERA PEREZ IVONNE ARLENE	HM 6 ROAD #0143		BO REAL ANON	PONCE	268-000-006-26
RIVERA QUI\ONES JAIME	SECTOR CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-59

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
RIVERA QUI\ONES WILLIAM				ADJUNTAS	290-000-008-53
RIVERA RODRIGUEZ LESTER		CARR0143	BO ANON CARMELITA	PONCE	268-000-006-58
RIVERA SANTIAGO RAMON	HM 1 ROAD #0010		BO.SALTILLO	ADJUNTAS	266-000-009-15
RIVERA VARGAS CARLOS				JAYUYA	291-000-005-25
ROBLES CARLOS J C/O RAUL SEGARRA	BO RUCIO		PENUELAS	PE\UELAS	315-000-003-06
ROBLES MELENDEZ MARCOS	HM 1 ROAD #0123		BO SALTILLO	ADJUNTAS	266-000-009-16
RODRIGUEZ COLON LYDIA				PONCE	292-000-001-51
RODRIGUEZ JIMENEZ MATEO	BO SUSUA ALTA			YAUCO	360-000-010-19
RODRIGUEZ LUIS ALFONSO	BO SALTILLO			ADJUNTAS	290-000-004-05
RODRIGUEZ PEREZ ROBOAM	BO CONSEJO			UTUADO	267-000-007-10
RODRIGUEZ RAMOS CARLOS L	HM 5 ROAD #0140		BO LA PICA	JAYUYA	267-000-008-55
RODRIGUEZ RIOS FELIX			BO LA PICA	JAYUYA	267-000-009-05
RODRIGUEZ RIOS FELIX C/O DOMINGO			BO PICA	JAYUYA	267-000-009-05
RODRIGUEZ RIVERA MIGUEL A	BO SUSUA			SABANA GRANDE	360-000-009-33
RODRIGUEZ RIVERA ROBERTO	BO ALMACIGO ALTO			YAUCO	360-000-005-01
RODRIGUEZ RODRIGUEZ JUAN	BO SUSUA ALTA			YAUCO	360-000-004-45
RODRIGUEZ SANTIAGO WILBER	BO SUSUA ALTA			YAUCO	360-000-010-97
RODRIGUEZ SERRANO EMILIO			BO ANON CARMELITA	PONCE	268-000-007-01
RODRIGUEZ VAZQUEZ JOSE D	BO SUSUA			SABANA GRANDE	360-000-003-19
RODRIGUEZ VDA MALDONADO	BO GARZAS			ADJUNTAS	290-000-001-64
ROSADO GONZALEZ CARMELO				ADJUNTAS	290-000-004-08
ROVIRA FERNANDEZ JOSE M				PONCE	268-000-006-27
RUIZ HERNANDEZ GUILLERMO	BO CONSEJO			UTUADO	267-000-003-15
RUIZ VARGAS ULISES	BO SANTANA			SABANA GRANDE	311-000-004-18
RULLAN MAYOL ALBERTO				ADJUNTAS	290-000-004-09
SALCEDO MELENDEZ MIGUEL	BUEN CONSEJO			UTUADO	267-000-007-49
SALCEDO MELENDEZ PAULINA	BUEN CONSEJO			UTUADO	267-000-007-54
SALCEDO MELENDEZ PILAR	BUEN CONSEJO			UTUADO	267-000-007-48
SALCEDO MELENDEZ RAMON	BO BUEN CONSEJO			UTUADO	267-000-001-50
SANTANA ALICEA LUIS	BO TABONUCO			SABANA GRANDE	311-000-005-02
SANTIAGO ALBINO ANICETO	BO SUSUA BAJA			YAUCO	384-000-005-56

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
SANTIAGO ALTRUZ FRANCISCO			P R	UTUADO	267-000-008-43
SANTIAGO ANGEL ALBERTO	BO SUSUA BAJA			YAUCO	384-000-005-31
SANTIAGO LUGO ARGEO	BO CONSEJO			UTUADO	267-000-007-44
SANTIAGO MALDONADO JOSE A				ADJUNTAS	290-000-005-65
SANTIAGO MELENDEZ FELICITA	HM 5 ROAD #0518		I I	ADJUNTAS	289-000-005-63
SANTIAGO NEGRON RAMON	BO SUSUA			SABANA GRANDE	360-000-003-70
SANTIAGO RIVERA JUAN	BUEN CONSEJO			UTUADO	267-000-007-17
SANTIAGO ROSADO ANIBAL	CARR 518 INT		BO GARZAS	ADJUNTAS	290-000-001-44
SANTIAGO TORRES RAUL	HM 8 ROAD #0143		BO SAN PATRICIO	PONCE	291-000-005-52
SANTIAGO VDA TORRES EPIFANIA	BO SUSUA			SABANA GRANDE	384-000-004-11
SANTIAGO VDA TORRES EPIFANIA	BO SUSUA			SABANA GRANDE	384-000-004-10
SANTOS TORRES MARTIN			JAYUYA ABAJO -JAUCA	JAYUYA	267-000-004-15
SEGARRA GUZMAN JOSE MIGUEL			VEGAS ARRIBA WARD	ADJUNTAS	266-000-010-17
SEGARRA MALDONADO IGNACIO				UTUADO	267-000-008-58
SEGARRA MALDONADO IGNACIO	HM 6 ROAD #0143		SAN PATRICIO	PONCE	267-000-008-53
SEGARRA MALDONADO SATURIO/IGN				UTUADO	267-000-008-47
SEGARRA MALDONADO SATURIO/IGN				UTUADO	267-000-007-37
SEGARRA MALDONADO SATURIO/IGN				UTUADO	267-000-007-38
SEMIDEY ORTIZ ROLANDO	HM 5 ROAD #0116		COM PALOMAS	YAUCO	384-000-005-53
SEPULVEDA MORALES LUIS M	BO SUSUA ALTA			YAUCO	360-000-010-97
SERRA DELGADO RAFAEL		CARR0143	BO ANON	PONCE	291-000-005-01
SERRALLES NEVARES FELIX JUAN				JAYUYA	268-000-007-08
SERRALLES NEVAREZ FELIX JUAN	CARR 143		BO ANON	PONCE	268-000-006-15
SERRANO BAEZ JUAN CONFESOR ETA			BO RINCON	SABANA GRANDE	311-000-010-07
SERRANO JUSINO JOSE L				UTUADO	267-000-008-57
SOLTERO PERALTA RAFAEL	BO RINCON			SABANA GRANDE	311-000-005-08
SOSA PEREZ DOMINGO			BO SALTILLO	ADJUNTAS	290-000-009-14
SOTO RIVERA ISRAEL			BO VEGAS ARRIBA	ADJUNTAS	266-000-005-56
SOTO TORRES HECTOR	BO SALTILLO			ADJUNTAS	315-000-002-25
STUBBS ROBERT			BO SALTILLO	ADJUNTAS	290-000-008-08
SUAREZ RAMIREZ ALFREDO L	BO JAUCA			JAYUYA	268-000-006-21

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
SUCN CARLOS E OLIVIERI GRAU			BO GUILARTE	ADJUNTAS	289-000-008-09
SUCN CARLOS LOPEZ DE TORO	LA PICA			JAYUYA	267-000-009-02
SUCN CRUZ FIGUEROA	BO SALTILLO			ADJUNTAS	290-000-005-03
SUCN DOMINGO J OLIVIERI GRAU	BO SUSUA ALTA			YAUCO	360-000-009-76
SUCN DOMINGO JOSE OLIVIERI				ADJUNTAS	289-000-004-30
SUCN DOMINGO JOSE OLIVIERI	HM 8 ROAD #0368		PARC H BO SUSUA	YAUCO	360-000-009-80
SUCN DOMINGO MASSOL	SECTOR CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-57
SUCN DOMINGO MASSOL	SECTOR CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-58
SUCN DOMINGO MASSOL	SECTOR CIENAGA		BO SALTILLO	ADJUNTAS	290-000-008-51
SUCN EMILIO SELLA PEREZ	HM 9 ROAD #0010		BO SALTILLO	ADJUNTAS	290-000-004-20
SUCN J SERRALLES	BO JAUCA			JAYUYA	267-000-010-01
SUCN JESUS ARMANDO	BO SUSUA			SABANA GRANDE	384-000-004-10
SUCN JUAN E OLIVIERI GRAU				ADJUNTAS	289-000-004-31
SUCN JUAN E OLIVIERI GRAU	PARC A I		BO SUSUA ALTA	YAUCO	360-000-009-86
SUCN JUAN MONSERRATE	B/ VEGAS ARRIBA			ADJUNTAS	267-000-006-07
SUCN JUAN MONSERRATE	B/ VEGAS ARRIBA			ADJUNTAS	267-000-006-07
SUCN JULIO CRUZ TORRES	BO JAUCA			JAYUYA	268-000-006-18
SUCN JULIO E TORRES C/O CLAUDIO G	BO SALTILLO			ADJUNTAS	266-000-009-46
SUCN JULIO E TORRES GREGOR				ADJUNTAS	290-000-004-06
SUCN MANUEL CRUZ SOTO	SECTOR LA PICA		BO CONSEJO	UTUADO	267-000-008-01
SUCN MARIA DE LOS A OLIVIERI			BO GUILARTE	ADJUNTAS	289-000-008-08
SUCN OLIVIERI GRAU ROSA E	HM 8 ROAD #0368		PARC H BO SUSUA ALTA	YAUCO	360-000-009-89
SUCN OLIVIERI MARIA DE LOS A	PARC K BO SUSUA ALTA			YAUCO	360-000-009-85
SUCN OLIVIERI MARIA DE LOS A	PARC J BO SUSUA ALTA			YAUCO	360-000-009-84
SUCN PEDRO RIVERA CARABALLO	BO VEGAS ARRIBA			ADJUNTAS	266-000-010-08
SUCN RAMON RUIZ HERNANDEZ	BO RUCIO		PENUELAS	PE\UELAS	315-000-003-07
SUCN ROSA ELVIRA OLIVIERI				ADJUNTAS	289-000-008-07
SUCRS NICOMEDES	B/ VEGAS ARRIBA			ADJUNTAS	267-000-002-19
TIRADO PEREZ LUIS A			BO CONSEJO	UTUADO	267-000-003-05
TORO SERAFINA	BO CONSEJO			UTUADO	267-000-007-25
TORRES FELICIANO PEDRO				ADJUNTAS	266-000-010-43

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
TORRES GREGORI CARLOS	HM 7 ROAD #0010		PARC J BO SALTILLO	ADJUNTAS	290-000-004-26
TORRES GREGORI CELIA M		CARR0010	PARC C BO SALTILLO	ADJUNTAS	290-000-004-24
TORRES GREGORI GLADYS	HM 8 ROAD #0010		PARC E BO SALTILLO	ADJUNTAS	290-000-004-27
TORRES GREGORI JOSE ANTONIO		CARR0010	PARC F BO SALTILLO	ADJUNTAS	290-000-004-23
TORRES GREGORI LUIS		CARR0010	PARC G BO SALTILLO	ADJUNTAS	290-000-004-28
TORRES GREGORI MARIA LUISA		CARR0010	PARC D BO SALTILLO	ADJUNTAS	290-000-004-25
TORRES GREGORI ROSA MARIA		CARR0010	PARC A BO SALTILLO	ADJUNTAS	290-000-004-22
TORRES NEGRON ELEUTERIO			BO CONSEJO	UTUADO	267-000-003-18
TORRES PEREZ JOSE A				ADJUNTAS	290-000-005-07
TORRES SANTIAGO JUAN B	BO SUSBA			SABANA GRANDE	384-000-004-11
TORRES SANTIAGO JUAN LUIS				JAYUYA	267-000-008-38
TORRES VELEZ DOMINGO	BO SUSUA ALTA			YAUCO	360-000-010-45
TORRES VERA CARLOS				ADJUNTAS	290-000-007-65
TORRES VERA CONFESOR	SOLAR A 6		BO SALTILLO	ADJUNTAS	315-000-001-08
TORRES VERA CONSUELO	SOLAR A 7		BO SALTILLO	ADJUNTAS	315-000-001-09
TORRUELLAS RIOS HECTOR		CARR0140	BO CONSEJO	UTUADO	267-000-008-42
TRANS UNION LEASING CORP	CARR PR 368		BO SUSUA ALTA	YAUCO	360-000-010-20
UN PEDAZO DE CIELO INC	CARR 139 BO ANON			PONCE	292-000-001-68
VALENTIN MANUEL ANTONIO	BO CONSEJO			UTUADO	267-000-007-06
VARGAS DAVID	BO CONSEJO			UTUADO	267-000-008-13
VAZQUEZ RUIZ GIOVANNI	HM 0 ROAD #0638		BO. SUSUA ALTA	YAUCO	360-000-009-28
VAZQUEZ SERRANO CABINO	HM 5 ROAD #0526		BO. GARZAS JUNCO	ADJUNTAS	289-000-005-67
VAZQUEZ VEGA ISAIAS	BO SUSUA ALTA			YAUCO	360-000-004-31
VEGA ASTACIO JESUS			BO SAN PATRICIO	PONCE	291-000-005-04
VEGA RIVERA MILTON	LA PICA			JAYUYA	267-000-009-20
VEGA VELEZ DOMINGO	BO SUSUA ALTA			YAUCO	360-000-010-59
VELAZCO SCHETINI HUGO R	BO TABONUCO			SABANA GRANDE	312-000-001-27
VELAZQUEZ FLORES ERICK	HM 6 ROAD #0364		BO RINCON	SABANA GRANDE	312-000-006-01
VELEZ ANDUJAR RAFAEL				ADJUNTAS	266-000-009-17
VELEZ BARBOSA WILSON	BO VEGAS ARRIBA			ADJUNTAS	266-000-010-15
VELEZ BIANCHI LUIS A	NORZAGARAY			UTUADO	267-000-008-51

Landowner	Address 1	Address 2	Address 3	Municipality	Property ID
VELEZ FRONTERA OSCAR	CARR PR 10 KM 32 3		BO SALTILLO	ADJUNTAS	266-000-009-18
VELEZ FRONTERA OSCAR	BO VEGAS ARRIBA			ADJUNTAS	266-000-009-49
VELEZ FRONTERA OSCAR				ADJUNTAS	266-000-009-14
VELEZ IRIZARRY HECTOR	HM 9 ROAD #0143		BO LA PICA	JAYUYA	291-000-005-24
VELEZ IRIZARRY REINALDO			BO JAUCA	JAYUYA	267-000-009-24
VELEZ RIVERA RAMON				JAYUYA	267-000-004-12
VELEZ RIVERA RAMON				JAYUYA	267-000-004-26
VELEZ SAEZ ELIO	BO PICA			JAYUYA	267-000-009-57
VELEZ SAEZ ELIO	BO PICA			JAYUYA	267-000-009-56
VIDRO VEGA ROBERTO	BO LA TORRE			SABANA GRANDE	360-000-003-22
VIVES AMENGUAL JAIME	BO LA PICA			JAYUYA	267-000-009-04
VIVES AMENGUAL JAIME	BO PICA			JAYUYA	267-000-009-03
WHITAKER SUNKLE DAVID R			BO CONSEJO	UTUADO	267-000-008-41
YORDAN TORRES GUSTAVO	PARC 6 LA PICA			JAYUYA	267-000-009-37
ZAMBRANA PAGAN FRANK		CARR0139	BO ANON	PONCE	292-000-001-65
ZAYAS CHARDON HUMBERTO	CARR 143		BO ANON	PONCE	268-000-006-01

APPENDIX F – Fleury and Brown's Framework for the Design of Wildlife Corridors (FDWC)

APPENDIX G –Using the ArcView™ Geoprocessing Wizard to Prioritize Land

Prioritization Process

Lands were prioritized in each corridor by first using the cookie cutter feature in ArcView™ to obtain a layer of the heavy, medium, and lightly forested areas within the corridor region. This same process was then used to obtain a layer of all of the soils of concern within the corridor region. Once these two layers were created we used the intersection feature to find areas that contained both soils and forest cover. This layer showed the areas of highest priority. Then we used the union feature to create a theme that had either the soils of concern or any type of forest cover. Next, all of the high priority regions were excluded from this theme by deleting them out of the table associated with it. This layer showed the areas of medium priority. Any areas not identified as medium or high priority were considered to be low priority.

Using the Geoprocessing Wizard

To use any of the features discussed above, the ArcView™ Geoprocessing wizard must be installed. Once installed the Geoprocessing wizard can be accessed by selecting *View → Geoprocessing Wizard*. Each of the features discussed below can then be utilized.

Cookie Cutter

The cookie cutter feature allows one theme to be cut into the shape of another theme layered over it. The result has all of the same data as the original theme excluding any data that is completely cut out.

This feature can be used by selecting *View → Geoprocessing Wizard → Clip Theme based on Another*. Then an input theme and a polygon overlay theme must be selected. The input theme is what you want to clip. The polygon overlay theme is what you want to clip with. Once these are selected an output file may be specified, or the process may be completed by clicking on *Finish*.

Intersect

The Intersect feature allows two themes to be intersected. The two themes are overlaid to form a new theme that contains all data common to the two original themes.

This feature can be used by selecting *View* → *Geoprocessing Wizard* → *Intersect Two Themes*. Next an input theme to intersect and an overlay theme must be chosen. An output file may be specified, or the process may be completed by clicking on *Finish*.

Union

The Union feature allows two themes to be united. The two themes are overlaid to form a new theme that contains all data from both original themes.

This feature can be used by selecting *View* → *Geoprocessing Wizard* → *Union Two Themes*. Next an input theme to intersect and an overlay theme must be chosen. An output file may be specified, or the process may be completed by clicking on *Finish*.

APPENDIX H - Original Landowner Questionnaire and Results

Original Questionnaire

Deforestation is increasing in Puerto Rico. Only thirty five percent of Puerto Rico is covered by forest. Recent legislation has therefore asked that the DRNA delineate two biological corridors to unite the forests of:

Maricao, Susua, and Guanica and
Toro Negro, Pueblo de Adjuntas, and Guilarte

A biological corridor is an area of conserved forest land that joins together two different forests. A corridor helps preserve the ecosystems of both forests by allowing wildlife to pass freely between the two. Many endangered species will have a better chance at survival when corridors are constructed.

Our task is to instruct the DNER where to place the corridors. We must take into account the wildlife of the joined forests when deciding where to place them. We will also assess the social and economic impact of the corridor in the region.

It is possible that some of your land could be beneficial to the corridor. To give us a better understanding of the social impact of the corridor, we would like to ask you a couple questions.

Were you aware of this law before we presented it to you today? What are your feelings about the law? Is it necessary? Explain please
How might you support or oppose the government in its efforts to implement biological corridors?
What are your concerns if these corridors were to be built in your area?
Are you aware of any on going conservation efforts?
Have you participated in conservation efforts before?
What is your land currently used for? What future plans do you have for it?
Do you have any land that you might be willing to sell for the purpose of conservation?
Do you have any other questions or concerns for our group?

Notes from Private Landowner Interviews

Interview #1
Property between Toro Negro and Tres Picachos
April 4, 2001

Were you aware of Law 1277 before we told you about it?
No, I was not aware of the law.

What are your feelings about the law?
It sounds like a good law. It could be beneficial.

Do you feel it is necessary to establish these corridors?
Yes, it is necessary to establish the corridors.

In what way would you collaborate with the DRNA in its plan to establish a biological corridor?

- ☐ Sell part or all of any relevant properties you own
- ☑ Conservation easements
- ☐ Establish your relevant properties as an auxiliary forest
- ☑ Voluntary conservation easements

Do you know of any conservation projects in or near your lands? Have you participated in any conservation projects?
There are some conservation projects in the area, but I have not participated in any.

Would you be worried if corridors were established in or near your lands?
It does not matter to me if a corridor were established in or near my lands.

What is your land used for now? What are some future plans for your lands?
There are no future plans for the land, other than to maintain it in its primary state.

Do you have any questions for our group?
No, I do not have any questions.

Notes from Private Landowner Interviews

Interview #2
This landowner has property near Route 10, between Utuado and Adjuntas. He does not actually own the land, but rather manages the land for a multi-millionaire friend of his living in Atlanta, GA. He used to have a bay oil factory on his land, but closed down in 1998 after the hurricane. He cannot find employment for his farm.
April 6, 2001

Were you aware of Law 1277 before we told you about it?
No, I was not aware of the law.

What are your feelings about the law?
It sounds good, but I worry that all factors might not be taken into account when establishing the corridor. For example, there are different soils, types of terrain, levels of rainfall, and trees between two forests that might make uniting them difficult.

Do you feel it is necessary to establish these corridors?
Yes, it must be necessary to establish the corridors since a law was passed declaring them to be established. Animals must be protected. Guánica farmers are poisoning the lands with insecticides. People that live within the corridor regions should not be allowed to destroy the forest by littering, for example.

In what way would you collaborate with the DRNA in its plan to establish a biological corridor?

- ☑ Sell part or all of any relevant properties you own
- ☐ Conservation easements
- ☐ Establish your relevant properties as an auxiliary forest
- ☐ Voluntary conservation easements

Do you know of any conservation projects in or near your lands? Have you participated in any conservation projects?
The Pueblo de Adjuntas has a conservation group, but I have not participated.

Would you be worried if corridors were established in or near your lands?
It depends what the DRNA will do with the land. There will likely be restrictions on land usage. I cannot put a tower on Cerro Punta because the DRNA will not allow it. I am trying to build a wind generator, but I cannot near Arecibo because of conservation regulations.

What is your land used for now? What are some future plans for your lands?
The land is not being used currently. I would like to cultivate bay oil again.

Do you have any questions for our group?
Land is scarce in Puerto Rico. How can the DRNA really acquire this land if it cannot profit from it? Some landowners want a lot of money for their land.

APPENDIX I - Brochure and Questionnaire

HOW THE CORRIDORS MIGHT AFFECT YOU

The biological corridors can provide neighboring communities with healthy water and cleaner air.

Should the corridors be delineated through your property, the DRNA may ask for your assistance in exercising conservation practices on your land.

ECONOMIC INCENTIVES FOR CONSERVING YOUR LAND

Under the auxiliary forest program, tax breaks are available if your land is of significant ecological value and is used for conservation purposes.

If your land is ecologically desirable, unused portions of it may be rented to the DRNA at a fair market value.

SERVICIO FORESTAL
Departamento de Recursos Naturales

WHERE CAN I FIND MORE INFORMATION?

To learn more about biological corridors, conservation, and if you will be affected by the new Law 1277, feel free to call Daniel Galán at the DRNA Forest Management Division at (787) 721-5495 or 724-3724.

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DRNA
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES

Department of Natural and Environmental Resources
Forest Management Division
P.O. Box 9066600
Pta. De Tierra Station,
San Juan, P.R. 00906-6600
Phone (787) 724-3724
Fax (787) 723-4255

BIOLOGICAL CORRIDORS:

PROMOTING AND MAINTAINING BIODIVERSITY IN PUERTO RICO

Department of Natural and Environmental Resources

INTRODUCTION

Puerto Rico is home to thousands of plants and animals, many of which are dependent upon Puerto Rico's forests for survival. Unfortunately, expanding cities and higher populations are causing more and more forests to disappear, taking valuable animal species with them.

Coquí frog, native to Puerto Rico

In 1985, only 32 percent of Puerto Rico was under forest cover with land continuing to be deforested. Eighty-five percent of this forest property is owned privately with few conservation measures in place.

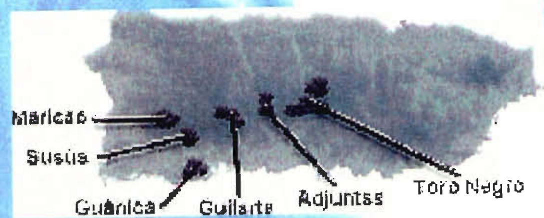
Enhancing Puerto Rico's scenic beauty and providing a habitat for wildlife are not the only benefits of the island's forests. Forests also provide clean air and a healthy water supply for many towns and cities. It is the mission of the Department of Natural and Environmental Resources (DRNA) to promote and maintain the forests and wildlife of Puerto Rico.

Broad-winged hawk, an endangered specie

NEW CONSERVATION LEGISLATION

Currently, the land between three state forests in the southwest, Maricao, Susúa and Guánica, and three state forests in the center, Guilarte, Adjuntas, and Toro Negro, face increased development and deforestation. Consequently, wildlife cannot pass freely between the forests.

To help combat deforestation and help wildlife populations, Puerto Rico has recently adopted Law 1277 which orders the DRNA to create two biological corridors to unite the state forests.



Three forests in the southwest and three in the center of Puerto Rico will be united via biological corridors

BIOLOGICAL CORRIDORS

A "biological corridor" is a narrow strip of forestland that connects two larger forests together. A corridor helps species to move between forests and to increase their populations.

Particularly in Puerto Rico, the nightjar, broad-winged hawk, and sharp-shinned hawk are three endangered bird species that will benefit from these corridors.

ESTABLISHING THE CORRIDORS

Ideally, all properties through which the corridor passes must be conserved. Some methods available to the DRNA to conserve lands include the following:

- **Auxiliary forest program**
  Landowners do not have to pay taxes on their land if they agree to use the land only for conservation
- **Conservation easements**
  DRNA pays landowners rent in order to use part or all of their land for conservation
- **Title purchases**
  Buy a property from its owner at a compromised price
- **Expropriation**
  In rare cases, the DRNA can force landowners to sell their property at a fair value

Conservation works best when it is a joint effort on behalf of both the DRNA and the community. Therefore, the DRNA desires a compromise with landowners whenever lands must be conserved.

Matrulla Lake near Toro Negro

꧁ CUESTIONARIO ꧂

[QUESTIONNAIRE]

Por favor, responda a las siguientes preguntas y devuelva sus respuestas al DRNA en el sobre incluido. Sus respuestas ayudarán al DRNA en sus planes para el establecimiento de los corredores biológicos.

[Please respond to the following questions and return your responses to the DNER in the accompanying envelope. Your responses will considerably help the DRNA with their corridor plans]

1) **¿En qué municipio está su propiedad?** [In what municipality does your property reside?]

2) **¿Cuánto valen sus terrenos, más o menos?** [Approximately how much is your land worth?]

- ❑ **$0 - $25,000**
- ❑ **$25,000 - $50,000**
- ❑ **$50,000 - $100,000**
- ❑ **$100,000 - $200,000**
- ❑ **$200,000+**

3) **¿Conocía Usted esta ley antes de recibir el folleto?**
[Were you aware of this law before receiving the brochure?]

- ❑ **Sí – ¿Cómo? [yes – How?]**

- ❑ **No**

4) **¿Cómo se siente Usted sobre la ley? (favor de marcar todas las que apliquen)**
[How do you feel about the law? (check all that you feel)]

- ❑ **Es una buena idea** [It is a good idea]
- ❑ **No es una buena idea** [It is not a good idea]
- ❑ **Es justo** [It is fair]
- ❑ **No es justo** [It is fair]
- ❑ **No entiendo la ley completamente** [I do not fully understand the law]
- ❑ **Otra (explique, por favor)** [other (explain, please)]

5) **¿Entiende Usted que es necesario establecer los corredores?**
[Do you understand that it is necessary to build these corridors?]

- ❑ **Sí** [yes]
- ❑ **No – Explique, por favor.** [no – Explain, please]

6) ¿De qué manera podría Usted colaborar con el DRNA en su plan de establecer los corredores biológicos?
[In what way could you collaborate with the DNER in its plan to establish biological corridors?]

- ❑ **Vender parte o la totalidad de la propiedad** [Sell part or all of my property]
- ❑ **Unirse al programa de bosque auxiliar** [Auxiliary forest program]
- ❑ **Servidumbre de conservación** [Conservation easements]
- ❑ **Otra (explique, por favor)** [other (explain, please)]

7) ¿Ha participado Usted en algún proyecto de conservación?
[Have you participated in any conservation projects before?]

❑ **Sí (Explique, por favor)** [Yes (Explain, please)]

❑ **No**

8) ¿Se preocuparía Usted si se establecieran los corredores en o cerca de sus terrenos?
[Would you be worried if corridors were established on or near your property?]

❑ **Sí (Explique, por favor)** [Yes (Explain, please)]

❑ **No**

9) ¿Para qué utiliza su terreno ahora? ¿Cuáles son sus planes de uso para su terreno?
[For what are you using your land now? What future plans do you have for the land?]

Si tiene Usted algunas preguntas, se puede comunicarse al DRNA: (721-5495)
[Feel free to contact the DRNA if you have any questions at: (721-5495)]

INFORMACIÓN DE CONTACTO:
[CONTACT INFORMATION:]

Es posible que el DRNA quiera hablar con Usted sobre sus respuestas a este cuestionario para considerar sus necesidades durante el proceso del establecimiento de los corredores biológicos. No obstante, si no quiere ser contactado por un representante del DRNA, o si quiere permanecer anónimo, favor de marcar la última alternativa.
[The DNER may want to speak with you regarding your responses to this questionnaire in order to better accomadate your needs during the process of establishing these biological corridors. However, if you do not want to be contacted by a DNER representative, or wish remain anonymous, please check the appropriote box below].

NOMBRE [NAME]**:** ________________________________

DIRECCIÓN [ADDRESS]**:** ________________________________
____
____

❑ **No, no quiero que me contacte el DRNA**
[No, I do not want the DRNA to contact me]

❑ **Sí, quisiera que me contacte el DRNA sobre mis respuestas**
[Yes, I would like the DRNA to contact me about my responses]

Pueden contactarme por: [I can be contacted via]

❑ **Teléfono** [phone]**:**
Numero de teléfono: _____-_______ [Phone number]

Estoy disponible durante: [I am available in the:]
❑ **la mañana** [morning]
❑ **la tarde** [afternoon]

❑ **E-mail:** ________________________________

❑ **Quisiera permanecer anónimo** [I wish to remain anonymous]

Gracias por su tiempo. [Thank you for your time.]

APPENDIX J – Interpreting the Questionnaire

The purpose of this survey is to gauge public knowledge and awareness about the conservation laws that may affect them and to discover what would be the most preferred acquisition method if the DRNA were to acquire their land. Each question within the survey has a specific purpose. Understanding that purpose is crucial to being able to analyze the responses.

The first question asks what municipality the respondent's property resides. The answer to this question can allow the DRNA to group results by region while still allowing the respondent to remain anonymous. Results from the second question, the respondent's perceived value of his or her property, can be used to separate the responses from sampled landowners into similar property value ranges. The third question asks whether or not the respondent knows about the law previous to receiving the brochure. Its purpose is to discover the educational impact of the brochure and gauge public awareness of conservation legislation. If a majority of the recipients respond that they had not previously been aware of the law, this may indicate that the DRNA, with help from the Commonwealth of Puerto Rico, needs to better publicize conservation efforts and accompanying laws.

The fourth and fifth questions deal with the sentiment of the property owners about the new corridor legislation. The purpose of these two questions is to identify possible opposition to the corridor. After reading the brochure, if people still believe that the corridors are unnecessary, then it is likely they will not want to allow their land to be used for the conservation effort. The DRNA can conclude that they might have difficulty acquiring land from such landowners.

The sixth question deals with how the DRNA can approach acquiring the land involved in the corridor delineation. From these responses, it will become apparent which of the methods would be best to use when actually acquiring the land. This information can be helpful not only in the delineation of the corridors, but also in other DRNA projects where the acquisition of land is required.

The purpose for questions seven and eight is to further determine the sentiments and understanding of property owners about the biological corridors and conservation in general. If the landowner has participated in conservation efforts before, then it is likely he or she would be willing to participate again. Contrarily, if the landowner is worried about the corridor passing through his land then it is possible he or she will not want to help with the corridor establishment. However, if the landowner indicates he is worried because he still does not fully understand the corridor's function, then the DRNA should consider other means of dispersing information to clear any uncertainties.

The ninth question might also give the reviewer an idea as to whether or not the landowner would be willing to participate in a conservation project, either now or in the future. If a landowner's intentions for his or her land do not include agriculture or development, then it is possible the landowner might want to participate in one of the conservation incentives programs.

The remainder of the survey can help facilitate future communications between the DRNA and the property owner. It is our hope that this survey and the accompanying brochure will help the DRNA determine the most cost effective and socially acceptable method of delineating the corridors discussed in Law 1277 (2000).

APPENDIX K – Table of Conversions

Table K.1 Relevant Conversions

Unit	**Equals**
1 ha	10000 m^2
1 ha	11959.9 yd^2
1 ha	.01 km^2
1 ha	$3.861*10^{-3}$ mi^2
1 ha	2.471 acres
1 ha	107639.1 ft^2
1 m^2	$2.471*10^{-4}$ acres
1 yd^2	$2.066*10^{-4}$ acres

APPENDIX L – Law 1277 (2000)

(P. de la C. 1277)

LEY

Para establecer la "Ley para la Unificación de los Bosques Estatales de Maricao, Susúa, Guánica, Toro Negro, Guilarte y Pueblo de Adjuntas", la cual ordena al Secretario del Departamento de Recursos Naturales y Ambientales que identifique los terrenos ubicados entre éstos bosques estatales; demarque los terrenos a utilizarse para trazar dos (2) corredores biológicos que unan los mismos; delimite las zonas de amortiguamiento necesarias; determinen la forma de adquisición de los terrenos a nombre y en representación del Gobierno de Puerto Rico, así como cualquier derecho sobre los mismos, que resulten comprendidos por los corredores biológicos y por las zonas de amortiguamiento; y para otros fines.

EXPOSICION DE MOTIVOS

A nivel mundial, Puerto Rico es considerado como uno de los lugares de mayor densidad en la población. Consecuentemente, la amenaza urbana a sus áreas forestales se hace cada día mayor. Esta situación afecta la capacidad de los sistemas forestales para proveer recursos esenciales a la salud y bienestar del pueblo puertorriqueño.

Para el 1985, el treinta y dos (32) por ciento del territorio de Puerto Rico se componía de bosques, porcentaje que ha reflejado una tendencia descendiente. De esta área, el ochenta y cinco (85) por ciento se compone de propiedades privadas. Por tal razón, es sumamente importante que el Secretario del Departamento de Recursos Naturales y Ambientales establezca una comunicación eficaz con dichos propietarios con el fin de concientizarlos del valor de estos suelos boscosos; busque alternativas que beneficien a tales propietarios, a nuestra comunidad y al Estado, y establezca programas de asistencia tecnológica para sacar provecho económico a los bosques.

Actualmente, Puerto Rico cuenta con dieciséis bosques estatales ubicados de forma dispersa a través de toda la Isla. El aislamiento de cada bosque causa varios efectos: una limitación en la biodiversidad de las especies debido a la endogamia; la competencia por el alimento y el espacio; la alteración de los patrones de vida de estas especies; y la vulnerabilidad de las mismas a la depredación.

Las leyes de la naturaleza señalan que las diferentes especies dependen de una red de interacciones llevadas a cabo en su hábitat natural. Por ende, toda población de vida silvestre está sujeta al hábitat en el cual se procrea o alimenta necesitando, además, el espacio adecuado para su desarrollo y multiplicación. Es evidente que la relación entre el bosque y las especies resulta imprescindible para el aumento de la biodiversidad de las especies y la manutención de un balance o equilibrio ecológico. Esta máxima de interacción nos ilustra, que el aislamiento de los bosques coloca en alto riesgo la propia existencia de las especies.

Los bosques, recursos naturales capaces de restaurar el balance ecológico del medio ambiente, producen una serie de beneficios que nos ayudan a mantener una mejor calidad de vida, tales como: el aislamiento de ruidos; ayuda a la conservación de cuerpos de agua y del suelo; la evolución y refugio para la conservación de la flora y la fauna; la reducción de la temperatura y la estabilidad económica del sector en el cual se encuentran propiedades cercanas; y un ambiente sano para la recreación al aire libre y para la inspiración.

La presente medida es cónsona con las disposiciones de la Ley Núm. 133 de 1 de julio de 1975, según enmendada, conocida como "Ley de Bosques de Puerto Rico", especialmente con la política pública forestal del Estado Libre Asociado de Puerto Rico instaurada en su Artículo 2; y la Sección 19 del Artículo VI de la Constitución del Estado Libre Asociado de Puerto Rico, que establece la política pública para la más eficaz conservación de los recursos naturales de nuestra Isla, así como el mayor desarrollo y aprovechamiento de los mismos para el beneficio general de la comunidad.

Esta Asamblea Legislativa se propone fomentar aquellas acciones dirigidas a conservar nuestro ambiente, asegurar el balance ecológico de nuestra Isla; y proteger la vida silvestre. Este proyecto es una medida de conservación efectiva que integra los bosques de la región central oeste de la isla. Para lograr este objetivo se considera establecer dos corredores: uno, desde el Bosque de Maricao que pase por el Bosque de Susúa y termine en el Bosque de Guánica. Este corredor integrará un sistema ecológico que se desplaza desde una base geológica de serpentina a caliza. El otro corredor biológico unirá los Bosques de Toro Negro, Guilarte y Pueblo de Adjuntas. La unión de los terrenos de cordillera con los de la costa protegerá una mayor diversidad de especies y ecosistemas. Las zonas de amortiguamiento alrededor de estos bosques constituyen un elemento importante ya que ofrecen protección a su integridad fijando áreas de transición entre la vida urbana y la boscosa o rural.

DECRETASE POR LA ASAMBLEA LEGISLATIVA DE PUERTO RICO:

Artículo 1.-Título.-

Esta Ley se conocerá como "Ley para la Unificación de los Bosques Estatales de Maricao, Susúa, Guánica, Guilarte, Pueblo de Adjuntas y Toro Negro".

Artículo 2.-Declaración de Política Pública.-

Constituye política pública del Gobierno de Puerto Rico la adquisición y protección de terrenos forestales localizados entre los bosques mencionados en el Artículo 1 de esta Ley para crear dos (2) corredores biológicos con el propósito de expandir el territorio forestal y unificar dichos bosques. La importancia de crear un cordón de territorio forestal o boscoso es proveerle a las especies un hábitat natural, seguro, saludable y espacioso para garantizar su desarrollo y proliferación.

Los sistemas naturales constituyen un valioso recurso para restablecer el balance ecológico del medio ambiente, proteger el suelo de la erosión; regular el clima; producir oxígeno para mitigar el calentamiento global; proteger las cuencas hidrográficas o vertientes y reservas de agua fresca; y ser fuente de una gran cantidad de actividad biológica, lo cual provee un albergue a la vida animal y vegetal, entre otros.

El Gobierno de Puerto Rico reconoce, además, que debemos de actuar para generar cambios culturales e individuales basados en el valor intrínseco que tienen todos los recursos naturales. Dichos cambios implican prácticas nuevas, a raíz de las cuales estrecharemos nuestra relación con los sistemas naturales que nos rodean; y aprenderemos más sobre los procesos de la naturaleza y nuestro lugar dentro de ella.

Artículo 3.-Definiciones.-

Para los propósitos de esta Ley, los siguientes términos y frases tendrán el significado que a continuación se expresa:

(a) "Corredor biológico" significa el pasillo natural que une dos o más sistemas forestales con el propósito de expandir el hábitat de las especies, facilitando su libre reproducción y desplazamiento.

(b) "Zona de amortiguamiento" significa la franja natural que bordea los sistemas forestales cuya función es proteger la integridad de los mismos, sirviendo de área de transición entre la vida silvestre y el efecto antropológico.

(c) "Bosques" significa comunidades biológicas dominadas por árboles o arbustos leñosos incluyendo también otros tipos de plantas y fauna asociada que se encuentra en terrenos públicos o privados, urbanos o rurales.

(ch) "Bosques auxiliares" significa la clasificación de terrenos realizada por el Secretario del Departamento de Recursos Naturales y Ambientales en virtud del Artículo 10 de la Ley Núm. 133 de 1 de julio de 1975, según enmendada, conocida como "Ley de Bosques de Puerto Rico".

(d) "Reserva natural" significa aquellas áreas así designadas por la Junta de Planificación mediante Resolución que por sus características físicas, ecológicas, geográficas y por el valor social de los recursos naturales existentes en ellas, ameritan su conservación, preservación o restauración a su condición natural a tono con los Objetivos y Políticas Públicas del Plan de Usos de Terrenos de Puerto Rico, adoptado por la Junta el día 8 de junio de 1977 y por el Gobernador el día 22 de junio de 1977.

(e) "Secretario" significa el Secretario del Departamento de Recursos Naturales y Ambientales.

(f) "Junta" significa Junta de Planificación de Puerto Rico.

Artículo 4.-Deslinde de los Corredores Biológicos y Delimitación de las Zonas de Amortiguamiento; Facultades y Deberes del Secretario.-

Dentro del marco de sus respectivas facultades, se ordena al Secretario a realizar los siguientes actos, así como cualesquiera otros convenientes y necesarios para los fines de esta Ley:

(1) Identificar los terrenos ubicados entre los bosques estatales de Maricao, Susúa y Guánica; y de los de Guilarte, Pueblo de Adjuntas y Toro Negro. Se considerará como terrenos entre los bosques mencionados, toda área de suelo formada por terrenos boscosos que comprenda la formación de dos corredores biológicos: uno entre los bosques de Maricao, Susúa y Guánica y el otro entre los bosques de Guilarte, Pueblo de Adjunta y Toro Negro y las zonas de amortiguamiento a ser establecidas para éstos.

(2) Realizar un estudio y evaluación con el objetivo de demarcar o deslindar los terrenos a utilizarse para trazar los corredores biológicos que unan a estos bosques;

(3) Delimitar las zonas de amortiguamiento necesarias;

(4) Preparar planes para adquirir, a nombre y en representación del Gobierno de Puerto Rico, los terrenos, así como cualquier derecho sobre los mismos, que comprenden los corredores biológicos indicados y las zonas de amortiguamiento, siempre y cuando dichos terrenos no estén clasificados como bosques auxiliares ni designados como bosques estatales; y que su titularidad no constituya un obstáculo al establecimiento de los corredores biológicos ni las zonas de amortiguamiento.

(5) Promulgar un reglamento al amparo de esta Ley para cumplir con los propósitos esbozados en la misma.

Disponiéndose, además, que el Secretario deberá establecer una comunicación eficaz con el Secretario de Agricultura para armonizar las prácticas agrícolas con el mantenimiento de los terrenos forestales y con los propietarios de los terrenos boscosos que puedan resultar comprendidos por los corredores biológicos y las zonas de amortiguamiento, a fin de orientarlos sobre la posibilidad de que los mismos puedan ser así clasificados como bosques auxiliares, en cuyo caso, no serán adquiridos a nombre del Gobierno de Puerto

Rico en virtud de esta Ley, a menos que su titularidad constituya un impedimento a la instauración de los corredores biológicos propuestos o a las zonas de amortiguamiento.

Artículo 5.-Reglamento.-

La preparación del reglamento requerirá la celebración de vistas públicas en las áreas concernidas, de forma tal que la comunidad tenga la oportunidad de expresarse en torno a esta Ley y el contenido del referido reglamento.

Entre otras cosas, dicho reglamento deberá incluir lo siguiente:

(1) Una vez celebrada las vistas públicas requeridas en las cuales, además, se habrán de someter los trazados propuestos inicialmente para establecer los corredores biológicos y las zonas de amortiguamiento, y habiéndose tomado en consideración lo expresado en las mismas, los trazados finalmente seleccionados para dicho propósito, a fin de unificar los bosques estatales de Maricao, Susúa, Guánica, Guilarte, Pueblo de Adjuntas y Toro Negro, deberán ser incluidos y claramente señalados en el reglamento.

(2) El reglamento incluirá las normas que se deberán observar en los corredores biológicos y las zonas de amortiguamiento. Además, dispondrá las pautas y los requisitos aplicables al territorio deslindado o demarcado relacionado con los derechos, usos permitidos, restricciones, incentivos y otras condiciones específicas pertinentes a los corredores biológicos y las zonas de amortiguamiento.

(3) Este reglamento prohibirá la construcción de viviendas, el desarrollo de urbanizaciones, centros comerciales, industrias o cualquier otro tipo de desarrollo urbano o comercial que pueda amenazar la integridad de los bosques y la conservación de los corredores, sus zonas de amortiguamiento y la vida silvestre. Se restringirá la construcción de viviendas y carreteras.

(4) El reglamento establecerá las normas que se seguirán cuando se tengan que realizar mejoras o expansiones a carreteras.

Después de haberse elaborado el reglamento, acorde a lo dispuesto en este Artículo, el Secretario y el Presidente de la Junta someterán el mismo para la aprobación de la Asamblea Legislativa al comienzo de la sexta sesión ordinaria de 1999. Junto con el reglamento, los mismos presentarán un informe de los costos y gastos necesarios para la implantación de esta Ley, incluyendo la utilización de los fondos disponibles recaudados mediante la autorización dispuesta en la misma.

Artículo 6.-Vías de Acceso.-

Se ordena a la Autoridad de Carreteras y Transportación a estudiar las vías de acceso existentes en el área propuesta para los corredores biológicos y las zonas de amortiguamiento. Disponiéndose, además, que evaluarán y someterán al Secretario alternativas de desvíos, rutas alternas o cualquier otra solución dirigida a no alterar la integridad de dicha área, predicada en la convicción de que bisectar las áreas naturales es contraproducente a estos sistemas. Estas alternativas se presentarán a las comunidades afectadas en las vistas públicas a celebrarse previa a la preparación del reglamento referido en el Artículo 5 de esta Ley.

Después de haber recibido el insumo de las personas concernidas en las vistas públicas, la Autoridad de Carreteras y el Departamento de Transportación y Obras Públicas determinarán, conforme a sus respectivas facultades, las rutas, desvíos o cualquier otra solución que habrá de implantarse para proteger el área designada que comprenda los corredores biológicos y las zonas de amortiguamiento.

Artículo 7.-Comité Asesor.-

Se crea un Comité Asesor el que será presidido por el Secretario y estará compuesto por los siguientes miembros permanentes o un representante que éstos designen: Secretario del Departamento de Agricultura, Secretario del Departamento de Transportación y Obras Públicas, Presidente de la Junta de Planificación, Director de la Administración de Terrenos, el Director del Centro de Recaudación de Ingresos Municipales, Alcaldes de los municipios de Jayuya, Ciales, Orocovis, Peñuelas, Adjuntas, Yauco, Sabana Grande, San Germán, Maricao, Guánica, Guayanilla, Arecibo y Utuado; uno o dos miembros de la comunidad científica o universitaria y cualquier otro miembro que el Secretario estime necesario, cuya función esté relacionada con los fines de esta Ley y que esté facultado para brindar voluntariamente el asesoramiento técnico y profesional necesario para la implantación de la misma; y por dos personas provenientes de la empresa privada y de entidades sin fines de lucro que sean seleccionadas por el Secretario.

Este comité tendrá la función principal de elaborar un plan maestro que incluya lo siguiente:

(a) la identificación de terrenos entre los bosques estatales de Maricao, Susúa y Guánica; y entre los bosques de Guilarte, Pueblo de Adjuntas y Toro Negro que comprendan el trazado de dos corredores biológicos y las zonas de amortiguamiento a ser establecidas;

(b) la demarcación de bordes en las zonas de amortiguamiento necesarias;

(c) un plan de deslinde para los corredores biológicos y las zonas de amortiguamiento;

(d) un inventario de la flora y la fauna existente; trazados para los corredores biológicos y las zonas de amortiguamiento;

(e) propuesta vial para el área;

(f) creación de incentivos para los dueños de los terrenos identificados a ser comprendidos por los corredores biológicos o por las zonas de amortiguamiento;

(g) diseño de una campaña educativa y de promoción para la protección y conocimiento del sistema de bosques de la Cordillera Central y de la costa;

(h) diseño para la identificación de posibles áreas recreativas en el sistema de bosques;

(i) rezonificación de las áreas que comprenden el sistema de bosques y zonas de amortiguamiento;

(j) un plan diversificado para estimular la actividad económica de productos forestales para aquellas comunidades aledañas a este sistema;

(k) identificación de fuentes de ingreso para la ejecución de esta Ley;

(l) y el itinerario de adquisiciones o convenios con dueños de terrenos para la conversión de estos terrenos privados en un corredor biológico o zonas de amortiguamiento.

El plan maestro elaborado por el comité asesor será sometido al Secretario quien utilizará el mismo como una guía, conservando, en última instancia, la potestad de modificarlo, de así entenderlo necesario, para el debido desempeño de sus facultades y deberes en virtud de esta Ley.

Artículo 8.-Incentivos.-

Se faculta al Secretario a diseñar incentivos que sean atractivos para los propietarios de los terrenos que resulten incluidos en los corredores biológicos o las zonas de amortiguamiento, a fin de que los mismos colaboren en la consecución de los objetivos de esta Ley; a estimular la actividad económica en los bosques mediante asistencia técnica, la siembra de árboles madereros, repoblación y plantío en terrenos baldíos y de uso agrícola, establecimiento de aviarios para la reproducción de especies en cautiverio, en peligro de extinción; y cualesquiera otros cónsonos con los propósitos y objetivos de esta Ley.

Artículo 9.-Fondos.-

Los fondos requeridos para la implantación de esta Ley se obtendrán de aportaciones de empresas privadas, entidades sin fines de lucro, y del Fondo Especial de Desarrollo Forestal, según establecido en el Artículo 7 de la Ley Núm. 133 de 1 de julio de 1975, según enmendada, conocida como "Ley de Bosques de Puerto Rico".

Para la ejecución de esta Ley, también se autoriza por este Artículo la aceptación de fondos federales por parte del Secretario.

Artículo 10.-Vigencia.-

Esta Ley comenzará a regir inmediatamente después de su aprobación.

. . . .

Presidente de la Cámara

. . . .

Presidente del Senado

APPENDIX M – Contents of Accompanying CD-ROM

A CD accompanies the report which includes the IQP document, all ArcView™ layers used to design the corridors, an MS Access™ database of all property and landowner data, final presentation slides, the brochure, and the survey.

View the readme.txt file on the CD-ROM to learn how to open the ArcView™ project file properly.

Table M.1 Contents of Accompanying CD-ROM

File	Description
\AEXPLORER\	Directory containing installation files for the free ArcExplorer™ program required to view the ArcView™ layers
\arcview_files\	Directory of all ArcView™ layers used in designing the corridors
\ arcview_files\corridors.apr	ArcView™ project file
\ arcview_files\corridors.aep	ArcExplorer™ project file
\arcview_tools\	Directory with tools and extensions for use with ArcView™
\report\Brochure-english.doc	English version of the informational corridor brochure
\report\Brochure-spanish.doc	Spanish version of the informational corridor brochure
\report\FDWC.pdf	Fleury & Brown's Framework for the Design of Wildlife Corridors (reprinted from Fleury & Brown, 1997)
\report\IQP.doc	MS Word™ document of this report
\report\Properties_2000.mdb	MS Access™ 2000 database containing property numbers, tax-assessed values, acreages, and landowner contact information for all corridor properties
\report\Properties_97.mdb	MS Access™ 97 version of the Properties_2000.mdb database.
\report\Survey.doc	Questionnaire to be distributed to landowners

Glossary

Abiotic – characterized by the absence of life, such as soils and physiography

Biodiversity – The complexity of a gene pool in a given ecosystem

Biogeoclimatic – Of, relating to, or concerned with the relations of climate, living matter, and geography

Biotic – Characterized by the presence of life, such as flora and fauna

Bitmap – Uncompressed computer image file

Composition – Different layers of vegetation within a forest

Edge – Outer band in which species and vegetative composition differ from the interior of the patch.

Expropriate – Technique for acquiring land in which the government forces landowners from their land and pays them market value for the acquired property

Fragmentation – A forest becomes fragmented when it is separated from itself because of land development within it.

Hectare - Metric measurement for area. 1 hectare is 10,000 square meters, or approximately 2.47 acres.

Matrix – The environmental context in which a patch of land is located.

Network connectivity – The degree to which all the nodes of a system are connected.

Patch – The area of land to be connected by the corridor.

Watershed - A watershed is an area of land that permits water runoff into a lake or river at the basin ("Putting Together a Watershed," 2001).

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