



United States
Department of
Agriculture



El Yunque
National Forest

Draft
Environmental Impact Statement
for the Revised Land and Resource Management Plan



Forest
Service

Region 8

El Yunque
National Forest

R8-MB 148 B

September
2016

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Draft Environmental Impact Statement for the Revised Land and Resource Management Plan

Rio Grande, Puerto Rico

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Abstract: Three alternatives for revision of the 1997 El Yunque National Forest Revised Land and Resource Management Plan (Forest Plan) are described, compared, and analyzed in detail in this draft Environmental Impact Statement (EIS). Alternative 1 represents no change from the current Forest Plan. Alternative 2 is the proposed action for the draft revised Forest Plan and the alternative preferred by the Forest Service. Alternative 3 is a variation of alternative 2.

Comments on this draft EIS must be received or postmarked within 90 days of the Environmental Protection Agency's publication of the notice of availability in the *Federal Register*. It is important that reviewers provide their comments at such times and in such a way that they are useful to the agency's preparation of the final Environmental Impact Statement. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action (40 CFR 1502.10).

The decision to approve the revised Forest Plan for the El Yunque National Forest will be subject to the objection process identified in 36 CFR Part 219 Subpart B (219.50 to 219.62). Only those individuals and entities who have submitted timely and substantive formal comments related to the El Yunque National Forest Plan revision will be eligible to file an objection (36 Code of Federal Regulations (CFR) 219.53(a)).

Send comments to:

El Yunque National Forest
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Electronic comments may be submitted here: commentselyunqueplan@fs.fed.us
<http://www.fs.usda.gov/project/?project=44662>

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Summary

This draft environmental impact statement (EIS), prepared by the U.S. Forest Service, describes and analyzes in detail the three alternatives for managing the land and resources of the El Yunque National Forest. It describes the affected environment and discloses environmental effects of the alternatives. The process record is available on our public website at:

<http://www.fs.usda.gov/main/elyunque/landmanagement/planning>.

Proposed Action

The El Yunque National Forest proposes to revise the 1997 Land and Resource Management Plan for the Caribbean National Forest and Luquillo Experimental Forest, as amended (hereafter referred to as the 1997 Forest Plan), in compliance with the 2012 planning rule (36 CFR 219.17(3)(b)(1)). The proposed action addresses the planning, collaborative, sustainability, social, economic, and ecological needs that have been identified for the draft revised Plan. The Forest Plan guides all natural resource management activities on the El Yunque National Forest to meet the objectives of Federal law, regulations, and policy. The area affected by the proposal includes about 29,000 acres of the El Yunque National Forest (see Map 1-1).

Purpose and Need for Action

The need to revise the current Forest Plan includes the following:

- The existing Forest Plan is more than 17 years old and has been amended one time.
- There is a need to meet the legal requirements of the National Forest Management Act (NFMA) and the 2012 Planning Rule (36 CFR 219).
- Since the Forest Plan was approved in March 1997, there have been changes in economic, social, and ecological conditions, new policies and priorities, and new information based on monitoring and scientific research.
- There is a need for these changes to be reflected in the Plan.
- Extensive public and employee involvement, along with science-based evaluations, have helped to further identify the areas of the existing Forest Plan that need to be changed.

From 2012 through 2016, the El Yunque National Forest developed the El Yunque National Forest Plan Assessment (USDA Forest Service 2014), the El Yunque National Forest Need for Change (USDA Forest Service 2014, 2015) and the El Yunque Plan Revision, Proposed Management Strategies (USDA Forest Service 2015, 2016). The purpose of these documents was to assess new information, changes in technology, the 2012 Planning Rule, land uses, and to identify what did and did not work well in the 1997 Forest Plan. These assessments and public comments and recommendations were summarized into five areas where a change from current Forest Plan direction is needed:

1. Incorporate collaborative adaptive management at the Plan and site-specific levels.
2. Define a new recreation, access, and tourism system.
3. Promote a stronger regional identity in and around the Forest using an “all-lands” policy.
4. Increase regional environmental literacy and educating local communities.
5. Provide for healthy ecosystems.

Public Involvement

The notice of intent (NOI) to prepare an EIS was published in the *Federal Register* on September 18, 2014 (79 FR, pages 56050-56054). The legal notice was published in the two newspaper of record, *Nuevo Dia* and *San Juan Daily Star* on September 14, 2015. The public was asked to comment on the proposed action by November 3, 2014. From 2014 to 2015, approximately 28 outreach activities and meetings were hosted (see planning record or appendix A). Planning outreach activities included meetings with different communities and the public in general in locations that were accessible to the different municipalities located to the north, east and southwest of the Forest. Meetings were held with stakeholders including recreation outfitters, protected area land managers, municipality planners, the scientific and academic community, and the Center for Landscape Conservation (CCP for its acronym in Spanish). The meetings were designed to describe and discuss the existing forest and resource conditions being used to develop the proposed action, and to collect information and comments from the public on land use for the Forest, and to consider suggestions for new alternatives for managing the Forest. Information and recommendations from these planning outreach activities were used to develop the proposed action for the draft revised Plan. The proposed action was shared with the public through a series of community meetings and interest group meetings to validate its content. The public outreach process spanned almost 2 years and the complete public involvement process can be found in the planning record.

There will be additional opportunities for public involvement. Concurrent with the release of this draft EIS, a notice of availability, published in the *Federal Register* initiates the formal 90-day comment period on the draft EIS and proposed Forest Plan as required by NFMA regulations at 36 CFR 219. Only those individuals and entities who have submitted substantive formal comments related to this plan revision during the opportunities provided for public comment will be eligible to file an objection (36 Code of Federal Regulations (CFR) 219.53(a)).

Issues

Significant issues are those directly or indirectly caused by implementing the proposed action. These issues drive the range of alternatives and effects analysis. Alternatives were developed around those issues that involved unresolved conflicts concerning alternative uses of available resources. See the “Alternatives” section in chapter 2. No areas of scientific controversy were identified.

Significant Issues

Based on comments and analysis from Forest Service personnel, the public, other agencies and nongovernmental organizations, the following significant issues were identified:

1. What is the best approach to provide sustainable recreation opportunities that minimize impacts to the forest while meeting current and future needs and demands of users and surrounding communities?
2. What is the best approach to respond to the potential effects of climate change on Forest resources and ecosystem services?
3. How, where, and to what extent can the Forest provide opportunities that contribute to and enhance social and economic conditions in the region?

Alternatives

Three alternatives are described, compared, and analyzed in detail.

Alternative 1.

The “no action” alternative would continue management under the 1997 Revised Land and Resource Management Plan for the Caribbean National Forest and Luquillo Experimental Forest, as amended. The alternative retains the 1997 Forest Plan goals and objectives, standards and guidelines and nine management area prescriptions (as amended). Management would continue to be focused on four vegetation types and would retain direction for managing species as management indicator species. Recreation would continue to be promoted in functional wetlands that are above 600 meters in elevation. One area suitable for wilderness designation (the Baño de Oro Inventoried Roadless area) would continue to be managed as part of the proposed expansion to the Baño de Oro Research Natural Area, which would continue to provide for long-term watershed research and studies. Three rivers would remain eligible for wild and scenic river designation. This alternative does not address sustainable forest recreation or include management areas that would improve social and economic development at a broader landscape scale.

Alternative 2.

Alternative 2 is the proposed action for the draft revised Forest Plan. It addresses public desire to access the forest for recreation, but recognizes carrying capacities and the need to maintain sufficient infrastructure to support visitation. It addresses climate change by shifting recreational opportunities at the lower elevations of the Forest, which are better suited for recreational use. Alternative 2 would:

- Propose a new planning system based on ecological, social, and economic sustainability.
- Recognize the need to protect and restore the functional wetlands that occur over 600 meters in elevation and increase forest vegetation types from 4 to 15 to reflect the new vegetation classification system and the Forest’s most recent findings.
- Promote recreation sustainability, and address increased demands and needs by promoting recreation at lower elevations in a setting closer to local communities.
- Introduce plan components for environmental education, collaboration, and ecosystem services.
- Establish nine management areas including a new scenic byway corridor for PR 186.
- Establish three geographic areas (El Norte, El Este and El Oeste and Sur) to increase community interactions and an “all-lands” approach to planning.
- Establish a community interface resource management area (CIRMA).
- Create an expanded management area for the purpose of research and long-term watershed studies.
- Remove direction for managing species as management indicator species and replace it with species of conservation concern.
- Provide additional management direction for priority watersheds using the national watershed condition framework.

Alternative 2 would retain existing Forest Plan direction (including standards and guidelines) for research on wilderness and wild and scenic rivers on the Forest.

Alternative 3.

Alternative 3 was developed to respond to concerns related to sustainability. It would reduce the number of maintained trail miles. This alternative would expand wilderness, and would not create a scenic byway management area. This alternative is based on alternative 2 with the following changes:

- Recommend designation of the Baño de Oro Research Natural Area as wilderness.

- Provide additional plan components to address invasive species management in areas of road rights-of-way, recreation areas, and threatened and endangered habitats in order to manage non-native species and restore landscape-level conditions.
- Address some sustainable recreation concerns by reducing the trail system to a level that can be maintained.
- Create two geographic areas, North and South, to connect with communities on both sides of the Forest.
- Exclude the scenic byway management area for PR 186, due to the amount of use this would produce on the western side of the Forest.

Alternatives Considered but Eliminated from Detailed Study

Public comments received in response to the proposed action provided suggestions for alternative methods of achieving the purpose and need. Some of these alternatives may have been outside the scope of what can be included in the draft, revised El Yunque Forest Plan, duplicative of the alternatives considered in detail or determined to be components that would cause unnecessary environmental harm. Three alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

Custodial (no recreation management, special uses, or research management).

This alternative was not considered in detail because it does not meet law or policy requirements to provide multiple uses. The Forest has “experimental forest” designation.

Intense recovery of the Puerto Rican parrot.

This alternative was not considered in detail because El Yunque National Forest is not preferred habitat.

Recommending designation of all eligible wild and scenic rivers.

This alternative was not considered in detail for the following reasons:

- There is little public interest in wild and scenic river designation for six rivers;
- Additional areas would increase management complexity; and,
- People would still like to have access to these areas.

Summary of Effects and Comparison of Alternatives

Ecological Sustainability.

All native ecosystems and native species, including at-risk species, would be protected in all alternatives. Each alternative includes the Forest Plan components for ecosystem diversity necessary to provide the ecological conditions to conserve threatened and endangered species. Alternative 1 emphasizes the acquisition and conservation of key land units connected to the Forest, addressing some interests in landscape connectivity. However, Forest Plan (proposed action) components that promote landscape connectivity and an “all-lands” approach to Forest management and conservation is a key in alternative 2 through the development of a new community interface resource management area (CIRMA) and the identification of three geographic areas. The geographic areas target conservation initiatives that may be developed, including stream corridors and riparian areas. The new management and geographic areas provide plan components that connect the Forest to other public lands and protected areas. In alternative 2

these areas provide direction that would identify and protect critical connections and developments at the sub-regional level.

Soil, water and air quality would be maintained in all alternatives. Alternative 2 would include watershed priority management to improve watershed conditions in specific areas.

Climate change is expected to create impacts, such as sea-level rise, increases in temperature, and greater variation in precipitation. Management direction in all alternatives focuses on creating diverse, functioning ecosystems that are resilient to these changes. The draft revised plan (alternative 2) proposes aligning management areas, enhancing landscape connectivity, and maintaining wetland conditions to foster amphibian habitat.

The Forest Plan components for the experimental forest designation would be retained in all alternatives. Alternative 2 would include a management area designated for ongoing, long-term research (Bisley, El Verde, Baño de Oro) and emphasize Forest monitoring as a fundamental part of adaptive management.

Social and Economic Sustainability.

In all alternatives the Forest would continue to provide open space and natural settings, as well as an array of goods and services that are important to nearby residents and various communities of interest. However, alternative 1 (current plan) does not include components oriented toward sustainable recreation opportunities and settings. In the long term, this direction would lead to adverse impacts from increased, unsustainable recreation across the Forest. Alternative 1 does not address opportunities for increasing environmental education and literacy at a regional level or with specific groups (e.g., schools, university groups); nor does it provide direction for using research and knowledge development within the context of adaptive forest management. Alternative 2 and 3 are designed to address these needs.

Alternative 2 (proposed action) differs from alternative 1 and alternative 3 in its development of a recreation corridor along PR Road 191, a scenic byway along PR Road 186, and a community interface resource management area (CIRMA) where multiple sustainable uses, including passive and active recreation can be developed and carried out in collaboration with nearby communities and governments. Under the draft revised plan direction, recreation activities would be dispersed to lower elevations of the Forest, alleviating some of the existing pressure of intense use along PR 191, and ultimately allowing for more sustainable levels of recreation throughout the Forest and satisfying a broader range of recreation values and interests. Alternative 3 would eliminate recreation trails that may not be sustainably maintained.

In alternative 1, one area suitable for wilderness designation (the Baño de Oro Inventoried Roadless Area) would continue to be managed as part of the proposed expansion to the Baño de Oro Research Natural Area, providing for long-term watershed research and studies. Three rivers would remain eligible for wild and scenic river designation. Alternative 2 does not recommend any areas for wilderness designation. The draft revised plan would expand (increase the acreage) the Baño de Oro Research Natural Area to include all primary forest on the eastern side of the Forest. No new wild and scenic river recommendations would be provided. Alternative 3 differs from alternative 1 and 2 by recommending the designation of a new wilderness area in the expanded Baño de Oro Research Natural Area. If designated as wilderness, recreation and non-market services interests and values would be served, but research and education stakeholders, particularly manipulative research interests and needs, are likely to be impacted (as these uses would be prohibited under wilderness designation).

While each alternative has the potential to affect local businesses and industrial sectors, the contribution of the El Yunque to the local economy, and the relative differences between the alternatives, would not be

large enough to cause measurable changes to local economic diversity (e.g., the number of economic sectors) or economic dependency (i.e., a limited number of industries dominate the local economy). However, alternative 2 best promotes existing and new economic opportunities tied to the Forest, particularly through the development or demonstration of multiple, sustainable uses in the CIRMA and nearby communities. The draft revised plan (alternative 2) includes management strategies that support community collaboration and development, and ultimately lead not only to the creation of indirect and induced jobs, but also enhanced stewardship of the Forest and its goods and services.

Overall, shifts in the local economy are likely to occur over the next 20 years or so, though not as a direct result of actions implemented under any alternative management scenario. Under all proposed alternatives, payments to the Commonwealth and municipalities would continue to help fund schools, roads, and public services; and ultimately contribute to the sustainability and health of local communities, particularly by supporting important amenities and services provided by local and Commonwealth governments.

Comparison of Alternatives

Tables at the end of chapter 2, beginning on page 31 compare the alternatives by a variety of measures. Table 2-3 qualitatively compares the alternatives by the significant issues identified during the public participation process. Table 2-4 compares the alternatives by management area allocation acres. Table 2-5 compares timber suitability acres and timber volume by alternative. Table 2-6 compares recommended wilderness acres by alternative.

Table S-1. Comparison of alternatives by significant issues

Significant Issues	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3
<p>Issue 1. What is the best way to provide sustainable recreation opportunities that minimize impacts to the Forest while meeting current and future needs and demands?</p>	<p>The 1997 Plan does not include plan components that address sustainable recreation. The plan increases the recreational opportunity; therefore, impacts will be expected to increase. This alternative helps us to meet current and future demands regardless of impacts. The alternative does not contemplate the impacts of recreation site development.</p>	<p>The alternative provides for sustainable recreation by including plan components that consider wetlands, community interface areas, limits on capacity and funding. The alternative addresses current conditions of cultural resources, the need to protect sensitive areas at higher elevations, disperse the recreational opportunity away from PR Road 191 in order to decrease crowding and improve setting.</p>	<p>This alternative provides for sustainable recreation. The plan reduces the recreational opportunity and setting by reducing the trail system. The alternative responds to the issue by reducing capability to meet demands.</p>
<p>Issue 2. What is the best approach to respond to the potential effects of climate change on the Forest resources, ecosystem services and others?</p>	<p>This alternative does not respond to the issue. There are no specific plan components in response to climate change.</p>	<p>The alternative contains plan components that focus on climate change.</p>	<p>The alternative responds to the issue by promoting species management on T&E Habitats and invasive species. Provides a stronger response to climate change.</p>
<p>Issue 3. How, where, and to what extent can the Forest provide opportunities that contribute to/enhance social and economic conditions in the region?</p>	<p>The Forest's main contributions to the social and economic condition would continue to include recreation, water and biodiversity. The alternative responds to the issue by maximizing outputs of recreational opportunities, providing for water, timber products and research within the Forest.</p>	<p>The alternative responds to the issue by introducing recreational sustainability, establishing plan components for recreation along Road 191 and shifting recreation opportunities to lower elevations, establishing a new access, recreation and tourism strategy based on collaboration and community partnerships. It best promotes existing and new economic opportunities tied to the Forest, particularly through the development or demonstration of multiple, sustainable uses in the CIRMA and nearby communities.</p>	<p>This alternative responds to the issue by reducing recreational opportunity within the National Forest lands while promoting recreational opportunities off National Forest lands.</p>

Chapter 1. Purpose of and Need for Action

This draft EIS and draft revised Forest Plan have been prepared in accordance with Title 36 Code of Federal Regulations, Part 219 – National Forest System Land Management Planning (2012 planning regulations), the National Forest Management Act of 1976 (NFMA), the National Environmental Policy Act (NEPA) of 1969 and other relevant Federal and state laws and regulations. This draft EIS discloses the direct, indirect and cumulative environmental impacts that would result from the proposed action and alternatives. This document is organized into the following sections.

Chapter 1. Purpose and Need for Action: This chapter includes information on the history of the project proposal, the purpose and need for the project and the Forest Service’s proposal for achieving the purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2. Alternatives, including the Proposed Action: This chapter provides a more detailed description of the Forest Service’s proposed action as well as alternative methods for achieving the stated purpose. These alternatives are based on significant issues raised by the public and other agencies. This discussion also includes any mitigation measures associated with the proposed action or alternatives. Finally, this section provides summary tables of the environmental consequences associated with each alternative.

Chapter 3. Affected Environmental and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. The analysis is organized by themes developed from public involvement. Major themes include: Ecological sustainability, social and economic sustainability, and resource integration.

Chapter 4. Consultation and Coordination: This chapter provides a list of preparers and agencies consulted during the development of the draft EIS.

Appendices: The appendices provide more detailed information to support the analyses presented in the draft EIS.

References and Literature Cited: This section lists reference documents used in the preparation of this plan.

Note: The draft Forest Plan for El Yunque National Forest is a separate accompanying document. Additional documentation, including more detailed analyses of project area resources, may be found in the planning project record located at the El Yunque National Forest Supervisor’s Office. Key analysis documents can be found online: <http://www.fs.usda.gov/main/elyunque/landmanagement/planning>.

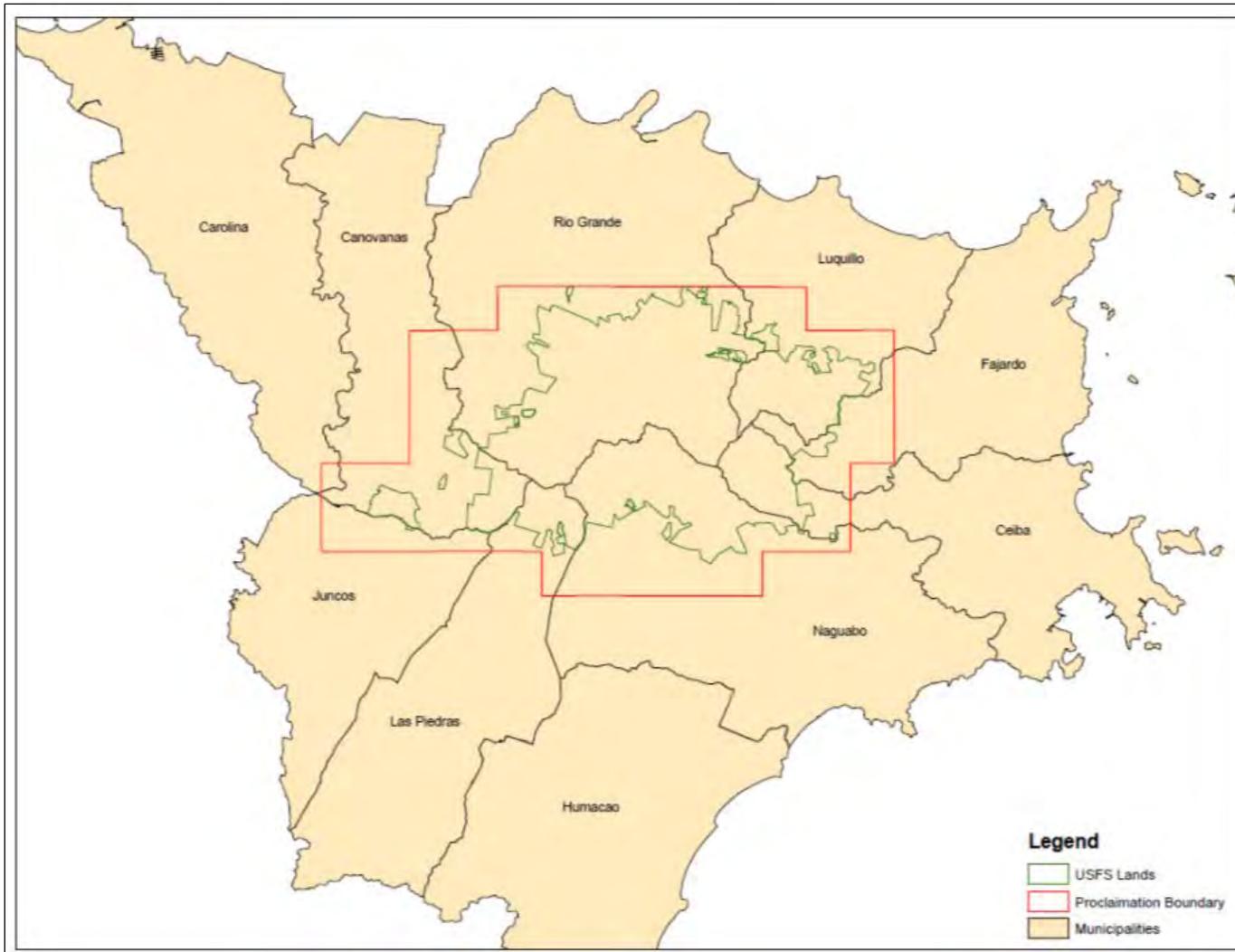
1.1 Location

The El Yunque National Forest is the only tropical forest administered by the USDA Forest Service with a Forest supervisor and staff. The Forest has dual designation as an experimental forest. Offices are located in the El Portal Tropical Forest Center and at the adjacent Catalina Work Station on Highway PR 191, kilometer 4.4, south of Palmer, Puerto Rico.

The Forest is located in the rugged Sierra de Luquillo Mountains, 25 miles southeast of San Juan, Puerto Rico. The Luquillo Mountains raise abruptly from sea level at Las Cabezas de San Juan on the northeastern tip of Puerto Rico to 1,074 meters in elevation at El Toro Peak. The Forest is approximately

29,000 acres (Map 1-1). Elevation ranges from about 330 to 3,533 feet above sea level. Topography is rugged, with 24 percent of the Forest exhibiting 60 percent slope or steeper.

There are three geographic scales considered in this document: municipal, regional, and Island-wide. In Puerto Rico, a municipality is the smallest division of administrative and electoral government, similar to a county in the United States. The Forest is surrounded by nine municipalities in Eastern Puerto Rico: Canóvanas, Ceiba, Fajardo, Juncos, Las Piedras, Luquillo, Naguabo, Rio Grande and Humacao. These comprise more than 185,000 acres (290 square miles), which is about 8.3 percent of the Island's total area. Stretching over 29,000 acres, the National Forest covers about 15 percent of the total El Yunque Region. Of the municipalities surrounding the El Yunque, Rio Grande is the largest in terms of area and also encompasses the largest area of National Forest land within its borders (20.26 square miles; 33.2 percent of its total land base). At the other end of the spectrum, Juncos is the smallest of the region's municipalities and encompasses the smallest area of National Forest land (0.03 square miles, 0.1 percent of municipality).



Map 1-1. El Yunque National Forest and vicinity

1.2 Background

In 1997, the Forest Service developed a management plan that considered several issues and management needs. The 1997 management concept focused on a strong conservation approach. The planning strategy was to obtain a formal designation for the research natural areas, wild and scenic rivers, and wilderness. Finally, the plan addressed the utilization of water, wildlife, and research. The social needs were addressed through recreation and access initiatives.

The 1997 Plan considered the following issues:

1. Demonstrating timber production while assuring compatibility with a diversity of other Forest values.
2. Recommending areas for congressional designation as wilderness.
3. Recommending areas for congressional designation as wild, scenic or recreational rivers.
4. Protecting the Primary Forest.
5. Providing recreation opportunities while protecting the ecological values of the Forest.
6. Protecting wildlife while conducting other forest management activities.
7. Providing and protecting the Forest's water quantity and quality.
8. Providing and managing appropriate Forest access.
9. Meeting the needs of tropical forestry research while protecting the Forest's environmental values.

In 2007, a comprehensive evaluation report (CER) of the Plan was conducted. The purpose was to review the accomplishments of the plan and recommend changes. The CER's findings were:

1. *Land ownership*: Desired conditions should state priorities clearly and emphasize the need for more partnerships.
2. *Access Management*: Desired conditions should address greenhouse gas emissions caused by vehicle traffic.
3. *Facilities*: Desired conditions should be updated to address minimizing construction practices that contribute to greenhouse gas emissions.
4. *Socioeconomics*: Monitoring should be developed to gather data on social and economic trends for future evaluations.
5. *Special Uses and Communication Sites*: Public-private partnerships may need to be increased. Climate change, sustainability, and green technology standards and guidelines should be incorporated into permit uses.
6. *Recreation*: Standards and guidelines for camping should be updated.
7. *Scenery*: Standards and guidelines should be updated using new Scenery Management System.
8. *Heritage*: Desired conditions should provide emphasis on preserving and stabilizing heritage resources. Management direction should be updated to reflect current science.
9. *Minerals*: Desired conditions should be updated to reflect management direction for minerals.
10. *Vegetative Communities*: Desired condition and management direction should be updated to reflect current science.

11. *Fish and Wildlife*: Desired conditions should be updated to provide protection for species that may be affected by climate change.
12. *Air*: Management direction should be updated to reflect current science.
13. *Research*: Desired conditions should be updated to address disclosure of research activities and promote high priority research topics for study.
14. *Timber Demonstration*: Management direction should be updated to reflect current science.

The 2014 and 2015 Need for Change document (USDA Forest Service 2014, 2015) identified the forest plan components that need to be updated or added in this forest planning process. Furthermore, congressional designation of the El Toro Wilderness and the Rio Mameyes, Rio de la Mina and Rio Icacos Wild and Scenic Rivers represented quite an achievement in land allocation. The significant number of recommendations from the comprehensive evaluation report, progress made on six of the nine issues considered in the 1997 Plan, and the assessment findings created the need to change the plan.

In 2012, the Forest Service established an interdisciplinary team (ID team) to lead the plan revision process. In the fall of that same year, the ID team assessed what had been accomplished, new information, changes in technology, new Forest Service Planning Rule and land uses, as well as what did and did not work well in the 1997 Forest Plan. The ID team also developed the following three important documents:

- **El Yunque National Forest Plan Assessment (2014)**. This document consists of ID team specialists' reports and supporting supplemental reports. Several topics are covered including: wildlife habitats, at-risk species, natural disturbances, recreation opportunities, etc. At the beginning of each subsection are findings that highlight accomplishments, changed conditions, challenges, opportunities, data gaps and research needs. The assessment feeds into the affected environment in chapter 3 of this draft EIS.
- **El Yunque National Forest Need for Change (2014–2015)**. This document focuses on management direction that “needs to change” in the current Forest Plan. Using the findings in the assessment, the ID team developed “need for change” statements. These statements framed the scope of the proposed action.
- **El Yunque Plan Revision: Proposed Management Strategies (2015–2016)**. This document addresses need for change statements in the El Yunque National Forest Need for Change. Management strategies describe, in broad terms, how the agency would achieve desired conditions over time while considering priorities, such as program direction, budget trends, past program accomplishments and partnership opportunities. In some instances, these proposed management approaches are applied to areas that are similar in some respect across the El Yunque National Forest and were used to draft social zones or management areas.

These documents are located on the El Yunque website:

<http://www.fs.usda.gov/main/elyunque/landmanagement/planning>.

1.3 Purpose and Need for Action

The need to revise the current Forest Plan includes: (1) the existing Forest Plan is more than 17 years old and has been amended three times. There is a need to meet the legal requirements of the National Forest Management Act (NFMA) and the 2012 Planning Rule (36 CFR 219), (2) since the Forest Plan was approved in March 1997, there have been changes in economic, social, and ecological conditions, new policies and priorities, and new information based on monitoring and scientific research. There is a need for these changes to be reflected in the plan. Extensive public and employee involvement, along with science-based evaluations, have helped to further identify the areas of the existing Forest Plan that need to be changed.

From 2013 through 2016, the El Yunque National Forest developed the El Yunque National Forest-Forest Plan Assessment (USDA Forest Service 2014), the El Yunque National Forest Need to Change (USDA Forest Service 2014, 2015) and the El Yunque Plan Revision: Proposed Management Strategies (USDA Forest Service 2015, 2016). The purpose of these documents was to assess new information, changes in technology, the 2012 Planning Rule, land uses, and to identify what did and did not work well in the 1997 Forest Plan. These assessments and public comments and recommendations were summarized into five areas where a change from current Forest Plan direction is needed:

1. Incorporate collaborative adaptive management at the plan and site specific levels.

- *Sustain and develop partnerships.* Continue current regional collaboration efforts engaged in conservation, management, and land use in a sustainable manner while seeking out opportunities for further partnership efforts. Shift priorities from primarily a Forest Service-driven management focus to more collaborative management. Partnership opportunities and collaborations support the achievement of desired conditions and objectives of the Plan.
- *Integrate agencies and stakeholders in conservation efforts.* Facilitate and coordinate a framework similar to the concept of a State Technical Committee by integrating agencies and concerned citizens in the region in processes to request support or funds for programs and promote outreach for incentive programs available for private land-owners in the areas adjacent to the Forest.
- *Provide opportunities for research.* Develop initiatives with agencies, academic institutions, and citizen scientist groups for various projects.

2. Define a new recreation, access, and tourism system.

- *Provide for sustainable recreation.* The Forest provides sustainable recreation opportunities that are in harmony and sustainable within the natural setting, where people enjoy and value its unique tropical ecosystem which includes protecting and maintaining historical and cultural recreation resources. Future demands and limited agency resources will require public support and new partnerships to improve recreation facilities and services on the Forest as well as the capacity to support recreation usage without causing damage to the environment.

3. Promote a stronger regional identity in and around the Forest using an “all-lands” policy.

- *Consider the ecological, social and economic needs of the broader landscape.* An area (CIRMA) of community interface for management of resources at the lower elevations of the Forest is sustainably managed in accessible locations suitable for multiple use management and provides for forest products.

4. Increase regional environmental literacy and educating local communities.

- *Connect the surrounding communities to the Forest’s natural landscapes.* Assist in developing community capacity for participation in various management activities in areas such as interpretation, education, recreation, economic development, conservation, restoration, research and monitoring. Identify and overcome barriers that inhibit these populations from connecting socially, culturally and economically to the natural landscapes within and surrounding the Forest.

5. Provide for healthy ecosystems

- *Conserve and restore ecosystems.* Protect and conserve the functional wetlands and primary forest and maintain and improve watershed conditions on the Forest while monitoring, adapting and mitigating the impacts of climate change.

1.4 Proposed Action

The El Yunque National Forest proposes to revise the 1997 Land and Resource Management Plan for the Caribbean National Forest and Luquillo Experimental Forest, as amended (hereafter referred to as the 1997 Forest Plan), in compliance with the 2012 planning rule (36 CFR 219.17(3)(b)(1)). The proposed action addresses the planning, collaborative, sustainability, social, economic, and ecological needs that have been identified for the draft revised plan. The Forest Plan guides all natural resource management activities on the El Yunque National Forest to meet the objectives of Federal law, regulations and policy. The area affected by the proposal includes about 29,000 acres of the El Yunque National Forest (Map 1-1). See the “Alternatives” section for detailed information.

1.5 Decision Framework

The responsible official for the analysis is the Forest Supervisor for the El Yunque National Forest. Based on the analysis and subsequent public comments, the responsible official will prepare a final environmental impact statement and identify a selected alternative in a draft record of decision that will be subject to an objection process guided by the direction in 36 CFR 219 Subpart B (219.50 to 219.62).

The decision will:

- Establish desired conditions and objectives;
- Establish Forestwide design criteria (standards and guidelines);
- Establish management areas and geographic areas;
- Determine suitability of land;
- Determine the maximum amount of timber that might be removed;
- Recommend areas for inclusion in the National Wilderness Preservation System (36 CFR 219.7(c)(2)(v)) if applicable; and
- Identify eligible wild and scenic rivers (36 CFR 219.7(c) (2) (vi)) if applicable

A final record of decision and accompanying Forest Plan sets a course of action for managing the Forest for the next 10 to 15 years. Project-level environmental analysis will still need to be completed for specific proposals to implement the direction in the Forest Plan.

1.6 Public Involvement

The notice of intent (NOI) to prepare an EIS was published in the Federal Register on September 18, 2014 (79 FR, pages 56050-56054). The legal notice was published in the two newspaper of records, *Nuevo Dia* and *San Juan Daily Star* on September 14, 2014. The public was asked to comment on the proposed action by November 3, 2014. From 2014 to 2015 approximately 28 outreach activities and meetings were hosted (see planning record). Planning outreach activities included meetings with different communities and the public in general in locations that were accessible to the different municipalities located to the north, east and southwest of the Forest. Meetings were held with stakeholders including recreation outfitters, protected area land managers, municipality planners, the scientific and academic community and the Center for Landscape Conservation (CCP for its acronym in Spanish). The meetings were designed to describe and discuss the existing Forest and resource conditions being used to develop the proposed action; to collect information and comments from the public on land use for the Forest, and to consider suggestions for new alternatives for managing the Forest. Information and recommendations from these planning outreach activities were used to develop the proposed action for the draft revised plan. The proposed action was shared with the public through a series of community meetings and interest

group meetings to validate its content. The public outreach process spanned more than two years and the complete public involvement process can be found in the planning record.

There will be additional opportunities for public involvement. Concurrent with the release of this draft EIS, a notice of availability (NOA), published in the *Federal Register* initiates the formal 90-day comment period on the draft EIS and proposed Forest Plan as required by Forest Service NFMA regulations at 36 CFR 219. Only those individuals and entities who have submitted substantive formal comments related to this plan revision during the opportunities provided for public comment, will be eligible to file an objection (36 Code of Federal Regulations (CFR) 219.53(a)).

1.7 Issues

Significant issues are those directly or indirectly caused by implementing the proposed action. These issues drive the range of alternatives and effects analysis. Alternatives were developed around those issues that involved unresolved conflicts concerning alternative uses of available resources. See the “Alternatives” section in chapter 2. No areas of scientific controversy were identified under the proposed action.

Based on comments from Forest Service personnel, the public, other agencies and non-governmental organizations, the following significant issues were identified:

The Forest Service separated the issues into two groups: significant and non-significant issues. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. Non-significant issues were identified as those: (1) outside the scope of the proposed action; (2) already decided by law, regulation, Forest Plan, or other higher level decision; (3) irrelevant to the decision to be made; or (4) conjectural and not supported by scientific or factual evidence. The Council on Environmental Quality (CEQ) NEPA regulations explain this delineation in Sec. 1501.7, “...identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)...”.

A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the process record. Additional information is available on our public website at: <http://www.fs.usda.gov/main/elyunque/landmanagement/planning>.

The Forest Service identified the following significant issues during scoping:

1. What is the best approach to provide sustainable recreation opportunities that minimize impacts to the Forest while meeting current and future needs and demands of users and surrounding communities?

Forest management strategies should determine an appropriate offering of sustainable recreation opportunities that respond to increasing and changing demands while providing for public health and safety, cultural resources stewardship and ecosystem protection (such as soil and water and riparian resources, wildlife habitat, and control of non-native invasive species).

The Forest, a popular tourism destination on the Island and within close proximity to the metropolitan area of San Juan, receives over 1 million visitors annually. Visitors use the Forest for a variety of recreational opportunities such as hiking, water play, sightseeing and camping. Much of the recreational infrastructure used by the public such as the trails, observation towers and picnic areas also constitute historic sites constructed during the 1930.

People want access to the Forest for recreation, but carrying capacities, user impacts to resources and maintaining sufficient infrastructure to support visitation, need to be determined. The lower elevations of the Forest may be better suited to provide recreation uses or access while the need to protect primary forest, cloud forest and wetlands (mainly above 600 meters in elevation), may be in conflict with recreational user demands. Some people want Forest recreation access to be more controlled and limited while others want more access to new areas and some prefer re-use of existing and abandoned sites before developing new ones.

2. What is the best approach to respond to the potential effects of climate change on Forest resources and ecosystem services?

The Forest should be able to contribute to the conservation of ecological system diversity on a landscape scale and simultaneously provide for the needs of diverse plant and animal species, as well as people. Forest uses and management activities may affect soil and water quality; riparian, wetland and watershed resources and the maintenance and restoration of terrestrial and aquatic biodiversity. The Forest may need to address additional challenges that increasing human population and urban development may present.

Ecosystem services are the suite of goods and services from the Forest vital to human health and livelihood and are traditionally viewed as benefits to society. They can include wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes. These outputs and services can be important to many of the communities around the National Forest.

Climate change may involve droughts or extreme weather events, which could impact water quantity and quality. Changes in climate may require adaptive strategies to facilitate the ability of ecosystems and species to adapt to changes in conditions such as stream temperatures, vegetation composition, wildlife habitat conditions and invasive species.

The Forest will be challenged with protecting and conserving the functional wetlands and primary forest and maintaining and improving watershed conditions while monitoring, adapting to and mitigating the impacts of climate change.

3. How, where, and to what extent can the Forest provide opportunities that contribute to and/or enhance social and economic conditions in the region?

Management activities and uses of the El Yunque may affect the role the Forest plays in the economy of local communities, including the production of ecosystem services. Activities such as tourism and recreation, as well as agroforestry and forest products, are important to local communities. Increasing population and development near the Forest may influence access to the National Forest, management activities such as special use requests, and responses to additional recreation demands and ecosystem services.

The El Yunque should evaluate how to provide and sustainably manage forest products and multiple uses at lower elevations while protecting Forest resources and providing for healthy terrestrial and aquatic ecosystems and watersheds. While there is interest in agroforestry and forest products, there are concerns that techniques and uses are sustainable and do not cause ecological or scenic impacts.

The El Yunque should evaluate how to provide diverse and sustainable developed and dispersed recreation opportunities that consider experiences and offerings off the Forest within the region.

There should be more integration with municipal and Commonwealth plans and planning regulations, as well as collaborative management strategies, which would help to strengthen regional economic and tourism networks.

1.8 Other Related Efforts

This document incorporates by reference (40 CFR 1502.21) the management direction and environmental analysis from the following programmatic decisions:

- Comprehensive River Management Plan
- Invasive Species Management Plan

Other ongoing efforts influencing the decision to be made:

- Transportation Analysis Plan
- Watershed Condition Framework
- Landownership Adjustment Strategy
- Communication Sites Plan

Chapter 2. Alternatives, Including the Proposed Action

This chapter describes and compares the alternatives considered for the El Yunque Forest Plan revision. Each alternative represents a different management emphasis for the El Yunque that addresses the significant issues identified during the planning process. Each alternative provides a different mixture of goods and services for the public and a different combination of resource outputs, land uses and environmental effects. The alternatives were developed according to NEPA procedures (40 CFR 1502).

2.1 Introduction

This chapter describes and compares the alternatives considered for the Revised Land and Resource Management Plan for El Yunque National Forest. It includes a description and map of each alternative considered. This section also presents the alternatives in comparative form, sharply defining the differences between each alternative and providing a clear basis for choice among options by the decision maker and the public. Some of the information used to compare the alternatives is based upon the design of the alternative (i.e., helicopter logging versus the use of skid trails) and some of the information is based upon the environmental, social and economic effects of implementing each alternative (i.e., the amount of erosion caused by helicopter logging versus skidding).

2.2 Alternative Development

Alternative 1 is the no-action alternative, which reflects the 1997 Forest Plan, as amended.

Alternative 2, the proposed action was developed by collaborating with the public for over two years. It is based on the roles and contributions of the El Yunque as well as addressing the management challenges ahead. The 2012 planning rule supports ecological, social, and economic sustainability as a goal for managing National Forest System (NFS) lands. To meet this requirement, the proposed action (proposed plan) includes desired conditions, objectives, suitability of lands, standards, guidelines, and management area and geographic areas that would provide a management framework for the El Yunque National Forest until amended or revised. Desired conditions are long term, and may not be immediately achieved. The proposed plan serves as the principle mitigation tool to avoid, minimize, rectify, or compensate for any adverse environmental impacts associated with multiple use management on the El Yunque.

Alternative 3 was developed to respond to concerns on sustainability. It would reduce the number of maintained trail miles. The alternative would expand wilderness, but would not create a scenic byway management area.

2.3 Alternatives Considered in Detail

In response to issues raised by the public, the Forest Service developed three alternatives, including alternative 1 (no action) (1997 Forest Plan), alternative 2 (proposed action, the preferred alternative), and alternative 3. The planning record includes responses to the significant issues described in chapter 1 as addressed in the proposed action.

2.3.1 Alternative 1 (No Action)

The no-action alternative would continue management under the 1997 Land and Resource Management Plan for the Caribbean National Forest and Luquillo Experimental Forest, as amended. The alternative retains the 1997 Forest Plan goals and objectives, standards and guidelines and nine management area prescriptions (as amended). Management would continue to be focused on four vegetation types and

would retain direction for managing species as management indicator species. Recreation would continue to be promoted in functional wetlands that are above 600 meters in elevation. One area suitable for wilderness designation (the Baño de Oro Inventoried Roadless Area) would continue to be managed as part of the proposed expansion to the Baño de Oro Research Natural Area, which would continue to provide for long-term watershed research and studies. Three rivers would remain eligible for wild and scenic river designation. This alternative does not address sustainable Forest recreation and does not consider management areas that would create socioeconomic development at a broader landscape perspective.

2.3.2 Alternative 2 (Proposed Action)

Alternative 2 is the proposed action for the draft revised Forest Plan. It addresses the public's desire to access the Forest for recreation, but recognizes carrying capacities and the need to maintain sufficient infrastructure to support visitation. It also addresses multiple-use of the Forest considering ecological, social and economic sustainability. It addresses climate change impacts by shifting recreational opportunities at the lower elevations of the Forest, which are better suited for recreational use by monitoring the effects of climate change with the development of standards, guidelines, and desired conditions that reduce the Forest's carbon footprint. Alternative 2 would address the following ecological and socioeconomic themes.

2.3.2.1 Ecological Themes

Landscape-scale Conservation Efforts.

The proposed plan identifies three geographic areas to provide opportunities for targeted conservation initiatives, such as stream corridors, riparian areas, wild and scenic river corridors, connections to the Corredor Ecologico del Noreste Natural Reserve; and to integrate with conservation easements, donations, and private lands.

Climate Change.

The plan proposes arranging management areas so they enhance landscape connectivity and maintain wetland conditions that foster amphibian habitat. The plan also proposes to adapt the recreational opportunities and settings to new climate patterns through plan components that provide for recreational opportunities and settings at lower elevations.

Wetlands.

The proposed plan recognizes lands above 600 meters of elevation that have the soil, vegetation and hydrological elements of a functional wetland. This is a forest condition not dealt with in the 1997 Plan. The proposed plan includes components that protect the current condition, and identifies management strategies and plan components to ensure functional wetlands are administered in accordance with management requirements.

Vegetation.

While the 1997 Plan was developed based on four forest types, the proposed El Yunque plan incorporates new information about the 15 vegetation types present in the Forest (see 2014 Forest Plan Assessment), and provides management direction that would protect and conserve the riparian areas. The proposed plan identifies suitable and non-suitable lands for anthropogenic uses and has plan components for the new vegetation types that are rare for Puerto Rico and endemic to the El Yunque.

Water.

The watercourses within the El Yunque provide many beneficial uses including recreation, fish and wildlife maintenance, in-stream flow, and water level protection. The proposed plan provides for the beneficial uses of water, incorporates the watershed condition framework, and maintains water quality.

Flora.

There are an estimated total of 636 native and endemic plant species in El Yunque. Their conservation status was evaluated and 39 potential species of conservation concern were identified in the proposed plan. Species of conservation concern are designated by the Regional Forester, along with eight plant species that are federally listed as endangered or threatened by the U.S. Fish and Wildlife Service.

Wildlife.

There are an estimated 166 animal species found in El Yunque, which include 32 species of snails and crustaceans (invertebrate species), 134 vertebrate species, and about 11 orders of insects that include multiple families. The proposed plan identifies at-risk species. At-risk species for planning are threatened, endangered, proposed, and candidate species designated by the U.S. Fish and Wildlife Service including four species federally listed as endangered or threatened (Puerto Rican parrot, Puerto Rican broad-winged and sharp-shinned hawks, and the Puerto Rican boa). The elfin-woods warbler, which was recently proposed for listing, is also included. The list of 34 potential species of conservation concern in the proposed plan includes coquies, anole lizards, bats, birds, fishes, freshwater shrimp and snails.

Focal Species.

The proposed plan identifies five species groupings that would be monitored as focal species: one snail species, one group of four bird species, one group of ten amphibians (different coquies), one group of two reptiles, and one group of three aquatic species.

Non-native species.

The proposed plan provides direction for restoring and expanding the range of native species. It also provides direction to better control the introduction and spread of invasive species on the Forest, including direction to minimize the spread of invasive plants that may increase as a result of management activities.

2.3.2.2 Social and Economic Themes***Connect with Communities through Recreation.***

The communities surrounding the Forest represent a broad range in recreation needs and demands. The proposed plan identifies recreational settings available outside the Forest boundary that would permit increased integration of access, recreation, and aspects of tourism at the sub-regional level. It also provides opportunities to better connect urban areas and rural communities to the scenic attractions, historic places, and recreation opportunities located in the lower elevations of the Forest. The plan creates a scenic route management area.

Increase Environmental Literacy and Education.

Throughout the planning process the public has communicated an interest in the Forest's role in environmental education. The proposed plan enhances the surrounding communities' connection to the Forest's natural landscapes. It provides opportunities to help develop community capacity for participation in various management activities through recreation, increased environmental literacy and

education; enhance landscape scale conservation efforts, and strengthen collaborative relationships and adaptive, co-management approaches.

Strengthen Collaborative Relationships and Adaptive, Co-Management Approaches.

The proposed plan identifies three new geographical areas that would allow the Forest to increase its engagement with local community stakeholders and Forest users. The plan provides opportunities for addressing new scientific information on, and changes in; social, economic, and ecological conditions within and around the Forest.

Community Interface Resource Management Area (CIRMA).

The Community Interface Resource Management Area (CIRMA) is the best example of the shift from Forest Service driven management priorities to a more collaborative management and is the identified area where sustainable Forest practices could be considered with a community based co-management approach. Some CIRMA management strategies include agroforestry approaches that can demonstrate potential application in the El Yunque region in addition to municipal collaboration projects to develop low impact recreational sites, trails and cultural resource interpretation programs

Monitoring.

The proposed plan includes an extensive monitoring plan. Public input indicates interest in commitment to a citizen based collaborative approach to monitoring combined with support from regional protected area managers.

2.3.2.3 Wilderness Inventory and Evaluation, and Wild and Scenic Rivers

Based on the inventory, one area that may be suitable for wilderness designation (Management Area–Baño de Oro) was identified. The proposed plan does not recommend any areas for wilderness designation because the Forest has a designation and there is a lack of public support for further designations.

The 1997 Plan EIS evaluated 15 rivers for eligibility, classification, and suitability. Three rivers were congressionally designated; the Rio Mameyes, Rio de la Mina and Rio Icacos. Three rivers remain eligible; the Rio Espiritu Santo / Quebrada Sonadora, Rio Fajardo, and Rio Sabana. The proposed plan does not identify any new rivers as eligible and does not propose any new wild and scenic river recommendations.

2.3.2.4 Geographic Areas

The plan proposes three geographic areas (Map 2-1). Each geographic area encompasses a large area of land that is closely tied to the communities, conditions, and relationships beyond the Forest boundary:

El Norte-North (Rio Grande & Luquillo):

- Provides access to recreation settings and connects to a regional trail system.

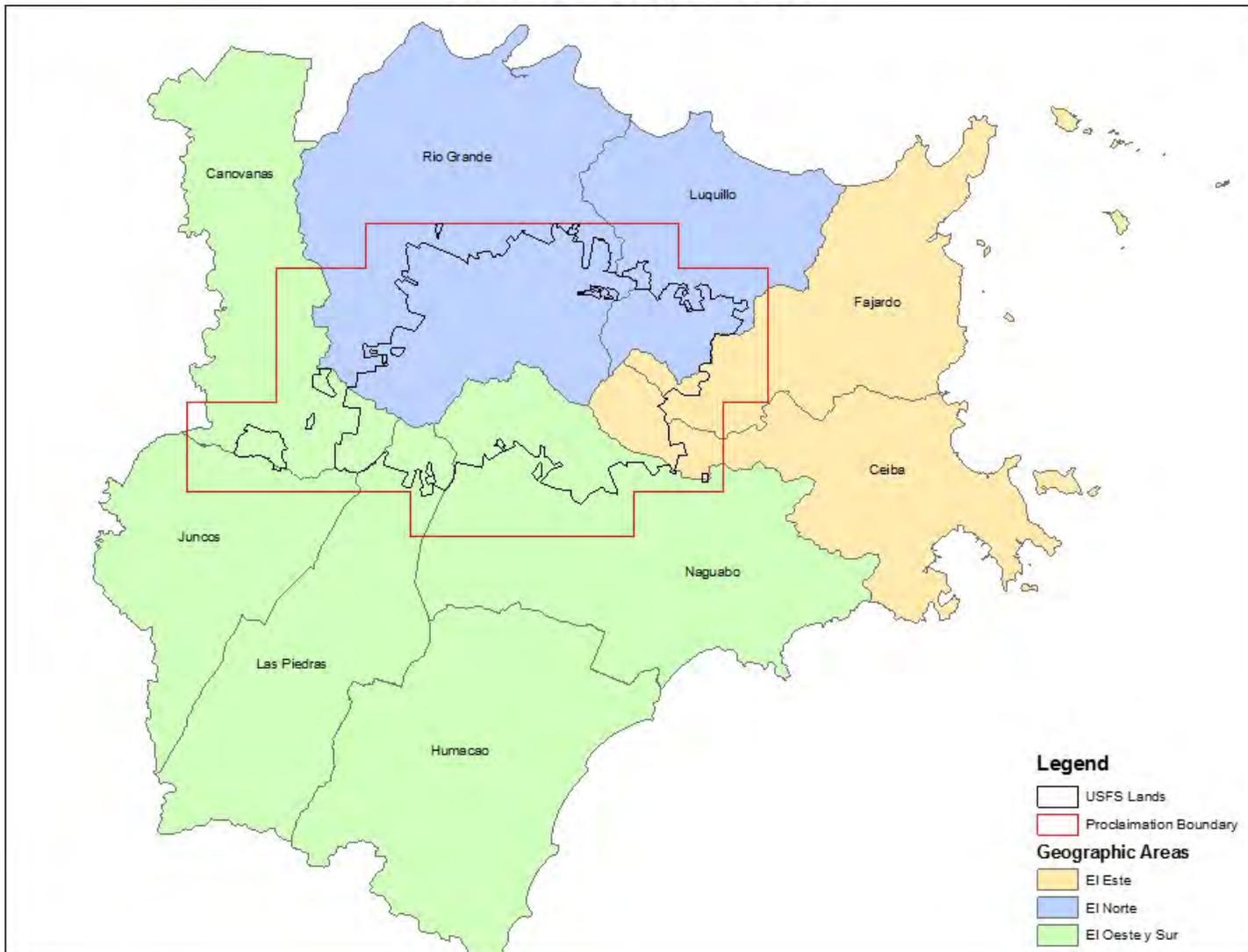
El Suroeste-Southwest (Canovanas, Juncos, Las Piedras, Naguabo and Humacao):

- This geographic area focuses on community-based use with an emphasis on environmental education and community enterprises.

El Este- East (Fajardo and Ceiba):

- This geographic area is based on watershed management and is focused on water quantity and watershed restoration and improvement.

Alternative 2: Geographic Areas



Map 2-1. Alternative 2 geographic areas

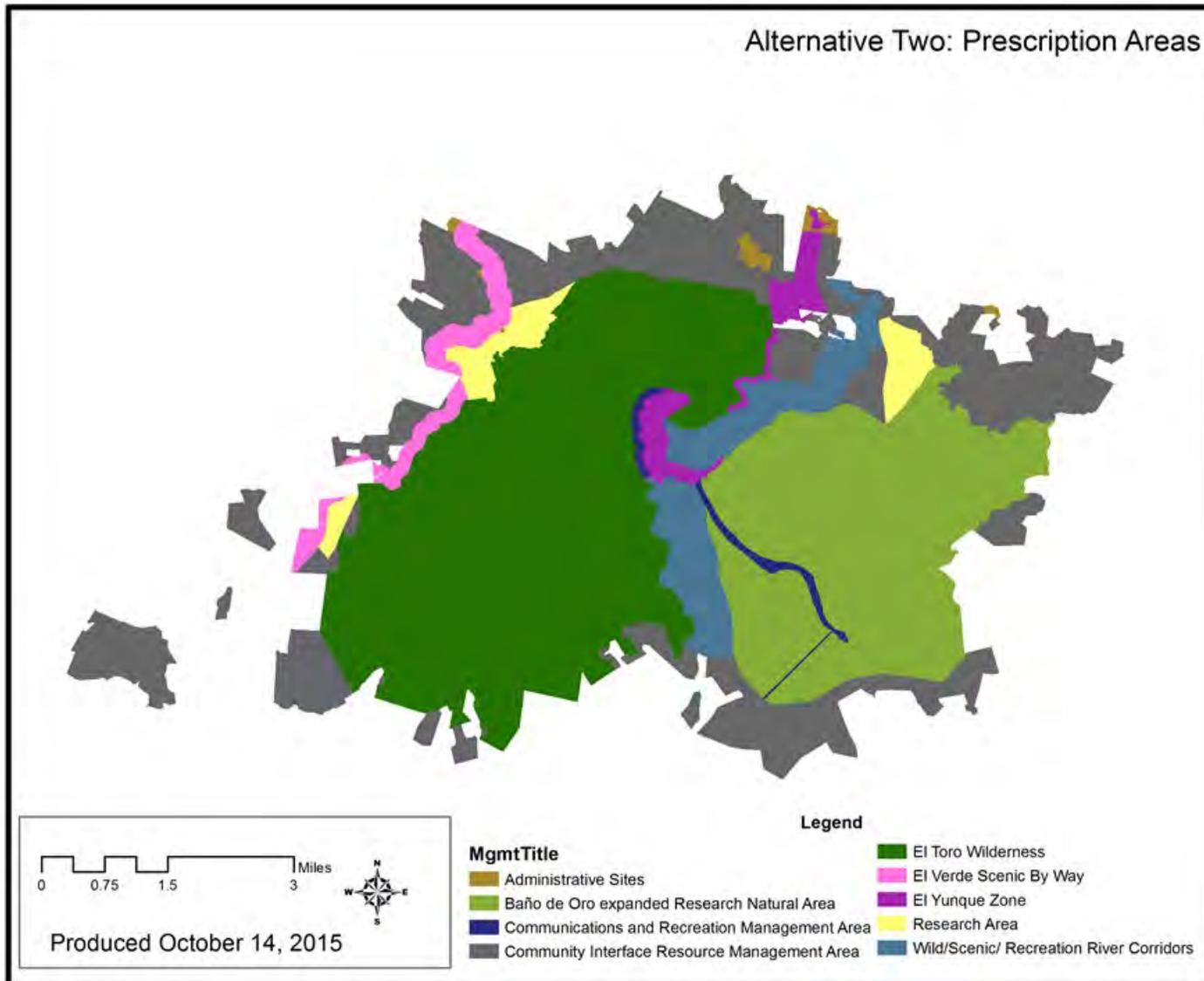
2.3.2.5 Management Areas (MA)

The plan proposes nine management areas (Map 2-2). Table 2-4 describes the emphasis for each management area.

Alternative 2 retains existing Forest Plan direction (including standards and guidelines) for the research, wild and scenic rivers, and wilderness management areas.

Table 2-1. Alternative 2, draft revised plan management areas

Management Area Number	Name	Acreage	Description	Management emphasis for the Management Area
MA 1	Administrative Sites	141	Areas occupied by El Portal Forest Center, Catalina Work Station, and other Forest Service administrative facilities.	Emphasis is placed on transitioning to Green Buildings, recycling, use of alternative energy and reducing carbon footprint. Facilities are shared with partners.
MA 2	El Yunque Recreation Zone	844	El Yunque Zone covers El Yunque Trail, Mount Britton Trail, Forest Service Road 10 and Big Tree Trail.	Area where emphasis is on use of existing developed recreation sites managed by capacity with strong emphasis on sustainability.
MA 3	Communication and Recreation Sites	241	Areas on El Yunque Peak and East Peak used for communication facilities, access roads to the communications sites, electrical power lines and recreation sites.	Communication facilities' footprint is reduced and facilities are energy efficient. Access to recreational settings that provide unique scenic and natural experience is maintained.
MA 4	Community Interface Resource Management Area	7,187	This consolidation of lands under one management area provide sections of the Forest where an assortment of resource management practices could be applied to encourage tropical forest management initiatives in the broader landscape of El Yunque.	Management focuses on community-based co-management, and improves access to lower lands.
MA 5	El Toro Wilderness	10,352	Designated area on the southwestern portion of the Forest.	Manage the area to maintain it within wilderness characteristics.
MA 6	Research Bisley and El Verde Station	789	Research, including long-term watershed studies and treatment/ control studies, is emphasized.	Facilitate tropical ecosystem studies at the landscape scale.
MA 7	Baño de Oro Expanded Research Natural Area	6,441	Existing and proposed research natural area (RNA). The existing Baño de Oro RNA is expanded to encompass all of the primary forest area in east half of the Forest.	Implement non-manipulative studies. Maintained in undisturbed condition for current and future non-manipulative research.
MA 8	Wild Scenic Recreation River Corridors	1,531	Corridor along the Icacos, Mameyes, La Mina and Upper Mameyes designated as Wild and Scenic Rivers	Where protection of these rivers' outstanding characteristic is emphasized.
MA 9	El Verde-Scenic Byway Management Area	697	A 600-meter band of the PR 186 Road right-of-way from the CIRMA.	Protect scenery and develop a scenic byway.



Map 2-2. Proposed action (plan) management areas

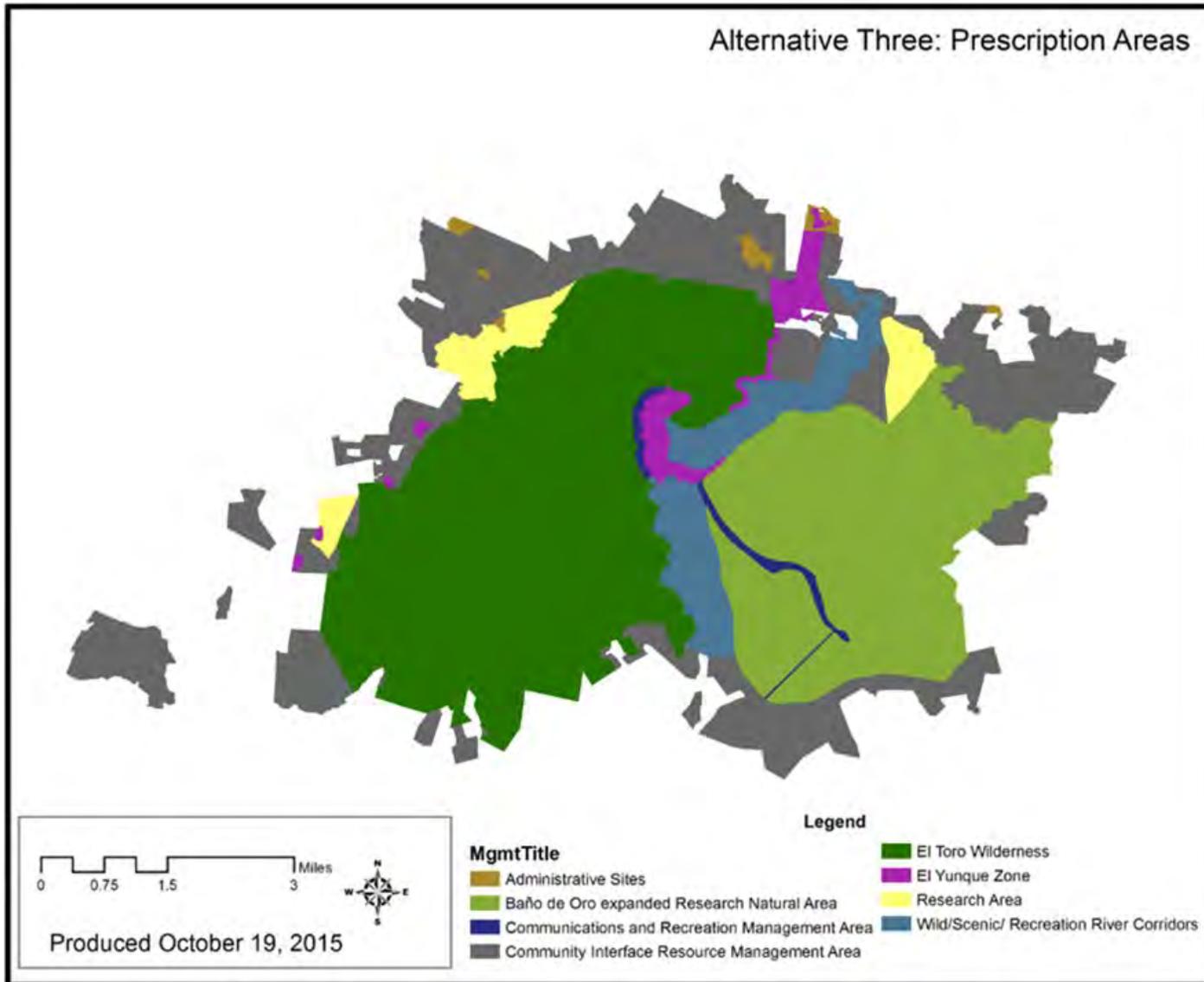
2.3.3 *Alternative 3*

Alternative 3 was developed in response to concerns on the sustainability. This alternative is based on alternative 2, but with the following changes which:

- Recommends expanding the wilderness.
- Recommends designating the Baño de Oro Research Natural Area as wilderness.
- Excludes any scenic byway management area for PR 186.
- Provides additional plan components to address invasive species management in areas of road rights-of-way, recreation areas, and threatened and endangered habitats in order to promote management of non-native species and to restore landscape level conditions.
- Addresses some sustainable recreation concerns by reducing the trail system to a level that can be maintained.
- Creates two geographic areas: North and South to connect with communities on both sides of the Forest.

Table 2-2. Alternative 3, draft revised plan management areas

Management Area Number	Name	Acreage	Description	Management emphasis for the Management Area
MA 1	Administrative Sites	141	Areas occupied by El Portal Forest Center, Catalina Work Station, and other Forest Service administrative facilities.	Emphasis is placed on transitioning to Green Buildings, recycling, use of alternative energy and reducing carbon footprint. Facilities are shared with partners.
MA 2	El Yunque Recreation Zone	844	El Yunque Zone covers El Yunque Trail, Mount Britton Trail, Forest Service Road 10 and Big Tree Trail.	Area where emphasis is on use of existing developed recreation sites managed by capacity with strong emphasis on sustainability.
MA 3	Communication and Recreation Sites	241	Areas on El Yunque Peak and East Peak used for communication facilities, access roads to the communications sites, electrical power lines and recreation sites.	Communication facilities' footprint is reduced and facilities are energy efficient. Access to recreational settings that provide unique scenic and natural experience is maintained.
MA 4	Community Interface Resource Management Area	7,884	This consolidation of lands under one management area provide sections of the Forest where an assortment of resource management practices could be applied to encourage tropical forest management initiatives in the broader landscape of El Yunque.	Management focuses on community-based co-management, and improves access to lower lands.
MA 5	El Toro Wilderness	10,352	Designated area on the southwestern portion of the Forest.	Manage the area to maintain it within wilderness characteristics.
MA 6	Research Bisley and El Verde Station	789	Research, including long-term watershed studies and treatment/ control studies, is emphasized.	Facilitate tropical ecosystem studies at the landscape scale.
MA 7	Baño de Oro Expanded Wilderness Area	6,441	Existing and proposed research natural area (RNA) will be proposed as Wilderness Designation.	Maintained in undisturbed condition for current wilderness designation.
MA 8	Wild Scenic Recreation River Corridors	1,531	Corridor along the Icacos, Mameyes, La Mina and Upper Mameyes designated as Wild and Scenic Rivers	Where protection of these rivers' outstanding characteristic is emphasized.



Map 2-3. Alternative 3 prescription areas

2.4 Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14).

Public comments received in response to the proposed action provided suggestions for alternative methods of achieving the purpose and need. Some of these alternatives may have been outside the scope of what can be included in the draft revised El Yunque Forest Plan, duplicative of the alternatives considered in detail, or determined to be components that would cause unnecessary environmental harm. Four alternatives were considered but dismissed from detailed consideration for reasons summarized below.

Custodial (no recreation management, special uses or research management).

This alternative was not considered in detail because it does not meet law or policy requirements to provide multiple uses. The Forest has experimental forest designation.

Intense recovery of the Puerto Rican parrot.

This alternative was not considered in detail because El Yunque National Forest is not preferred habitat.

Recommending designation of all eligible wild and scenic rivers.

This alternative was not considered in detail for the following reasons:

- There is no public interest in wild and scenic river designation for three rivers;
- Additional areas would increase management complexity; and,
- People would still like to have access to these areas.

2.5 Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. Table 2-3 qualitatively compares the alternatives by the significant issues identified during the public participation process. Table 2-4 compares the alternatives by management area allocation acres. Table 2-5 compares timber suitability acres and timber volume by alternative. Table 2-6 compares recommended wilderness acres by alternative.

Table 2-3. Comparison of alternatives by significant issues

Significant Issues	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3
<p>Issue 1. What is the best approach to provide sustainable recreation opportunities that minimize impacts to the Forest while meeting current and future needs and demands?</p>	<p>The 1997 Plan does not include plan components that address sustainable recreation. The plan increases the recreational opportunity; therefore, impacts will be expected to increase. This alternative helps us to meet current and future demands regardless of impacts. The alternative does not contemplate the impacts of recreation site development.</p>	<p>The alternative provides for sustainable recreation by including plan components that consider wetlands, community interface areas, limits on capacity and funding. The alternative addresses current conditions of cultural resources, the need to protect sensitive areas at higher elevations, disperse the recreational opportunity away from PR Road 191 in order to decrease crowding and improve setting.</p>	<p>This alternative provides for sustainable recreation. The plan reduces the recreational opportunity and setting by reducing the trail system. The alternative responds to the issue by reducing capability to meet demands.</p>
<p>Issue 2. What is the best approach to respond to the potential effects of climate change on the Forest resources, ecosystem services and others?</p>	<p>This alternative does not respond to the issue. There are no specific plan components in response to climate change.</p>	<p>The alternative contains plan components that focus on climate change.</p>	<p>The alternative responds to the issue by promoting species management on T&E habitats and invasive species. Provides a stronger response to climate change.</p>
<p>Issue 3. How, where, and to what extent can the Forest provide opportunities that contribute to/enhance social and economic conditions in the region?</p>	<p>The Forest's main contributions to the social and economic condition would continue to include recreation, water and biodiversity. The alternative responds to the issue by maximizing outputs of recreational opportunities, providing for water, timber products and research within the Forest.</p>	<p>The alternative responds to the issue by introducing recreational sustainability, establishing plan components for recreation along Road 191 and shifting recreation opportunities to lower elevations, establishing a new access, recreation and tourism strategy based on collaboration and community partnerships. It best promotes existing and new economic opportunities tied to the Forest, particularly through the development or demonstration of multiple, sustainable uses in the CIRMA and nearby communities</p>	<p>This alternative responds to the issue by reducing recreational opportunity within the National Forest lands while promoting recreational opportunities off National Forest lands.</p>

Table 2-4. Comparison of alternatives by management area (acres)

Management Area	Alternative 1 1997 Forest Plan	Alternative 2 Proposed Action	Alternative 3
Priority Watersheds (number)	N/A		
Wild and Scenic Rivers (number of eligible)	1,531	1,531	1,531
Management Area 1 (acres) Administrative Sites	161	141	141
Management Area 2 (acres) El Yunque Zone and Yokahu Zone	844	844	844
Management Area 2 Developed Recreation			
Management Area 3 (acres) Communication Sites	241	241	241
Management Area 4 (acres) (CIRMA)	-	7,187	7,187
Management Area 4-Integrated	6,225		
Management Area 5 (acres) El Toro Wilderness	10,352	10,352	16,793
Management Area 6 (acres) Research	789	789	789
Management Area 7 (acres) Research Natural Area	6,396	6,441	6,441
Management Area 8 (acres) Wild and Scenic Recreation River Corridors	1,233	1,531	1,531
Management Area 8- Timber Demonstration			
Management Area 9 (acres) El Verde -Scenic Byway	-	697	0
Management Area 9 Scenic and Recreation Corridors	0	697	-

Table 2-5. Comparison of acres suitable for timber production and estimated 10-year timber volume by alternative

Timber Suitability and Volume Criteria	Alternative 1	Alternative 2	Alternative 3
Land Classified as Suitable for Timber Production (acres)	1,167	7,187	7,187
Percent of Land Ownership Classified as Suitable for Timber Production (percent)	0	25	25
Sustained Yield Limit (MMCF)			
Projected Wood Sale Quantity, 1st decade	23	23	23
Projected Wood Sale Quantity, 5th decade	-		

Note: MMCF = Million cubic feet

Table 2-6. Summary of proposed wilderness by alternative

Existing Area	Alternative 1 1997 Plan	Alternative 2 Proposed Action	Alternative 3
El Toro Wilderness (acres)	10,363	10,352	10,352
Inventoried Roadless Area (acres)	6,441	6,441	6,441
Proposed Additional Wilderness (Baño de Oro) (acres)	0-	0	6,441

Chapter 3. Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the project area and the potential environmental consequences of implementing each alternative on that environment. The kinds of resource management activities allowed under each of the alternatives are reasonably foreseeable future actions to achieve the goals and objectives in the plan. However, the specific location, design, and extent of such activities are generally unknown. Therefore, the discussions in this chapter refer only to the potential for an effect to occur. The intent is to provide scientific analysis and information that allows a comparison of the alternatives and provide the basis for an informed decision. Information in this chapter is based on resource reports and supporting material, and all resource reports are incorporated by reference. Most resource analyses are available for viewing in the planning record or the Forest website. Those not on the website are available upon request. All reports are filed in the project record.

The Forest specialists developed their effects analysis considering the need for change and therefore need to revise the current plan. They also took into account the public comments to develop the alternatives, which address the issues that the Forest faces in its current condition. This analysis was developed in a matrix form, with each alternative analyzed to determine and consider how it would potentially affect the resources. Throughout the process we considered the public comments and need for revision identified as part of the analysis.

It should be noted that for the effects analysis alternative 1 is being analyzed at the same level as alternatives 2 and 3. However, alternative 1 is not being considered as a reference point or representative of the current conditions of the Forest (for the sake of effects analysis). The reason for this is that only a section of the policies outlined in the 1997 Plan were implemented (i.e., wilderness area, wild and scenic river designations). As such, the 1997 Plan only partially affected the current condition of the Forest. It is noteworthy to mention that alternative 1 (representative of the 1997 Plan) did not address significant factors present in the new planning rule (2012), such as sustainability and collaboration (i.e., “Plans will guide management of NFS lands so that they are ecologically sustainable and contribute to social and economic sustainability...”) (Section 219(1)(c), New Planning Rule 2012)). There is a gap between the old and the new planning rule, which creates inconsistencies between the requirements of the two sets of regulations for Forest land management planning. This translates to alternative 1 (no action) and alternatives 2 and 3 presenting different criteria and issues that were addressed in the planning phase and which are analyzed in the draft EIS. As such, alternatives 2 and 3 contain elements not present in alternative 1.

3.1 Assumptions

- The Forest Plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity (including ground-disturbing actions). As a result, it does not result in direct effects. However, there may be implications, or longer term indirect or cumulative environmental consequences from managing the Forests under this programmatic framework.
- Before any ground-disturbing actions take place, they must be authorized in a subsequent site-specific environmental analysis. Therefore, none of the alternatives would cause unavoidable adverse impacts or an irreversible or irretrievable commitment of resources.
- The plan decisions (desired conditions, objectives, standards, guidelines, management areas, and monitoring) will be followed when planning or implementing site-specific projects and activities.

- Law, policy, and regulations will be followed when planning or implementing site-specific projects and activities.
- Funding levels will be similar to the past 5 years.
- The planning timeframe for the effects analysis is 10 to 15 years; although other timeframes may be specified in the analysis depending on the resource and potential consequences.

3.2 Cumulative Effects

“Cumulative effects” is defined in the Council of Environmental Quality’s NEPA regulations as the “impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions...” 40 CFR 1508.7. The Council on Environmental Quality interprets this regulation as referring only to the cumulative impact of the direct and indirect effects of the proposed action and its alternatives when added to the aggregate effects of past, present, and reasonably foreseeable future actions on all land ownerships across an area that is deemed appropriate for the impacts being analyzed.

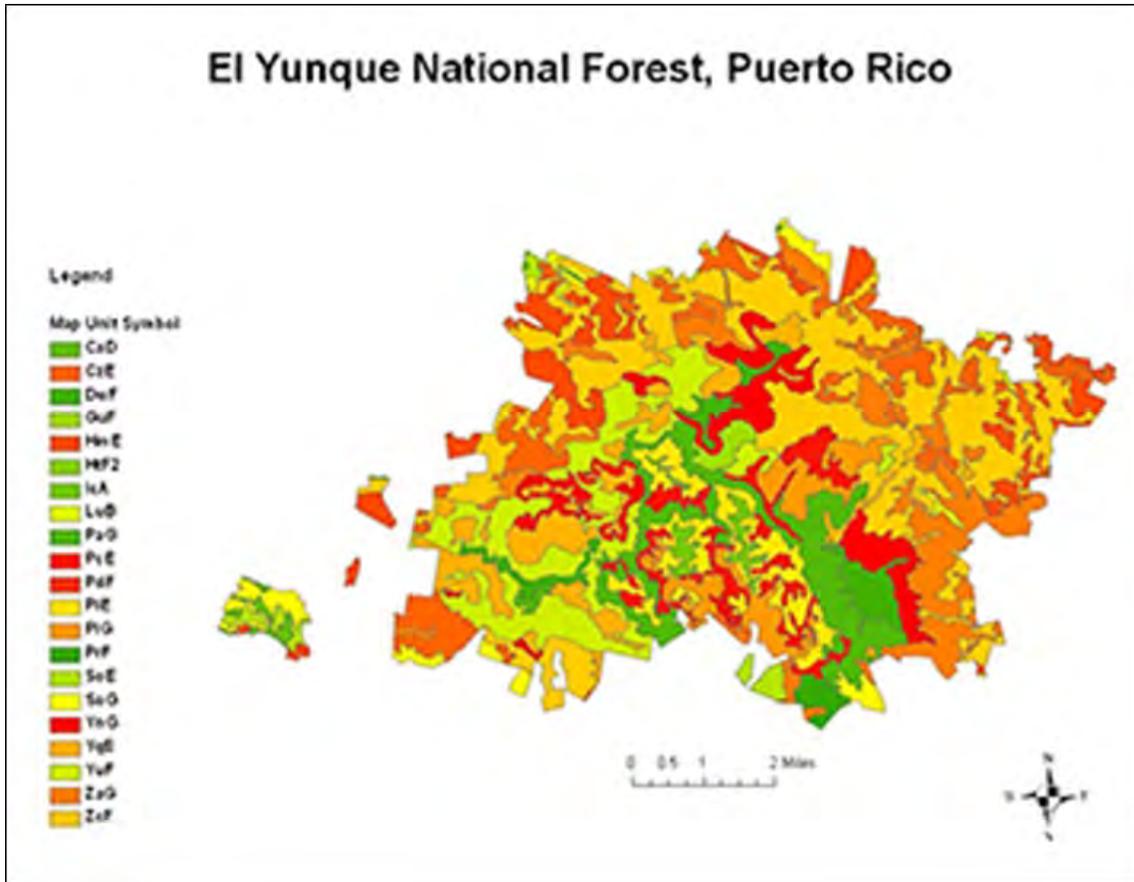
For this analysis, the geographic area of consideration is likely to vary by resource and may differ in spatial scale, as well as the activities that are considered in cumulative effects discussions for each resource. The cumulative effects analyses contained in this chapter do not attempt to quantify the effects of past human actions by adding up all prior planning actions on an action-by-action basis. In order to understand the contribution of past planning actions to the cumulative effects of the proposed action and alternatives, this analysis relies on current environmental conditions as a proxy for the impacts of past planning actions. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events. It is difficult to quantify how these aggregates have affected the environment and how they might contribute to cumulative effects. Unless otherwise identified, cumulative effects are considered for the expected life of the revised Forest Plan (10 to 15 years).

3.3 Physical Environment

3.3.1 Soils

The soils information for El Yunque can be accessed and reviewed in the SURGO (Soil Survey Geographic Database). The information in the database is certified as of October 24, 2012. The soil properties are considered static since the previous management plan. Only management activities related to the maintenance of the existing facilities and road access produced minimum and localized soil surface disturbances. The activities considered in the Forest Plan that can disturb the soil resources include recreation management, road maintenance, improvements in the scenic byways, and forest product utilization. The main concerns of the considered practices are the compaction, erosion, and reduction of the organic layer in the Forest. Healthy soils are critical for the Forest functions and to conserve activities essential for the regions and municipalities such as regulating water, sustaining of plant and animal life, cycling nutrients and physical stability and support.

The El Yunque has a mosaic of soils that include hydric soils which are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part as defined by the National Technical Committee for Hydric Soils (*Federal Register*; July 13, 1994). The considered management areas in the Forest include the identification of standards and guidelines as well as mitigation measures and monitoring plans directed to limit and reduce any long-term effects to soils for the considered alternatives.



Map 3-1. Soils on the El Yunque National Forest

Note: Soil map developed by the USDA Natural Resources Conservation Service.

3.3.1.1 Affected Environment

The Natural Resources Conservation Service (NRCS) describes the soil as a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment.

The soils of El Yunque are developed and modified by a series of natural factors which are:

- Climate
- Rainfall
- Temperature
- Plant and animal life
- Parent material
- Topography
- Time

Within the Forest boundaries, the reduction of soil integrity is a function of landslides and subsequent erosion. Landslides are common both far and near from roads associated to rain events. Illegal off-road vehicle use in the Forest is another activity impacting soils and accelerating erosion.

The following map unit names, or parts of map units which are complexes, meet the definition of hydric soils and have at least one of the hydric soil indicators. This list can help in planning land uses and updates the hydric soils previously noted in the Forest.

135 Prieto very cobbly clay loam

212 Yunque-Moteado complex, 20 to 65 percent slopes (Moteado part)

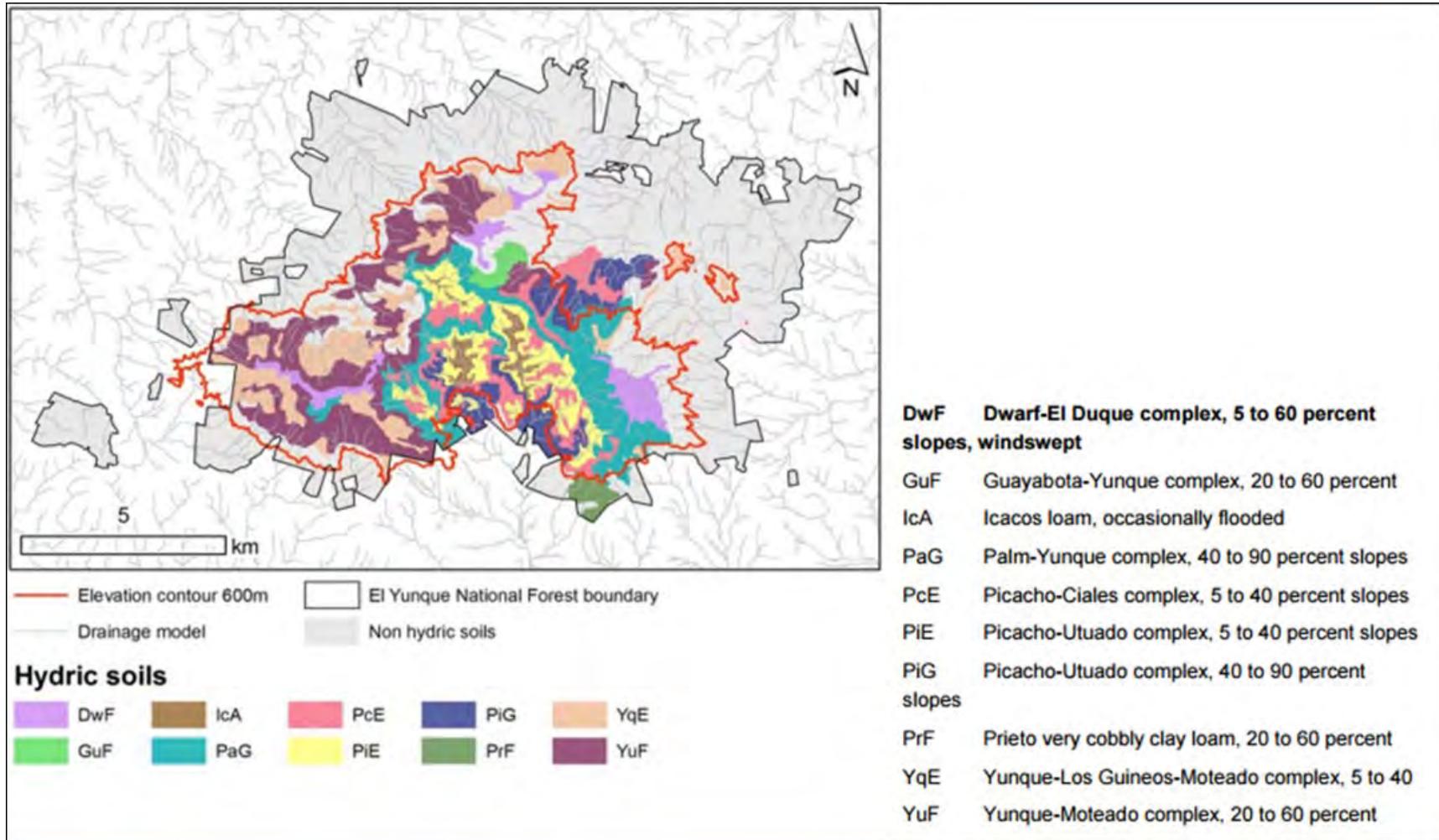
214 Yunque-Los Guineos-Moteado complex, 5 to 30 percent slopes (Moteado part)

215 Palm-Yunque complex, 35 to 85 percent slopes, extremely stony (Palm part)

223 Picacho-Ciales complex, 5 to 30 percent slopes (Ciales part)

231 Guayabota-Yunque complex, 30 to 60 percent slopes (Guayabota part)

311 Dwarf muck, 10 to 65 percent slopes, windswept



Map 3-2. Hydric soils, El Yunque National Forest (from the Forest Plan Assessment Map 2-6)

3.3.1.2 Environmental Consequences

The recreational activities associated with the number of visitors using the Forest are considered the ones that most likely will cause compaction, rutting, and impact over the organic surface. Other activities like road and trails maintenance can reduce soil productivity because of potential landslides and associated erosion. The analysis of the alternatives for the plan take into consideration the pressure that these activities can produce on the soils of the Forest. Other activities considered in the management zones for the plan alternatives are considered under their standards and guidelines principles as well as with the applicable best management practices. They would affect the soils resources minimally and are discussed generally.

Compaction is defined by the increase in soil bulk density due to an external force. From the use of heavy equipment, to the accumulative weight applied by hikers through the Forest trails, these activities can result in the alteration of soil chemical and physical properties. The main concern of soil compaction is the reduction of productivity by retarding root growth as well as changes in air and water/nutrient transfer in the soil. The impact can be most significant in wet soils and special mitigation practices are considered in the Forest trail system to reduce these impacts. The documentation of the hydric soils of the Forest and the restriction in activities through these soils reduce potential impacts in sensitive and less resilient soils.

Areas over 600 meters in elevation were identified in the plan as sensitive and under wetland classification considerations. These are addressed specifically as part of alternatives 2 and 3. The management plan establishes as a management strategy the protection of all hydric soils above the 600-meter elevational line in El Yunque National Forest (identified in the latest El Yunque soil survey of 2012). The periodic evaluation of the trails system and the application of best management practices will maintain soil conditions within acceptable standards. The management plan includes guidelines directed toward the stabilization of dispersed recreation sites that have exposed and/or highly compacted erodible mineral soils.

Erosion is a process in which the topsoil is removed faster than it is formed; and it can happen due to natural, human, or animal activity. Soil erosion results in land infertility and can require special management practices to reduce the erosion or to recover the soils natural characteristics. Erosion is an important process that needs to be considered and monitored in El Yunque forests because of the slopes, the changes in elevation, and action of rain and visitors.

Landslides are common, constantly reshaping the dynamic topography of the Forest. This type of soil displacement usually occurs during periods of high rainfall (Larsen and Torres-Sánchez 1992). Most landslides occur on the south side of the Forest, and are most common between 600 and 800 meters elevation. Commonly the failure surface for landslides, particularly the larger ones, is in the diorite derived soils (Río Blanco soils complex), along the contact with the surrounding soils derived from Cretaceous volcanic rocks. The largest recent landslides on the Forest are located in the Icacos Valley on the south side of the Forest, along Highway 191. (Guariguata and Larsen 1990; Larsen and Simon 1990). The management plan includes parameters directed toward stabilizing exposed soils caused by landslides.

Vegetation management related to timber management is associated with alternative 1; and alternatives 2 and 3 consider the utilization of wood products in the community interface resources management areas. The activities under alternatives 2 and 3 are considered in the Secondary Montane Forest classification. As part of the considered management strategies in the management plan, the current soils in the Secondary Montane Forest will be evaluated to determine soil formation stages and their contribution to appropriate ecosystem services. The management plan established the use of native vegetation as much as possible in watershed restoration and soils conservation projects. The design and implementation of

vegetation treatments for wildlife habitat improvements are considered under standards that reduce soil exposure and protect sensible areas.

Recreation offerings in the Forest include the use of several recreation sites (see Table 3-22, El Yunque National Forest recreation sites, in the 2014 Forest Plan Assessment) and trails within a primitive recreation experience that limits soil exposure and other associated impacts. The management plan considers a planned and properly designed network of facilities, roads, and trails as part of the recreation goals considered for the Forest. Stimulating the use and improvement of trails in the geographic region as part of the recreation considerations in the plan objectives, represent an action directed toward reducing impacts associated with recreational activities in sensitive areas of the Forest. The Forest Plan proposes linking existing trails to local communities located at lower elevations adjacent to the Forest boundary. The alternatives considered in the plan maintain the use of the trail system, including the research and service trails; but alternatives 2 and 3 target the use of trails in the lower elevations and the integration of geographic region as part of the recreation opportunity considerations. All of the recreation operation and management of the trails within the Forest will apply the Forest Service Manual parameters (FSM 2353 and FSH 2309.18).

The recreation areas in the Forest are designed to limit effects to resources, and within a certain level of use, the effect on the soil resources should be minimal. The potential impacts will be higher during construction phases in developed recreational areas. The current recreational facilities are concentrated along the corridor of PR Road 191 North. These areas are deep inside the Forest boundary and away from local communities. The Forest Plan proposes a shift from Forest Service-driven management priorities to a more collaborative management. This shift includes recreational options in the geographic region and are part of the considerations in alternatives 2 and 3 for the plan.

Roads can produce impacts in soil resources associated with exposure, compaction, shifts in natural runoff, and changes in functions and services by the creation of impervious surfaces. The 2014 Forest Plan Assessment for the El Yunque Forest Plan describe 11.27 miles of inventoried, classified National Forest System roads in the Forest transportation inventory. Sixty percent are managed and maintained for public use with high clearance vehicles, 38 percent for low clearance vehicles, and 2 percent are unclassified roads. The unclassified roads include roads present when the land was acquired, or those created in order to access private properties, and many have been closed to public access by means of closure orders.

Dirt roads might be needed to accomplish research objectives, and standards are defined for this type of activity to reduce impacts in soil resources. Alternative 2 considers PR Road 186 as a scenic route to decentralize the recreation opportunities within the Forest and reduce crowding of the PR Road 191. The Forest Plan includes a goal of establishing a partnership with the municipal planners and other agencies to promote the official state designation of the PR Road 186 Scenic Byway.

Comparison of Alternatives

The alternatives included practices and standards to produce low to moderate soil disturbances. Alternative 1 includes a Timber Demonstration management area of 1,167 acres that has the potential to produce the highest soil disturbances. The timber demonstration activity includes management practices that will reduce the potential impacts. Alternative 1 also includes developed recreation areas (1,083 acres) and integrated management areas (6,225 acres), which are other zones where soil disturbances are documented. In alternatives 2 and 3 the timber demonstration, the developed recreation and the integrated management areas are eliminated and the community interface management area is considered for 7,187 acres in the lower elevations of the Forest. The activities considered in the CIRMA will result in fewer impacts than the ones considered in the timber demonstration area in alternative 1 because the proposed

activities in the plan require the conservation of Forest coverage and the projects will be of a smaller scale. The designated areas (wilderness, research natural areas and wild and scenic recreation river corridors) are maintained in the three alternatives. The El Verde Scenic Byway management area is considered in alternative 2 with an area of 697.3 acres that integrates PR Road 186 and the rights-of-way associated with the road. In alternative 3 the El Verde Scenic Byway management area is considered under the CIRMA management area; but not a scenic byway.

The application of the best management practices, the appropriate mitigation actions, and a continuous monitoring plan would result in minimal soil effects for all the action alternatives. The cumulative effects are not expected to reduce soil productivity, although alternative 1 is the alternative that can produce the highest changes in soil properties because of the activities and the management areas considered in the alternative (see Table 3-1).

Table 3-1. Acres of activities with potential soil impacts

Alternative	Activities and Management Areas	Acres
1	Timber Demonstration	1,167.0
	Develop Recreation Areas	1,083.0
	Integrated Management Areas	6,225.0
	Total	8,475.0
2	CIRMA	7,187.0
	El Verde Scenic Byway	697.3
	Total	7,884.3
3	CIRMA	7,884.3

Cumulative Effects

The soil productivity would be mainly impacted by surface disturbance and vegetation loss associated with activities that produce these types of conditions. The cumulative results expected are increasing soil erosion and loss, landslides, and potential compaction, depending on the activity. The conservation of the hydric soils and zones over 600 meters of elevation established a protection parameter to the El Yunque’s most sensible soils. The management activities and areas considered in alternatives 2 and 3 redirects the recreational activities concentrated in PR Road 191 corridor to other areas that includes slopes, soils, and natural conditions less sensitive compared to the current recreational activities conducted in the Forest. The integration of the regional management areas and the incorporation of communities in the lower elevations of the Forest should reduce the pressure to the sensitive areas of the Forest.

The cumulative and environmental impacts of the proposed activities in the plan would be minimized for all the alternatives through the application of best management practices and the monitoring plan. The potential impacts in soils would be low for the alternatives 2 and 3 and from low to moderate in alternative 1. The overall cumulative effects of the management actions over time are not expected to reduce soil productivity.

3.3.2 Geology

3.3.2.1 Introduction

The geologic parent materials of El Yunque National Forest areas are of three basic types.

- Marine-deposited Cretaceous volcanic rocks, which are the most widespread.

- Tertiary intrusive quartz diorites, which occur on the south side of the Forest.
- Quaternary unconsolidated alluvial deposits (sands, gravels, silts and clays) occurring along major water courses.

The elevations on the Forest range from 100 feet (30.5 meters) at the northern boundary to 3,533 feet (1,077 meters) at El Toro Peak. The terrain ranges from gentle slopes in lower elevations to rugged side slopes exceeding 60 percent in higher elevations, where vertical rock-faced cliffs are numerous.

Mineral rights on the Forest that are former Spanish Crown Lands, are held by the Federal Government, and are not subject to U.S. reigning laws. Opening these lands to mineral entry would require an act of Congress or a presidential decision (USDI Bureau of Mines 1991).

Ownership of mineral rights on the remainder of the Forest is more complicated. These rights were transferred from the Commonwealth of Puerto Rico to the Federal Government by Puerto Rican Law of February 16, 1903 (Puerto Rico Department of Natural Resources 1976). However, U.S. law states that acceptance of jurisdiction by the Federal Government is not automatic for lands acquired after 1940. Rights on such lands may be claimed by the Commonwealth of Puerto Rico through the U.S. Secretary of Interior. Puerto Rican law does not recognize private mineral rights, except for “non-commercial minerals” (equivalent to salable minerals under U.S. regulations [sand, clay, gravel, etc.]) on private land.

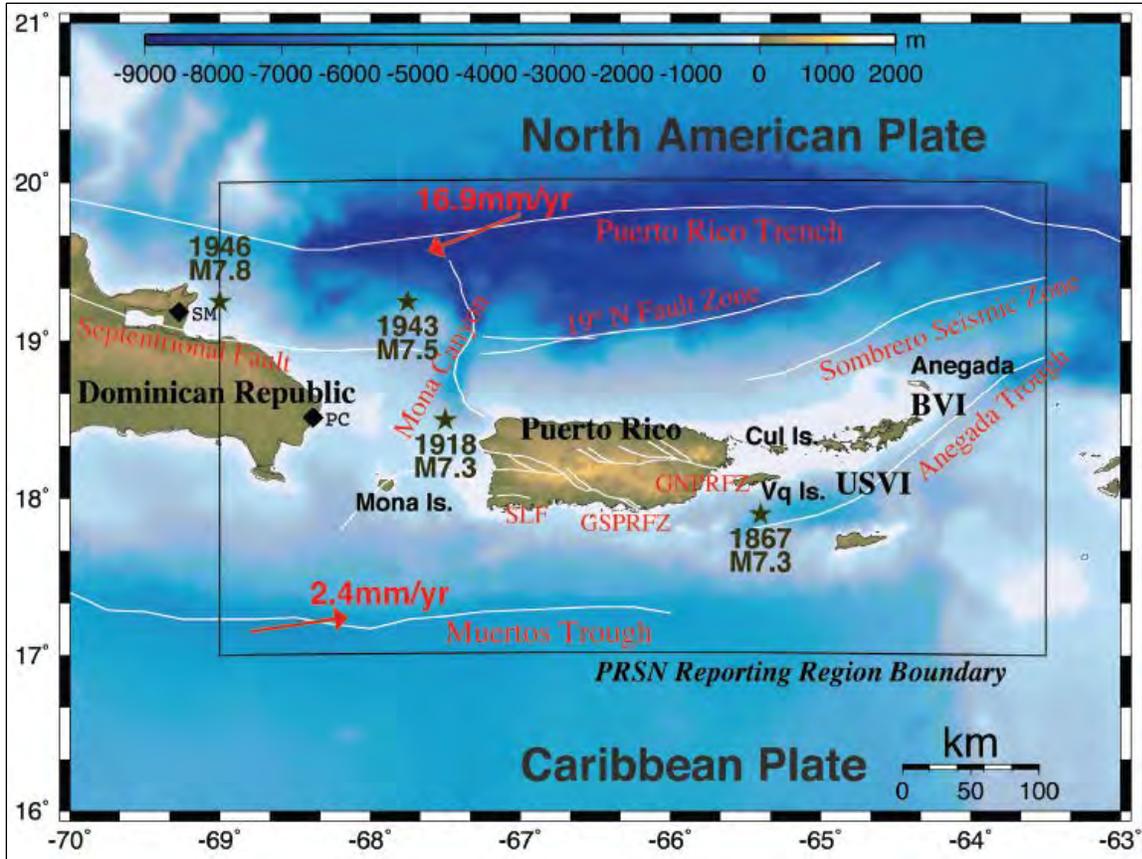
3.3.2.2 Affected Environment

The extraction and removal of mineral materials is the only management activity that has the potential to affect the geology of the area. El Yunque National Forest has no mineral activity and no outstanding mineral rights. Mineral management would not vary by alternative. The only salable mineral extraction that would be permitted would be incidental amounts for administrative uses; like cleaning the debris from landslides in the road system of the Forest. The application of best management practices and the standards considered by management areas will provide the protection and parameters for this type of activity.

Geological Hazards.

Puerto Rico is located on a microplate sandwiched between the obliquely sub-ducting North American and Caribbean plates (Map 3-3).

On average, Puerto Rico is strongly shaken with Modified Mercalli Intensity (MMI) >VII once every 100 years, and MMI >VI is experienced on the island once every 50 years.



Map 3-3. Map of northeastern Caribbean, showing major tectonic structures and approximate locations for damaging earthquakes in recent history

Adapted from Clinton et al. (2006).

All Alternatives

The extraction and removal of mineral materials is the only management activity that has the potential to affect the geology of the area. El Yunque National Forest has no mineral activity and no outstanding mineral rights. Mineral management would not vary by alternative. The only salable mineral extraction that would be permitted would be incidental amounts for administrative uses; like cleaning the debris from landslides in the road system of the Forest. The application of best management practices and the standards considered by management areas will provide the protection and parameters for this type of activity.

The potential for indirect effects can be considered from earthquakes and those can include landslides and damages in electrical lines, communication sites and other infrastructure in the Forest.

Cumulative Effects

The cumulative effects analysis considered the management activities on the Forest in relation to adjacent areas that include roads, trail and communication sites. Management activities in El Yunque National Forest should not affect geological resources of the Forest or the regions established for alternatives 2 and 3. Some of the previous activities on the Forest and adjacent areas may have a reduced degree of effect on geologic resources like the development of the communication sites and the development of roads and trails with rocks and other materials. The areas modified by these previous activities have adjusted and no

effects are reported in these areas. The considered management criteria for the communication sites and other management areas are not expected to cause any cumulative or significant effect in the mineral resources of the Forest.

3.3.3 Air Quality

3.3.3.1 Affected Environment

El Yunque National Forest does not implement any management activity that would adversely impact air quality. Because of the climate and environmental settings, activities such as prescribed burning and related events are not a concern for the air quality of the Forest. The locality of the El Yunque at the north east of Puerto Rico presents an excellent opportunity for monitoring the trade winds that flow mostly from the northeast toward the Island. Due to the changes in elevation within the Forest, there are vast differences in ecological settings because of the variation in rainfall, relative humidity, wind velocity, cloud cover, temperature, atmospheric saturation deficit, and solar radiation. Air quality directly affects plants, animal and fish habitat, and contributes to the scenic and recreational attributes of the Forest and nearby communities. Air is an essential resource of the Forest. In addition to being a physical resource, air is also an esthetic resource. The Forest's relatively cool clean air attracts many Forest visitors, and is valued by local residents as well.

The air quality within the Forest was documented as in good condition in the 2014 Forest Plan Assessment (2014) although the Saharan air layers during the summer months have been recognized as a potential impact to the air quality of the Forest. The study of the chemical characterization of cloud water samples can be used to analyze the average concentrations of organic aerosols and inorganic aerosols, nitrogen and total nitrogen among others, and compare them to similar locations. Other climate change potential changes from the current condition are considered in other sections of the document. The Plan considers maintaining air quality for a healthy and functional environment. The management activities considered in the Forest Plan are analyzed to consider the environmental consequences in the air resources of the Forest.

3.3.3.2 Environmental Consequences

For all the alternatives, the expected air quality effects from planned development and use of the Forest are temporary and limited. Effects include dust and vehicular emissions from potential facilities construction and maintenance, public travel on Forest roads, and smoke from picnic and camping activities. The alternatives would not vary in their effects on air quality. Alternative 1 includes the timber production demonstration and the developed recreation management areas that can be the sources of temporary air quality changes in specific sites of the Forest. Alternatives 2 and 3 exclude the timber demonstration management area and include the community interface resource management area, which provides the sustainable use of the Forest resources, but does not include a timber program. Alternatives 2 and 3 have a forest products program that provides some wood products. Alternative 2 includes a scenic byway management area along PR Road 186 that can contribute to temporary changes in air quality. The expected use of the scenic byway will be through an existing road and the activities are not expected to degrade the air quality of the area. The monitoring plan is a key component to the application of any of the alternatives and will help to determine any variations from the prevailing conditions of the air quality. Alternatives 2 and 3 include the application of the geographic areas (alternative 2–A. Rio Grande/Luquillo; B. Canovanas/Juncos/Las Piedras/Naguabo and Humacao; C. Fajardo/Ceiba; alternative 3–A. Canovanas/Rio Grande/Luquillo and Fajardo B. Juncos/Las Piedras/Naguabo/Humacao and Ceiba); these are important to the air resources of the Forest. The prevailing good air quality provided by El Yunque is considered an esthetic resource because of the pleasant sensations it provides to the visitors and community around the Forest. The integration of the geographic areas provides an additional recognition

of the air resources and opens the opportunity for collaborative work directed to monitor and protect the air quality of the Forest.

The monitoring plan will link to the climate change parameters because future projections using the parallel climate model show a decrease in average easterly winds over the Greater Antilles for the coming century, but an increase elsewhere in the Caribbean (Angeles et al. 2010). All the alternatives include the research and monitoring component for the Saharan layers of dust. The observed sensitivities of the dust to changes in climate indicate that future climate change could drastically change the amount of dust reaching the Caribbean (Prospero and Lamb 2003).

Cumulative Effects

The 2014 Forest Plan Assessment documented that the air quality within the Forest is in good condition. There are some activities and conditions associated with visitor density patterns in some areas of the Forest such as vehicle concentration that can degrade the air quality in some areas. If the interest and demand of the recreational areas are clustered, a cumulative effect can be expected unless the density is distributed through different areas of the Forest.

The identification of Saharan air layers during the summer months has the potential to impact the air quality of the Forest (2014 Forest Plan Assessment). This, added to the projected impacts of climate change, needs to be considered in all the alternatives to evaluate the cumulative effects that these conditions can create in the Forest. The increase in temperature and the associated urban development closer to the Forest edges (Lewsey et al. 2004; Kelman and West 2009) can also become a cumulative effect to air quality in relation to recurrence and distribution of wildfire.

The proposed alternatives are not expected to trigger environmental and social effects in the Forest in any particular manner. The protection and sustainable use of the Forest established by the proposed alternatives will reduce some of the potential cumulative effects to air quality on the Forest. All the alternatives present a Forest protection priority which is an important principle to sustain and protect the air quality for the visitors, stakeholders and region.

3.3.4 Effects of Climate Change on the Plan Area, Climate Trends

Average temperatures in the Caribbean region have increased over the past 40 years (Uyarra et al. 2005). Around the Luquillo Mountains, a small increase in annual maximum and minimum temperatures has been detected in long-term (62 year) records (Waide et al. 2013). Scientists predict warming will continue at an accelerated pace (IPCC 2007); however, climate models vary in the degree of warming (Table 3-2). Projected decreases in precipitation in the Caribbean suggest drier wet seasons, and even drier dry seasons (Table 3-3) (Cashman et al. 2010). Increasing sea surface temperatures may lift the base altitude of cloud formation (Still et al. 1999) and alter atmospheric circulation patterns (Woollings and Blackburn 2012). Any change in the cloud base height will further reduce precipitation in El Yunque (Comarazamy and González 2011). Climate change may also affect the distribution patterns and concentrations of air pollutants through changing wind and precipitation patterns (Bytnerowicz 2007) as well as increased temperatures (Bedsworth 2011).

Table 3-2. Climate model projections for increases in temperature at end of century

Source	Spatial Extent	Projection
Scatena (1998)	Puerto Rico	+1.5 to +2.5 °C
Girvetz et al. (2009); Meehl et al. (2007)	Puerto Rico	+2.2 to +2.7 °C
Campbell et al. (2011)	Caribbean	+2 to +5 °C
Christensen et al. (2007) (IPCC)	Central America	+1.8 to +5 °C
Magrin et al. (2007) (IPCC)	Latin America	+1 to +7.5 °C

Table 3-3. Climate model projections for changes in precipitation at end of century

Source	Spatial Extent	Projection
Girvetz et al. 2009; Meehl et al. 2007	Puerto Rico	-10 to -30% annually
Campbell et al. 2011	Caribbean	-25% to -50% annually
Biasutti et al. 2012 (IPCC)	Caribbean	-30% in spring and summer
Magrin et al. 2007 (IPCC)	Latin America	-40% to +10% annually

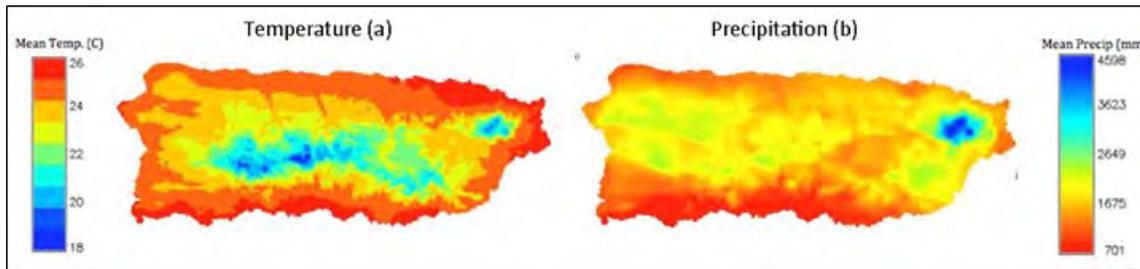


Figure 3-1. Spatial patterns of average annual temperature (a) and precipitation (b) from 1963–1995 based on historic observations

Source: (Daly et al. 2003)

3.3.4.1 Extreme Weather

Heavy rainfall events have become more common in Puerto Rico in recent years, particularly since 2009, with changes linked to high sea surface temperatures (Vélez Rodríguez and Votaw 2012). The frequency of extreme precipitation events is expected to continue to increase, leading to potential increases in inland flooding and landslides (Magrin et al. 2007; Seneviratne et al. 2012). Hurricane events are likely to become less frequent but more severe, with increased wind speeds, rainfall intensity, and storm surge height (Karl et al. 2009; Knutson et al. 2010). In the Caribbean, the occurrence of very warm days and nights is accelerating, while very cool days and nights are becoming less common (Peterson et al. 2002), increasing the likelihood of extreme heat waves (Anderson 2011). Additionally, as annual rainfall decreases over time in the Caribbean region, longer periods of drought are expected in the future (Breshears et al. 2005; Larsen 2000). In Puerto Rico, where nearly all wildfires are associated with human activity, the interactions between climate warming and drying and increased human development have the potential to increase the effects of fire (Robbins et al. 2008).

3.3.4.2 Terrestrial Ecosystems

Higher temperatures, changes in precipitation patterns, and any alteration in cloud cover will affect plant communities and ecosystem processes in El Yunque (Lasso and Ackerman 2003). Increasing night-time

temperatures may affect tropical tree growth and induce tree mortality (Clark et al. 2010; Wagner et al. 2012). Both intensified extreme weather events and progressively drier summer months in the Caribbean are expected to alter the distribution of tropical forest life-zones (Wunderle et al. 2011), potentially allowing low-elevation Tabonuco Forest species to colonize areas currently occupied by Palo Colorado Forest (Scatena 1998). Because they occur under narrowly defined environmental conditions, El Yunque's Cloud Forests are among the world's most sensitive ecosystems to climate change (Lasso and Ackerman 2003). Cloud Forest epiphytes (e.g., bromeliads) may experience moisture stress due to higher temperatures and less cloud cover with a rising cloud base, affecting epiphyte growth and flowering (Nadkarni and Solano 2002; Zotz and Bader 2009). Plant communities on isolated mountain peaks will be most vulnerable, as they will not be able to adapt to the shifting cloud base by moving to higher elevations (Laurance et al. 2011; Magrin et al. 2007).

3.3.4.3 Aquatic Ecosystems

Shifts in rainfall patterns due to climate change will lead to periods of flooding and drought that can significantly affect aquatic ecosystems and water resources (Seager et al. 2009). Increases in heavy downpours in Puerto Rico and more intense hurricanes in the wet season can lead to increased erosion and sedimentation in waterways (Carpenter et al. 1992; Cashman et al. 2010; Karl et al. 2009). Riparian areas will see changes in structure and composition due to altered temperature, precipitation, and run-off regimes as well as changes in the distribution of plant and animal species (Seavy et al. 2009). Extended droughts in the dry season may significantly affect aquatic organisms by reducing dissolved oxygen content (Mulholland et al. 1997). During droughts, freshwater aquatic communities will experience crowding of species, leading to habitat squeezes and reduced reproductive output (Covich et al. 2003). In El Yunque streams, extended periods of extreme low water flows may increase pollutant concentrations and excessive nutrients (Cashman et al. 2010; Covich et al. 2003).

3.3.4.4 Wildlife

Climatic warming may push the narrow thermal tolerances of many species in tropical environments above their upper limits (Huey et al. 2009; Laurance et al. 2011), prompting population losses and habitat changes that will affect animal communities (Blaustein et al. 2010). Because of their cool-adapted, range-restricted nature, high-elevation amphibians, including Puerto Rican coquí frogs, are especially vulnerable to future changes (Barker et al. 2011; Brodie et al. 2011; Longo et al. 2010; Stallard et al. 2001). More frequent drought conditions may increase the vulnerability of both reptiles and amphibians to water loss, parasites, and diseases including amphibian chytrid fungus (Anchukaitis and Evans 2010; Burrowes et al. 2004; Rogowitz 1996). Reduced rainfall may lead to decreased habitat quality for neo-tropical bird migrants wintering in El Yunque (Studs and Marra 2011), while cavity-nesting birds, including the Puerto Rican parrot (*Amazona vittata*), could see an increase in habitat competition and nesting predation with an increase in major hurricane disturbances (Arendt 2000; Pounds et al. 1999).

3.3.4.5 Recreation

The Caribbean region, where year-round warm weather is the principal tourism resource, may see increasing competition from other regions as warm seasons expand globally (Scott et al. 2004). Sea level rise will affect coastal resorts, which may affect tourist and recreationist preferences throughout Puerto Rico (Lewsey et al. 2004; Magrin et al. 2007). Climate change may affect recreation in El Yunque through changes to local ecosystems and resources that affect scenic values, as well as changes to weather patterns that may disrupt recreational activities and lead to changes in visitor use (Prideaux et al. 2010). Visitors to El Yunque may see effects to the local plant and animal communities that make the Forest unique (Scatena 1998). An increase in extreme weather events may increase damage to facilities and structures, reduce tourist access in some areas, and increase the need for road repairs (Joyce et al. 2008).

3.3.5 Water and Watersheds

This section offers the information and findings of effects of the alternatives on the water resources and watersheds within El Yunque National Forest designated zones. The main public uses of the waters that drain from the Forest are as municipal and domestic water sources, and as recreational opportunities for the visitors and surrounding communities in natural pools and scenic waterfalls. The 2014 Forest Plan Assessment identifies the water used for public consumption as an important commodity with economic significance. In this section, the information on watersheds, rivers and streams; riparian areas, wetlands and water quantity; is considered for the proposed action and alternatives for the Forest Plan.

Water resources are jointly managed by several state and Federal agencies on the Island. Water quality is regulated by the Puerto Rico Environmental Quality Board and the Environmental Protection Agency. Water extraction is regulated by the Department of Natural and Environmental Resources, and water distribution and supply is managed by the Puerto Rico Aqueducts and Sewers Authority. Water quality and quantity (part of the Caribbean Water Science Center) is managed by the U.S. Geological Survey (USGS). Ample information regarding the water resources of El Yunque National Forest, including instream flow data, is available and accessible in real time from the USGS and the other agencies mentioned above. The Forest protects the headwaters of eight watersheds which produce an estimated 73.5 billion gallons of water per year. The 2008 El Yunque National Forest Fiscal Year Monitoring and Evaluation Report presents a table of the conditions and trends of programmatic events associated with the desired future conditions of the Forest’s current land management plan.

Table 3-4. Conditions and trends of the current land management plan toward the established desired future conditions

DFC	Measurement or management action	2003	2004	2005	2006	2008
Healthy Watershed	Acres restored	9	8	15	7	12
Healthy Watershed	Acres affected by illegal use	0	0	0	8	1.5
Balanced Water Use	Extraction	51 mgd	66.4 mgd	66.4 mgd	66.4 mgd	66.4 mgd
Balanced Water Use	Intakes	32	34	36	36	36
Dynamic Links	Flows	Not below natural minimum				
Plan Goals	Number of programmatic events	6	8	8	7	3

3.3.5.1 Affected Environment: Watersheds

Conditions and Trends of the Current Land Management Plan Moving Toward the Desired Future Conditions

The watersheds within the designated areas of El Yunque are classified and defined by the hydrologic unit codes (HUCs) (http://pr.water.usgs.gov/public/rt/pr/rtmap_pr_east.html) that classify watersheds by size from region to sub-watersheds. Puerto Rico and other outlying Caribbean areas are in region 21. Table 3-5

includes the HUCs numbers, names, extents, and percent under Forest Service ownership for each watershed identified according to the El Yunque Watershed Condition Classification Supplemental Guidance (USDA Forest Service 2010; EIY 2010 WCC Reg Supp v.5).

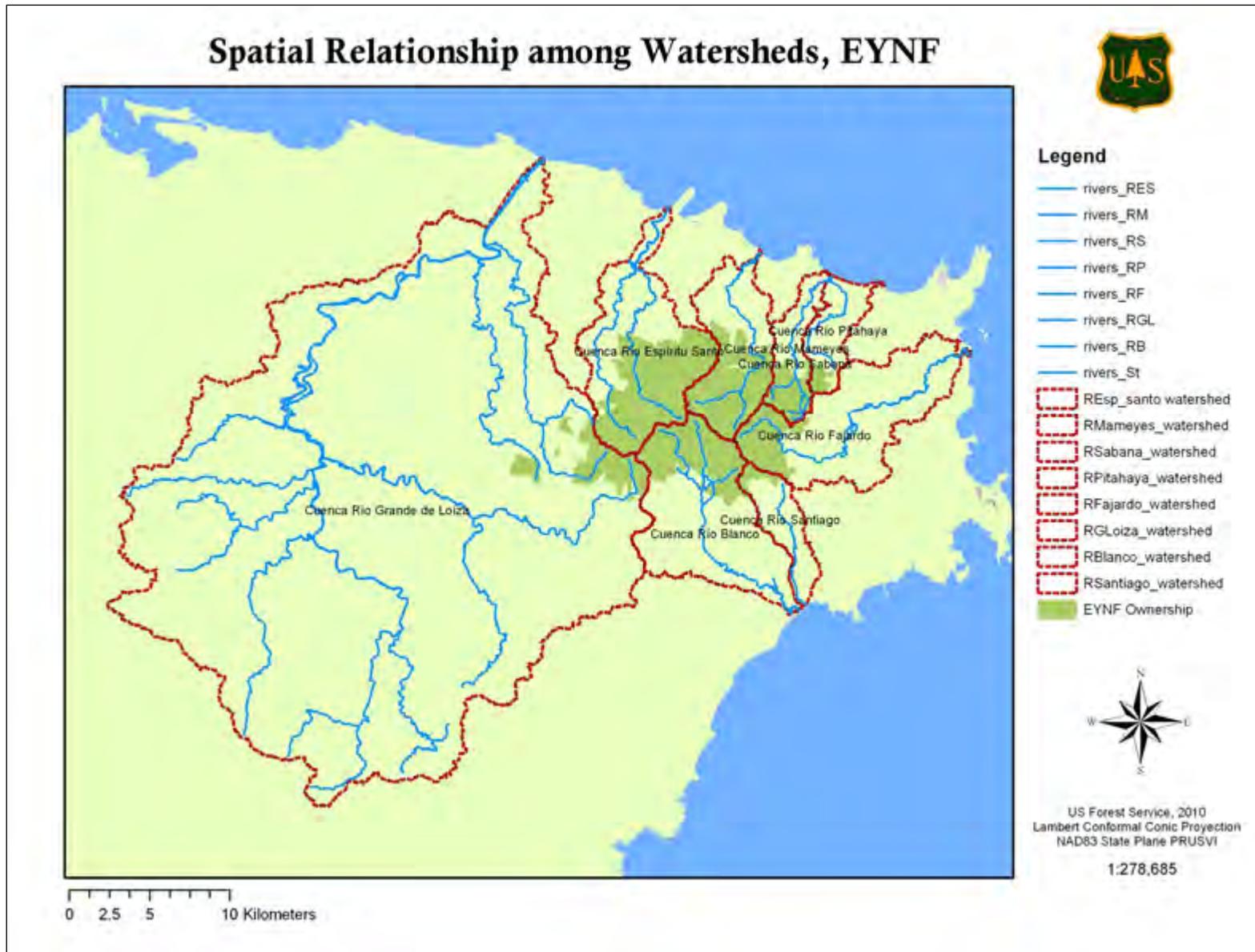
Table 3-5. Hydrologic units within the project area

HUC Number	Name	Total Acres	Percent of Acres under Forest Service Ownership
210100050202	Rio Blanco near mouth	17,341	30
210100050203	Rio Santiago near mouth	4,381	12
210100050204	Rio Fajardo near mouth	16,628	17
210100050302	Rio Pitahaya at mouth	4,085	11
210100050303	Rio Sabana at mouth	4,616	42
210100050304	Rio Mameyes near mouth	9,950	52
210100050305	Rio Espiritu Santo near mouth	15,761	55
210100050413	Rio Canovanas/within RGLoiza	11,209	14

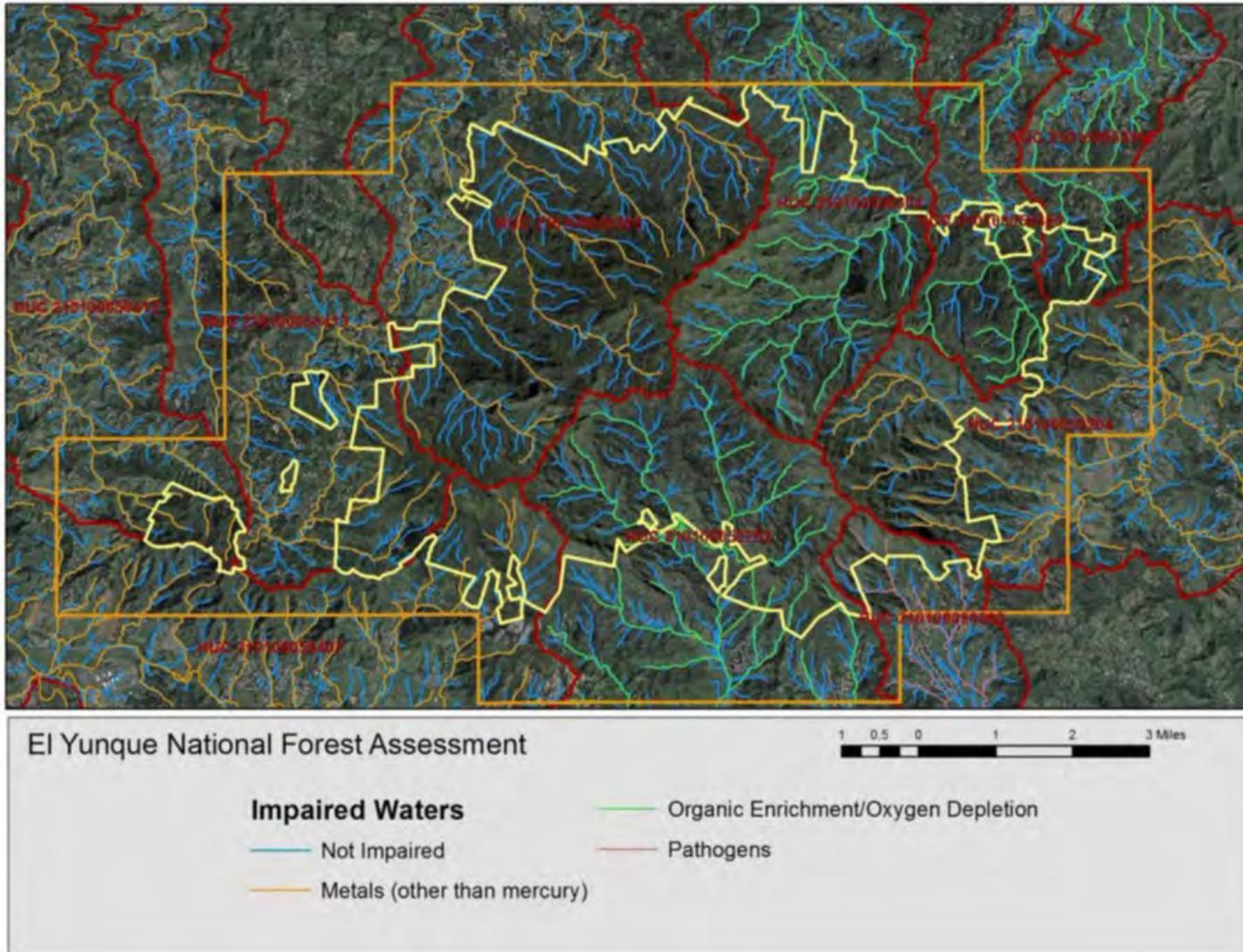
Map 3-4 shows the spatial relationship among the watersheds and El Yunque. The watershed condition framework (WCF) applies a comprehensive approach for implementing integrated restoration on priority watersheds on National Forests. On October 20, 2010, the Deputy Chief expressed a commitment on behalf of the agency to utilize the WCF process to produce a nationally consistent, comparable, and creditable process to assess and restore watersheds. The framework was applied in El Yunque to identify watershed attributes and indicators to determine watershed condition across the Forest.

The current conditions of the watersheds are explained in the 2014 Forest Plan Assessment (see Section 2.5.2. pages 63–65 of the 2014 Forest Plan Assessment for the El Yunque National Forest). There are 34 water intakes withdrawing over 46 million gallons per day from the Forest, so an important element of the WCF is identifying and analyzing impaired water resources (Map 3-5).

There are no direct effects from implementing the plan although there is the potential for direct/indirect effects at the project level. At the end of this section, Table 3-9. Summary of effects by alternative and watershed summarizes the indirect, direct, and cumulative effects by watershed for potential projects that could be implemented by alternative.



Map 3-4. Spatial relationship among watersheds, El Yunque



Map 3-5. El Yunque National Forest impaired and non-impaired waterbodies

Source: 2014 Forest Plan Assessment for the El Yunque National Forest

3.3.5.2 Affected Environment: Rivers and Streams

The stream flows of the hydrologic network within the Forest are highly variable, running very high during heavy rains and much lower during periods of low rainfall. Stream water is generally clear, with low accumulations of dissolved nutrients at low flows, and turbid during high flows. The steep drainage of the eight watersheds is formed by volcanoclastic and igneous rocks that exert a strong, localized lithologic influence on the stream channels. The rivers of the El Yunque are known for their biodiversity and conservation management in the surrounding watersheds. Mameyes River, as one of the last undammed rivers in Puerto Rico that originates on El Yunque, can be used as a reference stream to estimate the natural range of variance for El Yunque aquatic ecosystems.

The longitudinal profiles of the rivers are influenced by the multiple rocks types; coarse sediments are delivered by landslides along steep hillslopes (greater than 12 degrees) to the channels and also may influence channel gradients and geometry (Pike 2008). Río la Mina, Río Mameyes and a tributary; and the Río Icacos, a tributary of the Río Blanco are designated as wild and scenic rivers (National Park Service 2005).

Monthly water budgets show that higher rainfall occurs from August to December, with a rainfall peak in November. A rainfall peak also occurs in May. March is the driest month of the year, which has important management implications: water diversion for human use should not exceed a level that would cause unacceptable stream habitat degradation during March. Runoff volume follows the monthly rainfall pattern: streamflow peaks in November with a second peak in May and is lowest in March.

The parameters in the WCF (watershed condition framework) are presented in Table 3-6. These parameters were considered and analyzed for the Plan alternatives considering short- (1 to 10 years) and long-term (1 to 50 years) scenarios in the Blanco, Canovanas, Espiritu Santo, Fajardo, Mameyes, Pitahaya, Sabana and Santiago watersheds.

Table 3-6. Watershed condition framework parameters analyzed in this Plan

Key Attribute Name	Measure
Hydrologic Function	Flow Characteristics
Water Quality Sediments	Forest Coverage Rating
Water Quality Sediments	Riparian Road Density
Water Quality Sediments	Road Density Rating
Water Quality Sediments	Road Maintenance Index
Water Quality Toxics	Impaired Water Listed as 303D
Water Quality Toxics	Water Quality Problem (not 303D listed)

The need of a standardized regional approach for ecological and biological planning for the forest planning process was the main reason to develop a collaborative initiative to create what is known as the Ecological Sustainability Evaluation (ESE) tool. The ESE tool is a strategic conservation planning tool used by the Forest Service Southern Region for forest planning. Ecological systems, watersheds, terrestrial and aquatic species are carried through the preliminary assessment and sustainability framework (including strategies and plan alternatives) to ascertain expected outcomes. The tool utilizes a standardized process while being flexible, efficient, and adaptable to Forest-specific priorities and needs. The ESE tool uses prioritization algorithms utilizing rank, importance rating, attributes and indicators, stresses and threats, scope and severity ratings, and management opportunities to assist and support management decisions while creating a standardized, credible, and defensible process record. The ESE

tool analysis also considered the short-term (1 to 10 years) and long-term (1 to 50 years) scenarios in the Forest.

The Forest's streams are considered high quality waters that constitute an exceptional resource (Environmental Quality Board 1990). Generally, the water meets or exceeds Commonwealth water quality standards. Fecal coliform limits are being exceeded at heavily used undeveloped recreation sites, such as Puente Roto.

The Puerto Rico Aqueduct and Sewer Authority (PRASA) operate 12 dams on the Forest, diverting stream water to treatment plants to provide municipal water. These systems consist of low concrete dams (less than 6 feet in height), simple passive intake structures, and buried pipelines carrying the water to off-Forest treatment plants where sediments are removed and the water is chlorinated. In addition to public use of Forest water through PRASA's facilities, 36 private families obtain their domestic water from the Forest. These families use smaller dams (no more than 3 feet height) combined with 1- to 2-inch pipes.

3.3.5.3 Environmental Consequences: Rivers and Streams

All Alternatives

None of the alternatives considered in the Forest Plan would have any measurable effect on the amount of water produced by the Forest. Direct effects are caused by an action and occur at the same time and place, whereas indirect effects are caused by the action, but manifested later in time or farther removed in distance (but are generally foreseeable) (CEQ regulations Section 1508.8). For all alternatives, management activities on National Forest System land, and continued growth and development on private land have the potential for direct and indirect impacts to rivers and streams.

The Forest Plan proposes management to meet Forest land management objectives and move towards desired conditions. Effects are disclosed in general terms with estimations of "probable" effects. Direct and indirect effects would occur at the project level (where implementation occurs), where the effects are specific for an action where data related to that action and Forest monitoring is available.

For all the Plan alternatives the continuing urbanization and increase in construction in the areas around the Forest can increase the expansion of "urban-forest interfaces" or "wildland-urban interfaces" (Radeloff et al. 2005). The WCF and the ESE tool analysis identified the following issues.

- The Rio Blanco Watershed is a priority watershed.
- The impacts in all the watersheds and river system will be more relevant for each alternative in the long-term scenarios. For alternative 1 the watersheds and hydrologic network will show less favorable conditions compared to alternative 2 and 3 according to the ESE tool analysis.
- Five watersheds were rated as "very good" in the planning area for all the alternatives and time scenarios. This indicates that the watershed conditions are optimal; and that associated species' populations should remain robust and potentially even expand.
- Three watersheds (Rio Mameyes, Rio Espiritu Santo and Rio Blanco) were rated "good" which indicates that conditions are acceptable and that associated species' populations should remain stable.
- The ESE Tool analysis indicates that watershed condition remain in a sustainable level or improve in the long-term scenarios in alternatives 2 and 3.
- The application of best management practices should eliminate the long-term effects and indirect impacts to rivers for all the alternatives.

Alternative 1

This alternative preserves the management strategies of the 1997 Forest Land and Resource Management Plan. Under the 1997 Plan the information and application of the WCF was not applied, reducing the opportunity to categorize priority watershed according to their ecological and physical conditions. The consideration of an “all-lands” strategy that could produce adoption or collaborative management programs for creeks and rivers was not considered under the management strategies in the 1997 Plan, reducing the potential benefits of monitoring components for rivers and watersheds through community and environmental organization agreements.

Alternatives 2 and 3

Alternatives 2 and 3 present similar conditions of long-term improvements and sustaining the conditions of the rivers and watersheds. The alternatives identified priority watersheds for improvement following completion of the WCF. Collaborative and cooperative agreements with communities and environmental organizations provide a regional management perspective for the rivers and watersheds that starts within the Forest, but can continue through private properties resulting in a complete watershed approach. The themes in the Forest Plan show the need to maintain a healthy, accessible, and sustainable Forest and provide economic, ecological and social opportunities through an inclusive and collaborative Forest management approach. Alternative 2 considers the integration of the scenic byway of road PR Road 186 and is the preferred alternative. However, alternative 3 provides a better scenario for the Rio Espiritu Santo Watershed in the long term (see Figure 3-2). Both alternatives 2 and 3 maintain the quality of the Rio Espiritu Santo Watershed in the short-term scenario. Activities associated with the scenic byway in PR Road 186 will provide additional benefits to the Forest and further management considerations.

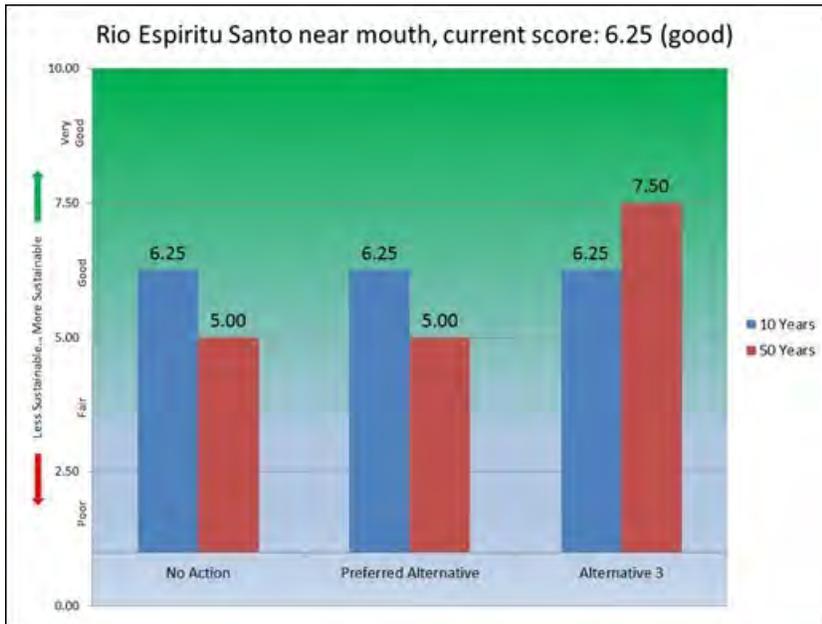


Figure 3-2. ESE Tool analysis for the Rio Espiritu Santo Watershed

Alternatives 2 and 3 include enrichment planting strategies to improve the riparian zone vegetation. This initiative could be developed with community groups or others. The project could be in phases to extend the enrichment of the riparian zones outside the Forest in collaboration with environmental organizations in the region (example: Coalition for the Northeast Corridor). In these projects, the Forest Service

provides vegetation and technical assistance and the community groups provide the volunteers for the planting and monitoring activities.

The International Analog Forestry Network (<http://www.analogforestry.org/>) recommended strategy of riparian restoration projects uses species such as cedro (*Cedrela odorata*), guanabana (*Annona muricata*), guaba (*Inga* sp.), mahogany (*Swietenia macrophylla*) and other species, including fruit trees, to create a favorable environment in the restoration projects. Including species adapted to riparian areas like the heliconias also provides an economic opportunity for production and business with tropical flowers.

Under alternatives 2 and 3 the geographic areas concept provides a better distribution and association of the municipalities in which the watersheds are defined and can provide for a stronger community interaction in watershed approaches and programs. Alternative 2 considers the geographic areas and provides the integration of watershed management for the Fajardo and Ceiba area which is the main water supply watershed for the municipalities to the north of the Forest.

Cumulative Effects: Rivers and Streams

The cumulative effects analysis considers the eight HUCs identified in region of Puerto Rico (Region 21) as displayed earlier in affected environment; the temporal timeframe is the life of the plan. The Forest accounts for about 31.4 percent of the total area that composes the watersheds within the designated boundary. Past actions that have influenced the current condition include the approval of facilities near or close to a river or stream. Foreseeable actions on State, private or other Federal lands include the changes in zoning or land use that can occur in the municipalities that border the Forest and are outside of Forest Service control.

In no action (alternative 1) when these actions are considered with the management plan that has been in place since 1997, the cumulative impacts throughout the rivers that flow from the Forest include the considerations of additional recreational areas, the timber demonstration projects and a management perspective based on management activities in the rivers and stream within the Forest boundaries. The construction of housing projects, the development of rural landscapes and urbanization on private lands adjacent to the Forest can create cumulative impacts.

In alternative 2 and 3 although cumulative impacts would be possible from the development of rural landscape, the effects could be reduced with the “all-lands” approach and the integration of a regional management perspective. Jennings et al. (2014) documents that tropical landcover change, resulting from direct human activities, interacts with anthropogenic ecosystem drivers such as climate change and affects watershed supply. The scenic byway considered in alternative 2 is a use that would represent potential cumulative effects in the Rio Espiritu Santo Watershed. The use of an existing road (PR 186) for the scenic byway section would also represent the potential maintenance and drainage improvements that could reduce cumulative impacts associated with the no action (alternative 1) option. The consideration of recreational facilities or the development of recreational trails could have cumulative impacts depending of their location. It is important to note that most visitors enjoy or find pleasing contact with and use of the rivers and streams in El Yunque. In alternative 2 and 3 the proposed trails associated with the river course would need special attention because of the cumulative impacts expected from these activities.

3.3.5.4 Affected Environment: Riparian Areas

The plan considers the restoration and conservation of riparian zones with native species to sustain its diversity and functions. All the alternatives recognize that the riparian zones deliver ecological services to the aquatic ecosystems and watersheds of El Yunque and the surrounding regional lands. As part of the 2014 Forest Plan Assessment, 100-foot (30.5 meters) buffer zones were placed around the rivers (National Hydrography Dataset) inside the Forest to estimate riparian forests. The buffer zones were separated into

Submontane Moist, Montane Wet and Rain, and Montane Cloud Wet and Rain Riparian Forests using a combination of ecological life zones data and the 600-meter elevation line. These river buffer zones integrate 2,113.83 acres. Table 3-7 shows the distribution of acres per zone in the Forest. The 2014 Forest Plan Assessment presents a description of the vegetation described by different studies in these zones (Heartsill-Scalley et al. 2007; Brown et al. 2006; Pike and Scatena 2009; Scatena 1990; O’Connor et al. 2000; Scatena and Larsen 1990).

Table 3-7. River buffer zones in the planning area

River Buffer Zone	Area in Acres
Submontane Moist	58.96
Montane Wet and Rain	1,350.14
Montane Cloud Wet and Rain	704.73

Source: 2014 Forest Plan Assessment, El Yunque National Forest

The Forest plan recognizes the need of a survey in the riparian zones and defines standards and guidelines to achieve the goal of maintaining or improve the functional ecological connections provided by riparian zones through the management regions.

3.3.5.5 Environmental Consequences: Riparian Areas

All Alternatives

All alternatives would emphasize protection and improvement of riparian areas. Management activities consistent with best management practices and standards and guidelines will be implemented as described in the 2014 Forest Plan Assessment. For the estimated score in the ESE Tool, watershed improvement varies by alternatives. Alternatives 2 and 3 present a better score for Rio Mameyes, Rio Espiritu Santo, and Rio Canovanas in the long-term scenarios.

Alternatives 2 and 3 emphasize the collaborative approaches for conservation education regarding aquatic ecosystems or a related ecosystem component for at least one priority watershed every 2 years to enhance public awareness and opportunities and to better understand scientific land management. These alternatives also encourage the collaborative agreements with communities, agencies, and environmental organizations to establish permanent plots in order to monitor environmental change and its effect to El Yunque wetlands and the broader landscape. Alternative 1 presents conservation approaches for the riparian areas, but does not provide specific direction or management strategies for improvement and does not establish priority watersheds for the Forest. The riparian and watershed composition and structure are key components of aquatic ecosystems and are, therefore, important components of aquatic ecosystems monitoring.

Alternative 1

This alternative follows the management strategy of the 1997 Forest Land and Resource Management Plan which follows a similar delineation of the riparian zone (100-foot buffer) used for the 2014 Forest Plan Assessment. The alternative includes the development of recreational areas with construction intended to reduce sedimentation to conserve riparian areas. The 1997 Plan includes a timber harvest component that is identified as a sediment source action in the long-term scenario of the Plan. The alternative does not integrate the evaluation of the WCF and did not establish a priority watershed as part of the analysis. Alternative 1 does not consider the geographical zones considered in alternatives 2 and 3, where there is the potential integration of community groups and organizations to participate in management strategies applied to riparian zones.

Alternatives 2 and 3

In alternatives 2 and 3, the WCF identified one priority watershed for improvements in the short-term scenario of the Plan. The WCF identified the Rio Blanco watershed as the highest priority for improvement within the Forest. This watershed will be managed to supply appropriate ecological services.

The identification of geographic areas in these alternatives also provides opportunities for targeted conservation initiatives, such as for stream corridors, riparian areas, wild and scenic river corridors, and potential riparian conservation connection projects with other naturally protected areas in the regions like the Corredor Ecologico del Noreste Natural Reserve. Alternative 2 includes a geographic area that covers the eastern municipalities of Fajardo and Ceiba which specifically establish management emphasis in watershed management. This geographic area could be used as a reference for watershed integrated management initiatives developed in collaboration with eastern municipalities. Alternatives 2 and 3 promote the engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. The riparian management zones are defined in these alternatives as 100 feet from the edges unless a site-specific analysis is conducted to identify and delineate a more specific riparian management zone. Standards and guidelines require the use of best management practices approved by the Forest Service for all management activities or maintenance practices proposed close to riparian areas.

Cumulative Effects

The cumulative effects for the El Yunque National Forest were determined using current information provided in the 2014 Forest Plan Assessment, existing data, past practices, identified project effects and the available information on private land actions. The ESE Tool analysis indicated the cumulative effects for alternative 2 and 3 are not considerably different and none result in long-term impacts. Alternative 1 presented less improvement in the watershed conditions compared to the other alternatives in three watersheds. Because of its relatively high road density, the Rio Fajardo Watershed moved from very good to fair condition for all alternatives. Alternative 2 best addresses this condition shift by defining a geographic zone which integrates the watershed with the management strategies.

Summary of Effects, All Alternatives

All alternatives would emphasize protecting and improving riparian areas. Management activities consistent with best management practices and standards and guidelines will be implemented as described in the 2014 Forest Plan Assessment. The application of the ESE tool would help ensure all the watersheds maintain a similar score considering the planning area element. The estimated score in the ESE Tool for watershed improvement varies by alternatives. Alternatives 2 and 3 present a better score for Rio Mameyes, Rio Espiritu Santo and Rio Canovanas in the long-term scenarios.

Alternatives 2 and 3 emphasize the collaborative approaches for conservation education regarding aquatic ecosystems or a related ecosystem component for at least 1 priority watershed every 2 years to enhance public awareness and opportunities and to better understand scientific land management. These alternatives also encourage collaborative agreements with communities, agencies and environmental organizations to establish permanent plots in order to monitor environmental change and its effect to El Yunque wetlands and the broader landscape. Alternative 1 presents conservation approaches for the riparian areas, but did not provide specific direction or management strategies for improvement and did not establish priority watersheds for the Forest. The riparian and watershed composition and structure are key components of aquatic ecosystems and are, therefore, important components of aquatic ecosystems monitoring.

3.3.5.6 Affected Environment: Water Quality and Quantity

The 2014 Forest Plan Assessment describes the importance of the water resources produced in the Luquillo Mountains. The Luquillo Mountains supply more than 20 percent of the Island's municipal water each year, with the El Yunque providing an average of 276 cubic hectometers of water per year for municipal uses (Scatena and Johnson 2001). The rivers that drain the Luquillo Experimental Forest all have steep gradients, boulder- and bedrock-lined channels with steep-pool morphology, and waterfalls (Ahmad et al. 1993). The yearly water production of El Yunque is estimated at 73.5 billion gallons per year ([LRMP] USDA Forest Service 1997). Estimated as the cost paid by the consumer, water extracted from the streams that drain the Luquillo Mountains is worth about \$25 million per year. Because of the importance of understanding where the water is most available and how the quantity changes; with individual storms, season, and on annual to decadal time scales; water budgets have been developed for El Yunque National Forest.

Water quality in the watersheds of the El Yunque is relatively pure. According to McDowell (1994), water chemistry data indicate that major cations and anion concentrations do not exceed water quality standards. El Yunque common aquatic species include the following: seven freshwater shrimp species (*Xiphocaris elongata*, *Atya scabra*, *Micratya poeyi*, *Macrobrachium faustinum*, *Macrobrachium heterchirus*, *Macrobrachium carcinus*, and *Macrobrachium crenulatum*), one crab species (*Epilobocera sinuatifrons*), and five fish species (*Sicydium plumieri*, *Awaous banana*, *Agonostomus monticola*, *Anguilla rostrata*, and *Gobiomorus dormitor*). There are no rare or federally listed aquatic species on the El Yunque.

Population trends developed from long-term monitoring sites in many of the watersheds show a stable count of common aquatic species on the El Yunque. Many of the freshwater shrimp live their entire life cycle within El Yunque river systems. The river system defined for the WCF connects with coastal areas that integrate an estuary ecosystem, which provides an important condition and habitat for the El Yunque aquatic species. Endemic freshwater fishes have the same biological cycle, except the American eel (*Anguilla rostrata*). The American eel is a catadromous fish species, where adults travel to breeding areas in the Sargasso Sea to the north and the next generation of young eels return to the El Yunque streams.

Primary impacts of the Forest from pollution are associated with public use of pools and river segments as recreational areas and from sediments produced by landslides in the Forest. Some impacts from airborne pollutants have been found in the waters (Jennings et al. 2014) of some watersheds. These are periodic events but have been identified as important monitoring components of the effects of climate change on El Yunque. There are 34 water intakes withdrawing over 46 million gallons per day from the Forest, in some basins, up to 82 percent of the median flow is diverted. Currently, 70 percent of water generated within the Forest is diverted before reaching the ocean, up from 54 percent in 1994 (Crook et al. 2007). The Plan considers improvement of the stream water network information to evaluate the quality and supply parameters of the resources. The management strategy will be developed considering an outreach component to promote the value and influence of the resource in relation to the socioeconomic system or aspects of the region.

3.3.5.7 Environmental Consequences: Water Quality

Effects Common to All Alternatives

Water quality and quantity were identified as key services provided by the Forest and should be maintained or improved as part of the management actions considered. The use of water for human consumption has to be balanced with in-stream flow needs for use, recreation, research, and aquatic and terrestrial ecosystem maintenance. Integrating a watershed management perspective, the Forest should conserve a functional linkage for the aquatic wildlife from inside the Forest to the ocean. Alternative 2 and 3 consider the watershed management approach and apply the WCF as part of the analysis for the

management strategies. All the alternatives consider the conservation and application of best management practices applicable for water resource protection. The watershed approach considered with the geographic zones in the Forest plan will serve to minimize potential pollution problems and improve the restoration and monitoring strategies throughout the Forest.

All the alternatives established that no management practice may cause detrimental changes in water quality and chemical composition, or block the watercourse or deposit sediment that would adversely affect the water conditions and fish habitat. The Plan considers key ecosystem characteristic related to drought, measured by drought severity indices and trends (from U.S. Geological Survey), which would be monitored over time as the data is updated through the water resource strategies applied in the Forest Plan.

Alternative 1

Alternative 1 follows the 1997 Revised Land and Resource Management Plan which provide standards and guidelines to maintain a conservation track for the water resources of the Forest. This alternative does not establish a watershed approach with the definition of priorities and the analysis provided by the WCF. The application of management practices with this alternative will be focused within the Forest boundaries which can limit the management effectiveness for aquatic species.

Alternatives 2 and 3

These alternatives present similar conservation strategies for water resources. Improving or conserving water quality is achieved in both alternatives. The strategy of working with partners and/or other agencies to establish environmental flow ranges based on an empirical Forest water budget is proposed in both alternatives, but alternative 2 provides the integration of geographical areas that should provide additional opportunities for partnerships. The integration of the geographical region could develop projects for specific watersheds, like the one that drains toward Northeast Ecological Corridor establishing a transboundary conservation initiative from Federal property to state and private areas to improve the management of aquatic ecosystems. The application of the WCF will provide a conservation strategy starting with the Rio Blanco Watershed that was identified as a priority watershed. The alternatives protect surface and sub-surface water resources from physical, chemical, and biological pollutants, and eliminate modifying flow regimes to levels that affect the abiotic functions and biotic needs for viable population in the aquatic ecosystems of the Forest.

Water Quality and Quantity Cumulative Effects

The Forest accounts for about 31.4 percent of the total area that compose the watersheds within the designated boundary. Past actions that have influenced the current condition include the approval of facilities near or close to a river or stream. Foreseeable actions on State, private or other Federal lands include the changes in zoning or land use that can occur in the municipalities that border the Forest and are outside of Forest Service control. Climate change is likely to amplify existing pressures on water resources and water availability in northeastern Puerto Rico, especially in combination with increased urban development and water extraction (Crook and others 2007). The quality of water would also show the cumulative effects of climate change because extended periods of extreme low flows in the dry season may result in increased pollutant concentrations and excessive nutrients in Caribbean streams (Cashman et al. 2010; Covich et al. 2003).

In no action (alternative 1) when these actions are considered with the management plan that has been in place since 1997, the cumulative impacts throughout the rivers that flows from the Forest include the considerations of additional recreational areas, the timber demonstration projects and a management perspective based on management activities in the rivers and stream within the Forest boundaries. The

construction of housing projects, the development of rural landscapes and urbanization on private lands adjacent to the Forest can create cumulative impacts. In alternatives 2 and 3, although cumulative impacts would be possible from the development of rural landscape, the effects could be reduced with the “all-lands” approach and the integration of a regional management perspective. Considering climate change, it can be expected that more intense rainfall events lead to increased runoff in the wet season; these events can also lead to decreased water quality through increased turbidity and erosion as well as flooding (Cashman et al. 2010). Watersheds that respond quickly to precipitation, such as in the Luquillo Mountains, may be especially affected (Schellekens et al. 2004). The scenic byway proposed in alternative 2 could have potential cumulative effects in the Rio Espiritu Santo Watershed. The use of an existing road (PR 186) for the scenic byway section would also represent the potential maintenance and drainage improvements that could reduce cumulative impacts associated with the no action (alternative 1) option. This maintenance is important in the consideration of cumulative effects considering climate change because an increase in extreme weather events may increase damage to facilities and structures, reduce tourist access in some areas, and increase the need for road repairs (Joyce et al. 2008).

3.3.5.8 Watershed Health: Watershed Condition Framework

The watersheds identified in El Yunque were analyzed using the watershed condition framework (WCF) that evaluated watershed conditions based on watershed characteristics and attributes. Through the WCF, the watershed health is evaluated to establish priority watersheds that require restoration. The WCF classifies watershed condition, develops restoration in priority watersheds, and monitors accomplishments (USDA Forest Service 2011a, 2011b, 2011c). The WCF classified all the watersheds within the planning area as “good” or “very good” (the tables are included in the administrative record). The Plan establishes that the Forest will proceed with the application of the watershed condition framework according to the restoration action plans.

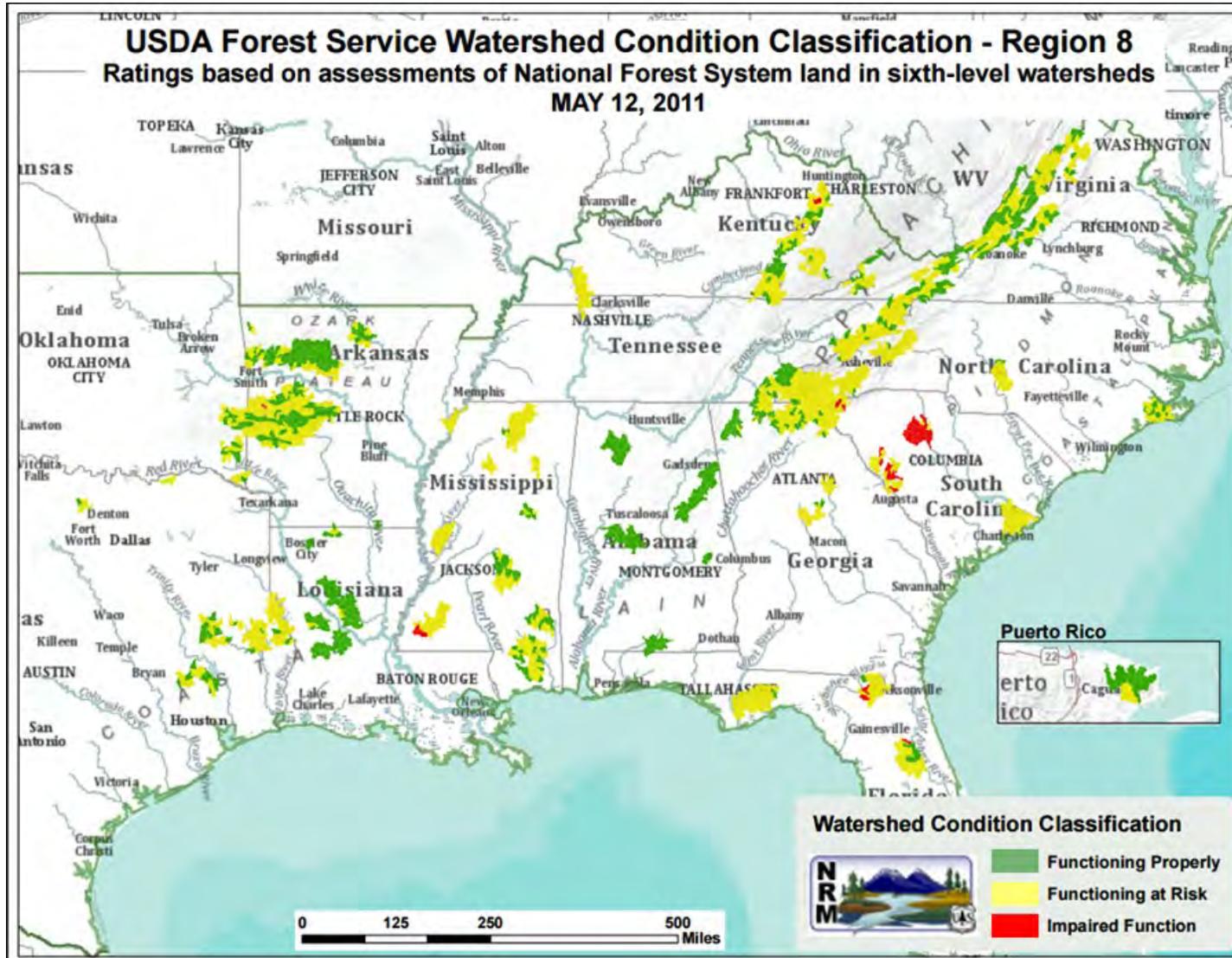
Priority Watersheds

The Rio Blanco watershed was identified as a priority watershed under the WCF ranking system. The 2014 Forest Plan Assessment provides additional information of the watershed condition and the Plan identifies management strategies considered to improve the watershed health conditions. The watershed was classified as “functioning at risk” as part of the Regional assessment with the watershed condition (Map 3-6). The Rio Blanco watershed covers 17,341 acres, 30 percent of which (5,181 acres) are under Forest Service ownership. The El Yunque Watershed Condition Classification Supplemental Guidance (2010) results for the Rio Blanco Watershed are presented in Table 3-8.

No direct or indirect effects are expected from the implementation of the Plan. The consideration of projects in the management areas has the potential for effects and Table 3-9 and Table 3-10 describe some examples considered as part of the analysis process for the alternatives by watersheds.

Table 3-8. El Yunque watershed condition classification supplemental guidance classification for the Rio Blanco Watershed

Water Quantity Condition Indicator	Diversions Not Meeting Standards Developed by FERC Penstock System that Feed the Hydro Power Plant
Water Quantity Condition Indicator	Diversions not meeting standards developed by FERC penstock system that feed the hydro power plant
Aquatic Habitat Condition Indicator	On the Forest functioning at risk: aquatic habitat is not significant impacted but fragmented by FERC dams
Channel Shape and Function	Impaired functioning: Highly erodible soils, high sand content; upper watershed flat and funnels water into channels and causes erosion; landslides have impacted channel shape
Aquatic Biota Condition Indicator	On the Forest functioning at risk: penstock complex has impacted life forms during droughts
Road Maintenance	Impaired functioning: lots of trails and roads which need deferred maintenance
Proximity to Water	Impaired functioning: the extensive trail systems are notable along the streams, because of the nature of the trail system



Map 3-6. Watershed condition classification, Region 8

Table 3-9. Summary of effects by alternative and watershed

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Canovanas: At Mouth; El Yunque			
No Action	1. Increase of recreation activities considered in the developed recreational area could produce indirect impacts over the riparian vegetation and sensible areas. 2. Access to extract timber as part of the timber demonstration area can produce impacts in the aquatic habitats and can affect the riparian areas.	Direct effects could be expected from the development of recreation facilities considered in the zone and from the timber demonstration.	Because of the recreational activities considered in the no-action alternative, some negative cumulative effects could be expected in the Canovanas River because of visitor pressure and recreational activities concentrated in the watershed.
Alternative 2	The CIRMA includes the possibility of applied community-based enterprises, groups, and other organizations that could cause indirect effects in rivers, floodplains, and riparian areas.	The watershed includes areas considered under the CIRMA Management Area that could be used to disperse the visitors pressure considered in the corridor of PR Road 191. The increase in visitors could impact riparian areas and produce some direct effects in the vegetation.	1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	The CIRMA management area include the possibility of applied community-based enterprises, groups, and other organizations that could cause indirect effects in rivers, floodplains, and riparian areas.	The watershed includes areas considered under the CIRMA Management Area that could be used to disperse the visitor pressure considered in the corridor of PR Road 191. The increase in visitors could impact riparian areas and produce some direct effects in the vegetation.	1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Espiritu Santo: At Mouth; El Yunque			
No Action	Areas of the watershed are considered under the timber demonstration activity and the activities could produce indirect effects in the drainage areas of the watershed associated with Rio Espiritu Santo.	The watershed includes zones associated with develop recreational areas and integrated management areas. Direct impact could be expected from recreational activities.	The management areas considered under the no-action alternative could produce cumulative impacts associated with visitors and recreational develop areas.
Alternative 2	The expected increase in use and visits in the areas within the watershed could produce additional pressure and trash problems identified in some drainage areas through the watershed landscape.	The watershed includes areas considered under the CIRMA Management Area that could be used to disperse the visitors pressure considered in the corridor of PR Road 191. The increase in visitors could impact riparian areas and produce some direct effects in the vegetation.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	The expected increase in use and visits in the areas within the watershed could produce additional pressure and trash problems identified in some drainage areas through the watershed landscape.	The watershed includes areas considered under the CIRMA Management Area that could be used to disperse the visitors pressure considered in the corridor of PR Road 191. The increase in visitors could impact riparian areas and produce some direct effects in the vegetation.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Mameyes: At Mouth; El Yunque			
No Action	The consideration of activities to improve the recreational facilities could cause additional pressure to riparian zones.	The water quality will show the effects of the concentration of visitors in the recreational facilities within the watershed.	Because of the recreational activities considered in the no-action alternative, some negative cumulative effects could be expected in the Mameyes River because of visitor pressure and recreational activities concentrated in the watershed.
Alternative 2	Positive effects should be expected at the watershed level because of the geographic management perspective considered in the alternative.	The lower elevation zones of the watershed are included in the CIRMA management area and the potential activities considered for this area could produce impact in the riparian areas of the watershed.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	Positive effects should be expected at the watershed level because of the geographic management perspective considered in the alternative.	The lower elevation zones of the watershed are included in the CIRMA management area and the potential activities considered for this area could produce impact in the riparian areas of the watershed.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Sabana: At Mouth; El Yunque			
No Action	<ol style="list-style-type: none"> Increase of recreation activities considered in the integrated management area could produce indirect impacts over the riparian vegetation and sensible areas. Access to extract timber as part of the timber demonstration area can produce impacts in the aquatic habitats and can affect the riparian areas. 	<ol style="list-style-type: none"> Access to extract timber and the logging activities will produce impacts in the aquatic habitats and can affect the riparian areas. 	<ol style="list-style-type: none"> The recreation activities will also produce cumulative effects. There is a risk of affect to the condition of the river because of the combination of activities that can be applied in closer areas of the Forest (timber demonstration, integrated management).
Alternative 2	<p>The CIRMA management area include the possibility of applied community-based enterprises, groups, and other organizations that could produce indirect effects in rivers, floodplains, and riparian areas.</p>	<ol style="list-style-type: none"> The lower elevation zones of the watershed are included in the CIRMA management area and the potential activities considered for this area could produce impact in the riparian areas of the watershed. The higher elevation zones of the watershed are in the natural research area and no impacts from the allowed activities are expected. 	<ol style="list-style-type: none"> Improvement in aquatic habitat is expected. Higher density of native species is expected. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	<p>The CIRMA management area include the possibility of applied community-based enterprises, groups, and other organizations that could produce indirect effects in rivers, floodplains, and riparian areas.</p>	<p>The lower elevation zones of the watershed are included in the CIRMA management area and the potential activities considered for this area could produce impact in the riparian areas of the watershed.</p>	<ol style="list-style-type: none"> Improvement in aquatic habitat is expected. Higher density of native species is expected. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Fajardo: At Mouth; El Yunque			
No Action	The areas of the watershed are considered under the integrated management description, and dispersed recreation could produce direct impacts in the Wet Forest of the zone. No indirect effects are expected from the activities applicable in the research natural area.	<ol style="list-style-type: none"> 1. The areas of the watershed are considered under the integrated management description and dispersed recreation could produce direct impacts in the Wet Forest of the zone. 2. The research natural area is also considered under the no-action alternative and no direct effects are expected. 	The areas of the watershed have steep terrain and cumulative effects could be expected from landslides that could occur naturally or can be caused by disperse recreation activities.
Alternative 2	The areas of the watershed are considered under the CIRMA Management area and recreation activities could be considered producing indirect impacts in the Wet Forest of the zone. No indirect effects are expected from the activities applicable in the research natural area.	<ol style="list-style-type: none"> 1. Most of the terrain in the watershed is under the Natural Research Baño de Oro Area and no direct effects are expected from the activities. 2. Management application in the CIRMA areas will provide habitat improvement of riparian zones through the watershed. 	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	The areas of the watershed are considered under the CIRMA Management area and recreation activities could be considered producing indirect impacts in the Wet Forest of the zone. No indirect effects are expected from the activities applicable in the research natural area.	<ol style="list-style-type: none"> 1. Most of the terrain in the watershed is under the Natural Research Baño de Oro Area and no direct effects are expected from the activities. 2. Management application in the CIRMA areas will provide habitat improvement of riparian zones through the watershed. 	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Santiago: At Mouth; El Yunque			
No Action	The areas of the watershed are considered under the integrated management description and dispersed recreation could produce direct impacts in the Wet Forest of the zone.	The areas of the watershed are considered under the integrated management description and dispersed recreation could produce direct impacts in the Wet Forest of the zone.	The area of the watershed within the Forest is small and no major cumulative impacts are expected from the activities considered under the no-action alternative.
Alternative 2	The areas of the watershed are considered in the CIRMA Management Area and activities directed toward community-based enterprises are considered. Because of the Montane Wet Forest type the considered activities will be directed toward restoration and conservation of the riparian areas reducing the direct and indirect effects.	The areas of the watershed are considered in the CIRMA Management Area and activities directed toward community-based enterprises are considered. Because of the Montane Wet Forest type the considered activities will be directed toward restoration and conservation of the riparian areas reducing the direct and indirect effects	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	The areas of the watershed are considered in the CIRMA Management Area and activities directed toward community-based enterprises are considered. Because of the Montane Wet Forest type the considered activities will be directed toward restoration and conservation of the riparian areas reducing the direct and indirect effects.	The areas of the watershed are considered in the CIRMA Management Area and activities directed toward community-based enterprises are considered. Because of the Montane Wet Forest type the considered activities will be directed toward restoration and conservation of the riparian areas reducing the direct and indirect effects.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Blanco: At Mouth; El Yunque			
No Action	Increase of recreation activities could produce indirect impacts over the riparian vegetation and sensible areas.	Impacts from the consideration of recreational projects in the watershed.	The expected effects are related to the recreational activities considered in the watershed.
Alternative 2	Soil movements and sediments can be produced from CIRMA projects.	Management application in the CIRMA areas will provide habitat improvement of riparian zones through the watershed.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	Soil movements and sediments can be produced from CIRMA projects.	Management application in the CIRMA areas will provide habitat improvement of riparian zones through the watershed.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Alternative Name	Indirect Effects	Direct Effects	Cumulative Effects
Rio Pitahaya: At Mouth; El Yunque			
No Action	Increase of recreation activities could produce indirect impacts over the riparian vegetation and sensible areas.	Access to extract timber and the logging activities will produce impacts in the aquatic habitats and can affect the riparian areas.	<ol style="list-style-type: none"> 1. The recreation activities will also produce cumulative effects. 2. There is a risk of affect the condition of the river because of the combination of activities that can be applied in closer areas of the Forest (timber demonstration, integrated management, research, administrative site)
Alternative 2	Soil movements and sediments can be produced from CIRMA projects.	Management application in the CIRMA areas will provide habitat improvement of riparian zones through the watershed.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.
Alternative 3	1. Soil movements and sediments can be produced from CIRMA projects.	1. Management application in the CIRMA areas will provide habitat improvement of riparian zones through the watershed.	<ol style="list-style-type: none"> 1. Improvement in aquatic habitat is expected. 2. Higher density of native species is expected. 3. Engagement of community-based enterprises, groups, and other organizations for rivers, floodplains, and riparian area restoration and conservation efforts. 4. Geographic area concept that can be considered a model for integrated watershed management by geographic areas.

Table 3-10. Element composite scores by alternative as for the El Yunque Planning Area calculated by the Ecological Sustainability Evaluation Tool

Element Name	Planning Area Element Score	Planning Area Element Rating	Alternative Name	Years From Current	Estimated Element Score
Rio Pitahaya at mouth	7.5	Very Good	No Action	10	6.25
	7.5	Very Good	No Action	50	6.25
	7.5	Very Good	Preferred Alternative	10	6.25
	7.5	Very Good	Preferred Alternative	50	6.25
	7.5	Very Good	Alternative 3	10	6.25
	7.5	Very Good	Alternative 3	50	6.25
Rio Mameyes at mouth	6.25	Good	No Action	10	4.84
	6.25	Good	No Action	50	4.84
	6.25	Good	Preferred Alternative	10	4.84
	6.25	Good	Preferred Alternative	50	6.25
	6.25	Good	Alternative 3	10	4.84
	6.25	Good	Alternative 3	50	6.25
Rio Espiritu Santo near mouth	6.25	Good	No Action	10	6.25
	6.25	Good	No Action	50	5.00
	6.25	Good	Preferred Alternative	10	6.25
	6.25	Good	Preferred Alternative	50	5.00
	6.25	Good	Alternative 3	10	6.25
	6.25	Good	Alternative 3	50	7.50
Rio Canovanas	7.5	Very Good	No Action	10	7.50
	7.5	Very Good	No Action	50	5.31
	7.5	Very Good	Preferred Alternative	10	7.50
	7.5	Very Good	Preferred Alternative	50	7.50
	7.5	Very Good	Alternative 3	10	7.50
	7.5	Very Good	Alternative 3	50	7.50
Rio Santiago near mouth	7.5	Very Good	No Action	10	6.25
	7.5	Very Good	No Action	50	6.25
	7.5	Very Good	Preferred Alternative	10	6.25
	7.5	Very Good	Preferred Alternative	50	6.25

Element Name	Planning Area Element Score	Planning Area Element Rating	Alternative Name	Years From Current	Estimated Element Score
	7.5	Very Good	Alternative 3	10	6.25
	7.5	Very Good	Alternative 3	50	6.25
Rio Sabana at mouth	7.5	Very Good	No Action	10	7.50
	7.5	Very Good	No Action	50	7.50
	7.5	Very Good	Preferred Alternative	10	7.50
	7.5	Very Good	Preferred Alternative	50	7.50
	7.5	Very Good	Alternative 3	10	7.50
	7.5	Very Good	Alternative 3	50	7.50
Rio Blanco near mouth	6.25	Good	No Action	10	4.84
	6.25	Good	No Action	50	5.31
	6.25	Good	Preferred Alternative	10	4.84
	6.25	Good	Preferred Alternative	50	5.31
	6.25	Good	Alternative 3	10	4.84
	6.25	Good	Alternative 3	50	5.31
Rio Fajardo near mouth	7.5	Very Good	No Action	10	7.50
	7.5	Very Good	No Action	50	6.25
	7.5	Very Good	Preferred Alternative	10	7.50
	7.5	Very Good	Preferred Alternative	50	6.25
	7.5	Very Good	Alternative 3	10	7.50
	7.5	Very Good	Alternative 3	50	6.25

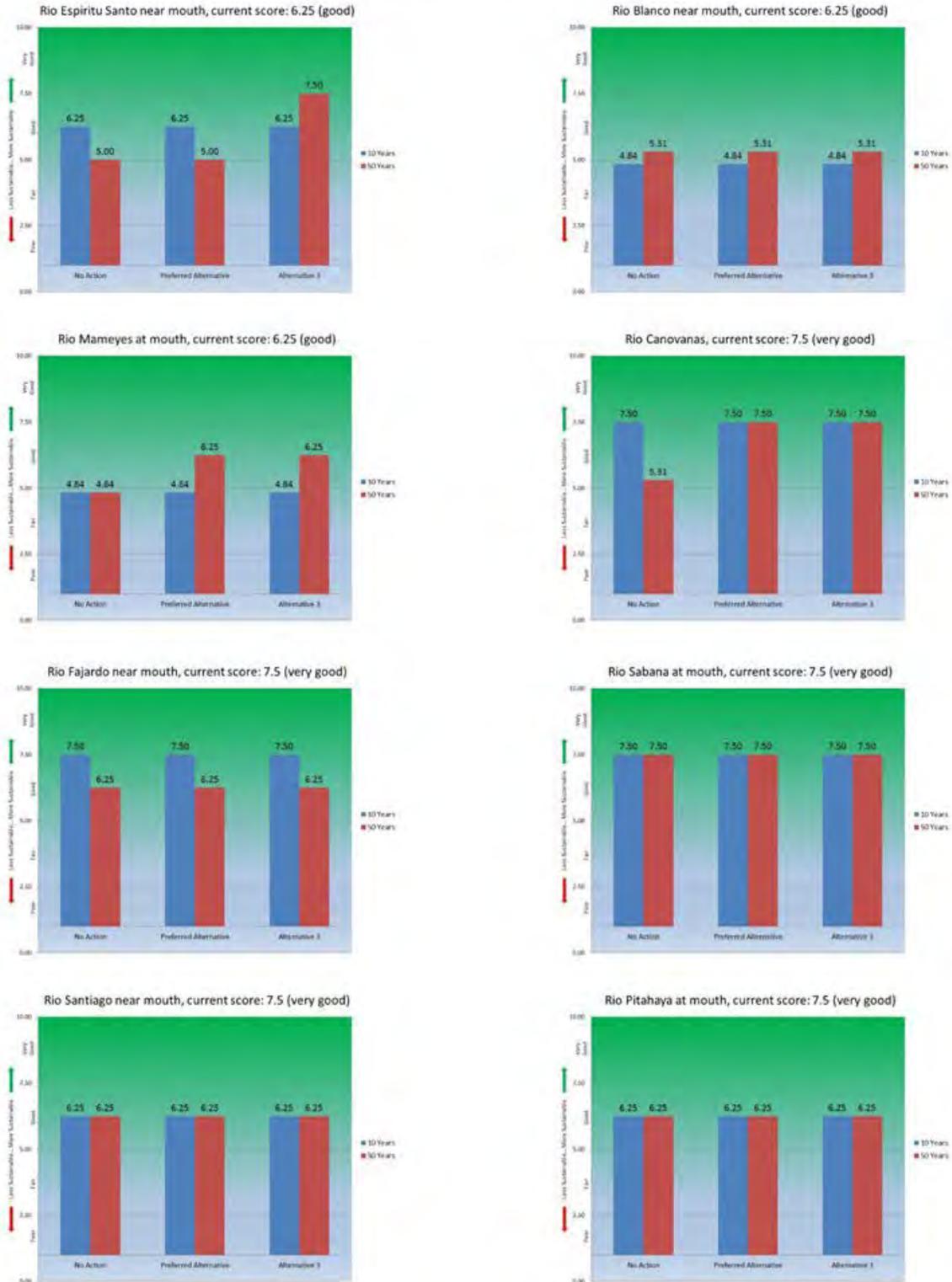


Figure 3-3. Graphic representation by watershed of the ecological sustainability evaluation for the El Yunque National Forest Watersheds

3.4 Biological Environment

3.4.1 Ecological Systems

3.4.1.1 Affected Environment

A vegetation classification process was developed for the revision of El Yunque Management Plan in 2013. The geospatial dataset was created and modified at the International Institute of Tropical (IITF) Forestry GIS and Remote Sensing Lab with expertise from scientists and foresters from the IITF and El Yunque. The geospatial data was based on the PRGAP 2000 land cover map (Gould et al. 2007). The original data was modified to better-fit Forest management needs. We modified the PRGAP land cover by incorporating information from the Holdridge ecological life zones (Ewel and Whitmore 1973), 600-meter elevation line (USGS), and 3300-millimeter precipitation line (Daly et al. 2003) to create the new vegetation classification. We also created a 100-foot buffer around the rivers (National Hydrography Dataset) inside the Forest to identify riparian forest. The river buffer zones were separated into Submontane Moist, Montane Wet and Rain, and Montane Cloud Wet and Rain riparian forests using a combination of ecological life zones data and the 600-meter elevation line (USDA Forest Service, El Yunque Forest Plan Assessment 2014)

Vegetation classification provides a common language for the effective management and conservation at all scales. The vegetation can be described by its repeating patterns in species composition and/or growth forms and structure and relationships to the environment in which found. As with any taxonomy, we use vegetation classification to simplify the patterns in order to communicate and share information.

We initiated our mapping efforts using IITF (Bill Gould) Land Cover 2000–National Vegetation (Map 3-7). As analyzed, the Forest contains 15 forest types. This map follows a hierarchy of the National Vegetation Classification (NVC) down to “groups.”

1. In the USNVC System D represent division; M represents mega-groups and G represents groups.
2. The numbers associated with the hierarchal units come from the NVC System nomenclature.

The hierarchy of the NVC continues down with “associations” and “alliances,” which focus and refine the ecosystems vegetation or environmental conditions at the scale needed to assess timber stands. See, USDA Forest Service, El Yunque Forest Plan Assessment 2014 for a detailed description of vegetation types.

Distribution, Extent and Trends of the Luquillo Mountain Range

The Forest is located in the rugged Sierra de Luquillo Mountains, 25 miles southeast of San Juan, Puerto Rico. It is the only tropical forest administered by the USDA Forest Service. Puerto Rico lies between the Atlantic Ocean and the Caribbean Sea; it is the easternmost island of the Greater Antilles. The total land area is 3,421 square miles.

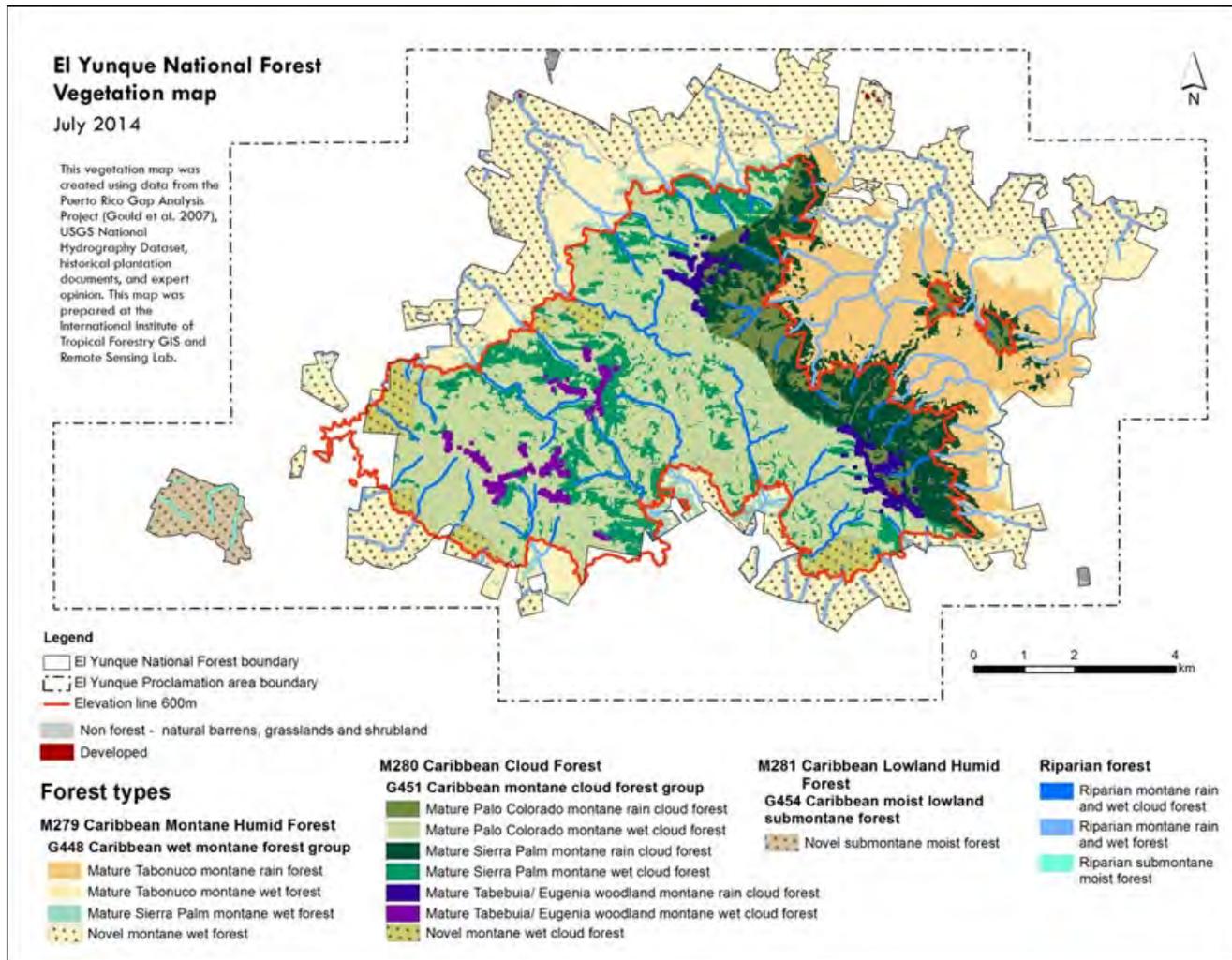
The Forest contains about 29,000 acres. Elevation ranges from 100 to 3,533 feet above sea level. The climate is tropical. Average annual rainfall over the Forest is 120 inches per year. Topography is rugged, with 24 percent of the Forest exhibiting 60 percent slope or steeper. The Luquillo Mountains have a humid maritime climate.

Although the El Yunque is one of the smallest forests in the National Forest System (29,000 acres or roughly 11,300 hectares), it is one of the most biologically diverse areas that the agency manages. The El Yunque contains at least 830 native species of plants (Weaver et al. 2013) and over 240 species of native trees, of which 88 are rare or endemic. Sixty-eight (68) are limited to Puerto Rico and 23 are only found

in the Forest. Along with the trees, the El Yunque includes 50 species of native orchids and over 150 species of ferns. This relatively small land area also supports 127 species of terrestrial vertebrate (land animals with backbones) and 10 species of aquatic invertebrates (water animals without backbones) ([LRMP] USDA Forest Service 1997).

Luquillo Mountain Range Ecosystems

The forest types of El Yunque support a large diversity of tropical species. The dominant life zone distinctions include Subtropical Wet Forest, Subtropical Rain Forests, and Subtropical Lower Montane Wet and Rain forests. In El Yunque, vegetation types and community structure shift as a result of continuous change in cloud cover, wind exposure, soil moisture, temperature, and precipitation across an elevational gradient, with land use intensity decreasing with elevation from secondary lowlands forests to protected peaks (Jennings et al. 2014).



Map 3-7. El Yunque National Forest vegetation map

Source: Quiñones, M.; Rivera, L.A.; Gould, W.A. 2013. El Yunque National Forest vegetation map. Terrestrial Ecosystem Assessment chapter of the land and resources management plan revision for El Yunque National Forest. Vector data. USDA Forest Service, San Juan, Puerto Rico.

Table 3-11. Vegetation classification, El Yunque National Forest

El Yunque Vegetation Classification	Area (acres)
M279 Caribbean Montane Humid Forest	
G448 Caribbean Wet Montane Forest Group	
Mature Tabonuco Montane Rain Forest	3,471
Mature Tabonuco Montane Wet Forest	2,619
Mature Sierra Palm Montane Wet Forest	496
Secondary Montane Wet Forest	5,843
M280 Caribbean Cloud Forest	
G451 Caribbean Montane Cloud Forest Group	
Mature Palo Colorado Montane Rain Cloud Forest	918
Mature Palo Colorado Montane Wet Cloud Forest	6,808
Mature Sierra Palm Montane Rain Cloud Forest	2,142
Mature Sierra Palm Montane Wet Cloud Forest	2,035
Mature Tabebuia/Eugenia Woodland Montane Rain Cloud Forest	342
Mature Tabebuia/Eugenia Woodland Montane Wet Cloud Forest	298
Secondary Montane Wet Cloud Forest	725
M281 Caribbean Lowland Humid Forest	
G454 Caribbean Moist Lowland Submontane Forest	
Secondary Submontane Moist Forest	506
Riparian Forest	
Riparian Montane Rain and Wet Cloud Forest	705
Riparian Montane Rain and Wet Forest	1,350
Riparian Submontane Moist Forest	59
Non Forest	
Non Forest -Natural Barrens, Grasslands and Shrublands	297
Developed	19
Grand Total	28,633

El Yunque Vegetation Types

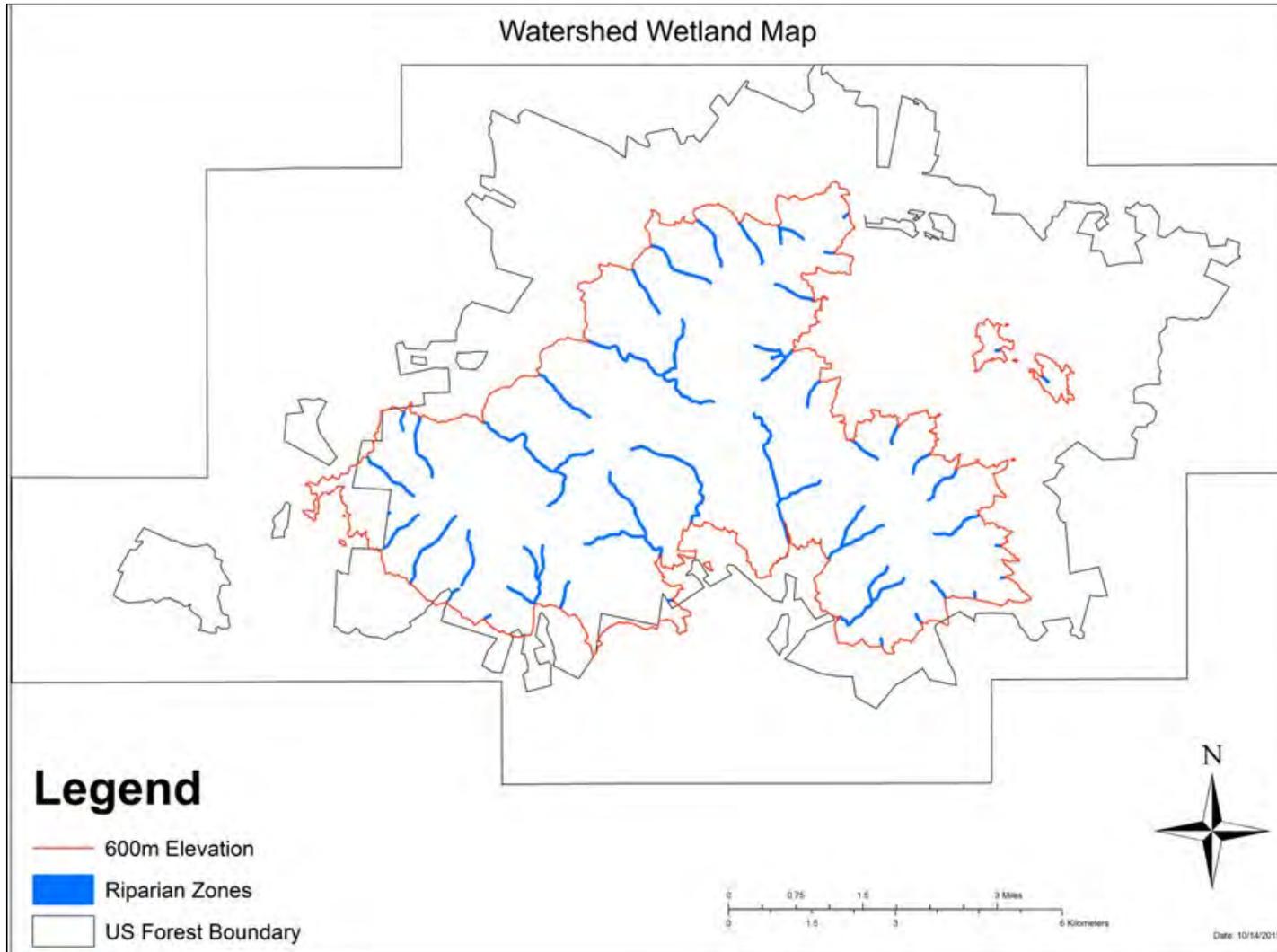
Functional Montane Wetland.

All plant communities located above the 600-meter elevation line at El Yunque, above the cloud condensation level, are wetland communities. The 600-meter elevation boundary determines where clouds will form and, thus, where the Cloud Forest community begins (Harris et al. 2012). From the total of 1,487 plant species listed on the Puerto Rico 2012 Final Regional Wetland Plant List (prepared by the U.S. Army Corps of Engineers), 559 (or 38 percent) of the list is reported to be present on the El Yunque. The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin et al. 1979; U.S. Army Corps of Engineers 1987; National Research Council 1995; Tiner and Burke 1995). All of them are in the above 600-meter elevation lands. These lands represent 46.76 percent of El Yunque or 13,268 acres.

See Map 3-8 for the location of vegetation types inside the wetland (all lands above 600 meters of elevation). The number of acres for each vegetation type is included below.

Table 3-12. Vegetation types and acreage

Community	Acres
Mature Palo Colorado Montane Rain Cloud Forest	918
Mature Palo Colorado Montane Wet Cloud Forest	6,808
Mature Sierra Palm Montane Rain Cloud Forest	2,142
Mature Sierra Palm Montane Wet Cloud Forest	2,035
Mature Tabebuia/Eugenia Woodland Montane Rain Cloud Forest	342
Mature Tabebuia/Eugenia Woodland Montane Wet Cloud Forest	298
Secondary Montane Wet Cloud Forest	725



Map 3-8. Watershed wetland map

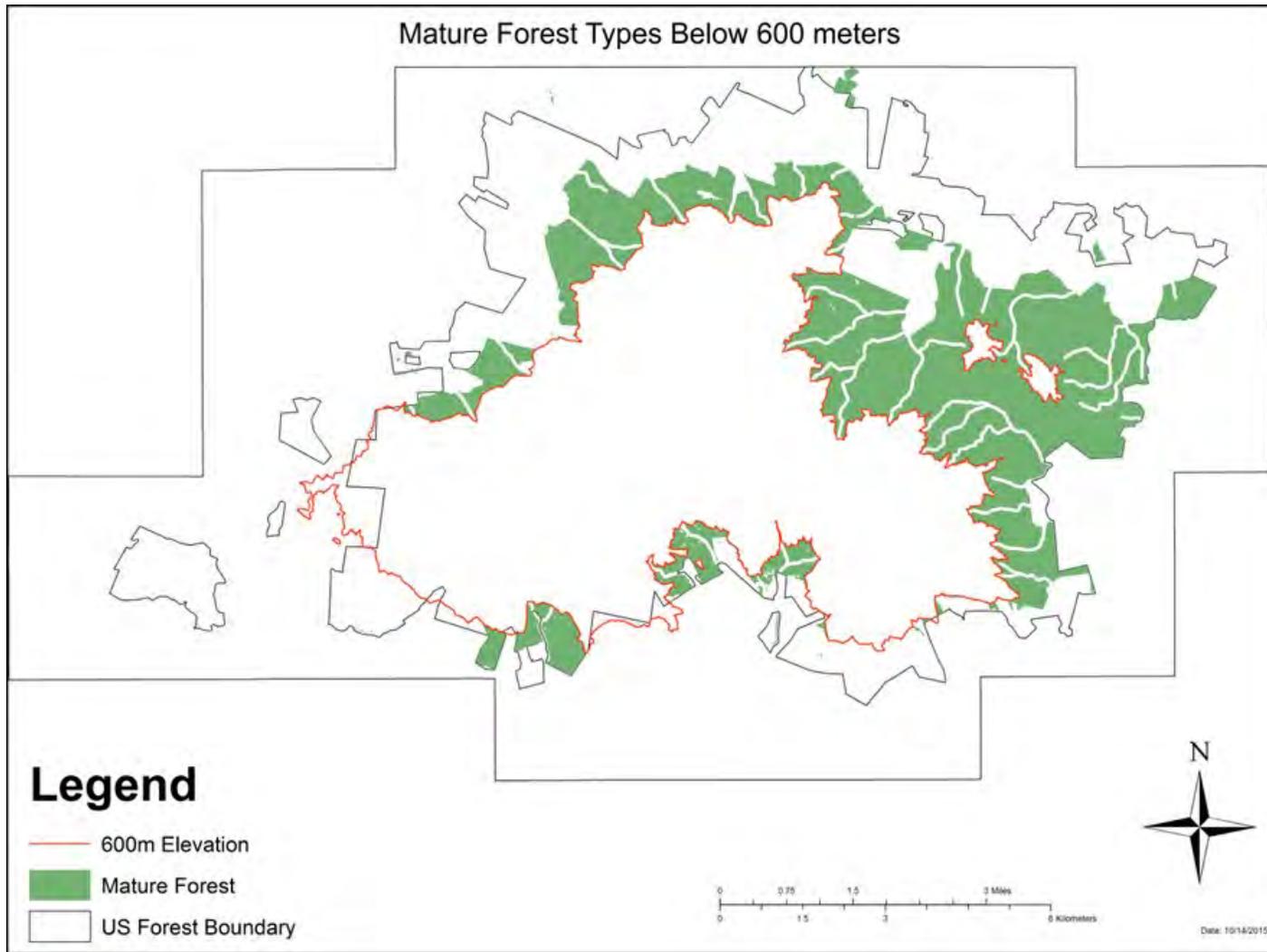
Mature Primary Forest.

Primary refers to tropical forests essentially unchanged by human intervention—the tropical equivalent of temperate forest old growth. The largest block of such lands in Puerto Rico is in El Yunque, an area of approximately 13,700 acres. Most of El Yunque primary forest is protected under a designated area (wilderness, research natural area, wild and scenic river, wetland and riparian areas). The majority of the Primary Forest is over 600-meters elevation line but there is other Primary Forest outside this area (as shown in Map 3-9) that are part of the Mature Tabonuco Montane Rain Forest (3,470.54 acres) and the Mature Tabonuco Montane Wet Forest (2,619.04 acres).

See Map 3-9 for the location of vegetation types inside the Mature Forest type below the 600-meter elevation line. The number of acres for each vegetation type is included below.

Table 3-13. Vegetation types of the Mature/Primary Forest below 600 meters of elevation

Vegetation Type	Acres
Mature Tabonuco montane rain forest	3470.54
Mature Tabonuco montane wet forest	2619.04



Map 3-9. Mature forest types below 600 meters

Montane Wet Secondary Forest.

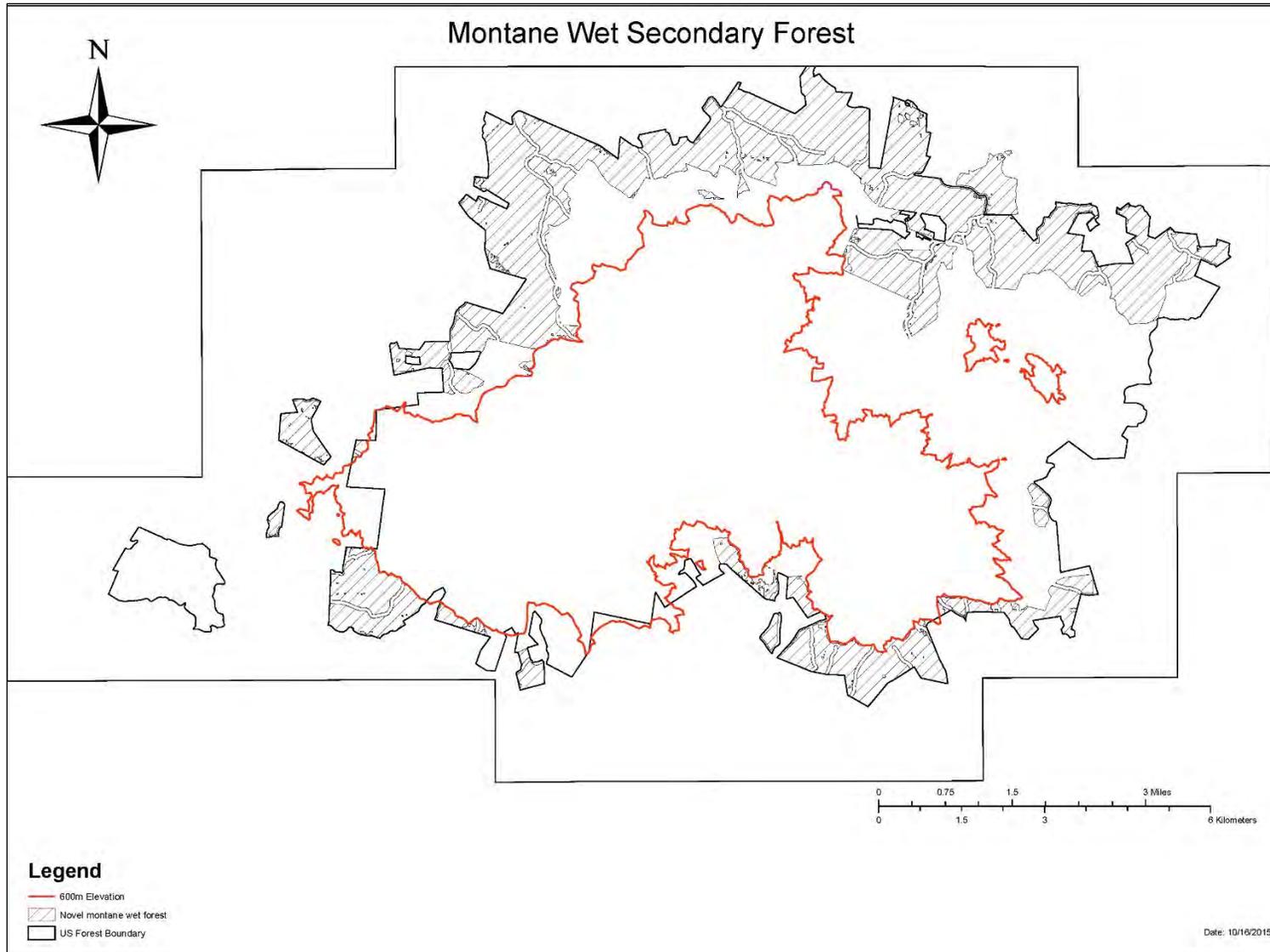
Researchers examined Secondary Forest stands growing on abandoned pastures on the lower northern slopes of the Luquillo Mountains. After 40 years of recovery, these stands could not be distinguished from undisturbed sites in terms of density, basal area, species numbers, or diversity. However, centuries would be required before the species compositions were similar. In other words, a Secondary Forest will only become a Primary Forest after a long period of time has passed. Secondary Forests recovering after disturbance on the lower slopes of the Luquillo Mountains will most probably carry the signature of past land use for several centuries, at least with regard to species composition. Since the 1920s, at least 120 tree species were introduced into the El Yunque, including 112 non-native and 8 species native to other areas in Puerto Rico. Most were planted along the El Yunque northeastern, western, and southern borders for timber production and watershed protection (Weaver et al. 2013). Although Secondary Forest has regenerated throughout the lower El Yunque during the past 70 years, much of boundary area still contains numerous introduced native and non-native trees (Weaver et al. 2013).

Secondary Forests are forests regenerating largely through natural processes after significant human and/or natural disturbance of the original forest vegetation at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition with respect to nearby Primary Forests on similar sites (Chokkalingam et al. 2001). Map 3-10 includes the Secondary Montane Wet Forest and Secondary Sub-Montane Moist Forest).

See Map 3-10 for the location of vegetation types inside the Montane Wet Secondary Forest type. The number of acres for each vegetation type is included below.

Table 3-14. Vegetation types of the Montane Wet Secondary Forest

Vegetation Type	Acres
Secondary montane wet forest	5,843.41
Secondary sub-montane moist forest	505.85



Map 3-10. Montane Wet Secondary Forest

Riparian Areas.

This section describes the vegetation of the forest riparian areas. A riparian zone or riparian area is the interface between land and a river or stream. Plant habitats and communities along the river margins and banks are called riparian vegetation, characterized by hydrophilic plants. A Riparian Forest is the woodlands along the banks of stream or river. On the El Yunque the width of this riparian forest is 100 feet from each side of the river or the stream bank.

Some examples of this vegetation type have being described for El Yunque; Montane Pterocarpus Forest, Riverine Palm and Riparian Forest (Harris et al. 2012).

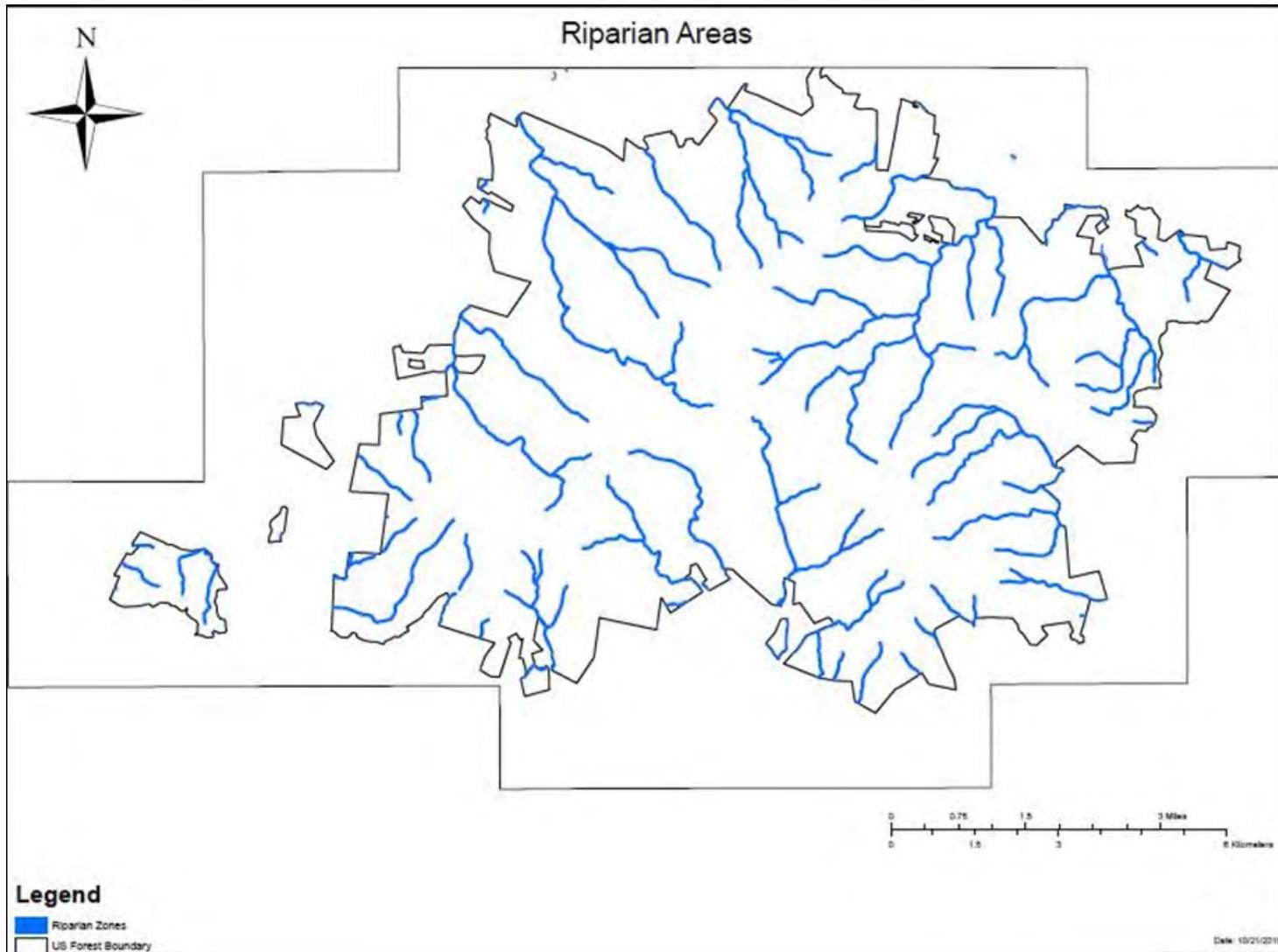
Vegetation transects along a fluvial disturbance gradient from the middle of the channel into the adjacent forest follows a consistent pattern. Cushion mosses colonize in-channel boulders, whereas herbs, ferns, and grasses grow along channel margins, and woody shrubs and trees establish on higher, less frequently flooded surfaces. Vegetation stature similarly increases with the relative elevation above the channel. Short-stature vegetation grows along the channel and tall, closed-canopy woody vegetation and tall grasses grow on the banks and hill slopes (Pike and Scatena 2009).

Mosses and lichens that require shade are more common in steep land streams having ample canopy cover. Conversely, wider lowland channels have a greater amount of incidental light and consequently have a greater abundance of grasses. Furthermore, unlike many arid and semi-arid riparian forests, there is no distinct riparian forest community in the headwater streams of the Luquillo Mountains. Riparian forests along many alluvial streams in arid and semi-arid regions often have a unique composition and greater productivity than the surrounding vegetation due to increased availability of water. Yet in the continually humid climate of the Luquillo Mountains, both riparian and non-riparian forests have ample moisture availability and are consequently similar in composition, but can be different in structure and biomass (Pike and Scatena 2009).

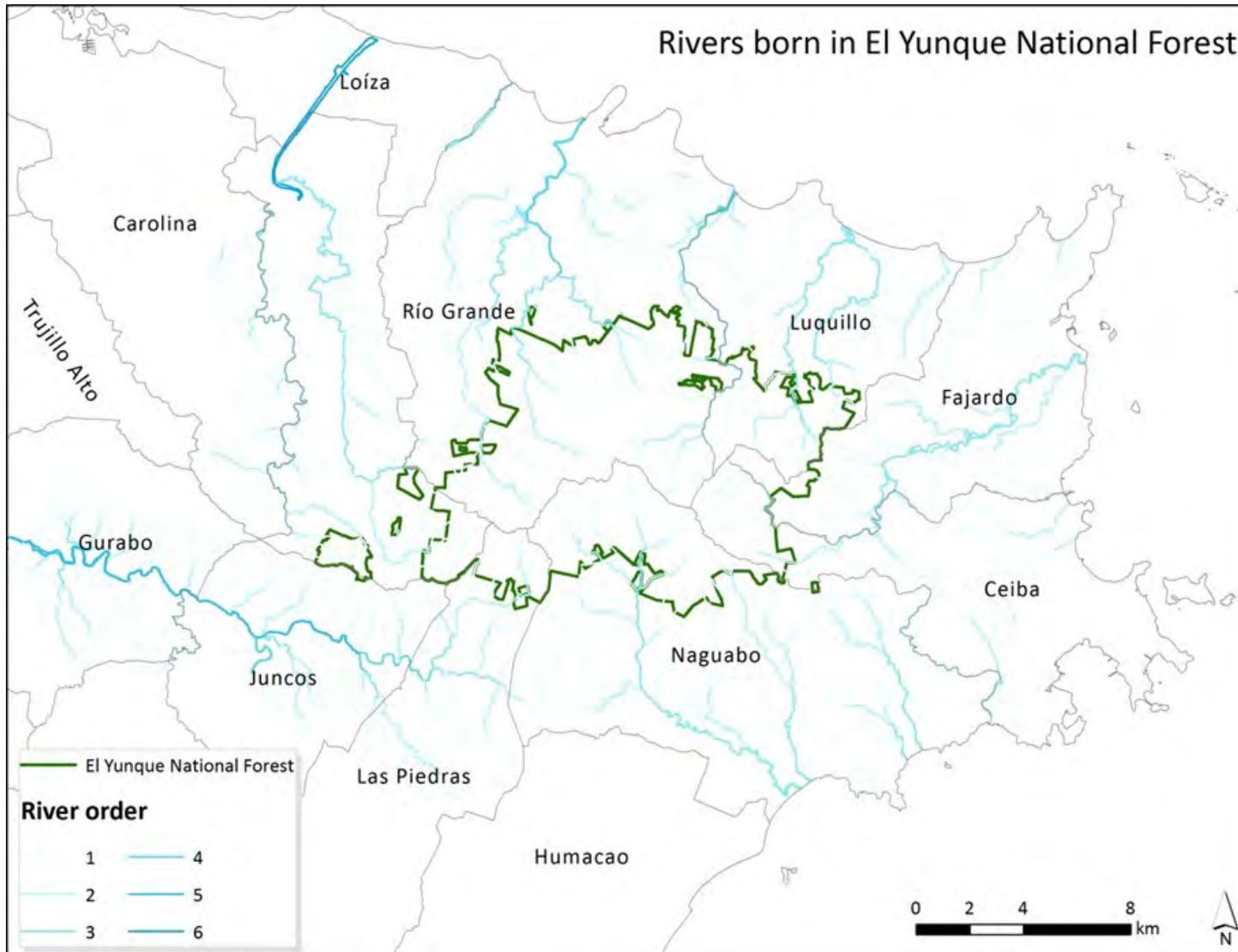
See Map 3-11 for the location of vegetation types inside the Riparian Areas and the number of acres for each Riparian Area type is included below.

Table 3-15. Vegetation types of the Riparian areas at El Yunque

Community	Acres
Riparian montane rain and wet cloud forest	705
Riparian montane rain and wet forest	1350
Riparian submontane moist forest	59



Map 3-11. Riparian areas



Map 3-12. El Yunque National Forest rivers

Embedded Rare Communities

The Subtropical Montane Rain Forest Zone.

This, the wettest of the sea-level belt of Subtropical Life Zones (lower rainfall limit about 3,800 millimeters), occupies very little area in Puerto Rico, occurring only in a single crescent-shaped band on the windward faces of the Luquillo Mountains (above 600 meter above sea level). It lies wholly within the El Yunque and encompasses much of the area traversed by visitors going to the recreation area in “the rain forest” (La Mina Recreational Area). This life zone is characterized by a super abundance of precipitation. The water regime at La Mina indicates that the soil is at field capacity all year, and abundant runoff is produced every month, with 6 months each year yielding more than 300 millimeters. The annual total of 3,400 millimeters of runoff is more than twice as much as most areas of the world receive as annual rainfall input. The constantly wet soil eliminates water as a potentially limiting growth factor in this environment, but oxygen stress, which can inhibit root respiration, may exert an important influence on plant growth (Ewel and Whitmore 1973).

The species found here are essentially the same as those found in the surrounding Subtropical Montane Wet Cloud Forest. The main features of the Subtropical Montane Rain Cloud Forest are the high frequency of palms, *Prestoea montana* (R. Grah.) Nichols (palma de sierra, sierra palm) in this case, and a super abundance of epiphytes; no stem, building, highway marker, or fence post escapes colonization and most leaves, even those in the upper canopy, are covered with epiphyllae. The spiny tree fern, *Nephelea portoricensis* (Kuhn) Tryon, is more abundant here than in the Subtropical Montane Wet Cloud Forest (Ewel and Whitmore 1973). Because of the small area it occupies, the Subtropical Rain Forest in Puerto Rico is primarily of academic interest and recreational value. The Baño de Oro Natural Area, much of which lies in this life zone, may be the only place in the world where an example of the mature vegetation of Subtropical Montane Rain Forest is likely to receive long-term protection, while still being readily accessible (Ewel and Whitmore 1973).

The Subtropical Lower Montane Rain Forest Zone (Mature Tabonuco Montane Rain Forest).

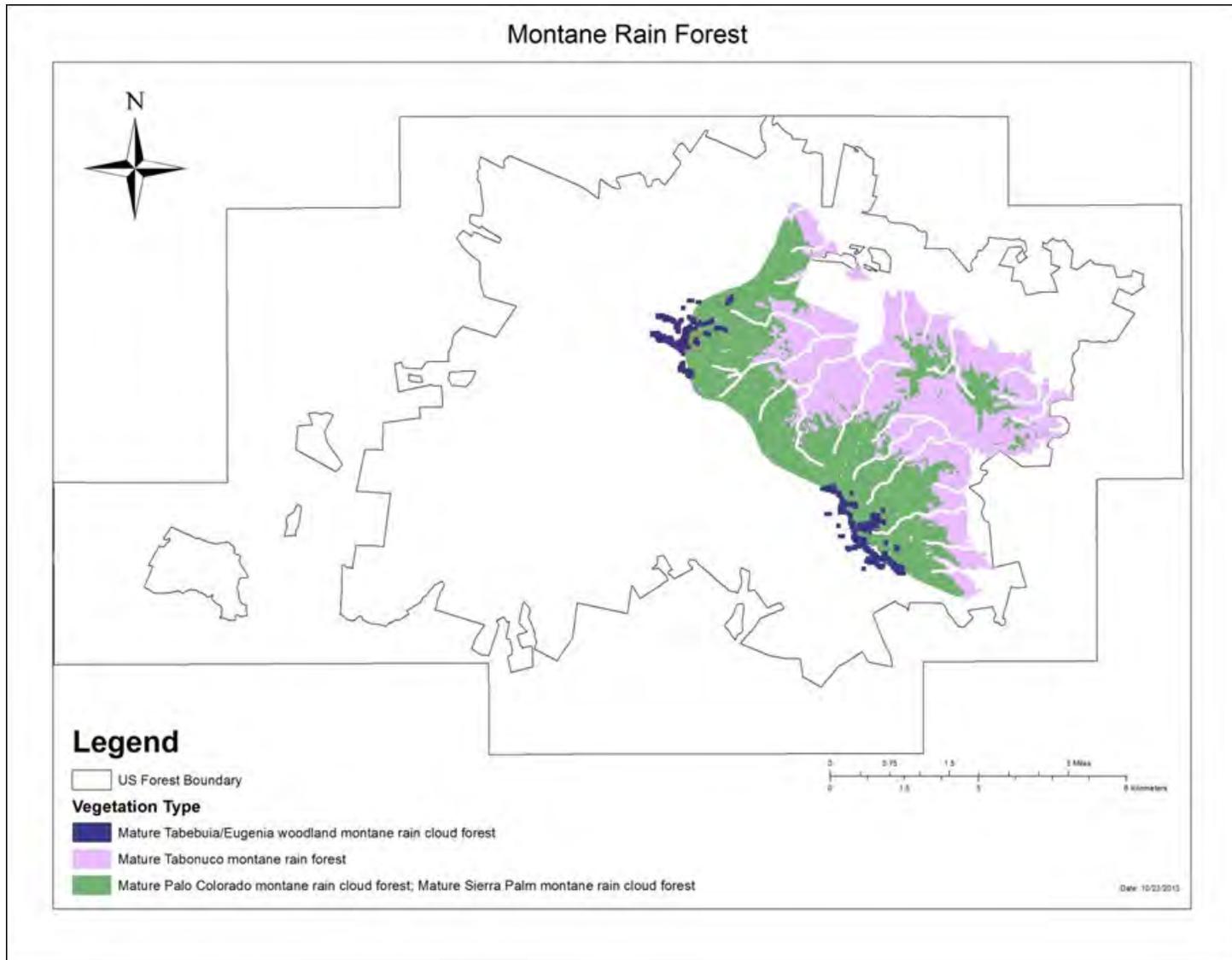
This life zone occupies less area than any other in Puerto Rico and the U. S. Virgin Islands, and is found only in a narrow band on the windward slopes of the Luquillo Mountains, immediately above the Subtropical Montane Wet Forest. Here, there is a mean annual temperature (based on the mean of average daily maximum and average daily minimum) of 18.6 °C, an annual rainfall of 4,533 millimeters, and a mean relative humidity of 98.5 percent. If these conditions can be considered representative of the long-term mean values for this site, they would indicate an average, year-round runoff of almost 300 millimeters per month, and some months could yield almost twice that amount. The vegetation of this life zone in Puerto Rico is very similar to that of Lower Montane Wet Forest; the characteristic which distinguishes the two, is the greater abundance of epiphytes, epiphyllae, palms, and tree ferns in the Lower Montane Rain Forest. Most of this life zone in Puerto Rico is in the Dwarf Cloud Forest association (Tabebuia/Eugenia Woodland), where much of the vegetation on the exposed ridges has a windswept appearance. Howard (1969) described the morphology and structure of many of the species found in this environment, while Gilt (1969) documented the formation of aerial roots, which are extremely abundant on many species in this association. The water-saturated soil is covered with a soil-free root mat, and the root-soil-earthworm relationships here were investigated by Lyford (1969). Epiphytes, most of which are leafy hepatics, cover everything; this component of the flora was described by Fulford et al. (1970). In a study, Weaver (1972) removed all of the epiphytes from three plots and compared these to plots with the epiphytes left intact. He found that although the total amount of water reaching the ground was slightly affected, the distribution pattern of through fall and stem flow was significantly altered. Lower Montane Rain forest in Puerto Rico is primarily a biological curiosity, but an

invaluable one since it represents an environmental extreme and, as such, is an excellent tool for investigating the response of natural ecosystems to environmental stress, like climate change. It is indeed fortunate that the limited amount of this life zone in Puerto Rico is located in a publicly-controlled forest, including the upper parts of the Baño de Oro Natural Area where long-term protection is the goal (Ewel and Whitmore 1973).

See Map 3-13 for the location of vegetation types inside the Montane Rain Forest vegetation types and the number of acres for each vegetation type is included below.

Table 3-16. Vegetation types inside the Montane Rain Forest

Community	Acres
Mature Tabebuia/Eugenia Woodland Montane Rain Cloud Forest	345
Mature Tabonuco Montane Rain Forest	3,471
Mature Palo Colorado Montane Rain Cloud Forest	918
Mature Sierra Palm Montane Rain Cloud Forest	2,142



Map 3-13. Montane Rain Forest

Process for Evaluating Effects to Ecosystem Integrity and Sustainability

Steps used to build an ecological sustainability framework are documented within the ecological sustainability evaluation tool and described in appendix B. The ecological sustainability evaluation database serves as the source for evaluating ecosystem diversity on the El Yunque and developing plan components for the new revised Forest Plan. The Forest Service developed a relational database, the ecological sustainability evaluation tool, based on the structure of the ecological planning tool designed by The Nature Conservancy.

To evaluate ecological sustainability, the planning team identified key characteristics for each ecosystem, identified measurable indicators for each key characteristic, weighted them in importance and defined ranges of acceptability for each ecosystem across each alternative, both at 10- and 50-year timeframes. This process is further described in Appendix B and within the Ecological Sustainability Evaluation tool.

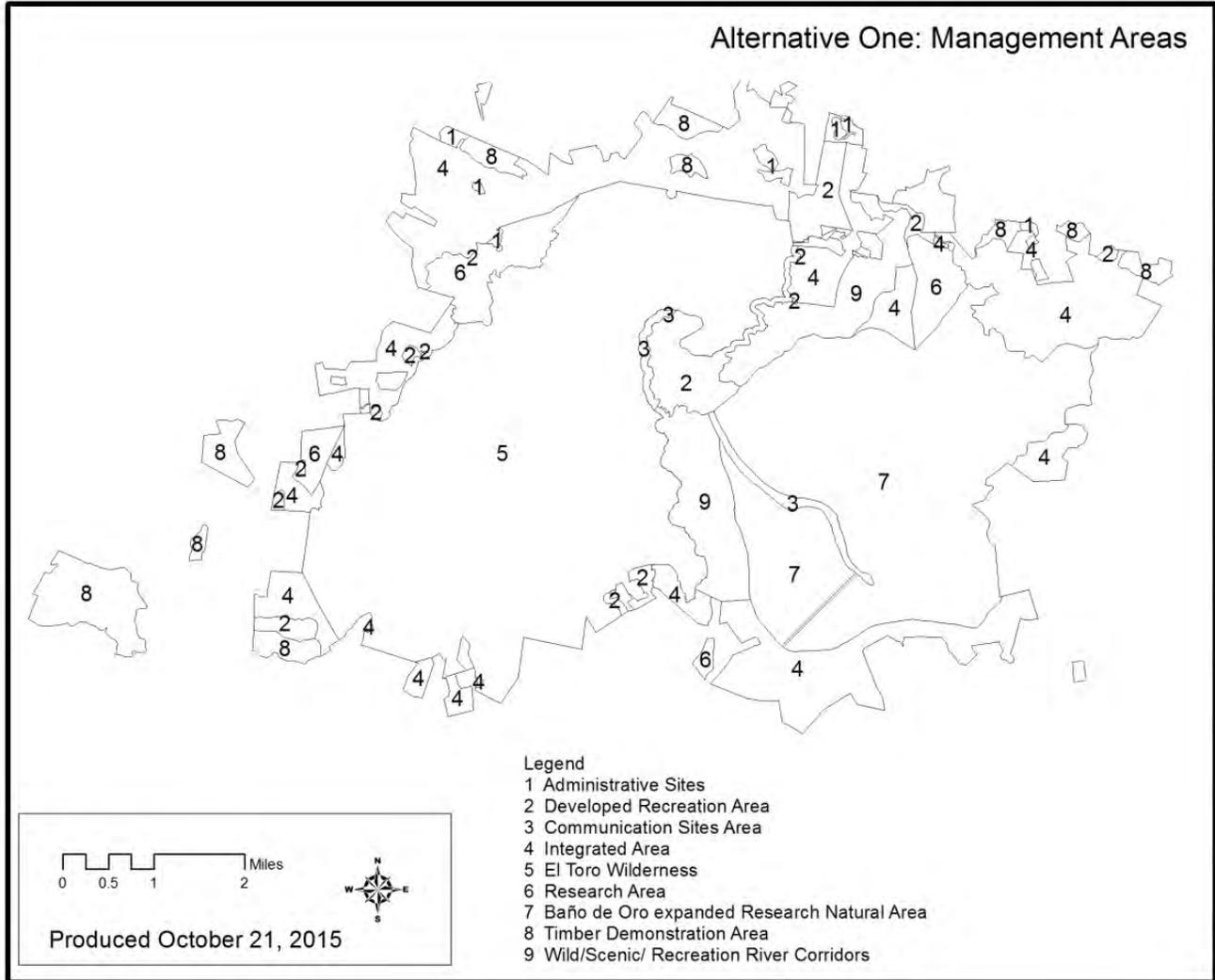
Indicators and Details

- Changes in spatial Extent
- Deviation from Natural Range of Variability
- Paved open road density
- Recreational area density
- Trail density
- Percent of non-desirable invasives
- Percent of change of the structure and composition of the Forest
- Percent of roads and recreational facilities under construction/repair

3.4.1.2 Environmental Consequences

Alternative 1

Alternative 1 will maintain and preserve the management areas and activities per the 1997 land management plan for el Yunque National Forest. Map 3-14 describes the management areas as delineated in alternative 1.



Map 3-14. Alternative 1 management areas (1997 Land Management Plan)

Source: Forest Service Planning Maps (2015).

Functional Montane Wetlands

Affected Environment.

All plant communities located above the 600-meter elevation line on the El Yunque, above the cloud condensation level, are wetland communities. Above this line determines where clouds will form and, thus, where the Cloud Forest community begins. All of these lands have characteristics of wetlands, that is, hydrophytic vegetation, hydric soils, and wetland hydrology.

Effects:

Alternative 1 includes parts of management areas; integrated areas, developed recreation, and research area inside the 600 meters above sea level; which is the wetland determination line. Activities proposed for these management areas will have impacts if implemented inside the Functional Wetland. Vegetation, hydric soils, and hydrology are expected to negatively affect the implementation of proposed activities inside the wetland. Best management practices (BMP) and mitigation measures will minimize the effects of implementing this alternative.

The maintenance and repair of trails with the 1997 Management Plan protocols have the potential to affect the wetland condition elements of the lands, particularly in the surrounding Mature/Primary forest along the trails.

The recreational areas are within the Functional Wetland and the Montane Rain Forest Zone (a unique ecosystem to Puerto Rico, only present at El Yunque). Maintaining the visitation plan directly impacts the water quality, soils, vegetation, air quality and wildlife. See other sections for more detailed effects to the resources. Infrastructure maintenance also affects these other resources, and as result, the vegetation may change in its composition and character particularly federally listed species and species of conservation concern known to inhabit along the trail system that traverses the Wetland and the Rain Forest Zone (6.1 miles of trail).

Potential effects that could occur from management action that are inside the Functional Wetland include soil erosion, stream sedimentation, hydrologic system disturbance, disturbance to wildlife and disturbance to ground cover and shrub population in the general area of proposed project sites.

Cumulative Effects:

The cumulative effects analyzed for the Functional Wetland are based on management practices within the Forest boundary; although under new regulation, using collaboration in Forest management and the “all-lands” approach, could assist in mitigating effects such as impact to the riparian zone and estuarine areas (inside and outside Forest boundaries). The time for the analysis of the framework is 15 years or the life of the plan. It will be necessary to analyze how much private land falls within the 600-meter elevation belt; defined as a wetland. Under this alternative the wetland could be impacted cumulatively by uses described in the Forest Plan such as developed recreation, urban development and climate change. For climate change impact see “Forest Service Research and Development, General Technical Report SR-193.”

The cumulative effects are associated to the timing and addition of projects allowed in the management areas at the same time. Considering the construction of recreation sites, actions of research activities and projects in the integrated management area has the potential to produce cumulative effects in the Functional Wetland vegetation type.

Overall implementation of alternative 1 will modify the Functional Wetland’s vegetation, hydric soils and hydrology.

Mature Primary Forest

Effects:

Although alternative 1 protects the Primary Forest with a series of plan components such as wilderness, wild and scenic rivers, and natural research area designations, there are some pockets of Primary Forest allocated to other management areas (research, integrated and develop recreation) that can affect the integrity and character of the Primary Forest. There would be potential for impacts to the primary forest in areas surrounding the project site.

Impacts to the Primary Forest in the surroundings of the project site. Also the potential of introduction of non-native species to its surroundings may occur.

Cumulative Effects:

Allowed projects will have secondary impact to the integrity of the surroundings primary forest along a time scale (15 years or the life of the plan) as other activities close to the project site create impacts that will overlap. The cumulative effects analyzed for the Mature/Primary Forest are based on management practices within the Forest boundary; although under new regulation, using collaboration and the “all-

lands” approach could assist in mitigating effects of impacts to the Mature/Primary Forest. The cumulative effect under this alternative would be related to recreation development in the areas of mature/primary forest. Continued recreation use within the mature/primary forest will cumulatively effect vegetation and species in these sensitive areas.

Overall, Alternative 1 has potential to affect the Primary Forest directly by reduction of its size, integrity, and character. These effects are not consistent with the vision established in the new management plan and are not compatible with the core management theme of conserve and restore ecosystems for this vegetation type.

Montane Wet Secondary Forest

Affected Environment.

Secondary Forests are Forests regenerating largely through natural processes after significant human and/or natural disturbance of the original forest vegetation at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition with respect to nearby Primary Forests on similar sites.

Effects:

Alternative 1 proposes for these lands the management areas of: timber demonstration, developed recreation, administrative sites, research and integrated management area. The area included in these MAs are: develop recreation—1,348 acres; timber demonstration—1,167 acres; integrated—6,219 acres; research—919 acres; and 204 acres in administrative sites for a total of 9,857 acres (which represents around 35 percent of the El Yunque lands). About 6,348 acres have being identified as Secondary Forest, the rest, 3,509 acres, will be on Primary Forest. Even though there are standards and guidelines to protect the Primary Forest, part of it has being located in MAs where proposed projects might affect it.

There would be potential for direct impacts to the following resources: watersheds, riparian areas, aquatic habitats and species, flora and fauna, soil, species of conservation concern, recreation, scenery, ecological services, forest products, and timber. Soil erosion and compaction, streams sedimentation, wildlife disturbance, habitat for flora and fauna disturbance and reduction, diversity, scenic values, vegetation and habitat for species of conservation concern will be part of the effects on these lands with the implementation of the potential projects allowed in these management areas. See other sections for more detail on effects to the resources.

Potential impacts from alternative 1 are related to increased recreation activities; recovery of species and diversity; recovery of forest crown cover; recovery of appropriate habitat for plants and animals; soil recovery and potential encroachment of invasive species.

Cumulative Effects:

The implementation of several of these projects in the same watershed definitely risks the impairment of watersheds of the Forest in the time scale of 15 years or the life of the plan, as other activities close to the project site create impacts that will overlap. The cumulative effects analyzed for the Montane Wet Secondary Forest are based on management practices within the Forest boundary; although under new regulation, using collaboration and the “all-lands” approach could assist in mitigating effects of Forest multiple uses and climate change impacts.

Overall, alternative 1 will have the potential to affect several resources, some of which may take decades to recover.

Riparian Areas

Affected Environment.

A riparian zone or riparian area is the interface between land and a river or stream. A Riparian Forest is the woodlands along the banks of stream or river. On the El Yunque, the width of this riparian area is designated as 100 feet from each river or stream bank, until actual field delineation. It has been calculated as 2,113 acres along an altitudinal gradient. The riparian areas network interacts with the El Yunque in all cardinal directions from the peaks to its boundaries.

Effects:

Under alternative 1, the timber demonstration and developed recreation management areas are the ones with high potential to impact the riparian areas while preparing access to extract timber and the logging activities themselves. The developed recreation sites are all associated with a stream, which is the preferred feature in the location of the sites. The visitors to the Forest developed recreation sites prefer to wade in water and recreate in the riparian zone when facilities are full or want to interact with the Forest outside the developed picnic shelters. Many are developed for the use of the water environment. Dispersed recreation in the integrated management area could also impact the riparian area if the site is heavily visited. The resources expected to be impacted are water quality, aquatic habitat and species, wildlife, soil, and riparian vegetation. Trash generated by visitor and the proper handling of it is another impact to the environment in high visited sites. See other sections for more details on effects to the resources.

Potential indirect impacts are associated with soil erosion, soil compaction, vegetation trampling, and fine sediment movement in the water channel.

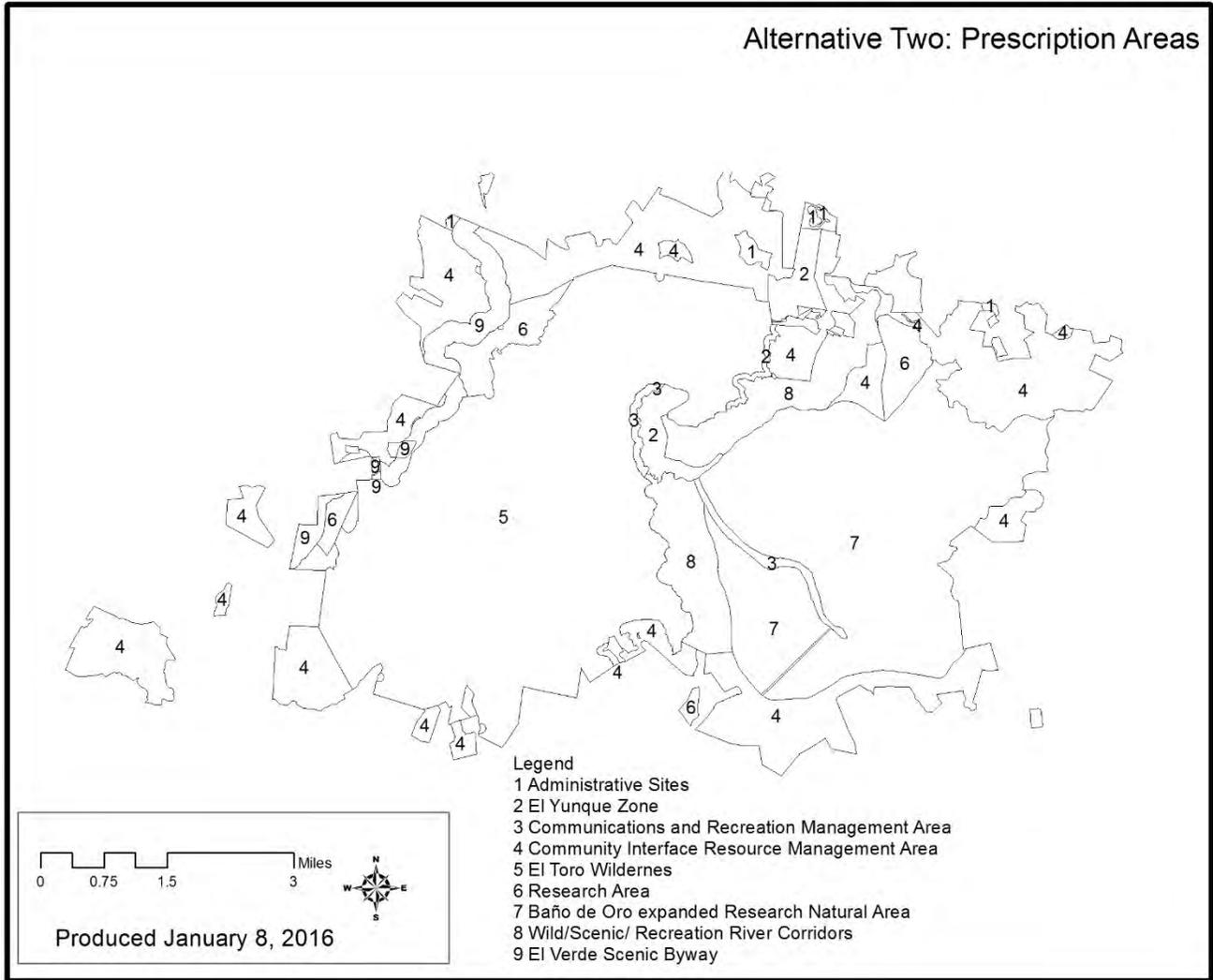
Cumulative Effects:

Impacts could eventually overlap when timber management and developed recreation areas are relatively close. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the riparian areas are based on management practices within the Forest boundary; although under new regulation which uses collaboration and the “all-lands” approach could assist in mitigating effects. This alternative does not consider land acquisition along riverbanks to protect riparian areas which could have a cumulative effects.

Overall, alternative 1 will have potential to affect the riparian area resource, if implemented in these lands without an appropriated buffer or some capacity control to the recreational sites.

Alternative 2

Refer to Map 3-15 for alternative 2 prescription areas.



Map 3-15. Alternative 2 management areas

Source: Forest Service Planning Maps (2016).

Functional Montane Wetland

Effects:

In alternative 2, most of the lands above the 600-meter altitude line (Functional Wetland) are assigned to the El Toro Wilderness, wild and scenic river corridors and Baño de Oro Research Natural Area; management areas that are protected designated lands.

Management areas for communication, the develop recreation area at El Yunque Peak, and the PR Road 191 corridor are the zones with more potential for direct effects to the environment by means of trash, vegetation trampling, soil compaction and erosion, direct use of water streams by visitors, and human waste from an estimated 1.2 million visitors per year. In addition, the vehicles used to access these areas can affect the water, soil, and air resources. The proposal to initiate management by capacity with strong emphasis on sustainability is expected to greatly reduce or inhibit direct effects to the environment. Maintenance protocols to structures and facilities in these management areas need to be revised to avoid impacts to the Functional Wetlands of El Yunque. Best management practices and other mitigating

measures will reduce the effects of the impacts to the resources. See other sections for more detailed effects to the resources.

There are several trails closed to the public (or in use) due to damages by past hurricanes and/or visitors deviating from the main trail, that need erosion control measures while plans for repair or mitigations are initiated.

Cumulative Effects:

The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the Functional Wetland are based on management practices within the Forest boundary; although under new regulation which uses collaboration and the “all-lands” approach could assist in mitigating effects. Any cumulative effects under this alternative are related to protection of the wetland with desired conditions, objectives, standards, and guidelines. The alternative not only considers the wetland in land management but it also develops strategies that protect it and mitigate the effects caused by other uses within the Forest.

Overall, there would be no significant impacts to the functions of Wetlands with the implementation of alternative 2.

Mature Primary Forest

Effects:

There would be no potential for direct effects to the Mature/Primary forest with the implementation of alternative 2. Most of this Forest is protected under designated lands and those outside are protected by means of standards and guidelines that calls to total preservation of the mature forest.

Cumulative Effects:

There would be no cumulative effects to the Mature/Primary Forest with the implementation of alternative 2. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the Mature/Primary Forest are based on management practices within the Forest boundary; although under new regulations which use collaboration and the “all-lands” approach could assist in mitigating effects.

Overall there would be no significant effects to the Mature/Primary Forest with the implementation of this alternative.

Montane Wet Secondary Forest

Effects:

In alternative 2, Community Interface Resource Management Area (CIRMA) (7,187 acres) is located in this vegetation type. It provides areas and sections of the Forest where an assortment of resource management practices could be applied to encourage tropical forest management initiatives in the broader landscape of El Yunque. Proposed activities could include sustainable forest products, applied management strategies, dispersed or develop recreation, Forest restoration projects, watershed improvements, wildlife habitat improvement, riparian zones restoration, co-management interface areas, aquatic habitat improvement, and the interpretation of cultural icons recognized in the selected areas.

Even though there are standards and guidelines to protect the Primary Forest, part of this type is located where proposed projects might affect these Forests. There would be the potential for impacts to the following resources: watersheds, riparian areas, aquatic habitats and species, flora and fauna, soil, species of conservation concern, recreation, scenery, ecological services, forest products, including wood products. Effects to these lands with the implementation of the potential projects allowed in these management areas include soil erosion and compaction, streams sedimentation, wildlife disturbance,

habitat for flora and fauna disturbance and reduction, diversity, scenic values, vegetation and habitat for species of conservation concern. See other sections for more detailed effects to the resources.

The NEPA process that occurs before any particular project is implemented should mitigate direct impacts if properly carried out. The NEPA process will minimize direct effects from management activities.

Potential impacts from implementing alternative 2 are related to increased recreation activities, recovery of species and diversity, recovery of forest crown cover, recovery of appropriate habitat for plants and animals, soil recovery and potential encroachment of invasive species.

Cumulative Effects:

The implementation of several of these projects in the same watershed over time definitely risks the impairment of watersheds of the Forest. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the Montane Wet Secondary Forest are based on management practices within the Forest boundary; although under new regulation, using collaboration and the “all-lands” approach could assist in mitigating effects.

Overall, alternative 2 has potential to affect several resources if implemented in these lands without appropriate mitigation.

Riparian Areas

Effects:

The potential developed recreation sites proposed under alternative 2 are mostly associated with a stream which is the preferred feature in the location of the sites. The visitors to the Forest developed recreation sites prefer to wade in water and recreate in the riparian zone when facilities are full or want to interact with the Forest outside the developed picnic shelters. Many are developed for the use of the water environment. Dispersed recreation in the CIRMA and other potential activities proposed could also impact the riparian area if the site is heavily visited or intensively used. The resources expected to be impacted are water quality, aquatic habitat and species, wildlife, the soil and the riparian vegetation. Trash generated by visitor and the proper handling of it is another impact to the environment in high visited sites.

The NEPA process expected to occur before any particular project is implemented should mitigate impacts if properly carried out. The NEPA process will minimize direct effects from management activities.

The potential for indirect impacts are associated with the soil erosion, compaction of soil, vegetation trampling, vegetation composition change, and fine sediments movement into the water channel. See other sections for a more detail effects to the resources.

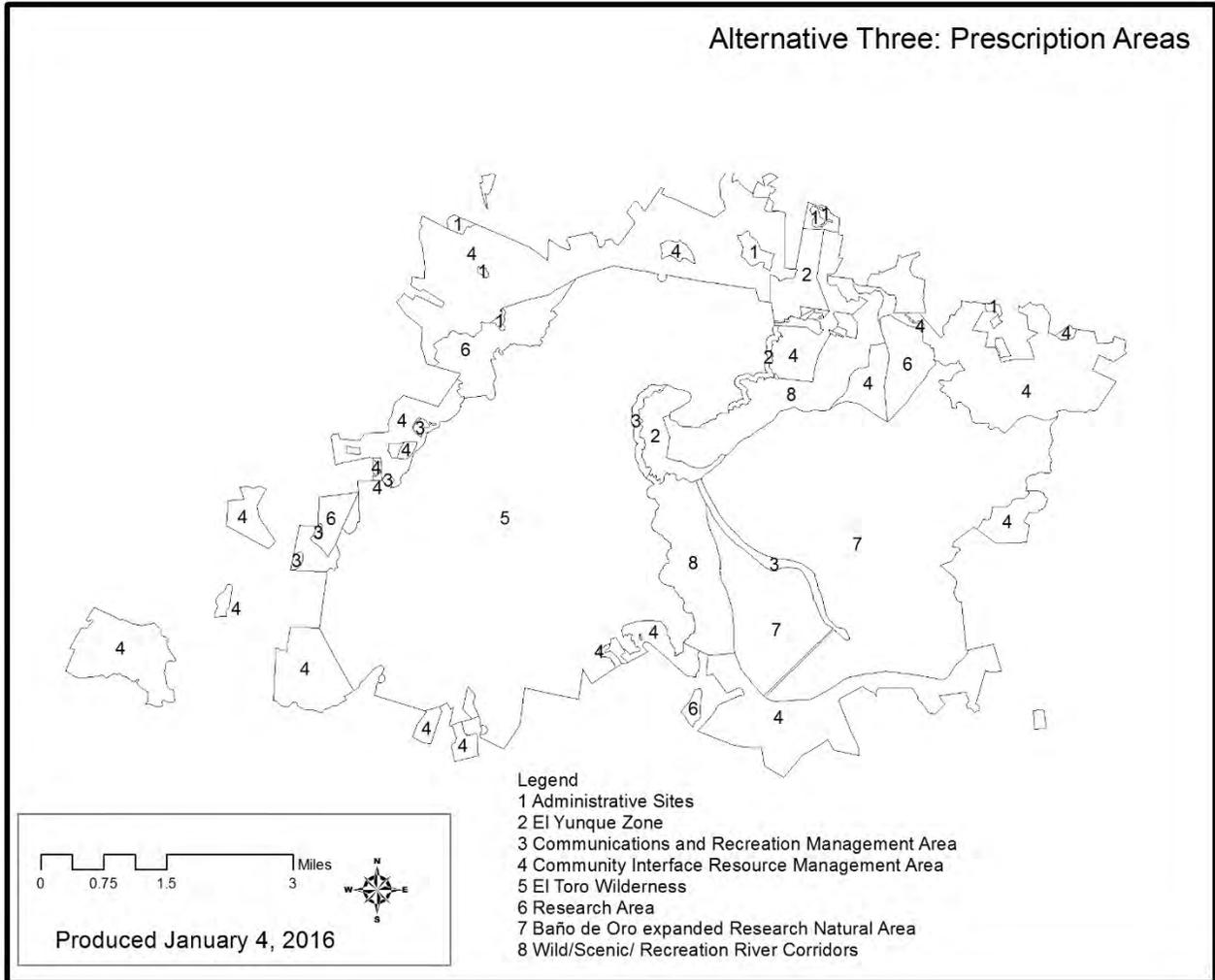
Cumulative Effects:

Impacts could eventually overlap when forest products management and dispersed and developed recreation areas are relatively close, or end up impacting the same drainage system. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the riparian areas are based on management practices within the Forest boundary; although under new regulation using collaboration and the “all-lands” approach could assist in mitigating effects.

Overall, alternative 2 may have potential to affect the riparian area resource if implemented in these lands without an appropriated buffer or some capacity control to the recreational sites.

Alternative 3

Refer to the following map for alternative 3 prescription areas.



Map 3-16. Alternative 3 management areas

Source: Forest Service Planning Maps (2016)

Functional Montane Wetland

Effects:

Under alternative 3, most of the lands above the 600-meter altitude line (Functional Wetland) are assigned to the El Toro Wilderness, wild and scenic river corridors and recommendation for designation of Baño de Oro Wilderness (changing the research natural area designation of those lands) (management areas that are protected designated lands).

The management areas for Communication, Develop Recreation Area at El Yunque Peak, Road 186 and PR Road 191 Corridors are the zones with more potential of direct effects to the environment by means of trash, vegetation trampling, soil compaction and erosion, direct use of water streams by visitors, and human waste by an estimated 1.2 million visitors per year. In addition, the vehicles used to access these areas can affect the water, soil, and air resources. The proposal to initiate management by capacity with

strong emphasis on sustainability is expected to greatly reduce or inhibit impacts to the environment. Maintenance protocols to structures and facilities in these management areas need to be revised to avoid impacts to the Functional Wetland of El Yunque. See other sections for more detailed effects to the resources.

There are several trails closed to the public (or in use) due to damages by past hurricanes and/or visitors deviating from the main trail, that need erosion control measures while plans for repair or mitigations are initiated.

Cumulative Effects:

There are no cumulative effects to the Functional Wetland with the implementation of alternative 3. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the Functional Wetland are based on management practices within the Forest boundary; although under new regulation, using collaboration and the “all-lands” approach could assist in mitigating effects.

Overall, there would be no significant impact to the functions of the Wetlands of El Yunque with the implementation of alternative 3 because the management activities for alternative 3, which are the same as alternative 2.

Mature Primary Forest

Affected Environment.

Primary refers to tropical forests essentially unchanged by human intervention. The largest block of such lands in Puerto Rico is in El Yunque, an area of approximately 13,700 acres.

Effects:

There would be no potential for direct effects to the Mature/Primary forest with the implementation of alternative 3. Most of this forest is protected under designated lands and those outside are protected by means of standards and guidelines that call to total preservation of the mature forest.

There would be no cumulative effects to the Mature/Primary Forest with the implementation of alternative 3. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the Mature/Primary Forest is based on management practices within the Forest boundary; under new regulation, using collaboration and the “all-lands” approach could assist in mitigating effects.

Overall, there are no significant effects to the Mature/Primary Forest with the implementation of this alternative.

Montane Wet Secondary Forest

Effects:

In alternative 3, the Community Interface Resource Management Area (CIRMA) (7,187 acres) is located in this vegetation type. It provides areas and sections of the Forest where an assortment of resource management practices could be applied to encourage tropical forest management initiatives in the broader landscape of El Yunque. The considered activities could include sustainable forest products, applied management strategies, dispersed or developed recreation, Forest restoration projects, watershed improvements, wildlife habitat improvement, riparian zones restoration, co-management interface areas, aquatic habitat improvement, and the interpretation of cultural icons recognized in the selected areas.

Even though there are standards and guidelines to protect the Primary Forest, part of the Forest is located where proposed projects might affect those Forests. There is potential for impacts to the following resources: watersheds, riparian areas, aquatic habitats and species, flora and fauna, soil, species of conservation concern, recreation, scenery, ecological services, forest products, including wood products.

Effects to these lands with the implementation of the potential projects allowed in these management areas include soil erosion and compaction, streams sedimentation, wildlife disturbance, habitat for flora and fauna disturbance and reduction, diversity, scenic values, vegetation and habitat for species of conservation concern. See other sections for more detailed effects to the resources.

The NEPA process expected to occur before any particular project is implemented should mitigate direct impacts if properly carried out. The NEPA process will minimize direct effects from management activities.

Potential effects from implementing alternative 3 are related to increased recreation activities, recovery of species and diversity, recovery of forest crown cover, recovery of appropriate habitat for plants and animals, soil recovery and potential increment of invasive species (20 more acres than alternative 2).

The implementation of several projects in the same watershed over time definitely risks the impairment of watersheds of the Forest. The time scale of this analysis is 15 years or the life of the plan. The cumulative effects analyzed for the Montane Wet Secondary Forest will be based on management practices within the Forest boundary; although under new regulation, using collaboration and the “all-lands” approach could assist in mitigating effects.

Overall, alternative 3 has potential to affect several resources if implemented in these lands without appropriate mitigation.

Riparian Areas

Effects:

The developed recreation potential sites proposed by alternative 3 are mostly associated with a stream which is the preferred feature in the location of the sites. The visitors to the Forest developed sites prefer to wade in water and recreate in the riparian zone when facilities are full or want to interact with the Forest outside the developed picnic shelters. Many are developed for the use of the water environment. Dispersed recreation in the CIRMA and other potential activities proposed could also impact the riparian area if the site is heavily visited or intensively used. The resources expected to be impacted are water quality, aquatic habitat and species, wildlife, the soil and the riparian vegetation. Trash generated by visitors and the proper handling of it is another impact to the environment in high visited sites. See other sections for more detailed effects to the resources.

The NEPA process expected to occur before any particular project is implemented is expected to mitigate direct impacts if properly carried out. The NEPA process will minimize direct effects from management activities.

Potential impacts are associated with the soil erosion, compaction of soil, vegetation trampling, vegetation composition change and fine sediments movement into the water channel.

Cumulative Effects:

Impacts could eventually overlap when forest products management and dispersed and developed recreation areas are relatively close, or end up impacting the same drainage system. The time scale of this analysis is of 15 years or the life of the plan. The cumulative effects analyzed for the riparian areas will be based on management practices within the Forest boundary; although under new regulation, using collaboration and the “all-lands” approach could assist in mitigating effects.

Overall, alternative 3 may has the potential to affect the riparian area resource if implemented in these lands or some capacity control to the recreational sites.

Table 3-17. Determination of effects for alternative 3

	Alternative 1	Alternative 2	Alternative 3
Functional Wetland	Potential effects	No effects	No effects
Mature/Primary Forest	Potential effects	No effects	No effects
Montane Wet Secondary	Potential effects	Potential effects	Potential effects (greater acreage than alternative 2)
Riparian Areas	Potential effects	Potential effects	Potential effects

3.4.2 Aquatic Ecosystems

3.4.2.1 Affected Environment

The El Yunque aquatic ecosystem affected environment can be defined by two elements: (1) the types of streams and rivers that occur in the planning area; and (2) the composition and structure of aquatic faunal communities that persist in El Yunque streams. In this plan, the aquatic ecosystem's first physical element is characterized as Tropical Montane in morphology with a variable degree of steepness. The water quality is currently considered high due to little sedimentation or man-made point sources of pollution into this ecosystem. These steep mountains are formed by volcanoclastic and igneous rocks that exert a strong localized lithologic influence on the stream channels. Longitudinal profiles also show the influence of multiple rock types. Landslides along steep hillslopes ($>12^\circ$), deliver coarse sediment ($>2,000$ millimeters) to the channels and also may influence channel gradient and geometry (Pike 2008).

Aquatic ecosystems on the El Yunque also have steep gradients, channels lined with coarse boulder-sized sediment, numerous bedrock cascades, and abrupt waterfalls (up to 30 meters in height) (Ahmad et al. 1993). First-order perennial streams have bouldered channels in steeply sloped reaches, and clay and soil-lined channels in reaches with more gentle slopes. Second- and third-order streams have steep gradient reaches, exposed bedrock channels, large boulders, and periodic waterfalls. Due to rapid decomposition, these channels lack the large coarse woody debris dams that create aquatic habitat in many channels in humid temperate environments (Covich and Crowl 1990). Fourth and fifth-order (wide and slow moving waters) streams occur only at the lower elevations along the coastal plain, which is outside of the El Yunque. Most habitats are categorized as either pools or riffles (rapids-like setting).

The second element of the affected environment consists of the biological component of the aquatic faunal community. El Yunque common aquatic species include the following species that act as first-level and second-level consumers: seven freshwater shrimp species (*Xiphocaris elongata*, *Atya scabra*, *Micratya poeyi*, *Macrobrachium faustinum*, *Macrobrachium heterchirus*, *Macrobrachium carcinus*, and *Macrobrachium crenulatum*), one crab species (*Epilobocera sinuatifrons*), and five fish species (*Sicydium plumieri*, *Awaous banana*, *Agonostomus monticola*, *Anguilla rostrata*, and *Gobiomorus dormitor*). There are no rare or federally listed aquatic species on the El Yunque.

Population indices of these aquatic species from long-term monitoring sites conducted by the El Yunque in many of the watersheds show a stable count of common aquatic species on the El Yunque. Many of the freshwater shrimp live their entire life cycle within the river systems where they are found. It is the same biological cycle for many of the endemic freshwater fishes with the exception of the American eel (*Anguilla rostrata*). The American eel is a catadromous fish species where adults travel to breeding areas in the Sargasso Sea to the north and the next generation of young eels return to the El Yunque streams.

There are no managed sport fishes on the El Yunque due to natural conditions proving too challenging with high occurrence of flash flooding and high competition for resources. Invasive aquatic species are

insignificant to the aquatic ecosystems at this time. Thus, healthy native aquatic species populations provide a measurable component of the affected environment for aquatic ecosystems.

Alternative 1

Desired conditions, objectives and standards/guidelines for the management areas in the 1997 Forest Plan are issue driven. The 1997 management concept focused on a conservation approach with little vegetation management. The planning strategy was for developing solutions to nine issues through plan components.

Current (1997) management area designations would continue providing adequate standards and guidelines found in other resource areas such as the water and fisheries component of the wildlife section. These adequate standards and guidelines make reference to what is now specifically known as “aquatic ecosystems through reference to maintenance of different ecological components” and “provide protection when allowing actions near this ecosystem.”

Long-term implementation of the plan would result in the continued functioning and protection of all federally designated rivers, streams, and their respective riparian areas, with robust populations of aquatic species.

Aquatic ecosystem management parameters in this alternative would not reduce resiliency to change. This is based on reviewing 17 years of management using the direction in the 1997 Forest Plan.

Water quality and an appropriate flow regime would remain that is constructive for aquatic fauna and riparian vegetation would continue to be provided.

Biotic resources would be managed for continued sustainability through cursory monitoring and abiotic conditions would still be collected. Developed recreation facilities would occur adjacent or within aquatic ecosystem zones. Best management practices would still be emphasized for both use and improvements for these human recreational benefits.

Monitoring data that would be collected should provide simple visuals of habitat conditions.

Alternative 2

Desired conditions, objectives, and standards/guidelines for the management areas under this alternative emphasizes social and economic sustainability through a more dispersed recreation strategy, enhancing ecosystem services, continued at-risk species stewardship through high quality habitat conditions, and improved resilience to climate change where possible. Potential effects to aquatic resources would be evaluated based on indices of monitoring variables that are identified in the proposed monitoring plan. Aquatic ecosystems programmatic management would continue to implement best management practices for any management action conducted on the Forest.

In the long term (and cumulatively) the use (small scale) of Forest lands for agroforestry would enable a more diverse vegetation structure in a management area where plantations were used in the past. Recreation resources would be improved and a strategy to disperse public use would be spread to the periphery of the Forest. Improved at-risk species stewardship is anticipated through a more collaborative process; overall implementation of alternative 2 would improve the aquatic ecosystem.

Alternative 3

Desired conditions, objectives, and standards/guidelines for the management areas in this alternative are the same as alternative 2, with new elements that implement a preservation approach to all resource areas by reducing trails, significantly increasing the scope of invasive species eradication, recommending a new wilderness area, and eliminating the scenic byway. Most of the other similar elements of social and

economic sustainability are retained in this alternative. Potential effects to aquatic ecosystems would be evaluated using the monitoring variables that are identified in the proposed monitoring plan. Aquatic ecosystems management would continue to implement best management practices for any management conducted by the Forest.

Long-term (and cumulative) effects would be similar to alternative 2 in the use of agroforestry, with the additional results of more use on fewer trails and more lands in wilderness category.

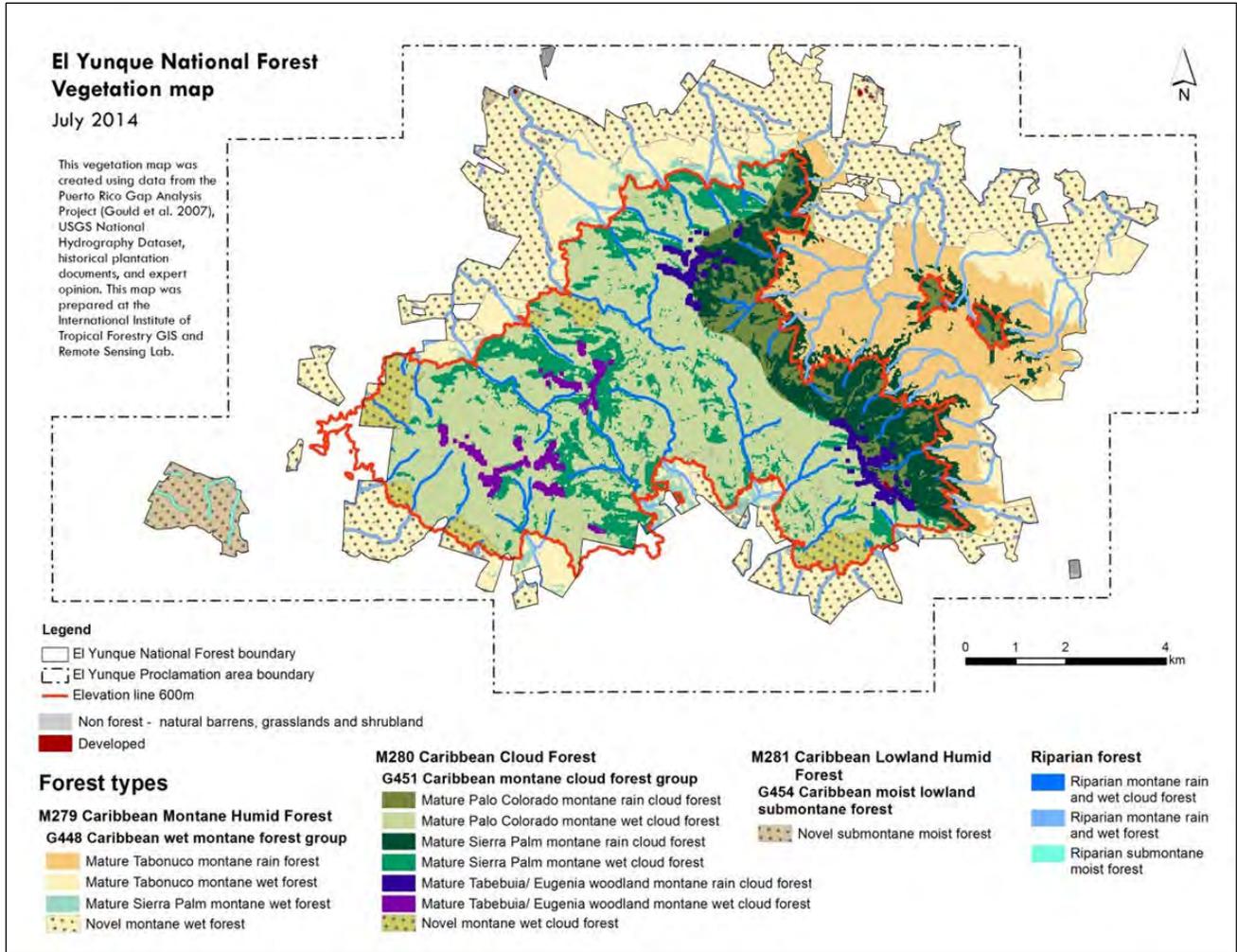
3.4.3 Threatened and Endangered Species/Species of Conservation Concern

This section covers federally threatened and endangered (T&E) species and any applicable candidate and proposed species, which require protection or consultation under the Endangered Species Act (36 CFR 219.16). The Forest Service cooperates with the United States Fish and Wildlife Service (USFWS) in the identification and evaluation of species likely to be affected and in the development of Forest plan components that contribute to their recovery.

For this section of the document there will be three forms of effects analysis: direct, indirect and cumulative. An effect is often defined as a change measured “by comparing starting and ending points of reference for a specific indicator and relative to some benchmark of magnitude” (Dube et al., 2006). Thus a direct effect is caused by the action that occurs at the same time and place (National Environmental Policy Act 1969). An indirect effect is caused by the action and occurs later in time or is farther removed in distance, but is still reasonably foreseeable (National Environmental Policy Act 1969). A cumulative effect is defined as the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of the agency or person undertaking such other actions. As a caveat, this is a planning action based on policy; this means that plan-level analysis is not based on actual actions, but the implementation of policy for future possibilities throughout the planning area.

3.4.3.1 Affected Environment–Threatened and Endangered Species

Thirteen species of federally T&E plant and animal species with ranges occurring in the municipalities of Rio Grande, Luquillo, Naguabo, and Canovanas were included and evaluated in the ecological sustainability evaluation process. Throughout the El Yunque, T&E species protection and habitat enhancement is a priority, so their needs are particularly emphasized. The overall affected environment can be summarized as a tropical rainforest within the Caribbean Basin located between North America and South America. The vegetation on the El Yunque is consistent with Tropical Wet Rain forests and is arranged into 15 new vegetation types (see Map 3-17).



Map 3-17. El Yunque National Forest vegetation

Source: Quiñones, M.; Rivera, L.A.; Gould, W.A. 2013. El Yunque National Forest vegetation map. Terrestrial Ecosystem Assessment chapter of the land and resources management plan revision for El Yunque National Forest. Vector data. USDA Forest Service, San Juan, PR.

Table 3-18. List of federally threatened and endangered and candidate (T&E) species on El Yunque

Common Name	Scientific Name	Category	Status
Puerto Rican Parrot	<i>Amazona vittata</i>	Bird	Endangered
Puerto Rican Broad-winged Hawk	<i>Buteo platypterus brunnescens</i>	Bird	Endangered
Puerto Rican Sharp-shinned Hawk	<i>Accipiter striatus venator</i>	Bird	Endangered
Elfin Woods Warbler	<i>Setophaga angelae</i>	Bird	Threatened
Puerto Rican Boa	<i>Epicratus inornatus</i>	Reptile	Endangered
White-necked Crow	<i>Corvus leucognaphalus</i>	Bird	Extirpated from Puerto Rico

3.4.3.2 Environmental Consequences—Threatened and Endangered Species

Forest planning is a 2-tier system consisting of:

- A Forest Plan that provides broad management direction for the next 10 to 15 years, and
- Project-level decisions within the Forest Plan direction.

Forest plan components, such as desired conditions, standards and guidelines, and objectives, provide broad management direction. These Forest Plan components comply with the requirements of the Endangered Species Act of 1973 (ESA) and the associated recovery plan for each federally listed species.

Project-level analysis evaluates site-specific impacts, based on conditions on-the-ground. Additional mitigation measures may be developed, if needed.

In general, all federally listed T&E species would continue to be managed and protected across the Forest in accordance with Forest Service policy, recommended protection measures in the recovery plans, and all applicable state and Federal laws. Individual projects during the next planning period may result in direct negative effects to an individual, but effects analysis and consultation will take place at the project level should this situation ever occur.

Cumulative Effects, All Alternatives

Public lands play a critical role in the conservation of rare species and native habitats, which sometimes receive little formal protection or conservation on private lands. This is especially true for federally listed plants, which receive no legal protection on private lands. During the next 10 to 50 years of Forest Plan implementation, human populations are likely to either expand or shift to urban areas, affecting present urbanizations, roads, and associated traffic. These trends suggest not only that public lands will play an increasingly important role in the conservation of T&E species in the future, but also that land management to ensure recovery and/or prevention of Federal listing of species may be increasingly difficult.

The area adjacent to the Northwest portion of the El Yunque is near one of the most rapidly urbanizing areas around its periphery; it also supports some of the highest densities of T&E species and proposed species of conservation concern along changing elevation gradients on the Forest. In terms of management for habitats for federally-listed species, some of these areas have already been designated as part of the El Toro Wilderness Area.

For some species such as the Puerto Rican parrot and elfin woods warbler, the Forest Service consistently works beyond the plan area boundary to collaborate and cooperate with U.S. Fish and Wildlife Service (USFWS), state, and other partners to support an “all-lands” approach to species recovery. The agency has also worked and continues to work with partners to reintroduce at-risk species into historical habitat on National Forest System lands where appropriate.

Thus, the planning components provide sustainable and long-term habitat management for all federally listed species to better meet changes to conditions that may warrant the use of scientific land management options.

Puerto Rican Parrot (*Amazona vittata*)

The Puerto Rican parrot was listed as endangered in 1968. Under its 2009 recovery plan, this endemic species is the only native parrot in the United States and it was considered one of the ten most endangered birds in the world. The bird is not historically dependent on a specific habitat on the El Yunque and had wide ranges throughout Puerto Rico. “Amazona parrots in general are known to range widely within the forest types they inhabit, regularly flying long distances to obtain food” (Snyder et al. 1987). A continuing

interagency recovery effort among the Forest Service, USFWS, and the Puerto Rico Department of Natural and Environmental Resources (PRDNER), presently supports a minimum of 25 to 28 wild individuals surviving in the El Yunque in eastern Puerto Rico and 75 to 80 wild individuals in the Río Abajo Forest in north central Puerto Rico. Two combined captive population aviaries hold more than 300 individuals: the Iguaca Aviary and the José L. Vivaldi Aviary in the El Yunque and Río Abajo state forest, respectively. According to the population viability analysis (2003) of the Puerto Rican parrot, the species is still slowly coming out of a genetic bottleneck and through the interagency effort has been addressing limiting population growth factors to assist the parrot in reaching a more viable status. The interagency recovery effort has also realized that the El Yunque is not the preferred habitat of the Puerto Rican parrot and foresees a more promising population growth in a third wild flock location in the western section of Puerto Rico. The species was at 13 individuals in 1976 and presently has a total population, including captive birds, at approximately 400 individuals (Velez 2013).

Indices are not to be confused with a census that shows the total count. The following graphs exhibit the erratic movements of the Puerto Rican parrot pre-breeding population, which is the period before the breeding pairs lay eggs and any new parrots from the aviaries. Trends can be explained through effects from predation, hurricanes, genetic bottleneck, and carry capacity of the area.

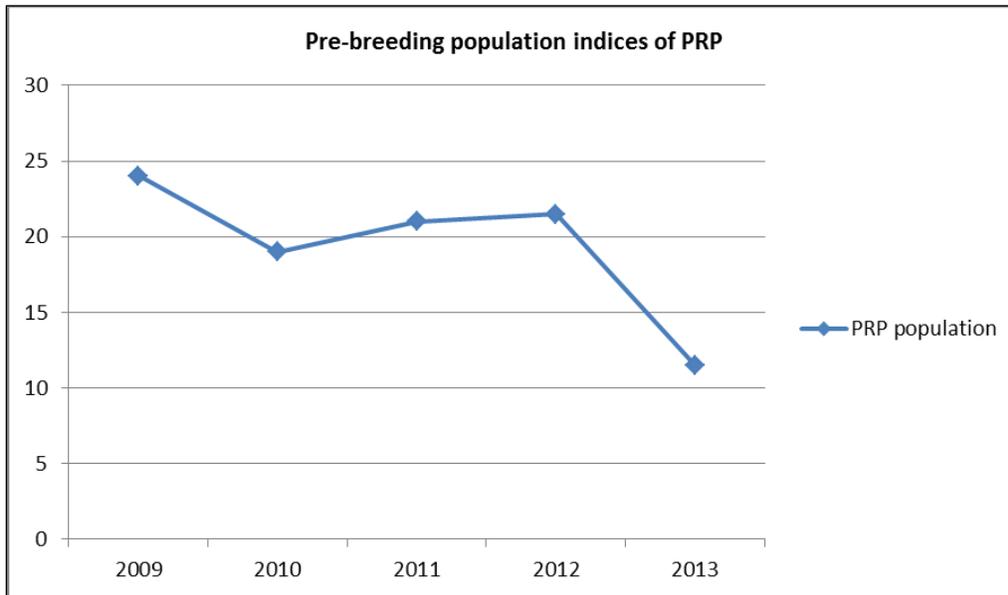


Figure 3-4. Population trend of a wild flock of Puerto Rican parrots on the El Yunque 1973 to 2006 (USFWS 2009)

Note: Puerto Rican parrots counted during pre-breeding surveys (March and April) in the El Yunque from 1973 to 2006. The number of breeding individuals recorded each year is also depicted in the lower part of this figure. The average observed rate of increase (Caughley 1977) is expressed as the finite rate (λ).

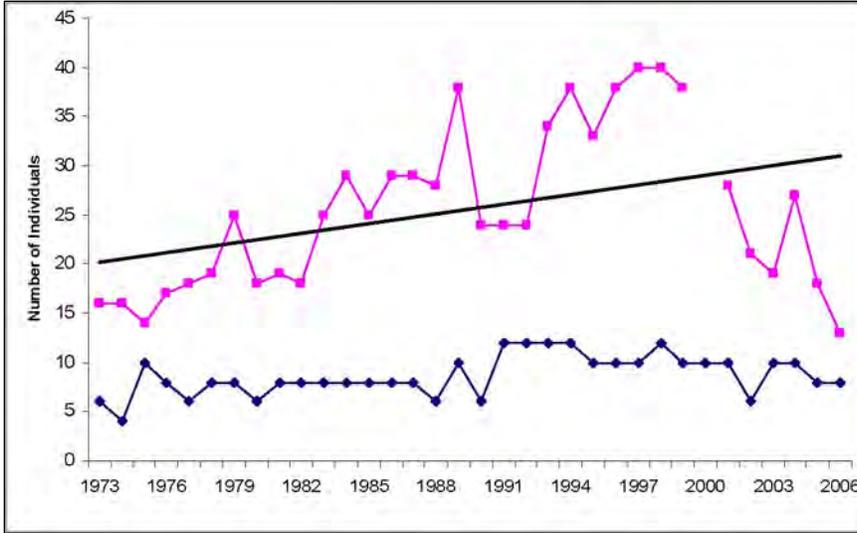


Figure 3-5. Population trend of a wild flock of Puerto Rican parrots on the El Yunque 2009 to 2013 (USFWS 2013)

Note: Average Puerto Rican parrots counted during pre-breeding indices (March and April) in the El Yunque. Indices are not to be confused with a census that shows the total count. These two graphs exhibit the erratic movements of the Puerto Rican parrot pre-breeding population, which is the period before the breeding pairs lay eggs and any new parrots from the aviaries. Trends can be explained through effects from predation, hurricanes, genetic bottleneck, and carry capacity of the area.

Alternative 1

The 1997 Forest Plan for the El Yunque has made the recovery of the Puerto Rican parrot a significant mile post for the overall effectiveness of a majority of management activities on the Forest. In the stewardship of habitats that at the time contained active Puerto Rican parrot nests (such as in the higher eastern interior), management activities were restrained under the assumption that those habitats held a vital element for the recovery of the bird. Eventually the local Puerto Rican parrot population dwindled over time due to limiting population factors, although the quality of the habitat remained stable for all other land management uses.

The population is no longer expected to grow significantly on the El Yunque, but still functions as an important resource for the successful recovery outside of the El Yunque in more preferred habitat. Population and active nest data can be interpreted that levels will be either rising or falling, but remaining within a range.

Planning components continue to provide protection to identified habitats that are in use and provide consideration in relation to other management uses.

Alternative 2

There would be a continued emphasis on parrot recovery with partners throughout identified habitat with planning components to manage any new suitable habitat use (e.g., nesting availability, population limiting factors control, enforced area closure of Forest Service Road 12 and competing land management use guidance). This allows for an ample degree of adaptive management for accumulating scientific data on the biology of the parrot.

An increased ability to improve resiliency to climate change through wildlife stand improvement components after a naturally occurring event and the monitoring of any new wildlife interactions will further assist in protecting the local Puerto Rican parrot population.

Consideration through the project-level evaluation of the new scenic byway (PR Road 186) in the western portion of the El Yunque is emphasized at the plan level that ensures management efforts to provide high quality habitat.

Regarding the establishment of Community Interface Resources Management Area (CIRMA), activities for sustainable resource use are not exempted from any wildlife and fisheries planning components. This ensures that if any parrot use (foraging or nesting) is found immediately within this new or any other management area, it will be a management priority.

Alternative 3

The potential for direct effects to the Puerto Rican parrot would be the same as in alternative 2. However, indirectly, the exclusion of the new scenic byway would not create any potential increase of management of the right-of-way in the PR Road 186 area (in the northwest portion of the El Yunque). This would increase the beneficial use by the parrot if it flies off El Yunque lands through the western portion. The benefit would be minor due to knowledge that the activity would not create a significant change in Puerto Rican parrot behavior through this land use designation.

Cumulative Effects

Puerto Rican parrot habitat would continue to be maintained and enhanced in all alternatives, as it has been since the 1997 Forest Plan was implemented.

In alternatives 2 and 3, cumulative effects from the creation of the CIRMA and scenic byway may increase human presence in the form of diverted recreational use at small recreation areas (e.g., picnic sites, vistas) or small-scale use of sustainable agroforestry for the surrounding community. The CIRMA points of interest are located in the north, east, and southern periphery of the El Yunque and are specifically meant to be small scale to ensure intact ecological services. Any interested group would be instructed to report any Puerto Rican parrot immediately to the El Yunque and monitoring of those areas by El Yunque personnel would provide continued stewardship of the habitat.

The scenic byway would, over time, increase vehicular use in alternative 2; thus, it is expected that there would be an increase of potential noise from vehicular and human presence in any rehabilitated recreation site. The intent of the scenic byway is that it is meant to be used as a travel route through the El Yunque in its western section. The designated management area is over 100 meters away in most areas to the El Toro Wilderness Area, and provides a buffer, due to the dense vegetation structure of the tropical rainforest. These and other planning components do provide for the project-level analysis, a strong foundation for any mitigation.

Puerto Rican Broad-winged Hawk (*Buteo platypterus brunnescens*): Endangered

The Puerto Rican broad-winged hawk was federally listed as endangered in 1994. This hawk is an endemic woodland raptor of upland montane forests of Puerto Rico (Hengstenberg and Vilella 2005). It is a subspecies of the broad-winged hawk. Breeding in Puerto Rico begins in late December, with nests placed in the upper reaches, but below the high canopy (Delannoy and Tossas 2002). This species occurs in Elfin Woodland, Sierra Palm, Caimitillo-Granadillo, and Tabonuco Forest type of the Rio Abajo Commonwealth Forest (Western Puerto Rico), Carite Commonwealth Forest (Southeastern Puerto Rico), and El Yunque (USFWS 2010). The raptor is known to prefer forest types with an open mid-story vegetation structure to prey on species such as lizards and small birds. The broad-winged hawk in Puerto Rico is non-migratory and exhibits a limited geographic range with all known populations restricted to Montane Forests (Delannoy 1997). The hawk's population was estimated at about 125 individuals Islandwide in 1994 (USFWS 2010). There have been very few observations of the broad-winged hawk in annual bird counts, but it is known to still exist on the El Yunque.

Table 3-19. Present observation trend of the Puerto Rican broad-winged hawk (Delannoy 1992)

Forest	Census Area (km ²)	Number of Hawks	Estimated Population
Luquillo (El Yunque)	206.4	58	124.20

The Puerto Rican broad-winged hawk's density and population estimates varied considerably among forests, being highest at Rio Abajo Forest and lowest in El Yunque (Delannoy 1995).

Alternative 1

In alternative 1, the hawk's habitat would continue to be maintained and enhanced as it has since the 1997 Forest Plan was written. The direction of this management area would continue to protect the species and its habitat, providing a naturally driven vegetative structure. However, without more direction to stimulate reproduction the Puerto Rican broad-winged hawk population would stay constant or trending towards decline.

Alternative 2 and 3

Alternatives 2 emphasize the evaluation of the new scenic byway (PR Road 186) in the western portion of the El Yunque, while alternative 3 doesn't consider this possibility. This would be expected to improve management efforts providing high quality habitat for the species and other species of this system (restoring ecological functions after a natural disaster, for example). Intrinsically, alternatives 2 and 3 would be expected to provide the greatest amount of benefits and protection for the Puerto Rican broad-winged hawk. These alternatives provide new tools for partnerships with academic institutions and others to continue collecting scientific information on the species.

Cumulative Effects

Cumulative effects may take the form of the shifting human population and stresses on the natural resources of El Yunque. There may be various degrees of partnership opportunities that all of these alternatives present to work on behalf of this species. The new Northeast corridor would provide a link between the Forest and the coastal region of Northeast Puerto Rico, which may present a variety of habitat for the species.

Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*): Endangered

The Puerto Rican sharp-shinned hawk, a subspecies of the sharp-shinned hawk, was designated a federally endangered species in 1994. There are more individuals outside of the El Yunque, but a survey by Delannoy (1992) reported only a solitary territorial hawk pair in the southcentral part of the Forest. This area is located within the Palo Colorado Forest type in the Lower Mountain Forest Life Zone (Ewel and Whitmore 1973). Sixty individuals of Puerto Rican sharp-shinned hawks were counted in Islandwide surveys conducted in 1983, and a breeding density of 0.73 hawks per square kilometer was estimated (Cruz and Delannoy 1986). In 1985, 72 individuals were counted and a breeding population of 0.76 hawks per square kilometer (230 to 250 Islandwide) was estimated in Islandwide surveys (Cruz and Delannoy 1986). In 1992, a total of 285.6 square kilometers was censused, yielding 82 sharp-shinned hawks: 80 outside of the El Yunque and 2 within the Caribbean National Forest (El Yunque). An overall population of 129 individuals has been estimated for these forests (Delannoy 1992). As of late, an individual has been observed during population indices counts for the Puerto Rican parrot which may show a new area of occurrence for the small raptor in the western section of the El Yunque (Cano 2013). The hawk prefers an open mid-story vegetation structure for its preferred prey species of lizards and small birds.

Table 3-20. Average density and estimated population of the Puerto Rican sharp-shinned hawk (Delannoy 1992)

Forest	Census Area (km ²)	Number of Hawks	Average Density \pm S.E.	Min-max	Estimated population \pm S.E.
Luquillo (El Yunque)	285.6	82	-	-	129.30

Alternative 1

In alternative 1, the hawk's habitat would continue to be maintained and enhanced as it has since the 1997 Forest Plan was written. The direction of this management area would continue to protect the species and its habitat, providing a naturally driven vegetative structure. However, without more direction to stimulate reproduction, the Puerto Rican sharp-shinned hawk population would stay constant.

Alternative 2 and 3

These alternatives would have the following direct and indirect effects. Alternative 2 has an emphasis on the evaluation of the new scenic byway (PR Road 186) in the western portion of the El Yunque. This would be expected to improve management efforts providing high quality habitat for the Puerto Rican sharp-shinned hawk and other species of this system (restoring ecological functions after a natural disaster, for example). Intrinsically, alternative 2 and 3 would be expected to provide the greatest amount of benefits and protection for the species. These alternatives provide new tools for partnerships with academic institutions and others to continue collecting scientific information on the species.

Cumulative Effects

Cumulative effects may take the form of the shifting human population and stresses on the natural resources of El Yunque. There may be various degrees of partnership opportunities that all of these alternatives present to work on behalf of this species. The new Northeast corridor would provide a link between the Forest and the coastal region of Northeast Puerto Rico, which may present a variety of habitat for use of species.

Elfin-Woods Warbler (*Setophaga angelae*): Threatened

The Elfin-woods warbler was listed as a candidate species in 1982. As of January 2016, the bird is well on its way to becoming listed as threatened (and is treated as such), with a deadline of November 30, 2015, for public comments. The species is endemic to Puerto Rico and has been reported in Humid Montane Forest habitats. Initially thought to occur only in the Luquillo Mountains (El Yunque), this species was later discovered in the Maricao, Toro Negro, and Carite Commonwealth forests (Gochfeld et al. 1973; Cruz and Delannoy 1984a; Raffaele 1998). Kepler and Parkes (1972) described the elfin-woods warbler from the high elevation Elfin Woodland Forests (640 to 1,030 meters or 2,099 to 3,378 feet) and occasionally in Palo Colorado Forests on El Yunque. Wiley and Bauer (1985) later reported the species from the Elfin Forests and lower elevation forests (370 to 600 meters or 1,213 to 1,968 feet) such as Palo Colorado and Sierra Palm forests in the El Yunque. According to Arendt (2013), "since its discovery and classification there has been concern regarding the status and future of the Elfin-woods warbler owing to its limited range and dwindling habitat...and predicted repercussions of escalating climate change." Thus, there may be a decreasing habitat quality trend occurring on the El Yunque that includes food resources and vegetation structures that the bird requires. The USFWS has completed a candidate conservation agreement with the El Yunque in 2014 because the Forest is one of the last two locations in Puerto Rico that the warbler is found.

Of all plants and animal species known to occur on the El Yunque, no other species has the potential to have a greater influence on Forest Service management. The El Yunque is the bird's preferred habitat and poses a new set of management parameters.

Alternative 1

In alternative 1, the elfin-woods warbler habitat would continue to be maintained and if possible enhanced. Although this species is not specifically mentioned for management concerns, it is known indirectly as a species of which to be aware.

Management areas such as El Toro Wilderness Area (MA-5) and Baño de Oro expanded Research Natural Area (MA-7) would resume protective standards and guidelines.

Although this alternative contains an emphasis on retaining a natural vegetation composition and structure, the plan would not build the resilience of the habitat against climate change or changes in human activity (e.g., recreation pressures) that may prove detrimental over the long term. These long-term conditions may take the form of degrading foraging and nesting habitats, which may limit population growth and expansion of the species on the El Yunque.

Alternative 2 and 3

With emphasis on increased ecological/economic sustainability, conditions of the habitats occupied by the elfin-woods warbler would improve due to a higher priority on habitat management. Scientific knowledge is being accumulated over this species' biological needs and these alternatives would foster the partnership with academic institutions to evaluate ecological and economic value. The desired conditions for "at risk" species includes the need for metapopulation management. This means a collaboration with partners outside of the El Yunque to reach goals both in and outside of the planning area.

These alternatives also included standards and guidelines specific to this species needs in moving it toward a viable population. Including a management area's map in the new Forest Plan would confirm the priority of all management uses to take into considerations of this little-known warbler's biological needs.

In the following photos, note the high quality of the Elfin woodlands (Mature *Tabebuia*/*Eugenia* Woodland Wet Cloud Forest) and Palo Colorado (Wet and Rain). These alternatives would allow a more adaptive approach to improve the species' habitat. In other words, if a degree of variation does occur from these baseline conditions, the El Yunque would scientifically attempt to find the source of the change and determine how to address it.



Figure 3- 6. Desired Elfin Woodlands (Mature *Tabebuia*/*Eugenia* Woodland Montane Wet Cloud Forest) (left); desired Palo Colorado forest type (right)

Puerto Rican Boa (*Epicratus inornatus*): Endangered

Listed as an endangered species in 1970, this boa is found mostly in the northern half of the Island of Puerto Rico. Rivero (1998) stated that the Puerto Rican boa is distributed throughout the Island, being more abundant in the “mogotes” of the north and much less abundant in the dry southern region of the Island. Wunderle et al. (2004) studied habitat use of the boa the El Yunque and indicated that, although the boa were located in a variety of microhabitats (i.e., vine enclosed broadleaf trees and shrubs, vine tangles, bamboo, dead trees, buildings and streams), the highest mean percentage of fixes for boas tracked by telemetry occurred in broadleaf trees followed by ground or below-ground sites. This radio telemetry study by Wunderle at El Yunque monitored 24 snakes with a total 70 tagged Puerto Rican boas with transponders (pit-tags). Boas were found incidentally during daylight and evening hours while walking or driving to sites with radio-marked boas. According to Wunderle et al. (2004), much of the boa’s apparent rarity is related to the observer’s inability to see this cryptic species within the Forest. As an example, Wunderle et al. (2004) failed to visually detect telemetry-tracked boas in an average of 85 percent of their telemetry relocations. Because of this, it is likely that the species is more abundant than generally perceived.

Alternative 1

Under alternative 1, the boa’s habitat would continue to be maintained and enhanced as it has since the 1997 Forest Plan was written. The direction of this management area would continue to protect the species and its habitat providing a naturally driven vegetative structure. However, without more direction to stimulate reproduction and survival, the Puerto Rican boa population would remain as is.

Alternative 2

Alternative 2 emphasizes the construction of the new scenic byway (PR Road 186) in the western portion of the El Yunque. There would be an increase in vehicular travel and individuals may be affected. However, the habitat of the species as a whole will still remain functioning and contributing to a sustainable population.

Alternative 3

Alternative 3 would be expected to provide the greatest amount of benefits and protection for the Puerto Rican boa. This may be due to the restoration of habitat after natural disasters that would be expected to provide high quality habitat for the species. Also, the absence of the new scenic byway (PR Road 186) would reduce the risk to individuals. This alternative also provides new tools for partnerships with academic institutions and other partners to continue collecting scientific information on the species’ biological and behavioral trends.

Cumulative Effects

Cumulative effects may take the form of the shifting human population and stresses on the natural resources of El Yunque. There may be various degrees of partnership opportunities that all of these alternatives present to work on behalf of this species. The new Northeast corridor would provide a link between the Forest and the coastal region of Northeast Puerto Rico, which may present a variety of habitat for use by the species.

White-necked Crow (*Corvus leucognaphalus*): Extirpated from Puerto Rico

The endangered white-necked crow no longer exists on the Island of Puerto Rico, but still occurs in neighboring Dominican Republic (Island of Hispaniola). The bird had an original range of both of the Greater Antilles Islands (Puerto Rico and Hispaniola), but over time was confined to only one Island. Due to considerable lowland forest clearance and hunting, the species was last seen in Puerto Rico in 1963.

There is a low potential for reintroduction of this species, but the El Yunque would be a likely location for its recovery.

There will be no analysis of trends or drivers for this species since the species does not occur on the Island of Puerto Rico as unofficially accepted by Federal and state land managing agencies.

3.4.3.3 Species Diversity (Potential Species of Conservation Concern)

The ecosystems of the tropical rainforests support the largest biodiversity on the planet. The planning team evaluated ecological conditions on the El Yunque to provide for species diversity using a coarse-filter/fine-filter approach. Most plant and animal species on the Forest will be sustained by maintaining and restoring the composition, structure, function and connectivity of a diversity of ecosystems in the plan area.

Where needed, the team developed fine-filter strategies to contribute to the recovery of threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern—all collectively called “at-risk species.”

To assess species diversity, a comprehensive list of plant and animal species was compiled as part of the El Yunque National Forest Plan Assessment by combining species lists from a variety of sources, including the following:

- Federally listed threatened and endangered species obtained from the USFWS;
- State species of conservation from the Puerto Rico Natural Heritage Program, State Comprehensive Wildlife Conservation Strategy;
- Birds of conservation concern compiled by the USFWS; and
- The Forest Service’s list of sensitive species.

Additional species were added based on input from recognized conservation experts within the state. All species were considered in the design of ecological conditions within the plan area.

Species were then screened for inclusion in the framework and designated as species of conservation concern. The planning team used a species and Ecological Sustainability Evaluation framework for the analysis of species diversity and ecological sustainability and integrity built around principles developed by The Nature Conservancy in their Conservation Action Planning Workbook (The Nature Conservancy 2005).

Many of the proposed species of conservation concern are also considered to be at-risk species by the USFWS; many have been petitioned to be listed under the Endangered Species Act. In Puerto Rico, large publicly owned landscapes such as the El Yunque support some of the best habitat and highest densities of at-risk species in the commonwealth.

The 2012 Forest Planning Rule requires that species of conservation concern be, “known to occur in the plan area” and that the regional forester identify the species of conservation concern for which “the best available scientific information indicates substantial concern about the species’ capability to persist over the long term in the plan area.” The 2012 Forest Planning Rule recognizes that there are limits to the agency’s authority and the inherent capability of the land in providing for species. In contrast, the 1982 Forest Planning Rule required management prescriptions to, “provide for adequate fish and wildlife habitat to maintain viable populations for all existing species.” The management emphasis on species of conservation concern is more focused than the viability provision under the 1982 Rule. If the responsible official determines that it is beyond the authority or not within the inherent capability of the plan area to maintain or restore ecological conditions to maintain viability of a species of conservation concern in the plan area, then the responsible official shall:

1. Document the basis for that determination;
2. Include plan components, including standards and guidelines, to maintain or restore ecological conditions within the plan area to contribute to maintaining a viable population of the species within its range.

Table 3- 21. Potential species of conservation concern (fauna)

Taxonomic Group	Taxonomic Subgroup	Species	Common Name
Amphibian	Frog	<i>Eleutherodactylus brittoni</i>	Grass Coqui
Amphibian	Frog	<i>Eleutherodactylus eneidae</i>	Eneida's coqui
Amphibian	Frog	<i>Eleutherodactylus gryllus</i>	Cricket coqui
Amphibian	Frog	<i>Eleutherodactylus hedricki</i>	Hedrick's coqui
Amphibian	Frog	<i>Eleutherodactylus karlschmidti</i>	Web-footed coqui
Amphibian	Frog	<i>Eleutherodactylus locustus</i>	Locust coqui
Amphibian	Frog	<i>Eleutherodactylus portoricensis</i>	Upland coqui
Amphibian	Frog	<i>Eleutherodactylus richmondi</i>	Richmond's coqui
Amphibian	Frog	<i>Eleutherodactylus unicolor</i>	Dwarf coqui
Amphibian	Frog	<i>Eleutherodactylus wightmanae</i>	Melodius coqui
Aquatic	Eel	<i>Anguilla rostrata</i>	American eel
Aquatic	Fish	<i>Awaous banana</i>	Yellow river goby
Aquatic	Fish	<i>Dormitator maculatus</i>	Fat sleeper
Aquatic	Fish	<i>Eleotris pisonis</i>	Spinycheek sleeper
Aquatic	Fish	<i>Gobiomorus dormitor</i>	Bigmouth sleeper
Aquatic	Invertebrate	<i>Macrobrachium carcinus</i>	Bigclaw river shrimp
Aquatic	Invertebrate	<i>Macrobrachium crenulatum</i>	Crenulated river shrimp
Bird	Bird	<i>Falco peregrinus</i>	Peregrine falcon
Bird	Bird	<i>Icterus portoricensis</i>	Puerto Rican oriole
Mammal	Bat	<i>Stenoderma rufum</i>	Red-fig eating bat
Mollusc	Snail	<i>Luquillia luquillensis</i>	Luquillo mountain land snail
Reptile	Lizard	<i>Anolis cuvieri</i>	Puerto Rican giant anole
Reptile	Lizard	<i>Anolis occultus</i>	Dwarf anole

3.4.3.4 Terrestrial and Aquatic Species Covered by Ecosystem Components (coarse/fine-filter)

For the purposes of this analysis, the planning team used species groups, as needed, as an evaluation tool to improve planning efficiency and for development of management strategies.

Species were grouped according to ecosystem group or habitat needs, limiting factors, threats or specific habitat elements. No federally listed threatened and endangered species are included due to their specific analysis of all alternatives. Those known as potential species of conservation concern were included in species groups in this section because their habitats are connected to ecosystem group maintenance and restoration, and ecological sustainability. Each group was analyzed by species group and determinations

made on whether species needs were fully met by plan components, considering locations for species and management area direction associated with their known populations. A description of affected environment and direct, indirect, and cumulative effects of plan alternatives on species groups and weights for general species’ groups and the biological requirements associated with habitats is given below. The following species groups can be linked to general plan direction associated with the maintenance and restoration of the following forest type groups, or other plan components.

The rationale to assigning conservation status ranking is similar to the NatureServe’s framework and core methodology. The El Yunque biologists mimicked the Global, National, and State ranks with the collected information by focusing on extinction risk on the global scale, and their extirpation risk at national and subnational level. The El Yunque is fortunate that the Island of Puerto Rico is a relatively small island compared to other islands in the Antilles and that most of the species are endemic to this 100 mile by 45 mile Caribbean basin isle. Thus, much of the information found in the International Union of Conservation of Nature (IUCN) and the State Natural Heritage Plan (Puerto Rico Wildlife Conservation Strategy) are interpreted to populate these three ranks. Adhering to the same NatureServe factors such as range extent, area of occupancy, population size, and number of occurrences, the biologists devised a working ranking system. Fine-filter processing of the individual species was done on a case-by-case discussion over criteria qualifications with the Southern Region Office of the USDA Forest Service. As a caveat, many species did not have all of these factors documented, but many other biologists on the Island acknowledge these data gaps.

Those species that did not have these requirements were evaluated through this coarse-filter approach. Most of the species were analyzed individually, but an occurrence or grouping of species that belong to the same taxonomical family was used. Using the criteria of the new potential species of conservation concern as guidance throughout the process provided the capability to separate those species that would not retain the required ranks to move forward as a species of conservation concern.

The graphical interpretation of the Southern Region’s ecological sustainability evaluation (ESE) tool uses a range of 0 to 10, where a score of 0 to 2.5 is designated as poor or less sustainable. A score of 2.6 to 5.0 is fair, and 5.1 to 10.00 is good or more sustainable. For more detailed information about the ESE please refer to the administrative file for the new Forest Plan for the El Yunque.

Table 3-22. Species group and associated ecological/vegetation system groups from Ecological Sustainability Evaluation tool

Species Group
Freshwater Crustaceans
Riparian Associates
Mature Tabebuia/Eugenia Woodland Associates
Palo Colorado Associates
Tabonuco Associates

Table 3-23. Group weight and description

Group Weight	Group Weight Description
Very High	All or nearly all of the species’ requirements are met by the species group.
High	A high proportion of the species’ requirements are met by the species group.
Moderate	A moderate proportion of the species’ requirements are met by the species group.
Low	A low proportion of the species’ requirements are met by the species group.

Potential Direct and Indirect Effects Common to All Alternatives

In general, allowing natural recovery or intentional hand/mechanical treatments would be the primary management activities used to maintain and improve desired habitat conditions for at-risk species in all three alternatives. However, the extent of these treatments and the resulting quality and amount of habitat vary across the alternatives. Portions of the Forest have been heavily impacted by past naturally occurring events (e.g., hurricanes, landslides, and flooding); the ecological services should be restored to improve habitat for at-risk species that have been or continue to be impacted by these effects. A history of recreational use occurs in the interior and dispersed spots throughout the Forest. The planning components programmatically give parameters to this activity and adapt the intent of reducing the over-use of recreation infrastructure in the interior with a collaborative approach on the periphery of the Forest.

Cumulative Effects Common to All Alternatives

Public lands play a critical role in the conservation of rare species and native habitats, which sometimes receive little formal protection or conservation on private lands. During the next 10 to 50 years of Forest Plan implementation, human populations are likely to either expand or shift to urban areas; this will affect present urbanization, roads, and associated traffic. These trends suggest that both public and other lands will play an increasingly important role in the conservation of potential species of conservation concern in the future.

The Northwest portion of the El Yunque is near to one of the most rapidly urbanizing areas around its periphery; it also supports some of the highest densities of potential species of conservation concern.

For some potential species of conservation concern the Forest Service consistently works beyond the plan area boundary to collaborate and cooperate with USFWS, states, other partners, and landowners, to support an “all-lands” approach to potential species of conservation concern awareness. The agency has worked and continues to work with partners to reintroduce at-risk species into historical habitat on National Forest System lands where appropriate.

Forest planning components, current and new, emphasize degrees of restoration, resilience, and sustainability. These interrelated organizing concepts are reflected in the development of the Forest Plan. Restoration in its broadest sense is about protecting, restoring, and transforming not only ecosystems, but also human systems toward resilience. Resilience is about sustainability—ecological, economic and social—under the pressures of changing atmospheric, demographic, social and political climates. As values for and use of the Forest change, it brings in new uses that have never been considered (e.g., the growing importance of carbon sequestration and other ecosystem services).

Many other factors will continue to intersect with climate change to create context for managing resources—shifting demographics diversity, urbanization, technology, new attitudes about resource use, protection, social license, governance, and the role of government.

Due to the interaction of climate change and other factors, the El Yunque National Forest is experiencing increased threats from potential fire, new insect and plant interactions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity and/or for longer durations.

Species Groups: Freshwater Crustaceans and Rio Mameyes Associates**Table 3-24. Freshwater crustaceans**

Species Group	Scientific Name	Common Name	Designation	Group Weight
Invertebrate	<i>Macrobrachium carcinus</i>	Bigclaw river shrimp	PSCC	Very High
Invertebrate	<i>Macrobrachium crenulatum</i>	Crenulated river shrimp	PSCC	Very High

Table 3-25. Rio Mameyes associates

Species Group	Scientific Name	Common Name	Designation	Group Weight
Fish	<i>Anguilla rostrata</i>	Freshwater eel	PSCC	Very High
Fish	<i>Awaous banana</i>	River goby	PSCC	Very High
Fish	<i>Dormitor maculatus</i>	Fat sleeper	PSCC	Very High
Fish	<i>Eleotris pisonis</i>	Spinycheek sleeper	PSCC	Very High
Fish	<i>Gobiomorus dormitor</i>	Bigmouth sleeper	PSCC	Very High

Alternative 1

This alternative retains all protective standards and guidelines for the waterways of the El Yunque in the current Forest Plan, which are included under management area (MA) 9, and specific Forest-level themes (riparian and watersheds). These standards and guidelines address water quality through best management practices within the planning unit.

Through the ecological sustainability evaluation (ESE) tool and related graphs, the result of implementing alternative 1 is likely to be fair (4.84 out of 10.0) for the next 10 and 50 years. The interpretation of these results is that components such as water quality and quantity should be appropriate for a functioning aquatic-dependent ecosystem. In the long term (50 years) it may be more difficult dealing with other long-term management challenges, such as climate change and human population use. Thus, there is a strong notion that this alternative, although prescriptive for ecological benefits, may be limited in new methods to collaborate and manage for unseen future scenarios.

Alternative 2 and 3

Specific riparian and watershed area desired conditions found in both alternatives would continue to provide aquatic habitat protection and high water quality. A summary from relevant desired conditions of aquatic themes is as follows:

All rivers will remain free of impoundments within the existing Forest boundary. Opportunities for treatment versus control research will be provided, as long as such use does not detract from Wild, Scenic or Recreation river qualities.

Restore and maintain riparian zones with native species to sustain its diversity and functions.

Plan components (standards and guidelines) are designed to maintain and improve habitat for species in this group. Both alternatives provide emphasis on ecologically/economical sustainable conditions to ensure this management goal. The four management areas that are “preservative” in nature—MA-7 Baño

del Oro expanded Research Natural Area, MA-5 El Toro Wilderness Area, MA-6 Research Area, and the MA-8 Wild/Scenic/Recreation River Corridors—provide resilience for change to both habitats and ecological functions. Those significant management areas that allow for various degrees of use include MA-3 Communication and Recreation and MA-4 Community Interface Resource Management Area.

Cumulative Effects

Through the ecological sustainability evaluation (ESE) tool and related graphs, the result of implementing alternative 2 and 3 is likely to be fair (4.84 out of 10.0) for the next 10 years and good (6.25 out of 10) for the next 50 years. With more freedom to collaborate and manage with partners, this will contribute to gaining new scientific information to better address long-term challenges that may occur outside of the planning unit, such as adjacent municipal government management plans and regional natural resource use issues.

Aquatic fauna population are expected to remain stable with effects to individuals, but if monitoring shows otherwise, the El Yunque will be able to implement policy with better public understanding or participation towards sustainable stewardship.

Species Groups: Mature *Tabebuia/Eugenia* (Elfin) Woodland Associates

Table 3-26. Mature *Tabebuia/Eugenia* (Elfin) Woodland Associates

Species Group	Scientific Name	Common Name	Designation	Group Weight
Amphibian	<i>Eleutherodactylus eneidae</i>	Mottled coqui	PSCC	High
Amphibian	<i>Eleutherodactylus gryllus</i>	Cricket coqui	PSCC	High
Amphibian	<i>Eleutherodactylus portoricensis</i>	Puerto Rican coqui or upland coqui	PSCC	Moderate
Amphibian	<i>Eleutherodactylus richmondi</i>	Richmond’s coqui	PSCC	Moderate
Amphibian	<i>Eleutherodactylus unicolor</i>	Burrow coqui	PSCC	High
Snail	<i>Luquilia luquillensis</i>	Luquillo Mountain land snail	PSCC	Very High

Alternative 1

In alternative 1, Mature *Tabebuia/Eugenia* Woodland forest type associate habitat would continue to be maintained and enhanced as it has since the 1997 Forest Plan was written.

Through the ESE tool and related graphs, the result of implementing alternative 1 for the Montane Wet Cloud Forest version for this forest type is likely to be good (6.38 out of 10.0) for the next 10 and 50 years. Also, the Montane Rain Cloud Forest version for this forest type is likely to be good (6.72 out of 10) for both the next 10 and 50 years. The interpretation of these results is that components such as vegetation structure, composition, and function, should be adequate in sustaining this habitat type for use by the species mentioned above. In the long term (50 years), it may be more difficult dealing with other long-term management challenges, such as climate change, new fauna species and diseases, and human population use.

Thus, there is a strong notion that this alternative, with its prescriptive disposition for ecological benefits, may provide good conditions for species use. Again, this alternative requires a different timeframe with new methods to collaborate and manage for unseen future circumstances.

Alternative 2 and 3

Alternatives 2 and 3 propose the dispersion of recreational use from the interior of the El Yunque to its periphery, thus lowering impacts from human activity to these species. If recreational areas in this habitat would be proposed, the wildlife policy would be to keep recreational impacts low relative to the functions of this vegetation type. Using these alternatives, individuals of the species may be impacted, but the species as a whole should remain viable.

Through the ESE tool and related graphs of the ESE tool analysis, the result of implementing alternative 1 for the Montane Wet Cloud Forest version for this forest type is likely to be good (6.38 out of 10.0) for the next 10 years and (5.73 out of 10) 50 years. Also, the Montane Rain Cloud Forest version for this forest type is likely to be good (6.72 out of 10) for both the next 10 and 50 years. The interpretation of these results is that components such as vegetation structure, composition, and function should be adequate in sustaining this habitat type for use by the species mentioned above. Species population should remain stable, but monitoring and research should detect the long-term severe changes. Also in the long term (50 years), it may be more difficult dealing with other long-term management challenges, such as climate change, new fauna species and diseases, and human population use.

Cumulative Effects

The sources of cumulative effects may be from fluctuating human population and the stress this creates on the natural resources of the El Yunque. Interestingly, municipal and regional plans may present opportunities to improve habitats outside of the planning unit when projects are not significantly manipulative in their respective location. If their projects are significant, this may manifest effects to populations and their habitat within the planning unit that monitoring or research would be able to detect.

Because of continuous scientific information the El Yunque would be better equipped to adapt to climate change, to a limit. Finding out the limit through other efforts would provide data for our local species that are associated with this forest type and how the El Yunque may improve conditions, through actions such as artificial structures or acres of rehabilitation.

The emphasis for these alternatives is to promote local economy and protect scenic natural resources. This fits well with these two alternatives to establish more public participation and a sense of relevance to the stewardship of the El Yunque.

Species Groups: Palo Colorado Associates and Tabonuco Associates

Table 3-27. Palo Colorado Associates

Species Group	Scientific Name	Common Name	Designation	Group Weight
Amphibian	<i>Eleutherodactylus hedricki</i>	Hedrick’s coqui	PSCC	Moderate
Amphibian	<i>Eleutherodactylus karlschmidti</i>	Web-footed coqui	PSCC	Moderate
Amphibian	<i>Eleutherodactylus wightmanae</i>	Melodius coqui	PSCC	High

Table 3-28. Tabonuco Associates

Species Group	Scientific Name	Common Name	Designation	Group Weight
Mammal	<i>Stenoderma rufum</i>	Red fig-eating bat	PSCC	High
Bird	<i>Icterus portoricensis</i>	Puerto Rican oriole	PSCC	Moderate
Bird	<i>Falco peregrinus</i>	Peregrine falcon	PSCC	Moderate
Amphibian	<i>Eleutherodactylus brittoni</i>	Grass coqui	PSCC	Moderate
Amphibian	<i>Eleutherodactylus locustus</i>	Grass coqui	PSCC	Moderate
Reptile	<i>Anolis cuvieri</i>	Puerto Rican giant anole	PSCC	Moderate
Reptile	<i>Anolis occultus</i>	Dwarf anole	PSCC	Moderate

Alternative 1

In alternative 1, Mature Palo Colorado and Tabonuco forest type associate habitat would continue to be maintained and enhanced as it has since the 1997 Forest Plan was written.

Through the ESE tool and related graphs from the ESE Tool analysis, the result of implementing alternative 1 for the Palo Colorado Montane Rain Cloud Forest is likely to be good (7.08 out of 10.0) for the next 10 years and good (6.38 out of 10) for the next 50 years. Also, the Palo Colorado Montane Wet Cloud is likely to be good (6.38 out of 10) for both the next 10 and 50 years. Hence, components such as vegetation structure, composition, and function should be adequate in sustaining this habitat type for use by the species mentioned above. Species population should remain stable, but monitoring and research should see severe changes over the long term. Also, in the long term (50 years) it may be more difficult dealing with other long-term management challenges, such as climate change, new fauna species and diseases, and human population use.

Thus, there is a strong notion that this alternative with its prescriptive disposition for ecological benefits, may be provide good conditions for species use. Again, this alternative require a different timeframe in new methods to collaborate and manage for unseen future circumstances.

Alternative 2 and 3

A summary from relevant desired conditions of wildlife themes is as follows:

Maintain robust populations (and metapopulations) of identified At-risk species (Federally Threatened, Endangered, Proposed and Species of Conservation Concern) through managing identified population limiting factors on the El Yunque National Forest to better adapt to any possible change.

Rehabilitate known habitat (foraging, shelter and breeding) of At-risk species to improve habitat capabilities to support healthy populations’ needs, to the extent of that habitat’s resiliency to change.

Through the ESE tool and related graphs, the result of implementing alternatives 2 and 3 for the mature Palo Colorado Montane Rain Cloud Forest is likely to be good (6.56 out of 10.0) for the next 10 years and good (6.39 out of 10) for the next 50 years. Also, the Mature Palo Colorado Montane Wet Cloud Forest is likely to be good (6.38 out of 10) for both the next 10 and 50 years.

Cumulative Effects

Sources of cumulative effects may be from fluctuating human population and the stress this creates on the natural resources of the El Yunque. Interestingly, municipal and regional plans may present opportunities to improve habitats outside of the planning unit when projects are not significantly manipulative in their respective location. If their projects are significant this may manifest effects to populations and their habitats within the planning unit that monitoring or research would be able to detect.

Because of continuous scientific information, the El Yunque would be better equipped to adapt to climate change, to a limit. Finding out the limit through other efforts would provide data for our local species that are associated with this forest type and how the El Yunque may improve conditions, through actions such as artificial structures or acres of rehabilitation.

The emphasis for these alternatives is to promote local economy and protect scenic natural resources. This fits well with these two alternatives to establish more public participation and a sense of relevance to the stewardship of the El Yunque.

3.4.3.5 Flora: Federally Listed Species Environmental Effects

The Forest has a total of 830 flora species; of those 636 were evaluated to determine which should be categorized as federally listed species and species of conservation concern. This evaluation resulted in 8 federally listed species and 39 species of conservation concern.

As discussed earlier, the Ecological Sustainability Evaluation (ESE) tool is a strategic conservation planning tool used by the Forest Service Southern Region for Forest planning. Ecological systems, watersheds, and terrestrial and aquatic species are carried through the preliminary assessment and sustainability framework (including strategies and plan alternatives) to determine expected outcomes. The tool utilizes a standardized process while being flexible, efficient, and adaptable to Forest-specific priorities and needs. The ESE tool employs prioritization algorithms utilizing rank, importance rating, attributes and indicators, stresses and threats, scope and severity ratings, and management opportunities to assist and support management decisions while creating a standardized, credible, and defensible process record. The ESE tool analysis also considered the short term (1 to 10 years) and the long term (1 to 50 years) scenarios in the Forest.

Callicarpa ampla—Capa rosa

Known habitat is Mature Tabonuco Montane vegetation types. See the 2014 Forest Plan Assessment section on “Assessing Ecological Sustainability and Diversity of Plant and Animal Communities (Terrestrial Ecosystems)” for a detailed description of this vegetation type. See also the 2014 Forest Plan Assessment section on “Assessing Threatened, Endangered, Proposed and Candidate Species and Potential Species of Conservation Concern (At-Risk Flora)” for a detailed description of this species.

Alternative 1

This alternative has several management areas that allow activities that may have direct effects on this species. These include timber demonstration, research areas, integrated areas and developed recreation areas, and all have a potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. Diversity and forest cover is also expected to be directly impacted by the implementation of activities on these lands. These management actions could cause a high risk of losing populations of the species reported to be very rare and small in number. The NEPA process is expected to occur before any particular project is implemented. Hence, direct impacts would be mitigated if properly carried out; this alternative would have management practices for the conservation and recovery of the species that could also assist in protection. The NEPA process will minimize direct effects from management activities.

Indirect effect to this species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate of vegetation impacted, and continuous human activities on these lands.

Alternative 2

This alternative has the CIRMA that proposes activities that may have direct impact to this species. There are also activities proposed like improving recreation settings and access, improving roads and trails, improving watersheds, and provide forest products. All these actions incorporate vegetation management at some level in their implementation. There is a high risk of losing populations of the species reported to be very rare and small in number, if they are located in a management areas such as the CIRMA. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, if properly carried out. This alternative has management practices for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Beneficial effects to the populations of this species will occur because of the protection by standards and guidelines; and designated areas like wilderness, expanded research natural area, wild and scenic rivers corridors, Primary Forests, wetlands, and riparian zones.

Also, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Potential indirect beneficial effects associated with alternative 2 to these species are related to the focus of this alternative on ecological, social, and economic sustainability. This means that management practices and strategies considering sustainability will create a beneficial indirect effect on the species by sustaining the population in all activities.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that protect the species in El Yunque lands and its surroundings.

Alternative 3

There would be a reduction in protected areas (research natural area), but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive species and non-native species on all El Yunque lands may have direct effects on these species.

Potential beneficial effects may occur from management of the road and trail system to maintenance levels; this would reduce impacts on the species due to human interaction in certain areas where the species is located. The exclusion of the scenic byway management area would diminish the vegetation management effects at the Forest level. The Forest will have fewer activities on the corridor, which would result in fewer management actions that could affect the species in this particular area of the Forest.

Cumulative Effects

The cumulative effects for this alternative are the same as described in alternative 2.

Eugenia haematocarpa—Uvillo

Known habitat is Secondary Montane and Mature Tabonuco Montane vegetation types. See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species.

Alternative 1

This alternative has several management areas that may allow activities that could have direct effects on this species. Timber demonstration, research areas, integrated areas and developed recreation areas all have a potential to directly disturb the vegetation, soil, streams and associated fauna, in these lands. Diversity and forest cover is also expected to be directly impacted by the implementation of projects on these lands, where projects, such as further developing recreational sites or timber demo practices, are conducted where the species is located. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that is very rare and small in number. The NEPA process is expected to occur before any particular project is implemented, and should mitigate direct impacts if properly carried out. This alternative would have management practices for the conservation and recovery of the species that could also assist in protection.

Potential indirect effects to this species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate of vegetation impacted, and continuous human activities on these lands.

Alternative 2

Known habitat is Secondary Montane Forest and Mature Tabonuco Montane vegetation types. See the “Terrestrial Ecosystems” section for a detailed description of these vegetation types. See “At-Risk Flora”, for a detail description of this species.

This alternative has the CIRMA that proposes activities that may have direct impact to this species. These activities may include improving recreation settings and access, improving roads and trails, improving watersheds, and providing forest products. All these actions incorporate vegetation management at some level in their implementation, and there is a high risk of losing populations of the species that are very rare and small in number. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Potential beneficial effects to the populations of this species will be through protection by standards and guidelines and protected designated areas such as wilderness, expanded research natural area, wild and scenic river corridors, Primary Forests, wetlands, and riparian zones.

Also, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Potential indirect beneficial effects associated with alternative 2 to these species are related to the focus of this alternative on ecological, social, and economic sustainability. This means that management practices and strategies considering sustainability will create a beneficial indirect effect on the species.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species at El Yunque lands and its surroundings.

Alternative 3

Known habitat is Secondary Montane Forest and Mature Tabonuco Montane vegetation types. See the “Terrestrial Ecosystems” section for a detail description of these vegetation types. See “At-Risk Flora” for a detailed description of this species.

There would be a reduction in the number of acres of the Research Natural Area and the reduced area will be proposed as wilderness, standards and guidelines for Primary Forest will protect the lands excluded. Increase of invasive species and non-native species management to all El Yunque lands may have direct effects on these species.

Beneficial effects may occur from management of the road and trail system to maintenance levels, because of impacts on the species due to human interaction in certain areas. The exclusion of the Scenic Byway Management Area will reduce the vegetation management effects at the Forest level. The Forest will have fewer activities in the corridor resulting in fewer management actions that could affect the species.

Cumulative Effects

The cumulative effects for this alternative is the same as described in alternative 2.

Ilex obcordata—*Guayabota pequeña*

Known habitat is Mature Tabebuia/Eugenia woodland montane rain cloud forest vegetation type. (Pico El Yunque and Pico de El Este). See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species.

Alternative 1

This alternative recommends the no more development or expansion of communication facilities on El Yunque Peak and East Peak. These management recommendations markedly reduce the potential of direct impact to the species. El Yunque Peak is impacted by a high number of visitations to its featured points (El Yunque Trail, El Yunque Rock, and El Yunque and Mt. Britton Towers).

A potential effect on *Ilex* may be caused under this alternative because recreational development and the increased number of Forest visitors to the area that could trample on the species. The human activity in this area may impact vegetation by trampling, generating trash, and vigilance and maintenance on the various communication sites at Pico El Yunque and recreation points (Mt. Britton Tower).

Cumulative Effects

The most critical cumulative effects to this species and its natural habitat is the accumulation of small spills of oil, gasoline, diesel and fumes as part of the operation of the communication sites and ground maintenance, as well as the maintenance of the access roads and recreation points through time. The high humidity and high rate of precipitation in this unique vegetation type increases the impact to the environment over time.

Alternative 2

Effects are similar to alternative 1, while considering in this alternative the options of dispersing recreation to other areas in CIRMA could potentially reduce the amount of impact on the species in certain locations.

Cumulative Effects

A cumulative effect to this species is related to past projects that have impacted the species through habitat loss by projects such as the communication facilities and infrastructure development in these sites.

Alternative 3

Known habitat is Mature Tabebuia/Eugenia Woodland Montane Rain Cloud Forest vegetation type. (Pico El Yunque and Pico de El Este). See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species.

The effects are the same as described for alternative 2.

Lepanthes eltoroensis

Known habitat is Mature Tabebuia/Eugenia Woodland Montane Wet Cloud Forest. See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species. This vegetation type is located inside the El Toro Wilderness.

Alternative 1

Effects of this alternative to the species is visitation to the area. The trail where the species thrives is the only official access to the wilderness, and because most of the populations of this species are known to occur along the trail, the species is highly exposed to damage by trampling activities and also on some occasion to unauthorized collection of this very rare and endangered orchid.

Beneficial direct effects are associated with the designation of its habitat as part of the El Toro wilderness. Under this designation, the management practices are limited, and therefore this could result in less population loss of the species.

Potential for indirect effects most damaging to this species, such as trampling and unauthorized collections, are related to visitation of the area.

Cumulative Effects

Visitation activities over time may have cumulative detrimental effects to the species.

Alternative 2

Beneficial direct effects are associated with the designation of its habitat as part of the El Toro Wilderness. Under this designation the management practices and strategies (such as collaboration and environmental education) limit impacts and human interaction with the species which could result in less population loss.

The potential for indirect effects is the same as described in alternative 1.

Cumulative Effects

The cumulative effects for this alternative are similar to alternative 1. However, the increase of environmental literacy component and the revision of wilderness management directions of this alternative may reduce effects of visitation and human dynamics. As management direction for the wilderness area is developed, the amount of visitation and type of uses should consider minimal impacts to the species.

Alternative 3

Known habitat is Mature Tabebuia/Eugenia Woodland Montane Wet Cloud Forest. See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. This vegetation type is located inside the El Toro Wilderness. The effects are the same as described for alternative 2.

Direct, Indirect, and Cumulative Effects. Same as alternative 1.

Pleodendron macranthum*—*Chupacallos

Known habitat is Secondary Montane and Mature Tabonuco Montane vegetation types. See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species.

Alternative 1

This alternative has several management areas that would allow activities that may have direct effects on this species. Management areas for timber demonstration, research areas, integrated area and developed recreation areas all have a potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. Although the NEPA process expected to occur before any particular project is implemented should mitigate direct impacts if properly carried out, this alternative would have management practices for the conservation and recovery of the species that would also assist in its protection.

Potential indirect effects to this species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems and recovery rate along time of vegetation impacted.

Alternative 2

This alternative has the CIRMA that proposes activities that may have direct impact to this species. These may include improving recreation settings and access, improving roads and trails, improving watersheds, and providing forest products. All these actions incorporate vegetation management at some level in their implementation. There is a high risk of losing populations of the species that are very rare and small in number. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts if properly carried out, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Potential beneficial effects to the populations of this species will be associated with the protection by guidelines, standards, and protected designated areas like wilderness, expanded research natural area, wild and scenic river corridors, Primary Forests, Wetlands and Riparian zones.

Also, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Indirect beneficial effects associated with alternative 2 to this species are related to the focus of this alternative to ecological, social, and economic sustainability. This means that management practices and strategies considering sustainability will create a beneficial indirect effect on the species.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species on the El Yunque and its surroundings.

Alternative 3

The effects are the same as described for alternative 2.

***Styrax portoricensis* – Palo de Jazmin**

Known habitat is Secondary Montane and Mature Tabonuco Montane vegetation types and Mature Palo Colorado Montane Wet Cloud Forest type. See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species.

Alternative 1

This alternative has several management areas that would allow activities that may have direct effects on this species. Management areas such as timber demonstration, research areas, integrated area and developed recreation areas all have a potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands, through the management practices and activities. Diversity and forest cover is also expected to be directly impacted by the implementation of projects on these lands such as further developing recreational sites or timber demo practices. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. Although the NEPA process expected to occur before any particular project is implemented should mitigate direct impacts if properly carried out, this alternative would have management practices for the conservation and recovery of the species that could also assist in its protection. Part of the population of this species is reported to be inside El Toro Wilderness area, which is expected to be fully protected, but because the small population sizes (sometimes consisting of one or two individuals) in isolated areas of the wilderness, lack of monitoring to determine population conditions puts this species at high risk.

Potential indirect effect to this species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in the management areas outside the wilderness.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on the lands outside the wilderness.

Alternative 2

This alternative has the CIRMA that proposes activities that may have direct impact to this species. These may include improving recreation settings and access, improving roads and trails, improving watersheds, and providing forest products. All these actions incorporate vegetation management at some level in their implementation. There is a high risk of losing populations of the species that are very rare and small in number, if they are located in management areas such as the CIRMA. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Standards and guidelines and protected designated areas such as wilderness, expanded research natural area, wild and scenic river corridors, Primary Forests, wetlands, and riparian zones, would have beneficial direct effects to the populations of this species.

Also, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Indirect beneficial effects associated with alternative 2 to this species are related to the focus of this alternative to ecological, social and economic sustainability. This means that management practices and strategies considering sustainability will create a beneficial indirect effect on the species due to trying to sustain the population in all activities.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species at El Yunque lands and its surroundings.

Alternative 3

The effects are the same as described for alternative 2.

***Ternstroemia luquillensis* – Palo Colorado**

Known habitat is Mature Tabonuco Montane vegetation types, Mature Palo Colorado Montane vegetation types and Mature Tabebuia/Eugenia Woodland Montane Rain Cloud vegetation types. See the 2014 Forest Plan Assessment “Terrestrial Ecosystems” section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment “At-Risk Flora” section for a detailed description of this species.

Alternative 1

This alternative has several management areas that allow activities that may have direct effects on this species. Management areas such as timber demonstration, research areas, integrated area and developed recreation areas all have a potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. Diversity and forest cover is also expected to be directly impacted by the implementation of projects on these lands, where projects such as further developing recreational sites or timber demo practices where the species is located. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, if properly carried out, this alternative has management practices for the conservation and recovery of the species that could also assist in its protection.

Part of the population of this species is reported to be inside El Toro Wilderness area, the research natural area, wild and scenic river corridors and El Yunque Peak, which is expected to be fully protected. However, because of the small population sizes mostly consisting of one or two individuals in isolated areas of designated areas, lack of monitoring to determine population conditions puts this species at high risk.

Potential indirect effect to this species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in the management areas outside the wilderness and the research natural area and other protected areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on the lands outside the wilderness and the research natural area.

Alternative 2

Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts if properly carried out, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection. There is a high risk of losing populations of the species that are very rare and small in number, due to various reasons including the lack of monitoring. Part of the population of this species is reported to be inside El Toro Wilderness area, the research natural area, wild and scenic river corridors, wetlands and El Yunque Peak, which is expected to be fully protected. However, because the small population sizes mostly consisting of one or two individuals in isolated sites of designated areas, lack of monitoring to determine population conditions puts this species at very high risk. This alternative does, however, consider monitoring and collaboration that could help mitigate the effects of the population's conditions.

There are no potential indirect effects to the species with the implementation of this alternative.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species at El Yunque lands and its surroundings.

Alternative 3

The effects are the same as described for alternative 2.

Ternstroemia subsessilis

Known habitat is Mature Palo Colorado Montane vegetation types, Mature Sierra Palm Montane vegetation types and Mature Tabebuia/Eugenia Woodland Montane Rain Cloud vegetation types. See the 2014 Forest Plan Assessment "Terrestrial Ecosystems" section for a detailed description of this vegetation type. See the 2014 Forest Plan Assessment "At-Risk Flora" section for a detailed description of this species.

Alternative 1

This alternative has several management areas that may have direct effects on this species. These include timber demonstration, research areas, wild and scenic rivers, and developed recreation areas; all of which have the potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands.

Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. Part of the population of this species is reported to be inside the research natural area, wild and scenic river corridors, the wetlands and East Peak, which is expected to be fully protected. However, because the small population sizes mostly consisting of one or two individuals in isolated areas of designated areas, lack of monitoring to determine population conditions puts this species at very high risk. This alternative does, however, consider monitoring and collaboration that could help mitigate the effects of the population's conditions.

Indirect effects to this species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in the management areas outside the wilderness and the research natural area.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on the lands outside the wilderness and the research natural area and other protected lands.

Alternative 2

Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection. There is a high risk of losing populations of the species that are very rare and small in number, due to various reasons including the lack of monitoring. Part of the population of this species is reported to be inside El Toro Wilderness area, the research natural area, wild and scenic river corridors, wetlands, and El Yunque Peak, which is expected to be fully protected. However, because the small population sizes mostly consisting of one or two individuals in isolated sites of designated areas, lack of monitoring to determine population conditions puts this species at very high risk.

No indirect effects are expected to occur with the implementation of this alternative.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species at El Yunque lands and its surroundings.

Alternative 3

The effects are the same as described for alternative 2.

3.4.3.6 Flora: Species of Conservation Concern

3.4.3.7 Affected Environment

Using the best available scientific information, species known to occur in the plan area for which there is substantial concern about the species' capability to persist over the long term in the plan area were evaluated. We assume that populations of all the species of conservation concern are stable until we can

gather data to quantify and locate the populations in existence on the El Yunque. This assumption is based on the lack of forest-disturbing activities in the Forest, but we will consider climate change in the analysis. To be classified as “at risk,” a species must have an Extent of Occurrence EOO of <20,000 square kilometers, the threshold for IUCN’s threatened categories. Puerto Rico measures 8,870 square kilometers, therefore all endemic species (229) are technically considered “at risk” (Krupnick et al. 2009; Miller et al. 2012).

A brief description of the ecology and distribution for the potential species of conservation concern for the El Yunque and the environmental effects of the alternatives proposed for the land management plan revision follows.

Table 3- 29. Potential species of conservation concern (flora)

Taxonomic Group	Taxonomic Subgroup	Species	Common Name
Vascular Plant	Fern	<i>Lindsaea stricta</i> var. <i>jamesoniformis</i>	Lindsaea
Vascular Plant	Herb	<i>Pilea multicaulis</i>	P. Multicaulis
Vascular Plant	Herb	<i>Pilea yunquensis</i>	P. Yunquensis (endemic)
Vascular Plant	Orchid	<i>Brachionidium ciliolatum</i>	B. Ciliolatum
Vascular Plant	Orchid	<i>Brachionidium parvum</i>	B. Parvum
Vascular Plant	Orchid	<i>Lepanthes caritensis</i>	Carite babyfoot orchid
Vascular Plant	Orchid	<i>Lepanthes dodiana</i>	Dodiana babyfoot orchid
Vascular Plant	Orchid	<i>Lepanthes selenitepala</i> spp <i>ackermanii</i>	Ackerman babyfoot orchid
Vascular Plant	Orchid	<i>Lepanthes stimsonii</i>	Stimson babyfoot orchid
Vascular Plant	Orchid	<i>Lepanthes veleziana</i>	Velez babyfoot orchid
Vascular Plant	Orchid	<i>Lepanthes woodburyana</i>	Woodbury babyfoot orchid
Vascular Plant	Shrub	<i>Brunfelsia lactea</i>	Jazmin de monte (endemic)
Vascular Plant	Shrub	<i>Brunfelsia portoricensis</i>	Jazmin portoricensis (endemic)
Vascular Plant	Shrub	<i>Marlierea sintenisii</i>	Beruquillo
Vascular Plant	Shrub	<i>Miconia foveolata</i>	Camasey
Vascular Plant	Shrub	<i>Solanum woodbury</i>	Solanum (endemic)
Vascular Plant	Shrub	<i>Urera chorocalpa</i>	Ortiga (endemic)
Vascular Plant	Shrub	<i>Varronia wagnerorum</i>	Varronia (endemic)
Vascular Plant	Shrub/Small tree	<i>Cybianthus sintenisii</i>	Cybianthus (endemic)
Vascular Plant	Shrub/Small tree	<i>Eugenia egersii</i>	Palo de murta (endemic)
Vascular Plant	Shrub/Small tree	<i>Xylosma schwanneckiana</i>	Palo de Candela (endemic)
Vascular Plant	Small tree	<i>Miconia pycnoneura</i>	Camasey
Vascular Plant	Tree	<i>Ardisia luquillensis</i>	Mamayuelo (endemic)
Vascular Plant	Tree	<i>Banara portoricensis</i>	Caracolillo (endemic)
Vascular Plant	Tree	<i>Calyptranthes luquillensis</i>	C. Luquillensis (endemic)
Vascular Plant	Tree	<i>Calyptranthes woodburyi</i>	C. Woodburyi (endemic)
Vascular Plant	Tree	<i>Coccoloba rugosa</i>	Ortegon
Vascular Plant	Tree	<i>Conostegia hotteana</i>	Camasey peludo

Taxonomic Group	Taxonomic Subgroup	Species	Common Name
Vascular Plant	Tree	<i>Laplacea portoricensis</i>	Maricao verde
Vascular Plant	Tree	<i>Magnolia splendens</i>	Laurel sabino (endemic)
Vascular Plant	Tree	<i>Maytenus elongata</i>	Cuero de Sapo
Vascular Plant	Tree	<i>Morella holdrigeana</i>	Palo de cera (endemic)
Vascular Plant	Tree	<i>Psidium sintenisii</i>	Hoja menuda (endemic)
Vascular Plant	Tree	<i>Ravenia urbanii</i>	Tortugo prieto (endemic)
Vascular Plant	Tree	<i>Symplocos lanata</i>	Nispero cimarron (endemic)
Vascular Plant	Tree	<i>Ternstroemia heptasepala</i>	Palo colorado (endemic)
Vascular Plant	Tree	<i>Ternstroemia stahlii</i>	Palo de buey (endemic)
Vascular Plant	Vine	<i>Gonocalix portoricensis</i>	Gonocalyx (endemic)
Vascular Plant	Vine	<i>Mikania pachyphyla</i>	Mikania (endemic)

Orchids

Of the 149 orchid species reported to Puerto Rico, 45 percent are reported as being native to the Luquillo Mountains (Kasomenakis 1988). Seven endemic species and one native are considered at-risk species and have been proposed for further analysis as potential species of conservation concern for the El Yunque National Forest (Table 3- 29). These are small plants that range in size from several millimeters to 14 centimeters tall. They are epiphytic plants found in a variety of environments, from mossy boulders along streams to moss covered tree trunks and branches in Wet Mountain and Wet Mountain Cloud Forest and on sphagnum moss on the peaks forest floor. Two of them *Brachionidium ciliolatum* and *Lepanthes selenitepala* are endemic to the Luquillo Mountains. Some are also present in the Sierra de Cayey and the Cordillera Central (on State Forests), but there is an overall lack of information on the population locations and sizes. The altitudinal ranges goes from 215 meters to 1,300 meters above sea level.

They are mostly threatened by vegetation management affecting forest canopy, road and trail right of way maintenance, hurricane winds, landslides, low population numbers and some unauthorized collecting.

Climate change that affects the humidity required for the different vegetation types where they thrive may impair the moss layers in the different forest compartments where they are present, directly impacting their survival, reproduction, and population sizes.

Alternative 1

This alternative has several management areas that may have direct effects on these species. These include timber demonstration, research areas, integrated area and developed recreation areas, and all have a potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. Diversity and forest cover is also expected to be directly impacted by the implementation of projects on these lands, such as projects which further develop recreational sites or timber demo practices where the species is located. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. The NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts. This alternative would also have management practices for the conservation and recovery of the species that could assist in its protection.

Standards and guidelines and protected designated areas such as wilderness, expanded research natural area, wild and scenic river corridors, Primary Forests, wetlands, and riparian zones, would have beneficial direct effects to the populations of this species.

Indirect effects to these species are associated with the erosion created by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on these lands. The proximity of some of the proposed activities to each other is critical to this type of effects.

Alternative 2

This alternative has the CIRMA that proposes activities that may have direct impact to these species. These may include improving recreation settings and access, improving roads and trails, improving watersheds, and providing forest products. All these actions incorporate vegetation management at some level in their implementation. There is a high risk of losing populations of the species that are reported to be very rare and small in number. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, this alternative also has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Beneficial direct effects to many of the populations of these orchids will be associated with the protection provided by guidelines, standards and protected designated areas like wilderness, expanded research natural area, wild and scenic rivers, Primary Forests, Wetlands and Riparian zones.

In addition, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Indirect beneficial effects associated with alternative 2 to these species are related to the focus of this alternative on ecological, social, and economic sustainability. This means that management practices and strategies considering sustainability will create a beneficial indirect effect on the species.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species on El Yunque National Forest lands and its surroundings.

Alternative 3

There will be a reduction in protected area as research natural area, but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive species and non-native species on all El Yunque lands may have direct effects on these species.

Beneficial effects may occur from management of the road and trail system maintenance levels, considering it would reduce the impacts on the species from human interaction in certain areas where the species is located. The exclusion of the Scenic Byway Management Area will reduce the effects of vegetation management at the Forest level. The Forest will have fewer activities in the corridor, resulting in less management actions that could affect the species in this particular area of the Forest.

Cumulative Effects

The cumulative effects are the same as described in alternative 2.

Vines

There are two vines proposed as species of conservation concern, one (*Gonocalix portoricensis*) is endemic to the El Yunque and restricted to the peaks, and the other is endemic to Puerto Rico (*Mikania pachyphyla*) (Table 3- 29). The latter is present also in the Cordillera Central; its population is estimated at 2,946 individuals, but the population in the El Yunque has not being determined or mapped. *G. portoricensis* population is being estimated to be eight individuals.

They are mostly threatened by vegetation management affecting forest canopy, road and trail right-of-way maintenance, hurricane winds, low population numbers, and landslides.

Climate change that affects the humidity required for the different vegetation types where they thrive may impair its persistence at the El Yunque.

Alternative 1

These species are not expected to be directly affected by this alternative, given the fact that they are reported in areas designated for protection, such as wetlands, Mature Palm Forests and Cloud Rain vegetation types.

These species are not expected to be indirectly affected by this alternative.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices that persist and protect the species in El Yunque lands and its surroundings.

Alternative 2

These species are not expected to be directly affected by this alternative, given the fact that they are reported in areas designated for protection, like Wetlands, Mature Palm Forests and Cloud Rain vegetation types.

These species are not expected to be indirectly affected by this alternative.

Cumulative Effects

The cumulative effect of this alternative will be associated with long-term benefits of management practices and management strategies that persist and protect the species in El Yunque lands and its surroundings.

Alternative 3

There will be a reduction in the protected research natural area, but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive and non-native species on all El Yunque lands may have direct effects on these species.

Beneficial effects may occur from management of the road and trail system maintenance levels, considering it would reduce the impacts on the species due to human interaction in certain areas where the species is located. The exclusion of the Scenic Byway Management Area will reduce the vegetation management effects at the Forest level. The Forest will have fewer activities on the corridor, resulting in fewer management actions that could affect the species in this particular area of the Forest.

Cumulative Effects

The cumulative effects are the same as described for alternative 2.

Shrubs

There are 11 endemic shrub species recommended as potential species of conservation concern on the El Yunque, of which 4 are endemic to the Luquillo Mountains (*Marlierea sintenisii*, *Miconia faveolata*, *Varronia wagnerorum*, and *Solanum woodbury*). There are seven plant families represented in this group (Table 3- 29).

All of these species are reported or estimated to have small populations, making the species vulnerable to any disturbance that may change the vegetation structure of the Forest, its geomorphology, or its landform morphology.

The principal immediate threat to all these species on the El Yunque is the lack of information about their population numbers and location so that we can monitor the effects of stresses such as climate change, hurricane winds, landslides and canopy (structure) changes. Shrubs are part of the ground cover vegetation strata and are a key element in the food web of the Forest.

Alternative 1

This alternative has several management areas that may have direct effects on these species. These include timber demonstration, research areas, integrated area and developed recreation areas, and all have the potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. Diversity and forest cover are also expected to be directly impacted by the implementation of projects on these lands, where projects such as further developing recreational sites or timber demo practices are implemented where the species is located. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. The NEPA process expected to occur before any particular project is implemented should mitigate direct impacts. In addition, this alternative would have management practices for the conservation and recovery of the species that would help protect it.

Standards and guidelines and protected designated areas such as wilderness, expanded research natural area, wild and scenic river corridors, Primary Forests, Wetlands, and Riparian Zones, would have beneficial direct effects to the populations of this species.

Indirect effect to this species are associated with erosion caused by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on these lands. The proximity of some of the proposed projects to each other is critical to these effects.

Alternative 2

This alternative has the CIRMA that proposes activities that may have direct impact to these species. Proposed activities such as improving recreation settings and access, improving roads and trails, improving watersheds, and providing forest products are expected to have direct effects these species. All these actions incorporate vegetation management at some level in their implementation. There is a high risk of losing populations of the species that are very rare and small in number, if they are located in a management areas such as the CIRMA. Although the NEPA process is expected to occur before any particular project is implemented and should mitigate direct impacts, this alternative has management

practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Beneficial direct effects to many of the populations of these shrubs will be associated with the protection provided by guidelines, standards and protected designated areas like wilderness, expanded research natural area, wild and scenic rivers corridors, Primary Forests, Wetlands and Riparian zones.

In addition, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Indirect effects associated with the proposed activities of alternative 2 to these species are soil erosion, soil compaction, vegetation trampling, and vegetation density reduction mostly associated with providing recreation and forest products, although this alternative includes activities such as collaboration, environmental education and other management strategies that could mitigate these indirect effects.

Cumulative Effects

The cumulative effect in this alternative will be associated with the intensity and proximity of the activities implementation. Direct and indirect effects may be compounded if proximity of projects to each other is not considered.

Alternative 3

There will be a reduction in the protected research natural area, but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive species and non-native species on all El Yunque lands may have direct effects on these species.

Beneficial effects may occur from management of the road and trail system maintenance levels, considering it would reduce the impacts on the species due to human interaction in certain areas where the species is located. The exclusion of the Scenic Byway Management Area will reduce the vegetation management effects at the Forest level. The Forest will have fewer activities on the corridor, resulting in fewer management actions that could affect the species in this particular area of the Forest.

Cumulative Effects

The cumulative effects are the same as described for alternative 2.

Trees

There are 15 species in this group recommended for species of conservation concern; 8 endemic, 4 native, and 3 endemic to the El Yunque (*Magnolia splendens*, *Calytrantes luquillensis* and *Ternstroemia heptasepala*) (Table 3- 29). They represent 12 plant families. All of the species listed (except the magnolia) thrive under the dominant canopy of the Forest (they are small trees, 50 feet at the tallest). All of them are reported or estimated to have small populations making them vulnerable to any disturbance that may change the vegetation structure of the Forest, its geomorphology, or its landform morphology.

The principal immediate threat to all these species in the El Yunque is the lack of information about their population numbers and location so that we can monitor the effects of stresses or disturbances as climate change, hurricane winds, landslides and canopy (structure) changes.

***Magnolia splendens* – Laurel Sabino (G3)**

This species is endemic to the Luquillo Mountains and the only known populations are inside the El Yunque. It is native to an area where tree growth is slow, 0.06 inches diameter increase in a period of 5 years from a sample of 46 trees. Most seeds apparently are sterile; this fact greatly limits the future of this

tree. Young trees are being encouraged wherever they appear naturally; its range is between 400 to 850 meters of elevation above sea level. This means that part of the population is expected to be inside the Cloud Forest (Functional Wetland). During the 1930s the use of mature trees for furniture and cabinet making by the Civilian Conservation Corps dramatically reduced the mature population of this species (Little and Wadsworth 1964).

The Department of the Environment and Natural Resources of the Free Associated State of Puerto Rico classifies the species as a “critical element” based on its classification code. It is a species to be monitored to determine its actual present range, population sizes and locations, phenology, and reproduction efforts.

Alternative 1

This alternative has several management areas that may have direct effects on these species. These include timber demonstration, research areas, integrated area and developed recreation areas, and all have the potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. Diversity and forest cover are also expected to be directly impacted by the implementation of projects on these lands, where projects such as further developing recreational sites or timber demo practices occur where the species is located. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. The NEPA process expected to occur before any particular project is implemented should mitigate direct impacts; however, this alternative would have management practices for the conservation and recovery of the species that would also protect it.

Many of the populations of these trees will be protected by guidelines, standards, and protected designated areas like wilderness, research natural area, Wetlands, and Primary Forests.

Potential indirect effect to these species are associated with erosion created by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on these lands. The proximity of some of the proposed projects to each other is critical to this type of effects.

Alternative 2

This alternative has the CIRMA that proposes activities that may have direct impacts on these species. Proposed activities such as improving recreation settings and access, improving roads and trails, improving watersheds, and providing forest products, are expected to have direct effects on this species. All these actions incorporate vegetation management at some level in their implementation. There is a high risk of losing populations of the species that are very rare and small in number if they are located in a management areas such as the CIRMA. The NEPA process expected to occur before any particular project is implemented should mitigate direct impacts; however, this alternative has management practices and strategies (such as collaboration and environmental education) for the conservation and recovery of the species, as well as management strategies that would assist in its protection.

Beneficial direct effects to many of the populations of these trees will be associated with the protection from guidelines, standards, and protected designated areas like wilderness, expanded research natural area, wild and scenic river corridors, Primary Forests, Wetlands, and riparian zones.

In addition, standards and guidelines associated with management of invasive species and climate change will benefit the persistence and/or recovery of these species in the El Yunque ecosystems.

Potential indirect effects to this species associated with the activities of alternative 2 would allow soil erosion, soil compaction, and vegetation trampling and vegetation density reduction mostly associated with providing recreation and forest products, although this alternative includes activities such as collaboration, environmental education and other management strategies that could mitigate these indirect effects.

Cumulative Effects

The cumulative effect in this alternative will be associated with the intensity and proximity of the activities implementation. Direct and indirect effects may be compound if proximity of projects to each other is not considered.

Alternative 3

There will be a reduction in the protected research natural area, but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive species and non-native species on all El Yunque lands may have direct effects on these species.

Beneficial effects may occur from management of the road and trail system maintenance levels; this would reduce the impacts on the species due to human interaction in certain areas where the species is located. The exclusion of the Scenic Byway Management Area will reduce the vegetation management effects at the Forest level. The Forest will have fewer activities on the corridor, resulting in fewer management actions that could affect the species in this particular area of the Forest.

Cumulative Effects

The cumulative effects are the same as described for alternative 2.

Ferns and Herbs

There are three species in this group, one endemic to El Yunque (*Pilea multicaulis*), and three endemic to Puerto Rico (Table 3- 29). Three species are reported to range between 650 and 1,300 meters of elevation above sea level in the Cloud Forest (Functional Wetland). The population in the El Yunque still needs to be assessed. *Lindsaea stricta* var. *jamesoniiformis* is the only fern in this group.

All of these species are reported or estimated to have small population that renders the species vulnerable to any disturbance that may change the vegetation structure of the Forest, its geomorphology, or its landform morphology.

The principal immediate threat to all these species at El Yunque is the lack of information about their population numbers and location to be able to monitor the effects of stresses or disturbances as climate change, hurricane winds, landslides and canopy changes.

Alternative 1

This alternative has several management areas that may have direct effects on these species. These include timber demonstration, research areas, integrated area and developed recreation areas, and all have the potential to directly disturb the vegetation, soil, streams, and associated fauna in these lands. Diversity and forest cover are also expected to be directly impacted by the implementation of projects on these lands, where projects such as further developing recreational sites or timber demo practices occur where the species is located. These management areas and practices resulting from this alternative could result in a high risk of losing populations of the species that are very rare and small in number. The NEPA process expected to occur before any particular project is implemented should mitigate direct impacts; however, this alternative would have management practices for the conservation and recovery of the species that could also help protect them.

Many of the populations of these ferns and herbs will be protected by guidelines, standards, and protected designated areas like wilderness, research natural areas, wild and scenic river corridors and Primary Forests.

Potential indirect effects to this species are associated to erosion created by soil movement, tree felling and extraction, and trampling created by human activities in these management areas.

Cumulative Effects

Cumulative effects are associated with long-term erosion problems, recovery rate over time of vegetation impacted, and continuous human activities over time on these lands. The proximity of some of the proposed projects to each other is critical to these type of effects.

Alternative 2

There will be a reduction in the protected research natural area, but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive species and non-native species on all El Yunque lands may have direct effects on these species.

Potential indirect effects associated with the proposed activities of alternative 2 to these species are soil erosion, soil compaction, vegetation trampling and vegetation density reduction mostly associated with providing recreation and forest products; although this alternative proposes activities such as collaboration, environmental education and other management strategies that could mitigate these indirect effects.

Cumulative Effects

The cumulative effects in this alternative will be associated with the intensity and proximity of the activities implementation. Direct and indirect effects may be compound if proximity of projects to each other is not considered.

Alternative 3

There will be a reduction in the protected research natural area, but standards and guidelines for Primary Forest will protect the lands excluded. Increased management of invasive species and non-native species on all El Yunque lands may have direct effects on these species.

Beneficial effects may occur from management of road and trail system maintenance levels, considering it would reduce the impacts on the species due to human interaction in certain areas where the species is located. The exclusion of the scenic byway management area will reduce the vegetation management effects at the Forest level. The Forest will have fewer activities on the corridor and therefore result in fewer management actions that could affect the species in this particular area of the Forest.

Cumulative Effects

The cumulative effects are the same as described for alternative 2.

3.4.4 Forest Health

Functioning ecological systems that support the diversity of native plants and animals depend on healthy forests to warrant the physical and biotic resources to support these systems. Most of the ecosystems dominated by native species are resistant or resilient to dramatic change caused by abiotic and biotic stressors. Through an adaptive management approach, priorities for management activities can be modified to respond to changing conditions that could affect the functioning ecological systems of the Forest. In El Yunque, the forest types area associated with the elevation and amount of rain they receive,

creating conditions to the define areas of the Forest as wetland and other, as with a mosaic of vegetation species because of previous management practices and disturbances that dominate the lower elevations of the Forest.

3.4.4.1 Affected Environment: Terrestrial Ecosystems–Vegetation

The Plan established the preservation of Primary Forests and the conservation, maintenance, and restoration primarily with native species. The Plantation/Secondary Montane Wet Forest and Plantation/Secondary Submontane Moist Forest will be evaluated in relation to the ecological vegetation composition and ecological functions to monitor its resistant or resilient to dramatic change caused by abiotic and biotic stressors.

3.4.4.2 Environmental Consequences: Terrestrial Ecosystems–Vegetation

Alternative 1

This alternative maintains the management conditions of the 1997 Plan in which the re-construction of trails was considered in areas of Primary Forests. A demonstration project of sustainable timber production was also considered as part of the management strategies for alternative 1. The timber demonstration area considers the removal of up to one-third of the overstory trees. The alternative also considers the application of selective cuttings to benefit trees with greater potential for future growth and value. For alternative 1, the expected direct and indirect effects are minimal because of the standard and guidelines considered for the restoration of the trails and because the timber demonstration project include no Primary Forest and only represents a small part of the Forest (1,167 acres). No alterations of the vegetation diversity are expected from the management applications.

Alternative 2 and 3

These alternatives include the vision of retaining a healthy, accessible, and sustainable forest that integrates multiple uses; provides economic, ecological, and social opportunities; promotes education, environmental justice, cultural and environmental identity, and awareness for the conservation of its natural resources; and for adaptive Forest management that is inclusive and collaborative. The alternatives also identify geographic areas for the El Yunque Region. This approach benefits the evaluation of the terrestrial ecosystem in relation to the vegetation because the geographic areas permit the development of specific desired conditions, objectives, goals, and other plan components conducive to effective planning and management that fit the sub-regional context.

For alternative 2 the Region is divided in three geographic areas providing a watershed management component to the geographic areas that integrate the municipalities of Ceiba and Fajardo. The application of this third geographic area provides an important recognition to the water resources of El Yunque and deals with an integrated watershed management approach that could be applied according to the watershed classification framework. Both alternatives consider the CIRMA that merges segments of the Forest that were considered for timber demonstration, developed recreation and integrated management in the 1997 plan. This consolidation of lands under one management area provide sections of the Forest where an assortment of resource management practices could be applied to encourage tropical forest management initiatives in the broader landscape of El Yunque. The CIRMA management area is at the lower elevation areas of the Forest and it includes areas where plantations for potential timber projects were established in previous management plans. The absence of timber stand improvements in plantations and the impact of natural disturbances have created a mosaic of vegetation in these areas where introduced species, like the mahogany, share the forest composition with native species. The stand dynamic of the these forests is different from other Mature Primary Forests within El Yunque and the succession that these forest stands that follow will create a combination of species that tropical ecologists

have identified as an “emerging forest”. The adaptation and naturalization of introduced and exotic species in these areas added with climate changes and the tension created by external land uses in the periphery of the Forest present conditions that require a special outlook to the forests that compose the CIRMA. The standards and guidelines considered for this management area will diminish any direct or indirect effects.

Cumulative Effects

The alternatives 2 and 3 include the geographic area approaches that provide regional perspective of the vegetation management. These alternatives could represent positive effects for the vegetation of the region as private lands are considered and observed as part of the regional management approach. The CIRMA provides opportunities for forest product utilization strategies that are applied in other tropical forests that can be coordinated with community groups and residents. The application of agroforestry initiatives and analog forestry practices could represent restoration initiatives with potential economic revenues. The demonstration and application of these practices could be reproduced in other areas promoting the extension of the forest coverage in the region.

3.4.4.3 Affected Environment: Insects and Diseases

This section examines the potential threats to forest health and those that might require active prevention, suppression, or monitoring efforts, as well as strategies in each of the three alternatives for achieving healthy forests.

Alternative 1 maintains a timber demonstration area that used a reduced area of the Forest for the silvicultural practices associated for the project. Alternatives 2 and 3 do not consider a timber demonstration project, but include the CIRMA located at the lower elevation areas of the Forest and adjacent areas where plantations for potential timber projects were established in previous management plans. In this management area, an assortment of resource management practices could be applied to encourage tropical forest management initiatives in the broader landscape of El Yunque.

The considered actions and standards and guidelines defined for the CIRMA are expected to improve the native species diversity and the resilience of the area to potential stressors such as diseases, insect outbreaks and responses to natural disturbances. Some of the specifications for this area include

- Maintain trees and vegetation on the stream bank except at designated crossings or for ecological or stream restoration.
- Conduct enrichment planting strategies in the riparian zone with native species.
- Retain stumps, standing snags, den trees, and coarse woody debris. Exceptions may be made where necessary to control insects or disease outbreaks or to provide public and employee safety.
- Forest products projects should maintain forest canopy coverage of areas that prevent canopy openings larger than 0.1 acre of the prevailing coverage to permit the retention of trees which are not yet mature.

The rapid growth rate of some tropical trees species, as well as the fact that the growth is continuous over much of the year, allow trees to outgrow the attack from most leaf-feeding insects (Hodges and McFadden 1987). Insects also have beneficial roles in the Forest such as the process of pollination and seed dispersal. Some birds and fishes rely on insects for their nutrition. Drewry (1970) published a list of 1,200 insects collected at El Verde, and were deposited in the collection at El Verde Field Station.

The literature did not account for major harmful effects from insects in El Yunque National Forest. Studies for some species like *Heliconia caribaea* (Richardson and Hull 2000) and in Bromeliads

(Richardson 1999) show a high diversity of ecosystems at different scales of the Forest that are important to the insect fauna of the Forest.

The Forest Service conducts communication efforts and participates in interagency groups that focus on monitoring and identification of insect outbreaks in Puerto Rico. The USDA Animal and Plant Health Inspection Service (APHIS), the Department of Agriculture of Puerto Rico, the Department of Natural and Environmental Resources, the Agricultural Experimental Station of the University of Puerto Rico, the U.S. Fish and Wildlife Service and the Forest Service integrate a working group for the reported cases of *Hypogeococcus pungens*; an insect, native to South America, that attacks the cactus of the Island. Similar approaches were done for the pink hibiscus mealybug (*Maconellicoccus hirsutus*) that attacks more than 200 plant species, including agricultural value species. This bug has been controlled with biological controls and no major problems have been reported in the Forest from this insect. The red palm mite (*Raoiella indica* Hirst), a pest of several important ornamental and fruit-producing palm species, has invaded the Western Hemisphere and is in the process of colonizing islands in the Caribbean, as well as other areas on the mainland. In November 2006, this pest was found in Puerto Rico, but it has not been reported in El Yunque. The Tebebuia trees through the Island have been observed with dramatically deformed foliage. The deformations were produced by the thrips named *Holopothrips tabebuiae* and it was reported in Puerto Rico in 2007. Within 6 months of its discovery in Puerto Rico virtually every *Tabebuia heterophylla*, commonly called the robe rosado, was infested and displaying the symptoms of crinkled leaves, deformed by the feeding thrips. Other species of *Tabebuia* are also infested, but at much lower rates. The thrips and its damage are still common, but the thrips does not appear to have impacted the populations of *Tabebuia heterophylla* in Puerto Rico.

Alternatives 1, 2, and 3

The considered management applications for the three alternatives maintain a monitoring protocol and the collaborative initiatives with agencies that observe insect and diseases outbreaks in Puerto Rico. No direct or indirect effects are expected, and the preferred alternative (alternative 2) includes the management practices as well as the standards and guidelines to improve the native species diversity and the resilience of the area to potential stressors such as diseases, insect outbreaks and responses to natural disturbances.

Alternatives 2 and 3 include the geographic areas for the El Yunque Forest region and this perspective of the “all-lands” approach should benefit the monitoring strategies as well as the participation of organizations and interest groups that could help in the identification of changes in species conditions that could be associated with insect and diseases outbreaks.

3.4.4.4 Affected Environment: Non-native Fauna and Diseases

Terrestrial species such as mongoose (*Herpestes auro punctatus*), black rats (*Rattus rattus*), feral dogs (*Canis familiaris*) and cats (*Felis catus*) are reported in the 2014 Forest Plan Assessment. These species can affect niche availability and individual behavior of native and endemic species. Some of these species are associated with recreational areas because of the availability of food leftovers. The wild and scenic rivers management area are maintained in all the considered alternatives and the trapping and removal of feral dogs, cats, and mongoose is considered as part of the standard and guidelines management applications.

The chytrid fungus (*Batrachochytrium dendrobatis*) was identified in Puerto Rico since the mid-1970s (Longo et al. 2010). The fungus has affected populations of endemic coquis (tree frogs) species and scientists believe that it can be exacerbated by climate change. The considered alternatives are not expected to promote the fungus conditions in the native and endemic fauna that could be affected.

3.4.4.5 Environmental Consequences: Non-native Fauna and Diseases

Alternatives 1, 2 and 3

Alternative 1 considers the development of recreational areas that could have indirect effects in the presence of some of the non-native fauna identified as undesirable in the natural environment of the Forest. Alternatives 2 and 3 consider the use of the lower elevations and the spaces with potential use in the CIRMA to disperse recreational activities and reduce pressure in some of the current recreational areas. This action could produce some indirect effects in relation to the presence of non-native fauna species in the CIRMA, but could also produce a positive direct effect if the non-native fauna populations decrease in the higher elevation zones of the Forest.

Alternatives 2 and 3 include the geographic areas for the forest region and the participation of organizations and interest groups that could help in the control strategies and in the outreach process to reduce the behavior of visitors that could increase the populations of non-native fauna that could affect the forest environment. The effects to public health and ecological dynamics of feral dogs, cats, and mongoose are expected to be locally controlled with the trap and removal standard and guidelines applications.

3.4.4.6 Affected Environment: Non-native Plant Species

Since the 1930s planted areas with non-native species, mainly mahogany were established within the Forest. In 1963 the practice of line planting of mahogany was applied until the late 1980s (Weaver 2012). Most of the planted areas are located under the 600-meters elevation mark but some were planted over that elevation mark. The absence of silvicultural management on the planted areas opened the opportunity for the establishment of a rich understory of native species. In these areas of the Forest there has been no account or report of changes or alterations of the ecosystem functions and conditions.

3.4.4.7 Environmental Consequences: Non-native Plant Species

Alternatives 1, 2 and 3

Alternative 1 includes the timber demonstration area where these areas will be managed to maintain the composition of timber species, mainly mahogany. Alternatives 2 and 3 consider the use of the lower elevations of the CIRMA to develop projects that encourage forest management initiatives that could be applied to tropical forests. This action could produce some indirect effects in relation to the presence of non-native plant species in the CIRMA, but the products can be used to promote local businesses. The standard and guidelines considered establish specific conditions to assure the ecosystems functions and the application of practices that benefit the native species, such as:

- Conduct enrichment planting strategies in the riparian zone with native species, and
- Do not remove trees and vegetation on the stream bank except at designated crossings or for ecological or stream restoration. Forest products projects should maintain forest canopy coverage of the areas prevent canopy openings larger than 0.1 acre of the prevailing coverage to permit the retention of trees which are not yet mature.

3.4.4.8 Affected Environment: Non-native Invasive Aquatic Species

The aquatic ecosystems of the Forest were defined by two elements in the 2014 Forest Plan Assessment:

- Defined in relation to the type of stream and rivers that occurs in the planning area, and
- Defined by the composition and structure of the aquatic faunal communities that persists in the Forest streams.

None of the aquatic species identified are classified as federally listed aquatic species. Standards and guidelines have been promulgated for healthy native wildlife and aquatic species population.

3.5 Economic and Social Environment

3.5.1 Socioeconomics

3.5.1.1 Affected Environment

Humans have long-standing and complex ties to El Yunque. The human uses, values, interactions, and impacts associated with the Forest have shifted over time. Historically, the area now encompassed by El Yunque was a place of sacred and supernatural experience revered by the Taínos and other pre-Colombian inhabitants. Through the process of European colonization and early association with the United States, the Forest increasingly came to be seen through a utilitarian lens as a source of timber and later, charcoal, water, and recreation (Domínguez Cristóbal 1997a, 1997b; Robinson 1997). Today, people view the Forest as a place of profound ecological, social, economic, historical, and cultural importance, and associate it with a wide range of benefits and services for local communities and society at large.

It is important to understand the socioeconomic conditions and trends in and around the Forest and how they might be affected by Forest management decisions, particularly as neighboring and nearby communities often have strong ties to public lands and are those most likely to be affected by changes in management direction and use. In this section, we provide information on the socioeconomic environment surrounding El Yunque and analyze the potential effects of the three proposed alternatives on local communities, the broader region within which it is situated, and society at large. Consistent with the 2014 Forest Plan Assessment and other planning documents, nine municipalities comprise the socioeconomic environment described in this section: Canóvanas, Ceiba, Fajardo, Juncos, Las Piedras, Luquillo, Naguabo, Humacao and Río Grande (also referred to here as the El Yunque Region or the region) (Map 1-1). These municipalities and the communities therein have longstanding social and economic ties to the Forest and the goods and services that it protects and provides.

Below, we describe the current conditions and trends related to the socioeconomic environment in the area surrounding El Yunque (i.e., affected environment), including population dynamics, human health and well-being, economic diversity, and other socioeconomic factors. This information provides a baseline against which the potential consequences of alternative management scenarios can be measured. Then, we describe the economic implications of plan alternatives taking into account potential changes in budget expenditures associated with management actions on the Forest, as well as potential changes in collaboration and partnerships associated with new and modified management strategies. We then discuss the social implications of management actions and strategies, focusing on communities of place (i.e., defined by geographic or political boundaries) and interest (e.g., stakeholder or interest groups). Information is analyzed at multiple levels (e.g., community, municipal, regional) to provide for a better understanding of existing and potential intraregional differences and nuances. Future projections are largely based on qualitative analysis carried out by a multi-disciplinary team of scientists and practitioners.

The nine municipalities surrounding the El Yunque extend over 336 square miles (about 10 percent of Puerto Rico's total area) (Table 3-30). They encompass coastline, plains, hills, and mountains within a complex matrix of land cover and use (Gould et al. 2012). El Yunque accounts for 13 percent of their total combined area. Eight municipalities have some of their land base within the boundaries of the El Yunque, ranging from less than 1 percent of the total area of Juncos to more than 33 percent of Río Grande).

Humacao is the only municipality in the El Yunque Region with no land falling within the national Forest boundary.

Table 3-30. Total area and national forest area in the El Yunque Region

Municipality	Total Area (square miles)	Total Area (acres)	NF Area (square miles)	NF Area (acres)	% NF Acreage
Canóvanas	33.00	21,121	3.19	2,042	9.7
Ceiba	29.26	18,729	3.34	2,135	11.5
Fajardo	30.23	19,348	0.95	608	3.2
Humacao	44.75	28,640	0	0	0
Juncos	26.59	17,017	0.03	21	0.1
Las Piedras	33.89	21,692	1.98	1,268	5.8
Luquillo	25.79	16,503	5.62	3,599	21.6
Naguabo	51.78	33,141	8.38	5,360	16.1
Río Grande	60.85	38,943	20.26	12,969	33.2
Region	336.14	215,134	43.75	28,002	13.0
Puerto Rico	3,515	2,249,600	43.75	28,002	1.2

Population Trends

Information on population and other demographic conditions and trends is fundamental to sound resource management, particularly in terms of understanding and managing human-environment interactions. Nearly 330,000 people lived in the nine municipalities comprising the El Yunque Region in 2014 (U.S. Census Bureau 2015) (Table 3-31). Humacao had the largest population (57,181), followed by Río Grande and Canóvanas (52,668; 47,457, respectively); while Ceiba and Luquillo had the smallest populations (12,607; 19,338, respectively). The area surrounding El Yunque accommodated a growing population and an increasing percent of Puerto Rico's total population through the early 2000s. However, the total number of inhabitants in the region is estimated to have declined since about 2010, decreasing by 2.35 percent between 2010 and 2014 (-0.59 percent per year) (U.S. Census Bureau 2015) (Figure 3-7). During this period, Naguabo was the only municipality in the area that continued to see an estimated increase in population (0.16 percent per year), while Las Piedras showed no measurable change in its population and the other seven municipalities saw population declines. Fajardo and Ceiba demonstrated the highest rates of population loss between 2010 and 2014 (-1.99, -1.88 percent per year, respectively). These losses continued a downward trend experienced in the two municipalities beginning in the mid-2000s, attributed in part to the closure of Roosevelt Roads Naval Base in 2004, which led to the relocation of thousands of military members and their families to other bases around the world.

Puerto Rico as a whole has seen significant changes in the size of its population since the early 2000s (i.e., 2000–2010: -0.22 percent per year; 2010–2014: -1.19 percent per year) (U.S. Census Bureau 2015), demonstrating the greatest exodus of people since the “Great Migration” of Puerto Ricans to mainland U.S. following World War II (Cohn et al. 2014). Population loss across Puerto Rico, including the El Yunque Region, is projected to persist and perhaps increase with continued outmigration (e.g., 2015–2025 projected at -6.9 percent (Banco Popular de Puerto Rico 2013) and an overall decline in birth rates (e.g., 2000: 15.2, 2013: 10.1 live births per 1,000 persons) (CDCP 2002, 2015)).

Table 3-31. Total population and population change in the municipalities in the El Yunque Region and Puerto Rico, 1970–2014, select years

Area	Population (average annual change)					
	1970	1980	1990	2000	2010	2014
Canóvanas	-	31,880 (-)	36,816 (1.55%)	43,335 (1.77%)	47,648 (0.99%)	47,648 (-0.04%)
Ceiba	10,312	14,944 (4.49%)	17,145 (1.47%)	18,004 (0.50%)	13,631 (-2.43%)	12,607 (-0.75%)
Fajardo	23,032	32,087 (3.93%)	36,882 (1.49%)	40,712 (1.04%)	36,993 (-0.91%)	34,049 (-0.80%)
Humacao	36,023	46,134 (2.81%)	55,203 (1.97%)	59,035 (0.69%)	58,466 (-0.10%)	57,181 (-0.55%)
Juncos	21,814	25,397 (1.64%)	30,612 (2.05%)	36,452 (1.91%)	40,290 (1.05%)	40,102 (-0.47%)
Las Piedras	18,112	22,412 (2.37%)	27,896 (2.45%)	34,485 (2.36%)	38,675 (1.22%)	38,671 (0.00%)
Luquillo	10,390	14,895 (4.34%)	18,100 (2.15%)	19,817 (0.95%)	20,068 (0.13%)	19,338 (-0.91%)
Naguabo	17,996	20,617 (1.46%)	22,620 (0.97%)	23,753 (0.50%)	26,720 (1.25%)	26,886 (0.16%)
Río Grande	22,032	34,283 (5.56%)	45,648 (3.32%)	52,362 (1.47%)	54,304 (0.37%)	52,668 (-0.75%)
Region	-	242,649 (-)	290,922 (2.00%)	327,955 (1.41%)	336,795 (0.35%)	328,959 (-0.59%)
% Puerto Rico	-	6.15%	6.69%	8.61%	9.04%	9.27%
Puerto Rico	2,712,033	3,196,520 (7.59%)	3,522,037 (8.26%)	3,808,610 (7.52%)	3,725,789 (-2.22%)	3,548,397 (-4.76%)

Source: U.S. Census Bureau, American Fact Finder 2015.

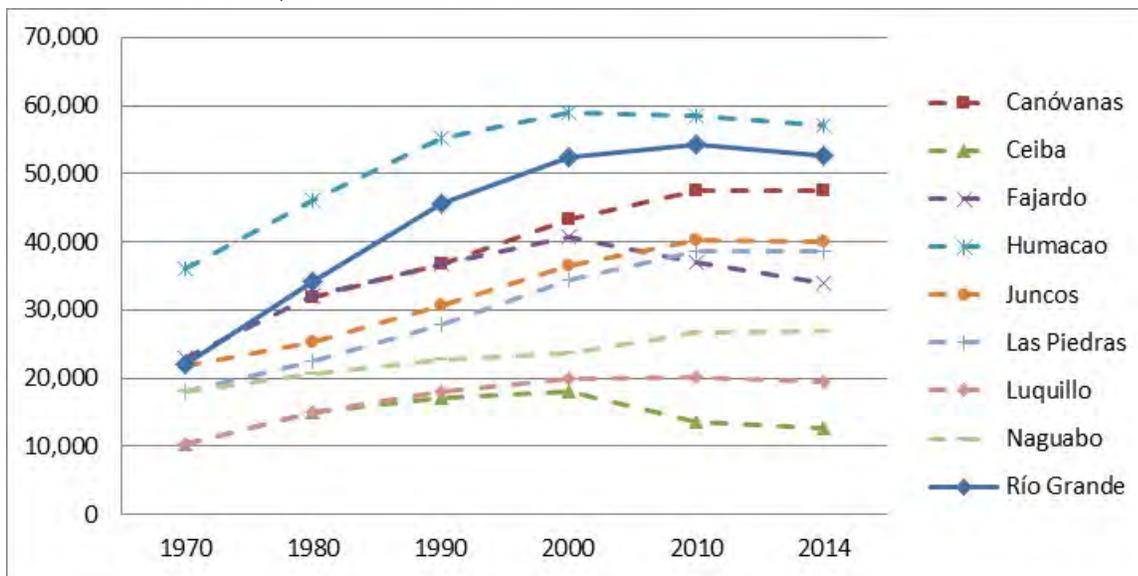


Figure 3-7. Total population in the municipalities surrounding the El Yunque, 1970 to 2014, select years

Data source: U.S. Census Bureau, American Fact Finder (2015).

Population Density

There were about 979 persons per square mile in the El Yunque Region in 2014, which was slightly less than the population density Islandwide (1,009 persons per square mile) (U.S. Census Bureau) (Table 3-32). Population densities within the region have increased since 1970, though growth peaked in the early 2000s, following the total population trend. Intra-regionally, there was considerable variation in population densities at the municipal level, ranging from 431 persons per square mile in Ceiba to 1,508 persons per square mile in Juncos. Notably, Ceiba's population density in 2010, while the lowest in the region, still ranked higher than 93 percent of all counties in the U.S. Additionally, Puerto Rico's population density in 2010 was second only to New Jersey (1,196 persons per square mile) and places Puerto Rico among the most densely populated countries in the world (UN 2013).

Table 3-32. Population density in the El Yunque Region and Puerto Rico, 1970–2014, select years

Geographic Area	Population Density persons/mi ²					
	1970	1980	1990	2000	2010	2014
Canóvanas	-	966.1	1,122.4	1,321.2	1,449.8	1,438.1
Ceiba	381.9	553.5	591.2	620.8	469.5	430.9
Fajardo	743.0	1,002.7	1,233.5	1,361.6	1,238.7	1,126.3
Humacao						1,277.8
Juncos	839.0	940.6	1,150.8	1,370.4	1,521.0	1,508.2
Las Piedras	548.8	659.2	822.9	1,017.3	1,141.5	1,141.1
Luquillo	399.6	572.9	704.3	771.1	777.5	7,49.8
Naguabo	346.1	396.5	437.5	459.4	517.2	519.2
Río Grande	361.2	553.0	752.0	862.6	895.8	865.5
El Yunque Region	-	674.6	809.2	923.1	955.4	978.64
Puerto Rico	792.3	924.4	1,027.9	1,112.0	1,088.2	1,009.5

Urban/rural Population¹

Population growth in the region surrounding El Yunque throughout much of the 20th Century, led to extensive expansion in housing, infrastructure, and other built-up areas, and ultimately, more than 95 percent of the population being classified as urban by the U.S. Census Bureau in 2010, ranging from 88 percent in Ceiba to 98 percent in Fajardo (Table 3-33). As recently as the 1970s, more than 60 percent of the area's population was classified as rural (U.S. Census Bureau 2015). Since then, the area has steadily shifted from a rural to an urban dominated population as the density of residents and residential, commercial, and other developed areas have increased. Only Ceiba has seen a recent decline in the percent of its population that is classified as urban, which is attributable in large part to the marked decline in its total population since the early 2000s (Table 3-33; Figure 3-7). Similar trends may be seen in much of the region, as people continue to leave the Island from both urban and rural areas and as population totals continue to decline. Nevertheless, given the density of housing, infrastructure, and other built up areas, and the persisting high density of inhabitants, the population surrounding El Yunque is likely to remain highly urbanized into the foreseeable future.

¹ In the remainder of this section, data is provided for the eight municipalities directly bordering El Yunque, following the analysis conducted for the Forest Assessment. Humacao was not analyzed in the Assessment and therefore is not included in the remaining data presented here.

Table 3-33. Population classified as urban by the U.S. Census Bureau in the region surrounding the El Yunque National Forest, select years 1970 to 2010

Jurisdiction	Urban Population as Percent of Total Population				
	1970	1980	1990	2000	2010
Canóvanas	*	61.3	69.1	97.3	97.7
Ceiba	28.6	60.9	78.7	92.7	88.2
Fajardo	79.2	83.9	85.8	97.8	97.9
Juncos	36.6	72.7	81.4	98.5	96.8
Las Piedras	25.6	27.0	58.6	93.1	97.6
Luquillo	0.0	30.4	47.9	93.9	91.6
Naguabo	25.7	20.1	27.6	91.1	90.6
Río Grande	31.8	56.2	55.3	95.6	97.4
Region	36.7	55.0	64.5	95.6	96.0
Puerto Rico	58.1	66.8	71.2	94.4	93.4

* Canóvanas was legally designated as a municipality in September 1970, after the decennial census was conducted. Therefore, the regional data point does not include Canóvanas in the 1970 data point.

Source: U.S. Census Bureau, American Factfinder 2015.

Urbanization can result in increased job opportunities and better health care options as compared to rural areas, but also often implies increased demands and impacts on natural resources and services (McKinney 2002). Increases in housing, infrastructure, and other built-up areas has directly impacted forest cover in the region through its removal, affecting forest processes through fragmentation of the landscape, disruption of hydrological systems, introduction of nonnative species, and interruption of nutrient cycles, for example, which collectively result in changes in the benefits and services that a forest provides (Lugo et al. 2004). The impacts of urbanization are further compounded in the context of global climate change, particularly in places like Puerto Rico, where human resources and capital infrastructure to address such problems are limited. For example, as projected sea level rise leads to a loss of land and infrastructure, there is potential for inland and upland migrations of populations, resulting in more intensive and extensive urban development closer to the Forest edge (Lewsey et al. 2004; Kelman and West 2009). Indirectly, increases in population density and urbanization can lead to impoverishments in the quality of recreational and other human interactions with nature due to the loss of open spaces, natural scenery, recreational sites, and other resources (Lugo et al. 2004). And while the population in Puerto Rico in general and around El Yunque in particular, has recently begun to decrease, high rates of population density and development persist, with ongoing implications for the Forest, its management, and its interconnections with other natural or vegetated areas within the broader landscape.

Age and Gender

The median age of the regional population has been increasing slowly over the past several decades, ranging from 34.3 to 37.7 years in 2014 (Naguabo, Ceiba, respectively) (U.S. Census Bureau 2015). Except for Fajardo and Ceiba, the municipalities surrounding the El Yunque have slightly younger populations than the United States and Puerto Rico as a whole (i.e., 36.8, 36.9 years, respectively). The municipalities to the south of the Forest (Naguabo, Las Piedras, Juncos) had the youngest populations in the region in terms of the median age of their inhabitants, followed by the municipalities to the north (Canóvanas, Río Grande, Luquillo), and those to the east (Fajardo, Ceiba). Females represent slightly more of the regional population than males (52 versus 48 percent, respectively) (Figure 3-8). When age is considered, females account for 50.5 percent and males for 49.5 percent of the population aged 44 years and less, but in the population aged 45 years and older, females account for 54.3 percent of the total.

While the population surrounding El Yunque has aged slowly but steadily in recent decades, the age structure of the regional population has changed quite dramatically in recent years (Figure 3-8). Through the end of the 20th Century, the municipalities surrounding the Forest demonstrated a pyramidal age structure, which is associated with moderate population growth (i.e., proportionally more of the population is found in the younger age groups). By 2014, the age structure shifted to a more conical shape, with a smaller proportion of children (less than 18 years of age) and a greater proportion of individuals aged 40 years or more in the population. This shift is indicative of very limited to no population growth as the proportion of individuals in each age group falls within a small range of variation. Canóvanas and Fajardo saw some of the most pronounced changes in population structure during this time as the proportion of individuals in older age groups expanded and younger age groups retracted (McGinley 2016).

As the population around the Forest continues to shift in terms of number, age structure, and gender distribution, as predicted in the near term at least, changes are likely to occur in individual and community values, uses, needs, and demands on public lands. For example, in general, the emigrants leaving Puerto Rico in recent years are younger on average than those who remain in Puerto Rico, but have similar or slightly lower levels of educational attainment as the Islandwide population (refuting reports of a perceived “brain drain” [i.e., increasing out-migration of the most educated and trained professionals] in Puerto Rico) (Birston and Meléndez 2015; Duany 2015). This leaves behind a growing segment of the population over 45 years of age. The already perceptible shifts in the region’s population and age structure, which are likely to be exacerbated by increasing emigration, will bring with them changes in the needs and demands for health care, education, recreation, and other resources and amenities that directly and indirectly influence the Forest and its planning and management, including new and different opportunities for Forest use and interaction.

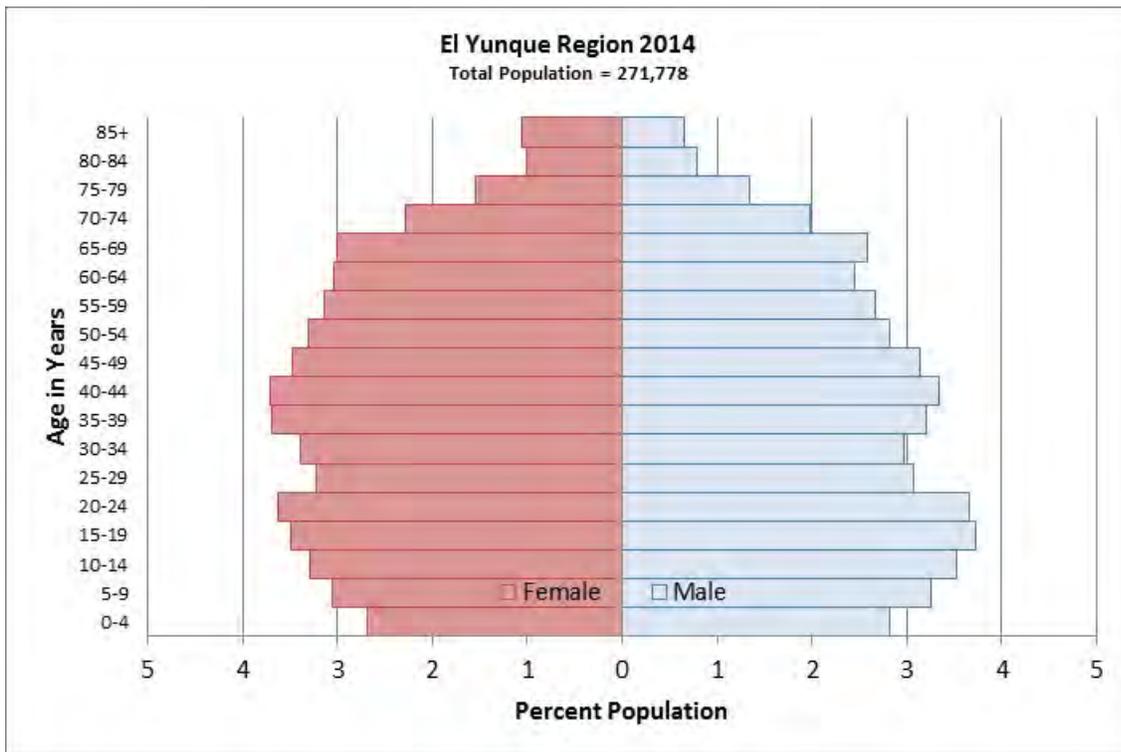
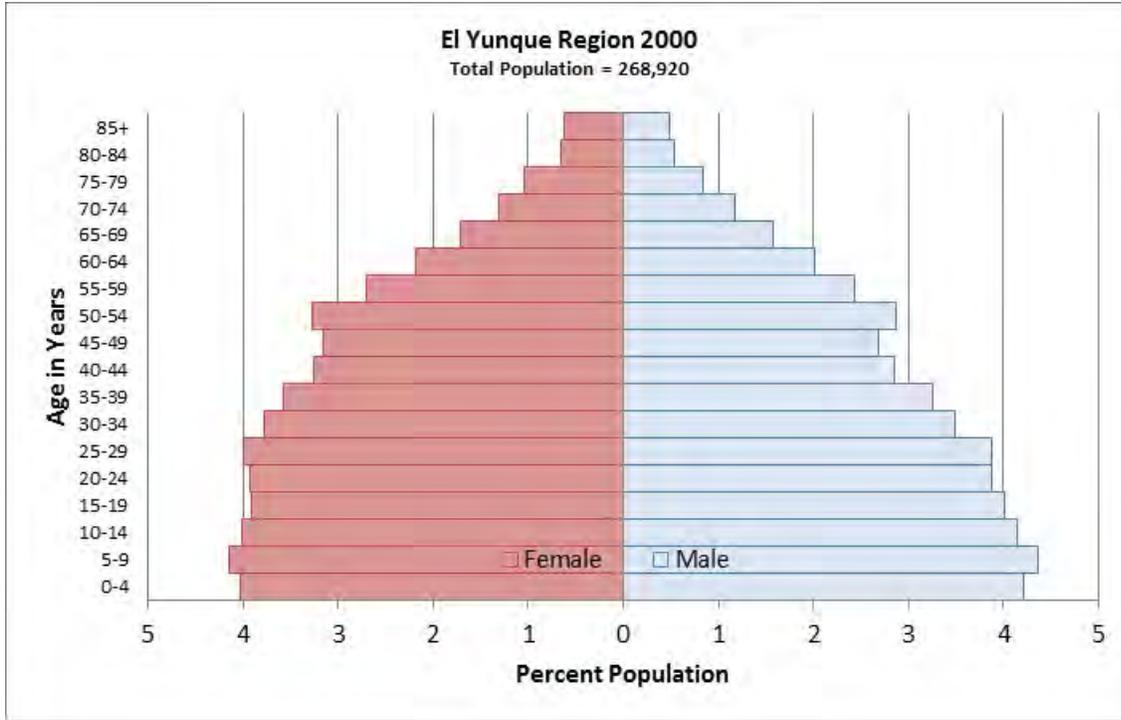


Figure 3-8. Total population of the El Yunque Region in 2000 and 2014 by age and gender

Data Source: U.S. Census Bureau, American Factfinder (2015).

Education

In 2010, 69 percent of the adult population (25 years or older) in the area had finished high school (69 percent) and about 19 percent had completed a bachelor's degree or higher (19 percent) (Table 3-34). Educational attainment in the region is slightly less than Islandwide rates, and lower than the mainland U.S. rates (high school or higher: 87.1; bachelor's or higher: 29.9). Within the region, Fajardo and Ceiba were the most educated in terms of adults with high school and college education, while Naguabo and Las Piedras had the lowest percent of their adult populations having earned a high school and bachelor's degree. The number and percent of the population with high school and college education increased significantly throughout the region from 1990 to 2010. Given Islandwide trends, the region is expected to continue to see slow but steady increases in overall educational attainment, despite declines in total population (Birston and Meléndez 2015; Duany 2015).

Table 3-34. Educational level of the population aged 25 years or more in the region surrounding the El Yunque National Forest and Puerto Rico, 1990, 2000, and 2010

	Total Population > 25 years			Percent of Population > 25 years					
				High School Graduate or Higher			Bachelor's Degree or Higher		
	1990	2000	2010	1990	2000	2010	1990	2000	2010
Canóvanas	19,629	24,911	29,770	44.2	54.9	69.3	8.2	10.9	18.7
Ceiba	9,136	10,733	9,158	60.3	66.0	70.7	10.2	16.3	22.0
Fajardo	20,668	25,203	24,231	51.3	63.2	72.6	11.7	16.2	21.5
Juncos	16,855	21,627	25,513	40.7	56.0	70.0	8.3	13.2	19.1
Las Piedras	15,121	20,324	24,916	43.8	57.0	68.2	8.7	13.1	18.2
Luquillo	9,933	11,858	13,008	50.6	59.8	70.8	11.4	17.6	17.6
Naguabo	12,326	14,120	16,840	40.5	51.9	65.7	8.4	12.3	17.6
Río Grande	24,522	31,032	35,204	47.9	59.5	70.6	11.9	13.6	19.6
Region	130,180	159,808	178,640	46.1	57.9	69.7	9.8	14.2	19.3
Puerto Rico	1,952,297	2,288,326	2,438,057	49.7	60.0	68.6	14.3	18.3	22.0

Source: (1990) Oficina del Censo, Junta de Planificación de Puerto Rico 2015; (2000, 2010) U.S. Census Bureau, American Factfinder (2015).

Income and Poverty

Personal and family income are key indicators of the overall economic conditions or well-being of a community and are important considerations in public land management decisions, particularly where these decisions may affect income opportunities. Per capita income in the municipalities surrounding the El Yunque was \$9,451 in 2010, which was slightly less than that of Puerto Rico as a whole (\$10,355) (Table 3-35). There were fairly sizable intraregional differences in income, ranging from a per capita income of \$7,548 in Naguabo to \$10,409 in Río Grande, and a median family income of \$18,109 in Naguabo to \$24,160 in Río Grande. Overall, the municipalities in the northern part of the region (Río Grande, Canóvanas, and Luquillo) had higher median family and per capita income in 2010, followed by those in the East (Fajardo and Ceiba), while the municipalities in the southern part of the study area (Naguabo, Las Piedras, Juncos) exhibited comparatively lower income levels.

Table 3-35. Per capita and median family income in current dollars (not adjusted for inflation) of Puerto Rico and the municipalities surrounding the El Yunque National Forest, select years 1970 to 2010

	1970	1980	1990	2000	2010
Per Capita Income					
Canóvanas	*	\$1,650	\$3,303	\$5,917	\$9,852
Ceiba	\$1,233	\$2,817	\$5,119	\$9,256	\$9,658
Fajardo	\$1,160	\$1,925	\$4,148	\$7,852	\$9,949
Juncos	\$801	\$1,623	\$3,388	\$6,369	\$8,968
Las Piedras	\$714	\$1,627	\$3,965	\$6,427	\$9,078
Luquillo	\$861	\$1,633	\$3,795	\$7,529	\$10,506
Naguabo	\$768	\$1,581	\$3,221	\$6,960	\$7,548
Río Grande	\$754	\$1,772	\$3,529	\$7,347	\$10,049
Puerto Rico	\$981	\$2,126	\$4,177	\$8,185	\$10,355
Median Family Income					
Canóvanas	*	\$5,431	\$9,499	\$15,033	\$24,122
Ceiba	\$3,947	\$7,355	\$13,159	\$18,851	\$22,768
Fajardo	\$3,574	\$5,381	\$10,843	\$18,387	\$22,095
Juncos	\$2,842	\$5,073	\$9,144	\$14,672	\$20,282
Las Piedras	\$2,691	\$5,339	\$10,251	\$16,408	\$20,931
Luquillo	\$3,039	\$5,296	\$10,264	\$15,203	\$22,866
Naguabo	\$2,350	\$4,725	\$8,795	\$12,957	\$18,109
Río Grande	\$2,793	\$5,980	\$10,795	\$17,033	\$24,160
Puerto Rico	\$3,063	\$5,923	\$9,988	\$16,543	\$21,764

* Canóvanas was legally designated as a municipality in September 1970, after the decennial census was conducted.

Source: (1970-1990) Oficina del Censo, Junta de Planificación de Puerto Rico 2015; (2000, 2010) U.S. Census Bureau, American Factfinder (2015).

Per capita and median family incomes in current dollars (value at the time earned/received) have increased across Puerto Rico and within the study area for several decades. However, to accurately compare income over time, summary measures (medians, means, etc.) should be adjusted to account for changes in the cost of living (i.e., inflation) (U.S. Census Bureau 2013). When adjusted for inflation, income across Puerto Rico and within the area around El Yunque have only modestly increased since 1970 (0.66 percent per year and 0.71 percent per year from 1970 to 2010, respectively) (Figure 3-9). Within the study area, Río Grande experienced the greatest average annual increase in real median family income at a rate of 1.35 percent per year over inflation from 1970 to 2010. Ceiba demonstrated the lowest growth rate in real median family income at 0.07 percent per year during this 40-year time period. Ultimately, while median family and per capita income have increased in the study area and across Puerto Rico over the past several decades, they have only modestly outpaced the rate of inflation. This slow growth in personal and family income is in large part a reflection of the sluggish Puerto Rican economy that has struggled for decades under mounting government debt and the high costs of doing business on the Island (Cohn et al. 2014; Federal Reserve Bank of New York 2012).

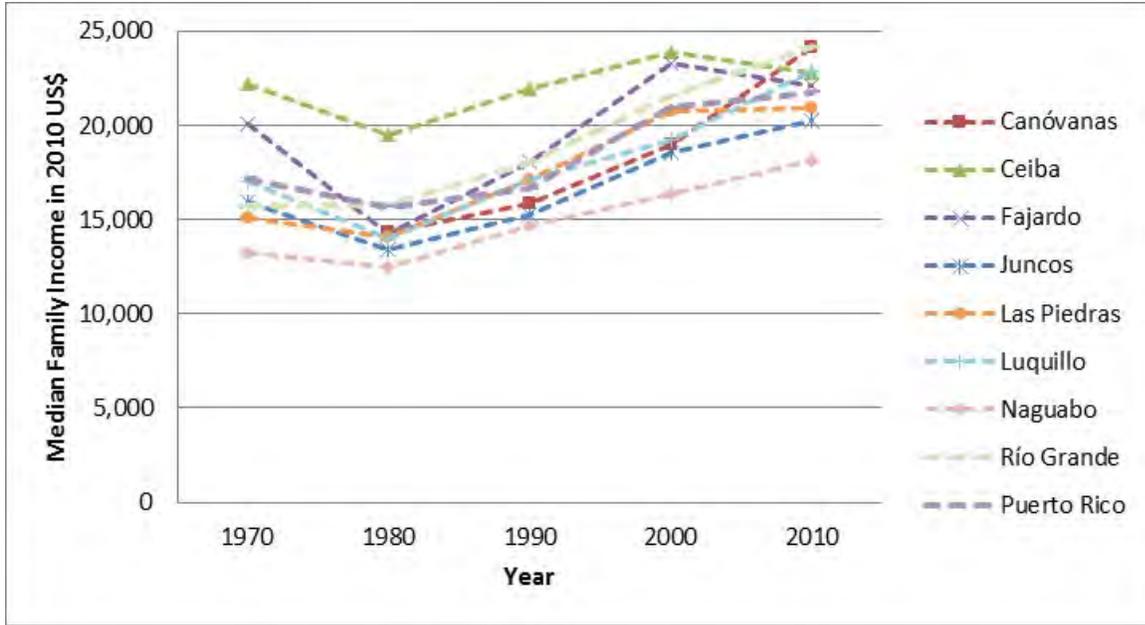


Figure 3-9. Real median family income (adjusted for inflation to the value of a U.S. dollar in 2010) of Puerto Rico and of the municipalities surrounding the El Yunque National Forest, select years 1970 to 2010

Source: U.S. Census Bureau, American Factfinder (2015).

Poverty

Poverty levels are another important indicator of community well-being. In 2010, about 44.2 percent of the population in the region was living below the poverty level as defined by the U.S. Census Bureau (2015). Fairly significant intraregional differences existed, with Fajardo and Río Grande having the lowest poverty rates (42.1 percent), and Naguabo demonstrating the highest (52.6 percent). The percentages of people living below the poverty level generally have been declining throughout the region since 1970 at least, with the exception of Ceiba, which increased to 43.1 percent in 2010 from 38.6 percent in 2000 (Oficina del Censo 2015) (Figure 3-10). Despite general improvements, poverty in the region and across Puerto Rico occurs at significantly higher rates than in the U.S. For example, the percent of people living in poverty in the region surrounding the El Yunque in 2010 was nearly three times the national rate (14.3 percent) and almost double that of Mississippi (21 percent), which had the highest state-wide poverty rate in the U.S. in 2010 (U.S. Census Bureau 2015).

Children represent a disproportionate share of the poor in the El Yunque region, as throughout Puerto Rico. In 2013, children (less than 18 years of age) represented less than 25 percent of the total population in the region, but they represented more than 33 percent of the population living below the poverty level (Figure 3-10). Of the estimated 71,912 children living in the region in 2013, 56 percent were considered to be living below the poverty level (U.S. Census Bureau 2015). Intraregional differences were notable for this variable as well, as the municipalities to the south of the El Yunque along with Luquillo had higher childhood poverty rates than the other municipalities in the northern and eastern vicinities of the Forest. Naguabo had the highest childhood poverty rate at 67.5 percent in 2010. Ceiba demonstrated the greatest increase in the childhood poverty rate (0.93 percent per year) between 2000 and 2010, despite a decrease in the total number of children living in poverty. Conversely, Canóvanas and Juncos experienced the most significant decreases in childhood poverty rates between 2000 and 2010 (-0.11 and -0.65 percent per year, respectively).

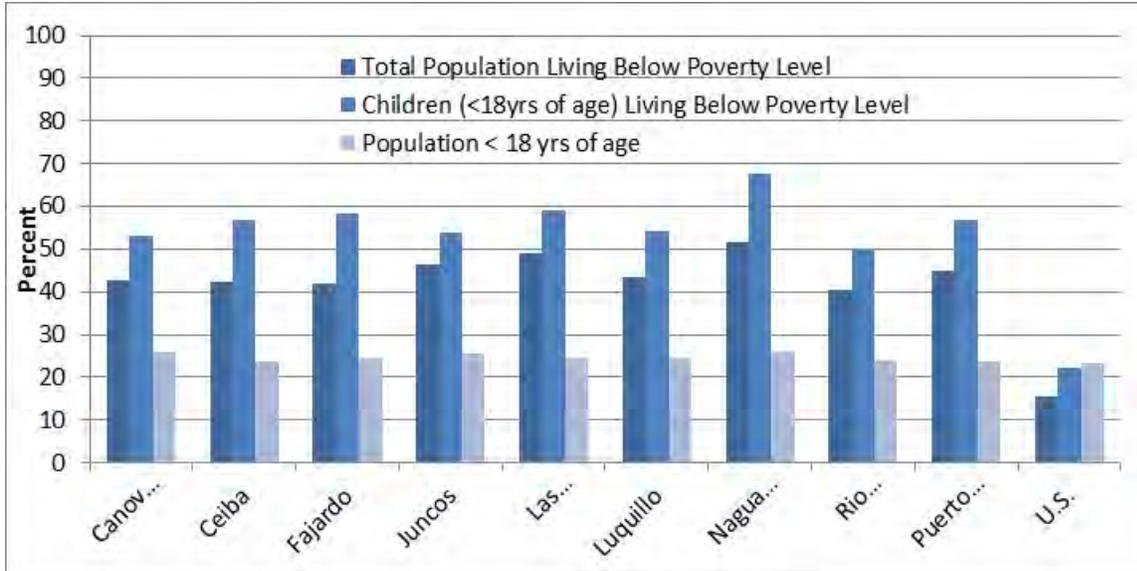


Figure 3-10. 2013 five year estimate (2009–2013) of poverty levels for the total population and persons less than 18 years of age and the percent of the total population less than 18 years of age in the region surrounding the El Yunque National Forest, Puerto Rico, and the United States

Source: U.S. Census Bureau, American Factfinder (2015).

Overall, while the populations surrounding the El Yunque are living longer and spending more years in formal education, which enhances the knowledge and skills available for responding to demands and changes in the social and natural environment, per capita and family income have only modestly outpaced inflation, and poverty remains high, particularly among children. Limited growth in income and persisting poverty among a large segment of the population are signs of social vulnerabilities and may be indicators of large segments of society that are being “left behind” or at risk of further decline. Low income and high poverty rates also often result in greater demands for public services and resources, including from public lands. Therefore, it is important for management decisions to account for how these community members or segments of society may be affected by changes in management direction and Forest use.

Employment and Economic Diversity

Other economic variables, such as employment rates and economic sectorialization (e.g., employment by industry sector) can be used as indicators of a community’s overall economic diversity and health and community capacity to adapt to gradual or unexpected changes in the social and natural environments. In 2010, 83.2 percent of the active labor force in the area around El Yunque was employed, resulting in a 16.8 percent unemployment rate; which is similar to the Islandwide unemployment rate, but much higher than that of the U.S. (9.7 percent). About 48 percent of the regional population over 16 years of age was actively seeking employment (i.e., in the labor force) in 2010, which is comparable to the island-wide rate (47 percent) but significantly less than the mainland active labor force rate (65 percent) in 2010. Intra-regionally, unemployment rates ranged fairly widely from 11.7 percent in Ceiba to 21.0 percent in Luquillo in 2010 (El Yunque 2014). Unemployment rates decreased throughout the area and across Puerto Rico between 2000 and 2010 (U.S. Census Bureau 2015). Ceiba demonstrated the largest reduction in its unemployment rate during this period (-0.67 percent per year), but also saw the only reduction in the number of people actively seeking employment (-0.16 percent per year) (El Yunque 2014). Most municipalities saw measurable increases in their labor forces (greater than 0.5 percent per year), with the greatest increase occurred in Canóvanas (1.41 percent per year), which also saw a significant decrease in unemployment between 2000 and 2010 (-0.58 percent per year) (El Yunque 2014).

The majority of jobs in the region in 2010 were in the education, health, and social services sector (21 percent), followed by retail trade (13 percent), manufacturing (12 percent) and arts, entertainment, recreation, and accommodations (10 percent), all of which increased over the respective 2000 rates, with the exception of manufacturing (Figure 3-11). Altogether, the majority of wage and salary jobs in the region in 2010 were in the service sector (77 percent). These types of jobs produce services, such as health care or education, as opposed to tangible objects, and encompass a wide range in wages and skills (e.g., doctors, chemists, software developers, restaurant workers, bus drivers). Goods producing jobs (i.e., agriculture, forestry, fishing, hunting, mining, construction, and manufacturing) accounted for 23 percent of the jobs in the region. These statistics are not so different from the U.S., where about 79 percent of jobs were in the services industry and 21 percent of jobs were in the goods producing industry in 2010 (U.S. Census Bureau 2015).

At the municipal level, education, health, and social services jobs accounted for the greatest percent of jobs in the area, excepting in Las Piedras where manufacturing was the biggest provider of jobs in 2010 (Table 3-36). And, while the agricultural industry was once a significant sector in the local economy and in Puerto Rican economy as a whole, today the sector contributes about 0.8 percent to the GDP and provides less than one percent of jobs Islandwide. Similarly, less than 1 percent of jobs within the region are attributed to agriculture, ranging from 0.45 percent in Canóvanas to 2.04 percent in Las Piedras (Table 3-36).

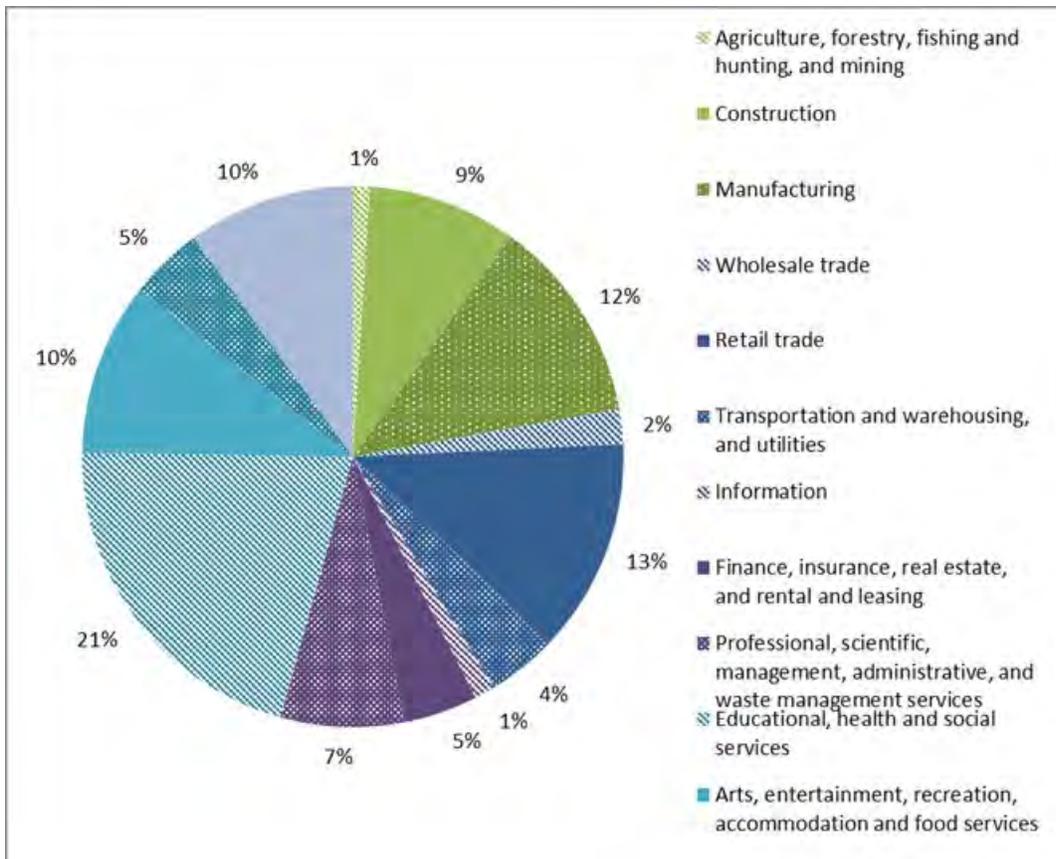


Figure 3-11. Industry by occupation for civilian employed population 16 years and older of the El Yunque Region, 2010 five-year estimate (2006–2010)

Source: U.S. Census Bureau, American Factfinder (2015).

Table 3-36. Industry by occupation for civilian employed population 16 years and older of the municipalities surrounding the El Yunque National Forest and Puerto Rico, 2010 (five year estimate 2006–2010)

	Canóvanas	Ceiba	Fajardo	Juncos	Las Piedras	Luquillo	Naguabo	Río Grande	Region
Agriculture, forestry, fishing hunting, mining	0.45%	1.27%	0.73%	0.98%	2.04%	1.50%	1.59%	0.57%	1.00%
Construction	9.47%	7.04%	6.56%	9.11%	9.03%	9.76%	15.01%	7.32%	8.89%
Manufacturing	8.52%	10.83%	7.68%	18.46%	22.78%	12.90%	11.17%	8.69%	12.29%
Wholesale trade	3.32%	0.22%	0.79%	3.46%	0.93%	0.73%	1.52%	2.78%	2.07%
Retail trade	13.25%	10.72%	15.57%	10.93%	9.07%	11.91%	14.20%	14.29%	12.77%
Transportation, warehousing, utilities	6.08%	3.40%	5.25%	2.14%	2.57%	2.65%	4.50%	5.08%	4.24%
Information	0.92%	0.77%	1.54%	1.58%	0.79%	2.44%	0.58%	1.32%	1.24%
Finance, insurance, real estate, rental leasing	4.85%	6.88%	5.53%	5.02%	4.18%	2.57%	2.20%	4.20%	4.47%
Professional, scientific, management, administrative, waste management services	6.81%	8.07%	8.45%	6.35%	9.46%	6.79%	5.88%	7.05%	7.34%
Educational, health, and social services	22.27%	26.09%	19.71%	19.99%	19.52%	21.01%	20.32%	20.83%	20.91%
Arts, entertainment, recreation, accommodation, food services	9.38%	10.74%	14.95%	5.28%	8.11%	14.17%	9.71%	11.76%	10.35%
Other services (except public administration)	4.28%	2.67%	3.68%	2.83%	5.13%	5.38%	4.44%	5.71%	4.40%
Public administration	10.40%	11.31%	9.56%	13.86%	6.39%	8.17%	8.88%	10.41%	10.01%

Source: U.S. Census Bureau, American Factfinder (2015).

Overall, Puerto Rico's economy has been somewhat listless for the past few decades (Cohn et al. 2014). While longstanding corporate tax breaks spurred economic and industrial growth across the Island for many years, their termination in 2006 combined with the recession in the U.S. and the larger global economic downturn and other local economic factors to produce an economic crisis from which the Island has yet to recover (Cohn et al. 2014; Federal Reserve Bank of New York 2012). Moreover, government expenditures and the Island's overall debt have increasingly exceeded revenues since the early 1990s, ultimately resulting in the downgrading of its debt to "junk" status in 2014 (Cohn et al. 2014). These factors and their effects are pronounced across the Island, including the area around El Yunque, and are reflected in part through the limited growth in income and persisting poverty among a large segment of the population. These conditions are not likely to improve anytime soon, particularly as the local and larger economies continue to languish, if not worsen, and may lead to marked changes in demands for services and resources from El Yunque and other public lands.

Economic and Social Contributions of El Yunque National Forest

El Yunque is a complex socio-ecological system that contributes to the sustainability of local communities and society at large through a wide range of products, services, uses, and opportunities. It directly contributes to local economies through employment, expenditures, and payments. In 2012, El Yunque spent \$3.53 million in salaries and non-salary expenditures and employed directly 27 full time equivalent (FTE) employees. These statistics were slightly lower than the 2008–2012 five-year average (\$3.61 million in expenditures, 29 FTE employees) (see 2014 Forest Plan Assessment). Forest Service employment and expenditures represent a direct investment in the local economy and also produce significant indirect and multiplier effects by stimulating additional investment and growth in businesses that are linked to or provide support for Forest-related activities and services. The Forest also makes payments to the local government through revenue sharing and payments in lieu of taxes (2012: \$150,000; \$10,000, respectively). Both types of payments have decreased in recent years, but remain important sources of income for local governments and provide support for critical public services and facilities (see 2014 Forest Plan Assessment).

The Forest provides a broad range of goods and services, including the provisioning of water, support for habitat for flora and fauna, regulation of air purification, maintenance of biodiversity, carbon sequestration, soil erosion control, nutrient cycling, research and education, and non-timber forest products (see for example, López-Marrero and Hermansen-Báez 2011). Some forest goods and services have been quantified. For example, water production is estimated to be valued at \$25 million a year and wildlife viewing activities are estimated to generate more than \$3 million a year (El Yunque 2014; Southwick 2007). Yet, most of the goods and services provided by El Yunque have not been quantified or are difficult to monetize. Moreover, while some forest goods and services benefit specific communities or areas near the Forest (i.e., place-based), the benefits derived from many of its goods and services transcend geographic or physical boundaries (i.e., interest- or value-based). Identifying and understanding both place-based and interest-based values that individuals and groups associate with the Forest is critical to assessing the potential effects of management alternatives and actions on economic and social sustainability.

Overall, area residents and other key stakeholders attach a wide range of values and interests to El Yunque. For example, some value the Forest for the economic opportunities that it offers businesses and communities. Others value the Forest for its recreation and leisure opportunities. And, some appreciate the Forest for its intrinsic value of existence. The values that people associate with the Forest often are interconnected and many people value the Forest for multiple reasons. Drawing from the collaborative Forest planning process involving local communities and other Forest stakeholders associated with El Yunque and work done by López-Marrero and Hermansen-Báez (2011) on stakeholder perceptions of the Forest's ecosystem services, we identified seven broad types of value or interest that individuals and

groups associate with the Forest (Table 3-37). These broad value/interest types were taken into account in our assessment of the potential consequences of proposed management alternatives, as discussed below.

Table 3-37. Seven broad types of socioeconomic and cultural values and interests associated with El Yunque National Forest

Value-Interest Type	Characteristics and Examples
Recreation	Active, passive recreation; e.g., hiking, bathing, bird watching, picnicking, camping, driving
Research and Education	Science and knowledge discovery, development, and exchange; e.g., K-university educational activities, experimental and observational research, hands-on conservation
History and Heritage	Cultural and historical heritage resources and activities; e.g., resources and activities related to historic sites, interpretation, folklore, national patrimony, cultural identity
Landscape Connectivity	All lands/all communities ideology/philosophy; e.g., biophysical and sociocultural connections to public, private, agricultural lands, waterways, beaches, reefs, neighborhoods, towns, cities, etc.
Economic Opportunities	Direct, indirect economic opportunities; e.g., tourism, art, NTFPs, wood products, telecommunications, etc.
Non-market Biophysical Services	Provisioning, regulating, supporting ecosystem services; e.g., water for consumption and recreation, habitat for flora and water and air purification, carbon sequestration, soil production and erosion control, nutrient cycling, biodiversity maintenance
Non-market Sociocultural Services	Social and cultural ecosystem services; e.g., scenic integrity, religious/spiritual value, human well-being, intrinsic/existence/option values

3.5.1.2 Environmental Consequences

Information on the socioeconomic conditions and trends of the region surrounding El Yunque provides the baseline for examining the potential consequences of the three proposed alternative scenarios for managing the Forest going forward. For El Yunque, the analysis of potential economic and social impacts is based largely on qualitative assessment. Tools for conducting quantitative analysis, such as IMPLAN and FEAST are not available for this Forest. Nevertheless, we can qualitatively assess the potential effects of the alternatives on socioeconomic indicators, such as employment, labor income, ecosystem services, and human values and interests, based on professional expertise and the best available scientific information. Implementation of any alternative would comply with existing rights, Federal regulations, Forest Services policies and directives, and all other related requirements. Key assumptions in the analysis include full implementation of each alternative and Forest Service budgets remaining constant across all alternatives. Actual impacts on neighboring communities and other stakeholders in the region and across the Island ultimately will depend on the uptake of opportunities provided by the Forest under any given alternative.

Effects Common to All Alternatives

Population Trends.

As detailed in the “Affected Environment” section above, the region surrounding El Yunque has been associated with increasing population totals and density until very recently. Since about 2010 the population around El Yunque has begun to decrease, following the broader Islandwide trend that began around the mid-2000s. Population loss is projected to continue across Puerto Rico, including the region around the Forest, for the next decade at least (Banco Popular de Puerto Rico 2013). Despite this shift in

population dynamics in the region, population density remains high. While none of the proposed alternatives is expected to influence population trends in the region or across the island in any measurable way, under all proposed alternatives, El Yunque will continue to provide open space and natural settings, as well as an array of goods and services that are important to nearby residents, various communities of interest, and society at large.

Forest Employment and Expenditures

Annual budgets for National Forests generally have been in decline in recent years and congressional appropriations that support salary and non-salary Forest expenditures have become increasingly variable. Consequently, it is difficult to forecast with any certainty El Yunque's future fiscal resources. Under each alternative, the Forest's budget will continue to be allocated among resource programs based on priorities identified through collaborative processes, monitoring, and adaptive management. If future funding allocations remain relatively constant, the Forest is expected to continue to directly support between 25 to 30 jobs (full-time equivalents) under the three alternative management scenarios. Salary and non-salary expenditures are expected to continue to exhaust annual allocations under each of the alternatives. While fluctuations in future Forest spending may affect future economic contributions associated with El Yunque, management actions implemented under any of the three alternatives are not expected to have a measurable effect on annual funding allocations to the Forest and, as such, total Forest expenditures (including salary and non-salary expenses) are not expected to vary across alternatives. The number of indirect and induced jobs may vary across alternatives, given different management strategies, as discussed below. In particular, alternatives 2 and 3 are expected to result in more induced and/or indirect jobs than alternative 1, given their focus on collaborative strategies to develop new recreational opportunities within and around the Forest and sustainable production in and around the Community Interface Resource Management Area (CIRMA).

While implementing alternative management scenarios on El Yunque has the potential to affect local businesses and industrial sectors, the contribution of El Yunque to the local economy, and the relative differences between the alternatives, would not be large enough to cause statistically measurable changes to local economic diversity (e.g., the number of economic sectors) or economic dependency (i.e., a limited number of industries dominates the local economy). Nevertheless, alternatives 2 and 3 are expected to have positive impacts on local economic diversity and dependency as compared to alternative 1. Shifts in the local economy are likely to occur over the next 20 years or so, though not as a direct result from the actions implemented under any alternative management scenario.

Payments to Local Governments

Although the future of receipt-sharing and per-acre Federal land payment programs is uncertain, the Twenty Five Percent Fund Act of 1908 guarantees Puerto Rico a 7-year rolling average of receipts from El Yunque. A portion of this is distributed to the eight municipalities with land inside the Forest boundaries to fund local schools and roads. Revenue sharing payments are authorized through the Secure Rural Schools Act (SRS Act), which was reauthorized and signed into law on April 16, 2015 (P.L. 114-10 Section 524). Under all proposed alternatives, payments to the Commonwealth and municipalities would continue to help fund schools, roads, and public services, and ultimately, contribute to the sustainability and health of local communities, particularly through support for important amenities and services provided by local and Commonwealth governments.

Cumulative Effects Common to All Alternatives

As described above in the section on the affected socioeconomic environment, population and urban density near the Forest and across the Island remain high, particularly in comparison to much of the mainland U.S. High population densities and urbanization can result in increased job opportunities and

better health care options as compared to rural areas, but also often implies increased demands and impacts on natural resources and the goods and services that they provide (McKinney 2002). High percentages and densities of built-up areas can alter Forest processes through fragmentation of the landscape, disruption of hydrological systems, introduction of nonnative species, and interruption of nutrient cycles, among other impacts (Lugo et al. 2004). Indirectly, such increases can lead to impoverishments in the quality of recreational, spiritual, and other human interactions with nature due to the change in and/or loss of open space, natural scenery, recreational sites, and other resources (Lugo et al. 2004).

The effects of urbanization are further compounded in the context of global climate change, particularly in places like Puerto Rico, where the projected impacts of climate change are significant and where human resources and capital infrastructure to address such problems are limited. Projected sea level rise in Puerto Rico will lead to a loss of land and infrastructure, which will likely trigger inland and upland migrations of human populations, and potentially more intensive and extensive urban development closer to the Forest edge (Lewsey et al. 2004; Kelman and West 2009). Moreover, land-use changes interact with climate change to alter fire regimes in tropical forests, such that the feedbacks between climate warming and drying and increased human development within the wildland-urban interface can increase the occurrence of and impacts from fire (Cochrane and Laurance 2008; Robbins et al. 2008). This is particularly critical for Puerto Rico, where nearly all wildfires are associated with human activity (Robbins et al. 2008).

None of the proposed alternatives is expected to influence population trends or climate change projections in any measurably significant way. Yet, all alternatives provide for the continued protection of the Forest and sustainable use of its vast array of goods and services. El Yunque encompasses the largest continuous forested area in the region, but it is surrounded by a dense patchwork of urban and peri-urban areas, agriculture, pasture, secondary forest, and other land uses. Its protection and sustainable use under all proposed alternatives will continue to alleviate some of the negative effects on quality of life that are associated with densely populated and urbanized areas, particularly in the context of a changing climate. Moreover, under all alternatives, the Forest will continue to provide a vast array of essential goods and services that benefit local communities, multiple interest groups and stakeholders, and society at large.

Alternative 1²

Under alternative 1, the 1997 Forest Plan will continue to guide management of the plan area. This alternative provides for increased recreation opportunities to meet current and future demands. However, in comparison to the other alternatives, the 1997 Plan does not include components oriented toward sustainable recreation opportunities and settings. This may benefit some recreation interest groups in the short term, but ultimately will lead to adverse impacts from increased, unsustainable recreation on the Forest in the long term.

Cultural and historical heritage resources are addressed through alternative 1 and would continue to be supported through existing management, but are not prioritized or enhanced through targeted management. The 1997 plan also provides direction and support for environmentally sound tropical forestry research, contributing to some key research and education values and interests. It also emphasizes the development of environmental interpretation and education programs and products. However, in comparison to alternatives 2 and 3, alternative 1 does not specifically address opportunities for increasing environmental education and literacy at a regional level or with specific groups (e.g., schools, university

² The cumulative effects of alternative 1 are discussed under the section on “Cumulative Effects Common to All Alternatives.”

groups); nor does it provide direction for the use of research and knowledge development within the context of adaptive Forest management.

Alternative 1 emphasizes the acquisition and conservation of key land units connected to the Forest, addressing some interests in landscape connectivity. Yet, it provides limited focus or direction on the broader biophysical and sociocultural connections of El Yunque within the region, as compared to the other alternatives. The 1997 plan also emphasizes the importance of protecting water resources in terms of quantity and quality, as well as wildlife, primary forest, wilderness, and wild and scenic rivers, directly addressing values and interests associated with critical non-market biophysical and sociocultural services. However, it does not incorporate a holistic approach to managing the full spectrum of ecosystem services provided by the Forest as is proposed in alternatives 2 and 3.

Under alternative 1, the 1997 plan provides for economic opportunities through Forest management activities, largely associated with recreation and tourism on the Forest. It also provides for other Forest uses, such as telecommunication structures and a limited supply of wood products from timber harvest demonstrations. Nevertheless, economic opportunities under this alternative do not benefit from targeted direction to contribute to the local and larger socioeconomic environment as provided in the other alternatives.

Alternative 2

Alternative 2 takes a holistic approach to planning, emphasizing the importance of El Yunque's ecological, economic, and social resources and values to long-term sustainability. It addresses important recreation values and interests through significant enhancements to the recreation opportunities and settings offered by the Forest. Specifically, it differs from alternative 1 in its development of a recreation corridor along PR Road 191, a Scenic Byway along PR Road 186, and a Community Interface Resource Management Area (CIRMA), where multiple sustainable uses, including passive and active recreation can be developed and carried out in collaboration with nearby communities and governments. Under this plan direction, recreation activities will be dispersed to lower elevations of the Forest, alleviating some of the existing pressures of intense uses along PR Road 191, and ultimately allowing for more sustainable levels of recreation throughout the Forest and satisfying a broader range of recreation values and interests.

Unique to alternative 2, is the identification of three geographic areas (El Norte, El Suroeste, and El Este) to enhance the development of integrated management strategies that tie to the distinct conditions that exist at the subregional level around the Forest, which increases the Forest's effects on a broad range of value and interests. Alternative 2 calls for focused attention on increased access to recreation settings and connections to a regional trail system in El Norte GA, on community-based use of the Forest and increased environmental education and community enterprises in El Suroeste GA, and on watershed management in El Este.

Under alternative 2, research and education interests are supported through multiple components and strategies, including management areas designated for on-going, long-term research (Bisley, El Verde, Baño de Oro) and Forest monitoring as a fundamental part of adaptive management. This alternative goes beyond alternative 1 in its plan components related to environmental education, specifically in terms of its focus on enhancing environmental literacy in neighboring communities, local schools, and society at large. Alternative 2 also proposes enhanced interpretation efforts associated with natural and cultural resources. It addresses cultural and historical heritage interests and values through the prioritization and targeted management of important resources and sites. It also promotes cultural identity, national patrimony, and folklore associated with the Forest and its history. Altogether, these efforts promote greater awareness and understanding of the Forest's diverse resources and services and increasingly sustainable use and protection of these resources and services by a widening range of stakeholders.

Overall, this alternative greatly enhances access to information and education to local communities, other key stakeholders, and the public-at-large.

Landscape connectivity interests and values are supported through an “all-lands” approach to forest management, conservation, and restoration under alternative 2, particularly through the development of the CIRMA and the identification of three geographic areas. Alternative 2 goes beyond alternative 1 in supporting biophysical and sociocultural connections across the broader landscape, specifically through the identification of geographic areas where targeted conservation initiatives may be developed, such as for stream corridors, riparian areas, connections to other public lands and protected areas, facilitating the identification and protection of critical connections and developments at the sub-regional level.

Alternative 2 also promotes and provides greater access to existing and new economic opportunities tied to the Forest, particularly through the development or demonstration of multiple, sustainable uses in the CIRMA and nearby communities, and through management strategies that support community collaboration and development, and ultimately lead not only to the creation of indirect and induced jobs but also enhanced stewardship of the Forest and its goods and services.

Alternative 2 directly integrates plan components focused on the protection and promotion of the ecosystem services provided by El Yunque, addressing a broad range of interests and values associated with its non-market biophysical and sociocultural resources and processes. It enhances protection and monitoring of the Forest’s provisioning, regulating, and supporting services, as well as its scenic integrity, intrinsic values and other sociocultural services. Additionally, through management strategies that promote participation and collaboration, this alternative contributes to reduced impacts on sensitive areas through dispersed recreation and increased restoration in specific areas. Moreover, management of invasive species throughout the Forest may contribute to some key non-market biophysical services values and interests, as well as provide new and additional economic opportunities.

Alternative 3

Alternative 3 is similar to alternative 2, with the exception of a few key areas. First, it does not recommend the designation of a scenic Byway along PR Road 186 and differs from alternative 2 in further reducing the impacts from recreation, particularly through the elimination of trails that cannot be maintained. These differences may affect hikers, birders, bathers, and other recreation stakeholders. Also, alternative 3 recommends the designation of a new wilderness area, in the existing Baño de Oro Research Natural Area, which may serve recreation and non-market services interests and values, but impact research and education stakeholders, particularly manipulative research interests and needs as these would be prohibited under wilderness designation. This alternative decreases the scope of invasive species management as compared to alternative 2, though still greater than alternative 1. Finally, alternative 3 identifies two geographic areas (El Norte, El Sur) in which integrated management strategies may be developed in line with the conditions that exist at the subregional level around the Forest and enhancing the Forest’s overall effects on a broad range of value and interests.

3.5.2 Land Use and Ownership

3.5.2.1 Affected Environment

Approximately 29,000 acres of the El Yunque National Forest are located in the municipalities of Canovanas, Rio Grande, Luquillo, Fajardo, Cieba, Juncos, Las Piedras, and Naguabo. The lands program area includes several different activities. Affected environment and environmental consequences on land exchanges, purchases, boundary management, and other activities are primarily real estate-type activities. Special uses activities include authorizations to use National Forest System lands for non-Federal type uses. These uses can include utility corridors, private and public roadways, communications sites, or

signs. Actions and plans of local communities and their growth and development influence the El Yunque National Forest through land adjustment cases, land exchange concerns, utility needs and development, and residential impacts. These communities are also partners in maintaining and acquiring open space and providing needed services to residents and Forest users. The Forest Service may acquire lands through exchange, purchase, donation, or condemnation. Land exchange and land purchase have been, and would continue to be, the means by which the El Yunque National Forest acquires key wildland resources and open space areas. Most of the Federal lands exchanged are within or near existing communities and the majority of land conveyed to the Forest, as a result, is located in more remote areas. Procedures for processing cases and public participation is determined by set policies, rules and regulations outside the Forest Plan and would apply regardless of the alternative selected.

3.5.2.2 Environmental Consequences

All Alternatives

Criteria for land adjustment cases are very similar among all alternatives. Public concern about being involved early in land exchange projects and continued support for community needs would be addressed in all alternatives. As a result, the public would be informed of land exchanges early enough to meaningfully contribute to the outcome for the benefit of the community. This would increase trust in the Forest Service's lands program. Due to budgetary constraints, limitations of the plan and community influences, the Forest would likely continue to increase in acreage, but probably at a small rate throughout the life of the plan.

Given the increasing concern of local communities regarding Forest and other open space fragmentation in the region, all alternatives are likely to produce increased public awareness and landscape conservation through land acquisition and environmental education.

Under each alternative, the Forest would continue to pursue the acquisition of additional acres to add to the existing footprint of the Forest, with a primary focus on lands containing riparian areas along with rivers and streams to maintain and conserve water quality from the Forest to its connection to the sea. Lands would be evaluated for disposal and acquisition based on criteria developed in the Forest land ownership and acquisition strategy. Emphasis would continue to concentrate on lands with valuable recreation, wildlife habitat, or other natural resource attributes. Acreages such as those found in wilderness or other designated sites would not be considered for conveyance.

Alternative 1

The El Yunque National Forest Land Ownership and Acquisition Plan lists specific attributes and tracts to acquire—many of which have been acquired. However, the list has not been modified to keep up with adjustments. Other acquisition parcels are not listed and, therefore, may not be perceived as high priority. Parcels of importance would change throughout the life of the plan as resource values are discovered (archaeology resources) and identified, interested parties come forward, or additional species are listed or conditions change.

Land and Water Conservation Fund priority direction is contained in policy and ranking criteria, and this wording is no longer needed in the plan. The criteria of lands to acquire would continue to be effective for determining potential purchase cases instead of a list of priority properties.

Because this direction is redundant with Forest Service policy, it does not contribute to effects.

The plan states specific boundary and landline direction, but timeframes do not reflect current limitations in budget and the flexibility of the Forest to determine priority work. As a result, this direction would remain unachievable.

Alternative 2

Conservation easements and other land conservation and restoration programs under alternative 2 can lead to increases in lands dedicated to ecological conservation and restoration and in reductions in land fragmentation in the region surrounding the Forest.

Environmental education and agroforestry projects that can be developed within the Community Interface Resource Management Area (CIRMA) and promoted in neighboring lands under alternative 2 will contribute to enhanced agricultural, forestry, and other land use practices and lead to increases in recreation and employment opportunities.

This alternative includes guidelines that would likely result in similar land adjustment opportunities identified in the El Yunque National Forest Land Ownership and Adjustment Strategy. Including conveyance of inholdings that do not possess characteristics that would further the Forest Service mission and increase the ability to acquire non-NFS lands containing habitat for threatened, endangered, or sensitive species and consolidate Federal ownership.

Working collaboratively with local governments and communities early on the land exchange projects per the associated management approach may result in land exchanges being developed that meet communities and Forest needs and parties agreeing to potential tradeoffs of open space values for other resource benefits.

Alternative 2 would continue to allow for conveyance of lands to meet community and public needs and would add loss of wildland character to the list of lands that could be conveyed. This could provide incentives for non-Federal neighbors to protect those values to reduce the potential for land exchange or sale. This alternative would also add Forestwide emphasis to management approaches for collaboration with private landowners and local governments to protect Forest values from adjacent development impacts. This could result in less habitat fragmentation and greater watershed health to Forest resources from adjacent non-Federal uses by developing buffers on private lands. Characteristics of lands to acquire would be stated in the guidelines and priorities would be set using a ranking system in the Forest Service Handbook. Boundary survey and encroachments would not be specifically mentioned in alternative 2, but would still be part of a lands program and would be addressed according to policy and regulation and should not change current management.

Overall, alternative 2 would be substantially different from the 1997 plan. Adjustments of guidelines and desired conditions would reflect more succinctly the criteria of lands desired for Federal acquisition and those appropriate for conveyance. Values would be included to address local concerns about land exchanges that result in conveyance of NFS lands. Loss of wildland character as a conveyance characteristic would be a good communication tool with adjacent non-Federal owners who can work to protect those values, perhaps reducing encroachment cases. This would allow communities to identify important open space, but also to take some responsibility for preserving wildland and resource values. If land adjustment actions are consistent with the guidelines, key resource value properties would be acquired and would result in meeting the desired condition of a mostly contiguous land base that provides for biologically diverse public lands.

Alternative 3

This alternative is similar to alternative 2 except for additional congressionally designated wilderness area. These acres would be permanently removed from consideration for conveyance.

Cumulative Effects, All Alternatives

The cumulative environmental consequences are spatially bounded by an area larger than the El Yunque National Forest proclaimed boundary, generally the area immediately adjacent El Yunque National Forest. While population has demonstrated a decrease Islandwide since the early 2000s and more recently in the region surrounding the Forest since about 2010, land use change for development, tourism, exurban growth, and other factors may continue to affect the Forest and surrounding natural areas.

If private properties, especially inholdings change from rural or undeveloped land to subdivisions or higher density uses, residential encroachments on the Forest are expected to occur more frequently and degrade wildland character and other resource values, requiring additional land survey needs. If development increases and/or encroachment occurs, undeveloped lands and their open space values are converted to residential or commercial uses. This growth would likely result in continued pressures to maintain NFS lands for their open space values. This may also trigger the need to acquire rights-of-way in places where informal public access is lost to development. Working with other governmental partners on ordinances and plans under alternative 2 could continue to reduce potential impacts to Forest resources.

All communities adjacent to El Yunque recognize the open space and recreational values the Forest provides and have developed goals and objectives in their plans to preserve these characteristics. Entities like Puerto Rico Tourism Company, Center for Landscape Conservation, the Coalition Pro-Northeast Corridor as well as other partners can assist in acquiring key parcels that would help retain water resources and habitat for desired conditions for fish and other wildlife species. There may be additional tradeoffs of resource values on the Forest as local communities change demographically. There would also continue to be tension between the desires to retain NFS land near communities and the need to provide land for infrastructure for community expansion. Local collaboration expectations with communities and their desire for open space may result in localized exchanges. However, all alternatives acknowledge community needs and the locations where land adjustments are appropriate and minimize impacts.

3.5.3 Forest Products**3.5.3.1 Introduction****Timber Forest Products**

Planned harvests would only occur on lands “suitable for timber production”. The identification of lands as “suitable for timber production” does not mean that timber production is the primary purpose of management on those lands; rather, the production of wood products is compatible with the achievement of desired conditions and objectives established by the plan for those lands (36 CFR 219.11(a)(1)(iii)), and some regular flow of wood products may be expected.

Following natural disturbance events the removal of dead or damaged trees could also occur on lands identified as “not suited for timber production because timber production is not compatible with the desired conditions” (see Table 3-38).

Timber harvest and production can play an important role in attaining desired conditions for ecological sustainability and can contribute to social and economic sustainability. While the assessment identifies and evaluates how timber harvest and production contributes to social, economic, and ecological

sustainability, there is no timber program on the Forest or the region. The 1997 plan allocates 1,167 acres for the silvicultural demonstration program. No harvesting has occurred and timber utilization has been limited to salvage of dead and down trees basically for wood crafters and artisans.

The vegetation types, wildlife, and physical conditions impose non-suitability of the lands. In Table 3-38, lands outside of the wilderness area, but on slopes greater than 30 percent, are identified as “not suited for timber production,” because these lands are easily prone to landslides during heavy rains. The lands in category D (where timber production is not compatible with the Plan’s desired conditions) are the lands found within the existing and expanded research natural area. The only acres that are identified as “suitable for timber production” are those within the community interface resource management area (MA 4).

Table 3-38. Timber production suitability classification

Land Classification Category	Acres
A. Total National Forest System lands	28,223
B. Lands not suited for timber production due to legal availability or technical considerations	17,752
Wilderness	10,352
Slopes over 30% (outside of wilderness)	7,400
C. Lands that may be suited for timber production (A–B)	10,471
D. Lands not suited for timber production because timber production is not compatible with the desired conditions and objectives established by the Plan	3,284
E. Lands suited for timber production (C–D)	7,187
F. Lands not suited for timber production (B+D)	21,036

For alternative 1, the lands in category D (where timber production is not compatible with the Plan’s desired conditions) are all the lands that “may be suited for timber production” except for the lands in the Timber Demonstration Management Area, which comprise the only acres “suitable for timber production”. Note that while the 1997 Forest Plan had these timber demonstration acres classified as “not suitable for timber production,” it was decided that under the new understanding of what lands should be identified as “suitable for timber production” that these lands should now fall into that category.

Table 3-39. Timber production suitability classification for alternative 1

Land Classification Category	Acres
A. Total National Forest System lands	28,223
B. Lands not suited for timber production due to legal availability or technical considerations	17,752
Wilderness	10,352
Slopes over 30% (outside of wilderness)	7,400
C. Lands that may be suited for timber production (A–B)	10,471
D. Lands not suited for timber production because timber production is not compatible with the desired conditions and objectives established by the Plan	9,304
E. Lands suited for timber production (C–D)	1,167
F. Lands not suited for timber production (B+D)	27,056

Timber harvest and the production of wood products can play an important role in attaining desired conditions for ecological sustainability and can contribute to local social and economic sustainability. While the assessment identifies and evaluates how timber harvest and production contribute to social, economic, and ecological sustainability, there is no timber program on the Forest or the region. The 1997 plan did allocate 1,167 acres for a silvicultural demonstration program; this is continued in alternative 1. However, no harvesting has occurred and timber utilization has been limited to salvage of dead and down trees basically for wood crafters and artisans.

Alternatives 2 and 3 recognize that there is a local, non-commercial demand for wood products within the arts and crafts community. There are more than 600 artisans certified by the Puerto Rico Economic Development Administration. Most of the Island’s practicing artisans that work with wood use mainly locally available lumber resources that are harvested for that purpose, and milled in private sawmills (Kicliter 1997). Artisans’ state that the supply of wood is very scarce, difficult to maintain, and expensive (Kicliter 1997). Consequently, these alternatives promote the production of local wood products within the community interface resource management areas (CIRMA).

The type of wood products that might be produced from the CIRMA management area would be small-diameter timber (<8 inches or 20.3 centimeters of DBH) used mainly as poles, posts, carvings and other biological material harvested from within and on the edges of Forests that regenerates naturally on lands abandoned after non-forested uses, and manipulated or disturbed Forests.

Forest Yield

Most of the suitable Forest land is dominated by secondary stands in the process of separating into a maturing canopy structure. Typically, this Forest integrates three canopy levels at its mature stage. About 32 species of the 150 species identified in secondary stands are recognized as species with timber use value. The other species have added potential uses in relation to special forest products and are important for the ecological settings that these Forests provide in the El Yunque. To establish a sustainable yield capacity, the growth rate of the species that dominate the suitable Forest lands need to be considered as part of the wood utilization initiatives. Growth rate in the Subtropical Wet, Subtropical Rain, Lower Montane Wet, and Lower Montane Rain forest life zones of the Luquillo Mountains of Puerto Rico has been studied (Crow and Weaver 1977; Schmidt and Weaver 1981; Weaver 1979; Weaver and Birdsey 1990). In 2009, Brandeis published a report titled “Diameter Growth of Subtropical Trees in Puerto Rico” in which the growth among trees measured in the Forest inventories of Puerto Rico were calculated by annual increase for the period considered in the Forest Inventory Analysis (FIA). The document presents the periodic annual increment or PAI in tree diameters at breast height (DBH). The suitable Forest lands include a small area of subtropical moist forest and most of it is in the subtropical wet forest according to Ewel and Whitmore (1973). Table 3-40 from Brandeis (2009) shows the mean increment by life zones documenting similar PAI in the Subtropical Moist and Wet Rain Forests.

Table 3-40. Diameter at breast height (1.4 meters) periodic annual increments (PAI) by Holdridge life zone with number of trees measured, standard error of the mean, standard deviation of the mean, and maximum observed PAI increase from Puerto Rico forest inventory data in cm/year

Life Zone	N	Mean	SE	SD	Maximum
Subtropical Dry	307	0.20	0.03	0.45	5.74
Subtropical Moist	2,315	0.37	0.01	0.48	4.30
Subtropical Wet/rain	1,292	0.36	0.01	0.51	5.84
Lower Montane	112	0.20	0.02	0.24	1.28
All Life Zones	4,026	0.35	0.01	0.49	5.84

N = number of trees measured; SE = standard error of the mean; SD = standard deviation of the mean; Max = maximum observed.

Brandeis (2009) also provides the PAI measured by species as part of the appendix of the document. This information will be used in the evaluation of potential silvicultural applications to sustain the potential growth of selected species.

Planned Wood Product Sale Program

In alternatives 2 and 3, the amount of wood products expected from the CIRMA will fluctuate, depending on the previous silvicultural treatments that may have been applied in the area. After a review of several compartment examination and prescription reports prepared in the El Yunque, extreme variation from Secondary Forest to climatic Tabonuco-type forests was evident. In Tabonuco type forests, the understory density was generally lower with reports of 49 trees per acre in the DBH range of 4 to 16 inches (10 to 40 centimeters) (Stand 12 Compartment 1 Sabana) and in stands with Secondary Forests, the immature commercial species were reported at a rate of 100 trees per acre in the 4 to 12 inches (10 to 30 centimeter) DBH range.

The specific volume of production of stands throughout the CIRMA will also vary depending on the forest structure, previous treatments, site quality, and the response of the areas to natural disturbances. Alternative 1, which will continue the level of harvest from that estimated in the 1997 Plan, was estimated to be 22 acres per year for the first decade with 23 MCF (651 cubic meters) per year of yield (Table II-3, 1997 Plan FEIS). The number of acres per year was based on a scaled-down demonstration of forest products on 1,100 acres (about 4 percent of the Forest). For alternatives 2 and 3, even though there are 7,187 acres in the CIRMA where scheduled timber harvesting activities could occur, for the first two decades it has been determined that the level of harvesting activity from that estimated in the 1997 Forest Plan is the level that should be continued within the CIRMA. The silvicultural prescription considered for stands in the CIRMA would plan for a stand to be entered every 50 years. So $1,100 \text{ acres} \div 50 = 22 \text{ acres}$ to be treated per year. The yield of 1.045 MCF/acre (10.45 CCF/acre or 29.57 cubic meters/acre [where 1 cubic foot = .0283 cubic meters]) from the 1997 Forest Plan will also be used for the yield projections for all the alternatives. This will result in a total projected yield of 23 MCF/year ($22 \text{ acres} \times 1.045 = 23 \text{ MCF}$ [651 cubic meters]) or 230 MCF per decade. The ten year projections for the alternatives are shown in Table 3-41. The integration of other forest products from agroforestry activities is incorporated into these yields and a review of the projected harvest acres per year and yields will be conducted after the first 5 years of plan implementation.

Table 3-41. Projected wood sale quantity, and projected acres treated by alternative

	Alternative 1 1st Decade	Alternative 1 2nd Decade	Alternative 2 1st Decade	Alternative 2 2nd Decade
Projected Wood Sale Quantity in MCF (annually)	23	23	23	23
Acres Treated by Uneven-Aged Management or Thinning (annually)	22	22	22	22

Sustained Yield Limit

The sustained yield limit (SYL) is an estimate of the quantity of timber that can be removed annually in perpetuity on a sustained-yield basis (see 36 CFR 219.11(d)(6)). The SYL is also determined based on the total “lands that may be suited for timber production”, which from Table 3-39 is 10,471 acres. For El Yunque, the sustainable limit is the amount of timber that can be removed without exceeding the established level of annual growth. Silvicultural treatments in the Forest with structure and composition similar to the CIRMA forests in Puerto Rico has shown possibilities for a significant increase in the representation of promising tree species (Wadsworth 1986). The annual growth documented in this type

of forests is 3 to 4 cubic meters per hectare per year (or 1.6 cubic meters per acre per year) (Wadsworth 1986). Where 1 cubic meter = 35.3 cubic feet, this converts to 56.5 cubic feet per acre/year (or 0.565 CCF/acre/year). The SYL for El Yunque is therefore 56.5 cubic feet/acre \times 10,471 acres = 591,612 cubic feet per year or 591.6 MCF per year.

Non-timber Forest Products

There are several plant products (non-timber forest products) requested year-around and managed via free use permits. These products are mostly for personal consumption. Those products that are requested for commercial use are managed via small products forest sale permits; usually these include *Heliconia* flowers and dead tree fern stems of *Cyathea arborea*.

During Christmas season there are many requests for ñame (yams), yautia (tanager), malanga (taro) and bananas. All of these consumption products are vegetation persistent from past agricultural practices or from home gardens that existed prior to the 1920s when the lands were acquired by the Federal Government. These products are harvested yearly from the same location; with the root crops and the regenerative parts planted back in the same location for next year's harvest.

For home decoration and Christmas tree manufacture, the fallen leaves of the *Cecropia* tree are solicited during the season. As mentioned, dead and down trees are permitted to artisans, wood crafters or even for fire wood.

The permits generated by the El Yunque are in the average of 30 per year and are administered from the reception desk at the Forest headquarters building. Most of the users are from the adjacent communities of the El Yunque.

Other non-timber special forest products that may be provided from the El Yunque include such products as (1) foods, such as wild edible mushrooms, native fruits, and nuts; (2) medicinal plants and fungi; (3) floral greenery and horticultural stock; (4) fiber and dye plants, lichens, and fungi; (5) oils, resins, and other chemical extracts from plants, lichens, and fungi.

While these products can be provided through the use of a special forest product permit, there are strict limitations with the use of these permits. Special forest product permits can only be used for products that can be managed on a sustainable basis, and the amounts offered are limited to the amount that can be harvested annually in perpetuity (see 36 CFR 223.219).

3.5.3.2 Environmental Consequences

Alternative 1

Alternative 1 continues the allocation of 1,167 acres to the demonstration of sustainable timber production with 120 acres of roadside demonstration plots (LRMP 1997, pages II-18). These lands would be used to demonstrate how sustainable timber production could be achieved while still being compatible with the protection of the other Forest resources. Under this alternative, only 22 acres would be harvested each year. The timber products that would be available would primarily be posts, poles, and firewood.

Alternatives 2 and 3

Alternatives 2 and 3 allocate 7,187 acres of land for timber forest products. There is an increase of 6,020 acres due to the creation of the community interface resource management area (CIRMA). The CIRMA provides opportunities for forest product utilization strategies that can be coordinated with community groups and residents neighboring these areas. The CIRMA management activities represent a shift from the more traditional forms of timber management as would occur in alternative 1, to a more collaborative

management approach dependent on providing the types of wood products and special forest products that the local communities and local artisans have a demand for. While it is estimated that the acres treated and the total wood volume (in MCF) that would be produced would be the same for all three alternatives, the silvicultural treatments and the types of wood products that would be provided would be different under alternatives 2 and 3 than what would occur under alternative 1.

The issuance of non-timber forest products permits could also increase because the acres available in the CIRMA in alternatives 2 and 3 (7,187 acres) is considerably larger than the lands available in alternative 1 in the timber demonstration management area (1,167 acres).

3.5.4 *Cultural Resources*

The presence of humans in the El Yunque can be traced back almost a thousand years. During this period of time different groups, such as the Ostionan Ostionoid (pre-Tainos) and the Chican Ostionoid (known as Taínos), inhabited the zone surrounding the Luquillo Mountains.

The majority of prehistoric activity in the Forest has been identified in the shape of petroglyphs located in the lower elevations of the Forest, mostly under the 600-meter elevation. Such petroglyphs are not only remains of past activities, but artistic expressions of the Prehistoric people's set of beliefs and ideas about the world, and the supernatural world.

More systematic studies of the forestlands are required to document other prehistoric-era sites such as settlements or places of resource extraction.

European conquest and colonization of the Island of Borikén began by the end of the 15th Century, with colonization reaching the Luquillo Mountains by the early 1500s (Domínguez-Cristobal 2000; Weaver 2012). The direct effects of colonization were the decimation of indigenous population, and the annihilation of their socio-political structures and religion.

In part, this transformation was a direct result of mining activities established by Spaniards on the Island during the first three decades of colonization (Domínguez-Cristobal 2000). Mining was the most important economic activity during the early 16th Century, including the eastern mountains (Weaver 2012).

Small settlements took hold in the lower elevations of El Yunque. These consisted of clustered rural communities and small dispersed households. Economic exploitation of the El Yunque area continued between the 16th and 19th Century in the form of subsistence farming, and small-scale crop production such as coffee, tobacco, and sugar cane harvesting. Timber was one of the main product staples extracted from the Forest. These patterns along with the growing demand for wood used in construction, fuel, and ship building, mixed with, "poor agricultural farming practices, political instability, lack of communication between the metropolitan centers and the rural population and a scarcity of personnel and budget for forestry activities" resulted in the decimation of many primary forestlands across the Island; including some parts of the Luquillo Forest (Domínguez-Cristobal 2000; Weaver 2012). The origins of what we now call El Yunque and its conservation efforts are linked to several land use policies promoted by the Spanish Crown during the 19th Century. In 1876, King Alfonso XII issued the "Ordenanza de Montes", an ordinance that set the framework for the functioning of all Forest management activity on the Island. It is through this ordinance that the Inspección de Montes was created; an entity in charge of the management of Crown lands, including approximately 10,000 hectares pertaining to La Comarca de Luquillo designated as a watershed, soil, and timber reservation (Domínguez-Cristobal 2000; Valdés-Pizzini et al. 2000; Weaver 2012).

After the Spanish American War, and having Puerto Rico being transferred to the United States, the Americans installed a new colonial rule. The new political regime resulted in the adoption of an alternative management framework for those lands pertaining to the Spanish Crown, including El Yunque. Subsequently in 1903, President Theodore Roosevelt proclaimed the transferred Crown lands as the Luquillo Forest Reserve. The original proclamation boundary encompassed about 25,650 hectares classified as public Forest as soon as the government might acquire the lands; later, the boundary was modified (Weaver 2012, page 9). Since then, the Forest Service has been responsible for the management of the reserve. The first half of the 20th Century marked a major shift in the management policies implemented in El Yunque. After the Forest Service acquired the old Spanish Reserve they allowed the Parceleros to remain in place to “intercrop foodstuff with trees (a system called taungya or agroforestry) gradually reforesting Federal lands” (Weaver 2012). Slowly they were relocated to lands outside the Forest from the 1930s on.

With the start of the Great Depression Puerto Rico was heavily affected, in large part because of the prevailing Parcelero system, the lack of employment, and the overall poverty that was prevalent on the Island since prior to the economic collapse. The result of the initiatives promoted by the Roosevelt New Deal during the Great Depression brought to the El Yunque the Civilian Conservation Corp in 1935 (Valdés-Pizzinni et al. 2011). This program promoted temporary economic relief through the recruitment of young men that would be hired to engage in different reforestation, construction, and renovation projects in Federal and National Forests. Possibly the largest contributions of the CCC the construction of the main access and recreational infrastructure used in the Forest to this day. The CCC generated a new image of the Forest as the “recreational reconstruction of the forest” (Valdés-Pizzinni et al. 2011). Most of the Forest’s recreational manmade landmarks date to this period. Such infrastructure would subsequently make possible the steady increase in visitation of the Forest in the post- depression/post-war period. This CCC work was significant in introducing the urban building construction technique of reinforced concrete and architectural style elements into rural forest recreation settings throughout the island.

The CCC period also coincide with the beginnings of the scientific experimental initiatives and the military use of the Forest. In 1939 the Tropical Forest Experiment Station (Valdés-Pizzinni et al. 2011). The Experimental Station (renamed Institute of Tropical Forestry in 1960) centered its efforts in research on tropical forestry and continues to serve as one of the primary research centers of its type until the current date.

In 1942, the U.S. Army established a “warning radar system” at El Yunque Peak. Other military used of the Forest included maneuver practices in jungle warfare (Wadsworth 2014).

During the 1940s the Puerto Rican Government launched Operation Bootstrap, a strategy to promote the modernization and industrialization of the Island. With the Operation, lands that were once used for agricultural activity were either abandoned or sold for the construction of new suburbs, town houses, and related economic activity. The suburbanization of El Yunque periphery resulted in a rapid population increase in some of the municipalities within the region. However, despite this trend, El Yunque remained important for local residents and tourists in search of a pleasant aesthetic experience and a direct contact with nature.

3.5.4.1 Affected Environment

Archaeological investigations in the area of the El Yunque and surrounding municipalities date back to the late 19th Century when aficionados started recording some existing prehistoric sites around El Yunque. In the years following the transfer of sovereignty after the Spanish-American War, various scientists came to the Island as part of various scientific expeditions. Such academic endeavors, although producing some of the most significant research on Puerto Rican prehistory to this date, did not focus their attention on the

lands that are now the El Yunque National Forest. It is not until a decade after the passing of the National Historic Preservation Act (NHPA) in 1966 that serious archaeological research commences on the Forest. In the early 1980s various surveys of the different timber stands included the description of archaeological sites found during timber inventory work. By then archaeological areas of relevance had extended beyond interest in prehistory to include sites from the historic period such as Parcelero homesteads, Haciendas, and CCC-era infrastructure. In 1981, the Forest completed a comprehensive literature search that documented all reported cultural sites known within the forestlands (Daubon 1981). By the mid-1980s, proper archaeological work was being conducted by a Forest archaeologist, archaeology technicians, and para-professionals. The work carried out in compliance with the various sections of the NHPA continues to this date. In 2003, a Centennial Timeline summarizing the history of the Forest was completed. In 2005, a multi-property National Register Nomination titled the New Deal Era Properties was completed and accepted by the Advisory Council on Historic Preservation. The multi-property nomination centered on the Civilian Conservation Corp infrastructure on the Forest, which was completed with the aim of providing a historical context and stylistic framework which would facilitate the independent nomination of CCC-era properties in the Forest.

Some form of archaeological survey has been completed on about one third of the El Yunque National Forest. Much of such survey was conducted prior to the mid-1990s in support of improvement activities, land acquisitions, road and trail maintenance, and recreation development. This means that the criteria for testing many of these areas might have not responded to their archaeological potential, or to current scientific standards. Various areas have also been independently assessed as part of NHPA Section 106 consultation prior to independent project implementation.

The result of the archaeological work has been the discovery of many historical and archaeological resources. A total of 172 sites are listed for El Yunque as of fiscal year 2015. The NHPA requires that all buildings, structures, archaeological sites, objects and other cultural resources be evaluated and managed as significant or non-significant assets (eligible or not-eligible as per the legislation's wording). To reach such determination of significance the independent resources are evaluated based on their historic context, criteria of significance, and integrity in a multiparty consultation process.

So far 46 sites have been evaluated or partially evaluated and found eligible for inclusion in the National Register of Historic Places at the agency level. Formal concurrence from the State Historic Preservation Officer (SHPO) is required to cement the eligibility status in many of the cases. A total of 22 sites has been evaluated and found not eligible and 104 sites are pending a formal evaluation of eligibility. Of all the eligible properties only one prehistoric petroglyph site has been nominated and listed on the National Register of Historic Places.

Of the 33 sites listed in the New Deal Era Multi-property Nomination Form, ten have been deemed eligible by the agency, with two of them having official concurrence from the SHPO on that determination. One site was destroyed and thus is considered not eligible, while 22 are pending an eligibility determination. Of the 33, none has been independently listed.

3.5.4.2 Environmental Consequences

All Alternatives

Proposed practices can affect the different cultural resources in the Forest in different ways. Cultural resources in El Yunque National Forest can be broadly divided into three major groups: structures, rock art sites, and archaeological sites (historic and prehistoric). Each of them constitutes a sector with different characteristics and different susceptibilities to adverse effects.

Recreational use of the Forest presents the greatest potential effects on the cultural resources in the Forest. Given that all alternatives presented focus heavily on developing or maintaining a high level of recreation, the principal effect is to be received by the historic recreation infrastructure of the Forest. High levels of visitation signify greater access and use of the resources, which increases wear and tear on the infrastructure, and augments the likelihood of damage by use or vandalism. Activities associated with dispersed recreation can affect cultural resources; particularly trail construction associated with the expansion or alteration of existing historic trails.

Other activities involved in other management practices also present the possibility of having effects on cultural resources. For example, activities associated with watershed restoration could impact existing historic dams, which might be potentially eligible for inclusion in the National Register. Another example is the proposed limited timber extraction. Although the El Yunque does not have an active timber extraction program to the scale of other Forests in the mainland, the proposed limited timber demonstration areas (alternative 1) and the proposed “post” harvesting (from Forest products) in the CIRMA (alternatives 2 and 3) could involve activities that cause soil movements, mixing and/or compaction thus having the potential to disturb archaeological sites. Activities such as lowering the maintenance level of existing trails (alternative 3) will have effects on the existing historic trail infrastructure. The increase in the efforts to share historical information as well as the proposed reuse of existing historic infrastructure will also have direct and indirect effects on the resources in the Forest.

An outline of the actions that will have predicted effects on cultural resources is outlined below by alternative. For each alternative the effects of the desired future conditions (DFCs), management areas, and geographic areas was taken in account (if present on the plan). The DFC section includes the actions that were considered to have the likelihood of having effects on cultural resources. Actions not listed were found to present a very low to non-existent likelihood of effects, and thus were not outlined.

We acknowledge that some of the proposals made are programmatic in nature and do not present enough detailed information with enough definition to properly assess the effects of the individual undertakings. As such they will be assessed on a project-base-level at the moment of implementation. In the case of cultural resources the effects assessment will include NEPA, as well as NHPA consultation.

Alternative 1

New Developed Recreation Sites (Recreation and Facilities and Transportation)

Increase in public access and use of the Forest would have the potential to affect cultural resources. The increase in public visitation increases the potential for vandalism of archaeological sites and historic infrastructure. It also increases decay by wear and tear of actively used historic recreation infrastructure such as trails, observation towers, picnic shelters and access roads. The construction of new developed recreation areas would involve some level of soil movement, which potentially could disturb existing archaeological sites at the chosen development locations. Expansion of existing historical recreation infrastructure could also alter the context of each location altering its integrity and significance.

Environmental Education – Cultural Resources

The proposed educational and interpretative offering, which will “assist visitors and users in understanding... the role of ... cultural resources” will have the effect of increasing knowledge and awareness of the resources. That could have the effect of reducing misuse and vandalism because of increased awareness of the importance of the resource.

Wild and Scenic Rivers and Scenery – Cultural Resources

The proposed management of these areas as restricted development sections will reduce the possibility of undertakings which could disturb cultural resources.

Timber Demonstration – Cultural Resources

Extraction of timber has the potential to involve a variety of activities, which could result in soil movements and direct damage to archaeological resources. Such activities could include but are not limited to yarding, access road creations, soil compaction by machinery or traffic, and soil destabilization.

Management Areas - Cultural Resources**Management Area 1 (Administration sites).**

The proposed reconstruction of trails could affect their historic integrity.

Management Area 2 (Developed Recreation).

The development and enhancement of developed recreational activities in this area presents the potential to have direct and indirect effects on existing historic infrastructure and historic properties, which make up the backbone of the recreational offering. Effects of the actions on this area are the same as the ones outlined previously on the “New Developed Recreation Sites” assessment above.

Management Area 3 (Communications Sites).

The proposed removal of communications facilities from the east end of El Yunque Peak Site and the proposed interpretation of the cultural resources there will have the effect of removing the detracting modern infrastructure from the cultural resource enhancing its historical context and user experience.

Management Area 4 (Integrated).

Some research and dispersed recreation activities to take place in this area present the likelihood of potential disturbance to cultural resources if they involve soil movement and by increasing unsupervised access to existing or undiscovered resources in the area.

Management Area 5 (Wilderness).

The proposed management of these areas as restricted development sections will reduce the possibility of undertakings, which could disturb cultural resources.

Management Area 6 (Research Management Area).

The potential exists for research projects to disturb archaeological sites or alter the characteristic of existing historic properties if the research activity is to involve soil disturbance and/or installation of research equipment on historic properties.

Management Area 8 (Timber Demonstration).

The timber extraction activities proposed for this area have the same potential effects as the Timber Demonstration desired future condition.

Management Area 9 (Scenic Rivers and Scenery Resources).

The proposed management of these areas as restricted development sections will reduce the possibility of undertakings, which could disturb cultural resources.

Alternative 2**Socioeconomics - Cultural Resources.**

The economic opportunities provided to the community, such as guided excursions and outfitting opportunities, have the potential to increase visitation to cultural resources, such as scenic areas with petroglyphs, enhancing educational opportunities. Increasing unsupervised visitation and encounters with archaeological sites could lead to looting and damage to resources. Partnerships with the community have the potential effect of increasing site condition monitoring opportunities.

Environmental Education - Cultural Resources.

The development of interpretative and educational efforts can have a direct, indirect, and cumulative effect on the preservation of historic properties by increasing awareness of their importance in the public's mind, potentially reducing misuse and vandalism.

New Developed Recreation - Cultural Resources.

Developing recreational opportunities in the lower part of the Forest will have the effect of reducing the strain on the existing historic recreational infrastructure located on the upper part of the Forest (PR Road 191 Corridor). The development of new recreation areas in the lower parts could have a direct impact on already discovered or undiscovered historic and archaeological resources if the development includes soil movements. A long-term cumulative effect and indirect effect could result if the newly developed recreation opportunities grant access to archaeological and historic resources by means of developed recreation areas such as parking lots, picnic areas and trails. This might cause an increase in opportunities of unsupervised access to the resources, which could lead to looting, vandalism, and/or damage.

Actions on reducing the backlog of maintenance of existing recreational historic infrastructure will have a direct effect of improving the historic properties condition. The increase in historic literacy that will result from the development of the proposed historic/cultural recreation opportunity guides will have the potential effect of increasing awareness on the importance of heritage resources.

Forest Products - Cultural Resources.

The extraction of Forest products within the CIRMA could have a direct effect on archaeological/historic resources if the extraction of such resources would include any kind of soil movements such as those created during the construction of new access roads, timber yarding, planting and harvesting areas, etc.

Facilities and Transportation - Cultural Resources.

The proposed creation of timber extraction roads has the potential to disturb existing archaeological sites. The proposed private investment opportunities on abandoned historical facilities as well as the proposed annual maintenance inspections are likely to have an effect on the enhancement of the condition of the historic infrastructure.

Management Areas - Cultural Resources**Management Area 2 (El Yunque/Yokahu Zones).**

The restoration and management of recreation infrastructure in these areas will have a direct effect of maintaining/preserving existing historic infrastructure, which is the backbone of the infrastructural recreational offering. The interpretation of the cultural resources in that area could have a direct and cumulative effect of reducing damaging practices by the public such as vandalism. The increase in visitation to the resources in that area could have the indirect effect of increasing vandalism and wear and tear on the historic infrastructure.

Management Area 3 (Communications).

The proposed removal of communications facilities from the east end of El Yunque Peak Site will have the effect of removing the detracting modern infrastructure from the cultural resources located at the El Yunque Peak. The proposed interpretation of the cultural resources there will directly enhance its historical context and the public understanding.

Management Area 4 (CIRMA).

The increase in access of the community to this land will have the effect of increasing access to cultural resources in this area. That could develop into greater vandalism and looting of existing or still undiscovered cultural resources in that area. The use of the area for dispersed recreation could reduce the effects that the high visitation has on the cultural resources located on the upper part of the Forest. The co-management of this area could have the direct effect of increasing stewardship and co-management opportunities of the cultural resources in the area and can increase educational opportunities. Resource extraction activities proposed for this area have the direct or indirect potential of disturbing cultural resources if they involve the creation of roads, soil movement, or other practices similar to the ones outlined on the desired future conditions section for CIRMA.

Management Area 5 (El Toro Wilderness).

The preservation of the area as a wilderness would limit all development, thus directly reducing direct and indirect effects on present cultural resources. The restrictions it imposes on management practices will have the direct effect of reducing the ease of maintenance on the two historic trails existing in the area (Trade Winds and El Toro).

Management Area 6 (Research).

The potential exists for research projects to disturb archaeological sites or alter the characteristic of existing historic properties if the research activity is to involve soil disturbance and/or installation of research equipment on historic properties.

Management Area 7 (Research Natural Area).

The use of this area for non-manipulative studies only will have the indirect effect of restricting recreational use and discouraging public traffic, and reduces the likelihood of invasive research. All this has the direct effect of reducing the likelihood of disturbance to cultural resources in the area.

Management Area 9 (Scenic Byway 186).

The proposed creation of the Scenic Byway Management Area as outlined will require a higher level of maintenance, stewardship, and interpretation of the historic sites along the route. The increase in maintenance and interpretation will help improve and monitor the conditions of the resources, which have been neglected to a greater degree than similar resources along PR Road 191. This will have an effect on the resource by increasing public awareness of the resources importance, and has the potential to increase visitation to a number of historic structures along the route. The increase in visitation on the area might increase the likelihood of vandalism on the sites. It will also have the accumulative effect of wear and tear on the sporadically used historic road, bridges and related features.

Geographic Areas - Cultural Resources**North and Southwest Geographic Areas.**

The proposed increased interconnection of existing trail to points of access within the municipalities will likely have the indirect effect of increasing accessibility to the Forest and its cultural resources. This could translate into increased use of the newly accessible areas, augmenting the likelihood of wear and tear on

the existing historic trails, and increasing the potential of unauthorized activities such as vandalism and looting. The proposed development of collaborative efforts with the community for increasing collaboration, conservation, and interpretation initiatives will potentially have the indirect effect of increasing educational and interpretative opportunities to increase education about the cultural resources in the Forest. The increase in collaboration might directly affect the conservation and study of cultural resources by increasing research, funding, and partnerships towards that goal.

Alternative 3

The effect of the resources desired conditions are the same as in alternative 2, but it adds the following.

Extension of Wilderness to Research Natural Area - Cultural Resources.

The recommended extension of the wilderness area to encompass the Baño de Oro Research Natural Area would potentially have the effect of reducing the probability of site disturbances due to the highly regulated practices and activities allowed on wilderness reserves.

Facilities and Transportation - Cultural Resources.

The proposed change of trail care level to maintenance levels will have an effect on the maintenance of the many of the historic trails. The reduction of maintenance will affect the conservation of the historic trail system and its potential interpretative use.

Management Areas - Cultural Resources

Management Area 2 (El Yunque/Yokahu Zones).

The restoration and management of recreation infrastructure in those areas will have a direct effect of maintaining preserving existing historic infrastructure, which is the backbone of the infrastructural recreational offering. The interpretation of the cultural resources in that area could have the effect of reducing damaging practices by the public such as vandalism. The increase in visitation to the resources in that area could have the indirect effect of increasing vandalism and wear and tear on the historic infrastructure.

Management Area 3 (Communications).

The proposed removal of communications facilities from the east end of El Yunque Peak Site will have a direct effect of removing the detracting modern infrastructure from the cultural resources located at the El Yunque Peak. The proposed interpretation of the cultural resources there will directly enhance its historical context and the public understanding.

Management Area 4 (CIRMA).

The increase in access by the community to this land will have the direct effect of increasing access to cultural resources in this area. That could result in greater vandalism and looting of existing or still undiscovered cultural resources in that area. The use of the area for dispersed recreation could reduce the effects that the high visitation has on the cultural resources located on the upper part of the Forest. The co-management of this area could have the effect of increasing stewardship and co-management opportunities of the cultural resources in the area and can increase educational opportunities. Resource extraction activities proposed for this area have the potential of disturbing cultural resources if they involve the creation of roads, soil movement, or other practices similar to the ones outlined on the desired future conditions section for CIRMA.

Management Area 5 (El Toro Wilderness).

The preservation of the area as a wilderness section will limit all development, thus directly reducing direct and indirect effects on present cultural resources. The restrictions it imposes on management practices will have the direct effect of reducing the ease of maintenance on the two historic trails existing in the area (Trade Winds and El Toro).

Management Area 6 (Research).

The potential exists for research projects to disturb archaeological sites or alter the characteristic of existing historic properties if the research activity is to involve soil disturbance and/or installation of research equipment on historic properties.

Management Area 7 (Baño de Oro Proposed Wilderness).

The extension of the wilderness area into the 629-acre section of the research natural area will extend the protections and restrictions of wilderness management to this area. This will have the effect of limiting all development in the designated section, reducing direct and indirect effects to the cultural resources present. The restrictions it imposes on management practices will have the direct effect of reducing the ease of maintenance and monitoring of existing resources in the area.

Geographic Areas - Cultural Resources**North and South Geographic Areas.**

The proposed increase interconnection of existing trail to points of access within the municipalities will likely have the direct effect of increasing accessibility to the Forest and its cultural resources. This could translate in increased use of the newly accessible areas, increasing the likelihood of wear and tear on the existing historic trails and increasing the potential of unauthorized activities such as vandalism and looting. The proposed development of collaborative efforts with the community for increasing collaboration, conservation, and interpretation initiatives will potentially have the indirect effect of increasing educational and interpretative opportunities involving the cultural resources in the Forest. The increase in collaboration might directly affect the conservation and study of cultural resources by increasing research, funding, and partnerships towards that goal.

3.5.5 Recreation

This analysis focuses on recreation sustainability and issues related to visitor use, capacity, and recreation infrastructure (parking limitations, structures, maintenance, demand) and recreation impacts to resources. For the cumulative effects analysis the following activities and plans that occur on the private land/Forest interface were considered including the east, west and southwestern regions. Foreseeable actions include the development of a regional trail with municipalities and a non-profit partner that would connect the Forest to the coast, and a state proposal for a scenic byway on the western side of the Forest. Ongoing activities include community use located adjacent to the Forest interface areas. The timeframe is the life of the plan (approximately 15 years).

3.5.5.1 Affected Environment***Visitor Use and Recreation Settings***

Covering approximately 29,000 acres, the El Yunque is the only tropical rain forest in the National Forest System, boasting unique and breathtaking views, biodiversity, and a variety of outdoor recreational opportunities. It is a favorite recreation destination for both locals and the many tourists who visit Puerto Rico from around the world. The Forest receives over 650,000 visitors per year (Buta et al. 2014). These visitors make over 1.2 million site visits making it one of the most heavily visited Forests per acre in the

National Forest System. This means that most Forest visitors visit more than one Forest destination during their visit. The major recreation areas (picnic areas and trails, observation tower, pools and bathhouses) are located along the main access road PR-191, which was built in the 1930s by the Civil Conservation Corps (CCC). Many of these structures and facilities are still in use today.

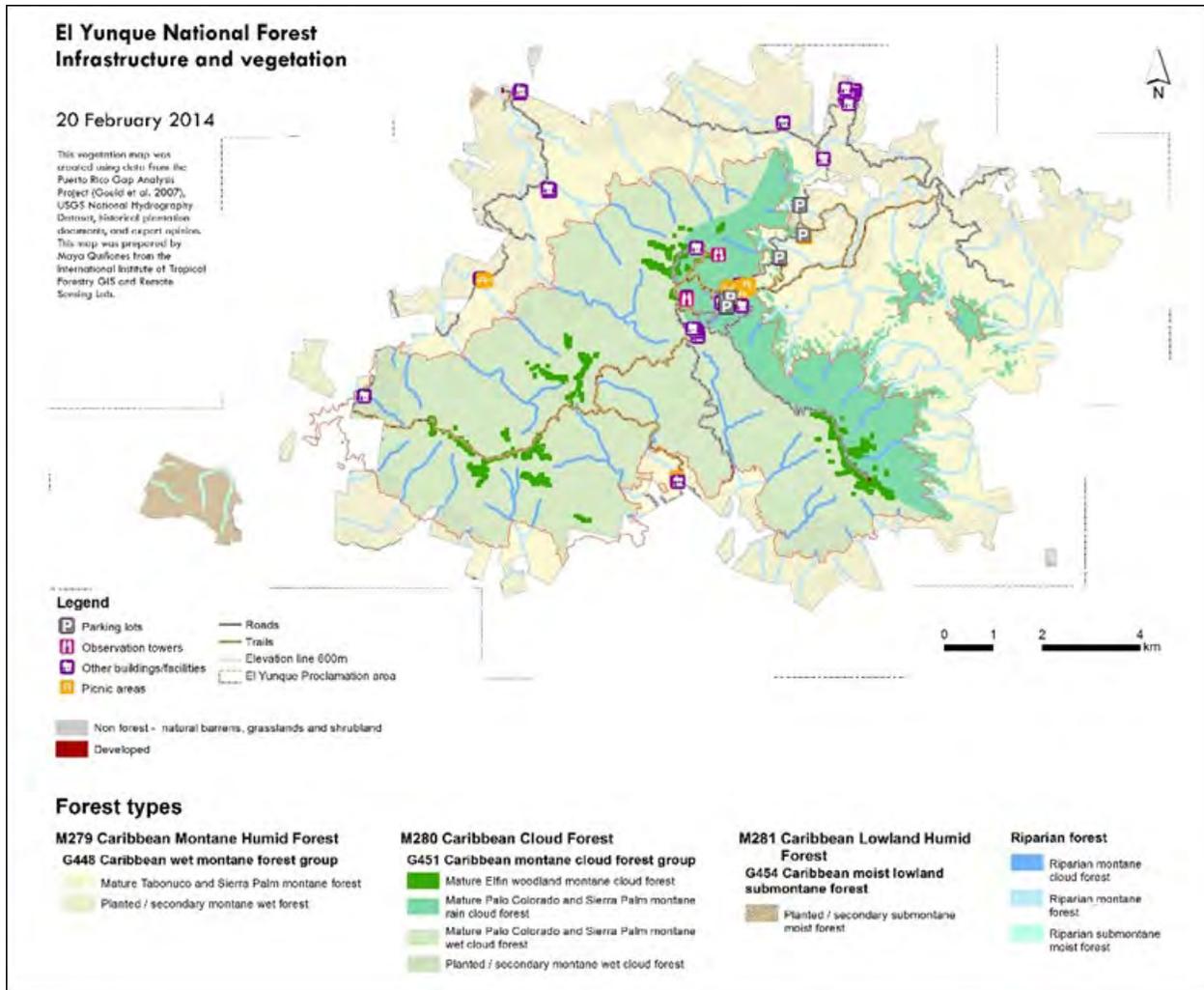
Recreation use occurs year-round due to the warm tropical climate. Use by local visitors is greater during the summer months, while more international visitors come during the winter months. The total number of visitors is approximately evenly divided between local residents and off-Island tourists. The types of recreation activities in the Forest has not changed drastically throughout the years. Visitors continue to enjoy hiking along trails, using the picnic areas, stopping at vista points and at the observation towers, photographing nature, and cooling off in the river and streams.

The recreation opportunity spectrum (ROS) is used to identify recreation activities throughout a Forest. The ROS provides a framework for Forest administrators to manage and users to enjoy a variety of recreation environments. The ROS is used to determine if projects are compatible with Forest recreation goals. At the project level, the desired ROS is used to determine if a project is moving toward or away from the desired ROS. In many cases, change to the transportation system can have the biggest impact on ROS. The main Forest recreation activities include hiking, viewing nature, picnicking, water play, scenic driving, and nature study. Primitive camping is available by permit only.

The ROS classes in El Yunque range from “semi primitive non-motorized” to “rural” settings. El Yunque has 21 active recreation sites that include a high capacity visitor center, 4 picnic areas totaling 51 picnic shelters, 12 observation sites, and 8.7 miles of trails. Recreational opportunities based on available recreation sites at El Yunque include hiking, backpacking, primitive camping, water play, picnicking, scenic driving, nature viewing, viewing cultural resources, photography, birdwatching, outdoor learning and nature study.

El Yunque has four access routes that run through the Forest; PR-191, PR-988, PR-9966, and PR-186. Recreational opportunities on PR-988, PR-9966, and PR-186 are currently limited due to available development, available personnel, road conditions, and limited use; making PR-191 an 8.1-mile, two lane road with no throughway, the primary recreation opportunity corridor. Despite a proportionally high level of concentrated development along PR-191, developed recreation sites do not meet the demand during high visitation periods.

Despite the level of development along the PR-191 corridor (Map 3-18), El Yunque is challenged to fully provide recreational opportunities. New vehicle limits on the highly popular PR-191 corridor are monitored by vehicle counters, allowing management the tools necessary to manage and regulate the maximum number of visitors in the corridor at one time and thus reduce some of the impacts associated with “extremely high” and “excessive” use. This management, however, comes at the cost of lost recreational opportunities to visitors who are not able to enter the PR-191 Corridor. While PR-186, PR-191 south, PR-988, and PR-9966 provide access to other locations in the Forest, road conditions and lack of public knowledge deter users from visiting these other locations. While potential and demand to develop additional recreational opportunities along state roads in El Yunque exist, current limitations to funding levels and adequate personnel prohibit increased development. These needs to account for both capital improvement costs along with the additional operation and maintenance costs associated with additional developed recreation sites.



Map 3-18. El Yunque National Forest infrastructure and vegetation

Recreation Infrastructure

Forest visitors visit several destinations during their time on the Forest. Recreation on the Forest has been ongoing since the first facilities were constructed during the CCC period in the 1930s. Most of these facilities are still in use. Several facilities have been improved to meet current sanitary and accessibility standards and to increase parking capacity by redesigning parking areas and creating overflow parking spaces. These include Yokahu Tower, Palma de Sierra Picnic Area, and Palo Colorado Picnic Area. Forest vegetation density and steep topography greatly limit expansion of existing facilities as well as the development of new facilities.

There are two recreation sites along PR-988 which are mostly used by neighboring communities; these are Puente Roto and Angelito Trail. Puente Roto is mostly used on weekends and holidays and has parking issues and trash problems. The Rio Mameyes was designated as a wild and scenic river which require special protection and management. Angelito Trail is a short trail that leads to Rio Mameye, a favorite local water play area. Parking in this area has been a concern due to several car clouting incidents. See the recreation specialist report for additional information on recreation sites and infrastructure.

State road PR-186 crosses through the western portion of El Yunque, traveling through a mixture of Forest and urban settings. Portions of this road have a number of scenic views and waterfalls; however, poor road conditions and lack of knowledge prevent Forest visitors from recreating on this portion of the Forest. Mostly locals recreate at the various river crossings that occur along this road.

Recreational opportunities are fairly limited. Currently, both El Toro Trailhead and Quebrada Grande Picnic Area are closed. El Toro Trail #34, a 2.2-mile trail crossing through El Toro Wilderness, is in need of repairs to address major drainage problems. Quebrada Grande Picnic Area is currently closed due to low use and poor road conditions in the area.

The high use of trails, especially the trails that do not have a built-hard surface, have eroded the trail surface causing erosion problems on the trail surface itself. In some cases the actual trail has become the main drainage-way. The picnic shelters also receive high use which require high maintenance for sanitary reasons and graffiti. See the recreation specialist report for additional information on recreation infrastructure.

Recreation Capacity

In 2011, capacity along PR-191 was set at 300 vehicles, based on 274 available parking spaces and approximately 26 parking spaces at private in-holding stores and restaurants along PR-191. Available parking at El Portal was evaluated separately because it is a recreation fee site.

Based on a 100 percent capacity of 300 vehicles, use classes were set as 33, 66, 100, 133, 166, and 200 percent plus, from low to excessive, using road counter data from PR-191 during portions of 2014 and 2015. The percentage of each use type was also computed based on counter data. In addition, the number of visitors in the Forest was approximated using an estimate of 2.5 visitors per vehicle. The results of this exercise are shown on Table 3-42.

Currently, developed recreation sites along PR-191 routinely receive very high (133 percent capacity) to excessive (200 percent capacity) use throughout the season, with a long recreational season that starts in November and continues into the new year to August, providing the Forest only two truly moderate use months (September and October). Highest use months are March, July, and December.

Table 3-42. Approximate vehicles and users per level of use

El Yunque Approximate Vehicles and Users Per Level of Use	Low (0-100)	Mod (101-200)	High (200-300)	Very high (300-400)	Extreme (400-500)	Excessive (500+)
Percent of use type per year	4%	15.0%	31.0%	30.0%	13.5%	7.0%
Number of vehicles in Forest	100	200	300	400	500	600
Percent of total capacity	33%	66%	100%	133%	166%	200%+
Vehicles seeking parking	0	0	40	140	240	340+
Total vehicles/day	300	500	700	900	1,100	1400
Total users/day (2.5/vehicle)	750	1,250	1,750	2,250	2,750	3500
Number of users in Forest (2.5/vehicle)	250	500	750	1,000	1,250	1500

'Number of vehicles in forest' and 'Number of users in forest' show an estimate of the number of users in the PR Road 191 corridor during a given use level while 'Total vehicles per day' and 'Total users per day' show an estimate of the total users per day during a given use level.

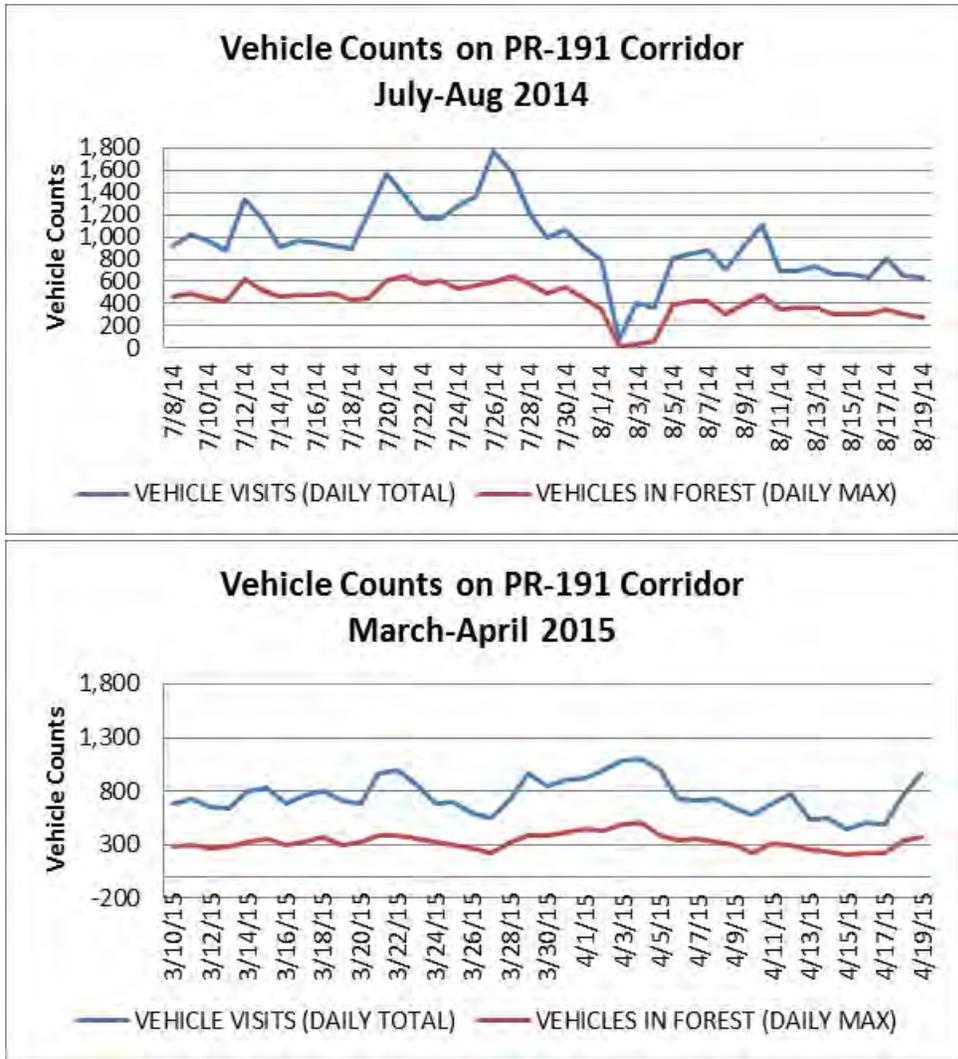


Figure 3-12. Vehicle use counts on PR Road 191 Corridor

Table 3-43 and Figure 3.12 shows “extreme” and “excessive” use during the July and August 2014 busy season. Table 3-44 and Figure 3.12 shows “very high” and “extreme” use during the March and April 2015 busy season. Daily total visits track the total number of visits during a given day, while daily max tracks the maximum number of vehicles in the Forest at any one time. The sudden drop in use in early August is due to extreme weather.

Capacity issues are mostly concentrated at Big Tree Trail, La Mina Falls, and Palo Colorado Picnic Areas. Big Tree Trail and Palo Colorado Picnic Areas provide the main access route to La Mina Falls. Additional details are located in the Recreation Specialist Report. This heavy concentration of people and vehicles have an impact on the resource. There are designated parking areas as well as overflow parking, but once these areas are full, people start parking their vehicles anywhere they find an open space along PR-191.

This uncontrolled parking impacts vegetation and natural drainages. Vehicles often get stuck and require towing. Another impact from high visitation is the amount of trash generated. Trash is piled next to trash cans once they are full and some of that trash ends up along the trails and in Rio de la Mina, a wild and scenic river. Outfitters and guides are also a part of the capacity issue. They continue their normal

operations regardless of the high visitation and traffic congestion. Some outfitters will drop their customers off at one of the two La Mina Falls access trails and pick them up at the other trail where they exit the falls. Tour buses average about 20 to 25 persons.

The Forest Interpretive Association is providing visitor services at El Portal and Palo Colorado Picnic Area. The Association also has store outlets at La Coca Falls and Yokahu Tower providing limited customer service. The food concessionaire provides some visitor service information at Big Tree Trailhead, Palo Colorado, and Palma de Sierra Picnic Areas. The El Yunque Park Rangers provide partners with visitor information training annually.

The capacity issue at La Mina Falls has made outfitters and Forest visitors seek other water venues in the Forest. Juan Diego Creek has recently become an option for people seeking a stream with a waterfall. Juan Diego Creek is near Big Tree Trail parking areas making it easy for people to walk along the road to reach the creek. The increase in visitation to this area has caused severe erosion problems along the paths that lead to the falls. Once there, some visitors have opened a new path to get to the upper portions of the creek, causing erosion problems. The Juan Diego Creek area is a small area which is being overused and is being negatively impacted by high visitation.

To address current capacity issues, the Forest has implemented traffic control operation (TCO) during high visitation periods (spring break and June and July). The TCO consists of placing Forest personnel at strategic recreation sites to monitor parking and traffic flow. Currently the state police, in cooperation with Forest personnel, assist during TCO. When all available parking areas are full a Forest closure is implemented at the La Coca Falls gate. The tram system is still being evaluated to determine the best activation periods and routes to be used. TCO staffing and funding has had an impact on the Forest due to the fact that high visitation mostly occurs on weekends and holidays.

Despite the high level of development on the PR-191 North Corridor, ongoing very high to excessive levels of use are taxing the existing infrastructure. Impacts from high visitation are varied both in type and duration. Types of impacts during “very high” to “excessive” use could include increased health and safety risks, impacts to trail resources, and social encounters.

During “very high” to “excessive” levels of use, risks to public health and safety increase due to the number of visitors on the road, high levels of traffic, limited restrooms, and longer emergency response times. Use levels are highly variable through the day as use increases and decreases and tend to peak between 10:00 a.m. and 2:00 p.m. during high visitation periods. The risk to public safety is particularly pronounced during extremely high to excessive use, when an alarmingly high number of vehicles and visitors are packed in a relatively small stretch of road with limited parking, leading to high a number of vehicles parking in non-designated spots, large crowds congregating in roads, extreme to excessive numbers of visitors overwhelming public restroom facilities, and a practical standstill of vehicular traffic, resulting in extended emergency vehicle response times. These increased risks, however, are short term and cease once the use levels are reduced, with the exception of health and sanitation impacts, which manifest in the form of urine smell around structures such as picnic and rain shelters, and can linger until major rain events.

Impacts to trails also increase during periods of very high to excessive use, when even the high level of trail development is not sufficient to reduce visitor impacts as crowds begin to pass each other on the trail shoulder, producing soil compaction, killing vegetation, and in essence widening the trail. These increased impacts are cumulative over time as the vegetation’s resiliency is effectively reduced due to ongoing trampling during repeated and prolonged periods of “very high” to “excessive” use.

Another impact along trails during periods of “very high” to “excessive” use is the number of social encounters. While a large number of facilities and trails fall under an “urban” ROS setting, which defines the level of social encounters as “Large numbers of users on site and in nearby areas” and “High number of social encounters”, one could easily argue that during periods of “extremely high” and “excessive” use, one could encounter such large crowds that would exceed even the “urban” setting. This is particularly pronounced around observation points where large crowds can block access and or views. For areas with ROS settings below “urban,” ROS settings would increase to “urban” during periods of “very high” to “excessive” due to the large number of encounters, regardless of the physical setting.

Figure 3-12 shows the daily use patterns for PR Road 191 during a week in July. These daily patterns show that demand increases in the morning, peaks in the afternoon, and drops in the evening. During the busy months, use can reach “high” (67 to 100 percent) capacity as early as 9:00 a.m., “very high” (101 to 133 percent) by 9:30 a.m., “extremely high” (134 to 166 percent) by 10:00 a.m., and “excessive” (167 to 200 percent) by 11:00 a.m. “Excessive” use can last as long as 3:30 p.m.; with use patterns dropping to high by around 5:00 p.m. Such a high level of use has forced the Forest to close access at approximately 450 to 500 vehicles due to the increased risk to public health and safety along with correlated trail widening during “extreme” and “excessive” use. Forest closures due to “extreme” and “excessive” use can be seen in the daily use patterns for Thursday, Friday, Saturday, and Sunday as a temporary steep drop in use. There is a second increase in use as the Forest is opened to the public again. The Forest is still fine-tuning the counter system to provide better real-time data so they can better manage use in the Forest.

Existing Recreation Sites in El Yunque

Forest access routes through the Forest include four state roads: PR Road 191 North, PR Road 191 South, PR Road 988, PR Road 9966, and PR Road 186. These access state roads vary in condition and level of amenities provided. Currently, the majority of the recreation infrastructure is centered on the north portion of PR Road 191 North, a limited 8.1-mile road with no throughway. Developed recreation is analyzed based on access routes.

Recreation Sites on PR Road 191 North

PR Road 191 is unique in that it runs through the center of El Yunque, providing intimate access to an otherwise highly inaccessible landscape. A landslide in the mid-1970s closed portions of PR Road 191 to the public. Use on PR Road 191 North is currently an 8.1-mile loop road. This means that vehicle traffic enters and exits this area of the Forest along the same road.

A total of 20 recreation sites range in ROS class from “roaded natural” to “urban.” The primary route through EL Yunque provides a high level of developed recreational opportunities in this area. There is a visitor center, an information roadside kiosk, 6 roadside observation sites, 3 picnic areas with a total of 41 picnic shelters, 5 trailheads serving 8.3 miles of trail connecting to an additional 7 observation sites and the recreation portion of the La Mina Wild and Scenic River, all along 8.1 miles of road through a tropical forest ecosystem. In addition, private inholdings along PR Road 191 North also provide a number of additional services ranging from novelty shops to food services (Table 3-37).

Table 3-43. Demand per trail system based on total visitors during low through excessive use

El Yunque Trail System: Demand Per Trail System Based on Total Visitors During Low Through Excessive Use	Parking	Miles	Low (0-100)	Mod (101-200)	High (200-300)	Very High (300-400)	Extreme (400-500)	Excessive (500+)
La Mina Falls Trail System	101	1.6	125	250	375	500	625	750
El Yunque Trail System	77	3.8	95	190	285	380	475	570
Mt. Britton Trail System	24	1.1	30	60	90	120	150	180
# of Users In Forest	202	6.5	250	500	750	1,000	1,250	1,500
# of Vehicles In Forest			100	200	300	400	500	600
% of Use Type/Year			4.0%	15.0%	31.0%	30.0%	13.5%	7.0%
Risk to Public Health and Safety			L	L	L	M	H	VH
Resource Damage			L	L	L	M	H	VH
Social Encounters			L	M	M	H	VH	VH

Table 3-44. Total Daily visitors per trail system (based on total use per day)

El Yunque Trail System: Total Daily Visitors Per Trail System (Based on Total Use Per Day)	Parking	Miles	Low (0-100)	Mod (101-200)	High (200-300)	Very High (300-400)	Extreme (400-500)	Excessive (500+)
La Mina Falls Trail System	101	1.6	375	625	875	1,125	1,375	1,750
El Yunque Trail System	77	3.8	285	475	665	855	1,045	1,330
Mt. Britton Trail System	24	1.1	90	150	210	270	330	420
Total # of Users/Day	202	6.5	750	1,250	1,750	2,250	2,750	3,500
Total # of Vehicles/Day			300	500	700	900	1,100	1,400
% of Use Type/Year			4.0%	15.0%	31.0%	30.0%	13.5%	7.0%
Risk to Public Health and Safety			L	L	L	M	H	VH
Resource Damage			L	L	L	M	H	VH
Social Encounters			L	M	M	H	VH	VH

Table 3-43 shows an estimate of the number of users wanting to use a particular trail system during “low,” “moderate,” “high,” “very high,” “extreme” and “excessive” use periods. Table 3-44 shows an estimate of the total number of users that may use a particular trail system per day during these same periods. (That is, Table 3-43 shows real-time demand while Table 3-44 shows total daily use). These tables show the magnitude of use during “very high” to “excessive” use; and also the percent of the year that the trail systems endure given use levels. Note that trails receive above maximum capacity (from “very high” to “excessive”) 50.5 percent of the time. For perspective, during excessive use levels there may be approximately 750 visitors at La Mina Falls Trail System and as many as 1,750 visits in a day. During

periods of “extremely high” to “excessive” use, some visitors will not be able to see La Mina Falls due to the large crowds.

Note that on Table 3-43 and Table 3-44, use is distributed based on parking availability as a percentage of total parking and is meant as general reference. While this table represents potential use based on available parking, La Mina Falls is incredibly popular, and may actually draw some use away from El Yunque Trail system parking areas. La Coca Trail was not included in the Forest trail system because of its low use, challenging conditions, and limited parking spaces (four each).

The alternatives presented focus on managing recreation in different Forest settings and circumstances. They provide direction on how to manage recreation activity in designated wilderness areas and wild and scenic rivers (alternative 1). Alternatives also address the impacts related to high concentrated visitation and finding new recreation alternatives outside the PR-191 corridor (alternatives 2 and 3).

The actions that will affect recreation are outlined by alternative. The desired conditions, management areas, and geographic areas were the major topics evaluated in each alternative. In the desired conditions section only the actions directly related to recreation were evaluated. The same applies for management and geographic areas.

3.5.5.2 Environmental Consequences

Effects Common to all Alternatives

All alternatives continue to offer recreation along the PR 191, resulting in continued need to address capacity on PR 191 and infrastructure maintenance for this corridor. This is a direct effect of using PR 191 as a recreation area in the Forest. All alternatives offer the same forms of recreational opportunities, which would continue to affect the resources that are utilized for these types of recreation. For example, water play would continue within the Forest, resulting in a need to monitor water quantity and quality as well as climate change effects.

Alternative 1

This alternative follows the 1997 Forest Plan direction which does not include a component that addresses sustainable recreation. This Plan calls for an increase in recreation opportunities to meet current and future demands regardless of impacts to the resource. There is limited direction to address the impacts that recreation site development will have on Forest infrastructure and capacity.

Under the current plan, there would continue to be impacts to existing recreation facilities with the increased use and high visitation. The deterioration of trails due to high use would continue to create safety issues. The cumulative effects of having more recreation development will detract from having a quality experience in the rain forest, due to how it impacts the natural settings of the Forest; not to mention the amount of impact it will have on other resources. The impact of climate change with relation to recreation is not addressed in this alternative. The social and economic issue related to recreation would continue to provide options to local businesses and outfitters and guides.

Recreation Sites.

The needs of Forest visitors are met with services and facilities. Opportunities and facilities for a wide variety of recreation experiences are met. Recreation demands are prioritized over impact to facilities and capacity issues. Trails systems focus on experience, ecosystems, difficulties, and length. Protection of the trail systems is not addressed. Recreation activity continues to be concentrated in the main PR-191 Corridor, because it does not offer recreation in other areas of the Forest.

Wild and Scenic Rivers - Recreation.

Recreation segments of designated wild and scenic rivers allow for picnic area and trail construction in close proximity to the river. This type of development would increase the amount of trash near the rivers.

Law Enforcement - Recreation.

Parking and traffic management and uniformed Forest Service personnel are used at times and locations of heavy public use. The increase in Forest visitation requires new and updated methods to deal with high visitation.

Environmental Education - Recreation.

The capacity for offering environmental education would continue to be reduced because this alternative does not offer environmental education under collaborative considerations. The program would continue to be oriented toward learning about the resource and not about protecting the resource or learning about impacts related to carrying capacity issues.

Management Areas - Recreation**Management Area 1 (Administrative sites):**

The recreation components in this management area are located at the lower levels of the Forest where building enhancement has occurred with the construction of the El Portal Visitor Center. The plan would allow for additional recreation development that may not be considering current visitor capacity levels, available facilities, parking and fiscal reality on the Forest.

Management Area 2 (Developed Recreation):

Management Area 2 direction provides for the construction of new developed recreation facilities, but does not address protection of the resources. The construction of new facilities could adversely affect the natural resources found in the PR-191 Corridor. This could also result in the unsustainable use of Forest ecological and infrastructure resources when considering climate change tendencies that can range from severe droughts (summer and fall 2015) to heavy rain events and flashfloods (resulting in landslides).

Management Area 3 (Communication Sites):

Improving vista point at El Yunque Peak Observation Tower would provide hikers with an undisturbed panoramic view of the Forest and the Atlantic Ocean coastline. There is limited conflict between recreation facilities and the communication sites and structures. The ROS setting changes from “semi-primitive non-motorized” along the hiking trails to “semi-primitive motorized” along the roads that service the communication sites, yet this as stated in this alternative does not propose a recreational alignment.

Management Area 4 (Integrated):

MA 4 would continue to be managed for ROS class “roaded natural undeveloped” near open roads and “semi-primitive non-motorized” which provides for a natural recreation setting. This MA does not include collaboration as an option with neighboring communities to better protect resources and to offer other uses within this management area; limiting socioeconomic development in these areas. No dispersed recreation is included to alleviate capacity issues on the PR-191 Corridor.

Management Area 5 (Wilderness):

Maximum encounters and group sizes need to be revised to address the protection of the resource; considering that wilderness designated areas have standards in respects to human encounters. There is a

trail that goes from east to west. The current group size is causing damage to the vegetation along the trail and increasing the number of social trails particularly during wet weather conditions.

Management Area 6 (Research):

Continues to limit recreation use in this area due to its location and lack of infrastructure

Management Area 7 (Research Natural Area):

Continues to allow recreation activity in the periphery of the management area. The area does not have an ROS class assignment.

Management Area 8 (Timber Demonstration):

This management area should not have an ROS class assignment for safety and health reasons.

Management Area 9 (Scenic and Recreation River Corridor):

Continue to manage the recreation segments of Rio de la Mina and Rio Mameyes. The proposed development of a picnic area near the crossing of the Rio Mameyes and PR-988 (Puente Roto) would increase recreation activity increasing trash along and near a wild and scenic river. There will also be an impact on the natural setting and create additional river access points.

Alternative 2

This alternative addresses the issue of sustainable recreation and the protection of the resource. Plan direction would limit recreation activities in sensitive areas of the Forest. It would allow at the project level for alternative recreation sites to be identified/constructed at lower forest elevations. The creation of the community interface resource management area (CIRMA) would provide for engagement with community groups to help manage and maintain recreation areas at the lower elevations near their communities. Capacity issues would be addressed and managed in a way that the resource is protected and the visitor becomes more involved in helping with trash management.

Alternative 2, the preferred alternative, addresses recreation capacity, the protection of the resource (wetlands), and identifying alternative recreation sites and activities in the lower elevations of the Forest located in the CIRMA and the development of an alternative scenic byway for vehicular recreation. A scenic byway and its further development from state and Federal agencies could create other recreation opportunities within the Forest and disperse these activities off of PR 191, reducing the pressure on sensitive species located on the PR 191 and its recreation sites. Recreation opportunities are in harmony with preserving and conserving the Forest ecosystems on both the PR-191 corridor and at lower elevations. The main recreation focus is to promote long-term ecological, cultural and historical, social, economic sustainability. The Forest carrying capacity is addressed along the PR-191 corridor for the sake of improving the recreation experience and at the same time protecting the resource. Existing facilities and trails located at remote sites at lower elevations are evaluated and co-management is pursued with neighboring community groups. Present and future recreation demands are balanced with the ability of the land to sustain use, the capacity of the Forest staff to manage its use, and the resource available to manage recreation opportunity. The management of trash along recreation segments of wild and scenic rivers and at other undeveloped recreation sites is done by getting Forest visitors to practice “Leave No Trace” and “Pack-it-in and Pack-it-out”.

Functional Wetlands - Recreation.

The protection and preservation of the functional wetlands could limit the types of recreation activities that occur within this elevation (above 600 meters).

Socioeconomic Resources - Recreation.

Provides for recreation opportunities at lower elevations which better connect neighboring communities with the Forest and could decrease saturation and uses of PR 191.

Environmental Education - Recreation.

Increased knowledge and collaboration in recreation management with neighboring communities.

Special Uses - Recreation.

The role that El Yunque holds as a tourist and recreation destination for locals and visitors that come to Puerto Rico must be closely monitored in relation to sustainability and protecting the resource.

Cultural Resources - Recreation.

The reuse of historic properties near recreation sites will make the visitor more aware of the Forest heritage program and give them a feeling of ownership and pride for what the Forest means to Puerto Rico.

Facilities and Transportation - Recreation.

A Forest transportation system to facilitate the public's access to the Forest during high visitation periods would be a safer alternative, but could cause an inconvenience to those wishing to visit recreation sites on their own. The proposed scenic byway would increase the enjoyment opportunities and help disperse vehicular traffic from visitors that mainly want to have a leisure drive through the Forest.

Management Areas - Recreation**Management Area 2 (El Yunque Recreation Zone):**

This zone includes all the recreation areas located along PR-191. The management of this zone will focus on capacity and sustainability issues as well as on the protection of the resource.

Management Area 3 (Communications and Recreation Sites):

Recreation sites are located near El Yunque Peak (El Yunque Peak Observation Tower, La Roca El Yunque, La Roca El Yunque Trail and El Yunque Trail). The scenic value and natural setting is unmatched in the Forest. There are no conflicts between the communication sites and recreation facilities (trails and observation sites). The only conflict would be from a scenery perspective: hiking in a natural setting and ending in an urban-like setting at El Yunque Peak (roads, antennas and concrete structures). There are no recreation sites near East Peak Communication site.

Management Area 4 (CIRMA):

This management area provides a unique opportunity to integrate different types of uses in proximity to one another and near communities located at the lower elevations of the Forest. There are numerous trails and facilities that are not in use or are abandoned which could be renovated and put back into use with the co-management of these communities. This management area would greatly contribute to alleviating the current capacity issues on the PR-191 corridor by providing other recreation opportunities outside the corridor.

Management Area 5 (El Toro Wilderness):

This is the only tropical and Puerto Rico's only wilderness area. This area will continue to provide a challenging hiking experience and the opportunity for solitude. Limited permit camping is allowed with limited group sizes and strict camping guidelines.

Management Area 8 (Wild and Scenic Rivers):

The recreation segments of Rio Mameyes and Rio de la Mina are managed following the current comprehensive river management plan. The plan provides guidelines for trash management and proper recreation guidelines that protect the rivers free-flowing condition, water quality, and remarkable values.

Management Area 9 (El Verde Scenic By-Way):

The scenic byway will make the area of El Verde once again accessible to Forest visitors. The byway in essence can provide alternative Forest access and recreation to that provided by the PR 191 corridor. Such access was a common alternative during the 1960s and 1970s during weekends and high visitation periods. There are various river crossings with parking spaces, abandoned picnic area, vista points and trailheads located along the scenic byway. In unity with the CIRMA this management area could become a favorite Forest recreation destination.

Geographic Areas - Recreation**El Norte/North:**

This geographic area includes the municipalities of Rio Grande and Luquillo. These two municipalities provide the major access points to the Forest as well as the major recreation destinations. Throughout the years both municipalities have provided support to the Forest for special events (Forest Clean Up Day), road maintenance, and improvements to state roads that lead to the Forest and the services and support of their Civil Defense Team during rescue operations related to Forest visitors getting lost or injured. The development of collaboration efforts should continue as the Forest looks to work closer with surrounding communities. The link to a regional trail system will be an important element in providing recreation opportunities at lower elevations and to adjoining natural reserves such as the Northeast Ecological Corridor.

El Suroeste/ The Southwest:

This geographic area considers and addresses the creation of a scenic byway along PR-186 that would contribute to creating alternative recreation destinations for Forest visitors.

El Este/ The East:

This geographic area includes and addresses water and watershed protection; which result in better water quality and quantity for visitors of the Forest.

Cumulative Effects

The Forest would cumulatively benefit due to how recreation sites are managed at lower elevations with collaborators and local communities. This alternative will have a positive cumulative effect in protecting cultural resources as well as sensitive ecological resources which are currently being impacted by recreation capacity issues on PR 191, by offering other recreation and cultural resources protection opportunities off PR 191.

Alternative 3

The impacts from this alternative are similar to alternative 2, with the exception of creating more wilderness area. The creation of more wilderness will limit recreation activities.

The effect on the resources are similar to alternative 2, but with the following modifications.

Wilderness Designation for the Baño de Oro Research Natural Area - Recreation:

The change from a research natural area to a wilderness area will not impact recreation activity. If wilderness designation is successful, recreation activity will not be affected because there are no recreation facilities or trails in the research natural area. The existing El Toro Wilderness Area is not near or adjacent to the research natural area, which means the physical setting will remain the same.

Facilities and Transportation - Recreation:

There would be a plan component to foster the reduction of the trail systems to meet maintenance levels. The elimination of a scenic byway would impact any future recreation opportunities along PR-186.

Management Areas - Recreation

The effects on the management area are the same as in alternative 2, but with the following modifications.

Management Area 9 (El Verde Scenic Byway):

The elimination of this MA will have a negative impact on recreation opportunities along PR-186. Without this designation, the current conditions will remain the same and with time may deteriorate making this area not attractive or inviting to Forest visitors. By not having a scenic byway on the western side of the Forest, congestion of PR-191 would continue and could become worse with more visitation.

Geographic Areas - Recreation

North and South Geographic Areas:

The realignment of geographic areas from three to two areas would not affect recreation activities. Most of the recreation activities occur on the North Geographic Area and access to the Forest would remain the same.

3.5.6 Wilderness and Inventoried Roadless Areas

3.5.6.1 Affected Environment

Congressionally designated wilderness areas are protected by the Wilderness Act (P.L. 88-577 (16 U.S. C. 1131-1136)) and valued for their ecological, historical, scientific and experiential resources. Outdoor recreation is one of the benefactors of wilderness and is one of the drivers of wilderness demand and management. According to trend data collected from 1965 to 1994, the trend in recreation visits to national forest wilderness areas has paralleled designations and use has increased over time. In addition to outdoor recreation in wilderness, a non-user component that values American wilderness also exists and is important to understand when analyzing areas that may be suitable for wilderness allocations.

Wilderness is valued for preserving representative natural ecosystems and local landscapes. The very existence of wilderness is valued by the American public as part of the natural heritage of the country.

The El Yunque National Forest is home to one designated wilderness areas: El Toro Wilderness which is made up of 10,352 acres. On the El Yunque National Forest this represents about one-third of the total Forest acreage. Annual wilderness use for El Yunque National Forest is about 1,000 visits per year, or about 0.5 percent of total visitor use.

Table 3-45. Existing designated wilderness areas

Wilderness Area	Acreage
El Toro Wilderness	10,352

The existing wilderness areas should maintain the areas’ natural characteristics. Four qualities help describe wilderness character:

1. *Untrammeled.* Wilderness is essentially unhindered and free from modern human control or manipulation.
2. *Naturalness.* Wilderness ecological systems are substantially free from the effects of modern civilization.
3. *Undeveloped.* Wilderness is essentially without permanent improvements or modern human occupation.
4. *Outstanding opportunities for solitude or a primitive and unconfined type of recreation.* Wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge.

Affected Environment Inventoried Roadless Areas

Inventoried roadless areas are designated areas under the Roadless Area Conservation Rule (RACR, 36 CFR Part 294). The Forest Service first inventoried these areas in 1972, as part of the Roadless Area Review and Evaluation phase I (RARE I). A second inventory was completed for RARE II in 1977 and then in the RACR in 2001. The El Yunque National Forest has one inventoried roadless areas on the Forest, which is the same area as the expanded Baño de Oro Research Natural Area (6,441 acres).

Table 3-46. Inventoried roadless areas, approximate GIS acreages

Roadless Area Acres	Acreage
Baño de Oro	6,441

Areas that May be Suitable for Wilderness Designation

The first step in the evaluation of areas that may be suitable for wilderness designation is to identify and inventory all areas that satisfy the definition of wilderness. Direction can be found in Section 2 (c) of the 1964 Wilderness Act and Forest Service Handbook 1909.12, Chapter 70–Wilderness Evaluation.

The Forest Service must evaluate lands that meet the inventory criteria for areas that may be suitable for wilderness during plan revision and, from the information gathered in that evaluation, consider alternatives for recommending wilderness. The previous planning process identified two areas as lands that may be suitable for inclusion in the National Wilderness Preservation System. These two inventoried areas totaled 23,600 acres out of the total 28,223 acres in El Yunque. None of the remaining acres meet the criteria for being included in an inventory of areas that may be suitable for wilderness designation. Of these two areas, one, the El Toro area, became designated as the El Toro Wilderness Area in 2005. The second area is the Mameyes Area (of approximately 11,000 acres), which includes the Baño de Oro Inventoried Roadless Area of 6,441 acres.

Table 3-47. Areas on the El Yunque that may be suitable for wilderness designation

Area	Acreage
Mameyes area	(Approximately) 11,000 acres

The Mameyes area was then further evaluated as to its suitability for wilderness designation (see appendix D). Based on this information, the planning team considered alternatives with varying amounts of recommended wilderness. Recommended areas would be managed to maintain their wilderness character until they are officially designated by Congress and added to the National Wilderness Preservation System.

Under alternatives 1 and 2, no additional areas would be recommended for wilderness designation. However, in alternative 3, the portion of the Mameyes area that is an inventoried roadless area would be recommended for wilderness designation.

Table 3-48. Summary recommendations by alternative

Existing Area	Alternative 1	Alternative 2	Alternative 3
El Toro Wilderness (acres)	10,363	10,352	10,352
Inventoried Roadless Area (acres)	6,441	6,441	
Proposed Additional Wilderness (Baño de Oro) (acres)	0	0	6,441

Wilderness has many positive effects. As stated previously, wilderness preserves natural systems and provides places of solitude for visitors. However, there are environmental effects within wilderness from many sources. Four previously defined wilderness characteristics are considered for effects, (1) untrammeled, (2) naturalness, (3) undeveloped; and (4) outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Recreational use can negatively impact the four wilderness characteristics, especially the opportunity for solitude and naturalness. Some of these negative impacts, especially on naturalness, include the following:

1. Soil compaction;
2. Vegetation loss, disturbance and/or replacement by non-native species such as noxious weeds on trails and campsites caused by recreation use;
3. Deterioration of water quality from improper disposal of human waste and waste water; and
4. Loss of or threats to biological/ecological processes and biodiversity through human disturbance.

Other environmental effects which impact the integrity of the natural systems in wilderness include air pollution from outside sources, interruption of natural functioning ecosystems by fire suppression, and threats to native plant species from the spread of noxious weeds from sources outside wilderness.

3.5.6.2 Environmental Effects

Effects Common to All Alternatives

All alternatives carry forward the need for wilderness patrols, wilderness rehabilitation of any impacted sites, wilderness education, and wilderness-specific management plans. These effects are common to all alternatives.

There would be no negative effects to the roadless character of inventoried roadless areas on the Forest from these alternatives. All of these areas have a recreation opportunity setting of “semi-primitive motorized” or “semi-primitive non-motorized” and would continue to implement the direction from the

2001 Roadless Area Conservation Rule (RACR) on limiting road construction and tree cutting in these areas.

Alternative 1

Wilderness and Recommended Wilderness.

Alternative 1 would not recommend any new wilderness study areas on the El Yunque. The management direction for El Toro Wilderness would continue as it is currently being managed.

Inventoried Roadless Areas.

The Baño de Oro inventoried roadless area would continue to be managed as a part of the proposed expanded Baño de Oro Research Natural Area. There would be no negative effect to the roadless character of the inventoried roadless area.

Opportunities for solitude and remoteness may decrease. Sights and sounds of man's activities may be more obvious. Noise levels and soil erosion may increase. Air and water quality may decrease although water quality would meet state and Federal standards. There would be no negative effect to the roadless character of inventoried roadless areas on the Forest from this alternative. The areas have a ROS setting of "semi-primitive motorized" and would continue to implement the direction from the 2001 RACR on limiting road construction and tree cutting in these areas.

Opportunities for solitude and remoteness may decrease. Sights and sounds of man's activities may be more obvious. Noise levels and soil erosion may increase. Air and water quality may decrease although water quality would meet state and Federal standards. There would be no negative effect to the roadless character of inventoried roadless areas on the Forest from this alternative. The areas have a ROS setting of "semi-primitive motorized" and would continue to implement the direction from the 2001 RACR on limiting road construction and tree cutting in these areas.

Alternative 2

Wilderness and Recommended Wilderness.

Alternative 2 would not recommend any new wilderness areas. Like alternative 1, the management direction would follow that for the El Toro Wilderness area.

Inventoried Roadless Areas.

The Baño de Oro Inventoried Roadless Area would continue to be managed as a part of the expanded Baño de Oro Research Natural Area. There would be no negative effect to the roadless character of the inventoried roadless area.

Alternative 3

Wilderness and Recommended Wilderness.

Under alternative 3, the management direction for the El Toro Wilderness Area would continue as it is currently being managed. The 6,141-acre Baño de Oro Inventoried Roadless Area would be recommended for wilderness designation. The 2,172-acre formally designated Baño de Oro Research Natural Area that is within the inventoried roadless area would become a part of the recommended wilderness. However, the proposal to officially expand the research natural area would not be pursued.

The recommended area would be managed the same as designated wilderness until a final determination is made by Congress as to whether it should be added to the National Wilderness Preservation system.

The primary change to the management of the Baño de Oro area under this alternative is that the area would be managed as a wilderness area instead of as a research natural area. This would have the effect of potentially increasing the recreational use of the area. Any research activities that would involve manipulating vegetation within this area, which could occur under alternatives 1 or 2, would not be conducted under this alternative. Water quality and air quality should remain good and the imprint of man's influence would not increase or would diminish over time. On some occasions there may be restoration of degraded resources in the recommended wilderness area, i.e., non-native invasive eradication or control.

Opportunities for solitude and remoteness would potentially increase as would the opportunity for primitive and unconfined recreation due to the reduction of research-related activities. Additional acreage for wilderness would allow wilderness user impacts to be dispersed across a larger area providing an increase in wilderness visitor satisfaction. Maintenance of trails and facilities would be limited to using hand tools only.

Educational opportunities for the scientific study of natural ecological processes would increase with the increased acres in wilderness. The naturalness, uniqueness and representative ecosystems of the designated areas would be maintained

Inventoried Roadless Areas.

In alternative 3, the Baño de Oro Inventoried Roadless Area is recommended for wilderness designation.

3.5.7 Wild and Scenic Rivers

3.5.7.1 Affected Environment

The Wild and Scenic Rivers Act (Public Law 90-542: 16 USC 1271-1287, October 2, 1968) and its amendments provide for the protection of selected rivers and their immediate environments. To be eligible for designation, rivers must possess one or more outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values. Designation preserves rivers in free-flowing condition, protects water quality, and protects their immediate environments for the benefit and enjoyment of present and future generations.

Most rivers are added to the National Wild and Scenic Rivers System (National System) through Federal legislation, after a study of the river's eligibility and suitability for designation. The Forest Service is required to consider and evaluate rivers on lands they manage for potential designation while preparing their broader land and resource management plans under Section 5(d)(1) of the Act.

Rivers and stream corridors accommodate different uses such as picnicking, day hiking, and walking for pleasure, primitive camping, swimming and nature study.

Demand for river designation is expressed primarily through public comment and responses to agency proposals. The degree to which the public input favors designation indicates the demand for a wide range of uses, activities, and resource qualities associated with river management.

Although demand is closely related to the current population and the projected growth of the local area, designation would likely produce increased levels of recreation use in designated and potential corridors.

Designated Rivers on the El Yunque National Forest.

The Caribbean National Forest Wild and Scenic Rivers Act of 2002 designated the following three rivers as part of the National Wild and Scenic River System: Rio Mameyes, Rio de la Mina, and Rio Icacos.

Non-Eligible/Eligible Rivers.

In previous planning efforts, rivers on El Yunque National Forest were considered for wild and scenic river eligibility. During the current planning effort another evaluation was done. Three streams or rivers in El Yunque were reviewed for potential eligibility. Of the three, one was found to be eligible based on its outstandingly remarkable values (ORVs). Rivers/streams must possess at least one ORV to be considered eligible. These streams were classified according to Section 2 of the Wild and Scenic Rivers Act. Table 3-49 shows the rivers that were studied and found eligible.

During this plan revision, any additional evaluation of rivers/streams was limited to the evaluation of any rivers or streams that were not previously evaluated for eligibility, or any rivers or streams with changed circumstances. However, the previous planning effort evaluated all the potential streams, and there has been no change in circumstances.

Table 3-49. Rivers studied for national wild and scenic river system

River	Miles	Preliminary Classification
Rio Espiritu Santo/ Quebrada Sonadora	2.9	Wild
	0.8	Scenic
	2.2	Recreation
Rio Fajardo	3.4	Wild
Rio Sabana	2.3	Wild
	0.3	Recreation

3.5.7.2 Environmental Consequences

The identification of a river for study through the Forest planning process does not trigger any protection under the act until designation by Congress. Importantly, identifying rivers as eligible, or eligible and suitable, does not create any new agency authority; rather, it focuses the management actions within the discretion of the Forest Service on protecting identified river values. For eligible rivers, the preliminary (inventoried) classification is to be maintained absent a suitability determination. The recommended classification is to be maintained throughout the duration of the Forest plan. Protection of rivers and streams through the Forest planning process helps to assure high-quality, free-flowing rivers and streams, as well as river-related recreation opportunities.

Management emphasis for the eligible rivers and their corridors is focused on protection and enhancement of the values for which they were established, without limiting other uses that do not substantially interfere with public use and enjoyment of those values. The establishment values (ORVs) for the rivers on the El Yunque National Forest include scenic, recreational, geological, fish and wildlife, historical, cultural or other values including ecological.

Most impacts to all rivers come from activities outside the river corridor. However, Forest management would be subordinate to the river's ORVs. Vegetation management, road construction and construction or removal of recreation facilities could cause erosion along the river, sedimentation from soil runoff, visual intrusions or noise from nearby activities

Increased public interest and use may result with the creation of CIRMA by having additional trailheads and trails and access points to the river to accommodate additional public interest and use of the river. However, increased recreation use due to designation may also result in more river-related activities and cause localized increases in soil compaction and erosion of stream banks and the need for limited public access.

River sections classified as scenic or recreational are managed with a wider variety of activities allowed within the river corridor. However, Forest management would be subordinate to the river’s ORVs. Sights and sounds of man’s activities would be more apparent. Management activities that have the greatest potential of affecting rivers and their potential suitability for wild and scenic designation are road construction, vegetation management, insect and disease control, special use utility right-of-ways and mineral extraction. Other management activities that also can affect the river resources to a degree are threatened and endangered species habitat management, range management, recreation and administrative site facilities.

Non-eligible Rivers:

Rivers determined to be not eligible may be managed on the El Yunque National Forest under a variety of management areas, geographic zones, and special designations. These prescriptions will allow a wide variety of activities within the river corridor. Management activities may include road construction, vegetation management, insect and disease control, special use utility right-of-ways and mineral extraction. Other management activities that also can affect the river resources to a lesser degree are threatened and endangered species habitat management, recreation and administrative site facility construction and wildlife and fisheries management.

Effects Common to All Alternatives

Under all alternatives, the three eligible wild and scenic rivers would retain their eligibility in accordance with Forest Service manual and handbook direction until they are evaluated for suitability and either designated or released. This means that they would be maintained in their free-flowing condition and their identified ORVs would be retained.

Faced with the challenge of managing the recreation segments of the existing designated wild and scenic rivers, the Forest does not have the management capacity and resources to pursue additional wild and scenic river designations. All of the streams and rivers that originate in the Forest will maintain their free-flowing condition, water quality and their “outstanding remarkable” values, so in essence they are being managed as wild and scenic rivers. The rivers conditions within the Forest were analyzed and determined to be in a good state (see 2014 Forest Plan Assessment).

3.5.8 Special Uses

Special uses are an integral part of the management of the Forest. It allows individuals and organizations to use resources provided by the land.

3.5.8.1 Affected Environment

Special uses permitted include areas for electronics and communications, temporary housing and camps, and water supply. Temporary permits are issued for projects such as recreation events, research, and filming/photography. Current permitted special uses are summarized in the following table.

Table 3-50. Summary of special use categories

Special Use Category	2012
Communication Sites	9
Filming and Photo	18
Food Concession	1
Organization Camp (e.g., Girl Scouts)	1
Outfitters and Guides	30

Special Use Category	2012
Recreational Residences	3
Recreation Events	15
Research	18
Road Right-of-Way	9
Water Right-of-Way	20

Electronic facilities, water systems, tours and outfitters, and research are the predominant special uses on the Forest. Research and outfitters/guides permits make up the vast amount of services requested by individuals and institutions. Communications and water intakes make the bulk of governmental requests for permits.

3.5.8.2 Environmental Effects

Alternative 1

Water – Special Uses.

The permitted extraction of water from the Forest will have the effect of supplying the local community with a water supply while at the same time controlling the extracted amount to benefit the health of the aquatic habitat.

New Developed Recreation Areas – Special Uses.

Access to the area by means of permitted outfitters and tours will have the effect of opening new areas of the Forest to tourism. The concentration of permitted use of the developed areas will potentially reduce the effects of dispersed recreation on other areas of the Forest, thus reducing damage to the natural environment and resources in the Forest overall.

The permitted use of the new developed areas will increase the likelihood of damage to the natural and cultural resources in or near the vicinity of the developed areas.

Minerals – Special Uses.

The extraction of minerals will not be permitted. This will have the effect of ensuring the health of the ecosystem, and other resources as well as the maintenance of healthy recreation, scenic and other natural forest values. The ban on the extraction of minerals from the Forest will have the direct effect of eliminating economic enterprises on this sector within the Forest.

Vegetation – Special Uses.

The permitted collection of plants and plant material (fruits, seeds, etc.) from the Forest will have the effect of reducing unchecked damage to the flora while at the same time providing access to it under justifiable means. The requirement of a permit for the salvage of timber allows the extraction of naturally fallen trees for non-economic, justifiable means, thus protecting the visual and ecosystem quality of the Forest.

Permits - Special Uses.

The requirement of permits for all commercial activities in the Forest will have the effect of ensuring control of such activities, while allowing the population and enterprises to benefit from the Forest. The Special Uses Program allows the use of the Forest for military exercise while placing specific parameters

for that use. Such controls will have the effect of reducing the footprint of the activities on the Forest and its resources and will reduce the visual impact to the visitor. The control of water intakes and research will have the direct effect of reducing the impacts of such activities while keeping the Forest open to them.

Recreation – Special Uses.

The requirement of permits for camping will ensure user safety while minimizing direct environmental impact on the Forest.

Facilities and Transportation – Special Uses.

The permitted use of Forest facilities for the Puerto Rican parrot recovery program will have the effect of enhancing the success rate of the recovery efforts.

Wild and Scenic Rivers – Special Uses.

The ban on permits for the construction of dams within the waterways in the sections cataloged as “wild rivers” will have the effect of ensuring the health and character of the rivers under this classification. It can also have the effect of reducing available water reserves for the use of the community under extreme weather conditions such as drought.

Research and Demonstration – Special Uses.

The permitted use of certain areas of the Forest for research and demonstration activities will have the effect of ensuring that the ecosystem and resources are protected while allowing those activities that are justifiable and beneficial for the greater good.

Management Areas – Special Uses

Management Area 2 (Developed Recreation):

The termination of permits for recreational residences that are no longer in use will have the effect of reducing the footprint of such structures and activities in the Forest. The discontinuation of their use will have the indirect effect of allowing the natural ecosystem around them to recover.

Management Area 3 (Communication Sites):

The ban on constructing new facilities, and consolidating permitted activities to a few sites, will have the effect of reducing the environmental, visual, and audio impact of the communication activities in the Forest. Removing the communication equipment around the El Yunque Peak Tower Heritage Site will have the effect of returning the sense of feeling to the site to its original intended purpose of an isolated observation tower. The goal of having one special use permit holder per facility manager will have the effect of reducing administrative burdens on the Forest. It could also have the indirect effect of reducing accessibility to the sites given that the discretionary use would be in the hands of the permit holder. The ban on new land clearings and new road constructions will have the effect of protecting the environment both directly and cumulative.

Management Area 7 (Research Natural Area):

The permitting of research activities within this area will allow access to investigators and the placement of temporary equipment. This could have the cumulative effect of enhancing the understanding of the Forest ecosystems in the long run. The ban on permitted facilities or occupation will have the effect of preserving the environment and the natural qualities of the area.

Alternative 2**Water – Special Uses.**

The ban on new water intake permits could have the effect of reducing availability of water to the communities in times of drought or if recent drier weather patterns start to prevail.

Wildlife – Special Uses.

Research activities as well as third party land management practices that can provide benefit to habitat (i.e., agroforestry activities) will require a permit. This will increase monitoring of activities, the results of which would allow better management of the resource and a reduction in the possibility of direct adverse effects on the fauna.

The conditioned permitted extraction of water will have the effect of securing a stable supply of water to maintain the aquatic habitats.

Socioeconomics – Special Uses.

All economic activities provided by the Forest to individuals, institutions, or communities will require a permit. This will include outfitting/guide services, resources collection and extraction, research, educational and interpretation activities. This will have the effect of providing a better quality of services, information, education, interpretation and other activities to the people and communities.

Ecosystem Services – Special Uses.

The permitted use of ecosystem services has the effect of providing resources and services while at the same time ensuring the protection of the environment and resources.

Recreation – Special Uses.

The requirement of permits for outfitting services, vending services, food concessionaires, and other for-profit activities will have the direct effect of controlling illegal activities and uses. It will have the indirect effect of enhancing the recreational and interpretative offering to the visitors. The use of outfitters might have the cumulative effect of reducing impacts on the Forest and recreation areas caused by high traffic, and individual vehicular use. The use of permitted outfitting/guides could have the effect of increasing peak visitation numbers to the Forest.

Forest Products – Special Uses.

The controlled and permitted extraction of Forest products will have the effect of reducing illegal activities and uses on the Forest and its resources. It will also have the indirect effect of allowing for the better management and monitoring of the area and its resources.

Permits - Special Uses.

Special use permits make the land, its resources, and opportunities available to the public, government, and entities. Special use permitting also has the direct effect of supporting communities and the economy. Permitted communication, water, research and military uses has the effect of enhancing the productivity of the Forest to the benefit of society in general. The implementation of the special uses program has the effect of securing accountability, transparency, equality and efficiency. It also has the indirect effect of helping manage, protect and monitor other resources and management areas.

Cultural Resources – Special Uses.

All cultural resource-related research by individuals and organizations outside the Forest Service will require a special use permit.

Facilities and Transportation – Special Uses.

All use of the communication equipment in the Forest will require a special use permit and will be limited to the communications management area. No new communication structures will be permitted.

The permitted use of existing infrastructure could have the effect of reducing maintenance costs.

The continuous support of the parrot aviary will have the effect of improving recovery conditions to the Puerto Rican parrot.

Minerals – Special Uses.

The ban on the permitted extraction of minerals limits will have the effect of limiting access to resources by the public.

Research – Special Uses.

The permitting of research activities will have the effect of filtering beneficial research and will help control research activities which could affect other resources such as scenery, recreational opportunities, water and air, etc.

Management Areas – Special Uses**Management Area 2 (El Yunque/Yokahu Zones):**

The focus on recreation on this area will impact the special uses program because of the focus on outfitted/guided alternative use of this area. Because outfitting permits are being issued to individuals, monitoring and enforcement would improve, but so would the workload. Permitting and the associated monitoring of vending and concessionaire activities will have the effect of increasing visitor's recreational opportunities and available facilities and services. Special use permits for the use of vacant infrastructure will help reduce deferred maintenance costs. It could also have the direct effect of rehabilitating historic infrastructure.

Management Area 3 (Communications):

The proposed removal of communications facilities from the east end of El Yunque Peak Site and East Peak area will mean that no new constructions will be authorized and that all new and proposed permitted communication activities will be limited to the existing infrastructure in the area. This will have the direct effect of reducing noise, traffic, and scenic contamination. It will have the indirect effect of reducing damage to the access road by reducing the amount of infrastructure in need of maintenance and refueling. The reduction in traffic will also have the effect of increasing hiker safety on the route by reducing encounters between vehicles and people.

Management Area 4 (CIRMA):

The controlling and permitting of activities within the CIRMA will have the effect of protecting the resources and land while allowing the use of the area and the establishment of projects from the community, collaborators, and enterprises. It will also have the indirect effect of aiding in the management and monitoring of the area and its resources. The management of special use permits within the CIRMA will also have the direct effect of reducing illegal activities and uses on the Forest and its resources within the CIRMA. We expect to see an increase in the collection and extraction of Forest resources if the CIRMA is implemented.

Management Area 5 (Wilderness):

The permitting of the limited outfitting and research activities within the wilderness will have the direct effect of reducing unintended damage to the resources and will maintain the wilderness characteristics of the area.

Management Area 6 (Research):

The issuing of permits for research will have the direct effect of reducing unintended damage to the resources and will help conserve/preserve the resources and the environment.

Management Area 7 (Baño de Oro Research Natural Area):

The requirements of permits for any activity in the area will have the direct effect of reducing unintended damage to the resources and will help conserve/preserve the resources and the environment.

Management Area 9 (Scenic By-Way 186):

The issuing of permits for enterprises will have the effect of allowing the development and implementation of projects, enterprises, and initiatives within the corridor, while at the same time helping to preserve the environment, nearby wilderness character, cultural resources, and infrastructure around the corridor. The establishment of such ventures could have the indirect effect of increasing Forest Services' and partners' visibility in that area of the Forest, which will increase the level and feeling of safety and monitoring of the area.

Geographic Areas – Special Uses

No significant effects are foreseen for the differences in the geographic areas.

Alternative 3

The effect of the resources' desired future conditions are the same as in alternative 2, with the following differences.

Extension of Wilderness to Research Natural Area – Special Uses.

This will limit the permitted activities to those allowed by the standard and guidelines outlined for the wilderness area. The regulation of the limited outfitting and research activities within the wilderness will have the direct effect of reducing unintended damage to the resources and will maintain the wilderness characteristics of the area. It will also have the direct effect of prohibiting new water intakes within the boundaries of the area.

Management Areas – Special Uses.

The effect of the resources within the management areas are the same as in alternative 2, with the exception of the lack of management area 9 (scenic byway) in this alternative.

Geographic Areas – Special Uses.

No significant effects are foreseen for the differences in the geographic areas.

3.5.9 Scenery

Scenery varies depending on existing natural features, which include vegetation, water features, landforms, geology, and human-made elements. Scenic character is a combination of the physical, biological, and cultural images that give an area its scenic identity and contributes to its sense of place. The landscape of the El Yunque National Forest has a wide variety of features that provide for some of the most spectacular scenery found anywhere in Puerto Rico. The El Yunque has a variety of scenic settings

from dense, enclosed picnic areas and trails, to cloud covered peaks and observation towers, which on clear days have vistas of the Atlantic Ocean and Caribbean Sea. The Forest also has many prehistoric and historic sites adding richness of character and culture. Scenery combines all the ecological features and human elements which together give a landscape its character and image. Viewing the natural scenery is one the major reasons most visitors have for visiting to the Forest (NVUM 2011).

The development on neighboring lands negatively impact the scenic resource as visitors approach the Forest along several state roads. Understanding the value of Forest scenery to the local communities is important as it affects real estate values and quality of life. In addition to other Forest natural resources, the scenery resource must be preserved and managed for future generations

3.5.9.1 Affected Environment

All Forest visitors' activities are experienced in a scenic environment defined by the arrangements of the landscapes' natural elements combined with components of the built environment. The natural scenic beauty of the Forest stands out, making it a major local and international recreation destination. Roads off-Forest as well as Forest roads, trails, and recreation sites are key components for viewing scenery, especially along the PR-191 Recreation Corridor.

Large areas of the Forest contain naturally evolving landscapes where processes occur with very little human intervention. The scenic character is basically intact with only minute deviations. Views beyond the immediate background are influenced by the viewer's elevation and vegetation type and density. Vegetation is dense with tall trees and large canopies while at the upper elevations the trees and palms are shorter and less dense with more shrubs and tall grasses.

Most of the Forest areas have a natural appearing scenic character. Deviations in the scenic character borrow from elements in the landscape. Roads and trails area a part of the natural appearing landscape, offering opportunities to view scenery. Historic structures such as the observation towers (Yokahu and Mount Britton) are noticeable, but borrow from the landscape elements and are positive cultural elements which add to the valued scenic character.

In all alternatives there would be little to no change in the landscape character of natural appearing and natural evolving. Alternatives 2 and 3 would result in more protection and enhancement to the scenic resources because of the focus on protecting the resources.

3.5.9.2 Environmental Consequences

All Alternatives

The scenic resource is affected by management activities that alter the appearance of what is seen in the landscape. Scenic effects are usually considered in terms of visual contrast with existing or adjacent conditions that result from management activities.

Due to the heavy concentration of recreation areas in the PR-191 Recreation Corridor, traffic congestion and overcrowding of favorite sites and parking areas continues to be a problem. Recreation use beyond capacity may cause natural resource damage adjacent to recreation sites, roads, and trails, affecting the naturally appearing scenery adjacent to these areas. Traffic congestion may affect access and opportunities to view scenery. There are management activities and areas that can result in visual alteration. Those that have the greatest potential of affecting scenery include the following:

- Road construction
- Vegetation management

- Special use utility right-of-ways

Other management activities that can also affect the scenery resource include:

- Threatened and endangered species habitat management
- Communication sites
- Administrative and recreation facilities construction

Changes to scenic conditions across the landscape mostly occur through natural processes such as hurricanes, tropical storms, tree falls, and landslides with naturally evolving landscapes. These natural disturbances will continue to shape the vegetation and landform features of the landscape.

Alternative 1

This alternative follows the desired future condition, goals, and standards and guidelines that appear in the 1997 Forest Plan. The scenery resource continues to be one of the most valued and enjoyed amenities by visitors. The scenery goals are set to protect, enhance, and where necessary, restore the scenery values of the Forest by considering the former visual quality objectives in resource planning and management, demonstration, and research activities.

Alternative 1 does not contemplate an “all-lands” approach for management and collaboration of scenic values, retaining the complete authority and responsibility of managing the scenery within the National Forest. This policy limits the strategies the Forest has to reduce the visual impacts of land fragmentation on the overall scenic viewshed.

Developed Recreation - Scenery.

Addresses recreation demands and development which would have an impact on the natural scenery. It could alter the natural setting and limit the natural scenic character, which is a recognizable value for the Forest and its visitors.

Wild and Scenic Rivers - Scenery.

The designation and management of the wild and scenic rivers protects the scenery and outstanding remarkable values of the rivers while providing a scenic enjoyment opportunity for Forest visitors.

Wilderness Area - Scenery.

Protects the scenery and natural setting that is found in this area.

Management Areas - Scenery.

All management areas would continue to meet their former visual quality objective ratings:

Table 3- 51. Management area visual quality objective ratings

Management Area	Visual Quality Objective Rating
MA 1 Administrative Sites	Partial Retention
MA 2 Developed Recreation	50% Retention
MA 3 Communication Sites	Modification
MA 4 Integrated	75% Retention, 20% Partial Retention, 5% Modification
MA 5 Wilderness	95% Preservation
MA 6 Research	40% Retention
MA 7 Research Natural Area	100% Preservation
MA 8 Timber Demo.	50% Partial Retention, 10% Modification
MA 9 Scenic and Recreational Rivers	5% Partial Retention

Alternative 2

This alternative addresses the protection of the resources. Scenery will continue to be a valued resource and will be managed accordingly. A scenic inventory of the Forest will be implemented using the Scenery Management System.

Alternative 2 considers an “all-lands” approach for management and collaboration of scenic values. This strategy provides the Forest broader opportunities to manage scenic viewshed which can help improve and maintain scenic character values that are affected by land fragmentation and peripheral urbanization, a growing issue for the region (see the 2014 Forest Plan Assessment).

Developed Recreation - Scenery.

Addresses recreation demands, but development is a lot less than alternative 1, which would have less impact on the natural scenery of the Forest. The development of recreation under this alternative would consider existing infrastructure at the lower elevations of the Forest, which would also impact the natural setting, but in a much reduced way.

Wild and Scenic Rivers - Scenery.

The designation and management of the wild and scenic rivers protect the scenery and outstanding remarkable values of the rivers while providing a scenic enjoyment opportunity for Forest visitors.

Riparian Zones - Scenery.

Riparian restoration under this alternative is more intense and the land acquisition program for the Forest considers acquiring riparian areas as a priority. This could help the management and protection of the scenic value that rivers possess with the Forest.

Wilderness Area - Scenery.

Protects the scenery and natural setting that is found in this area.

Management Areas - Scenery.**Management Area 1 Administrative:**

Scenery is impacted by structures, parking areas, roads, utilities and signage. The natural forest is a scenic background for these built elements. The scenic character of this management area closely resembles that of an urban/rural landscape. Under this alternative no new infrastructure will be developed within this management area, therefore the impact to the natural setting could be less.

Management Area 2 El Yunque Recreation Zone:

This management area is highly developed with picnic shelters, bathrooms, trails, roads, parking, observation towers and road and trail signage. The Forest scenery is closely integrated to the built environment. Under this alternative no new infrastructure will be developed within this management area, therefore the impact to the natural setting could be less.

Management Area 3 Communication and Recreation:

Communication antennas located at El Yunque Peak are highly visible when viewed from afar or after hiking for several hours and arriving at the peak. The communication site at East Peak is also visible from off the Forest and from key points within the Forest. The predominate cloud conditions at these peaks during most of the year greatly reduces the negative scenery that these antennas represent.

Management Area 4 CIRMA:

This management area will have some scenery impact as alternative sites are reused or restored at the Forest's lower elevations. Most of the scenery impact will be along existing roads that provide access to the Forest.

Management Area 5 El Toro Wilderness Area:

This management area would retain its natural scenic character. There would be minimal scenery impact because there would be no new trails developed in this area. Any trail maintenance would have some scenery impact but would be for a limited amount of time when trail work would be done.

Management Area 6 Research:

Scenery would be impacted in this management area where research plots are located. These sites are located in very isolated parts of the Forest and are not visible from roadways or recreation trails.

Management Area 7 Baño de Oro Research Natural Area:

Scenery would not be impacted.

Management Area 8 Wild and Scenic Rivers:

Scenic character would be managed by the comprehensive river management plan. The plan addresses the protection of the rivers outstanding remarkable values which includes the rivers scenic beauty.

Management Area 9 Scenic Byway PR-186:

This management area will greatly contribute to improving the scenery along this roadway. Scenic byway designation will prioritize the importance of providing a scenic experience to people that travel on this section of PR-186.

Geographic Areas - Scenery.

All geographic areas will continue to have the same scenic opportunities. Access roads to the Forest will continue to be the same. The North Geographic Area will continue to have the most used access routes to the PR-191 Recreation Corridor and the CIRMA.

Alternative 3

The effect on the scenery resource is the same as in alternative 2. This alternative would have added wilderness area acreage.

Resources - Scenery.

The effects on the scenery resources is the same as in alternative 2.

Management Areas - Scenery.***MA 9 Scenic Byway:***

Eliminating the scenic byway designation will have a negative impact on the scenery along the PR-186 roadway that crosses the Forest. The scenery resource will not be managed at the level of a scenic byway.

Geographic Areas - Scenery.

All geographic areas will continue to have the same scenic opportunities. Access roads to the Forest will continue to be the same. The North Geographic Area will continue to have the most used routes to the PR-191 Recreation Corridor and the CIRMA.

Cumulative Effects

Under all alternatives the cumulative effects on the scenery of the Forest would be the same; considering the management under the alternatives protect scenery within the Forest with minimal impacts. The scenery from a broader landscape perspective is not managed within the alternatives but there are possible positive impacts from alternative 2 and 3 which propose collaboration and an “all-lands” approach.

3.5.10 Infrastructure

3.5.10.1 Affected Environment

Infrastructure in the Forest is varied and vast, and consists of buildings, roads within the Forest boundaries, external roads, parking, transit, trails, research facilities, recreation facilities, abandoned facilities, water intakes, and non-Forest service buildings. Much of the infrastructure on the Forest is already considered a historic asset. The Forest infrastructure supports recreation, communications, access, water supply, research, and resource management. The main infrastructure within the Forest includes:

- 11.27 miles of National Forest System roads.
- 34 permitted water intakes.
- 1 Forest headquarters compound.
- 1 Visitors center (El Portal Del Yunque).
- 1 aviary facility.
- 1 quarters building El Verde site.
- 1 El Verde storage area.
- 3 observation platforms (Yokahu Tower, Mt. Britton Tower, and Los Picachos platform).
- 2 research stations (Long Term Ecological Research Station Site and Sabana Field Research Station).
- Living quarters in research stations.
- 3 open picnic áreas (Palo Colorado and Palma de Sierra, El Verde).
- 2 stores.
- 13 open trails.
- 7 empty historic structures.
- 2 closed pools (Baño de Oro and Baño Grande).

Forest Service buildings and structures (both administrative and recreation) support administrative and recreation programs across the El Yunque National Forest.

A facility master plan would be developed to guide the acquisition, continued use, maintenance, improvements and disposal of Forest Service facilities on the El Yunque National Forest. The plan would propose an overall reduction in facilities through consolidation and decommissioning.

3.5.10.2 Environmental Consequences, All Alternatives

Alternative 1

Alternative 1 would not change the way the Forest is managing the lands, it would simply implement the 1997 Forest Plan with the Forest’s current condition. This alternative does not propose the new requirements or the aspect of sustainable (ecological, social, and economic) use within the Forest; nor is the concept of collaboration a foothold to management.

New Developed Recreation Sites (Recreation Facilities and Transportation) - Infrastructure.

The proposed construction of new recreation areas can have the effect of dispersing recreation use stress on the existing infrastructure, thus reducing likelihood of vandalism, wear, and damage on existing recreation.

Environmental Education - Infrastructure.

The proposed educational and interpretive offering could have the indirect and cumulative effect of increasing awareness on the function, use, and importance of the existing recreational infrastructure. That could have the indirect effect of reducing misuse and vandalism because of the increased awareness of the importance of the resource.

Management Areas - Infrastructure.**Management Area 1 (Administration sites):**

The proposed reconstruction of trails could affect their historic integrity of many of the historic trails.

Management Area 2 (Developed Recreation):

The limitations on recreational activities in this area will have the indirect effect of reducing use stress and disturbances to the resources located in the other management areas.

Management Area 3 (Communications Sites):

The proposed removal of communications facilities will reduce maintenance costs and traffic in the area. This also has the potential indirect effect of enhancing the natural environment by reducing use of the area.

Management Area 5 (Wilderness):

The creation of the wilderness area will have the effect of increasing the difficulty and costs involved in the maintenance and repairs of the existing trails through the wilderness.

Alternative 2**Socioeconomic Resources - Infrastructure.**

Potential leasing of vacant infrastructure could have the effect of reducing management and maintenance costs and of enhancing and preserving the historic character of historic infrastructure, if implemented following the standards and guidelines outlined in the management plan.

Environmental Education - Infrastructure.

The development of interpretative and educational efforts can have a direct, indirect, and cumulative effect on the preservation of existing infrastructure by increasing awareness of their importance in the public's mind, potentially reducing misuse and vandalism. Existing vacant infrastructure reused in community-based interpretive and educational efforts, training, and demonstration will have the effect of reducing the amount of vacant infrastructure and could reduce existing deferred maintenance costs.

Climate Change - Infrastructure.

Increases in extreme weather events may increase damage to facilities and structures, reduce tourist access in some areas, and increase the need for road repairs. The projected increase in the dry weather periods will reduce the effects of rain erosion on the roads, possibly reducing maintenance needs. At the same time, the increase in intensity of severe weather systems such as hurricanes or heavy rain events will

directly affect the infrastructure by landslide damage, water erosion, wind damage, damage by fallen debris and destabilization of soils. The projected increases in urban area temperatures during the dry season and summer months might translate in higher visitation to the Forest by people looking for recreation in cooler areas with shade and accessible water like those provided by El Yunque. If visitation increases that will directly increase the wear and tear on the infrastructure, roads and trails, as well as the likelihood of intentional vandalism activities.

Recreation - Infrastructure.

Developing recreational opportunities in the lower part of the Forest will have the effect of reducing the strain on the existing recreational infrastructure located on the upper part of the Forest (Road 191 Corridor). The proposed evaluation of infrastructure investments could directly affect the maintenance and development of existing and new infrastructure by identifying partnerships, volunteering, and funding to support infrastructure management.

Cultural Resources - Infrastructure.

The proposed reduction of deferred maintenance of existing historic infrastructure will have a direct effect of improving the condition of many of the properties. The proposed restoration and reuse of existing historic infrastructure will have the effect of reducing the amount of vacant infrastructure and reduce operational and maintenance costs.

Management Areas - Infrastructure.

Management Area 2 (El Yunque/Yokahu Zones):

The restoration and management of recreation infrastructure in those areas will have a direct effect of maintaining preserving existing infrastructure. The interpretation of the historic properties in that area could have a direct and cumulative effect of reducing damaging practices by the public such as vandalism. The increase in visitation to the resources in that area could have the indirect effect of increasing vandalism and wear and tear on the infrastructure.

Management Area 3 (Communications):

The proposed removal of communications facilities from the east end of El Yunque Peak Site will have the effect of removing infrastructure, reducing maintenance and operational costs at El Yunque Peak. The proposed interpretation of the cultural resources there will directly enhance its historical context and the public understanding of historic infrastructure which could have the indirect effect of reducing vandalism and misuse.

Management Area 4 (Community Interface Resource Management Area - CIRMA):

Recreation relocation to this area will reduce stress on the upper Forest infrastructure, including roads, trail and facilities.

Management Area 5 (Wilderness):

The creation of the wilderness area will have the effect of increasing the difficulty and costs involved in maintaining and repairing the existing trails through the wilderness.

Management Area 9 (Scenic Byway 186):

The proposed creation of the scenic byway management area as outlined will require a higher level of maintenance, stewardship, and interpretation of the historic sites along the route. The increase in maintenance and interpretation will help improve and monitor the conditions of the resources, which have been neglected to a higher degree than similar resources along Road PR-191. This will have an effect on

the resource by increasing public awareness of the resources importance and has the potential to increase visitation to a number of historic structures along the route. The increase in visitation on the area might increase the likelihood vandalism on the sites. It will also have the cumulative effect of wear and tear on the sporadically used historic road, bridges and related features.

Geographic Areas - Infrastructure.

North and Southwest Geographic Areas:

The proposed increased interconnection of existing trail to points of access within the municipalities will likely have the indirect effect of increasing accessibility to the Forest and maintenance costs due to wear and tear on the existing historic trails. The proposed development of collaborative efforts with the community could have the effect of increasing the availability of partnerships, personnel and external funding for maintenance and use of existing infrastructure.

Alternative 3

The effect of the resources' desired future conditions are the same as in alternative 2, with the following differences.

Extension of Wilderness to Research Natural Area - Infrastructure.

The recommended extension of the wilderness area to encompass the Baño de Oro Research Natural Area will potentially have the effect of increasing maintenance costs of the infrastructure located within it due to the constraints imposed by wilderness regulation.

Facilities and Transportation - Infrastructure.

The proposed change of trail care level to maintenance levels will have an effect on the maintenance of many of the trails. The reduction of maintenance will affect the conservation of the trail system.

Management Areas - Infrastructure.

Management Area 2 (El Yunque/Yokahu Zones):

The restoration and management of recreation infrastructure in those areas will have a direct effect of maintaining and preserving existing infrastructure. The interpretation of the historic properties in that area could have a direct and cumulative effect of reducing damaging practices by the public such as vandalism. The increase in visitation to the resources in that area could have the indirect effect of increasing vandalism and wear and tear on the infrastructure.

Management Area 3 (Communications):

The proposed removal of communications facilities from the east end of El Yunque Peak Site will have the effect of removing infrastructure, thus reducing maintenance and operational costs at El Yunque Peak. The proposed interpretation of the cultural resources there will directly enhance its historical context and the public understanding of historic infrastructure which could have the indirect effect of reducing vandalism and misuse.

Management Area 5 (Wilderness):

The creation of the wilderness area will have the effect of increasing the difficulty and costs involved in the maintenance and repairs of the existing trails through the wilderness.

Management Area 7 (Baño de Oro Proposed Wilderness):

The creation of the wilderness area will have the effect of increasing the difficulty and costs involved in the maintenance and repairs of the existing trails through the wilderness.

Geographic Areas - Infrastructure.**North and South Geographic Areas:**

The proposed increased interconnection of existing trails to points of access within the municipalities will likely have the indirect effect of increasing accessibility to the Forest and maintenance costs due to wear and tear on the existing historic trails. The proposed development of collaborative efforts with the community could have the effect of increasing the availability of partnerships, personnel and external funding for maintenance and use of existing infrastructure.

3.6 Other Required Disclosures

3.6.1 *Environmental Justice*

Under legislation and presidential mandates, the Federal government requires “environmental justice” in all its agencies to ensure fair access to all in environmental regulations and decision making. Environmental justice is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The goal of environmental justice is for Federal agencies to identify impacts that are disproportionately high and adverse with respect to minority or low-income populations and identify alternatives that will avoid or mitigate those impacts. The Forest Service has specifically adopted this into its new planning rule. This is an opportunity for the Forest to address this issue and have a better connection with underserved populations.

The El Yunque has a conglomerate of unique qualities, one of the most significant are the communities that surround it. These communities can be identified within the framework of environmental justice qualities as described in the Planning Rule (2012). The communities in the region surrounding the Forest have the lowest income per capita in the nation. Youth programs are greatly needed to give equal opportunities in land use within National Forest lands and the communities that surround the Forest are mostly (all) Puerto Rican, a minority at a national level. Although some interaction with the Forest and the communities have existed in the past; historically they have not had a participative relationship with the Forest (underserved). These are precisely the traits that the new Forest Planning Rule (2012) describe as the types of populations that we should be actively engaging to encourage and enable their participation in planning processes regarding forest management activities and use of forest resources as part of seeking environmental justice. As the planning rule states in its preamble:

The Department recognizes the need to engage a full range of interests and individuals in the planning process and the responsibility to promote environmental justice. To encourage wide-ranging participation, the final rule retains the requirement for the responsible official to seek participation opportunities for traditionally underrepresented groups like youth, low-income populations, and minority populations.

The Department added requirements in §§ 219.8 and 10 to take into account opportunities to connect people with nature when developing plan components to contribute to social and economic sustainability and for multiple uses, including recreation, in addition to the requirements for outreach to youth, low-income, and minority populations included in this section. Specific

issues regarding recreation access on a unit will be addressed at the local level during the planning process.

Environmental Justice [...]

... While national level impacts are not expected to be disproportionate, yet-to-be-identified adverse impacts may be possible on a regional or local scale at the unit planning level. Differences in national level effects and regional/local level effects are the result of uneven distribution of minorities, low-income populations, and variations in regional, cultural, or traditional use, and differences in local access to resources. Impacts on the national forest level will be further examined at the unit level, including NEPA analysis for plan development, plan revision, or plan amendment and site-specific projects.

The participation efforts required by the final rule have significant potential to reach and involve diverse segments of the population that historically have not played a large role in NFS planning and management. Section 219.4(a) requires that when developing opportunities for public participation, the responsible official shall take into account the discrete and diverse roles, jurisdictions, responsibilities, and skills of interested and affected parties as well as the accessibility of the process, opportunities, and information. The responsible official is required to be proactive and use contemporary tools, such as the Internet, to engage the public, and share information in an open way with interested parties.

Requirements of § 219.4 to consider accessibility and requirements to encourage participation by youth, low income populations, and minority populations may improve environmental justice outcomes.

The El Yunque National Forest has, during all stages of the planning process, addressed youth, low income populations, minority populations, as well as underserved communities to promote and develop further accessibility to the Forest lands and Forest collaboration initiatives. At the assessment stage, the Forest developed community meetings and activities with communities that had not been engaged before. During the planning process (in the need for change, the proposed action as well as the development of the alternatives) the Forest met with these sectors of the public for their input and to establish a relationship for future engagement and collaborative opportunities within the realms of environmental education, recreation, access, tourism, conservation, etc. This became a historic opportunity for the Forest to not only address the Forest-wide issues but to contribute to the broader landscape as it seeks Environmental Justice for its local communities.

3.6.1.1 Affected Environment

The census data presented in the Economic and Social Environment sections describes the demographic conditions of communities surrounding the Forest, which is essential to understanding this section. The previous sections assessed the social and economic conditions and demographic trends in order to establish a baseline understanding of how the Forest contributes to social and economic sustainability of local beneficiaries and the general public.

The nine municipalities surrounding the El Yunque extend over 336 square miles (about 10 percent of Puerto Rico's total area) (Table 3-30). They encompass coastline, plains, hills, and mountains within a complex matrix of land cover and use (Gould et al. 2012). El Yunque accounts for 13 percent of their total combined area. Eight municipalities have some of their land base within the boundaries of the El Yunque, ranging from less than 1 percent of the total area of Juncos to more than 33 percent of Río Grande (Table 3-30). Humacao is the only municipality in the El Yunque Region with no land falling within the National

Forest boundary. Although it's ecological and socioeconomic connections are an important part of the relationship this municipality possesses with the Forest.

As the population around the Forest continues to shift in terms of number, age structure, and gender distribution, as predicted in the near term at least, changes are likely to occur in individual and community values, uses, needs, and demands on public lands.

Personal and family income are key indicators of the overall economic conditions or well-being of a community and are important considerations in public land management decisions, particularly where these decisions may affect income opportunities. For more detailed information please see the socioeconomic section.

Per capita and median family incomes in current dollars (value at the time earned/received) have increased across Puerto Rico and within the study area for several decades. However, to accurately compare income over time, summary measures (medians, means, etc.) should be adjusted to account for changes in the cost of living (i.e., inflation) (U.S. Census Bureau 2013). When adjusted for inflation, income across Puerto Rico and within the area around El Yunque have only modestly increased since 1970 (0.66 percent per year and 0.71 percent per year from 1970 to 2010, respectively) (Figure 3-9). Ultimately, while median family and per capita income have increased in the study area and across Puerto Rico over the past several decades, they have only modestly outpaced the rate of inflation. This slow growth in personal and family income is in large part a reflection of the sluggish Puerto Rican economy that has struggled for decades under mounting government debt and the high costs of doing business on the island (Cohn et al. 2014; Federal Reserve Bank of New York 2012).

Poverty levels are another important indicator of community well-being. In 2010, about 44.2 percent of the population in the region was living below the poverty level as defined by the U.S. Census Bureau (2015). Fairly significant intraregional differences existed, with Fajardo and Río Grande having the lowest poverty rates (42.1 percent), and Naguabo demonstrating the highest (52.6 percent). The percentages of people living below the poverty level generally have been declining throughout the region since 1970 at least, with the exception of Ceiba, which increased to 43.1 percent in 2010 from 38.6 percent in 2000 (Oficina del Censo 2015) (Figure 3-10). Despite general improvements, poverty in the region and across Puerto Rico occurs at significantly higher rates than in the U.S. For example, the percent of people living in poverty in the region surrounding the El Yunque in 2010 was nearly three times the national rate (14.3 percent) and almost double that of Mississippi (21 percent), which had the highest state-wide poverty rate in the U.S. in 2010 (U.S. Census Bureau 2015).

Children represent a disproportionate share of the poor in the El Yunque region, as throughout Puerto Rico. In 2013, children (less than 18 years of age) represented less than 25 percent of the total population in the region, but they represented more than 33 percent of the population living below the poverty level (Figure 3-10). Of the estimated 71,912 children living in the region in 2013, 56 percent were considered to be living below the poverty level (U.S. Census Bureau 2015).

Overall, while the populations surrounding the El Yunque are living longer and spending more years in formal education, which enhances the knowledge and skills available for responding to demands and changes in the social and natural environment, per capita and family income have only modestly outpaced inflation, and poverty remains high, particularly among children. Limited growth in income and persisting poverty among a large segment of the population are signs of social vulnerabilities and may be indicators of large segments of society that are being "left behind" or at risk of further decline. Low income and high poverty rates also often result in greater demands for public services and resources, including from public lands. Therefore, it is important for management decisions to account for how these community members or segments of society may be affected by changes in management direction and Forest use.

In conclusion although educational characteristics reflect a more educated population than in past years the poverty levels are extremely high. These ingredients point to shifting conditions around the Forest but it also points to future possibilities for land use and socioeconomic development. The varied socioeconomic conditions surrounding the Forest could result in a great opportunity to have positive impact on the broader landscape and Forest-wide conditions. The revised Forest Plan offers resources such as recreation, water, cultural resources, environmental education, vegetation, and forest products in a sustainable use focus that could also be a contribution to the socioeconomics of the region.

Effects Common to All Alternatives

While there are no populations in the plan area that will experience significant, adverse human health impacts or environmental effects due to management actions proposed under any of the alternatives, alternative 2 or 3 provide for more opportunities for collaboration and environmental justice and in turn socioeconomic development in the region more than alternative 1.

Under all alternatives, the Forest will continue to provide benefits to local beneficiaries and the general public which enhance their economic opportunities for employment and earning income. Detailed information on the Forest contribution in employment can be found in the “socioeconomic” section.

Under all the alternatives, the Forest will continue to provide benefits to local beneficiaries and the general public which enhance their quality of life through contributions to well-being, health and safety, water resources, recreation, traditional and cultural resources and many other important resources.

Alternative 1

This alternative does not address environmental justice within its land use, nor any resource-driven activities to address environmental justice. For instance; collaboration is not proposed in alternative 1 and therefore activities that include collaboration with surrounding communities is not considered. This would limit Forest activities that could address the needs of low-income populations, underserved populations, and youth and minorities populations surrounding the Forest.

Under this alternative the Forest will continue to provide resources as the other alternatives, but with less accessibility to certain communities (underserved), considering it will not consider management such as the community interface resource management area (CIRMA) in alternatives 2 and 3.

This alternative would have an indirect adverse effect on the surrounding landscape because limiting engagement with the public and local communities would not foster socioeconomic development within the Forest and expanding this outside the Forest as well.

This alternative would not foster relationships with the communities and management strategies of the Forest would not consider the populations which the new planning rule requires, in terms of environmental justice.

Alternative 2

Alternative 2 considers collaboration, and environmental justice in its development and content of Forest land management; as well as land use management that would impact the broader landscape.

This alternative would foster or consider the socioeconomic conditions of the surrounding communities (underserved, youth, minorities, low-income population) for its land use. For instance the Forest in this alternative could develop collaboration opportunities for socioeconomic development in sectors of the Forest accessible to communities that previously did not have accessibility to Forest lands. CIRMA are Forest lands that would serve as lands to develop activities such as forest products (agroforestry),

recreation, environmental educations, among other activities that could be developed with these communities.

This alternative could address socioeconomic issues the region is facing through the development of socioeconomic opportunities within the Forest and within the broader landscape when collaboration opportunities arise.

This alternative would foster long-term relationships with the communities and the management strategies of the Forest would consider populations in new planning rule which are deemed important to address issues arising in environmental justice.

Alternative 3

This alternative would have the same effects as alternative 2, although with geographical differences considering management areas such as the scenic by-way management area would not exist and therefore the opportunities for furthering access and socioeconomic development could be limited.

While there are no populations in the plan area that will experience significant, adverse human health impacts or environmental effects due to management actions proposed under any of the alternatives, alternatives 2 or 3 will provide for more opportunities for collaboration and environmental justice (and in turn more socioeconomic development opportunities in the region) than under alternative 1.

3.6.2 Relationship of Short-Term Use and Long-Term Productivity

The relationship between the short-term uses of the environment and the maintenance and enhancement of long-term productivity is complex. Short-term uses are generally those that occur irregularly on parts of the Forest, such as fixing the trail in a recreational site, a one day special activity in the forest, etc. Long-term uses refer to a period greater than ten years; for example use of a certain area for permits of communication towers and facilities.

Productivity is the capability of the land to provide market and amenity outputs and values for future generations. Soil and water are the primary factors of productivity and represent the relationship between short-term uses and long-term productivity. The quality of life for future generations would be determined by the capability of the land to maintain its productivity. By law, the Forest Service must ensure that land allocations and permitted activities do not significantly impair the long-term productivity of the land.

All the alternatives considered for the forest, including the preferred alternative, incorporate the concept of sustained yield of resource outputs while maintaining the productivity of all resources. The specific direction and mitigation measures included in the forest-wide management standards ensure that long-term productivity would not be impaired by the application of short-term management practices.

Each alternative considered in the Plan was analyzed, to ensure that the minimum standards could be met. Through this analysis, long-term productivity of the National Forest's ecosystems is assured for all alternatives.

As stated earlier, the effects of short-term or long-term uses are complex, and depend on management objectives and the resources that are emphasized. No alternative would be detrimental to the long-range productivity of the El Yunque National Forest.

The effects of implementing the Forest Plan will be monitored at the Forest level. Broad-scale monitoring will focus on changes in the environment that may affect resources on the El Yunque. Evaluation of the monitoring data collected will determine if standards for long-term productivity are being met, or if

management practices need to be adjusted. A monitoring design is included in chapter 4 of the Forest Plan.

3.6.3 Irreversible and Irrecoverable Effects

Irreversible and irretrievable commitments of resources are normally not made at the programmatic level of a Forest Plan. Irreversible commitments are decisions affecting non-renewable resources such as soils, minerals, plant and animal species, and cultural resources. Such commitments of resources are considered irreversible because the resource has been destroyed or removed, or the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense. While a Forest Plan can indicate the potential for such commitments, the actual commitment to develop, use, or affect non-renewable resources is normally made at the project level.

Irrecoverable commitments represent resource uses or production opportunities, which are foregone or cannot be realized during the planning period. These decisions are reversible, but the production opportunities foregone are irretrievable. An example of such commitments is the allocation of management prescriptions that do not allow timber harvests in areas containing suitable and accessible timber lands. For the period of time during which such allocations are made, the opportunity to produce timber from those areas is foregone, thus irretrievable.

The leasing of a resource or the increase of water extraction from the Forest is not made due to a request of a citizen, or an agency. The available information, the circumstances, the sites considered and additional technical information needs to be evaluated before taking any decision. Actual extraction of a resource could be considered an irreversible commitment, especially for non-renewable resources, like minerals. Any site-specific decisions to actually permit an extraction will occur following receipt of an application for permit for that extraction or activity.

3.6.4 Effects on Wetlands and Floodplains

No significant adverse impacts on wetlands or floodplains are anticipated. The plan integrates the definition of a functional wetland considering that all plant communities located above the 600-meters elevation line at El Yunque, above the cloud condensation level, are wetland communities. The 600-meter elevation boundary determines where clouds will form and, thus, where the cloud forest community begins (Harris et al. 2012).

Wetland values and functions would be protected in all alternatives through the implementation of the riparian management zones and following best management practices for forestry. Under the requirements of Executive Order 11990 and Clean Water Act, Section 404, wetland protection would be provided by ensuring that new construction of roads and other facilities would not have an adverse effect on sensitive aquatic habitat or wetland functions. In addition, wetland evaluation would be required before land exchanges or issuance of special-use permits in areas where conflicts with wetland ecosystems may occur.

Mitigation measures have been designed to conserve riparian areas and protect floodplains through the direction in the rivers and streams ecosystems. The direction of this ecosystem is embedded in all other ecosystem groups. Executive Order 11988 also requires site-specific analysis of floodplain values and functions for any project occurring within the 100-year floodplain zone, and prior to any land exchange involving these areas. Effects to wetlands are also discussed through the document especially in Section 3.3 “Physical Environment,” 3.3.5 “Water and Watersheds,” 3.4 “Biological Environment”, 3.4.1 “Ecological Systems,” of this draft EIS.

Protective measures for riparian areas include the delineation of riparian management zones on perennial and intermittent streams. Management activities within the riparian management zone must comply with

the best management practices and any other water quality regulations. Floodplains would be managed by locating critical facilities outside of floodplains or by using structural mitigation measures. Further protections are provided in Forest-wide standards for management of ephemeral stream zones.

3.6.5 Unavailable or Incomplete Information

The El Yunque National Forest has used the best available scientific information and state-of-the-art analytical tools to evaluate management activities and to estimate their environmental effects.

However, gaps will always exist in our knowledge. The Council on Environmental Quality regulations discuss the process for evaluating incomplete and unavailable information (40 CFR 1502.22 (a) and (b)). Incomplete or unavailable information is noted in this chapter for each resource, where applicable.

Forest Plan monitoring is designed to evaluate assumptions and predicted effects. Should new information become available, the need to change management direction or amend the Forest Plan would be determined through the monitoring and evaluation process.

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 Ceiba
 Fajardo
 Las Piedras
 Luquillo
 Naguabo
 Rio Grande

Juncos

Humacao

Non-government Organizations

Acampadores De Puerto Rico

Programa De Café De Sombra

Fondos Unidos De PR

Amigos De El Yunque

Alianza Ambiental De PR

Fideicomiso De Conservación De PR

Ciudadanos Pro Bosque San Patricio

American Red Cross

Amigos De Los Animales

Fundacion Luis Muñoz Marin

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Servicio De Extensión Agrícola 4H

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 Fundación Puertorriqueña De Conservación
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 Department of Natural and Environmental Resources
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 State Police of Puerto Rico
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Federal Government Agencies

Alcohol, Tobacco, Tax & Trade Bureau
 Natural Resource Conservation Services
 Department of Homeland Security
 USDA Animal & Plant & Plant Health Inspection Service-APHIS
 OSHA
 NOAA
 National Park Service: San Juan National Historic Site
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References

Clean Air Act, 42 U.S.C. 7401-7671q, July 14, 1955, as amended. This Act, as amended, is known as the Clean Air Act of 1970. The amendments made in 1970 established the core of the clean air program. The primary objective is to establish Federal standards for air pollutants. It is designed to improve air quality in areas of the country which do not meet Federal standards and to prevent significant deterioration in areas where air quality exceeds those standards.

36 Code of Federal Regulation (CFR) Part 219; National Forest System Land Management Planning. This planning rule sets forth process and content requirements to guide the development, amendment, and revision of land management plans to maintain and restore National Forest System (NFS) land and water ecosystems while providing for ecosystem services and multiple uses.

36 Code of Federal Regulation (CFR) Part 294; Roadless Area Conservation. The intent of this final rule is to provide lasting protection for inventoried roadless areas within the National Forest System in the context of multiple-use management.

40 Code of Federal Regulation (CFR) 1502; Environmental Impact Statement. The primary purpose of an environmental impact statement is to serve as an action-forcing device to insure that the policies and goals defined in the Act are infused into the ongoing programs and actions of the Federal Government.

40 Code of Federal Regulation (CFR) 1508; Terminology and Index. This Code of Federal Regulation has the intent of providing a list of terms and their meaning according to the Federal Government.

Endangered Species Act (ESA) of 1973, as amended; P.L. 93-205, 16 U.S.C. 1531 et seq. Protects threatened, endangered, and candidate species of fish, wildlife, and plants and their designated critical habitats. Under this law, no Federal action is allowed to jeopardize the continued existence of an endangered or threatened species. The ESA also requires consultation with the USFWS and the National Marine Fisheries Service and the preparation of a biological assessment when such species are present in an area that is affected by government activities.

Forest Service Handbook (FSH) 1909.12; Land Management Planning Handbook Chapter 70; Wilderness Evaluation. The primary function of the identification and inventory step is to comprehensively identify “all-lands” that may have wilderness characteristics within the plan area, using a transparent process. Lands included in the inventory will be carried forward for further evaluation.

Forest Service Handbook (FSH) 2309.18; Trails Management Handbook. Objectives of this handbook include: to provide trails that meet their trail management objectives, are consistent with the applicable land management plan, provide opportunities for satisfying recreation experiences, harmonize with and provide opportunities for enjoyment of the National Forest or grassland setting, and minimize maintenance costs.

Forest Service Handbook (FSH) 2300 – Chapter 2350; Trail, River, and Similar Recreation Opportunities. Objectives of this chapter include: to provide recreation-related opportunities for responsible use of national forests and national grasslands, and to mitigate adverse impacts of recreational uses on natural, cultural, and historical resources and on other uses through education, outdoor ethics programs, and on-the-ground management, including law enforcement and restoration.

National Environmental Policy Act of 1969 (NEPA), as amended; Public Law 91-190; 42 U.S.C. 4321 et seq. Requires Federal agencies to utilize a systematic approach when assessing environmental impacts of government activities. Establishes the use of environmental impact statements. NEPA proposes

an interdisciplinary approach in a decision making process designed to identify unacceptable or unnecessary impacts on the environment.

National Forest Management Act Of 1976; 16 U.S.C. 1600(note). This act recognizes that the management of the Nation's renewable resources is highly complex and the uses, demand for, and supply of the various resources are subject to change over time.

The Wilderness Act of 1964; Public Law 88-577; 16 U.S. C. 1131-1136. Established the National Wilderness Preservation System composed of federally owned areas designated by Congress. The act also stipulates these lands be administered for the “use and enjoyment of the American people in such manner as will leave them unimpaired for future use as wilderness and preserve their untouched character.

Wild and Scenic Rivers Act; U.S.C. 1271-1287. The purpose of this Act is to implement this policy by instilling a national wild and scenic rivers system, by designating the initial components of that system, and by prescribing the methods by which and standards according to which additional components may be added to the system from time to time.

Soils

Guariguata, M.R.; Larsen, M.C. 1990. Preliminary map showing landslides in El Yunque quadrangle, Puerto Rico: U.S. Geological Survey Open-file Report 89-257, scale 1:20,000, 1 sheet.

Larsen, M.C.; Simon, A. 1990. Landslide processes in saprolitic soils of a tropical rain forest, Puerto Rico. In: Larue, D.K.; Draper, G., editors; Transactions of the 12th Caribbean Geological Conference, St. Croix, U.S. Virgin Islands. Miami Geological Society. p. 217–222.

Larsen, M.C.; Torres-Sánchez, A.J. 1992. Landslides triggered by Hurricane Hugo in eastern Puerto Rico, September 1989: Caribbean Journal of Science 28(3-4): 113–125.

Geology

Clinton, J.F.; Cua, G.; Huérfano, V.; [and others]. 2006. The current state of seismic monitoring in Puerto Rico. Seismological Research Letters 77(5): September/October.

Lepore, C.; Kamal, S.A.; Shanahan, P.; Bras, R.F. Rainfall-induced landslide susceptibility zonation of Puerto Rico. Environmental Earth Science [DOI 10.1007/s12665-011-0976-1].

Monroe, W.H. 1979. Map showing landslides and areas of susceptibility to land sliding in Puerto Rico: U.S. Geological Survey Miscellaneous Investigations Series, Map I-1148, 1 sheet.

Air

Ángeles, M.E.; González, J.E.; Erickson, D.J.; Hernández, J.L. 2010. The impacts of climate changes on the renewable energy resources in the Caribbean Region. Journal of Solar Energy Engineering 132(3): 031009.

Prospero, J.M.; Lamb, P.J. 2003. African droughts and dust transport to the Caribbean: Climate change implications. Science 302(5647): 1024–1027.

Quiñones, F.; Torres, S. 2005. El Clima de Puerto Rico.

[http://www.recursosaguapuertorico.com/Clima_PR_for_Web_Page_2005_rev_Jan2012.pdf]

Water and Watersheds

- Ahmad, R.; Scatena, F.N.; Gupta, A. 1993. Morphology and sedimentation in Caribbean montane streams: Examples from Jamaica and Puerto Rico. *Sedimentary Geology*. 85: 157–169.
- Brown K.A.; Scatena; F.N.; Gurevitch, J. 2006. Effects of an invasive tree on community structure and diversity in a tropical forest in Puerto Rico. *Forest Ecology and Management* 226 (2006): 145–152.
- Cowardin, L.M.; Carter, V.; Golet F.C.; LaRoe, E.T. 1979. Classification of wetlands and deepwater habitats of the US. DIANE Publishing.
[\[https://books.google.com/books?hl=es&lr=&id=hKn1tI4QIoUC&oi=fnd&pg=PA1&dq=Cowardin+1979+wetlands&ots=23W-zozSS&sig=SHixw_BITIV25-BJFD5KoYadrm8#v=onepage&q=Cowardin%201979%20wetlands&f=false\]](https://books.google.com/books?hl=es&lr=&id=hKn1tI4QIoUC&oi=fnd&pg=PA1&dq=Cowardin+1979+wetlands&ots=23W-zozSS&sig=SHixw_BITIV25-BJFD5KoYadrm8#v=onepage&q=Cowardin%201979%20wetlands&f=false).
- Crook, K.E.; Scatena, F.N.; Pringle, C.M. 2007. Water withdrawn from the Luquillo Experimental Forest, 2004. General Technical Report IITF-GTR-34, USDA Forest Service, International Institute of Tropical Forestry, San Juan, PR. 26 p.
- Fulford, M.; Crandall, B.; Stotler, R. 1970. The ecology of an elfin forest in Puerto Rico: The leafy hepaticae of Pico del Oeste. *Journal of the Arnold Arboretum* 51: 56–69.
- Gilt, A.M. 1969. The ecology of an elfin forest in Puerto Rico: Agrial roots. *Journal of the Arnold Arboretum* 50: 197–209.
- Heartsill-Scalley, T.; Scatena, F.N.; Estrada, C. [and others]. 2007. Disturbances and long-term patterns of rainfall and throughfall nutrients fluxes in a subtropical wet forest in Puerto Rico. *Journal of Hydrology* 333(2-4): 472–485.
- Howard, R. A. 1969. The ecology of an elfin forest in Puerto Rico: Studies of stem growth and form and of leaf structure. *Journal of the Arnold Arboretum* 50.
[\[https://archive.org/details/cbarchive_49455_theecologyofanelfinforestinpue1970\]](https://archive.org/details/cbarchive_49455_theecologyofanelfinforestinpue1970).
- Lyford, W.H. 1969. The ecology of an elfin forest in Puerto Rico: Soil, root and earthworm relationships, *Journal of the Arnold Arboretum* 50 [210e224].
- McDowell, W.H.; Asbury, C.E. 1994. Export of carbon, nitrogen, and major ions from three tropical montane watersheds. *Limnology and Oceanography* 39(1): 111–125
- Miller, G.L.; Lugo, A.E. 2009. Guide to the ecological systems of Puerto Rico. General Technical Report IITF-GTR-35, USDA Forest Service, International Institute of Tropical Forestry, San Juan, PR. 437 p.
- National Research Council. 2008. Hydrologic effects of a changing forest landscape. National Academies Press [\[http://www.nap.edu/catalog/12223.html\]](http://www.nap.edu/catalog/12223.html).
- O'Connor, J.P.; Covich, P.A.; Scatena, F.N.; [and others]. 2000. Non-indigenous bamboo along headwater streams of the Luquillo Mountains, Puerto Rico: Leaf fall, aquatic leaf decay and patterns of invasion. *Journal of Tropical Ecology* 16: 499–516.
- Pike, A.S. 2008. Longitudinal patterns in stream channel geomorphology and aquatic habitat in the Luquillo Mountains of Puerto Rico. PhD dissertation, University of Pennsylvania. 88 p.

- Pike, A.S.; Scatena, F.N. 2009. Riparian indicators of flow frequency in a tropical montane stream network. University of Pennsylvania, Department of Earth and Environmental Science, 240 South 33rd Street, Philadelphia, PA 19104
- Radeloff, V.C., Hammer, R.B.; S.I. Stewart, S.I.; [and others]. 2005. The wildland-urban interface in the U.S. *Ecological Applications* 15(3): 799–805.
- Scatena, F.N.; Johnson, S.L. 2001. Instream-flow analysis for the Caribbean National Forest, Puerto Rico: Methods and analysis. General Technical Report IITF-GTR-11, USDA Forest Service, International Institute of Tropical Forestry, Rio Piedras, PR. 30 p.
- Tiner, R.W.; Burke, D.G. 1995. Wetlands of Maryland. U.S. Fish and Wildlife Service, Ecological Services, Region 5, Hadley, MA and Maryland Department of Natural Resources, Annapolis, MD, Cooperative publication, 193 pp. plus appendices.
[\[http://www.fws.gov/northeast/EcologicalServices/pdf/wetlands/MD_wetlands85.pdf\]](http://www.fws.gov/northeast/EcologicalServices/pdf/wetlands/MD_wetlands85.pdf).
- USDA Forest Service. 2016. Land and Resource Management Plan and Final Environmental Impact Statement. Columbia, SC.
- USDA Forest Service. 1985. Francis Marion National Forest.
- USDA Forest Service. 1997. Environmental impact statement (EIS) for the land and resource management plan for the Caribbean National Forest/Luquillo Experimental Forest. Southern Region, Puerto Rico.
- USDA Forest Service. 1997. Revised land and resource management plan, Caribbean National Forest/Luquillo Experimental Forest. Southern Region, Puerto Rico.
- USDA Forest Service. 2010. Forest Service watershed condition classification technical guide. Updated (October 25, 2010).
- USDA Forest Service. 2010. Watershed condition framework implementation guide. Updated (November 12, 2010).
- USDA Forest Service. 2010. El Yunque watershed condition classification supplemental guidance (EIY 2010 WCC RegSupp v.5).
- USDA Forest Service. 2011a. Watershed condition framework. Publication FS-977, May 2011. 34 p.
- USDA Forest Service. 2011b. Watershed condition framework technical guide. Publication FS-978, July 2011. 49 p.
- Weaver, P.L. 1972. Cloud moisture interception in the Luquillo Mountains of Puerto Rico. *Caribbean Journal of Science* 12: 129–144.

Threatened and Endangered Species

- Kepler, C.B.; Parkes, K.C. 1972. A new species of warbler (Parulidae) from Puerto Rico. *The Auk* 89: 1–18. [\[http://sora.unm.edu/sites/default/files/journals/auk/v089n01/p0001-p0018.pdf\]](http://sora.unm.edu/sites/default/files/journals/auk/v089n01/p0001-p0018.pdf).
- Rivero, J.A. 1998. Los anfibios y reptiles de Puerto Rico. University of Puerto Rico Press, Río Piedras, Puerto Rico. 510 p.

Wiley, J.W.; Bauer, G.P. 1985. Caribbean National Forest, Puerto Rico. *American Birds* 39: 12–18.

Climate Change

- Anchukaitis, K.J.; Evans, M.N. 2010. Tropical cloud forest climate variability and the demise of the Monteverde golden toad. *Proceedings of the National Academy of Sciences*. 107(11): 5036–5040.
- Anderson, B. 2011. Near-term increase in frequency of seasonal temperature extremes prior to the 2°C global warming target. *Climatic Change*. 108(3): 581–589.
- Arendt, W.J. 2000. Impact of nest predators, competitors, and ectoparasites on pearly-eyed thrashers, with comments on the potential implications for Puerto Rican parrot recovery. *Ornitología Neotropical* 11: 13–63.
- Barker, B.S.; Waide, R.B.; Cook, J.A. 2011. Deep intra-island divergence of a montane forest endemic: Phylogeography of the Puerto Rican frog (*Eleutherodactylus portoricensis*) (*anura*: *Eleutherodactylidae*). *Journal of Biogeography*. 38(12): 2311–2325.
- Bedsworth, L. 2012. Air quality planning in California's changing climate. *Climatic Change*. 111(1): 101–118.
- Blaustein, A.R.; Walls, S.C.; Bancroft, B.A. [and others]. 2010. Direct and indirect effects of climate change on amphibian populations. *Diversity*. 2(2): 281–313.
- Breshears, D.D.; Cobb, N.S.; Rich, P.M. [and others]. 2005. Regional vegetation die-off in response to global-change-type drought. *Proceedings of the National Academy of Sciences*. 102(42): 15144 – 15148.
- Brodie, J.; Post, E.; Laurance, W.F. 2011. Climate change and tropical biodiversity: a new focus. *Trends in Ecology and Evolution*. 27(3): 1–6.
- Burrowes, P.A.; Joglar, R.L.; Green, D.E. 2004. Potential causes for amphibian declines in Puerto Rico. *Herpetologica*. 60(2): 141–154.
- Bytnerowicz, A.; Omasa, K.; Paoletti, E. 2007. Integrated effects of air pollution and climate change on forests: A northern hemisphere perspective. *Environmental Pollution* 147: 438–445.
- Carpenter, S.R.; Fisher, S.G.; Grimm, N.B.; Kitchell, J.F. 1992. Global change and freshwater ecosystems. *Annual Review Ecological Systems*. 23: 119–139.
- Cashman, A.; Nurse, L.; John, C. 2010. Climate change in the Caribbean: The water management implications. *The Journal of Environment Development* 19(1): 42–67.
- Clark D.B.; Clark D.A.; Oberbauer, S.F. 2010. Annual wood production in a tropical rain forest in NE Costa Rica linked to climatic variation but not to increasing CO₂. *Global Change Biology* 16: 747–759.
- Comarazamy, D.E.; González, J.E. 2011. Regional long-term climate change (1950–2000) in the midtropical Atlantic and its impacts on the hydrological cycle of Puerto Rico. *Journal of Geophysical Research*. 116(D21): D00Q05.
- Covich, A.P.; Crowl, T.A.; Scatena, F.N. 2003. Effects of extreme low flows on freshwater shrimps in a perennial tropical stream. *Freshwater Biology*. 48(7): 1199–1206.

- Huey, R.B.; Deutsch, C.A.; Tewksbury, J.J. [and others]. 2009. Why tropical forest lizards are vulnerable to climate warming. *Proceedings of the Royal Society B: Biological Sciences*. 276(1664): 1939–1948.
- Joyce, L.A.; Blate, G.M.; Littell, J.S. [and others]. 2008. National forests. In: Julius, S.H.; West, editors. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. U.S. Environmental Protection Agency, Washington, DC. 873 p.
- Karl, T.R.; Melillo, J.M.; Peterson, T.C. 2009. Global climate change impacts in the United States. Cambridge University Press, NY. 188 p.
- Knutson, T.R.; McBride, J.L.; Chan, J. [and others]. 2010. Tropical cyclones and climate change. *Nature Geoscience*. 3(3): 157–163.
- Larsen, M.C. 2000. Analysis of 20th century rainfall and streamflow to characterize drought and water resources in Puerto Rico. *Physical Geography*. 21(6): 494–521.
- Lasso, E.; Ackerman, J.D. 2003. Flowering phenology of (*Werauhia sintenisii*), a bromeliad from the dwarf montane forest in Puerto Rico: An indicator of climate change? *Selbyana*. 24(1): 95–104.
- Laurance, W.F.; Useche, D.C.; Shoo, L.P. [and others]. 2011. Global warming, elevational ranges and the vulnerability of tropical biota. *Biological Conservation*. 144(1): 548–557.
- Lewsey, C.; Cid, G.; Kruse, E. 2004. Assessing climate change impacts on coastal infrastructure in the eastern Caribbean. *Marine Policy*. 28(5): 393–409.
- Longo, A.V.; Burrowes, P.A.; Joglar, R.L. 2010. Seasonality of (*Batrachochytrium dendrobatidis*) infection in direct-developing frogs suggests a mechanism for persistence. *Diseases of Aquatic Organisms*. 92: 253–260.
- Magrin, G.; Gay García, C.; Cruz Choque, D. [and others]. 2007. Latin America. In: Parry, M.L.; Canziani, O.F.; Palutikof, J.P., comps, eds. *Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press: 581–615.
- Mulholland, P.J.; Best, G.R.; Coutant, C.C. [and others]. 1997. Effects of climate change on freshwater ecosystems of the south-eastern United States and the Gulf Coast of Mexico. *Hydrological Processes*. 11: 949–970.
- Nadkarni, N.; Solano, R. 2002. Potential effects of climate change on canopy communities in a tropical cloud forest: an experimental approach. *Oecologia*. 131(4): 580–586.
- Peterson, T.C.; Taylor, M.A.; Demeritte, R. [and others]. 2002. Recent changes in climate extremes in the Caribbean region. *Journal of Geophysical Research* 107(D21): 4601.
- Pounds, J.A.; Fogden, M.P.L.; Campbell, J.H. 1999. Biological response to climate change on a tropical mountain. *Nature*. 398(6728): 611–615.
- Prideaux, B.; Coghlan, A.; McNamara, K. 2010. Assessing tourists' perceptions of climate change on mountain landscapes. *Tourism Recreation Research* 35(2): 187–199.

- Robbins, A.M.; Eckelmann, C.M.; Quiñones, M. 2008. Forest fires in the insular Caribbean. *AMBIO: A Journal of the Human Environment* 37(7): 528–534.
- Rogowitz, G.L. 1996. Evaluation of thermal acclimation and altitudinal variation of metabolism in a neotropical lizard (*Anolis gundlachi*). *Copeia* 1996(3): 535.
- Scatena, F.N. 1998. An assessment of climate change in the Luquillo Mountains of Puerto Rico. In: Segarra-García, R.I., editor. Proceeding tropical hydrology and Caribbean water resources. Third international symposium on tropical hydrology and Fifth Caribbean Islands water resources congress in San Juan, Puerto Rico. Herndon, VA: American Water Resources Association. p. 193–198.
- Scott, D.; McBoyle, G.; Schwartzentruber, M. 2004. Climate change and the distribution of climatic resources for tourism in North America. *Climate Research* 27(2): 105–117.
- Seager, R.; Tzanova, A.; Nakamura, J. 2009. Drought in the South-eastern United States: Causes, variability over the last millennium, and the potential for future hydroclimate change. *American Meteorological Society*. 22(19): 5021–5045.
- Seavy, N.E.; Gardali, T.; Golet, G.H. [and others]. 2009. Why climate change makes riparian restoration more important than ever: recommendations for practice and research. *Ecological Restoration*. 27(3): 330–338.
- Seneviratne, S.I.; Nicholls, N.; Easterling, D. [and others]. 2012. Changes in climate extremes and their impacts on the natural physical environment. In: Field, C.B [and others], eds. Managing the risks of extreme events and disasters to advance climate change adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK, and New York, NY, USA: Cambridge University Press. p. 109–230.
- Stallard, R.F. 2001. Possible environmental factors underlying amphibian decline in eastern Puerto Rico: Analysis of U.S. government data archives. *Conservation Biology* 15(4): 943–953.
- Still, C. J., Foster, P. N., and Schneider, S. H. 1999. Simulating the effects of climate change on tropical montane cloud forests. *Letters to Nature, Macmillan Magazines Ltd Nature, VOL 398*.
[http://stephenschneider.stanford.edu/Publications/PDF_Papers/StillEtAl.pdf].
- Studds, C.E.; Marra, P.P. 2011. Rainfall-induced changes in food availability modify the spring departure programme of a migratory bird. *Proceedings of the Royal Society B: Biological Sciences* 278(1723): 3437–3443.
- Uyarra, M.C.; Côté, I.M.; Gill, J.A. [and others]. 2005. Island-specific preferences of tourists for environmental features: implications of climate change for tourism-dependent states. *Environmental Conservation*. 32(1): 11–19.
- Vélez Rodríguez, Z.; Votaw, G. S. 2012. Precipitation in Puerto Rico and U.S. Virgin Islands. National Oceanic and Atmospheric Administration, San Juan, Puerto Rico. 6 p.
[<http://www.srh.noaa.gov/images/sju/climo/GV2012.pdf>; date accessed: August 22, 2013]
- Wagner, F.; Rossi, V.; Stahl, C. [and others]. 2012. Water availability is the main climate driver of neotropical tree growth. [<http://dx.plos.org/10.1371/journal.pone.0034074>; accessed June 18, 2013].
- Waide, R.B.; Comarazamy, D.E.; González, J.E. [and others]. 2013. Climate variability at multiple spatial and temporal scales in the Luquillo Mountains, Puerto Rico. *Ecological Bulletins*. 54: 21–41.

- Woollings, T.; Blackburn, M. 2012. The North Atlantic jet stream under climate change and its relation to the NAO and EA patterns. *Journal of Climate* 25(3): 886–902.
- Wunderle, J.M.; Arendt, W.J. 2011. Avian studies and research opportunities in the Luquillo Experimental Forest: A tropical rain forest in Puerto Rico. *Forest Ecology and Management* 262(1): 33–48.
- Zotz, G.; Bader, M.Y. 2009. Epiphytic plants in a changing World-Global: Change effects on vascular and non-vascular epiphytes. In: Lüttge, U.; Beyschlag, W.; Büdel, B.; editors. *Progress in Botany* 70(4): 147–170.

Ecological Resources

- Axelrod, F.S. 2011. A systematic vademecum to the vascular plants of Puerto Rico.
- Brokaw, N.; [and others]; editors. 2012. *A Caribbean forest tapestry: The multidimensional nature of disturbance and response*.
- Chokkalingam, U.; De Jong, W. 2001. Secondary forest: A working definition and typology. *International Forestry Review* 3(1).
- Departamento de Recursos Naturales, Estado Libre Asociado de Puerto Rico. 2007. *Elementos criticos de la Division de Patrimonio Natural-Plantas*. Revised.
- Evans, J.; Turnbull, J. 2004. *Plantation forestry in the tropics*. Third edition, Oxford University Press.
- Ewel, J.J.; Whitmore, J.L.; 1973. *The ecological life zones of Puerto Rico and the Virgin Islands*.
- Figueroa Colon, J.C.; Woodbury, R.O. 1996. *Rare and endangered plant species of Puerto Rico and the Virgin Islands: An annotated checklist*.
- Hamilton, L.S.; Juvik, J.O.; Scatena, F.N.; editors. 1994. *Tropical montane cloud forests*. *Ecological Studies* 110.
- Harris, N.L.; Lugo, A.E.; Brown, S.; Heartsill-Scalley, T.; editors. 2012. *Luquillo Experimental Forest: Research history and opportunities*. USDA Forest Service, EFR-1.
- Jennings, 2014. *Climate change effects in El Yunque National Forest, Puerto Rico and the Caribbean Region*. GTR-SRS 193, USDA Forest Service, Southern Research Station, Asheville, NC.
- Krupnick, G.A.; Miller, J.S.; Porter-Morgan, H.A. 2012. Addressing target two of the global strategy for plant conservation by rapidly identifying Puerto Rican plants at risk. Pedro Acevedo-Rodriguez National Museum of Natural History, Smithsonian Institution, Washington D.C.; The New York Botanical Garden, Bronx NY.
- Lichvar, R.W. 2012. Puerto Rico 2012 final regional wetland plant list. The national wetland plant list, ERDC/CRREL TR-12-11, U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, NH. [[http://acwc.sdp.sirsi.net/client/search/asset:asset?t:ac=\\$N/1012381](http://acwc.sdp.sirsi.net/client/search/asset:asset?t:ac=$N/1012381)]
- Little, E.L.; Woodbury, R.O. 1976. *Trees of the Caribbean National Forest, Puerto Rico*. Research Paper ITF-20, USDA Forest Service Institute of Tropical Forestry. 27 p.
- Little, E.L., Woodbury, R.O. 1980. *Rare and endemic trees of Puerto Rico and the Virgin Islands*. USDA Conservation Research Report 27. 26 p.

- Lugo, A.E. 2009. The emerging era of novel tropical forests. International Institute of Tropical Forestry, USDA Forest Service, 1201 Ceiba St. Jardín Botánico Sur, Río Piedras, Puerto Rico. *Biotropica* 41(5): 589–591.
- Marrero, J. 1947. A survey of the forest plantations in the Caribbean National Forest. Master thesis. Tropical Forest Experiment Station.
- Miller, G.L.; Lugo, A.E. 2009. Guide to the ecological systems of Puerto Rico.
- Natural Resources Conservation Service (NRCS). 2012. Soil survey of the Caribbean National Forest.
- (The) New York Botanical Garden. 2011. Puerto Rico endangered plants initiative (PREPI). [PREPI_SpecimenData.accdb]
- Panagopoulos, N. 1999. A guide to Caribbean vegetation types: Preliminary classification system and descriptions.
- Pike, A.S.; Scatena, F.N. 2009. Riparian indicator of flow frequency in a tropical montane stream network. University of Pennsylvania, Philadelphia.
- Quiñones, M.; Rivera, L.A; Gould, W.A. 2013. El Yunque National Forest vegetation map: Terrestrial Ecosystem Assessment chapter of the land and resources management plan revision for El Yunque National Forest. Vector data, USDA Forest Service, San Juan, Puerto Rico.
- USDA Forest Service. Undated. Plan maps: Contractor, Southern Region RIM (D. Jones).
- USDA Forest Service. 1997. Revised land and resource management plan, Caribbean National Forest/Luquillo Experimental Forest. Southern Region, Puerto Rico.
- USDA Forest Service. 2012. Ecological sustainability evaluation (ESE) tool; planning area element priority report. Planning area: El Yunque National Forest.
- USDA Forest Service. 2014. El Yunque National Forest Assessment. San Juan, PR.
- USDA Forest Service. 2014. Climate change effects in El Yunque National Forest, Puerto Rico and the Caribbean Region. General Technical Report GTR-SRS-193, USDA Forest Service, Southern Research Station, Asheville, NC.
- Weaver, P.L. 1994. Baño de Oro Natural Area, Luquillo Mountains, Puerto Rico.
- Weaver, P.L. 2012. The Luquillo Mountains: Forest resources and their history. General Technical Report IITF-44, USDA Forest Service, International Institute of Tropical Forestry, San Juan, Puerto Rico.
- Weaver, P.; Gould, W. 2013. Forest Vegetation along environmental gradients in the Northeastern of Puerto Rico. *Ecological Bulletin* 54.

Ecological Resources – Fauna

- Alexander, S.J.; Melain, R.J.; Blatner, K.A. 2001. Socio-economic research on non-timber forest products in the Pacific Northwest. USDA Forest Service Pacific Northwest Forest Sciences Laboratory, Corvallis, OR.

- Anadón-Irizarry, V. 2006. Distribution, habitat occupancy, and population density of the elfin-woods warbler (*Dendroica angelae*) in Puerto Rico. M.S. thesis, University of Puerto Rico, Mayagüez Campus. 53 p.
- Arendt, W.J.; Qian, S.S.; Mineard, K.A., 2013. Population decline of the elfin-woods warbler *Setophaga angelae* in eastern Puerto Rico. Bird Conservation International, Birdlife International 2013 [doi: 10.1017/S0959270913000166]. 11 p.
- Cano, F. 2013. Forest biologist. USDA Forest Service, El Yunque National Forest, Rio Grande, PR.
- Caughley, G.C. 1977. Analysis of vertebrate populations. Wiley, New York, NY, USA.
- Center for the Aquatic Technology Transfer (CATT). 2001. Report: The use of basinwide visual estimation technique on the Caribbean National Forest. Rio Grande, PR.
- Cruz, A.; Delannoy, C.A. 1984. Ecology of the elfin-woods warbler (*Dendroica angelae*). I. Distribution, habitat usage, and population densities. Caribbean Journal of Science 20 (1-2): 89–96.
- Cruz, A.; Delannoy, C.A. 1986. Status, breeding biology and conservation needs of the Puerto Rican sharp-shinned hawk. Final report submitted to the USFWS work contract no. 14-16-0004-82-031.
- Delannoy, C.A. 1992. Status surveys of the Puerto Rican sharp-shinned hawk and Puerto Rican broad-winged hawk. Final report submitted to the USFWS in work contract no. 14-16-0004-91-031.
- Delannoy, C.A. 1995. Space requirements and nesting: Site habitat characterization of the Puerto Rican broad-winged hawk. Final report submitted to the USFWS.
- DiFiore, S. 2001. Introduced species summary report: Small Indian mongoose (*Herpestes auropunctatus*). Columbia University.
- Ewel, J.S.; Whitmore, J.L. 1973. Ecological life zones of Puerto Rico and the U.S. Virgin Islands. USDA Forest Service Research Paper ITF-18, USDA Forest Service, International Institute of Tropical Forestry, San Juan, Puerto Rico. 72 p.
- Gannon, M.; Kurta, A.; Rodriguez-Duran, A.; Willig, M.R. 2005. Bats of Puerto Rico. Texas Tech University Press, Lubbock, TX.
- Garcia M.A.; Cruz-Burgos, J.A.; Ventosa, E.; Lopez, R. 2005. Puerto Rico comprehensive wildlife conservation strategy. Puerto Rico Department of Natural and Environmental Resources, San Juan, PR.
- Gochfeld, M.; Hill, D.; Tudor, G. 1973. A second population of the recently described elfin-woods warbler and other bird records from the West Indies. Caribbean Journal of Science 13(3-4): 231–235.
- Gould, W.A.; Alarcon, C.; Fevold, B. [and others]. 2008. The Puerto Rico gap analysis project. USDA Forest Service IITF-GTR-39, USDA Forest Service, International Institute of Tropical Forestry, San Juan, Puerto Rico.
- Hein, C.L.; Redd, S.M.; Crowl, T.A.; Gonzalez-Caban, A. 2007. Conservation of a predatory, freshwater shrimp (*Macrobrachium carcinus*) in Puerto Rico. Paper presented at the 2008 Association for Tropical Biology and Conservation Paramaribo, Suriname, 9–13 June 2008.

- Hengstenberg, D.W.; Vilella, F.J. 2004. Reproductive biology, abundance, and movement patterns of the Puerto Rican broad-winged hawk in a limestone forest of Puerto Rico. Final report submitted to the U.S. Geological Survey under Cooperative Agreement No. 14-45-009-1543-59.
- InfoNatura: Animals and ecosystems of Latin America [web application]. 2007. Version 5.0. NatureServe, Arlington, VA (USA). [http:// www.natureserve.org/infonatura](http://www.natureserve.org/infonatura); accessed April 29, 2013 .
- International Union for Conservation of Nature. 2012. IUCN red list of threatened species. Version 2012.2. [www.iucnredlist.org; downloaded April 29, 2013].
- Jensen, K.; Alvarado-Ramy, F.; González-Martínez, J. [and others]. 2004. B virus and free-ranging macaques, Puerto Rico. *Emerging Infectious Diseases* 10(3): 494–496.
- Joglar, R. 1998. *Los Coquies de Puerto Rico: Su historia natural y conservacion*. Primera Edicion Universidad de Puerto Rico.
- Kikkert, D.A.; Crawl, T.A.; Covich, A.P. 2009. Upstream migration of amphidromous shrimps in the Luquillo Experimental Forest, Puerto Rico: Temporal patterns and environmental cues. *Journal of the North American Benthological Society* 28(1): 233–246.
- Kwak, T.J.; Cooney, P.B.; Brown, C.H. 2007. Fishery population and habitat assessment in Puerto Rico streams: Phase I final report. USGS, North Carolina Cooperative Fish and Wildlife Research Unit, Department of Zoology, North Carolina State University.
- Longo, A.V.; Burrowes, P.A. 2010. Persistence with chytridiomycosis does not assure survival of direct-developing frogs. *EcoHealth* [doi: 10.1007/s1039-010-0327-9].
- López-Marrero, T.; Meyn, M.; Hermansen-Báez, L.A. 2011. El Yunque ecosystem services: A participatory research approach [fact sheet]. USDA Forest Service, Southern Research Station. Gainesville, FL:
- Mirjam, A.F. R.; Wiersum, K.F. 2003. The importance of non-timber forest product for forest-based rural livelihoods: An evolving research agenda. Presentation at the International Conference on Rural Livelihoods, Forests, and Biodiversity. May, Bonn, Germany.
- NatureServe. 2013. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. [<http://www.natureserve.org/explorer>; accessed April 29, 2013].
- Neal, J.W.; Lilyestrom, C.G.; Kwak, T.J. 2009. Factors influencing tropical island freshwater fishes: Species, status, and management implications in Puerto Rico. *Fisheries* 34(11): 546–554.
- Puente-Rolon, A.R.; Bird-Pico, F.J. 2004. Foraging behavior, home range, movements and activity patterns of (*Epicrates inornatus*) Boidae at Mata de Platano Reserve in Arecibo, Puerto Rico. *Caribbean Journal of Science* 40(3): 343–352.
- Raffaele, H.A. 1989. *A guide to the Birds of Puerto Rico and the Virgin Islands*. Princeton University Press.
- Rivera-Milan, F.F.; Ruiz, C.R.; Cruz, J.A. [and others]. 2003. Population monitoring of plain pigeons in Puerto Rico. *The Wilson Bulletin* 115 (1): 45–51.

- Rivera, R.L. 2008. Puerto Rico Department of Natural and Environmental Resources: Lista de elementos críticos y especies bajo vigilancia de la división de patrimonio natural (natural patrimony species list). San Juan, PR.
- Rivera, R.L. 2013. Personal discussion with PRDNER biologist representative Ramon L. Rivera-Lebron. Agreement on habitat criteria and explanation of natural patrimony list. Rio Grande, PR.
- Rivero, Juan A. 2006. Guía para la identificación de Lagartos y Culebras de Puerto Rico. La Editorial Universidad de Puerto Rico
- Robinson, K. 1997. Where dwarfs reign: A tropical rain forest in Puerto Rico. University of Puerto Rico Press, San Juan, PR.
- Samson F.B.; Knopf, F.L. 1994. Prairie conservation in North America. *Bioscience* 44:418–421. [doi:10.2307/1312365].
- Scatena, F.N.; Blanco, J.F.; Beard, K.H. [and others]. 2012. Disturbance regime. *In*: N. Brokaw, T.; Crowl, A.; Lugo, W. [and others]; editors. *A Caribbean forest tapestry: The Multidimensional Nature of Disturbance*. p. 164–200.
- Scatena, F.N.; Johnson, S.L. 2001. Instream-flow analysis for the Luquillo Experimental Forest, Puerto Rico: Methods and analysis. IITF-GTR-11, USDA Forest Service, International Institute of Tropical Forestry, San Juan, PR.
- Snyder, M.; Anderson, E.; Pringle, C. 2009. A migratory shrimp's perspective on habitat fragmentation in the neotropics: Extending our knowledge from Puerto Rico. *In*: Asakura, A.; editor. *New frontiers in crustacean biology*. Proceedings of the TCS Summer Meeting. Tokyo, Japan.
- Snyder, N.; Wiley, J.W.; Kepler, C.B. 1987. The parrots of Luquillo: Natural history and conservation of the Puerto Rican Parrot. Western Foundation of Vertebrate Zoology, Los Angeles, CA.
- Stickel, W.H.; and Cope, J.B. 1947. The home ranges and wanderings of snakes. *Copeia* (2) 127–135.
- Stork, N.E.; Coddington, J.A.; Colwell, R.K. [and others]. 2009. Vulnerability and resilience of tropical forest species to land-use change. *Conservation Biology* 23(6): 1438–1447. [doi:10.1111/j.1523-1739-2009.01335.x].
- USDA Forest Service 1960. USDA Forest Service: Multiple Use Sustained Yield Act. Washington DC.
- USDA Forest Service. 1997. Land and resources plan for the Caribbean National Forest. Rio Grande, PR.
- USDA Forest Service. 2012. New forest planning rule. Washington DC.
- USDA Forest Service. 2012. Planning Rule, 36 CFR Part 219. Federal Register 77(68), April 9.
- USDA Forest Service. 2013. Ecological assessment for the new Forest Plan (planning support document). Rio Grande, PR.
- USDA Forest Service. 2013a. Proposed Forest Service Handbook (FSH) 1909.12 directives. El Yunque National Forest, Rio Grande, PR. 6 p.
- USDA Forest Service. 2013b. Proposed FSH 1909.12, Chapter 10, version February 14.

- USDI Fish and Wildlife Service. 1997. Puerto Rican broad-winged hawk and Puerto Rican sharp-shinned hawk recovery plan. USDI Fish and Wildlife Service Southeast Region office, Atlanta, GA.
- USDI Fish and Wildlife Service. 1999. Final rule to remove the American peregrine falcon from the Federal list of endangered and threatened wildlife. *Federal Register* 64(164), Wednesday, August 25.
- USDI Fish and Wildlife Service. 2009. Recovery plan for the Puerto Rican parrot (*Amazona vittata*). Atlanta, GA. 75 p.
- USDI Fish and Wildlife Service. 2010. 5-year review of the Puerto Rican broad-winged hawk. USDI Fish and Wildlife Service Southeast Region, Caribbean ecological service field office, Boqueron, PR.
- USDI Fish and Wildlife Service. 2013. Puerto Rican parrot population indices from biologist Pablo Torres. Rio Grande, PRP field office, PR.
- White, T.H.; Jr., Collazo, J.A.; Vilella, F.J. 2005. Survival of captive-reared Puerto Rican parrots released in the Caribbean National Forest. *Condor* 107: 426–434.
- Wiley, J.W.; Bauer, G.P. 1985. Caribbean National Forest, Puerto Rico. *American Birds* 39: 12–18.
- Willig, M.R.; Bauman, A. 1984. Notes on bats from the Luquillo Mountains of Puerto Rico. CEER-T-194, Center for Energy and Environment Research, San Juan, PR. 12 p.
- Wunder, S. 2001. Poverty alleviation and tropical forests: What scope for synergies? *World Development* 29(11): 1817–1833.
- Wunderle, J.M.; Arendt, W.J. 2011. Avian studies and research opportunities in the Luquillo Experimental Forest: A tropical rain forest in Puerto Rico. *Forest Ecology and Management* 262 (1): 33–48.
- Wunderle, J.M.; Mercado, B. P.; Terranova, E. 2004. Spatial ecology of Puerto Rican boas. *Biotropica* 36(4): 555–571

Socioeconomic Resources

- American Sportfishing Association (ASA). 2007. State and national economic effects of fishing, hunting and wildlife-related recreation on U.S. Forest Service-managed lands. Report prepared for the Wildlife, Fish, and Rare Plants, USDA Forest Service [accessed November 15, 2013; http://www.fs.fed.us/biology/resources/pubs/wildlife/usfs_wildlife_based_recreation_economic_contributions_1_03_07.pdf].
- Banco Popular de Puerto Rico. 2013. Progreso económico. February. 4 p.
- Bram, J.; Martínez, F.E.; Steindel, C. 2008. Trends and developments in the economy of Puerto Rico. Current issues in economics and finance. Federal Reserve Bank of New York 14(2).
- CDC 2011. The Dengue update. Center for Disease Control Division of Vector Borne Diseases 3(1).
- CEQ. 1997. Environmental justice guidance under the National Environmental Policy Act. Council on Environmental Quality, Executive Office of the President, Washington, D.C.
- Cochrane, M.A.; Laurance, W.F. 2008. Synergisms among fire, land use, and climate change in the amazon. *AMBIO: A Journal of the Human Environment* 37(7): 522–527.

- Estudios Técnicos, Inc. 2012. Symposium: La Economía Efectiva: Oportunidades 2013. Fourth annual symposium on Puerto Rico's economy. November 29, 2012. San Juan, PR.
- Federal Bureau of Investigation. 2013. Offenses known to law enforcement. Tables. [<http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/offenses-known-to-law-enforcement>].
- Government Development Bank for Puerto Rico. 2011. Puerto Rico factsheet: July 2011 (2010 Data). Office of Economic Studies and Analysis.
- Greene, D. 2013. 'Don't give up on us': Puerto Ricans wrestle with high crime. NPR. February 7. [<http://www.npr.org/2013/02/07/171071473/-don-t-give-up-on-us-puerto-ricans-wrestle-with-high-crime>].
- Instituto de Estadísticas de Puerto Rico (2010). Nuevas estadísticas de mortalidad, 2000-08. San Juan, Puerto Rico. [Obtenido de www.estadisticas.gobierno.pr. Johanssen et al. 2009].
- Kelman, I.; West, J.J. 2009. Climate change and small island developing states: A critical review. *Ecological and Environmental Anthropology* 5(1): 1–16.
- Lewsey, C.; Cid, G.; Kruse, E. 2004. Assessing climate change impacts on coastal infrastructure in the eastern Caribbean. *Marine Policy* 28(5): 393–409.
- Lim, Y.K.; Cai, M.; Kalnay, E.; Zhou, L. 2005. Observational evidence of sensitivity of surface climate changes to land types and urbanization. *Geophysical Research Letters* 32(22): L22712.
- López-Marrero, T.; Hermansen-Báez, L.A. (2011). Land cover within and around El Yunque National Forest. [Fact sheet]. USDA Forest Service, Southern Research Station, Gainesville, FL. 4 p.
- Maldonado, M.M.; Valdes-Pizzini, M.; Latoni, A.R. 1999. Owning and contesting El Yunque: Forest resources, politics, and culture in Puerto Rico. *Berkley Journal of Sociology* 44(1999–2000). p. 82–100.
- Millenium Ecosystem Assessment (MEA). 2005. Ecosystems and human well-being: synthesis. World Resources Institute, Washington, D.C.
- Moody's Investors Services. 2012. Puerto Rico rating action investor teleconference presentation summary report, December 17, 2012. 18 p.
- Policia de Puerto Rico. 2013. Delitos Tipo 1 en Puerto Rico por Municipio.
- Puerto Rico Banking Association (Asociación de Bancos de Puerto Rico). 2012. Puerto Rico housing market perspectives 2011–2015. Prepared by: Estudios Técnicos, Inc. 37 p.
- Robles, F. 2012. Puerto Rico tackling fearful murder rate. *Miami Herald*. December 11.
- Robbins, A.M.; Eckelmann, C.M.; Quiñones, M. 2008. Forest fires in the insular Caribbean. *AMBIO: A Journal of the Human Environment* 37(7): 528–534.
- Robinson, K. 1997. *Where dwarfs reign: A tropical rain forest in Puerto Rico*. University of Puerto Rico Press, San Juan, PR.

- Rodríguez Ramos, R. 2010. Rethinking Puerto Rican precolonial history. University Alabama Press. 288 p.
- Saunders, N.J. 2005. The peoples of the Caribbean: An encyclopedia of archaeology and traditional culture. Santa Barbara, CA. ABC-CLIO.
- Shoichet, C.E. 2012. Puerto Rico: A forgotten front in America's drug war? CNN. June 10. [<http://www.cnn.com/2012/06/09/justice/puerto-rico-drug-trafficking>].
- Telemundo. 2012. Puerto Rico es comparado con Mexico en la tasa de homicidios. 12 Febrero.
- The World Bank. 2013. World development indicators. Life expectancy at birth. 20 October 2013. [<http://data.worldbank.org/indicator/SP.DYN.LE00.IN>].
- United Nations (UN). 2013. Demographic yearbook 2012. Sixty-third issue. Department of Economic and Social Affairs, New York.
- United Nations Development Program (UNDP). 2013. Summary: Human development report 2013. The Rise of the South: Human Progress in a Diverse World. UNDP, New York.
- United Nations Office on Drugs and Crime (UNODC). 2012. Intentional homicide, count and rate per 100,000 population (1995–2011). 30 November 2013. [<https://www.unodc.org/unodc/en/data-and-analysis/homicide.html>]
- United States Census Bureau (USCB). American fact finder. U.S. Census Bureau's American Community Survey Office. 30 December 2013 [<http://factfinder2.census.gov>].
- USDA. 2009. 2007 census of agriculture. National Agricultural Statistics Service, Puerto Rico Island and Municipio Data, San Juan, PR.
- USDA. 2012. USDA environmental justice strategic plan, 2012–2014. Washington, D.C.
- USDA Forest Service. 2013. Secure Rural Schools: Payments and Receipts, 15 November 2013.
- Van Middledyk, R.A. 2013. The history of Puerto Rico: From the Spanish Discovery to the American Occupation. CreateSpace Independent Publishing. 192 p.
- Valdés-Pizzini, Manuel. (2001). Por los caminos de la naturaleza: sociedad, tecnología y espacio natural en las ciencias sociales. In: Torres, L.; Torres, L.; editors. Introducción a las Ciencias Sociales: Sociedad y Cultura Contemporáneas (second edition). International Thompson. p. 420–450.
- Valdés-Pizzini, M.; Maldonado, M.M.; Latoni, A.R. 2000. Owning and contesting El Yunque: Forest resources, politics, and culture in Puerto Rico. *Berkeley Journal of Sociology: A Critical Review*, 44.
- Valdés-Pizzini, M.; González-Cruz, M.; Martínez-Reyes, J.E. 2011. La transformación del paisaje puertorriqueño y la disciplina del Cuerpo Civil de Conservación 1933–1942: Centro de Investigaciones Sociales, Universidad de Puerto Rico.
- Weaver, P.L. 2012. The Luquillo Mountains: Forest resources and their history. General Technical Report IITF-44, USDA Forest Service, International Institute of Tropical Forestry, San Juan, PR.

Recreation

- Commonwealth of Puerto Rico National Parks. 2007. State Comprehensive Outdoor Recreation Plan (SCORP) 2008–2013.
- Cordell, H.K. 2012. Outdoor recreation trends and futures. USDA Forest Service, Southern Research Station.
- Cordell, H.K.; Betz, C.J.; Green, G.T. 2008. Natural-based outdoor recreation trends, and wilderness. *International Journal of Wilderness*.
- Corredor Ecologico del Noreste. 2013. Turismo Libre—simple y espontanea.
- Louy, R. 2005. Last child in the woods: Saving our children from nature-deficit disorder. Algonquin Books of Chapel Hill, Chapel Hill, NC.
- USDA Forest Service. 1997a. Caribbean National Forest land and resource management plan. Caribbean National Forest, Southern Region.
- USDA Forest Service. 1997b. Final environmental impact statement for the Caribbean National Forest land and resource management plan. Caribbean National Forest, Southern Region.
- USDA Forest Service. 2000. The recreation agenda.
- USDA Forest Service. 2008. El Yunque National Forest national comprehensive evaluation report. El Yunque National Forest, Southern Region.
- USDA Forest Service. 2009. Interpretive and conservation education master plan. El Yunque National Forest, Southern Region.
- USDA Forest Service. 2010a. A framework for sustainable recreation.
- USDA Forest Service. 2010b. Caribbean National Forest wild and scenic comprehensive river management plan. El Yunque National Forest, Southern Region.
- USDA Forest Service. 2011. Citizen task force—El Toro Wilderness Area limits of acceptable change. El Yunque National Forest.
- USDA Forest Service. 2012a. 2006. National visitor use monitoring (NVUM) report. Caribbean National Forest, Southern Region.
- USDA Forest Service. 2012b. 2011 national visitor use monitoring (NVUM) report. El Yunque National Forest, Southern Region.
- Weaver, P.L. 2012. The Luquillo Mountains: Forest resources and their history. General Technical Report IITF-44, USDA Forest Service, International Institute of Tropical Forestry, San Juan, Puerto Rico.

Scenic Resources

- USDA Forest Service. 1995. Landscape aesthetics: A handbook for scenery management. Agriculture Handbook 701.
- USDA Forest Service. 1997. El Yunque National Forest land and resource management plan. El Yunque National Forest, Southwestern Region.

- USDA Forest Service. 2010. Caribbean National Forest national wild and scenic rivers comprehensive river management plan. El Yunque National Forest, Southwestern Region.
- USDA Forest Service. 2012a. 2006 National visitor use monitoring (NVUM) report.
- USDA Forest Service. 2012b. 2011 National visitor use monitoring (NVUM) report.
- USDA Forest Service. 2013a. Scenic character description: El Yunque National Forest. Hill, N.; unpublished.
- USDA Forest Service. 2013b. Scenery management system inventory report: El Yunque National Forest. Hill, N.; unpublished.

Cultural/Historic Resources

- Barnes, M.; Walker, J.B.; Miele, F. 2007. New Deal Era construction in the forest reserves in Puerto Rico. National Register of Historic Places Multiple Property Documentation Form (MPS) prepared by Southeast Regional Office-NPS and US Forest Service (MPS approved by NPS on November 11, 2007), manuscript in Puerto Rico State Historic Preservation Office.
- Domínguez-Cristóbal, C.M. 2000. Panorama histórico forestal de Puerto Rico. Editorial Universidad de Puerto Rico, San Juan.
- Hayward, M.; Cinquino, M.; Steinback, M.A. 2001. Prehistoric rock art of Puerto Rico. National Park Service, National Register of Historic Places, Multiple Property documentation Form, manuscript in the PRSHPO.
- Oliver, J. 1995. Cultural overview. In: Garrow, P.H.; [and others]. La Iglesia de Maraguez (PO-39). Investigations of a local ceremonial center in the Cerrillos River Valley, Ponce, Puerto Rico, manuscript in the PRSHPO. p. 12–39.
- Rouse, I. 1992. The Tainos: Rise and decline of the people who greeted Columbus. Yale University Press, New Haven.
- USDA Forest Service. 2014. Forest Plan Assessment: El Yunque National Forest. El Yunque National Forest; Rio Grande.
- Valdés-Pizzini, M.; Maldonado, M.M.; Latoni, A.R. 2000. Owning and contesting El Yunque: Forest resources, politics, and culture in Puerto Rico. *Berkeley Journal of Sociology: A Critical Review* 44.
- Valdés-Pizzini, M.; González-Cruz, M.; Martínez-Reyes, J.E. 2011. La transformación del paisaje puertorriqueño y la disciplina del Cuerpo Civil de Conservación 1933-1942: Centro de Investigaciones Sociales, Universidad de Puerto Rico.
- Wadsworth, F.H. 2012. Los bosques y el uso de madera en Puerto Rico. Instituto de Dasonomía Tropical.
- Walker, Jeff. (n.d.). [Citations from essay Pre-Columbian Use of the Sierra de Luquillo]. Unpublished raw data.
- Weaver, P.L. 2012. The Luquillo Mountains: Forest resources and their history. General Technical Report IITF-44, USDA Forest Service, International Institute of Tropical Forestry, San Juan, Puerto Rico.

Forest Health

- Drewry, G. E. 1970. A list of insects from El Verde Puerto Rico. In Odum, H.T.; Pigeon, R.F., eds. A tropical rain forest. Washington, DC: U.S. Atomic Energy Commission: E-129-150.
- Hodges, C.S.; Mc Fadden, M.W. 1987. Insects and diseases affecting forest plantations in tropical America. In: Figueroa, J.C.; Wadsworth, F.W.; Branham, S., eds. Management of the forests of tropical America. USDA Forest Service, Southern Forest Experiment Station, New Orleans, LA. P. 365–376.
- Longo, A.V.; Burrowes, P.A.; Joglar, R.L. 2010. Seasonality of *Batrachochytrium dendrobatis* infection in direct-developing frogs suggests a mechanism for persistence. *Diseases of Aquatic Organisms* 92: 253–260.
- Torres, J. A. 1994. Insects of the Luquillo Mountains, Puerto Rico. General Technical Report S-105, USDA Forest Service, Southern Forest Experimental Station.

Appendix A: Public Involvement

El Yunque National Forest was chosen along with seven other National Forests to be early adopter forests under the New Forest Planning Rule (2012). The new forest planning rule entails great emphasis in collaboration and public involvement during the planning process and the plan's implementation. El Yunque National Forest conducted public outreach meetings during the various phases of the planning process including development of the assessment, need for change, proposed action and plan alternatives. The Forest also participated in several activities from 2012 to 2016 to inform the public on the Forest Plan. Most of the Forest participation can be delineated in the following table.

Table A-1. Public participation planning activities by date

Planning Outreach Activities	Date
Listening Sessions	September 18–19, 2012
Collaboration Workshop	December 5–6, 2012
Citizens Participatory Group Meetings	May 31, 2013 to current
2013 El Tinglar Festival	April 13, 2013
Ethnographic Appraisal	July–August 2013
Meeting with International Institute of Tropical Forestry	October 30, 2013
NEPA Workshop	December 3–4, 2013
Community Meetings 2014: Naguabo	January 28, 2014
El Yunque Employee Meeting	February 19, 2014
Community Meetings 2014: Fajardo 1	March 27, 2014
Community Meetings 2014: Las Piedras 1	April 3, 2014
2014 El Tinglar Festival	April 5, 2014
Community Meetings 2014: Río Grande	April 10, 2014
Scientific Forum on El Yunque at the Department of Natural Resources in San Juan, PR	May 8, 2014
Employee Meeting at El Yunque	August 13, 2014
Protected Areas Congress	August 28–29, 2015
Focus Group Meetings: Municipal Planners 1	September 18, 2014
Focus Group Meetings: Protected Area Managers	September 25, 2014
2014 El Yunque Festival	October 4–5, 2014
Focus Groups Meetings: Outfitters and Tour Operators	October 9, 2014
Focus Group Meetings: Municipal Planners 2	October 16, 2014
Community Meetings 2014: Fajardo #2	October 30, 2014
Department of Natural Resources Symposium, San Juan	November 6–7, 2014
Community Meetings 2014: Luquillo #2	November 13, 2014
Community Meetings 2014: Las Piedras #2	November 25, 2014
Forest Products Symposium	December 5, 2014
Community Meetings 2014: Canovanas, Río Grande #2	December 11, 2015
International Day of Forests in El Portal Visitor Center, El Yunque	March 21, 2015
SHPO Planning Presentation	March 26, 2015
2015 El Tinglar Festival	April 11, 2015
"Para La Naturaleza" Environmental Fair	April 18, 2015

Planning Outreach Activities	Date
Interamerican University Environmental Fair, Fajardo Campus	April 30, 2015
Community Meetings 2015: Las Piedras #3	June 23, 2015
Community Meetings 2015: Luquillo #3	June 24, 2015
Community Meeting 2015: Interamerican University Law School, San Juan	June 25, 2015
2015 El Yunque Festival	October 3, 2015
2016 International Day Of Forests in El Portal Visitor Center, El Yunque	March 19, 2016
2016 El Tinglar Festival	April 9, 2016
2016 “Para La Naturaleza” Environmental Fair	April 16, 2016

In September 2012, the Cadre and EPS conducted a series of listening sessions to hear from community members, stakeholders, and employees. In December 2012, about 100 stakeholders including representatives from communities, agencies, organizations and Forest Service employees attended a workshop to discuss collaboration and learn more about the collaborative process and their level of interest to participate in the planning effort.

As a result of the two day workshop a collaborative coordinating committee made up of members of the community was assembled to work with the Forest Service to assist in public involvement and collaboration on issues throughout the planning process. The Citizens' Collaboration Committee (CCPP) has developed a Facebook page to help provide opportunities for the public to get information and comment on the Forest Plan revision process.

The public involvement process for El Yunque National Forest was designed to be effective at different stages. First, engaging the public started with the Forest Plan assessment and followed with the public presentation of the need for change and proposed action. Comments from the public, along with the 2014 Forest Plan Assessment, shaped the proposed action considering the need for change. There were three rounds of community meetings, which gave insight from the public’s perspective and created connections with communities (and new possible partners considering future collaboration opportunities).

The planning outreach activities included meetings with different communities and the public, which were held in locations accessible to the different municipalities in the region, specifically in municipalities located to the north, east and southwest of the Forest. Other outreach activities were conducted considering stakeholders, such as recreation outfitters/guides, protected area land managers, municipality planners, as well as the scientific and the academic community. These many activities which involved the public in the planning process was a monumental effort that was developed alongside with collaborators such as Center for Landscape Conservation (CCP for its acronym in Spanish) and the CCPP. The activities were designed to disseminate to the public the current conditions of the Forest lands and its resources through the assessment as it was being developed; then to collect information and comments from the public on land use for the El Yunque National Forest as well as suggestions developing new alternatives in managing the Forest.

Assessment Phase

Four public meetings were held in communities around the Forest for the public to learn more about the planning process and to provide comments on issues they felt were important in managing the Forest and to include in the Plan. An interactive mapping exercise helped participants identify locations where uses, issues, or opportunities occur in and around the Forest.

A one day forum “A Scientific and Social Look at El Yunque National Forest” was conducted in May 2014. Forest Service specialists and partners presented information on the draft assessment and participants were able to provide input on assessment topics.

Table A-2. Meetings for the Forest assessment

Municipality	Date	Location
Naguabo	January 28, 2014	Maizales Community Center
Fajardo	March 27, 2014	Universidad Interamericana de Fajardo
Las Piedras	April 3, 2014	Agriculture Extension Service Office: Las Piedras
Rio Grande	April 10, 2014	Baptist Church of Palmer
San Juan (Forum)	May 8, 2014	Department of Natural Resources Office: Rio Piedras

After this process the Forest specialists (ID team) and collaborators developed the proposed actions that were shared with the public through a series of community meetings and interest group meetings to later validate its content. The process was important to develop relationships, bonds, and connections with the communities in the region, as well as with collaborators interested in helping manage Forest lands. This outreach process spanned over 2 years and resulted in many of the considerations developed for the Forest Plan alternatives, specifically alternative 2; which is the preferred alternative.

Table A-3. Meetings: proposed action/need for change (2014)

Municipality	Date	Location
Fajardo	October 30, 2014	Universidad Interamericana de Fajardo
Luquillo	November 13, 2014	Salon de Alcaldes
Las Piedras	December 4, 2014	Salon de Alcaldes
Cubuy/Canovanas	December 12, 2014	Community Center: Cubuy

Table A-4. Meetings: Validate direction for plan alternatives (2015)

Municipality	Date	Location
Las Piedras	June 23, 2015	Salon de los Alcaldes
Luquillo	June 24, 2015; December 4, 2014	Salon de los Alcaldes
San Juan	June 25, 2015	Universidad Interamericana Law School, Hato Rey

Table A-5. Meetings: Focus groups (2014)

Date	Focus Group
September 18, 2014	Municipal Planners:Canovanas, Rio Grande, Luquillo
September 25, 2014	Eastern Puerto Rico Protected Area Managers
October 9, 2014	Forest Tour Operators
October 16, 2014	Municipal Planners: Ceiba, Fajardo
October 30, 2014	Youth outreach: Proyecto de Liderazgo Ambiental Comunitario (PLAC)/Community Environmental Leadership Project

There will be additional opportunities for public involvement in the NEPA review and plan revision processes. Concurrent with the release of this draft EIS, a notice of availability (NOA), published in the *Federal Register* initiates the formal 90-day comment period on the draft EIS and proposed Forest Plan as

required by Forest Service NFMA regulations at 36 CFR 219. Only those individuals and entities who have submitted substantive formal comments related to this plan revision during the opportunities provided for public comment will be eligible to file an objection (36 Code of Federal Regulations (CFR) 219.53(a)).

Based on comments from Forest Service personnel, the public, other agencies and non-governmental organizations, the planning ID team developed a list of issues to address in this draft EIS.

Public outreach meetings notes and additional information can be found in the planning record or on the web: <http://www.fs.usda.gov/main/elyunque/landmanagement/planning>.

Appendix B: Ecological Sustainability Evaluation (ESE) Tool and Species of Conservation Concern

The need of a standardized regional approach for ecological and biological planning for the Forest planning process was the main reason to develop a collaborative initiative to create what is known as the Ecological Sustainability Evaluation (ESE) tool. The ESE tool is a strategic conservation planning tool used by the USDA Forest Service Southern Region for forest planning. Ecological systems, watersheds, terrestrial and aquatic species are carried through the preliminary assessment, sustainability framework (including strategies and plan alternatives), and expected outcomes. The tool utilizes a standardized process while being flexible, efficient, and adaptable to Forest-specific priorities and needs. The ESE tool employs prioritization algorithms utilizing rank, importance rating, attributes and indicators, stresses and threats, scope and severity ratings, and management opportunities to assist and support management decisions while creating a standardized, credible, and defensible process record. The ESE tool analysis also considered the short term (1 to 10 years) and the long term (1 to 50 years) scenarios in the Forest.

El Yunque National Forest received assistance and technical advice from the regional office. The process included training for the vegetation and wildlife specialists to discuss the necessary information and process to integrate the data in the ESE tool format. The information was collected, identified, and integrated in the ESE tool by the Forest and wildlife program managers with the support of the regional office contractor and personnel.

Vegetation

To select the flora species for the ESE tool assessment, the current list of species reported for the Forest was the first source of information. To revise and enhance the list, a detailed review of the current and actual botanical literature was done to review and include any species reported for El Yunque. A total of 636 species of flora were included in the assessment and were appraised according to the criteria applied in the evaluation. Several bibliographical and web-based botanical references were used to consider distribution, stress and threats, environmental concerns and other indications for the species.

After these species were considered, a report was produced that identified the potential species of conservation concern. These species of conservation concern were reviewed in the current literature and were consulted with botanical experts to confirm the concerns identified in the ESE tool analysis. These species of conservation concern were used to identify plan components and used in the draft EIS to consider the impacts of the different Forest Plan alternatives.

Watersheds

Information from the watershed condition framework (WCF) and the El Yunque Watershed Condition Classification Supplemental Guidance (2010) completed for El Yunque National Forest were the main source of information for the ESE tool assessment. The 2014 Forest Plan Assessment, completed as part of the Forest Plan revision, also provided updated information for the watershed conditions within and outside the Forest boundaries.

The parameters in the WCF are presented in the following table. These parameters were considered and analyzed for the Plan alternatives considering short (1 to 10 years) and long (1 to 50 years) scenarios in the Blanco, Canovanas, Espiritu Santo, Fajardo, Mameyes, Pitahaya, Sabana and Santiago watersheds.

Table B- 1. Measurement criteria for watershed attributes

Key Attribute Name	What measure
Hydrologic Function	Flow Characteristics
Water Quality Sediments	Forest Coverage Rating
Water Quality Sediments	Riparian Road Density
Water Quality Sediments	Road Density Rating
Water Quality Sediments	Road Maintenance Index
Water Quality Toxics	Impaired Water Listed as 303D
Water Quality Toxics	Water Quality Problem (Not 303D listed)

The ESE tool reports include a planning area score based on current conditions and a rating for a 10 and 50 years scenario by alternative considered in the Plan. The ESE tool also produces graphic representation by sustainability rating, plan alternatives, and the 10- and 50-year scenarios.

Wildlife

The ESE tool is based on The Nature Conservancy’s Conservation Action Planning (CAP) process. The wildlife selection process was unique due to the fact that from the approximate 182 fauna species that were initially assessed, many are not included in either NatureServe or their Latin American affiliate, InfoNatura. These two data warehouses are the accepted source of the most up-to-date information on species occurrence and status.

The selection process for the El Yunque National Forest answered two questions in identifying those species that were not included in the standard NatureServe provided data, which provides the scientifically course and fine filter structure for the National Forests to use for plan development. First, what is the description of the methodology used to assign ranking to evaluate species; and second, how was the process conducted on those species that did not get identified as potential species of conservation concern (SCC), but were part of the initial list of evaluated species.

The rationale to assigning conservation status ranking was similar to the NatureServe’s framework and core methodology. The El Yunque biologists mimicked the Global, National, and State-ranks with the collected information by focusing on extinction risk on the global scale, and their extirpation risk at national and subnational levels. All species were considered in the design of ecological conditions within the plan area.

Species were then screened for inclusion in the framework and designated as potential SCC. The planning team used a species and ESE tool framework for the analysis of species diversity and ecological sustainability and integrity built around principles developed by The Nature Conservancy (TNC) in their Conservation Action Planning Workbook (TNC 2005).

Thus, much of the information found in the International Union of Conservation of Nature (IUCN) and the State Natural Heritage Plan (Puerto Rico wildlife conservation strategy) are interpreted to fulfill these ranks. Adhering to the same NatureServe factors such as range extent, area of occupancy, population size, and number of occurrences the biologists cumulated with a working ranking system. As a caveat, many species did not have all of these factors documented, but many other biologists on the Island acknowledge these data gaps.

The biologist then used the selected species to be incorporated into the prioritization elements found in both the preliminary assessment and sustainability framework of the ESE tool by inputting values into the

tool's matrix. The matrix contains the following planning elements: conservation target, status, condition, stresses and threats, and priority. This populated ESE tool can then be used as a management monitoring tool for the Forest wildlife and fisheries program manager.

Potential Species of Conservation Concern

The list of species of conservation concern is located in the section dealing with the species of conservation concern within the EIS document (chapter 3). For the detailed data analysis of the data see the ESE tool data table filed in the planning record.

Appendix C: Wild and Scenic Rivers Eligibility and Study Process

Introduction

This appendix addresses the suitability and eligibility of rivers located in the El Yunque National Forest for inclusion in the National Wild and Scenic River System. An eligibility study of the Forest's rivers was completed for the 1997 Forest Plan.

The Wild and Scenic Rivers Act

The National Wild and Scenic Rivers System was created by Congress in 1968 (public law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The Wild and Scenic Rivers Act protects the special character of these rivers, while also recognizing the potential for their appropriate use and development.

Selected rivers in the United States are preserved for possessing outstandingly remarkable values, which include scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Designated rivers, or rivers segments, are preserved in their free-flowing condition and are not dammed or otherwise impeded.

The process of determining whether a river should be recommended for inclusion into the National Wild and Scenic River System has three steps: an eligibility determination with assigned potential classification, a suitability determination, and recommendation to Congress. Any river deemed eligible may be studied for its suitability for inclusion in the national system at any time. Rivers may be studied for suitability as a part of land management plan development, revision, or amendment; in conjunction with a project decision, or in a separate study. A suitability study is done after an eligibility study is completed. A suitability study provides the basis for determining which eligible rivers or river segments should be recommended to Congress as potential additions to the national system. Suitability studies are analyzed and completed in an environmental impact statement; they may or may not be completed with revision of a land management plan.

When the Forest Service determines a river is eligible for inclusion in the national system, they must ensure the river has interim protection measures (Forest Service Handbook (FSH) 1909.12, chapter 80). These protection measures apply until a decision is made on the future use of the river and adjacent lands through an act of Congress, or until a determination is made that the river is not suitable.

Eligible wild and scenic rivers (or river segments) are assigned one or more potential classifications: wild, scenic, or recreational. These classifications are based on the developmental character of the river on the date of designation and dictate what level of interim protection measures to apply. Wild rivers are the most remote and undeveloped while recreational rivers often have many access points, roads, railroads, and bridges, and may have undergone some impoundment or diversion in the past. A river's classification is not necessarily related to the value that made it worthy of designation. That is, for a river to have a scenic classification, scenery does not have to be an outstandingly remarkable value.

When developing a plan or plan revision, the responsible official shall identify the eligibility of rivers for inclusion in the National Wild and Scenic Rivers System, unless a systematic inventory has been

previously completed and documented, and there are no changed circumstances that warrant additional review ((36 CFR sec. 219.7(c)(2)(vi))).

A systematic inventory of all potential study rivers was previously completed in 1997 LRMP for the Caribbean National Forest/Luquillo Experimental Forest. Fifteen rivers/perennial streams, totaling over 52 miles, were studied (see FEIS for the 1997 Forest Plan, Appendix D, and Table D-1). The result of this analysis was that of the 15 rivers studied, 6 rivers were determined to be eligible for designation. These rivers were the Rio Espiritu Santo, Rio Mameyes, Rio de la Mina, Rio Fajardo, Rio Icacos, and Rio Sabana. This plan revision was limited to the evaluation of any rivers that were not previously evaluated for eligibility and those with changed circumstances. There are no changed circumstances and all potential rivers were evaluated; therefore, no additional review is warranted.

Utilizing the 1997 Plan EIS Wild and Scenic River Eligibility Summary, the Rio Mameyes, Rio de la Mina and Rio Icacos were selected as rivers to be recommended for designation as wild and scenic rivers. The Caribbean National Forest Wild and Scenic Rivers Act of 2002 designated these rivers as part of the National Wild and Scenic River System.

Table C-1. Wild, scenic, and recreation rivers (designated December 2002)

River	Classifications	Length (miles)
Río Mameyes	Wild	1.6
	Scenic	1.4
	Recreation	1.0
Río de la Mina	Scenic	1.2
	Recreation	0.9
Río Icacos	Scenic	2.3

ID Team and Public Involvement

During this plan revision process, community outreach planning meetings were held. During these meetings the participants were informed of the designated wild and scenic rivers and that currently the Forest has three such rivers. The wild and scenic river designation process was explained during these meetings and during these meetings no community or participant indicated that recreational or other outstandingly remarkable values had changed from the previous study in the 1997 Forest Plan.

Inventoried Rivers

Appendix D of the 1997 LRMP contains a description of rivers. The 2014 Forest Plan Assessment and subsequent public involvement indicated no changed condition in regards to previously studied rivers. The following table summarizes the analysis:

Table C-2. El Yunque National Forest rivers analyzed

Potential classification of Eligible Rivers The potential classification of a river is based on the condition of the river and the adjacent lands as they exist at the time of study. The Wild and Scenic River Act specifies the following three classifications categories for eligible rivers.	Wild Those rivers or sections of rivers that are free of impoundment and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive lands.	Scenic Those rivers or section of rivers that are free of impoundment, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.	Recreation Those rivers or section of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some important impoundment or diversion in the past.
Rio Espiritu Santo	From headwaters of Rio Espiritu Santo to water supply intake immediately upstream from FDR 12 road crossing, 2.94. From headwaters of both Quebrada Sonadora tributaries to 100 yards of Route 186, 1.98 miles.	From water supply intake on Rio Espiritu Santo near FDR12 to 100 yards south of Route 186, 0.78 miles.	On Rio Espiritu Santo from 100 yards south of Route 186, north to Forest boundary, 1.96. On Quebrada Sonadora, from 100 yards south of Route 186, north to Rio Espiritu Santo, 0.28 miles.
Rio Mameyes	From its headwaters in the Baño de Oro Natural Area to the crossing points of Trail #24 and Trail #11, just upstream from the confluence with Rio La Mina, 2.1 miles.	From the crossing point of Trail #24 and #11 to the access point of Trail #7, 1.4 miles.	From the access point of Trail #7 to the Forest boundary west of the bridge on PR 191, 1.0 miles.
Rio La Mina	The La Mina has no wild component.	From its confluence with the Rio Mameyes upstream to the La Mina Falls, 1.2 miles.	From La Mina Falls to its headwaters located east of PR 191 between Km. 12 and Km. 12 in the El Yunque Zone, 0.9 miles.
Rio Fajardo	The total length of the river corridor from its headwaters approximately 0.5 mile north of West Peak to the Forest boundary approximately 1.5 miles east of East Peak, 3.4 miles.	The Rio Fajardo has no scenic components.	The Rio Fajardo has no recreational component.
Rio Icacos	The Rio Icacos has no wild component.	From its headwaters approximately 0.5 mile south of the intersection of the Mt. Britton Road (#9938) with PR 191 to the point where the river leaves National Forest ownership (approximately 0.25 mile upstream of the PREPA hydroelectric dam), 2.3 miles.	The Rio Icacos has no recreational component.

Potential classification of Eligible Rivers The potential classification of a river is based on the condition of the river and the adjacent lands as they exist at the time of study. The Wild and Scenic River Act specifies the following three classifications categories for eligible rivers.	Wild Those rivers or sections of rivers that are free of impoundment and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive lands.	Scenic Those rivers or section of rivers that are free of impoundment, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.	Recreation Those rivers or section of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some important impoundment or diversion in the past.
Rio Sabana	From its headwaters approximately 0.75 of a mile east of El Cacique Peak to 0.25 mile north of the PR 191 crossing near the southern Forest boundary, 1.8 miles.	The Rio Sabana has no scenic component	From approximately 0.25 mile north of the PR 191 crossing to the southern Forest boundary, 0.3 miles.

Eligible Rivers

Appendix D of the 1997 LRMP contains a description of eligible rivers and documentation of previous study process. The 2014 Forest Plan Assessment and subsequent public involvement indicated no changed condition in regards to previously studied rivers. The list of eligible rivers is:

- Rio Espiritu Santo/Quebrada Sonadora
- Rio Fajardo
- Rio Sabana

Suitability

Recommendations for wild and scenic river designation is part of the Forest Plan revision. The effects of designation is analyzed in chapter 3 of this document.

The identification of a river for study through the Forest planning process does not trigger any protection under the Act until designation by Congress. Importantly, identifying rivers as eligible, or eligible and suitable, does not create any new agency authority; rather, it focuses the management actions within the discretion of the Forest Service on protecting identified river values. For eligible rivers, the preliminary (inventoried) classification is to be maintained absent a suitability determination. The recommended classification is to be maintained throughout the duration of the Forest Plan. Protection of rivers and streams through the Forest planning process helps to assure high-quality, free-flowing rivers and streams, as well as river-related recreation opportunities.

Management emphasis for the eligible rivers and their corridors is focused on protection and enhancement of the values for which they were established, without limiting other uses that do not substantially interfere with public use and enjoyment of those values. The establishment values (ORVs) for the rivers on the El Yunque National Forest include scenic, recreational, geological, fish and wildlife, historical, cultural or other values including ecological.

Most impacts to all rivers come from upland activities outside the river corridor. However, Forest management would be subordinate to the river's ORVs. Vegetation management, road construction and construction or removal of recreation facilities could cause erosion along the river, sedimentation from soil runoff, visual intrusions or noise from nearby activities

Search and rescue operations may cause some impact from the use of equipment in the river corridor, but these are predicted to be minimal. Increased public interest and use may result with the creation of CIRMA by having additional trailheads and trails and access points to the river to accommodate additional public interest and use of the river. However, increased recreation use due to designation may also result in more river-related activities and cause localized increases in soil compaction and erosion of stream banks and the need for limited public access.

River sections classified as "scenic" or "recreational" are managed with a wider variety of activities allowed within the river corridor. However, Forest management would be subordinate to the river's ORVs. Sights and sounds of man's activities would be more apparent. Management activities that have the greatest potential of affecting rivers and their potential suitability for wild and scenic designation are road construction, vegetation management, insect and disease control, special use utility right-of-ways and mineral extraction. Other management activities that also can affect the river resources to a degree are threatened and endangered species habitat management, range management, recreation and administrative site facilities. Classification as "wild" would therefore be expected to have a smaller range of effects from activities within the river corridor, (e.g., no new roads, no new rights-of-way or wildlife openings).

Non-eligible Rivers.

Rivers determined to be not eligible may be managed on the El Yunque National Forest under a variety of management areas, geographic zones, and special designations. These prescriptions will allow a wide variety of activities within the river corridor. Management activities may include road construction, vegetation management, insect and disease control, special use utility right-of-ways and mineral extraction. Other management activities that also can affect the river resources to a lesser degree are threatened and endangered species habitat management, recreation and administrative site facility construction and wildlife and fisheries management.

Effects Common to all Alternatives

Under all alternatives, the three eligible wild and scenic rivers would retain their eligibility in accordance with Forest Service manual and handbook direction until they are evaluated for suitability and either designated or released. This means that they would be maintained in their free-flowing condition and their identified ORVs would be retained.

Faced with the challenge of managing the recreation segments of these rivers the Forest would not have the management capacity and resources to pursue additional wild and scenic river designations. All of the streams and rivers that originate in the Forest maintain their free-flowing condition, water quality, and their “outstandingly remarkable values” so in essence they are managed as wild and scenic rivers. River condition’s within the Forest were analyzed and determined to be in good state (see El Yunque Plan Assessment 2014).

The analysis of wild and scenic river eligibility was conducted for the previous Forest Planning process (1997) and has been updated to ensure that this could be considered within the public comments. Although the Forest has not requested more designation of wild and scenic rivers.

Eligibility

Appendix D of the 1997 LRMP contains a description of eligible rivers. The 2014 Forest Plan Assessment indicates no change condition in regards to previously determined rivers. The list of eligible rivers is:

1. Rio Espiritu Santo/Quebrada Sonadora
2. Rio Fajardo
3. Rio Sabana

Suitability

A suitability analysis for these three eligible rivers was not conducted as a part of this Forest Plan revision effort.

Appendix D: Roadless Area and Wilderness

Introduction

This appendix describes the process for identifying and evaluating lands that may be suitable for inclusion in the National Wilderness Preservation System and determining whether to recommend any such lands for wilderness designation. The process occurs in four primary steps: inventory, evaluation, analysis, and recommendation.

Inventory

Areas qualify for placement in inventory if they meet the statutory definition of wilderness. The Forest used the Forest Service Handbook (FSH) 1909.12 Chapter 70 inventory criteria to determine if an area meets the statutory definition of wilderness. The 1997 Plan EIS Roadless Area Evaluation identified two areas as lands that may be suitable for inclusion in the National Wilderness Preservation System, the El Toro Roadless Area (12,600 acres) and the Mameyes Roadless Area (11,000 acres). In 2005, the El Toro roadless area became the El Toro Wilderness Area (10,352 acres).

These two inventoried areas total 23,600 acres out of the total 28,223 acres on the Forest. None of the remaining acres meet the criteria for being included in an inventory of areas that may be suitable for wilderness designation.

The Mameyes Inventoried Area

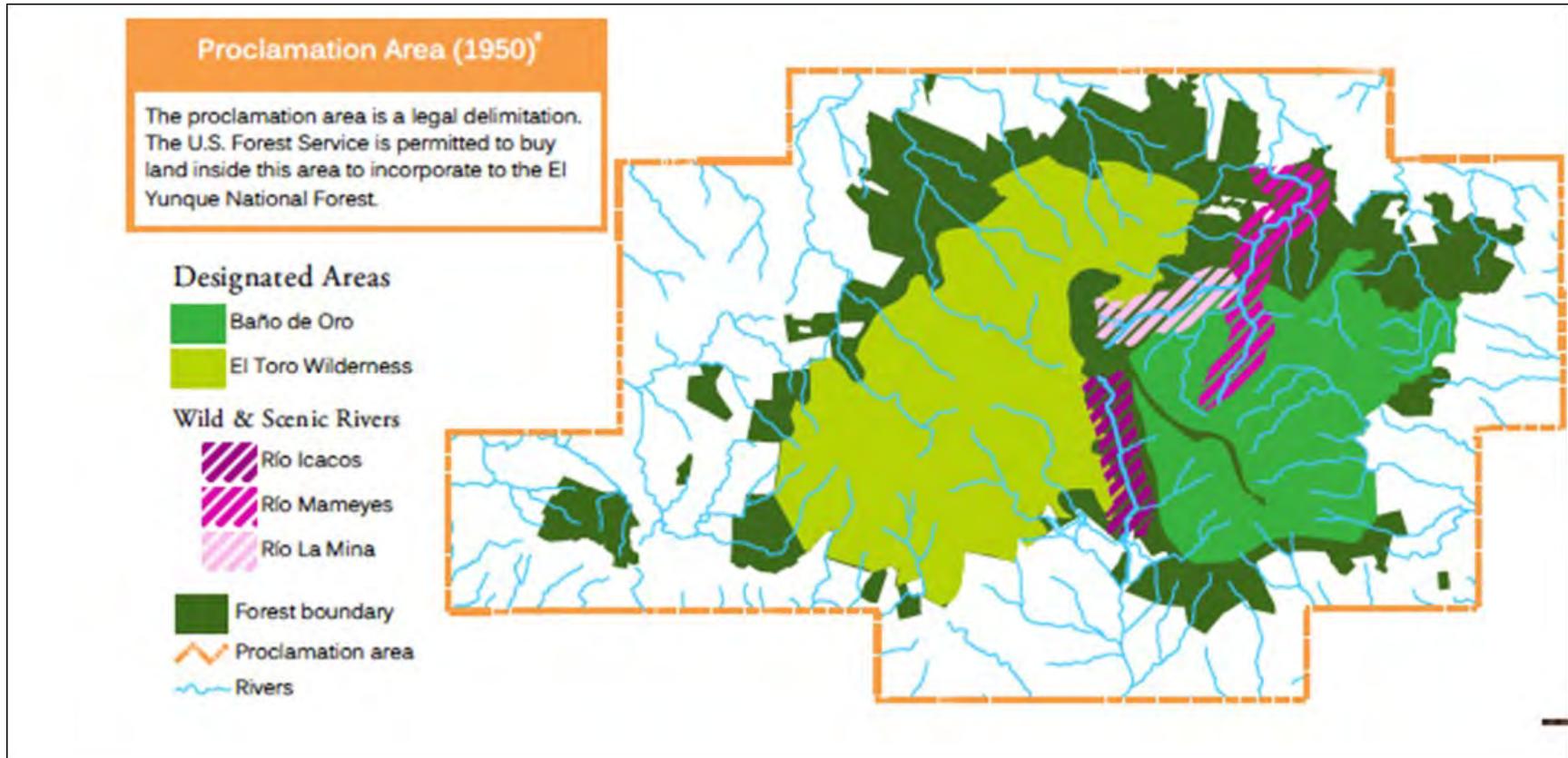
The Mameyes Inventoried Area, located in the eastern half of the El Yunque National Forest, is named for the Mameyes River which runs through the west-central portion of the area. It is bounded in the north by the PR Highway 988, on the east and south by the Forest boundary, and on the west by PR Highway 191. It includes 11,000 acres of the National Forest.

The area is accessible by vehicle from PR Highways 191 and 988. It may be entered from the west side by several foot trails and one service road, which branches from PR 191, and on the north side by several trails and two roads which are closed to vehicular use. No trails enter the area from the east or south, where the area is bounded by private land.

The area lies at Latitude 18 North in an equable maritime climate. The weather is rainy for about 9 months of the year, generally with showers of high intensity.

The area lies on the eastern half of conical Sierra de Luquillo region, with major rivers flowing north, east and south. The slopes in the southern portion are steep to precipitous, and the northern portion includes much land with more moderate slopes. The range in elevation is from 100 meters above sea level where the Mameyes River leaves the Forest, to 1000 meters elevation at East Peak (Pico del Este).

The soils are derived from volcanic sediments typically resulting in red clays. The southern portion of the area has sandy soils derived from granodiorite.



Map D-1. Proclamation area, El Yunque National Forest

Evaluation of the Mameyes Area

Degree to which the area appears to be affected primarily by the forces of nature, with the imprints of man's work substantially unnoticeable.

The vegetation is dense, mix evergreen forest ranging from 3 meters in height on the peaks to 20 meters at lower elevations. Included are Lower Montane and Subtropical Rainforest and Lower Montane and Subtropical Wet Forest life zones, with 12 forest types and 3 riparian areas. In total there are over 200 tree species native to the area. Although most of the area can be considered primary forest, much of the land is secondary forest lands. On these lands timber has been extracted and some lands were clear for agricultural purposes chiefly in the 1800s and the first four decades of the 20th Century. These lands again are forest with some being monocultures of native or non-native tree species. Understory vegetation structure ranges from very dense to fairly open. There are approximately 1,660 acres of mahogany plantations, primarily in the Bisley and Chiquito areas.

Several species of bats are common to the area, but there are no native terrestrial mammals. Feral mongooses, rats, mice and cats are present. The most evident native wildlife are numerous lizard and tree frog species. Species of birds are present, most are year round residents. Snails, crabs, fresh water shrimp and fish are found in the streams and rivers. Numerous species are endemic to the island.

The peaks in the area offer views of the most extensive uplands in the Forest to the west, the distant coastal lowlands, and the Atlantic Ocean and the Vieques Passage. Seen from above, the Forest is a mosaic of emerald tree colors and tree crown shapes. The major rivers of the area pass over spectacular falls and through canyons.

Old home sites and areas still recovering from farming, lumber, and charcoal logging are evident. Within the depths of the Forest evidence of past modification might escape the untrained eye, but in parts of the area along the western and northern borders the noise of traffic along PR 191 and 988 as over a million visitors drive within the Forest recreation areas. Because of the dense vegetation and steep terrain it is relatively easy to leave behind the sights, and most of the sounds, of civilization after penetrating only a few hundred meters in the area.

East Peak, in the center of the area, and nearby El Yunque Peak have communication towers, which are visible from some of the area, and paved road to this peak (Forest Development Road 27) although excluded from the area almost bisects the area. The vistas towards the Forest to west include several tall tower in the vicinity of El Yunque.

Some of the lands of the Mameyes Area have been managed as part of the then Luquillo Forest Reserve since 1903. Even before that, since 1876 the central portion of this area had been proclaimed a Forest reserve by Spain. To these "Crown lands" many more acres were added to the Forest through acquisition starting in 1931. In 1949 the Secretary of Agriculture designated 2,172 acres within the area as the Baño de Oro Research Natural Area. This portion of the area has since been managed in its natural condition with only non-manipulative research allowed. Prior to acquisition by the Forest Service, some of the northern half was exploited for timber and agriculture.

Degree to which the area has outstanding opportunities for solitude or for a primitive and unconfined type of recreation.

Much of the area is primary forest, especially the central core, and the natural integrity of these areas is very high. Most of the area offers a high degree of solitude to the visitor, because of the denseness of forest vegetation. Portions that border PR 191 on the west side are subject to considerable vehicular noise,

especially from truck and buses in the vicinity of the visitor's information centers. Solitude is highest in the south, east, and central parts of the area.

There currently is a very low level of human activity in the area consisting primarily of research activities and trails hiking.

Excellent opportunities are available to test one's ability and stamina in traversing steep, slippery, forested terrain. Forest travel off the trail is extremely difficult. Disorientation caused by dense vegetation is very common when traveling off the trails. The most remote and challenging areas are in the south, east, and central portions.

There are about 7 miles of trails, all in the northern half. There are very good opportunities for hiking, nature study, and photography in a wilderness environment. Opportunities also exist for swimming in the Mameyes, Fajardo, and Icacos Rivers. Although good access is limited fishing for fresh water shrimp is locally common. Because of the steep terrain and abundant rainfall, good camping opportunities are limited to a few areas during the dry season.

The size of the area is adequate to maintain many of the area's wilderness characteristics, but the shape and some external influences do limit wilderness quality. East Peak road, a special-use paved road, penetrates 3 miles in the area where it is only 4 miles wide. In general the area averages only 3 miles wide, making it susceptible to some external influences, particularly traffic noise on the west and north sides.

Degree to which the area may contain ecological, geological, or other features of scientific, educational, scenic or historic value.

The Forest of the most remote uplands and the area are Primary, some of the best examples of Primary forests in Puerto Rico. The northern one-third and the southern one-quarter of the area consist of cutover forest and land, which was formerly farmed. Much of the lands has been reforested artificially with mahogany, an introduced species. About 3 miles of stone-surfaced roads penetrate the area from the north. Several water catchments and water pipelines used by municipality and private users occur in the area. They are generally near the boundary, but some penetrate well into the Forest.

The area provides very good formal and informal outdoors education and scientific study opportunities. The core 2,200 acres of the area has been designated as the Baño de Oro Research Natural Area since 1949. In the Central portion of the area, stands of very large, old Palo Colorado trees and large mature Tabonuco trees are common in the research natural area.

Known resources include petroglyphs, mostly on rocks along rivers, and some man-made structures. Opportunities to better discover, protect and interpret cultural resources in the roadless area may be limited due to access restriction under wilderness designation. Actual investigations might be lower under wilderness designation as other areas receive higher priorities for cultural surveys due to other resource management activities.

Degree to which the area may be managed to preserve its wilderness characteristics.

The Mameyes Area boundary is not defined by natural features. It is defined by a series of manmade features, such as already established landlines and paved roads. There are few threats to the wilderness values of the area on the south and east sides, primarily due to the lack of public access to the Forest boundary. Non-wilderness types of activities will continue on adjacent private lands in those areas, but they primarily are small farm, pasture, and private residences with relatively little current effect on

wilderness characteristics. Nevertheless, such development is expected to increase, and with it impacts on the natural character of the area.

The north side of the area also has such influences, but there is public and administrative access as well. There is some non-wilderness activity and influence from vehicles. This access would facilitate administration of potential wilderness. Influences on the west side are primarily from recreational use along PR 191, and in the recreational areas. Activities along this boundary, which effect wilderness values, are noise from vehicles and from visitors using picnic areas and other developed recreation sites.

Within the area there are numerous ridges and streams, which can serve as manageable boundaries between lands of similar elevation. However, there are few good manageable boundaries between the upper elevation and the lower elevations. Best opportunities to enhance wilderness characteristics exist in the south and north portions, where ridges occur in appropriate locations.

The size of the area is adequate to maintain many of the area's wilderness characteristics, but the shape and some external influences do limit wilderness quality. East Peak road, a special-use paved road, penetrates three miles in the area where it is only four miles wide. In general the area averages only 3 miles wide, making it susceptible to some external influences, particularly traffic noise on the west and north sides.

Public Input

During the plan revision, community outreach planning meetings were held. During these meetings the participants were informed of the Wilderness Act and that currently the Forest has one federally designated wilderness area, El Toro Wilderness Area. The wilderness designation process was explained during these meetings and at no time was there any interest from the communities or participants in requesting that the Forest pursue designating additional wilderness areas. The public is more interested in having access to more Forest lands to address recreation, environmental education and agroforestry needs.

Present demand for wilderness area is low considering the amount of people that visit the Forest. With the designation of the ETWA, the only tropical wilderness in the National Forest System, the need to have additional wilderness areas is not a priority. The demand for a wilderness was addressed through the Caribbean National Forest Act of 2005.

Analysis

Designation would preclude certain types of wildlife habitat improvement activities that could be designated to increase the number and type of wildlife that use the area including endangered species. Habitats along most of the lower slopes of the area have been very significantly modified and active programs of tree planting and tree cutting to favor more desirable native tree species for wildlife use have been conducted in the past and continue to be useful in meeting wildlife habitat objectives. Opportunities to establish native plants favorable for wildlife and to accelerate secondary plant succession are desirable to increase habitat productivity and support wildlife populations.

On the upper slopes, which include areas where the Puerto Rican parrot nest, artificial nest structures are provided for parrot use. Constructed blinds for monitoring parrot activities are also used. These types of activities could continue under wilderness designation, but other types of habitat alteration, such as favoring some tree or vine species over other by selective tree thinning or cutting, would not be compatible with designation. However, at this time it is not foreseen that such habitat alterations will be needed to recover the parrot.

About one-third of the land within the area was acquired by the Forest Service under the Weeks Law, for producing timber and for watershed protection. Management of these acquired lands during the subsequent 50 years had been directed toward timber production. About 1,600 acres of lands in this area have been managed for timber production and other uses. The timber volume of this area has been inventoried in 1937, 1948, and 1968. Below 2,000 feet elevation, mature trees had been harvested selectively in the past on thousands of acres; immature stands were liberated and thinned repeatedly. Lands that had been deforested prior to purchase were planted with timber tree species, some pure and others intermixed with native tree species.

A prototype rural industry, using artisans and craftsmen to manufacture saleable articles from timber species, is being considered. Wilderness designation of these lands, which are highly capable of providing wood products on a sustained level, would preclude these acres from being used to help contribute to the high demand for these local wood products.

The National Forest was formally designated the Luquillo Experimental Forest because the complex nature of the Forest required an integrated research program. Scientists have located “representative areas” within the Forest to conduct studies. Two general approaches have been planned and followed to date in order to provide Forest managers with important, necessary information: basic studies to determine how ecosystems function, and applied studies of silvicultural treatments to enhance ecosystem stability, sustainable production of timber, wildlife habitat, water and other Forest resource. Several basic study sites are located in the Mameyes inventoried area. An example is the Baño de Oro Research Natural Area, where research monitoring has been in progress since 1946.

In several areas both basic and applied studies have been done, are continuing, or could be done. One is the 540-acre watershed of the upper Rio Sabana and Rio Camandulas, the only entire watershed in the primary Tabonuco forest. In the Mameyes Valley are three small watersheds (45 acres) already under calibration for studies of the impact of timber harvesting on soil and water resources. North of East Peak is a 200 comparative studies of this type of forest are possible, since the rest is within the research natural area, not available for manipulation. The 820-acre east side of the Rio Icacos Valley is the only lower montane wet forest available for comparative research.

The possibility of conducting selective vegetation treatments in some of these areas would be precluded by wilderness designation, and access for researchers to areas like Baño de Oro Research Natural Area to conduct non-manipulative research activities would be significantly hindered because the Bisley Road could not be used or possibly extended for vehicular access.

Although wilderness designation would make this area unavailable for many of the above uses, non-designation would not automatically result in significant reduction or degradation of the wilderness attributes of the area. Under a non-wilderness designation it is expected that several activities would occur on some acres including water and recreation developments, and timber management demonstration treatments and manipulative research treatments, both in secondary forest. Such treatments would require the use of some motorized equipment on well established secondary roads within the inventoried area.

Under direction currently being considered the maximum number of acres that could be treated during the next 10 years is less than 200 acres over the entire Forest, with the best areas located within the inventoried area. Such uses would interrupt some naturally occurring processes (such as secondary succession), and temporarily reduce the level of solitude and challenge in areas where such activities took place.

Several water catchment and transmission lines provide water and power to private landowners adjacent to the Forest. Water from two-thirds of the area currently enters municipal supply systems, including

Luquillo, Fajardo, Humacao, Vieques and during emergencies. A major transmission pipeline takes water from Rio Cristal to supply the entire town of Luquillo. A public hydroelectric plant operates with the waters of Rios Prieto and Icacos, which drain the southern slopes of the area. Although these uses and improvement are not incompatible with current wilderness management direction, more facilities for water diversion can be expected to be needed and proposed in the future.

The entire Forest also is a Biosphere Reserve, an internationally designated protected area managed to demonstrate the value of conservation. Management of lands within Biosphere Reserves can range from intense human use, including exploitation and site modification, to complete protection from non-natural modifications a management strategy identical to that of wilderness.

Opportunities exist to developed recreation facilities on some sites, which would help meet current and project demand. These include developing water, sanitary facilities, and picnic and/or campsites along Rio Chiquito and Rio Mameyes. The Forest currently is the second most visited tourist site in Puerto Rico, and half of the demand for recreation use is for developed recreation. Current demand is not being met with existing facilities.

It also needs to be considered that only about 1 percent of the land surface of the Island is unmodified, and no unmodified tracts larger than those in the Forest exist elsewhere. Moreover, other than the companion El Toro Wilderness Area, there are no other declared or prospective wilderness areas readily available to the millions of citizens in Puerto Rico. Although, the El Toro Wilderness Area is over a one-third of El Yunque National Forest acreage.

El Toro Wilderness within El Yunque is the only tropical forest wilderness within the National Forest System and the only within the U.S. Wildlife species such as the broad-winged hawk and the Puerto Rican parrot also depend to a certain extent on the undisturbed habitat.

The present demand for wilderness visitation is low considering the large number of people that visit the Forest. Lack of prior exposure to the interested users and the absence of an existing established concept of wilderness values in the general population are likely the main reasons for this lack of interest. When communicating with the public to explain this concept; acceptance of wilderness was vast; but no further desired designation was requested or desired.

The 11,000 acre Mameyes Area from the inventory compared to the 6,441-acre Inventoried Roadless Area

The Mameyes Inventory Area contains 11,000 acres. The area includes the Baño de Oro Research Natural Area (6,441 acres) as well as lands surrounding the research natural area (11,000 acres - 6,441 acres = 4,559 acres). The inventoried roadless area is the same as the research natural area and this is the area that is proposed for wilderness in alternative 3. The remaining 4,559 acres in the Mameyes Area were not recommended for wilderness in alternative 3 because they include another area set aside for research, but where the research activities would not be compatible with wilderness designation. For the other remaining acres, it was determined that these lands could provide better opportunities for meeting local community needs by placing them in the Community Interface Resource Management Area.

Table D-1. Summary of proposed wilderness by alternative¹

Existing Area	Alternative 1 1997 Plan	Alternative 2 Proposed Action	Alternative 3
El Toro Wilderness (acres)	10,363	10,352 ¹	10,352
Inventoried Roadless Area (acres)	6,441	6,441	-
Proposed Additional Wilderness (Baño de Oro) (acres)	0	0	6,441

¹ New acreage based on GIS Delineation process.

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