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Forest Plan Assessment

El Yunque National Forest

El Yunque National Forest
Rio Grande, Puerto Rico

El Yunque National Forest View

DRAFT

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Table of Contents

1 Introduction 1
1.1 Purpose of the Assessment 1
1.2 Structure of Assessment 1
1.3 Assessment Area 3
1.4 Role of Science 5
1.4.1 Introduction 5
1.4.2 Luquillo Experimental Forests 5
1.4.3 The LTER Network: 1988 to Today 6
1.5 Scientific Information Used for the Assessment 6
1.6 Main Research Achievements 9
1.7 Conclusion 10
1.8 References 11
2 Assessing Ecological Sustainability and Diversity of Plant and Animal Communities 13
2.1 Assessing Terrestrial Ecosystems, Aquatic Ecosystems, and Watersheds 13
2.1.1 Terrestrial Ecosystems, Aquatic Ecosystems and Watersheds Overview 13
2.1.2 Identifying the Ecosystems to be Addressed in the Assessment and Current Condition ..15
2.1.3 Spatial Scales for Assessing Ecosystem Integrity 40
2.1.4 Key Ecosystem Characteristics 42
2.1.5 Assessing Ecosystem Integrity 44
2.1.6 Describing the Natural Range of Variation 44
2.1.7 Current Condition and Trend of Key Ecosystem Characteristics and Integrity 45
2.1.8 Status of Ecosystem Integrity 45
2.2 Assessing Aquatic Ecosystems 45
2.3 Assessing Air 49
2.4 Assessing Soil Resources and Quality 51
2.5 Assessing Water 61
2.6 Assessing System Drivers and Stressors 72
2.6.1 Introduction 72
2.6.2 Climate Change 75
2.7 Assessing Threatened, Endangered, Proposed and Candidate Species and Potential Species of Conservation Concern 129
2.7.1 Threatened, Endangered, Proposed, and Candidate Species—Terrestrial Wildlife 129
2.7.2 Potential Species of Conservation Concern 142
2.8 Identifying and Assessing At-risk Flora Species in the El Yunque National Forest 153
3 Assessing Social and Economic Sustainability and Multiple Uses 161
3.1 Assessing Social, Cultural, and Economic Conditions 161
3.1.1 Social, Cultural, and Economic Context 161
3.1.2 Socioeconomic and Cultural Context Conditions and Trends 163
3.1.3 Demographic Conditions and Trends 166
3.1.4 Community Health and Well-being; Some Key Indicators of Human Assets and Vulnerabilities 174
3.1.5 Economic Health and Diversity 185
3.1.6 National Forest Socioeconomic Contributions in the El Yunque Region and Beyond ...192
3.1.7 Summary of Key Socioeconomic and Cultural Factors Influencing the EYNF and Influenced by the Plan Area 196
3.1.8 References 198
3.2 Assessing Ecosystem Services 201
3.3 Assessing Watersheds 209

3.4 Assessing Multiple Uses 220
3.4.1 Timber Resources 220
3.4.2 Fish, Wildlife, and Plants of Socioeconomic Importance 222
3.5 Assessing Recreation Setting, Opportunities and Access 231
3.6 Assessing Scenic Character 255
3.7 Assessing Renewable and Nonrenewable Energy and Mineral Resources 258
3.8 Infrastructure 266
3.9 Assessing Cultural and Historic Resources 287
3.10 Land Status, Ownership, Use, and Access Patterns 324
4 Assessing Designated Areas 359
Appendix A: The New El Yunque National Forest Vegetation Map Methodology 363
Appendix B: National Wetland Plant List, Caribbean Region 373
Appendix C: Map Unit Description for El Yunque National Forest 375
Appendix D. Ecosystems Description (Characterization) 383
Appendix E: EYNF Forest Type Structural Characteristics and Species Composition 391
Appendix F: Species Present in the Different Vegetation Types at EYNF 393
Appendix G: Species Utilized for Reforestation/Historic Planting Data/Recent Plantations 399
Appendix H: Objectives, Standards and Guidelines for Management Areas with PETC and SCC Species/ Ecological Sustainability Evaluation Tool Results 425
Appendix I: Supporting Data for Social and Economics 427
Appendix J: Summary of All Key Findings 435
Appendix K: List of Contributors 467

List of Tables

Table 2-1. Spacial scale for assessing ecosystem integrity 40
Table 2-2. Key ecosystem characteristics 41
Table 2-3. Summary of ecosystem description 42
Table 2-4. Key characteristics of aquatic ecosystems 48
Table 2-5. Climate model projections for increases in temperature at end of century 109
Table 2-6. Climate model projections for changes in precipitation at end of century 110
Table 2-7. Present observation trend of the Puerto Rican broad-winged hawk (Delannoy 1992) 139
Table 2-8. Average density and estimated population of the Puerto Rican sharp-shinned hawk (Delannoy 1992) 140
Table 2-9. Subnational (S) conservation status ranks (NatureServe 2013) 145
Table 2-10. Wildlife species of conservation concern 145
Table 2-11. Proposed list of potential species of conservation concern 156
Table 2-12. Ecological sustainability evaluation report for species at-risk 158
Table 3-1. Total area and national forest land area in the El Yunque Region 163
Table 3-2. Total population and population growth rates for the municipalities in the El Yunque Region and Puerto Rico, 1970–2010 167
Table 3-3. Population density (persons per square mile) for the municipalities in the El Yunque Region and Puerto Rico, 1970 to 2010 169
Table 3-4. Educational level of the population aged 25 years or more in the El Yunque Region and Puerto Rico in 2000 and 2010 178
Table 3-5. Per capita and median family income in the El Yunque Region and Puerto Rico, 2000 and 2010 in current dollars (not adjusted for inflation) 179
Table 3-6. Percent of total population that received benefits from the Temporary Assistance for Needy Families Program (TANF) and the Nutritional Assistance Program (PAN) in the El Yunque Region and Puerto Rico in 2011 183
Table 3-7. Number of incidents per 10,000 persons in 2010 184

Table 3-8. Total reported level 1 crime rates in the El Yunque Region and Puerto Rico 2008–2010 184
Table 3-9. Labor force and unemployment rates in the El Yunque Region and Puerto Rico in 2000 and 2010 186
Table 3-10. Market value of agricultural products sold in the El Yunque Region, 2002, 2010 191
Table 3-11. Payments in lieu of taxes and for secure rural schools in Puerto Rico, 1999 to 2012 193
Table 3-12. EYNF salaries and expenditures, 2008–2012 194
Table 3-13. USDA Forest Service employment in Puerto Rico, 2008–2012 194
Table 3-14. Categorization and description of El Yunque ecosystem services 203
Table 3-15. Negative and positive drivers affecting El Yunque and the services it provides listed by all groups[1], from most to least negative or positive effect 207
Table 3-16. Negative and positive drivers affecting El Yunque that were mentioned by individual groups 208
Table 3-17. Comparison of water budgets for the Luquillo Experimental Forest 212
Table 3-18. The primary uses of watershed resources in El Yunque 217
Table 3-19. Fish, wildlife, and plant species commonly enjoyed and used by the EYNF public 228
Table 3-20. ROS classes tiered to management area 233
Table 3-21. Preferred Forest recreation activities found in survey results in the 2006 and 2011 National Visitor Use Monitoring (NVUM) survey 235
Table 3-22. El Yunque National Forest recreation sites (from INFRA) 243
Table 3-23. Alternate sources of energy in Forest operations 263
Table 3-24. EYNF classified road system 268
Table 3-25. Unclassified roads at the Caribbean National Forest 270
Table 3-26. Summary of retention, decommission, or alternative use of facilities 283
Table 3-27. List of Pre-Columbian heritage assets 292
Table 3-28. List of heritage assets for the Spanish Colonial Period 296
Table 3-29. List of heritage assets of the Parceleros historic context 300
Table 3-30. List of heritage assets for potentially of the Parceleros historic context 301
Table 3-31. List of heritage assets of or potentially of the CCC period 306
Table 3-32. El Yunque National Forest priority heritage assets status 317
Table 3-33. EYNF special use permits 331
Table 3-34. Total area and national forest land area in the El Yunque Region 333
Table 3-35. Land ownership in the El Yunque Region 334
Table 3-36. List of protected natural areas surrounding EYNF (as of December 2012) 336
Table 3-37. Description of El Yunque special zoning regulation's zoning districts 343
Table 3-38. Applicable land use plans and zoning regulations in the El Yunque Region (as of December 2012) 346
Table 3-39. Percent land cover in the El Yunque Region, 2010 348
Table 3-40. Total area (in acres) of land cover types 350
Table 3-41. Change in the total area and percentage of urban land cover increase between 1998 and 2010 351
Table 3-42. Percentage of new urban areas not consistent with El Yunque special zoning regulation (1985–1995 and 1998–2010 periods) 353
Table 3-43. Number, area, and land use of farms in 2007 354
Table G-1. Species utilized for reforestation during the 1930s 399
Table G-2. Planting data from 1932 to 1945 400
Table G-3. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 13 404
Table G-4. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 11 406
Table G-5. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 9 408

Table G-6. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 8 410
Table G-7. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 7 413
Table G-8. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 5 415
Table G-9. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 4 419
Table G-10. El Yunque National Forest more recent plantation stands for selected compartments: Compartment 1 422
Table I-1. Number and percent of households by type in the El Yunque Region in 2000 and 2010 427
Table I-2. Population by age groups, 2000 and 2010 (number/[percent]) 429
Table I-3. Current (not adjust for inflation) per capita and median family income for the El Yunque Region and Puerto Rico 2000 and 2010 432
Table I-4. Current and adjusted (to 2010 US$) median family income in the El Yunque Region and Puerto Rico 1970–2010 432
Table I-5. Percent of families below the poverty line in the El Yunque Region and Puerto Rico, 1969 to 2009 432
Table I-6. Percent and number of children (<18 yrs) below the poverty line in the El Yunque Region and Puerto Rico, 2000 and 2010 433

List of Figures

Figure 2-1. Percentage of tract planted and success 27
Figure 2-2. Total acres of tract, acres planted and acres establish 27
Figure 2-3. Number of species planted per tract 28
Figure 2-4. Longitudinal profiles of the rivers of EYNF 47
Figure 2-5. Population trend of a wild flock of Puerto Rican parrots on the El Yunque 1973 to 2006 (USFWS 2009) 138
Figure 2-6. Population trend of a wild flock of Puerto Rican parrots on the El Yunque 2009 to 2013 (USFWS 2013) 139
Figure 3-1. Total population in the municipalities surrounding the EYNF, 1970 to 2010 168
Figure 3-2. Population density in the El Yunque Region and Puerto Rico, 1970 to 2010 169
Figure 3-3. Percent urban and rural population in municipalities surrounding the EYNF, the El Yunque Region, and Puerto Rico; 2000, 2010 170
Figure 3-4. Household composition in the El Yunque Region and Puerto Rico in 2010 172
Figure 3-5. The population pyramid for Puerto Rico in 2000 and 2010 173
Figure 3-6. Median age of the population in the municipalities of the El Yunque Region and in Puerto Rico in 2000 and 2010 173
Figure 3-7. Life expectancy at birth in Puerto Rico, 1960 to 2010 175
Figure 3-8. Leading causes of deaths in the El Yunque Region in 2000 and 2008 176
Figure 3-9. Reported dengue cases in Puerto Rico, 1998 and 2010 176
Figure 3-10. Real median family income (adjusted for inflation to the value of a U.S. dollar in 2010) in the El Yunque Region and Puerto Rico, 1970 to 2010 179
Figure 3-11. Gross national product of Puerto Rico, 2001-2011 180
Figure 3-12. Percent of families below the poverty line in the El Yunque Region, 1969 to 2009 182
Figure 3-13. Percent of children (<18 years) below poverty level in the El Yunque Region and Puerto Rico in 2000 and 2010 182
Figure 3-14. Labor force by occupation; distribution of Puerto Rico's GDP 187
Figure 3-15. Employment by industry in the El Yunque Region, 2000 189
Figure 3-16. Employment by industry in the El Yunque Region, 2010 190

Figure 3-17. Annual farm earnings in the El Yunque Region as a percent of the total number of farms in 2002 (n=628) and 2007 (n=834).....191
Figure 3-18. Secure rural schools revenue sharing payments to Puerto Rico, 2008–2012 193
Figure 3-19. Watersheds draining the Luquillo Experimental Forest 210
Figure 3-20. Water intakes on streams draining the Luquillo Experimental Forest.....214
Figure 3-21. Percentages of land cover in each municipality in 2010.....350
Figure 3-22. Percentage of urban land cover per municipality in 1998 and 2010.....351
Figure 3-23. Number of farms in the El Yunque Region, 1987 to 2007 355
Figure 3-24. Total area of farms (acres) in the El Yunque Region, 1987 to 2007 355
Figure 3-25. Size of farms in the El Yunque Region as a percent of the total number of farms in 2002 and 2007 356

List of Maps

Map 1-1. Area of analysis 4
Map 2-1. El Yunque National Forest vegetation.....16
Map 2-2. EYNF reforestation efforts between 1934 and 1942 26
Map 2-3. Areas planted in the 1930s, 1960s into the 1980s in our new ecosystem type matrix; Planted/Secondary Forest Area 29
Map 2-4. Timber demo stands (LRMP 1997 Management Area 8).....30
Map 2-5. Compartments and stands showing areas planted mostly with mahogany 31
Map 2-6. Hydric soils on the ELNF 37
Map 2-7. Hydric system of the EYNF above the 600 meters of altitude 38
Map 2-8. Drainage model of the EYNF 39
Map 2-9. El Yunque soil map units.....55
Map 2-10. El Yunque hydric soils.....56
Map 2-11. El Yunque National Forest depth to water table.....57
Map 2-12. El Yunque National Forest parent material 58
Map 2-13. Slope on the El Yunque National Forest.....59
Map 2-14. Slope aspect on the El Yunque National Forest.....60
Map 2-15 Drainage Basins ……62
Map 2-16 Land Bounderies and Waterflows……...66
Map 2-17 Streamflow in El Yunque National Forest……..67
Map 2-18 Water Intakes……..68
Map2-19 Impaired Waters ……..69
Map 2-20. Elfin Woodland Forest types with landforms from Gould et al. (2008) 135
Map 2-21. Tabonuco Forest type with landforms from Gould et al. (2008) 136
Map 2-22. Palo Colorado Forest type with landforms from Gould et al. (2008) 137
Map 3-1. Area of analysis for assessing the socioeconomic and cultural conditions of the EYNF and surrounding landscape 162
Map 3-2. Percent change in municipal populations of Puerto Rico between 2000 and 2010 168
Map 3-3. ROS classes of the El Yunque National Forest (draft) 234
Map 3-4. The Recreation Corridor 239
Map 3-5. EYNF classified transportation system.....269
Map 3-6. Crown Lands, El Yunque National Forest.....295
Map 3-7. Area of analysis for assessing the socioeconomic and cultural conditions of the EYNF and surrounding landscape 327
Map 3-8. Inholdings within the EYNF.....327
Map 3-9. EYNF boundary, proclamation boundary, and priority areas for acquisition.....328
Map 3-10. Roads and hiking trails in the EYNF 332
Map 3-11. Land ownership in the El Yunque Region (needs update for RRNB) 335

Map 3-12. Puerto Rico land use planning regions 338
Map 3-13. Region 9 proposed land classifications (draft 2012) (PRPB 2012a) 339
Map 3-14. Region 10 proposed land classifications (draft 2012) 340
Map 3-15. Region 11 proposed land classifications (draft 2012) 340
Map 3-16. El Yunque special zoning regulation's zoning districts 344
Map 3-17. Historical land use change in the El Yunque Region, 1936–1995 347
Map 3-18. Land cover within and around El Yunque National Forest in 2010 349
Map 3-19. Urban land cover in 1998 and 2010 352
Map 4-1. Wild and scenic rivers 361
Map H-1. Species richness index of the EYNF derived from Gould et al. (2008) 426

1 Introduction

1.1 Purpose of the Assessment

The 2012 Planning Rule provides the process and structure to create local land and resource management plans for all national forests and grasslands. Land and resource management plans establish requirements and constraints for on-the-ground management decisions within a national forest or grassland. The rule establishes an ongoing, three phase process: (1) assessment, (2) plan development or revision, and (3) monitoring. The 2012 Planning Rule is intended to create understanding around landscape-scale management. It takes an integrated and holistic approach that recognizes the inter-dependence of ecological processes with social and economic systems. The approach uses best available science to inform decision along the way. Collaboration with stakeholders and transparency of process are key ways the 2012 Planning Rule guides creation of forest plans for the future.

This document represents the assessment stage for the revision of the El Yunque National Forest's land and resource management plan and is designed to rapidly evaluate readily available information about relevant ecological, economic, and social conditions, trends, and sustainability and their relationship to the current land and resource management plan within the context of the broader landscape. Assessments are not decision making documents, but provide current information on planning topics.

"El Yunque is a forest of symbol and meanings and is a vital place in which Puerto Ricans, in their exercise of recreation and leisure, away from the mall, the office and the factories, escape from the urban stress and problems in search of therapy only to find themselves in a natural world that evokes a deep and ill-understood history. … In the popular imaginary, El Yunque is the place where the original heroes came from and a space where the national myths and sagas have sprung. Puerto Ricans perceptions of and feeling of attachment to El Yunque are saturated with patriotic and nationalistic meanings. … El Yunque enables Puerto Ricans to create and cement bonds with friends, family, and other important social groups, to transfer across generations their understanding of a unique Puerto Rico experience as can only be had in the forest. Not only does the forest embody their shared past, it also enables the celebrations of rituals and the construction of memories for the future" (Maldonado et al. 2000).

1.2 Structure of Assessment

In this assessment, we considered the geographic and ecological space of El Yunque National Forest. The three geographic scales considered are municipal, regional, and Islandwide. In Puerto Rico, a municipality is the smallest division of administrative and electoral government, similar to a county in the U.S. We defined the "region" as the eight municipalities that surround the National Forest. We considered how socioeconomic conditions compare and contrast within the region at the municipal level and how these conditions differ at the regional and Island-level as well.

The ecological space is contained in the rugged Sierra de Luquillo Mountains, 25 miles southeast of San Juan, Puerto Rico. The Luquillo Mountains rise 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. Assessing and comparing economic, social, and cultural conditions at a variety of scales is important because it allows decision-making to incorporate socioeconomic conditions and how they may differ in one area compared to another since the impacts of management decisions also

may differ from one area to another. Furthermore, a multi-level assessment can help identify areas in need of similar or different management strategies across Forest boundaries.

A summary of the existing relevant information evaluated in the assessment for the topics of 36 CFR 219.6(b) follows.

1) Terrestrial ecosystems, aquatic ecosystems, and watersheds;

2) Air, soil, and water resources and quality;

3) System drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change;

4) Baseline assessment of carbon stocks;

(5) Threatened, endangered, proposed and candidate species, and potential species of conservation concern present in the plan area;

6) Social, cultural, and economic conditions;

7) Benefits people obtain from the national forest system planning area (ecosystem services);

8) Multiple uses and their contributions to local, regional, and national economies;

9) Recreation settings, opportunities and access, and scenic character;

10) Renewable and nonrenewable energy and mineral resources;

11) Infrastructure, such as recreational facilities and transportation and utility corridors;

12) Cultural and historical resources and uses;

13) Land status and ownership, use, and access patterns; and

14) Existing designated areas located in the plan area including wilderness and wild and scenic rivers and potential need and opportunity for additional designated areas.

In general, for each of the topics the summary may:

a. Describe or identify important information evaluated in this phase.

b. Describe the nature, extent, and role of existing conditions and reasonably foreseeable future trends within the plan area and in the broader landscape. Trends may imply a range of changes that are reasonably foreseeable in the future. Statistical analysis is not implied or necessary to identify and describe trends in the assessment phase. Trends may be described in broad terms such as increasing, decreasing, or remaining stable.

c. Describe the contribution that the plan area makes to ecological, social, or economic sustainability related to the topic.

d. Identify information gaps as described in 36 CFR 219.6(a) (3).

The Luquillo Mountains of northeastern Puerto Rico contain the 11,310-hectare El Yunque National Forest (EYNF) also administratively designated as the Luquillo Experimental Forest (LEF). The Luquillo Mountains rise 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 in the LEF. If sea level were to rise 50 meters, the valleys of the major rivers surrounding the Luquillo Mountains would flood and form an island comparable in size to many of the Lesser Antilles (Weaver 2002). The EYNF is located in the rugged Sierra de Luquillo Mountains, 25 miles southeast of San Juan, Puerto Rico.

The Forest contains 29,000 acres. 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. The Forest's steep, wet, and isolated mountains were not traversed by PR route 191 until 1942. EYNF, the only tropical forest administered by the USDA Forest Service, is administered by a Forest supervisor and staff. Offices are located in El Portal Tropical Forest Center and adjacent Catalina Work Station on Highway PR 191, kilometer 4.4, south of Palmer, Puerto Rico. Also, research is conducted at the LEF by the International Institute of Tropical Forestry. The Institute is headed by a director and staffed with research scientists and technicians. The Institute's office is located on the grounds of the University of Puerto Rico's Botanical Garden in Rio Piedras, Puerto Rico.

The eight municipalities that comprise the socioeconomic area of analysis for the EYNF (from this point forward referred to as the "El Yunque Region") total more than 185,000 acres (290 square miles), which is about 8.3 percent of the Island's total area. Stretching over 28,000 acres, the National Forest covers about 15 percent of the total area of the El Yunque Region. Of the municipalities surrounding the EYNF, Rio Grande is the largest municipality 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).

1.3 Assessment Area

The EYNF is surrounded by eight municipalities in Eastern Puerto Rico: Canovanas, Ceiba, Fajardo, Juncos, Luquillo, Naguabo, and Rio Grande. Together, these eight municipalities represent the primary area of analysis for assessing the ecological, socioeconomic, and cultural context of the broader landscape within which the National Forest is situated (Map 1-1).

Map 1-1. Area of analysis

1.4 Role of Science

1.4.1 Introduction

1.4.1.1 Documentation of Best Available Scientific Information (BASI) in the Assessment Report

The assessment phase identifies and evaluates information relevant to the issues that will be considered later in the development of plan components and other plan content. During the assessment, the responsible official identifies and evaluates the conditions and trends of the assessment topics identified in 36 CFR 219.6(b) and the sustainability of social, economic, and social systems (36 CFR 219.5(a)(1)). This identification and evaluation uses information determined to be BASI (sec. 42.16) and the uncertainties, risks, and assumptions associated with the BASI (sec. 42.13).

In doing so, the responsible official must:

1. Describe how the BASI was used to inform the topics of the assessment. This can be done through a brief description and citation of the BASI. Contradictory BASI should also be described.

2. Identify the key scientific information determined to be BASI, based on the determination of what is most relevant, accurate, and reliable. This may be done through reference to a list of BASI or other methodology as determined by the responsible official. Explain the basis for this determination.

The responsible official should also identify known uncertainties, assumptions, or risks associated with the BASI relevant to the evaluation of conditions and trends and sustainability in the assessment (CFR 2007).

1.4.2 Luquillo Experimental Forests

In this report we use Luquillo Experimental Forest (LEF) and El Yunque National Forest (EYNF) interchangeably. The Luquillo Mountains in Puerto Rico provide an excellent natural research laboratory in which to study the diversity of tropical forest types, because five subtropical life zones are represented within an area of just over 11,000 hectares: Wet Forest, Rain Forest, Lower Montane Wet Forest, Lower Montane Rain Forest, and a small tract of land in the southwest portion that falls within the Moist Forest Life Zone. Puerto Rico falls within the subtropical belt of the Holdridge Life Zone System because of the temperature regime; frost is absent from all tropical and subtropical life zones. The region is also steeped in a rich tradition of forestry research that is unique among tropical forests; scientists have been active there since the end of the 19th century.

The International Institute of Tropical Forestry (the Institute) is a tropical forestry research and technology transfer institute. Located in Rio Piedras, Puerto Rico, it has a long and productive history. Created in 1939 as the Tropical Forest Experiment Station in cooperation with the University of Puerto Rico, the Institute has been continuously operating for 75 years. The Institute serves as a focal point for bringing external research and educational resources to bear on issues affecting tropical forest and grasslands.

In 1983, Brown et al. summarized major findings of past research that once had been scattered among obscure papers and large and inaccessible volumes to produce a succinct yet data-rich

summary that is still widely cited more than 25 years later. Since the publication of Brown et al. (1983), the publication was updated in 2012 with a review of significant new research that has led to new hypotheses and new conclusions about how tropical forests function. Improvements in technology and data storage over the past 25 years have resulted in vast new data sets, syntheses, and models for the LEF that were once unimaginable due to data storage and processing limitations. All research in the LEF has been reviewed in two recent books edited by Brokaw et al. (2012) and González et al. (2012).

1.4.3 The LTER Network: 1988 to Today

Most research conducted in the Luquillo Mountains until 1988 was of relatively short duration, from less than a year to a decade. Even H.T. Odum's Rain Forest Project, which in its time was the most comprehensive study of a tropical forest ever conducted, lasted only 5 years (1963 to 1968). Notable longer-term studies include (from 1942) monitoring of tree growth and survival under natural and managed conditions, the recovery of vegetation after ionizing radiation, and the recovery project for the endangered Puerto Rican parrot.

The LEF is part of a network of the Long-Term Ecological Research (LTER) program funded by the U.S. National Science Foundation. Its main goal is to understand the long-term dynamics of tropical forest ecosystems characterized by large-scale, infrequent disturbance, rapid processing of organic material, and high habitat and species diversity. The results are of theoretical interest and contribute to conservation management goals and understanding of global change. Natural disturbances in the Luquillo Mountains include hurricanes, landslides, treefalls, droughts, and floods. Human disturbances, mainly in the past, include road construction, charcoal production, clearing for pasture and crops, creation of coffee plantations, and logging. The LEF (known as LUQ in the LTER Network) was added to the LTER Network in 1988 and remains the only terrestrial tropical site in the network. At the time that the LUQ site was established, data on tropical forests were limited and basic information on topics such as carbon and nutrient dynamics, disturbance effects, and trophic interactions was largely lacking; the LUQ site already had a strong research basis on which the LTER could build. Establishing an LTER program at the LEF initiated a new research focus on ecosystem forcing functions of long duration, infrequent occurrence, or incremental effect. Now, some 25 years later, well above 1,000 publications addressing all of these topics and more have come out of the LUQ LTER. Information about the LUQ LTER can be obtained at http://luq.lternet.

1.5 Scientific Information Used for the Assessment

Recent publications and data sets enable the utilization of the best available scientific information for this assessment. The following paragraphs provide a summary of information reviewed.

Caribbean Tapestry

The book, Caribbean Tapestry, was published in response to the "Grand Challenges in Environmental Sciences" identified several years ago by the U.S. National Research Council. It discusses such topics as biodiversity and ecosystem functioning, hydrologic forecasting, and land-use dynamics. Global change threatens ecosystems worldwide, and tropical systems with their high diversity and rapid development are of special concern. We can mitigate the impacts of change if we understand how tropical ecosystems respond to disturbance. This book describes the impacts of, and recovery from, hurricanes, landslides, floods, droughts, and human disturbances in the Luquillo Mountains of Puerto Rico. These ecosystems recover quickly after natural disturbances, having been shaped over thousands of years by such events. Human disturbance,

however, has longer-lasting impacts. Chapters are by authors with many years of experience in Puerto Rico and other tropical areas and cover the history of research in these mountains, a framework for understanding disturbance and response, the environmental setting, the disturbance regime, response to disturbance, biotic mechanisms of response, management implications, and future directions. The publication provides a strong perspective on tropical ecosystem dynamics over multiple scales of time and space.

Luquillo Experimental Forest: Research History and Opportunities

The USFS Experimental Forests and Ranges Book Series has published its first book (accessible also online). Edited by Institute scientists, The Luquillo Experimental Forest: Research History and Opportunities summarizes and illustrates over 30 years of research at the site, including chapters on vegetation, ecosystem dynamics, soils, fungi, fauna, key findings and, of course, emerging research opportunities. The book is a reflection of the intense research agenda and collaborations at the site [http://www.treesearch.fs.fed.us/pubs/41159].

The Luquillo Mountains: Forest Resources and Their History

This report presents an overview of the El Yunque National Forest, in northeastern Puerto Rico. The principal topics include the environmental setting (geology, soils, and climate), environmental gradients, arborescent flora, vertebrate fauna, and forest management. A chronology from the time of European discovery to the present outlines major events in Luquillo Experimetal Forest, including an early presence of indigenous peoples, exploration for gold, timber extraction, farming, trail and road construction, and recreational developments (Weaver 2012).

Luquillo Long Term Ecological Research Program (LUQ)

The goal of LUQ is to understand how forest and stream ecosystems, and the services that they support, are changing in Puerto Ricol. This would provide guidance for management of change in the tropics. We focus on understanding the key role of disturbance in determining ecosystem functions, processes, and their services. In the first phases of LUQ (1988–2006), degrees and mechanisms of resistance and resilience were studied, especially after the passage of hurricanes. This background led to more recent work on response to human disturbance and climate change, both likely to cause long-term, directional change in ecosystems and services. The LUQ also identified ecosystem trends over its 23 years of existence and synthesized results in several books. Major achievements included leading the establishment of the National Ecological Observatory Network (NEON), CZO, Integrative Graduate Education and Research Traineeship (IGERT), and San Juan Urban Long Term Research Areas-Exploratory (ULTRA-Ex) programs in Puerto Rico, thereby creating a broad, strong synergy toward sustainability science in the tropics. Over the years, LUQ has also given a commanding perspective on tropical ecology, resulting in numerous synthetic works. A site-synthesis book for example, contains chapters whose content ranges from theory to management and reflects the benefit of long-term research toward understanding resistance and resilience of tropical systems in a changing disturbance regime.

Caribbean Landscape Conservation Cooperative (CLCC)

The Institute is the lead institution of the CLCC and part of the nationwide network of LCCs. The Institute and other partners in the CLCC are committed to integrating and promoting the role of working lands and seas in conserving natural resources, developing tools and information that help decisionmakers understand the value of working lands and agriculture as we work toward managing sustainable food, soils, water, wildlife, sea life, and open spaces in light of climate change, sea level rise, and the changing needs of society.

The National Ecological Observatory Network (NEON)

The Institute is a major collaborator of the NEON program in Puerto Rico. NEON has been under development for many years, but recently, $434 million in construction funding was provided to the program by the National Science Foundation. NEON will be the first continental ecological research platform and promises to change the way ecological research is accomplished. Data will be collected on biodiversity, disease and pathogens, nutrients, water, pollutants, and greenhouse gases at more than 60 sites spread from Alaska and Hawaii across the United States to Puerto Rico: the four corners of the network would cover more than 14,000 miles! The sites in Puerto Rico will be the southern and eastern-most in the network. The NEON program will use a single protocol to collect all data sets Nationwide, rather than the usual different instruments or protocols from site to site. The data collected will be freely available to scientists and the public in near-real time. Having vast amounts of baseline data available will allow scientists to design studies that build from that platform, without having the costs and efforts needed to collect baseline data. NEON will also provide the first truly standardized continental network of research sites dedicated to being able to describe and forecast ecological trends at such a large scale. Puerto Rico was chosen to represent the Atlantic Neotropical domain after the Institute, academic, and other scientists and educators came together to inform NEON on the advantages and opportunities of using the Island as an observational site.

Luquillo Critical Zone Observatory (LCZO)

The “critical zone” is defined as the outer layer of the Earth that directly sustains human life. It extends from the lower atmosphere into the underlying bedrock and includes all the physical, chemical, and biological processes that shape and transform the Earth’s surface. The LCZO is one of six National Science Foundation-supported observatories designed to provide an integrated platform for collaborative studies that will provide the scientific basis for the long-term management of critical zones.

The LCZO focuses on how water balances and mass fluxes differ in landscapes with contrasting lithology across a range of climatic and vegetation zones. Parent material has been recognized as a state factor for landscape and soil development for over a century. However, the influences of lithology on denudation, hydrologic routing, and the elemental cycles and flows are still poorly constrained in most studies. The LCZO will use the natural laboratory of the Luquillo Mountains to determine how critical zone processes differ in watersheds underlain by quartz diorite and volcaniclastic bedrock. Specifically, the LCZO will address how the bedrock is coupled to or decoupled from the hydrologic, geochemical, and biogeochemical cycles in these watersheds.

Long Term Ecological Research Data Archival and Long-Term Data Sets

Since its establishment in 1988, LUQ has had a formal Information and Data Management System (IMS), part of which is the publication of data generated by ongoing research activities. All long-term data sets for the LEF are available at the LTER website and currently include data sets on meteorology, hydrology, disturbance, nutrient and carbon dynamics, vegetation dynamics, animal population dynamics, and biological diversity. Information Management System guidelines for the LUQ LTER are in the Handbook to Data Management Policies, Data Archival, and Data Requests, which includes instructions and best practices for filing a new data set. One fundamental aspect of this data archival process is metadata, or “data about the data.” Metadata provide users with critical details about the data set under consideration, and documentation standards for metadata are also available at the LUQ LTER website.

The LUQ LTER follows Ecological Metadata Language (EML) standards. These comply with current archival mandates for both the LTER and Forest Service, which include the Federal Geographic Data Committee for both geographic and spatial data and the National Biological Information Infrastructure for biological and non-geospatial data. Furthermore, EML can be cross-walked to other standards, which facilitates correspondence to other data sets if needed and guarantees future accessibility and minimizes loss of information. Because the data management and archival policies of the LEF are stated explicitly, adequate data usage and interpretation and proper acknowledgment of data and resources are possible.

1.6 Main Research Achievements

1. Forest Inventory and Analysis (FIA)

Puerto Rico and the U.S. Virgin Islands are on the forefront of integrating inventory data in ecological research and analyses. The program has taken a stratified sampling approach to ensure that the range of ecosystems found in the region is adequately sampled. Plot intensification in the northern Karst region, urban areas, and the driest and wettest forests of the islands allows researchers more comprehensive datasets for statistical analyses.

2. Mapping and modeling terrestrial, freshwater, and marine animal species distributions

In 2008 the Institute initiated a new Forest Service publication series, the Research Map (RMAP), as an outlet for geospatial products based on Forest Service research. The Institute has developed maps on topics such as forest land cover change, protected area networks, land use and urbanization, and landscape units. Forest Service geospatial research, included research leading to RMAP publications, is keeping pace with rapidly evolving remote sensing and data analysis techniques.

3. Ecological Gradient Analyses in Tropical Ecosystems

We published an Ecological Bulletins book that contains a comprehensive analysis of ecological gradients in the Luquillo Mountains of Puerto Rico. Puerto Rico comprises six ecological life zones and is ideal for studying environmental gradients, given dramatic differences in temperature and precipitation associated with a rise in elevation from sea level to more than 1,000 meters over a distance of 10 to 15 kilometers. Chapters in this volume cover climatic (e.g., precipitation and energy), abiotic (e.g., nutrients, carbon stores soil characteristics and biogeochemistry), and biotic (e.g., microbes, plants, and animal biodiversity) patterns and responses to gradients. These original and synthetic research findings should be of considerable interest in understanding the importance of environmental gradients in molding the structure and functioning of ecological systems, and to those dedicated to managing or conserving complex tropical ecosystems in light of global change. An Institute scientist is a lead editor of this recently published book.

4. Conservation Science and Management – taking lead in the “all lands” approach

The Institute leads the Caribbean Landscape Conservation Cooperative, which is a partnership among research and management agencies, organizations, and individuals interested in achieving a sustainable future for the Caribbean islands by addressing climate change and other issues that threaten land and marine resources. The Cooperative Steering Committee includes eight Federal agencies, local governments, and non-governmental partners. Accomplishments this year include ratifying a charter for the Cooperative and establishing two pillars on which to develop decision-

making tools for conservation planning in light of climate change: modeling future scenarios of precipitation, urban growth, stream flows, vegetation dynamics, and species distributions—and assessing the existing situation of Ecosystem Governance—who and what controls conservation outcomes among the U.S. Caribbean governmental and non-governmental organizations, and Caribbean-wide.

5. 100th Anniversary of the Forest Service

The Forest Service celebrated the 100th anniversary of one of the most successful land conservation efforts in the U.S. The Weeks Act was signed into law in 1911, after a decade-long debate about the role of the Federal government in protecting forestlands. The Weeks Act allowed the use of Federal funding to purchase forest land for conservation. The Weeks Act appropriated $9 million to purchase 6 million acres of land in the eastern United States. The success of the Weeks Act and its contribution to the conservation of natural resources in the eastern United States has been enormous. During the last 100 years, The Weeks Act led to the creation of 52 national forests in 26 eastern states and the addition of 19.7 million acres on national forests and grasslands across 41 states and Puerto Rico.

6. LEF has a demonstration site of Large Scale Manipulative Experiments

The LUQ LTER has undertaken experimental manipulations to simulate the major effects of hurricane disturbance—canopy openness and debris addition to the forest floor. Using a factorial experiment allowed us to investigate the separate and combined effects of canopy opening and debris on wet tropical forest. The experimental outcomes may help direct forest management decisions in similar disturbance-prone environments.

7. Bisley Watersheds

Twenty-five years of continuous watershed monitoring in the LEF helps provide an understanding of how vegetation production will respond to the altered hydroclimatic conditions predicted with climate change. This is important when making decisions about food production and resource management.

8. Big-Leaf Mahogany

Big-leaf mahogany is the most important commercial timber species of the tropics. Current debate concerning whether to protect it as an endangered species has been hampered by the lack of complete, definitive scientific documentation. We published vital research on the ecology of big-leaf mahogany, including genetic variations, regeneration, natural distribution patterns and the silvicutural and trade implications for the tree.

1.7 Conclusion

The El Yunque National Forest Assessment utilizes the best available scientific information to describe land status, use, ownership, and access within and around the National Forest, including information from the Land Status Records System (LSRS), which is the official repository for all realty records and land title documents for National Forest System (NFS) lands, as well as the Land Areas of the National Forest System Report (LAR), which is an annual publication that tracks NFS system ownership and provides the most up-to-date statistics on land areas administered by the Forest Service. Information from the Puerto Rico Planning Board on current and historical land use, zoning, and related laws and other policy directives were also obtained and analyzed.

Also, it utilized scientific, peer reviewed researches, as well as information generated by the EYNF and other governmental and non-governmental sources. Two key resources were "The Luquillo Mountains: Forest Resources and their History" by Peter L. Weaver (2012), a general technical report produced by the International Institute of Tropical Forestry, and the "El Yunque Ecosystem Services Project", a participatory research project sponsored by the USFS Urban and Community Forest Program, led by Tania Lopez-Marrero and L. Annie Hermansen-Baez (2011).

The institute and its exceptional cadre of scientists, natural resources managers, professionals, and technicians have generated data that serves as a focal point for bringing better management practices to bear on issues affecting tropical forests, especially EYNF. Hence, this forest plan assessment was developed by using the best available scientific information (BASI) generated from the Institute, and from other agency experts, relevant to the issues that will be considered later in the development of plan components and other plan content.

1.8 References

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