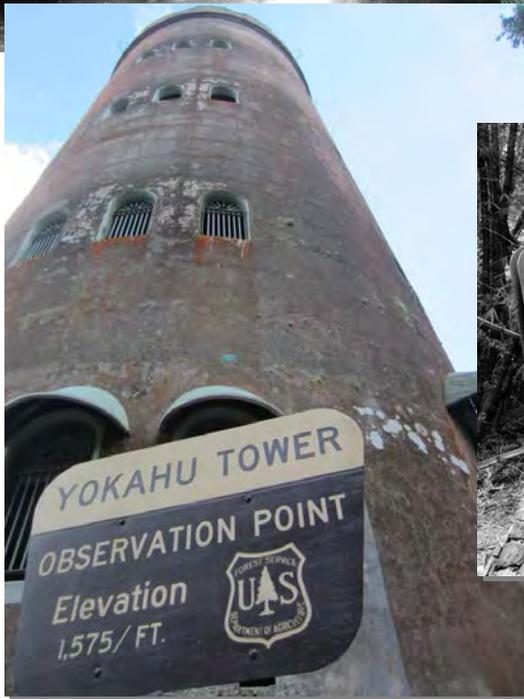


El Yunque National Forest Assessment 2014

Summary of Key Findings



US Forest Service
International Institute of Tropical Forestry
Centro para la Conservacion del Paisaje

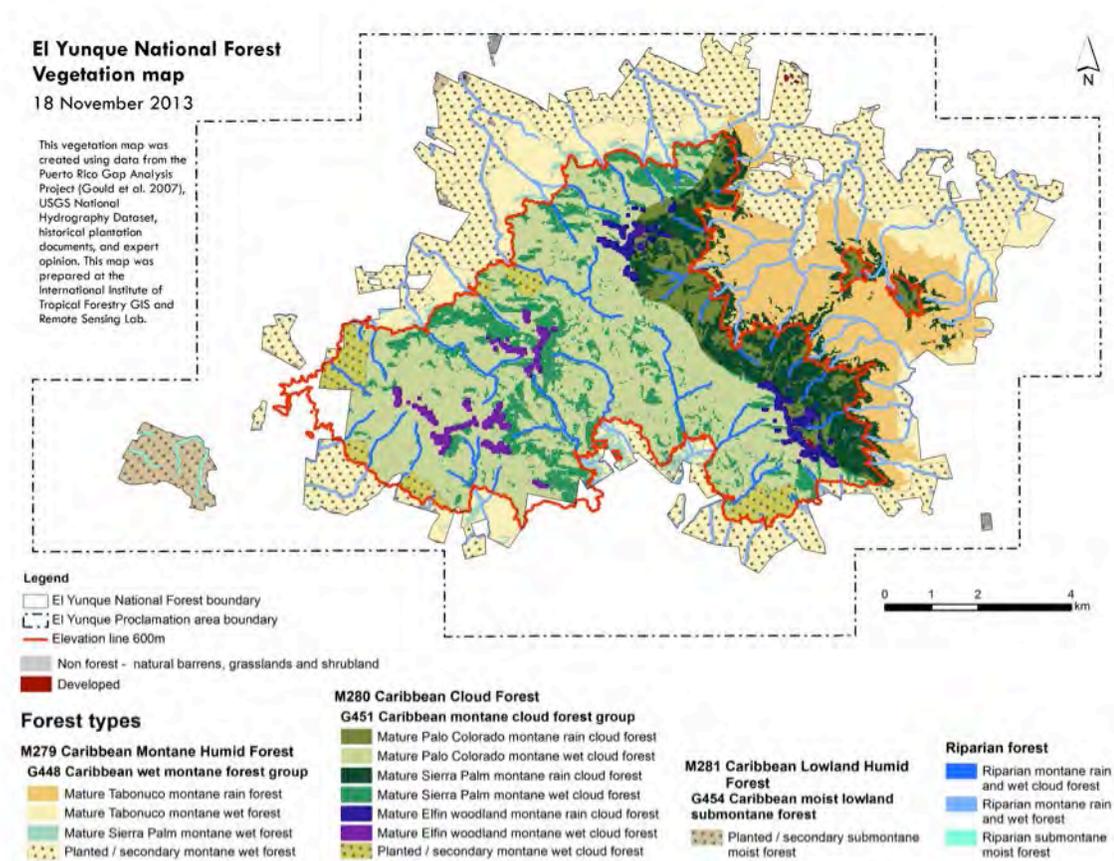


Appendix J: Summary of All Key Findings

A. Ecological Key Findings

Terrestrial Ecosystem

- Utilizing the directions of the New Planning Rule and utilizing the National Classification Vegetation Systems; **15 vegetation types have been identified and mapped**; of which 6 are located only in El Yunque National Forest and unique for the rest of Puerto Rico. **Of these 3 were the Riparian Areas mentioned above. The identified types of vegetation push us away from the tradition 4 forest types.**



Planted Forest/Secondary Forest or Novel Forests?

- There are 7,784.5 acres of lands at EYNF for which the actual National Vegetation Classification System vegetation association or alliances cannot be exactly determined with the information available at EYNF. Preliminarily, we identified these lands as Planted/Secondary Forest due to their past land uses and documented history. After a brief discussion of the definitions of the terms “plantation” and “secondary succession” and the more recent concept of “Novel Forest,” we have concluded that Novel Forest is the more appropriate preliminary descriptive name to this vegetation type until future research or silvicultural analysis and/or monitoring could determine the actual vegetation type or types present in these lands.

- Plantations. El Yunque has Novel Forests. We are entering an era of novel tropical forests because human activity continues to modify landscapes in ways that are unfavorable to the regeneration of traditional community assemblages, particularly in the periurban environment and after the cycle of deforestation, agricultural use, and abandonment of lands. We are entering an era of novel tropical forests because human activity continues to modify landscapes in ways that are unfavorable to the regeneration of traditional community assemblages, particularly in the periurban environment and after the cycle of deforestation, agricultural use, and abandonment of lands. Novel environmental conditions created by human activity favor the remixing of species and formation of Novel Forests. Novel Forests will probably behave ecologically as native forests do (i.e., protect soil, cycle nutrients, support wildlife, store carbon, and maintaining watershed functions). Moreover, Novel Forests mitigate species extinctions as they, like secondary forests, are in successional paths to maturity and species accumulation. Nature's response to the Homogeocene cannot continue to be ignored or remain undetected by ecologists. The dawn of the age of tropical novel forests is upon us and must not be ignored (Lugo 2009).

1.1.1.1 El Yunque National Forest Situation

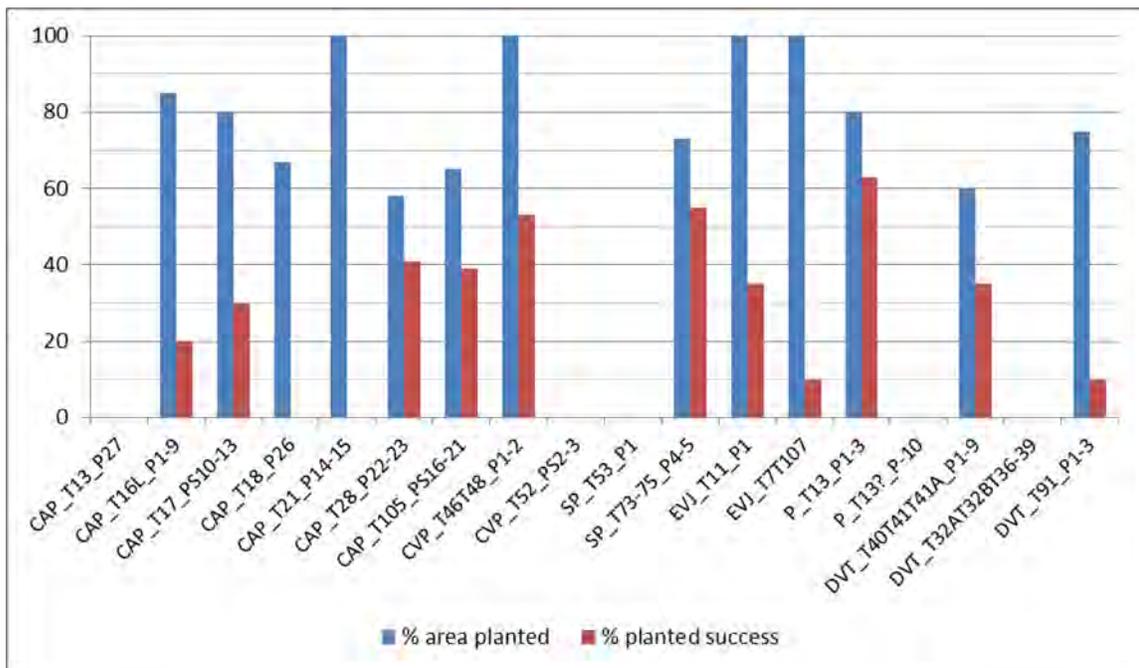
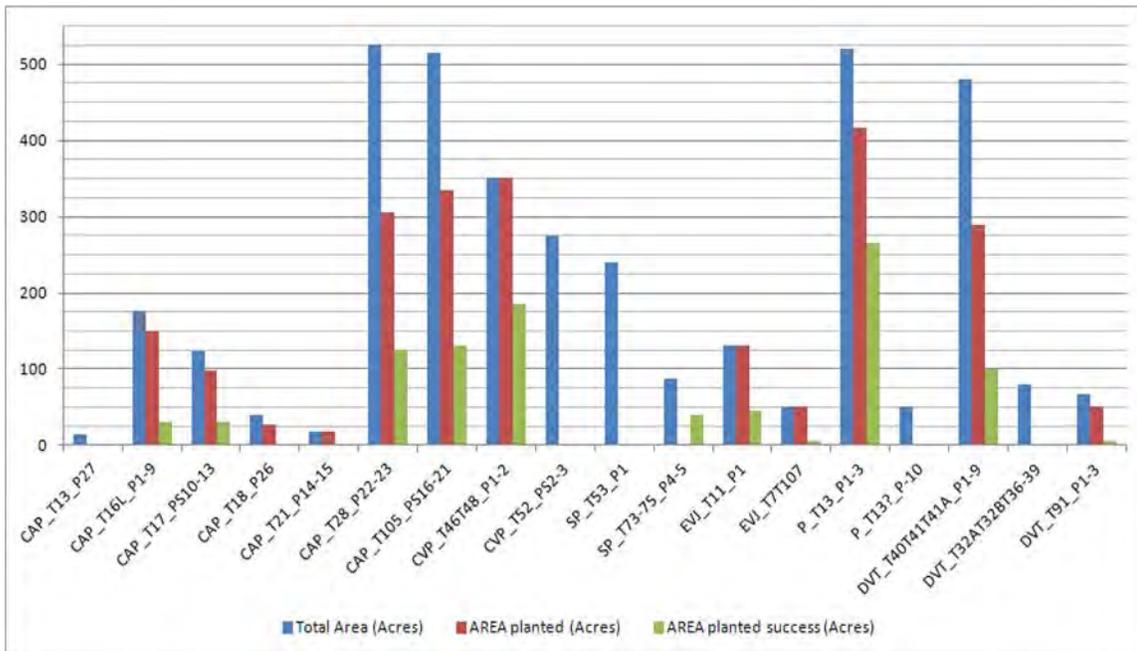


Figure 2-1. Percentage of tract planted and success



Source: Marrero (1947)
 Figure 2- 2. Total acres of tract, acres planted and acres establish
 Source: Marrero (1947)

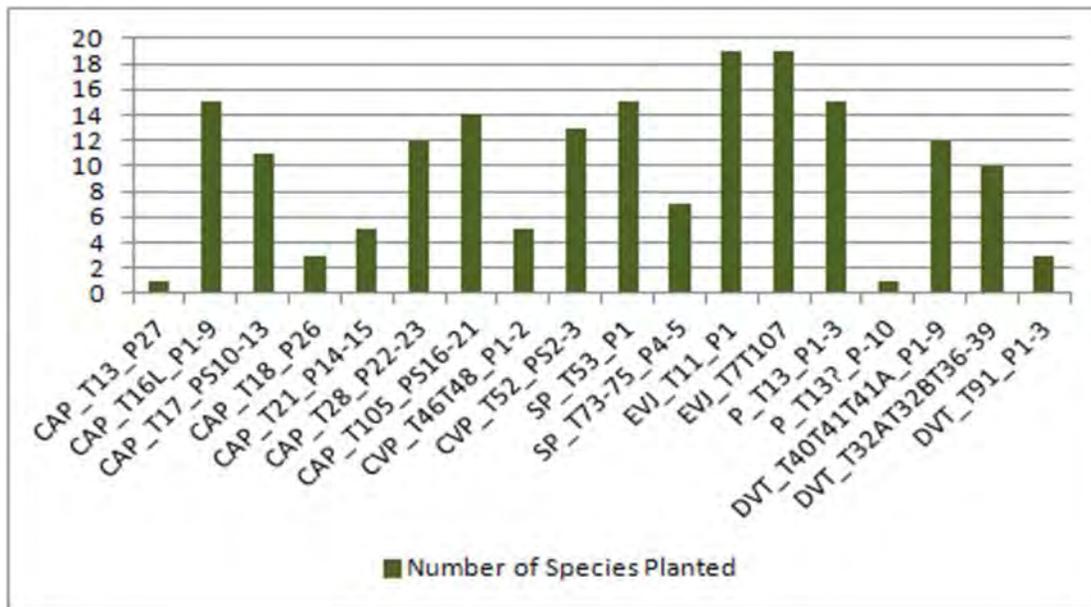
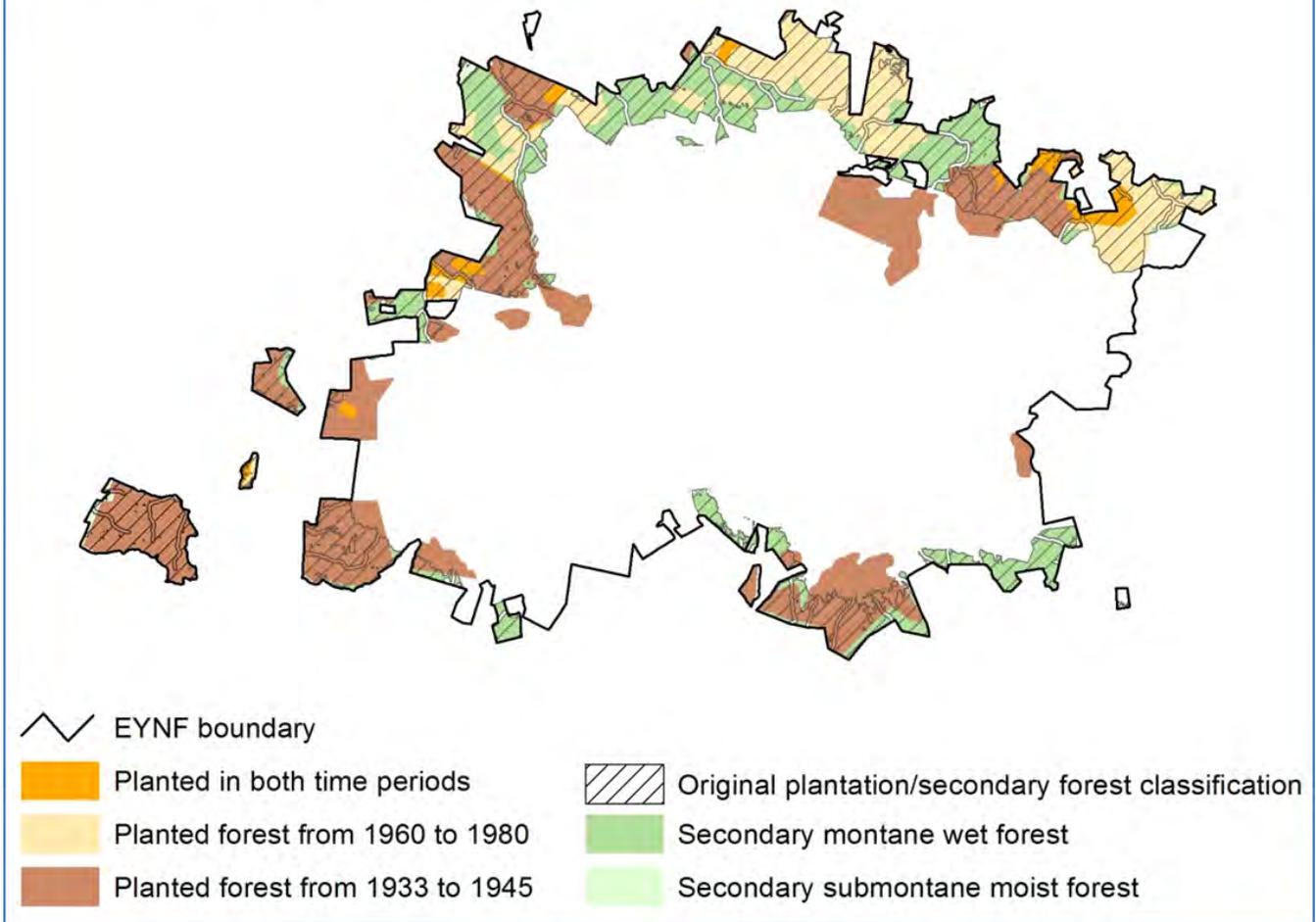


Figure 2-3. Number of species planted per tract
 Source: Marrero (1947)

- During 1998 another Hurricane (Georges, category 3) struck the Forest compounding the previous Hurricane effects. It is expected that after more than 20 years of no silvicultural treatment to those lands and two direct hits by hurricanes, plus six tropical storms and nine other hurricanes impacting the Island, the effect to the Forest is similar to what happened in the

Luquillo Mountain after the reforestation efforts during the 1934 to 1942 period (the establishment of a Novel Forest). Thus again we have a Novel Forest that is expected to persist for generations to come; therefore, those lands (aside from several small stands) are the new Vegetation type of EYNF and it will be very difficult to separate planted forest from secondary succession forests or to call a particular site a plantation, just because it was planted in the past. A thorough silvicultural analysis is needed to determine the condition, composition, structure and function of these lands.

Planted and secondary forest



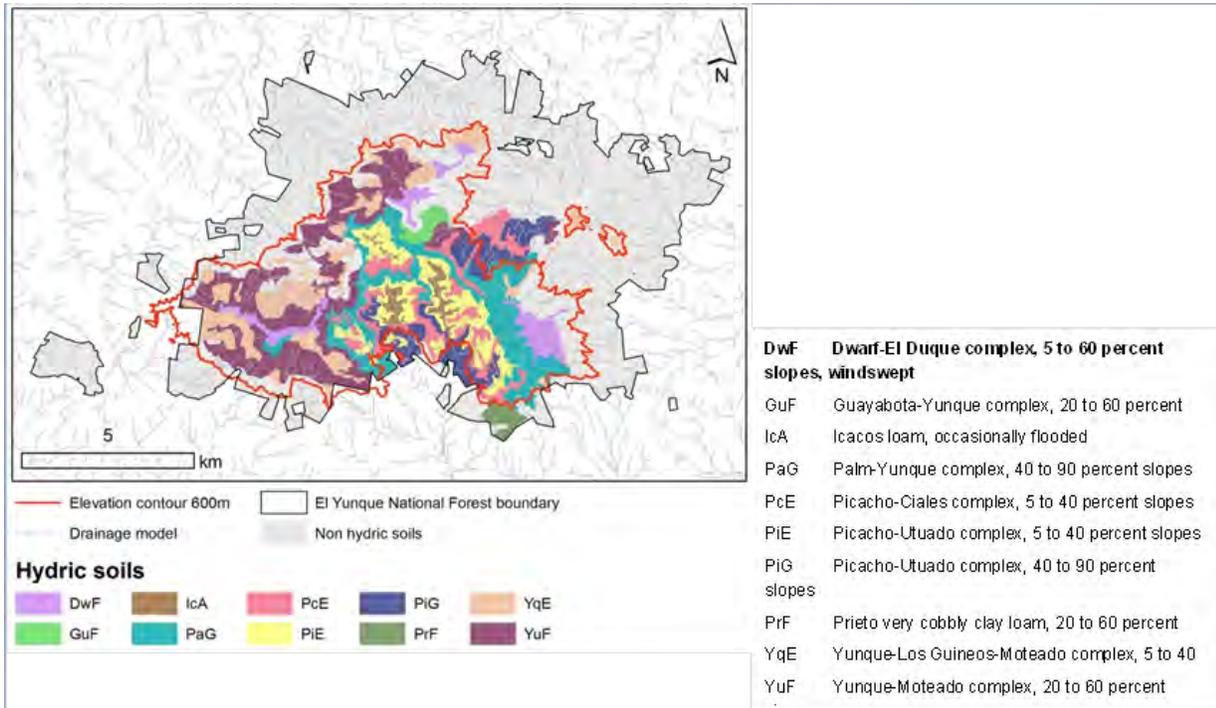
Thorough silvicultural analysis is needed to determine the condition, composition, structure and function of these lands. Map 2-2. Areas planted in the 1930s, 1960s into the 1980s in our new ecosystem type matrix; Planted/Secondary Forest Area.



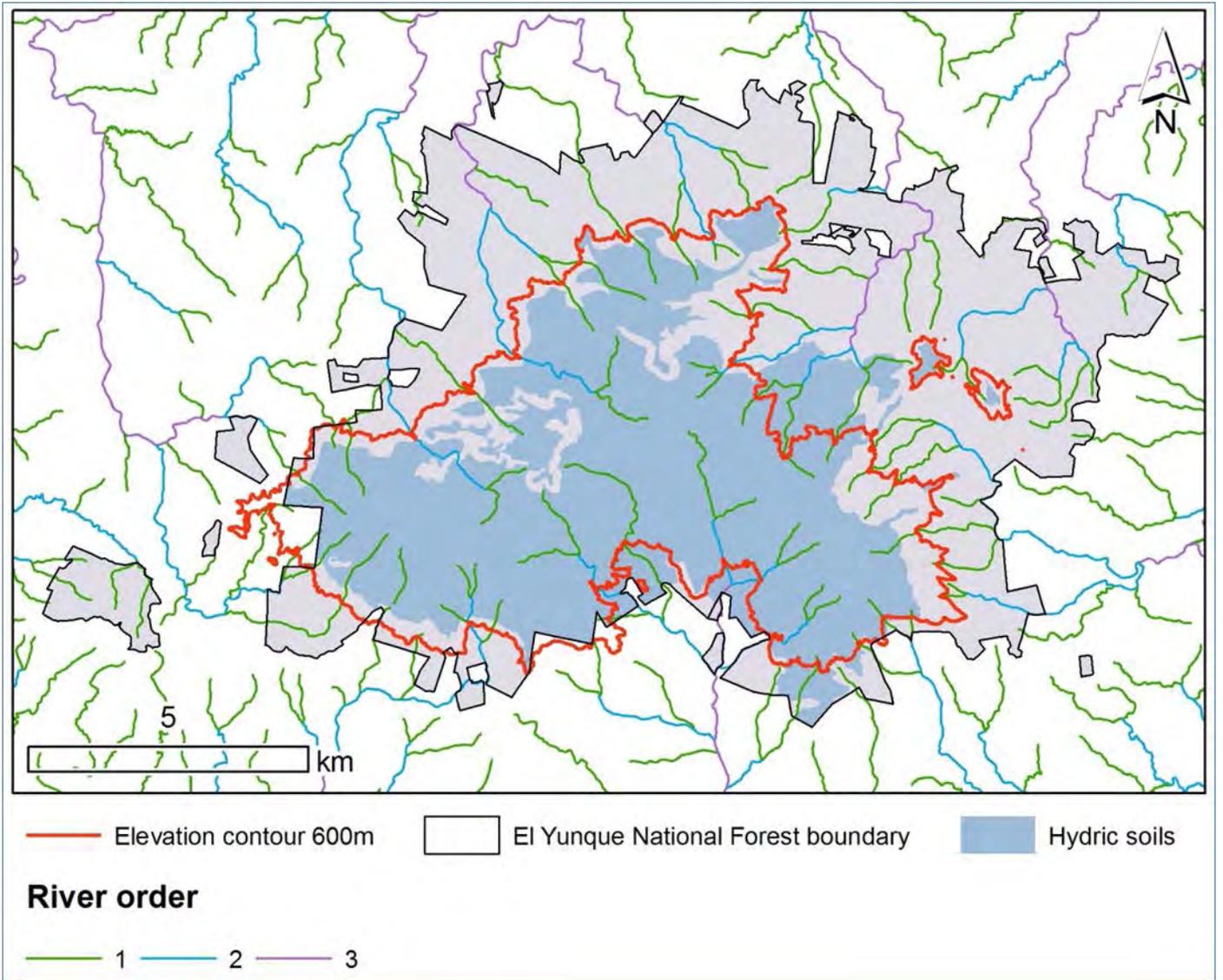
Sierra de Luquillo enshrouded in clouds; view from the Atlantic Ocean (photo by Luis A. Rivera)

- Vegetation and Environment of the Cloud Forest is a Functional Wetland. All forests above the cloud condensation level (600 meters of altitude) at the EYNF are cloud forests, including the elfin forests (Harris et al. 2012). In addition to the tabonuco-dominated, low-elevation forests, wetlands in the EYNF found below the cloud condensation level include riparian forests. All forests above the cloud condensation level (600 meters of altitude) at the EYNF are cloud forests, including the elfin forests (Harris et al. 2012). In addition to the tabonuco-dominated, low-elevation forests, wetlands in the EYNF found below the cloud condensation level include riparian forests. In the lower elevations of the Mameyes river watershed, the wetland tree *Pterocarpus officinalis* forms stands along riparian areas. A *P. officinalis* stand of approximately 3.7 hectares occurs at 500 meters above sea level in the EYNF; it is described as a montane riverine forest system with organic soil over clay. Other species within this rare wetland forest type include *Casearia arborea*, *Cordia borinquensis*, *Inga laurina*, *Manilkara bidentata*, the tree fern *Nephelea portoricensis*, and the palm *Prestoea montana*. The upper canopy is 25 to 30 meters in height, and a second canopy layer is found at 15 meters, with abundant epiphytes and woody vines. *Pterocarpus officinalis*, a species with a wide Caribbean distribution, also occurs in small groups of individuals along streamsides at elevations below the EYNF boundary (Harris et al. 2012).
- All vegetation above the cloud condensation level is classified as wetlands (Frangi 1983; Scatena 1993; Heartsill-Scalley 2005). Many environmental gradients reach their extreme values at the mountain peaks (e.g., highest wind speeds, lowest air temperatures, lowest incoming sunlight, highest rainfall, lowest soil oxygen concentrations, etc.). The vegetation responds in unique ways including unique vegetation structures, unique even between the forests of East Peak and West Peak (Howard 1968). Herbaceous and sphagnum bogs, riparian vegetation, and Palm Floodplain Forests (Frangi 1983; Frangi and Lugo 1985; Lugo et al. 1990) also occur above the cloud condensation level. In environments with high light levels, one can observe herbaceous bog areas that include clumps of *Carex polystachya*, *Eleocharis* spp., large masses of *Sphagnum*, and other wetland vegetation (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 are reported to be present at the EYNF (see Appendix B). Soils Above the Cloud Condensation Level (Above 600 meters of Altitude)

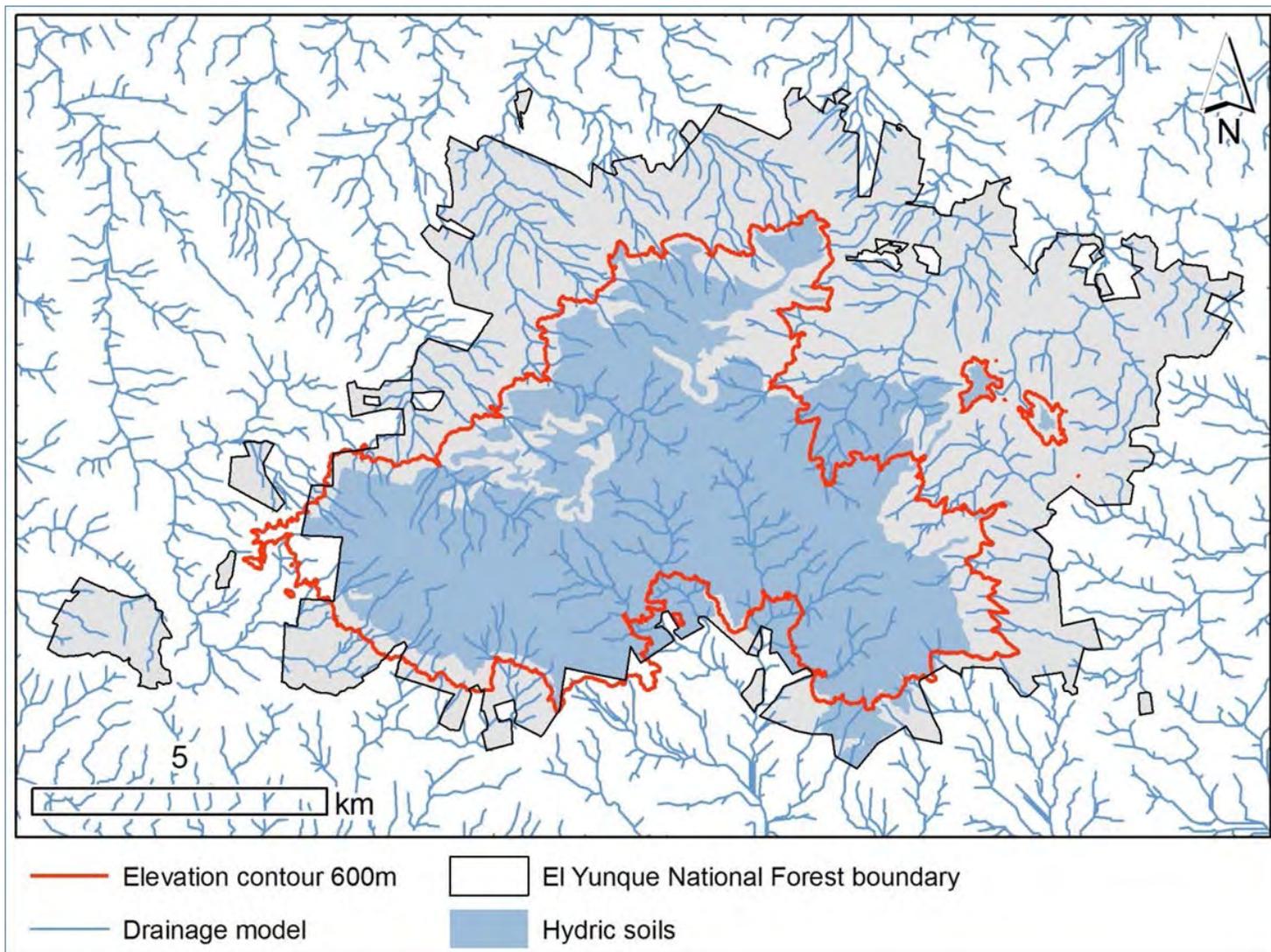
The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others 1979; U.S. Army Corps of Engineers 1987; National Research Council 1995; Tiner and Burke 1995). Criteria for each of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands. Hydric soils are defined by the National Technical Committee for Hydric Soils as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994). These soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytes if hydrologically unaltered (Natural Resources Conservation Service 2012).



Map 2-5. Hydric soils on the ELNF



Map 2-6. Hydric system of the EYNF above the 600 meters of altitude



Map 2-7. Drainage model of the EYNF

Riparian Areas

Riparian Forest- A riparian zone or riparian area is the interface between land and a river or stream.

- Some examples of this vegetation type have been described for EYNF as conceptual model of wetland ecosystems or generalized geohydrologic setting of wetlands; Montane Pterocarpus Forest and Riverine Palm and Riparian Forest (Harris et al. 2012; Miller and Lugo 2009).
- Riparian Submontane Moist Forest (58.96 acres). This is the riparian vegetation along rivers and streams of the Planted/Secondary Submontane Moist Forest at EYNF.
- Riparian Montane Rain and Wet Forest (1350.14 acres). This is the riparian vegetation along rivers and streams of the forests below the 600 meters of elevation at EYNF.

- Riparian Montane Rain and Wet Cloud Forest (704.73 acres). This is the riparian vegetation along rivers and streams of the forests above the 600 meters of elevation at EYNF.
- Survey data from Pike and Scatena (2009) indicates mosses and short grasses dominate at a stage often inundated by sub-effective flows. Herbaceous vegetation is associated with intermediate discharges that correspond to the threshold for sediment mobilization. Near-channel woody shrubs and trees establish at elevations along the channel margin inundated by a less frequent discharge that is coincident with the effective discharge of bed-load sediment transport. In montane reaches that lack a floodplain, a boundary that is characterized by the incipient presence of soil, woody shrubs, and trees corresponds to the same flow frequency as the bankfull discharge of nearby alluvial channels. The reference discharge based on these riparian features in steep land sites has an average exceedance probability between 0.09 and 0.30 percent, and a recurrence interval between 40 and 90 days. We conclude that flows with similar frequencies influence the establishment of riparian vegetation, soil development, and substrate characteristics along channel margins in similar ways. Thus, these riparian features can be used as an indicator of hydrogeomorphic site conditions to identify active channel boundaries that occur at a constant flow frequency throughout the study stream network (Pike and Scatena 2009). Although there are consistent vegetation patterns at a given reach, not all of the types of vegetation are present everywhere because the abundance of certain species can also be influenced by differences in microclimate, light availability, and land-use legacies (Heartsill-Scalley 2003; Brown et al. 2006). In areas surrounded by forests, the riparian understory vegetation is mainly composed of shrubs, herbs, and ferns. The riparian zones surrounded by pastures and mixed land use are commonly dominated by grasses, vines, and bare soil.
- More diverse riparian communities dominate other low-elevation wetland areas. In the Luquillo Forest dynamics plot along the Prieta and Toronja streams, Heartsill-Scalley et al. (2009b) calculated the minimum distance of individual stems (greater than 10 centimeters DBH) to the nearest of the two streams. The species with stems in close proximity to streams were *Clusia rosea*, *Coccoloba diversifolia*, *Margaritaria nobilis*, *Ixora ferrea*, *Trichilia pallida*, and *Guettarda valenzuelana*, with a median distance to streams between 21 and 29 meters. *Margaritaria nobilis* and *C. diversifolia*, however, were most abundant closer to the streams, with 75 percent of their stems within 30 to 40 meters of the stream. Other species had 75 percent of their stems within 40 to 50 meters from the stream and included *Clusia rosea*, *Guatteria caribaea*, *G. valenzuelana*, *Byrsonima wadsworthii*, and *Eugenia stahlii* (Harris et al. 2012).

Air

- The conditions of the air surrounding El Yunque have remained relatively constant in the past; however, they have begun to change in recent years due to increased anthropogenic activity and climate change. Many of the increased concentrations of aerosols and other contaminants can lead to bigger consequences for the forest environment and the surrounding communities, have negative effects on nutrient cycles and precipitation, and reduce air quality. Some of these effects have already begun to show, and are expected to worsen with deteriorating conditions.

Soils

- Soils within EYNF boundaries appear to possess good integrity, with disruption caused by landslides and subsequent erosion.
- There is a preponderance of partially hydric soils and mostly are in the D Hydrologic group.
- Within forest boundaries, soil loss of integrity is a function of landslides, and subsequent erosion. Landslides are common both far and near from roads. Vegetative succession, an essential element of soil erosion control, is controlled by soil factors (Shiels et al., 2008).

Water Resources

- There are 34 water intakes withdrawing over 46 million gallons per day from the Forest, in some basins, up to 82% of the median flow is diverted, on a typical day, 70% of water (add date) generated within the Forest is diverted before reaching the ocean, up from 54% in 1994 (Crook et al. 2007).
- Minimum flows are not being maintained, impairing ocean connectivity, including observed 0 flow on the Río Icacos (Crook et al., 2007) – Add to the statement the purposes: ecological vs consumptive.
- All streams (ask him to Identify) within the Forest are impaired. Fecal coliforms, metals (which other metals other than mercury, and Organic Enrichment/Oxygen Depletion were the most prevalent reasons for impairment. (EQB, 2011)

Drivers and Stressors

- 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 2-1). Projected decreases in precipitation in the Caribbean suggest drier wet seasons, and even drier dry seasons (Table 2-2) (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 decrease precipitation in EYNF (Comarazamy and González 2011). Climate change may also affect the distribution patterns and concentrations of air pollutants through changing wind and precipitation patterns (Bytnerowicz and 2007) as well as increased temperatures (Bedsworth 2011).

Table 2-1. 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 2-2. 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

- 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).

- **Terrestrial Ecosystems.** Higher temperatures, changes in precipitation patterns, and any alteration in cloud cover will affect plant communities and ecosystem processes in EYNF (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, EYNF'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).
- **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 greater 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 decreasing dissolved oxygen content (Mulholland et al. 1997). Freshwater aquatic communities during drought will experience crowding of species, leading to habitat squeezes and a decrease in reproductive output (Covich et al. 2003). In EYNF streams, extended periods of extreme low water flows may result in increased pollutant concentrations and excessive nutrients (Cashman et al. 2010; Covich et al. 2003).
- **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 neotropical bird migrants wintering in EYNF (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).

- 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 EYNF 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 EYNF 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).

Identifying and Assessing At-Risk Species in the Planning Process

Fauna

The results are a summary of the information found through this document.

There are within the designation of at-risk species in the new planning rule two sections of categorization, “1) federally recognized threatened, endangered, proposed and candidate species... and 2) species of conservation concern” (USDA Forest Service 2013b).

- For the EYNF under the federally listed endangered, threatened, proposed, or candidate category there are five listed species: the Puerto Rican parrot, Puerto Rican broad-winged and sharp-shinned hawks, Puerto Rican boa, and Elfin-woods warbler. One listed species has been extirpated, the white-necked crow.
- Under the New Planning Rule the species of conservation concern category consists of nine species of coquies, two species of anole lizards, one bat species, four bird species, five species of fishes and two species of freshwater shrimp.
- The Elfin-woods warbler is now in a higher priority for the USFWS and is presently conducting a candidate conservation plan with the EYNF to meet the challenge of reducing range. The conservation plan is an attempt to avoid being categorized as endangered.
- Regarding the four federally listed birds: Puerto Rican parrot, Elfin-woods warbler, Puerto Rican sharp-shinned hawk and Puerto Rican broad-winged hawk, population conditions on the EYNF are greatly affected by the present vegetation structure. To improve habitat quality, there is a need for wildlife stand improvements for these species to address changed conditions and vegetation structure diversity in corridors throughout the EYNF.

Flora

- From the Element Priority Report (ESE Tool), 51 species were identified as species at-risk. Eight (8) Federally listed, twenty six in the G1 rank, sixteen in the G2 rank and one in the G3 rank. From this information an initial potential list of fourteen (14) plants Species of Conservation Concern (SCC) was recommended for further analysis and determination. To all (51) species the native status was determined; the last date of official recorded occurrence was documented and the local or Federal legal conservation status established.

B. Social- Economic Key Findings

- The population in the El Yunque Region is growing, though growth rates are slowing. The El Yunque regional population has been increasing for decades, but the growth rate has slowed significantly in recent years. The municipal populations to the south of the EYNF (Naguabo, Las Piedras, and Juncos) continue to grow at faster rates than those to the north (Canovanas, Rio Grande, and Luquillo) and east (Fajardo, Ceiba). Population growth surrounding the Forest can be associated with increasing demands for services and products, especially in the southern

populations as they continue to grow at a comparatively faster pace. Populations surrounding the EYNF are increasingly dense and urbanized, and many of the negative effects of urbanization are likely to be compounded in the context of global climate change. The regional population is increasingly urbanized, and outpacing the Island as a whole in terms of urban growth. Though urbanization is often associated with increased job opportunities and better health care options as compared to rural areas, this increasing urbanization around the Forest is likely to result in increasing impacts from fragmentation and increasing pressure on watershed functions and water resources, for example. 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. 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). 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 have the potential to increase the ecological and economic effects of 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).

- The Regional population is getting older. While the population in the El Yunque Region is slightly younger than the Island as a whole, much of the regional population is aging, with a growing segment of the population represented by people over the age of 55. Additionally, the life expectancy for Puerto Ricans has steadily increased over the past several decades, and mortality rates have decreased. As the population ages, demands for resources and services from the National Forest also will change, such as increased demands for less strenuous and more motorized recreation opportunities.
- Per capita and family wealth have increased, but only modestly outpacing inflation, and poverty remains high among families and, particularly, among children. When adjusted for inflation, income across the Island and within the El Yunque Region has only modestly increased since 1970, representing limited growth in basic social assets that are crucial to enhanced quality of life and human well-being.
- Overall, the municipalities to the north of the EYNF (Canovanas, Rio Grande, and Luquillo) had the highest levels of median family and per capita income in 2010, followed by those to the east (Fajardo and Ceiba), while the municipalities to the south of the Forest (Naguabo, Las Piedras, Juncos) exhibited comparatively lower levels of income. While income has increased slowly but steadily in the El Yunque Region, nearly 41 percent of families were living below the poverty line in 2009. Throughout the Region the percent of families living below the poverty line has steadily decreased in recent years; but despite these declines, poverty occurs at significantly higher rates than in the U.S., for example. Limited growth in personal and family wealth and persisting poverty among families, and children in particular, are signs of social vulnerabilities and may be indicators of large segments of society that are being left behind. Moreover, low income and high poverty rates imply greater demands on public services and resources. Unemployment rates are high but improving slowly and education rates are increasing. While unemployment rates remain high for the El Yunque Region, they are decreasing slowly. When decreasing unemployment is taken into consideration with the fact that there has been a steady increase in the number of individuals looking for work or actively working (i.e., increasing labor force) in most municipalities, there is an indication that opportunities for employment have increased in recent years, which may signal opportunities for improvements in some key local economic conditions. However, the harsh economic conditions across the Island are not expected to improve much in the near future. The populations surrounding the EYNF are spending more years in formal educational programs and as education levels continue to increase, so do the knowledge and skills

available for responding to demands and changes in the social and natural environment. Nonetheless, while the regional population is increasingly educated as a whole, lower income individuals and families and less educated segments of the populations may be left further behind, further expanding income and education gaps in the overall population.

- The Regional economy is fairly diverse, predominated by government- and service-oriented industries; agriculture is not a prominent sector of the economy, but is prominent across the landscape. Overall, there is measurable economic diversity in terms of job distribution by major industrial sector in the El Yunque Region, which is a benefit to adaptability to potential changes in future social and natural conditions. Government-, social services-, retail trade-, and private-sector-service-oriented industries are the most prominent and growing. Conversely, agriculture represents a very minor portion of the economy, but farmland is prominent across the landscape and farms continue to be important sources of income for their owners, and important contributors of open space, scenic vistas, and wildlife habitat. Given persisting pressures from a growing population with high rates of poverty and unemployment, there is a large draw on public resources to relieve poverty and to provide services such as medical care and utilities at a lower cost to groups unable to afford them otherwise, resulting in a relatively high tax burden and disproportionate investment of public resources in a single segment of the population.
- The EYNF spans eight municipalities in eastern Puerto Rico, encompassing about 15 percent of their total area. The eight municipalities that comprise 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 (Error! Reference source not found.). Stretching over 28,000 acres, the National Forest covers about 15 percent of the total area of the El Yunque Region. Forested areas represent the largest portion of land cover in the region surrounding the EYNF, and forested cover has increased over the past several decades. Nonetheless, urban cover is increasing at a much more rapid pace, resulting in landscape fragmentation and negative impacts on the Forest and other natural areas in the Region. Forests account for 43 percent of the El Yunque Region; followed by pasture (including agricultural lands), 36 percent; and urban areas (10 percent). Inconsistent land use planning and enforcement have resulted in haphazard urban expansion in the region, as across the Island, oftentimes in areas not suitable for urban development. Urban and built-up areas lead to landscape fragmentation or removal of forested lands, which in turn affect ecosystem structure and function and the services provided by forests within and around the EYNF. Land dedicated to farms in the region surrounding the EYNF is decreasing, while also being increasingly "parcelized" and fragmented. Farmland is important for the production of food and the preservation of open space, scenic vistas, and wildlife habitat, but these areas are increasingly susceptible to urban development and other macro- and socio- economic forces. Between 2002 and 2007, the area of farms decreased in the El Yunque Region; however, the number of farms increased (from 628 to 834 farms). While some of the fluctuation in farm numbers likely comes from small operations that enter and exit agricultural activity in response to fluctuations in the marketplace, much of the change in the number and area of farms is an indication of the "parcelization," conversion, and ultimate fragmentation of larger agricultural landholdings within the El Yunque Region.
- The Regional economy is fairly diverse, predominated by government- and service-oriented industries; agriculture is not a prominent sector of the economy, but is prominent across the landscape.
- The EYNF directly contributes to local economies through employment, expenditures, and payments from revenue sharing and in-lieu of taxes, though these payments have been in decline in recent years.

- The EYNF represents innumerable and invaluable economic, social, and cultural contributions to local communities and beyond.

Cultural

- The inventory of cultural and historic resources is still incomplete. The vast amount of information regarding cultural resources is fragmented and unorganized. Important archaeological data is missing in order to fully assess the significance of pre-Columbian sites within the Forest. In addition, data in relation to the current condition of Spanish Colonial and American Colonial periods is also missing.
- Although the Forest administration has made good progress in the inspection and nomination of heritage resources, it has not been able to enhance, stabilize, and develop interpretive initiatives in the Forest. Maintenance of PHAs is a critical issue as deferred maintenance of one-third of properties listed has not been conducted. In addition, relatively few heritage sites potentially eligible for NRHP have been nominated.
- While most of these programs concentrate on the natural history and ecological value of the Forest, the interpretation of cultural and historic resources is quite limited. This situation inhibits the possibility to promote social and economic sustainability amongst local communities in a more effective manner.
- Although efforts have been made, the current conservation education programs reveal that most of the designed educational activities do not necessarily respond to the local cultural context but are more “packed” educational strategies, which are generically applied to different forests’ communities within the Forest Service system.

Ecosystem Services

- Many of the major ecosystem services provided by El Yunque National Forest identified by all stakeholder groups include: clean water, habitat for flora and fauna, air purification, recreation, and scenic value.
- Rapid land-use changes in the communities surrounding the forest have occurred as a result of limited success of Puerto Rican land-use policies. This is due to the top-down institutional approach and poor enforcement of laws and regulations (Lugo and others, 2004.) This can have impacts on services.
- Stakeholder groups such as scientists and forest managers identified certain ecosystem services that were not identified by the rest of the stakeholders. These ecosystem services were categorized into two groups: regulating and supporting and included carbon sequestration, soil erosion control, nutrient cycling, soil formation, and maintenance of biodiversity.

Multiple Uses Timber

- The potential of timber harvesting contribution exists. However, the need for timber harvest in the EYNF must be reexamined under the pressure of urban expansion as forest ecosystems become increasingly more valuable as an integral unit to protect flora, fauna, and water resources benefiting the heavily populated northeastern part of the island (Weaver, 2012). Earlier versions of the forest management plan suggested that a small scale sustainable commercial timber harvest could be implemented on lands reforested since the 1920s at EYNF. The proposal for commercial timber harvest, however, was highly controversial and was suspended in the revised plan due to public outcry (Weaver, 2012). Nevertheless a proposal for a Timber Management Demonstration Program was approved in the revised LRMP of 1997.

- EYNF is a provider non-timber forest products. The forest continues to serve local communities by providing small products.

Wildlife

- Illegal fishing and related water contamination is still happening within the boundaries of the forest. This is a concern for management purposes.
- Wildlife watching is an increasing activity with a strong trend of remaining prevalent for many public visitors.
- Access and services for the public are important for the enjoyment of many common wildlife species
- Non-timber forest products shows a legitimate long-term use of areas of the Forest that may benefit both wildlife and community sustainability. This includes agroforestry and collaboration with agriculture agencies. There is potential to include agroforestry practices inside and outside the boundaries of the forests for our management plan.

Assessing Recreation Setting, Opportunities and Access

- High visitation continues to be during two periods during the year: December to April and June to August
- The prominent recreation sites are located along the PR-191 Recreation Corridor
- Recreation site conditions are being affected by reductions in personnel and funding.
- Recreation activities on the Forest are very "compatible" among the users and the natural setting.
- The Forest continues to foster recreation connections with adjacent municipalities, PR Tourism Company, several universities, Amigos del Yunque and non-governmental groups.
- Non-developed recreational sites, thefts, and crowding are conditions and trends that are affecting recreation.
- Access and services for the public are important for the enjoyment of the forest.
- The current camping opportunities do not meet current demands. It needs to be updated and revised.
- Recreational opportunities have not changed.

Scenic Character

- Visitors are drawn to the EYNF for its natural scenic beauty comprised of immensely diverse vegetation, steep landforms, clear streams, and waterfalls. Roads off-forest as well as most Forest roads, trails, and recreation sites have high concern for viewing scenery... Currently, about 60 percent of the Forest has natural scenic character, and about 39 percent has a naturally appearing scenic character (USDA Forest Service 2013b). Forest visitors and adjacent landowners are sensitive to noticeable changes in the landscape whether they are human caused or the result of natural processes.

Assessing Renewable and Nonrenewable Energy and Mineral Resources

- EYNF contribution to energy activity remains low for wind energy and is high for hydropower. The EYNF region serves as a pillar for the Island's social and economic development primarily

thru the tourism and recreation sectors. There is one windmill farm located of the Forest in the Rio Blanco Watershed valley. Highly erodible soils, steep hills and narrow valleys reduce the potential for wind energy facilities within or near the Forest. There is one hydroelectric on the Forest. However, formal designations such as wilderness, research natural area and wild and scenic review severely limit the potential establishment of hydroelectric dams within the Forest even when the land produces vast amounts of water.

- EYNF contribution to minerals activity remains low. Low quantities of minerals within the Forest reduce potential for commercial activity. Even recreational minerals activity interest has decreased.

Infrastructure

Roads

- Intense road maintenance needs. The roadbed section will require continuous annual maintenance to maintain its functionality of providing all-weather access year-round to the Long-term Ecological Research sites. The road shall be mowed annually or as needed to provide adequate safe sight distance and to reduce unsafe conditions. Road ditches, culverts, and drop inlets shall be maintained clean and open to reduce roadbed erosion and resource damage. Roads have significant contribution to the scientific use of the Forest.
- Use of off-road vehicles on Forest roads. The operation of these vehicles on Forest Service roads is prohibited. The Forest Service does not allow the operation of these vehicles on Forest Service lands. The damage to the ecosystem, including noise, pollution, and property damage by such units is well documented. At present time the use of Forest Service roads and lands by these units is known and public notification by means of closure orders has been used to reduce the Agency's overall liability. The illegal practice is still happening, but at a lower level.
- Need for gated roads. The EYNF is visited, due to its proximity to the metropolitan area, by thousands every year. The Forest is under the category of "Urban Forest" due to the proximity of large population with less than 1 hour of travel time.

Buildings

- High number of vacant facilities. Eleven out of 31 buildings in current inventory are vacant, including the recently vacated old Aviary facilities. All vacant facilities, except one, are eligible for the National Register of Historic Places. Several other facilities in the recreation inventory are vacant as well as non-Forest Service facilities owned by special use permittees, including Navy facilities vacated in fiscal year 2005. Since fiscal year 2008 the Forest has pursued and identified interest on vacant facilities. Interest was identified to operate facilities as eco-lodges, and for research and education. However, no private investment occurs.
- Deterioration of historic facilities. All of the historical facilities eligible for nomination or nominated are in severe deterioration. Eliminated the rest of the finding, only stay with the first sentence. The Agency has not longer a need for use of historic properties and establishing and implementing alternatives for historic properties that are no longer needed for agency purposes. All eligible historic facilities (13 structures, 15,407 square feet) have been retained for alternate use except the Army House (Infra # 86006) and 2/3 (480 square feet) of the Stone House Apartments (Infra # 86021) which are identified for decommission.
- Lack of accessibility of most facilities. Only 4 out of 31 buildings in the FA&O inventory, accounting for 13,164 square feet out of a total Forest gross square footage of 71,008 are accessible. Most Forest structures were constructed prior to 1980 before accessibility was emphasized in facility design. The Catalina Service Center office building (10,800 square feet), the facility housing most Forest employees, and where a significant interaction takes place with

visitors and cooperators, was expanded and remodeled in 1996 and made accessible at that time. El Portal Rain Forest Center, designed to meet ADA accessibility standards and constructed in 1996, is not accessible. A lack of focus in accessibility requirements by the contractor and contracted inspection resulted in numerous minor deviations that prevent the facility from being listed as accessible. The most critical and obvious features are parking stalls and ramps slopes. There is a design completed to correct the deficiencies.

- High operation cost of El Portal/Headquarters Complex. The El Portal visitor center and Headquarters office complex are highly mechanical facilities designed without much consideration to energy efficiency. Considering the hot and humid climate and marine environment, maintenance and operation costs are high. The Forest has moved forward in looking for cost reductions and has completed an Energy Use Analysis and Savings Plan with immediate, short-term, and long-term actions. An immediate action implemented since fiscal year 2006 was the installation of air conditioning thermostat timers. With the reduced use of the computer room resulting from the move of the servers to a central location in mainland U.S., and the implementation of other short-term actions identified in the Energy Savings Plan, the Forest reduced energy use levels from 503,300 kilowatts per hour in fiscal year 2008 to 399,980 kilowatts per hour in fiscal year 2009, for a 21 percent reduction. Utility bills were reduced during that same time period from \$127,014 per year to \$82,226 per year, for a 35 percent reduction. Use levels remained steady (2 percent reduction) in fiscal year 2010, but the utility bill increased 13 percent due to increases in fuel prices, but still a 27 percent reduction from fiscal year 2008 level. The next action is a CIP project for energy retrofitting combined with additional square footage to relocate employees at El Portal to Catalina.

Economic

- There are opportunities for private ventures. While determining whether uses for private interests can be accommodated off-Forest, there may be need for increased public-private partnerships through concessions, permits, or in some cases agreements to offer new recreation services and/or uses for non-used Forest facilities when feasible.
- We do not expect to expand telecommunication uses at the peaks. As equipment systems tend to become smaller, less space and fewer facilities will be needed in the future.
- FAA remains at the East Peak site. Opportunities for dispersed recreation, research, and educational studies in this area may need to be more closely defined and provided to the extent possible that they do not conflict with existing communication uses.
- Financial sustainability to all facility development is needed. There is a need for facilities construction and operation to minimize practices that contribute to greenhouse gases emissions, and minimize dependency on non-renewable energy sources.

Institutional Framework

- Climate change, sustainability, and green technology concepts should be incorporated into permit holder and concession responsibilities. Creating structures that are sustainable for the type of environment and use them experience is difficult, since there are few facilities that see hundreds of visitors a day.

Lands

- EYNF land ownership has remained stable in recent years, though priority acquisition areas remain largely unprotected on private lands. Total EYNF acreage has held at 28,002 acres for many years, consisting of one large block of forest and several small isolated parcels. Several parcels of land were identified in the 1997 land management plan as priority acquisition areas for

the consolidation of the Forest, protection of wildlife, and expansion of recreational opportunities, among other purposes. Nonetheless, very few of these have been obtained through the National Forest or its partners, nor have they been submitted to formal conservation programs by private landowners, essentially leaving them open to possible degradation or conversion.

- The EYNF has several designated land uses, which contribute to forest conservation and socio-ecological sustainability. Special designated land uses within the EYNF include federally-designated experimental forest, research natural area, wild and scenic river segments, and wilderness area. The Forest, in its entirety, also is internationally recognized as a UNESCO Biosphere Reserve. The Forest is recognized by the government of Puerto Rico as a priority conservation area, having a scenic byway, and a critical wildlife area.
- The EYNF encompasses over 30 miles of roads and 36 miles of trails, but given its popularity, there is frequent congestion and overcrowding of the Forest during high use times. More than 30 miles of roads transect the Forest, though vehicular access is limited to a single point of entry at the intersection of PR 191 and PR 9966. Within the boundaries of the EYNF, there are 24 miles of recreational trails and 12 miles of administrative trails, which are restricted to foot traffic only. Nonetheless, given the heavy concentration of recreation opportunities along PR 191, there is a tendency toward overcrowding of recreation sites and parking areas and congestion of roads and trails.



Appendix K

EL YUNQUE NATIONAL FOREST LIST OF ASSESSMENT CONTRIBUTORS 2012-2015

Internal Disciplinary Team:

CANO, FELIPE: USFS, Wildlife Biologist
BUSTAM, TINELLE: USFS, Recreation
DRAGONI, ALEXIS: CCP, Hydrology
GONZALEZ, GRIZELLE: USFS- IITF, Project Leader
GONZALEZ, EDGARDO: CCP, Forest Management
GUERRERO, CARMEN: IDS, Planning
HILLS, NICOLE: USFS, Landscape Architect
JENNINGS, LISA: Climate Change
JONES, WILLIAM: USFS Geographic Information System Specialist
KRUPP, CAROLYN: USFS, Public Affairs Specialist
MCGINLEY, KATHLEEN: USFS- IITF, Research Social Scientist Specialist
MELENDEZ, SHARON: CCP, Archaeologist
MOSCOSO CINTRON, FEDERICO: CCP, Public Engagement Specialist
ORTEGA, JOSE: USFS- Recreation Program Director, Recreation
RIOS, PEDRO: USFS-Ecosystems and Planning Leader, Team Leader
RIVERA, LUIS A.: USFS-Forester, Vegetation
RIVERA HERRERA, LUIS JORGE: IDS, Planning
TORRES, ALEJANDRO: CCP, Cultural Resources
TREASURE, EMRYS: USFS - EFETAC, Biological Scientist

Administrative Support:

AVILA, ROSA: USFS- IITF, Budget Officer
CRUZ, LUCY: USFS, Executive Assistant to Forest Supervisor
GARCIA, ELBA: USFS, Administrative Support Clerk
GOMEZ, DELIA: USFS, Administrative Support Assistant
MARTINEZ, IVETTE: USFS, Financial Budget Officer
RAMOS MORALES, MICHELLE: Contractor, Administrative Support
RIVERA, YIRALIZ: Contractor, Administrative Support
RODRIGUEZ, MARIAN: Contractor, Administrative Support
TAYLOR, MAPLE: USFS, Writer/ Editor

Scientific and Technical Support:

GOULD, WILLIAM: USFS- IITF, Research Ecologist
PARES, ISABEL: Contractor, GIS Specialist
QUINONES, MAYA: USFS- IITF, GIS Specialist
SANTANA TORRES, CHRISTIAN: USFS- IITF, Forest Health
MARCANO, HUMFREDO: USFS- SRS, FIA Research Ecologist

USFS= United States Forest Service
 IITF= International Institute of Tropical Forestry
 GIS= Geographical Information System
 IDS=Iniciativa de Desarrollo Sustentable
 CCP= Centro para Conservación del Paisaje
 EFETAC= Eastern Forest Environmental Threat Assessment Center