PUERTO RICAN PARROT RECOVERY PROGRAM

THIRD POPULATION REINTRODUCTION SITE EVALUATION

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INTRODUCTION

Given the continuing critically-endangered status of the Puerto Rican Parrot (*Amazona vittata*), coupled with the geographic isolation of the remnant wild population in the El Yunque National Forest (YNF), the establishment of at least 2 additional wild populations via reintroductions of parrots from the captive population was cited as a necessary conservation measure in the recent species Recovery Plan (USFWS 2009). According to the Recovery Plan, necessary prerequisites for downlisting the Puerto Rican Parrot from Endangered to Threatened include, among others, the following conditions:

1) A second wild population in the northwestern karst region exists with a population size (yet to be determined) that exhibits vital parameters consistent with a trajectory towards population maintenance;

2) The reintroduction or creation of at least a third wild population has been achieved in a suitable forested area in the island reflecting lessons and demographic expectations stemming from work with wild populations and release programs in the Rio Abajo Commonwealth Forest and YNF.

A second population has now been established in the Rio Abajo Commonwealth Forest (RAF) (USFWS, PRDNER, unpubl. data), and results to date indicate that reintroduced parrots have indeed established a resident and successfully reproducing wild population in the Rio Abajo forest. Accordingly, a critical and logical next step is to select an appropriate site for a third wild population. Because of the complex logistics and lengthy pre-release preparations for a reintroduction (White et al. 2003), it is imperative that a site be selected well in advance of the target date for the actual reintroduction. In this document, we describe the methods employed, results obtained, and subsequent recommendations derived from the evaluation of several potential reintroduction sites throughout the island of Puerto Rico.

METHODS

First, an evaluation team comprised of at least 2-3 personnel from each of the 3 cooperating agencies (*i.e.*, USFWS, USFS, PRDNER) was assembled. Members of the team were selected based on their direct knowledge and experience regarding conservation of the Puerto Rican Parrot and/or its habitat. On occasion, additional team members were incorporated as needed. The total participating team members and their associated agencies were:

Thomas White – USFWS

Wilfredo Abreu – USFWS

Pablo Torres – USFWS

Miguel Toledo – USFWS

Omar Monsegur – PRDNER/USFWS

Jesús Rios – PRDNER/USFWS

Anastasio Gomez – USFS

Benjamín Fuentes – USFS

Ivan Llerandi – PRDNER

Jose Sustache – PRDNER

Eddie Velez – PRDNER

Next, a total of 6 distinct forested areas located throughout Puerto Rico were selected for preliminary “rapid assessment” evaluation. Areas were selected based on their geographic location, extent of existing forest cover, and existing legal protection status and/or willingness of landowners to provide long-term access and continued cooperation with recovery efforts. The areas selected were the following (Fig. 1):

1) Casas de La Selva (Carite Commonwealth Forest area; privately owned)
2) Guanica Commonwealth Forest and Biosphere Reserve (PRDNER)
3) Maricao Commonwealth Forest (PRDNER)
4) Guajataca Commonwealth Forest (PRDNER)
5) El Tallonal Forest Reserve (Karst region; privately owned)
6) Rio Encantado Forest Reserve Complex (Karst region; privately owned)

The objective of the rapid assessment evaluation was to assess the suitability of each area for supporting a wild population of Puerto Rican Parrots, and to rank each area in order to select the 2 most suitable areas for further, more detailed evaluations. From March 2008 – February 2009, the evaluation team made a 3-day visit to each of the 6 sites to obtain data on arboreal species composition and abundance relative to potential parrot food sources, presence of cavities or potential cavities for nesting, avian predators and abundances, site accessibility, and existence of infrastructures or other support facilities for a reintroduction effort. Long-term climatological data for each area were also obtained from publicly accessible sources (*i.e.*, NOAA Southern Regional Climate Center, Baton Rouge, LA www.sercc.com).

Upon arriving each area, the team first met with the area manager(s) to obtain general information on property boundaries, trails, status of relations with adjacent property owners, security issues, and any other helpful information or advice. Line transect sampling was used to collect vegetation data, and point counts were used to detect presence of avian predators. Depending on overall size of the particular area, 3-8 transects measuring 2 meters wide and 300 meters long were conducted. Transects were located only in natural forest areas (as opposed to exotic plantations), and were also located as to sample as much of the inherent variation in natural forest structure observed within the area. We used a combination of topographic maps, aerial photo imagery (*i.e.*, GoogleEarth®), and advice from area managers to select transect sites. Within each transect, the species and diameter of all individual trees having a DBH (diameter-at-breast height) greater than 10 cm were recorded. Any natural tree cavity observed, either within or outside of transects, was also noted. Depending on local weather conditions, avian predator point counts were conducted either during the mornings (*i.e.*, 8-11 AM) or afternoons (*i.e.*, 3-6 PM), with the stipulation that each area was sampled at least once during each time period.

After visiting all sites and collecting necessary information, the team then met to conduct a comparative evaluation of each site relative to the others. To do this, a SWOT (<u>S</u>trengths, <u>W</u>eaknesses, <u>O</u>pportunities, <u>T</u>hreats) analysis based on the methodology of Trujillo (2005) was used. The SWOT analysis is an empirical method for assessing current strengths and weaknesses of the environmental units of interest (*e.g.*, reintroduction sites) and allows predictions of future opportunities and threats. Directly quoting Trujillo (2005): “This method pursues internal and external analyses of an environmental unit (*e.g*., release site), examining its resources and management strategies (Martínez and Casas 2002). Internal analyses consist of evaluating strength and weakness indicators, while external analyses consist of evaluating opportunities and threats. In this context, the strengths are the inherent attributes or suitability of a habitat that justify its use as potential area for reintroduction. The weaknesses are the risks of losing these inherent attributes by natural causes such as predation by native species or natural catastrophes. Thus, weaknesses give us an indication of the vulnerability of the habitat. Threats are a measurement of the decline in inherent qualities by inadequate management or adverse surrounding conditions, while the opportunities include the sustainable use or management of the area according to its strengths, weaknesses and threats”. This analytical method has the advantages of simplicity, precision, broad applicability, and effective use of empirical data in conjunction with expert opinion.

For the initial round of comparative evaluations, an abbreviated and simplified form of Trujillo’s (2005) SWOT analysis was performed. For each area, a score ranging from 1-4 (*e.g*., 1 = poor; 4 = excellent) was assigned to each of 26 separate environmental descriptors (Trujillo 2005). The total score assigned to each area was the sum of the individual descriptor scores. Thus, the maximum possible score for any area was 104. The areas were then ranked by total score, and the 2 highest scoring areas were then chosen for further evaluation.

Once the 2 primary candidate areas were determined, the evaluation team made a second site visit of 5 days duration to each area. During these visits, additional line transects were conducted at sites not previously sampled during the initial visit. For each area, the vegetation data from both transect samplings (*i.e*., first and second visits) were then combined to increase total sample size for this component, thereby providing a more representative sample of the area's vegetation. Additional avian predator counts were also conducted in order to compare with previous counts. Because of time limitations and logistical constraints, we also used previously compiled data (*e.g*., Trujillo 2005) in conjunction with consultations with local experts on avian ecology (*i.e*., Dr. Carlos Delannoy – UPR-RUM; Dr. Wayne Arendt – USFS-IITF) to aid in assessing potential differences between the 2 areas regarding Pearly-eyed Thrasher (*Margarops fuscatus*) numbers. During the second site visits, the team was also particularly observant regarding qualitative aspects such as access and security issues, and existing or potential support infrastructures.

Following the second site visits, the evaluation team again met to conduct a detailed and complete SWOT analysis of each area following procedures of Trujillo (2005). In fact, for this meeting Ana Trujillo also attended and assisted the team by providing input and helpful advice on the complete SWOT analytical procedure.

According to Trujillo (2005), in a complete SWOT analysis each descriptor is affected by four different coefficients: 1) importance, 2) temporal, 3) spatial, and, 4) occurrence probability. Their values range from 0 to 1. The importance coefficient (IC) is defined as the relevance of a descriptor to quantify the quality of an area for parrots. To calculate the IC, the descriptors are ranked according to their weight or relevance to the reintroduction process, using an arbitrary scale of 100 to 1000 (Trujillo 2005). These weights were based on empirical data and expert opinion. We reviewed the IC relative weight values previously assigned to 35 environmental descriptors by Trujillo (2005) to see if these values were in concordance with current knowledge and experience. We concluded that the vast majority of the IC weights were still appropriate, and made only a few slight changes and descriptor additions to update the list of Trujillo (2005). This resulted in a list of 39 individual descriptors (Table 1), which also facilitated comparison of our results with those of Trujillo (2005). Note that a few descriptors (*i.e*., 2.2, 2.3, and 2.6) do not, by their very nature, apply specifically to Puerto Rico. However, they were included in order to validate direct comparisons with results of Trujillo (2005). To calculate the IC of each descriptor, we used the following equation:

$$IC_d = \frac{W_d x IC_{ind}}{TS_{ind}}$$

Where W_d is the descriptor weight value, IC_{ind} is the IC of its respective indicator, and TS_{ind} is the sum of all the descriptor weight values for the indicator. We then summed all 39 individual ICs in order to verify that the total equaled 1, thereby providing a validation of the previous calculations. In order to obtain the IC for each indicator, we summed the sub-total weight of the descriptors for each indicator and divided it by the total of all descriptor weights (*i.e*., strength 5,800/20,300; weakness 3,700/20,300; threats 5,100/20,300 and opportunity

5,700/20,300). This recalculation was necessary because we added additional descriptors to the list of Trujillo (2005).

The spatial coefficient (SC) measures the effect of a given descriptor on the surface area of a given environmental unit. If the descriptor equally affects all environmental units surface, then its value will be 1. However, if the descriptor differentially affects the area, the SC is broken down according to percentage of the forest areas affected, taking the total area as 1. Also, if a given descriptor value varied over time (*i.e*., during the year) then it is affected by a temporal coefficient (TC). In order to calculate the TC, it is necessary that the descriptor be allocated according to the actual time in which the descriptor has an effect (*e.g.,* the hurricane risk descriptor is only relevant 6 months of the year). Accordingly, the sum of all such subdivided TCs is 1. Finally, the occurrence probability coefficient (OPC) of a given descriptor indicates the likelihood of this factor or event being present or occurring. When the OPC is 1, this means the observation or event was present with absolute certainty. In contrast, if the event did not nor does not occur, the value is zero. Any descriptor which did not need to be broken down maintained a coefficient of 1.

To estimate the habitat suitability of each area, we then calculated various quality indices: 1) Optimal quality index (OQ): the sum of the inherent quality values of all descriptors; 2) Actual quality index (AQ): the sum of actual quality values of all descriptors; and 3) Quality deviation index (QD): the sum of all quality deviations. A quality deviation is simply the difference between a given descriptor's optimal quality and its actual quality. According to Trujillo (2005), the overall optimal and actual qualities for each area were calculated based on the following equation:

$$Q = \sum_{i=1}^{m} \sum_{j=1}^{n} \left[k_i e_j t_i p_j N_{ij} \right] H$$

Where:

Q = descriptor quality, on a scale of 0 to 10.

K_j = importance coefficient assigned to each descriptor.

E_j= spatial coefficient assigned to each descriptor.

T_j = temporal coefficient assigned to each descriptor.

P_j = occurrence probability coefficient assigned to each descriptor.

Nij = descriptor being evaluated, on a scale of 0 to 10

M = number of descriptors being considered.

N = number of environmental sub-units.

H = spatial coefficient of the environmental unit (its value is 1).

Once we had identified the specific descriptors associated with QDs for each area, we reviewed each descriptor for which one of the areas exhibited a deficiency with respect to the other to determine if any practical management strategies existed that could feasibly eliminate or mitigate for observed deficiencies. That is, we looked at each descriptor for which one area was considered inferior to the other, and then determined if the deficiency could be remedied by management. To detect these particular QDs, we examined the differences in Actual Quality between each area for all descriptors, as this provided a measure of relative differences in quality between areas. For those descriptors for which both areas exhibited the same QD, we assumed equal gains to be accrued to each area by any proposed management actions. However, there were some descriptors (*e.g.*, climate) that could not be mitigated. To quantify the effect of each proposed management strategy on the actual habitat quality of each area, we calculated the quality units which could potentially be recovered from the overall QD if the management activity was conducted. For this analysis, we assumed that completion or implementation of a given management strategy would eliminate the QD, thereby restoring the descriptor to its optimum quality (OQ) value for a particular area. We also calculated the relative effect of each feasible management activity as a percentage of the total QD for each area that was attributable to the specific QD descriptors. This indicated specific management actions which may have the greatest positive effect on habitat quality. We then summed all QD descriptors that could be mitigated by each proposed management, and calculated the net potential gain in AQ for each area.

RESULTS

Based on the rapid assessment evaluations and initial SWOT analysis, the Maricao and Guajataca Commonwealth Forests emerged as the first and second highest ranking habitats, respectively (Fig. 2). Accordingly, these forests were then designated for additional, more detailed evaluation. Of the remaining 4 forests that were not selected, each had various deficiencies which resulted in their being discounted as reintroduction sites at this time (Table 2).

The secondary site visits and evaluations of Maricao and Guajataca took place during October 2009 and February 2010, respectively. Results of the first and second site visits were combined for purposes of the final SWOT analysis conducted in March 2010, and details of the site visits are attached in Appendix 1. Results of the SWOT analysis for Maricao and Guajataca are presented in Tables 3 and 4. The Optimal Quality index for both areas was 9.44, with Maricao and Guajataca achieving an Actual Quality index of 7.41 and 7.09, respectively (Tables 3-5; Fig. 3). These indices were likewise associated with Quality Deviations (QD) of 2.03 and 2.36 for Maricao and Guajataca, respectively. Of the 24 individual area descriptors associated with differential QDs, 13 (7 for Maricao; 6 for Guajataca) were determined to be subject to amelioration or mitigation via management actions, thereby potentially increasing the Actual Quality index of each area by 0.656 and 0.711 for Guajataca and Maricao, respectively (Tables 6,7). Of the total manageable differential QDs of each area, this would represent the annulment of 27.9% and 35% of observed deficiencies for Guajataca and Maricao, respectively (Fig. 4). In other words, if all potentially manageable QDs were successfully mitigated, the Actual Quality index for Guajataca would be 7.74, and for Maricao would be 8.12, for an overall gain in habitat quality of 9.3% and 9.6%, respectively (Tables 6, 7; Figs. 4, 5).

Regarding the specific deficiencies of each area, some descriptors were more significant than others in terms of overall impact on habitat quality (Figs. 6-11). For example, at Guajataca the heavy use of the forest by the public, combined with the ease and numerous points by which the forest can be entered accounted for nearly 23% of the total QDs deemed potentially manageable (Table 6). Also, high numbers of exotic mammals (*e.g.*, dogs, cats, rats, mongooses) closely associated with human activities and settlements, accounted for another 20.1% of QD. Together these 2 factors – if successfully controlled or mitigated – would potentially annul 43% of the manageable deficiencies of the Guajataca Forest (Fig. 12). Accomplishing this however, would require *successfully* limiting public access to a substantial portion of the forest, particularly those areas near any potential parrot release site and/or nesting areas. We emphasize “successfully”, because during our evaluations we observed not only evidence of clandestine uncontrolled human entry into the Guajataca Forest, but also direct evidence of illegal hunting in the form of numerous spent shotgun shells at sites well within the forest boundary (Figs. 13, 14).

For the Maricao Forest, we determined that 43.3% of the manageable QD could be annulled by the construction of an adequate trail system for post-release monitoring of parrot activities (Table 7; Fig. 15), particularly in the Rio Maricao watershed between PR-120 and the Maricao Fish Hatchery. Within this area lies what is ostensibly some of the best habitat for parrots (Fig. 16), but difficulties in traversing the area make biological monitoring activities extremely challenging. A well-designed trail system and observation platform network, accessible from within the secure confines of the Fish Hatchery, would alleviate much of this difficulty. An additional 24.6 % of manageable QD could be annulled by implementation of parrot nest management techniques to control potential honeybee and warble fly infestations (Table 7), similar to that currently done successfully in El Yunque.

Both areas exhibited particular strengths and advantages relative to certain descriptors. For Guajataca, major advantages include relatively low numbers of avian predators, slightly drier overall climate, and an extensive and well-maintained trail system (Fig. 17). In fact, the Guajataca Forest has more trails (44 kms) than the El Yunque National Forest (38 kms). However, this extensive trail system, ease of access, and presence of public camping areas also make the Guajataca Forest one of the most heavily used by the public in Puerto Rico. These human pressures are likely to increase, given the increasing development surrounding the Guajataca Forest, including a new extension of the PR-22 expressway just north of the Forest (Fig. 18).

Although some natural tree cavities were found in both areas, Guajataca, due to its karst geology (Fig. 19), has perhaps a slight advantage over Maricao in terms of "natural cavities", as some potential nesting sites may exist as holes in rock outcroppings. However, as in Rio Abajo, reintroduced parrots in either Guajataca or Maricao will also require supplemental artificial nest cavities during the initial phase of population establishment. To date however, no reintroduced parrots at Rio Abajo have yet been documented using holes in rock outcroppings for nesting. Further, although Guajataca has a generally drier climate than Maricao, the temporal distribution of rainfall differs between the 2 areas. For example, during the peak of wild parrot fledging season (*i.e.*, May 10 – June 20), Guajataca exhibits a peak in daily precipitation, whereas during the same time period Maricao experiences a decline in daily precipitation (Fig. 20). Based on 10 years of data on wild parrot fledgling survival in El Yunque, parrot chicks which experience heavy rainfall (*i.e.*, > 0.5 in/day) within the first 3 days of fledging have a 3.5x greater probability of mortality (USFWS, unpubl. data). Accordingly, young parrot fledglings may potentially be exposed to more high rainfall events and attendant mortality at Guajataca than at Maricao. Of course, this assumes the same temporal patterns in fledging between El Yunque and reintroduced populations elsewhere. Thus far, preliminary evidence suggests that recently reintroduced parrots at Rio Abajo are nesting slightly later than those in El Yunque (PRDNER, unpubl. data).

Major advantages of the Maricao Forest include its large size, which at 4,483 ha is approximately 4.5x the size of Guajataca (971 ha). Within the Municipality of Maricao there are also an additional 268 ha of privately-owned forested lands under the PRDNER Program of Auxiliary Forests (Gobierno Municipal de Maricao 2008), as well as substantial areas of abandoned coffee plantations which have reverted back to secondary forests, providing landscape connectivity between the Maricao Forest and other major forested areas, such as the Susua Forest, the Guilarte Forest, the Central Cordillera, and potentially even the northern Karst region (Fig. 1). Another significant advantage of Maricao is the existing support infrastructure and security for a potential reintroduction site afforded by the Maricao Fish Hatchery (Figs. 21, 22). Considering that the reintroduction effort will necessitate maintaining a population of captive parrots on-site for a minimum of 5 years, this advantage may substantially reduce overall costs and help to minimize potential theft problems. Given the high value of Puerto Rican Parrots on the illicit market, and the unavoidable high profile and publicity of any future reintroduction efforts, site security must be taken as a serious concern.

Other major advantages of the Maricao area include lower human population density and associated activities, lower levels of current and proposed development projects (Gobierno Municipal de Maricao 2008), high biodiversity, broad variation in habitat types, and the highest potential food availability for parrots of any of the areas evaluated (Appendix 1). Because of its geographical location, the Maricao Forest also lies in an area subject to different hurricane trajectories and risks than Guajataca, which shares such trajectories with the Rio Abajo Forest, home to one of the 2 existing wild parrot populations. This is important because any hurricane that directly impacts Rio Abajo would most likely directly impact Guajataca (Fig. 23). While we recognize that any major hurricane that passes across western Puerto Rico will cause widespread damage, those areas along the eye wall trajectory would be most impacted (Boose *et al*. 2004). Thus, parrot populations in Rio Abajo and Guajataca would both be subject to direct impacts from the same hurricane (see White *et al*. 2005). Finally, the presence of the nearby Monte del Estado Recreational Center presents a potential base of operations for staff working on the reintroduction effort. The Center, operated by the Puerto Rico National Parks Company (PRNPC), has numerous cabins (Fig. 24) with full amenities (*e.g*., electricity, water, kitchen, etc.) which can comfortably house 4-5 personnel for extended periods. It may be possible to establish a MOU or similar arrangement with the

PRNPC to provide a specific cabin for exclusive use by the reintroduction team at no cost, or for at least a nominal fee.

RECOMMENDATIONS

Based on our assessments, it appears that although both the Guajataca and Maricao State Forests may be considered as “good” habitat for the Puerto Rican Parrot, Maricao has certain unique advantages that make it the most appropriate site for initiating a third wild population of parrots. The geographic location, size, topography, habitat diversity, landscape connectivity, high biodiversity, lower human pressures, security, and existing support facilities all combine to result in an area with significant potential for successfully supporting a wild population of Puerto Rican Parrots. Because of the existing support facilities at Maricao and direct access to the actual release site, logistics and costs associated with construction and maintenance of the necessary large on-site training and release cage complex (Fig. 25) should also be less at Maricao than at Guajataca.

However, this is not to say that Maricao is a perfect site. For example, in order to successfully establish and manage a parrot population at Maricao, significant improvements must be made in the existing trail system to facilitate biological monitoring by field staff. Because the most logical and appropriate site for a training and release cage complex is within the area immediately surrounding the Maricao Fish Hatchery, the initial priority for trail additions and improvements should be within the Rio Maricao watershed. In fact, during our site visits to Maricao, we discovered the remains of an old, abandoned trail leading from the Fish Hatchery up the Rio Maricao watershed to PR-120. This trail system could most likely be re-opened and extended with less effort and less potential environmental impact than the construction of a completely new trail system. By terminating such trail improvements some distance (*e.g*., 200-300m) below the trail terminus at PR-120, the upper trailhead would remain unimproved and thus, less noticeable to passersby. Over time, it should be possible for the USFS to bring experienced trail construction teams from some of the National Forests in the mainland US to focus specifically on this essential task. We believe this would not only result in a safe and adequate trail system, but also allow local Recovery Program personnel (*e.g*., PRDNER, USFWS, USFS) to focus on the biological preparations for the reintroduction.

Further, neither the Maricao nor Guajataca Commonwealth Forests have up-to-date management plans that take into account Threatened and Endangered species conservation requirements relative to ongoing or planned management activities (Marelisa Rivera, USFWS, *in litt*. 14 May 2010). Joint interagency efforts to incorporate specific management needs relative to the Puerto Rican Parrot into future strategic management of the Maricao Forest must be part of the overall reintroduction plan. This should be accomplished using a species-specific threat analysis relative to the 5 listing factors included in Section 4 of the Endangered Species Act (ESA).

Finally, the current Recovery Plan (USFWS 2009) states that among the prerequisites for eventual delisting of the species are: 1) At least three interacting populations exist in the wild and population growth is sustained for 10 years after downlisting has occurred, and 2) Long term protection of the habitat occupied by each wild population is achieved. With respect to requirement number 1, given the extreme geographic isolation and current extent and rate of urbanization surrounding El Yunque (Lugo et al. 2004), it is biologically unrealistic to assume any meaningful future “interaction” between the El Yunque population and either the current second population in Rio Abajo or any third population to be established in western Puerto Rico. In essence, what this means in terms of stated species recovery goals is that a *minimum* of 4 wild populations (including El Yunque) must exist. Given that the second of these populations has already been established in the Rio Abajo Forest, it follows that the next 2 populations must be established in such a manner as to: 1) maximize probability of successful population establishment, growth and expansion, and 2) maximize probability of interactions between populations. This finding, taken together with requirement number 2 above, indicates that both such populations (*i.e*., third, fourth) should be established within the currently protected forest lands of western Puerto Rico. Figure 26 provides a hypothetical scenario of how and where such populations could potentially exist and interact.

In further consideration of requirement number 2 above, the currently projected land use changes and human population growth in the Maricao area suggest a slower rate of change than that in the area of Guajataca (Trujillo 2005, Gobierno Municipal de Maricao 2008)(Figs. 27, 28). In particular, the planned extension of the PR-22 Expressway, which will pass within approximately 4 km of the Guajataca Forest (Fig. 18), will most likely contribute to increases in local urbanization and related disturbances in areas adjacent to said transportation corridor. Moreover, recent efforts by the Government of Puerto Rico to modify certain protections previously afforded to the Karst region in favor of increased development pose an ominous threat to future landscape integrity in that region.

There is now a substantial body of scientific evidence indicating that climatic changes, both globally and regionally, are occurring (*e.g*., McCarty 2001, Marini *et al*. 2009). In Puerto Rico, the general trend is apparently towards a warmer and drier climate (Van der Molen 2002). Although the long-term effects of these changes on the Puerto Rican Parrot are impossible to predict, logic and prudence dictate that the establishment of multiple populations amongst ecologically distinct areas may prevent such changes from uniformly impacting the species as a whole (Wilson *et al*. 2005, Lawler *et al*. 2009). Thus, establishing a Parrot population in the Maricao Forest, an area with distinctly different ecological characteristics than either El Yunque or Rio Abajo, may further serve to achieve this goal and thereby increase long-term viability of the species (McCarty 2001, Carroll *et al*. 2009).

In any reintroduction, natural interactions occur between resident and reintroduced species. In this case, there are several Federally-listed species occurring within, and in areas surrounding, the Maricao Commonwealth Forest. These include the Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*), Puerto Rican Broad-winged Hawk (*Buteo platypterus brunnescens*), Puerto Rican Nightjar (*Caprimulgus noctitherus*), Puerto Rican Boa (*Epicrates inornatus*), and the plant species *Cordia bellonis*, *Cranichis ricartii*, *Crescentia* *portoricensis*, *Gesneria pauciflora*, *Ottoschulzia rhodoxylon*, and *Zanthoxylum thomasianum.* In addition, the endemic Elfin Woods Warbler (*Dendroica angelae*) is currently being evaluated as a candidate for protection under the ESA (Marelisa Rivera, USFWS, *in litt*. 14 May 2010). Potential interactions – both direct and indirect – between the Puerto Rican Parrot and the aforementioned species must be considered as part of any reintroduction plan in Maricao. Direct interactions are those between individuals of the given species, while indirect interactions are those effects that may accrue from species-specific management actions. We will now address each of these in turn.

Although the Maricao Commonwealth Forest is currently the main breeding site for the Puerto Rican Sharp-shinned Hawk (USFWS 1997), management actions for the Puerto Rican Parrot are unlikely to adversely impact this species. Because both species have very similar habitat affinities (Snyder et al. 1987, USFWS 1997) any habitat management activities which benefit one species are likely to also benefit the other. Behaviorally, because both species are sensitive to disturbance at nesting sites and also nest at approximately the same times, any nest management activities for Parrots would necessarily be conducted in a manner which also minimizes disturbance to any nearby nesting Sharp-shins. Further, potential predation by Sharp-shins on Parrots would be highly unlikely, based on numerous documented observations in El Yunque. In contrast to Broad-winged Hawks, which can take prey the size of Parrots (and have actually done so in Rio Abajo), Sharp-shins target much smaller prey, with most (99%) being birds of less than 30 grams (Snyder et al. 1987). In fact, Sharp-shins themselves weigh at most only slightly more than half that of Parrots. Snyder et al. (1987; p187), in describing their direct observations of interactions between these 2 species stated: “The parrots do not appear to respond to sharp-shins as threats of any major significance”.

In contrast, Broad-winged Hawks can pose a threat to parrots, based on observations in Rio Abajo (PRDNER, unpubl. data). However, nesting by Broad-wings in Maricao has not been documented (USFWS 1997), thus any sightings of this species in Maricao may be of scattered random individuals foraging in or near the forest. In the event that individual Broad-wings become a *bona fide* threat to Parrots, non-lethal measures such as trapping and relocating may be the most feasible management response.

Reintroducing the Parrot in Maricao would likely have little, if any, measurable effects on the ecology of the Puerto Rican Nightjar. In fact, there is currently no documentation of Nightjar presence within the specific area suggested (*i.e.*, Rio Maricao watershed) for the actual Parrot releases and artificial nest cavity installations (Vilella and Gonzalez 2009; Figs. 1-3). However, even if present, the marked differences in preferred habitat and nesting and foraging ecology between Nightjars and Parrots (Snyder *et al*. 1987, Vilella 2008, Vilella and Gonzalez 2009) preclude any competitive interactions. This is because the Nightjar is a ground-nesting, nocturnal/crepuscular insectivore, while the Parrot is a secondary cavity-nesting, diurnal frugivore. Nevertheless, prior surveys to detect any nesting Nightjars should be conducted in areas targeted for specific Parrot management activities to avoid any potential adverse impact on Nightjars.

We do not anticipate negative impacts to the Elfin Woods Warbler from a reintroduced Parrot population in the Maricao Forest. Because both of these endemic species are also sympatric and naturally-occurring in El Yunque (Snyder *et al*. 1987), they represent an example of ecologically co-evolved species in montane forest habitats of Puerto Rico.

Although the Puerto Rican Boa is reported as occurring within the Maricao Commonwealth Forest, its spatial distribution and habitat-specific abundances within the Forest are unknown. However, given the known habitat preference of the Boa for elevations below approximately 400 meters (USFWS 1986, Wunderle *et al*. 2004), this species is likely most common at the lower elevations along the southern flanks of the Maricao Forest. Indeed, within the wild Parrot nesting area in El Yunque (approx. 600-700 m) there have been no documented sightings of Boas, nor any incidents of Parrot nest predations by Boas. The proposed reintroduction site in Maricao is at an elevation of approximately 450 m, with most of the immediately surrounding forest area ranging from 450-600 m. Nevertheless, surveys to determine the status of the Puerto Rican Boa within the immediate environs of the proposed release site should be conducted by qualified personnel prior to the reintroduction.

Regarding impacts to listed plant species, the activities to most likely have potential impacts would be those directly associated with the construction of the training and release cage complex, and the proposed trail improvements in the

Rio Maricao watershed. In such cases, a thorough botanical inventory in the target areas should be conducted by qualified personnel prior to actual management activities to identify any listed species subject to potential adverse impacts. Some of the listed plant species however, (*e.g.*, *Ottoshulzia rhodoxylon*, *Zanthoxylum thomasianum*) are more typically found in the drier lower montane semi-evergreen forests than in the upper Rio Maricao watershed (USFWS 1988, 1994), where most of the proposed infrastructural improvements would occur. However, the location of proposed structures or trails can be adjusted to avoid impacts to protected plants to the maximum extent possible. For unavoidable impacts and wherever possible individual plants could be removed and replanted in nearby suitable sites to prevent loss, similar to that which was done in preparation for construction of the new Luquillo (Iguaca) Aviary in El Yunque. As stated previously, improvements to an existing, albeit abandoned, trail system in the Rio Maricao watershed could minimize some potential impacts and attendant mitigation measures.

In summary, we believe that given recommended improvements and management actions, and the implementation of similar pre- and post-release strategies and nest management techniques currently used in Rio Abajo and El Yunque, the Maricao Commonwealth Forest should be the reintroduction site for a third wild population of Puerto Rican Parrots, with the Guajataca Forest being subject to re-evaluation in the future as a potential site for yet a fourth wild population.

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APPENDIX 1

RESULTS OF SITE EVALUATIONS FOR GUAJATACA AND MARICAO