

**ASSESSING THE STATUS, ECOLOGY AND DISTRIBUTION OF THE
ELFIN WOODS WARBLER (*Dendroica angelae*) TO INFLUENCE ITS
LONG TERM CONSERVATION**



FINAL REPORT - July 2004

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PROJECT SUMMARY

The endemic Elfin Woods Warbler (EWWA) (*Dendroica angelae*) is found in upland forests and is considered a threatened species. It was discovered in the Luquillo Forest in 1971 and later in Maricao, Carite and Toro Negro Forests. The objectives of this study were to determine the current geographic distribution, habitat occupancy and density of the EWWA. We surveyed EWWA populations from March through May and August through November 2003 in Maricao, Guilarte, Bosque del Pueblo, and Toro Negro Forests. EWWA populations were surveyed in Luquillo and Carite Forests for nine weeks during June and July 2003. Survey routes 0.8 to 3 km in length, with point-count stations spaced 200m apart, were established to sample all habitats 250 to 1030 m in elevation. Counts were limited to 10 minutes per point-count station.

Our results indicated that EWWA distribution was limited to populations in Maricao and Luquillo Forests. EWWA in Maricao were located in the following forest types: Exposed Woodland, Dry Slope and *Podocarpus* Forests at elevations that ranged from 280-790 m. EWWA densities were higher in *Podocarpus*, lower in Exposed Woodland, and lowest in Dry Slope Forest. EWWA in Luquillo Forest were located in Dwarf, Palo Colorado, and Tabonuco Forests, at elevations that ranged from 270 to 910 m. EWWA densities were higher in Palo Colorado, slightly lower in Dwarf Forest and lowest in Tabonuco Forest. EWWA abundance increased with elevation in Maricao and Luquillo Forests.

We extrapolated our density estimates to larger and un-sampled areas in the Maricao and Luquillo Forests tentatively and apprehensively due to the patchy distribution of the EWWA, and came up with population estimates of 1142 in Maricao Forest and 688 in Luquillo Forest. These estimates are to be taken very cautiously. In conclusion, this study showed that the EWWA had a limited distribution in Puerto Rico, restricted to a handful

number of habitats and low in numbers. Based on these findings we recommend the immediate protection of this bird species by listing it endangered under the Endangered Species Act and the International Union for Conservation of Nature.

Team members and the Important Bird Areas program have been creating public awareness of the status of the species through a poster, oral presentations, workshops, symposiums, and TV program.

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INTRODUCTION

The endemic Elfin Woods Warbler (EWWA hereafter) (*Dendroica angelae* Kepler and Parkes) is found in various upland forest of Puerto Rico (Oberle 2000). Cameron and Angela Kepler discovered the species in 1971 while conducting research on the Puerto Rican Tody (*Todus mexicanus*) and Puerto Rican Parrot (*Amazona vittata*) in the Luquillo Forest (Kepler and Parkes 1972). Kepler and Parkes (op. cit.) traced the EWWAs preferred habitat to Elfin Forest (at elevations of 640-1030 m) and occasionally in Colorado Forest (at elevations of 370-600 m).

In 1972 a second population was discovered in the Maricao Forest of western Puerto Rico at elevations of 800 m (Gochfeld 1973). Two additional populations were discovered in Carite and Toro Negro forests (Pérez-Rivera 1979). Studies of distribution and habitat use (Cruz and Delannoy 1984a), feeding ecology (Cruz and Delannoy 1984b), and breeding biology (Arroyo-Vázquez 1992) in Maricao Forest complete the published record of this species. Nesting of EWWA occurs in April and May (Arroyo-Vázquez op.cit).

The EWWA is a threatened species, listed as an endangered species candidate by the US FWS and is considered vulnerable by the PR DNER due to its small range and estimated population size of only 300 pairs (Kepler and Parkes 1972). Although some montane forests are protected public lands, they are threatened by lack of comprehensive forest management plans and conflicting management objectives that arise from an increasing human population (Delannoy 1997). Road construction and the installation of power-lines and communication infrastructure (e.g., microwave, TV, and radio antennas) in the past 20 years have resulted in substantial habitat destruction, fragmentation, and alteration of the endemic and endangered Puerto Rican Broad-winged Hawk (*Buteo platypterus brunnescens*) and Sharp-shinned Hawk

(*Accipiter striatus venator*) (Delannoy 1997). The EWWA shares most of its range and habitat with Sharp-shins and Broad-wings, thus it is possible that it may have suffered from habitat loss as well.

Natural disasters, such as hurricanes, pose a threat to EWWA habitat and can affect its population size and distribution (Dr. Wayne Arendt, US FWS, pers. obs.). A direct hit of Hurricane Hugo to the Caribbean National Forest in 1989 resulted in 40 % decline of the wild flock of the endemic and endangered Puerto Rican Parrot, *Amazona vittata* (Wilson et al. 1994). Surveys to determine the EWWA current geographical distribution, especially away from its known range, and its population size are conservation priorities (BirdLife International 2000).

The EWWA seems to be tied to forest types in the wettest portions of its range. Wiley and Bauer (1985) reported EWWAs from Dwarf, Palo Colorado and Sierra Palm forests within the Luquillo Forest. Cruz and Delannoy (1984a) reported EWWAs most abundant in the *Podocarpus* Forest type of Maricao Forest. However, the presence of the EWWA has not been determined in potential habitats away from its known range nor in secondary forests and coffee plantations in the highlands of the central mountain range.

AIMS AND OBJECTIVES

Aims:

To assess the current geographical distribution, density and habitat occupancy of the EWWA in Puerto Rico in order to formulate management guidelines and recommendations for its long-term conservation.

Objectives:

- To establish and delineate the EWWA geographical distribution.
- To determine the EWWA population size.
- To assess the habitat occupancy by the EWWA.
- To make recommendations to the Puerto Rico Department of Natural and Environmental Resources (PR DNER) and U.S. Fish and Wildlife Service (US FWS) for the possible classification of the EWWA as an endangered or threatened species.
- To share research information and collaborate with the Puerto Rican Ornithological Society (PROS) to designate EWWA habitat as Important Bird Areas (IBAs).

STUDY AREAS

Surveys were conducted in the upland forests of Luquillo, Carite, Maricao, Toro Negro, Bosque del Pueblo and Guilarte (Figure 1).

Luquillo Forest - The Luquillo Forest (11 330 ha), is located in the Sierra de Luquillo in eastern Puerto Rico. Elevations range from 100 to 1075 m. Temperature changes with altitude with 77 °F in the lowlands and 66.2 °F above 1000 m (Weaver 1972; Delannoy 1997). The mean annual rainfall range from approximately 245 cm/yr at lower elevations to approximately 400 cm/yr at higher elevations (Brown et al. 1983). Wadsworth (1951) distinguished four types of forests from low to high elevations in Sierra de Luquillo: Tabonuco (*Dacryodes excelsa*), Palo Colorado (*Cyrilla racemiflora*), Sierra Palm (*Prestoea montana*) and Dwarf forests. Ninety-seven point-count stations were established 200 m apart

along 19 kms of trails to determine density and survey EWWA distribution within the Luquillo Forest. Surveys were conducted in 3 km of trail in East Peak (Dwarf Forest; elevations of 680-900 m), in 3km of trail in Icacos Valley (Palo Colorado; elevations of 590-620 m), in 3km of trail in Tradewinds Trail (Palo Colorado and Dwarf forests; elevations of 680-750 m), in 3km of trail in El Toro Trail (Palo Colorado and Dwarf forests; elevations of 560-920 m), in 3km of trail in Mount Britton (Sierra Palm; elevations of 680-890 m), in 2 km of trail in Baño de Oro (Sierra Palm; elevations of 580-770 m) and in 2km of trail in Rio Cristal (Tabonuco; elevations of 200-300 m).

Carite Forest- Carite Forest comprises an area of 2777 ha in the Sierra de Cayey of southeastern Puerto Rico. It has elevations ranging from 250-900 m with an annual precipitation of 235 cm and a mean annual temperature of 71.6 °F (Delannoy 1997). The Department of Natural Resources (1976) described six forest types: Slope Forest, Tabonuco, Ausubo (*Manilkara bidentata*), Sierra Palm, *Micropholis* and *Buchenavia* and Dwarf forests. *Eucalyptus robustus* and *Pinus caribaea* replaced some of the forest's native vegetation (Perez- Rivera and Nadal 1996). Twenty-nine point-count stations were established 200 m apart along 5 km of trails to determine density and survey EWWA distribution within the Carite Forest. Surveys were conducted in 1km of trail in Charco Azul 1 (Ausubo, *Micropholis* and *Buchenavia*; elevations of 540-560 m), 1.2 km of trail in Charco Azul 2 (Ausubo, *Micropholis* and *Buchenavia*; elevations of 580-620 m), 1.2 km of trail in Cerro La Santa (Dwarf forest and Sierra Palm; elevations of 730-810 m) and 1.6 km of trail in El Seis (Sierra Palm, *Micropholis* and *Buchenavia*; elevations of 700-800 m).

Maricao Forest – The Maricao Forest (4150 ha) lies in the western end of the Cordillera Central. Elevations range from 15 to 900 m, with mean annual temperature of

71.2 °F and precipitation of 235 cm (Cruz and Delannoy 1986; Delannoy 1997). The Department of Natural Resources (1976) described five types of forests: Dry Slope, Slope Forest, Mixed Hardwood, Exposed Woodland and *Podocarpus* Forest. Sixty-four point-count stations were established 200 m apart along 11.6 km of trail to determine density and survey EWWA distribution within the Maricao Forest. Surveys were conducted in 3km of trail in Alto del Descanso (Exposed Woodland and Dry Slope; elevations of 440-680 m), in 3km of trail in Caín Alto (*Podocarpus*, Dry Slope and Exposed Woodland; elevations of 280-700 m), in 1km of trail in Merenderos (*Podocarpus*, Dry Slope and Exposed Woodland; elevations of 560-720 m), in 1km of trail in Viveros (*Podocarpus*; elevations of 610-780 m), in 1km of trail in Campamento Santana (Dry Slope and Mixed Hardwood; elevations of 470-490 m), in 1km of trail in Caballeriza (*Podocarpus*; elevations of 740-790 m) and 1.6 km of trail in Talitas (Exposed Woodland and Dry Slope; elevations of 510-640 m).

Toro Negro Forest - The Toro Negro Forest is located in the central portion of the Cordillera Central and covers an area of 2733.1 ha. Elevations range from 440 to 1338 m in Cerro Punta, the highest peak in the island (Silander et al. 1986). Average annual precipitation varies from 203.1 to 291.9 cm and temperature ranges of 66.9-77 °F (Delannoy 1997). Rainfall usually declines between November and April, but is rarely a prolonged dry period (Birdsey and Jiménez 1985). Four forest types were described by Silander et al (1986): Tabonuco, Dwarf, *Micropholis* and *Buchenavia* and Sierra Palm forests. Thirty point-count stations were established 200 m apart along 5.8 km of trail to determine density and survey EWWA distribution within the Toro Negro Forest. Surveys were conducted in 2 km of trail in El Bolo (Sierra Palm; elevations of 910-1000 m), in 0.8 km of trail in Vega Grande (Sierra Palm; elevations of 843-850 m), in 1 km of trail in Doña Tona (Sierra Palm

and plantations; elevations of 780-840 m) and in 2 km of trail in Maravilla (Sierra Palm, Dwarf, *Micropholis* and *Buchenavia* forests; elevations of 860-1140 m).

Guilarte Forest – Guilarte Forest (1457 ha) lies in the center of the Cordillera Central and west of Toro Negro Forest. Elevations vary from 760 to 1205 m with an annual precipitation of 200.1cm and a mean annual temperature of 70.3 °F (Silander et al. 1986). The Department of Natural Resources (1976) described four forest types: Sierra Palm, *Micropholis* and *Buchenavia*, dwarfed vegetation consisting of evergreen; small leaves species (i.e. *Tabebuia schumanniana*, *Ocotea spathulata* etc.) and plantations (coffee and *Eucalyptus*). Nineteen point-count stations were established 200 m apart along 3.4 km of trails to determine density and survey EWWA distribution within the Guilarte Forest. Surveys were conducted in 1 km of trail in Cerro Guilarte (shaded coffee plantations and Sierra Palm; elevations of 940-1080 m), in 1.2 km of trail in Silla de Calderón (secondary forest; elevations of 720-760 m) and in 1.2 km of trail in Mata de Plátano (shaded coffee plantations; elevations 760-820 m)

Bosque del Pueblo – Bosque del Pueblo Forest (283 ha) is located in Adjuntas in the Cordillera Central. Elevation ranges from 400–700 m with an annual mean temperature of 72 °F and an average precipitation of 31.5-35 cm (DNER unpubl. report). Fifteen point-count stations were established 200 m apart along 3 km of trails to determine density and survey EWWA distribution within Bosque del Pueblo. Surveys were conducted in 1 km in Trail 1 (elevations of 560-590 m), 1km in Trail 2 (elevations of 500-590 m) and 1km in Trail 3 (elevations of 575-650 m). All three trails were in secondary forest.



Figure 1. EWWA surveyed areas in Puerto Rico in 2003. USGS DEM Map of Puerto Rico.

M – Maricao B – Bosque del Pueblo G – Guilarte

T – Toro Negro C – Carite L- Luquillo

METHODS

Surveys were conducted from March through May, and again from August through November 2003, in the forests of the western half of the island; Maricao, Toro Negro, Bosque del Pueblo and Guilarte. Luquillo and Carite Forests were surveyed during a nine week period in June and July 2003.

Fifteen field assistants participated in the island-wide surveys. Since EWWA identification and detection skills among field assistants varied and could affect the precision and accuracy of counts, they were trained before the surveys began. The training consisted of exercises to standardize survey procedures and improve visual and auditory EWWA identification skills. These exercises were conducted in the Maricao Forest. Playbacks of vocalizations and repeated on-site sightings of EWWA were used to help improve the field assistants' identification skills. Pictures were also used to emphasize EWWA characteristics such as plumage, size and behavior. The assistants worked in pairs to maximize safety in the

field. Assistant's rotations in surveyed areas were made to diminish detection bias (Ralph et al. 1993).

Accessibility in the study areas was limited, therefore, survey routes were established along existing forest trails and primitive (dirt) roads. Each surveyed route was 0.8-3 km in length with point count stations 200 m apart to avoid counting the same individual twice. Counts were limited to 10 minutes per point-count station and began 30 min after sunrise and finished approximately at 1100. We used EWWA song playbacks in all point-count stations during five of the ten minutes periods to determine its presence. EWWA responded to an average song playback distance of 72 m. EWWA within this distance always responded to song playback, almost always approaching very close to the observer. We took this distance as the EWWAs maximum detection distance. We assumed that all EWWA within a circular area of 1.6 ha (radius=72m) around each point-count station responded to song playbacks and were detected. Density (No. EWWA/ha) was calculated dividing the number of EWWA counted between the total area surveyed. Playbacks of EWWA vocalizations were not used during surveys conducted from March through May 2003 because we did not want to interfere with the breeding pairs' behavior. However, because the species has a reduced period of singing in June and July (right at the end of the breeding season) (Waide 1995), playbacks were used from then on to improve visual detections.

We spent 131 working-hours (h) (9 surveys) in Maricao Forest, 138 h (7 surveys) in the Luquillo Forest, 55 h (8 surveys) in Toro Negro Forest, 35 h (7 surveys) in Carite Forest, 31 h (8 surveys) in Guilarte Forest, and 19 h (9 surveys) in Bosque del Pueblo. Field data included EWWA age (juvenile or adult) general behavior (singing, foraging, mating, nest

building, feeding juveniles, moving in mixed-species flocks) and name of the observers, date, weather conditions and time of count at each point count station.

Other field data taken at each point-count station employed Global Position System (GPS) readings. These readings were taken with a Garmin etrex Venture GPS instrument to read UTM (Universal Transverse Mercator) grid coordinates. Each reading was transferred to a digital topographic map. A Sun Pocket altimeter was used to annotate elevations. The altimeter was calibrated next to a USGS Bench Mark plaque previous to its use. Habitat types were identified and named following vegetation studies available in the scientific literature.

RESULTS

Our surveys revealed that the EWWA was only found in Maricao and Luquillo Forests. The EWWA distribution in the Luquillo Forest is observed in Figure 2. Most EWWA were detected along the Tradewinds Trail and Icacos Valley, fewer along El Toro Trail and East Peak, one sighting in Río Cristal watershed and none along Mount Britton and Baño de Oro Trails. The EWWA distribution in Maricao Forest is observed in Figure 3. Even though EWWA were present in every sampled area in Maricao Forest, most were detected in Los Viveros, Caballeriza, Merenderos, El Descanso and Cain Alto trails. Fewer EWWA were detected along Campamento Santana and Talitas trails.

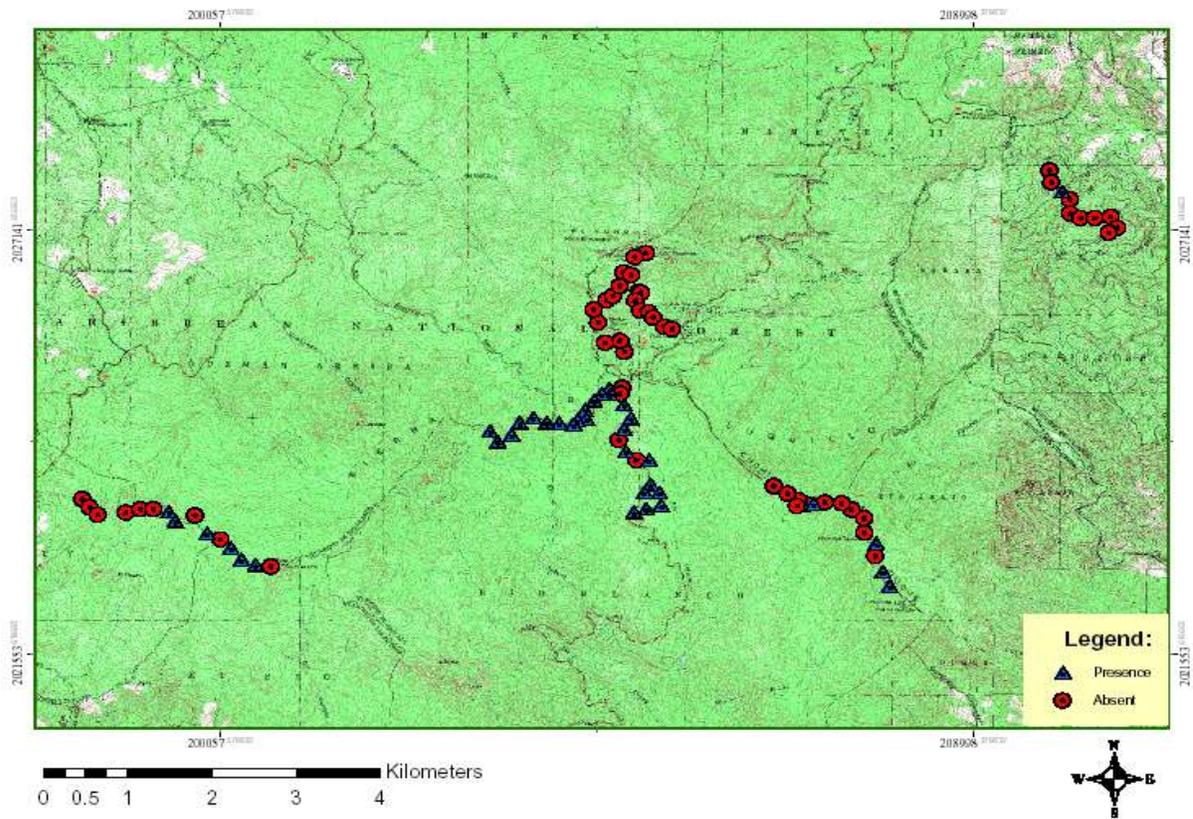


Figure 2. EWWA surveyed areas in Luquillo Forest.

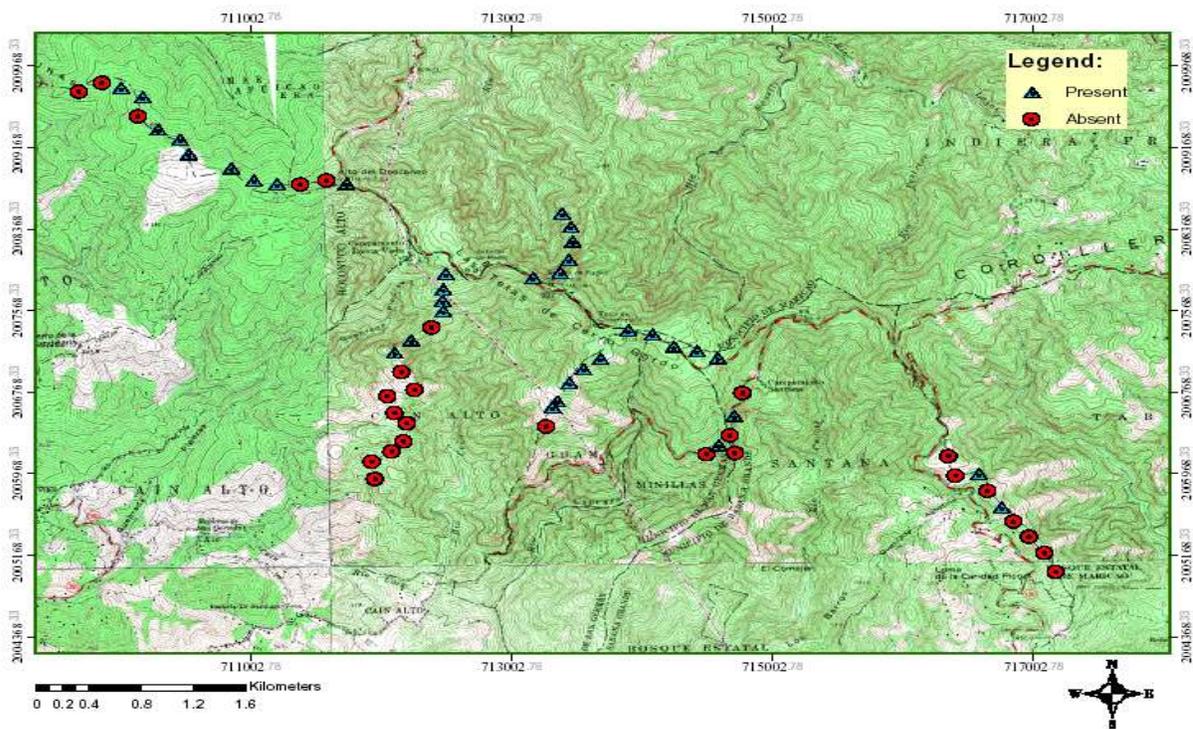


Figure 3. EWWA surveyed areas in Maricao Forest.

EWWA density in Luquillo Forest was highest in Palo Colorado Forest, slightly lower in Dwarf Forest and lowest in Tabonuco Forest, with no detections in Sierra Palm Forest (Figure 4). EWWA detections and abundance increased with elevation in Luquillo Forest (Figure 5). Almost all EWWA detected were between 590-910 m and became more abundant at 710-720 m in elevation (Figure 5).

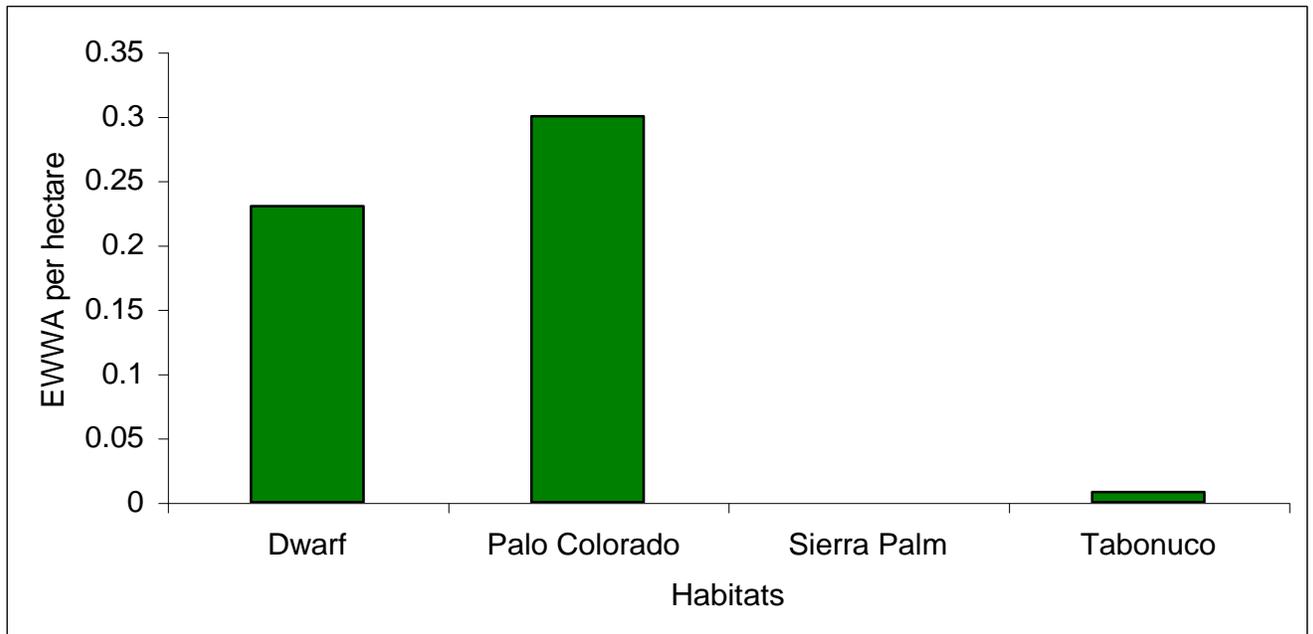


Figure 4. EWWA density per habitat in the Luquillo Forest.

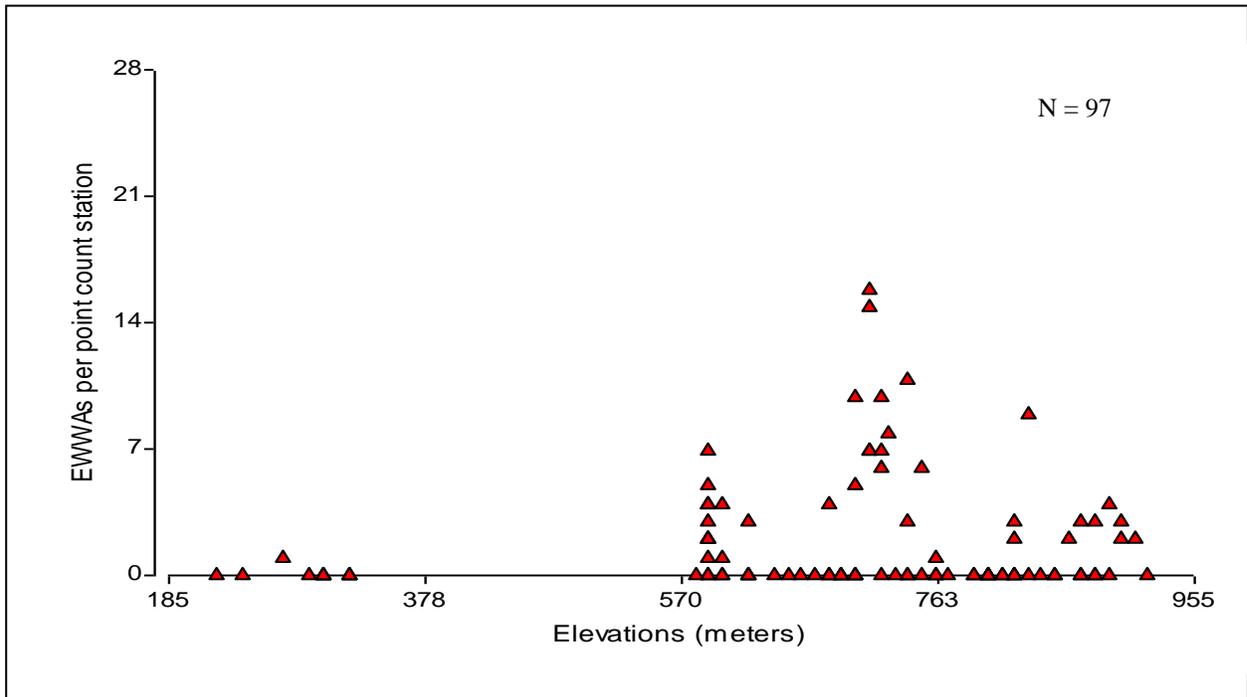


Figure 5. EWWA abundance per elevations in the Luquillo Forest. Diamond shapes represent point count stations.

EWWA density in Maricao Forest was highest in *Podocarpus*, lower in Exposed Woodland, and lowest in Dry Slope Forest (Figure 6). EWWA detections and abundance also increased with elevation in Maricao Forest (Figure 7). Most EWWA detected were between 470-790m and became more abundant at 650-760m in elevation (Figure 7). A composite plot of EWWA abundance per elevations in Luquillo and Maricao Forests revealed a great degree of overlap (Figure 8). There were point-count stations with higher abundance values in Maricao than in Luquillo Forest. Abundance values peaked more to the right (higher elevations) in Luquillo than in Maricao Forest but tapered more to the left end (lower elevations) in Maricao than in Luquillo Forest.

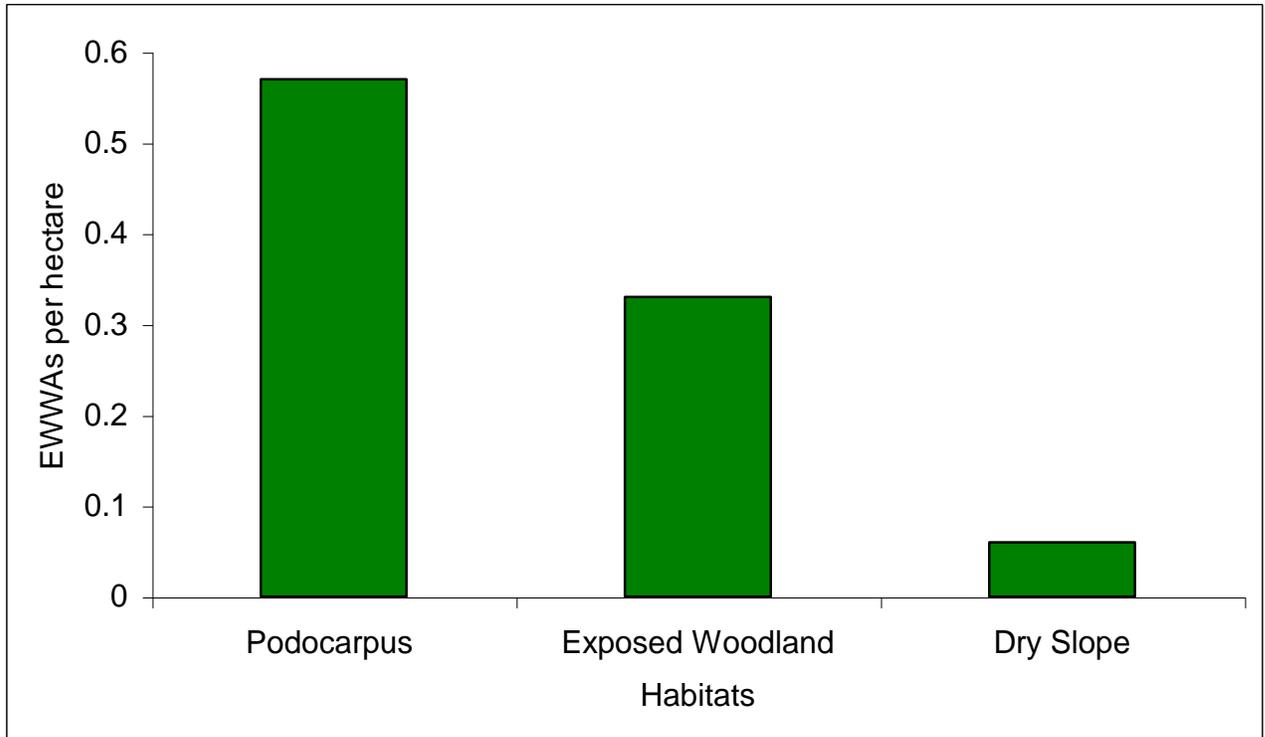


Figure 6. EWWA density per habitat in the Maricao Forest.

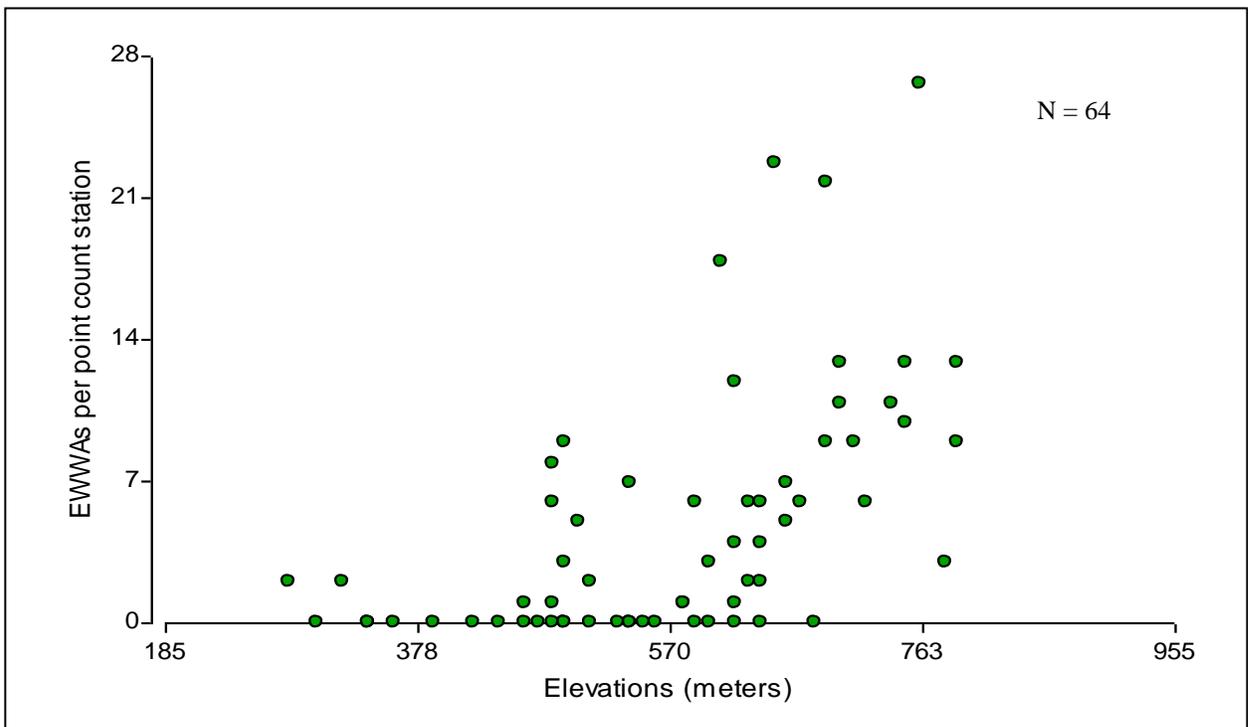


Figure 7. EWWA abundance per elevations in the Maricao Forest. Circle shapes represent point count stations.

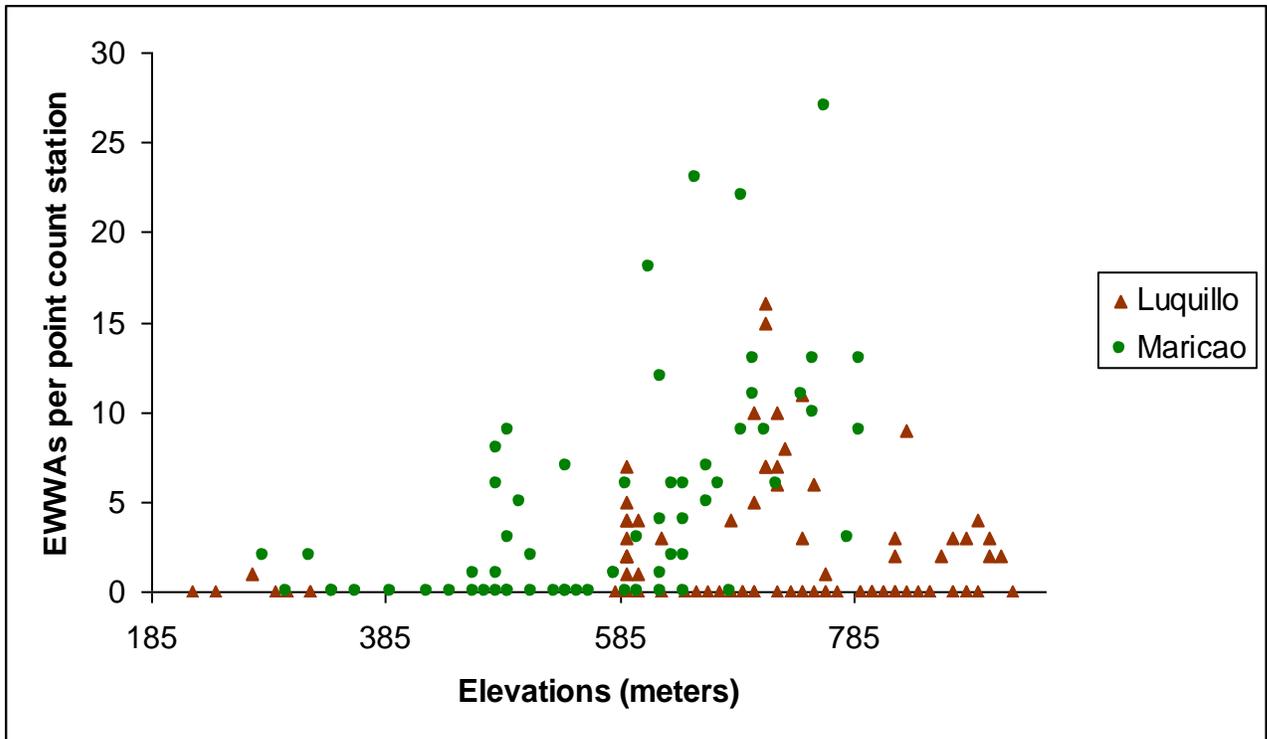


Figure 8. Composite of EWWA abundance per elevations in Luquillo and Maricao Forests.

Our results on EWWAs seasonal detections in the Maricao Forest showed an increase in number of EWWA from August to November (Figure 9).

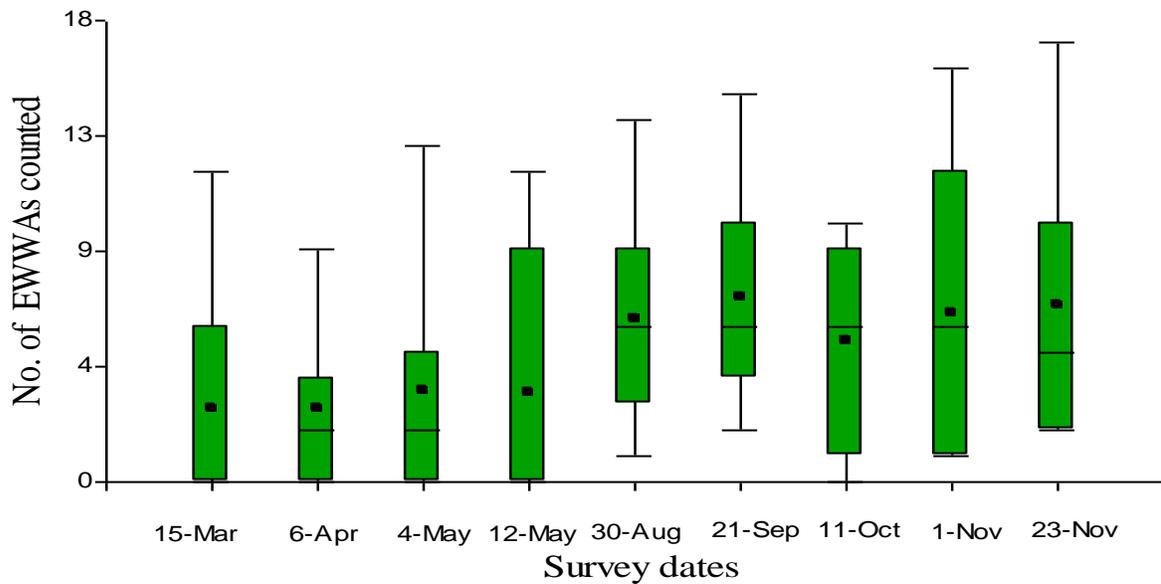


Figure 9. Box plot of seasonal detections of EWWA in the Maricao Forest. The green box represents the area with more detections, the end of the boxes indicate the maximum and minimum detected on each date. The vertical lines outside the box represent the standard deviation, the horizontal line inside the box denote the median and the square inside the box the average of the results on each date.

Even though we are very tentative and apprehensive about extrapolating our density estimates to larger and un-sampled areas in Maricao and Luquillo Forests due to the patchy distribution of the EWWA, we did it anyway and came up with population estimates of 1142 in Maricao Forest and 688 in Luquillo Forest. These estimates are to be taken very cautiously.

DISCUSSION

At present, there are EWWA populations on opposite ends of the island, in Maricao Forest in the western end of the Cordillera Central and in Luquillo Forest in the Sierra de Luquillo of eastern Puerto Rico. The EWWA apparently is no longer present in the upland forests of Toro Negro and Carite, formerly part of its distribution range in Puerto Rico.

Other habitats (i.e., coffee and timber plantations and secondary forests) we sampled in the upland forests of Guilarte and Bosque del Pueblo yielded negative results as well. The EWWA was not found either in Dwarf Forest, Sierra Palm, and Tabonuco Forest of the Los Tres Picachos Forest, an upland forest located in the municipalities of Ciales and Jayuya in the interior of the Cordillera Central (Miranda-Castro et al. 2000). Although there seems to be available habitat left for the EWWA in these upland forests, the species is not present.

Kepler and Parkes (1972) observed that the Dwarf Forest was the preferred EWWA habitat, which contrasts with our results of more detections and higher densities in Palo Colorado Forest in the Luquillo Forest. This shift in the EWWA use of this limited habitat in Luquillo Forest (approximately 300 ha left) could be related to loss and unavailability of the Dwarf Forest due to increase use for recreation and installation of communication infrastructure (Waide 1995). Hurricanes Hugo (1989) and Georges (1998) damaged severely the Dwarf Forest and other forest types as well in the Luquillo Forest. Response of bird populations to hurricane damage includes shifts in diet, foraging sites or habitats, and reproductive changes (Wiley and Wunderle 1993). This shift in habitat use also reveals ecological plasticity and adaptation to habitat changes, which insure survival of the species. The absence of the EWWA from the Sierra Palm Forest in the Luquillo Forest was unexpected, as other investigators have reported the species from this forest type (Wiley and Bauer 1985). Perhaps there is a seasonal use of this forest type by the EWWA as our surveys were limited to nine weeks during June and July 2003. This is apparently the case. Monthly counts conducted from 1989-1993 at Mt. Britton (which has extensive areas with Sierra Palm Forest), revealed very low EWWA abundance and in most months no birds were observed (Waide 1995). EWWA uses of habitats in Maricao Forest have remained consistent over the

years. Cruz and Delannoy (1984a) found *Podocarpus* as the most used EWWA habitat in Maricao Forest, which is consistent with this study.

The EWWA has experienced a slight altitudinal shift in distribution in the Luquillo Forest when compared to historical data. Kepler and Parkes (1972) pointed out that this species was found from 640 to 1030 m in elevation in the Luquillo Forest. Later, Waide (1995) observed the EWWA between 710 to 954 m. We determined the EWWA altitudinal range to be from 590-910 m. However, we had one EWWA detection at 270 m. This outlying detection could be related to seasonal EWWA altitudinal movements within the Luquillo Forest, not previously detected. We have found that the EWWA could go undetected often (due to reduced singing activity) without the aid of song playbacks.

The historical altitudinal record of the EWWA in Maricao Forest is consistent with our findings. Cruz and Delannoy (1984a) found most EWWA between 600 to 880 m and became more abundant between 650-760 m in this study. However, we had EWWA at 280 m and most were detected between 470-790 m. The EWWA had never been surveyed to these lower elevations before, these are new records. Our data seems to support Gochfeld's (1973) remarks about the possibility of some EWWA seasonal vertical migration within the Maricao Forest. There is a consistent altitudinal pattern in abundance both in Luquillo and Maricao Forests, very low numbers at lower elevations and an increase in abundance with elevation though with considerable variation.

The historical EWWA population estimate for the Luquillo Forest has remained a benchmark statistic for many years. Kepler and Parkes (1972) estimated the population as 300 pairs. Waide (1995) believed the 300 pairs estimate was too high and came up with a new estimate of 138 pairs (275 individuals). Waide warns caution with his estimate due to

“considerable activity of *Dendroica angelae* outside the elfin woodland”. Our population estimate of 688 is similar to the 1972 estimate but we are also apprehensive about it due to the EWWA patchy distribution in the Luquillo Forest. Our 1142 EWWA population estimate in Maricao Forest is the first and only estimate. This estimate warrants caution due to the EWWA patchy distribution in Maricao Forest as well.

RECOMMENDATIONS

This study showed that the EWWA has a limited distribution in Puerto Rico, is restricted to a handful of habitats in Maricao and Luquillo Forests, and is found in low densities showing requirements of conservation management to assure the survival of the species. According to our findings, we recommend the pertinent agencies the immediate protection of this bird species by listing it endangered under the Endangered Species Act and the International Union for Conservation of Nature (IUCN). We recommend the endangered category based on IUCN Red List Categories and Criteria (IUCN 2001). See Appendix 7.

In order to create more accurate recommendations to protect EWWA, other scientific studies have to be conducted to understand why this species distribution is fragmented in the island! Studies in habitat requirements are crucial to the survival of this species. Vegetation at each sampling point should be measured and analyzed to develop a better understanding of the reason for the patchy distribution. Also, studies of the biology of EWWA should be initiated to learn about reproduction, territorial behavior, seasonal movements and mortality to formulate clear guideline management for the survival of the species.

Long-term populations monitoring should be continued at existing sites in Maricao and Luquillo and extended to other parts of the forests. Surveys have to be established in

forest of its historical distribution to detect if reintegration of the species occurs in those forests in the future. Maps of EWWA distribution should be improved regularly to compare changes of population movements inside the forests.

Until other studies are completed, it is imperative to protect the habitat the species occupies. No human disturbance or construction should be allowed in order to avoid worsening habitat fragmentation and risky population decline.

PUBLIC AWARENESS

The EWWA is a species mostly known by trained individuals in bird detection but not by the general public. From January 2003 through May 2004 team members and the IBA program have been creating public awareness of the status of the species through posters, oral presentations, workshops, symposiums, and TV programs.

Trainings

Dr. Carlos Delannoy and team leader trained 15 university students in point counts methods and improvement of visual and auditory EWWA identification skills. Trainings were held in January, June and August 2003. Their fascination for the species resulted in that two of the team members decided to continue studies (Masters Degree) in different ecological aspects of the EWWA.

Presentations

Two meetings well held with the professor and students working on the project to update results. The first was on August 19, 2003 and the second on March 30, 2004. Some of the most important results were presented to students to inform the achievements of our findings.

Project EWWA 2003

Also, on January 29, 2004 the project and its results were presented to the AIA and SOPI members.

Workshops –Teachers workshops on April 24 and May 15, 2004 at the IBA. We talked about the endemic birds of Puerto Rico and mentioned the findings of the project, gave them a summary of the results and EWWA educational materials.



Symposiums - On April 3, 2003 team leader participated in a symposium entitled “Graduated Investigation in Organismal and Molecular Biology ” and presented the projects proposal to faculty and students at the UPR, Mayagüez Campus. During this activity a sincere interest in learning more about the Elfin Woods Warbler and its future fate was shown by those present. Approximately 100 people attended the presentation.

On November 29, 2003, team leader gave a presentation of the taxonomic and ecological profile of the birds of Guilarte Forest, Adjuntas Puerto Rico. EWWA absence in this forest was mentioned in the presentation. Local biologists attending the talk were concerned to learn that no EWWA detections were made in this forest since Guilarte Forest was described as a potential habitat for the species. Sixty people attended the symposium.

On April 30, 2004 team leader presented results and recommendations in the XXIII Symposium of Flora and Fauna in the Caribbean at UPR, Humacao Campus. This presentation began with this quote “The EWWA doesn’t have bright colors as the Puerto Rican Parrot but it is a species that needs, as the parrot, our protection now, otherwise it is going to disappear forever”. This starting point grabbed the attention of those presents and the perspective that not only the parrot, a well-known bird in Puerto Rico needs protection but also species need protection worldwide. Over 200 people attended and hear the message.

Posters - Team members prepared a poster highlighting key results and recommendations to be presented in the IX Sigma Xi Poster Day organized by the Sigma Xi Scientific Research Society on April 1, 2004 at UPR- Mayagüez. Team members and the public engaged in a question and answer session. Approximately 100 people attended the activity. A summary of important aspects concerning EWWA protection was handed to the public as well as a pin button.

On April 29, 2004 the poster was presented to workers at Baxter Factory and residents of Maricao. The main topic was disappearance risk of the species. They were informed that according to our findings, the largest population of this species is in their hometown. Maricao residents have the obligation of protecting the forest in order to guarantee survival of the EWWA and other species.

Newspaper article - Dr. Adrienne G. Tossas, coordinator of the IBA program in Puerto Rico, published a progress report of the EWWA project in the Puerto Rican Ornithological Society’s (PROS) bimonthly newsletter, El Bien–te–veo issued in July (vol. VI no. IV).

An article about the EWWA project appeared in La Gaceta Colegial, a newspaper of the UPR-Mayagüez Campus (October-November 2003 year 5 vol. V 7pp). The article emphasized the international silver award given by British Petroleum to graduate and undergraduate students of the Biology Department. The interviewer showed great interest in the student's participation. British Petroleum's webpage was promoted in this article. The article is available at <http://www.uprm.edu/gaceta/>

Festival – On May 1, 2004 a talk about the project was given in the Maricao Endemic Birds Festival held in the forest. Approximately 40 people attended this activity most of them community members, who own land near the forest areas. Buttons of the species were given to the participants. Most of them didn't know about the species. They thought it was the common warbler. They showed interest in learning more about it and in how they can help to protect it. We told them to protect areas of mature forest in their lands because those were the areas that EWWA preferred and to forest the other land areas that have not been used for agriculture, house or recreation

TV program- On October 3, 2003 the local TV program "Geoambiente" filmed the EWWA and other endemic birds in Maricao Forest. The program's producer and host, María Falcón, pointed out the birds' importance for scientific studies, tourism, history, education and conservation. The team leader spoke about the EWWAs current project. It's the first time that the EWWA's features in an environmental TV program.



Reports

Final reports of this study have been submitted to the National Heritage program and the Forestry Division of the Puerto Rican Department of Natural and Environmental Resources, the US Forest Service and US Fish and Wildlife Service.



FUTURE WORK

A second population survey was initiated on December 2003 in the Maricao Forest in order to assess a more precise EWWA population estimate and to continue monitoring its populations. Vegetation and entomology analyses of the EWWA habitat will begin in August 2004 as two-university graduate students' research.

Project EWWA 2003

Important Birds Areas Program of the Ornithological Society of Puerto Rico and team members intends to continue building public awareness of the critical status of the EWWA.

Acknowledgements

We are grateful to BP conservation programme for believing in our potential as young conservationists and fastening our professional growth.

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To Adrienne G. Tossas, Ph.D., IBA Coordinator with gratitude for encouraging and inspiring us in the diffusion of the project in order promote public awareness not only of the status of this species, but of conservation in general.

Our special thanks to Jose González and Felisa Collazo for facilitating the beautiful picture of one so difficult to shoot at.

Finally thanks to Heinz Weidisch for producing the maps describing EWWA distribution.

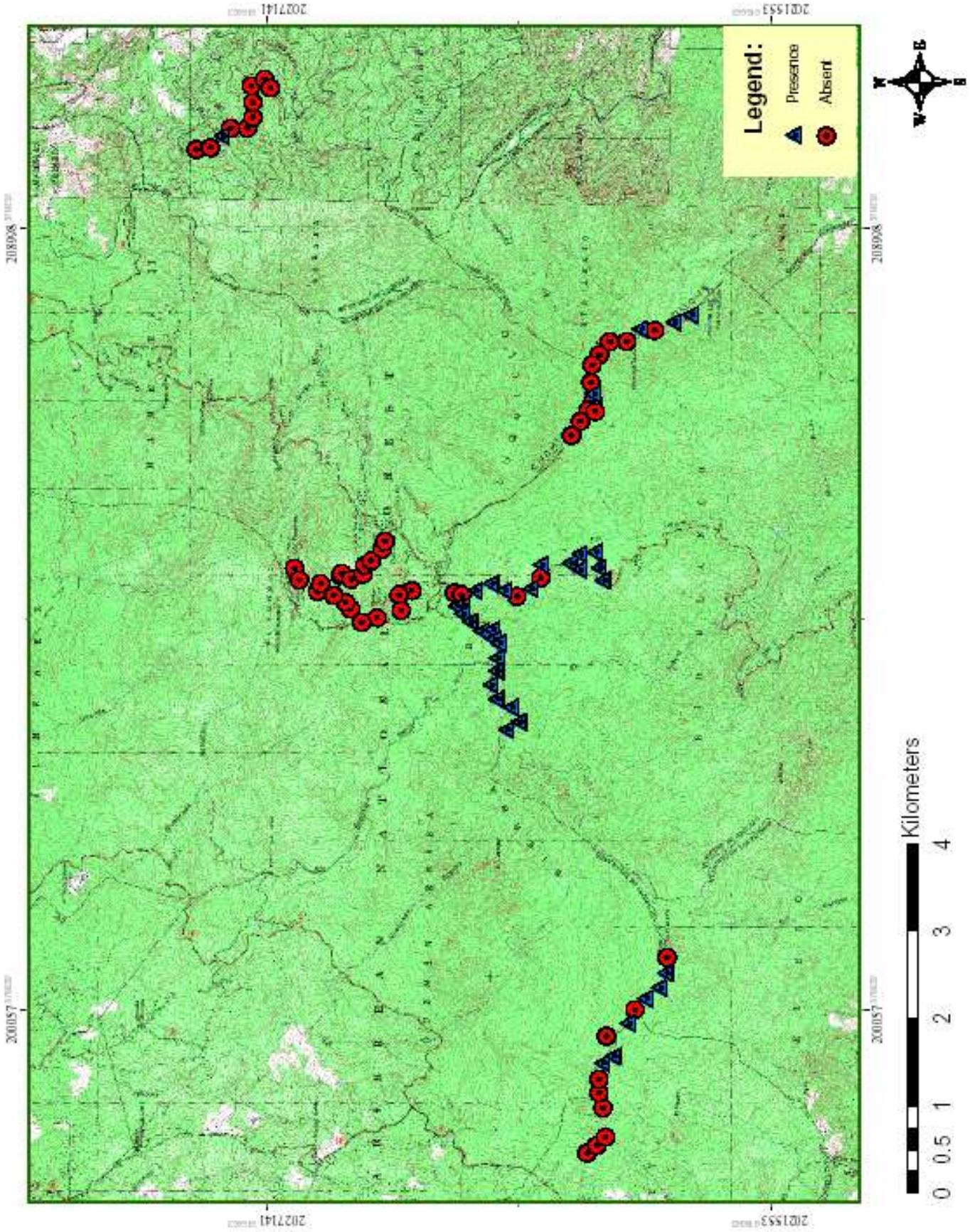
LITERATURE CITED

- Arroyo-Vázquez, B. 1992. Observations of the breeding biology of the Elfin Woods Warbler. *Wilson Bull.* 104:362-365.
- BirdLife International. 2000. *Threatened birds of the world.* Lynx Edicions, Barcelona, Spain.
- Birdsey, R.A. and D. Jiménez. 1985 *The forests of Toro Negro.* USDA For Serv. Res. Pap. SO-222.
- Brown, S, A. E. Lugo, S. Silander, and L. Liegel. 1983. *Research history and opportunities in the Luquillo Experimental Forest.* U.S.D.A., Forest Service, Southern Forest Experimental Station, General Technical Report, SO-44.

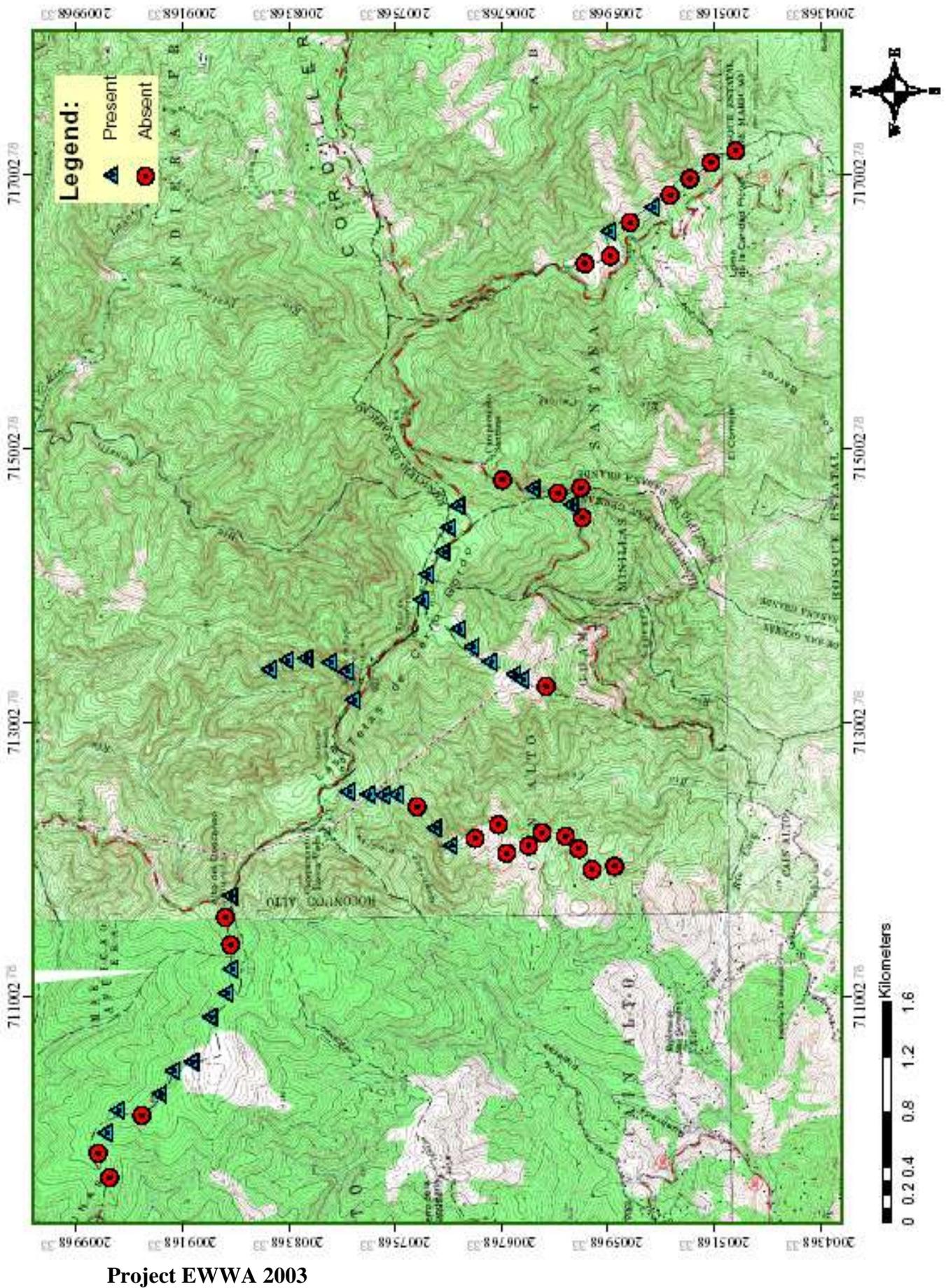
- Cruz, A. and C. A. Delannoy. 1984a. Ecology of the Elfin Woods Warbler (*Dendroica angelae*). I. Distribution, habitat usage, and population densities. *Carib. J. Sci.* 20:89-96.
- Cruz, A. and C. A. Delannoy. 1984b. Ecology of the Elfin Woods Warbler (*Dendroica angelae*). II. Feeding ecology of the Elfin Woods Warbler and associated insectivorous birds in Puerto Rico. *Carib. J. Sci.* 20:153-162.
- Cruz, A., and C.A. Delannoy. 1986. Status, breeding biology and conservation needs of the Puerto Rican Sharpshinned Hawk (*Accipiter striatus venator*). Fin. Rep. Submitted to the U.S. Fish and Wildlife Service as specified in work contract no. 14-16-0004-82-047.
- Delannoy, C.A. 1997. Status of the Broad-winged Hawk and Sharp-Shinned Hawk in Puerto Rico. *Carib. J. Sci.* 33(1-2):21-33.
- Department of Natural Resources. 1976. The master plan for the commonwealth forests of Puerto Rico. San Juan, P.R. 258 p.
- Gochfeld, M., D. O. Hill, and G. Tudor. 1973. A second population of the recently described Elfin Woods Warbler and other bird records from the West Indies. *Carib. J. Sci.* 13:231-235.
- IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland Switzerland and Cambridge, UK ii + 30 pp.
<http://www.iucn.org/themes/ssc/redlists/redlistcatsenglish.pdf>
- Kepler, C. B. and K. C. Parkes. 1972. A new species of warbler (Parulidae) from Puerto Rico. *Auk* 89:1-18.
- Miranda-Castro L., A. R. Puente-Rolón and S. Vega-Castillo. 2000. First list of the Vertebrates of Los Tres Picachos State Forest, Puerto Rico, with Data on Relative Abundance and Altitudinal Distribution. *Carib. J. Sci.* 36(1-2):117-126.
- Oberle, M.W. 2000. Puerto Rico's birds in photographs. 2nd edition. Editorial Humanitas, San Juan, Puerto Rico.
- Pérez-Rivera, R. A. 1979. Lista revisada de los animales vulnerables, amenazados o en peligro de extinción en Puerto Rico. Cuadernos de Revista Cayey, Num. 3, Universidad de Puerto Rico, Cayey, Puerto Rico.
- Pérez-Rivera, R.A. and E. Nadal. 1996. Use of Bird Nests by *Eleutherodactylus*

- Frogs in the Carite Forest, Puerto Rico. *Carib. J. Sci.* 32(2): 201-205.
- Ralph, C.J, G.R. Geupel, P.Pyle, T.E. Martin and D.F. De Sante. 1993. Handbook of Field Methods for Monitoring Landbirds. Pacific Southwest Research Station Albany, California. 6 p.
- Silander, S., H. G. de Rubio, M. Miranda y M. Vázquez. 1986. Los Bosques de Puerto Rico, Vol X Tomo II. Commonwealth of Puerto Rico, Dept. of Natural Resources, p. 278-333.
- Wadsworth, F.H. 1951. Forest management in the Luquillo mountains I. The Setting *Carib. For.* 12:93-114.
- Waide, R.B. 1995. Status and Conservation of the Elfin Woods Warbler (*Dendroica angelae*) in the Luquillo Experimental Forest. Unpublished Report.
- Weaver, P.L. 1972. Cloud moisture interception in the Luquillo mountains of Puerto Rico. *Carib. J. Sci.* 12: 129-144.
- Wiley, J.W. and G.P. Bauer. 1985. Caribbean National Forest, Puerto Rico. *Amer. Birds* 239:12-18.
- Wiley, J.W. and J. Wunderle. 1993. The effects of hurricanes on birds, with special reference to Caribbean Islands. *Bird Conserv. Intern.* 3 : 319 –349.
- Wilson, M. H., C. B. Kepler, N. F. R. Snyder, S. R. Derrickson, F. J. Dein, J. W. Wiley, J. M. Wunderle, Jr., A. E. Lugo, D. L. Graham, and W. D. Toone. 1994. Puerto Rican Parrots and potential limitations of the metapopulation approach to species conservation. *Conserv. Biology* 8:114-123.

APPENDIXES

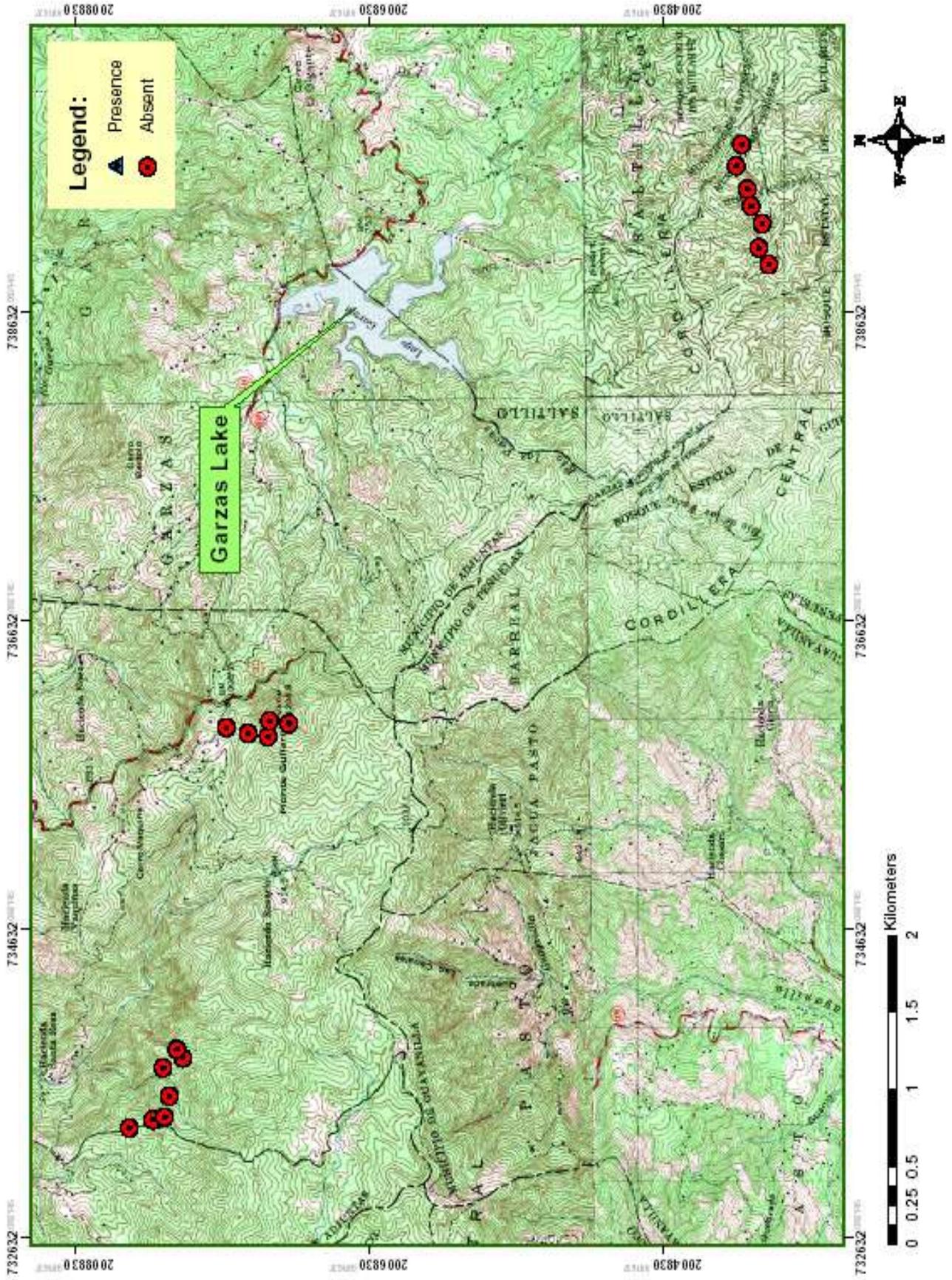


Appendix 1. Distribution patterns of the EWWA per point-count stations in Luquillo Forest.

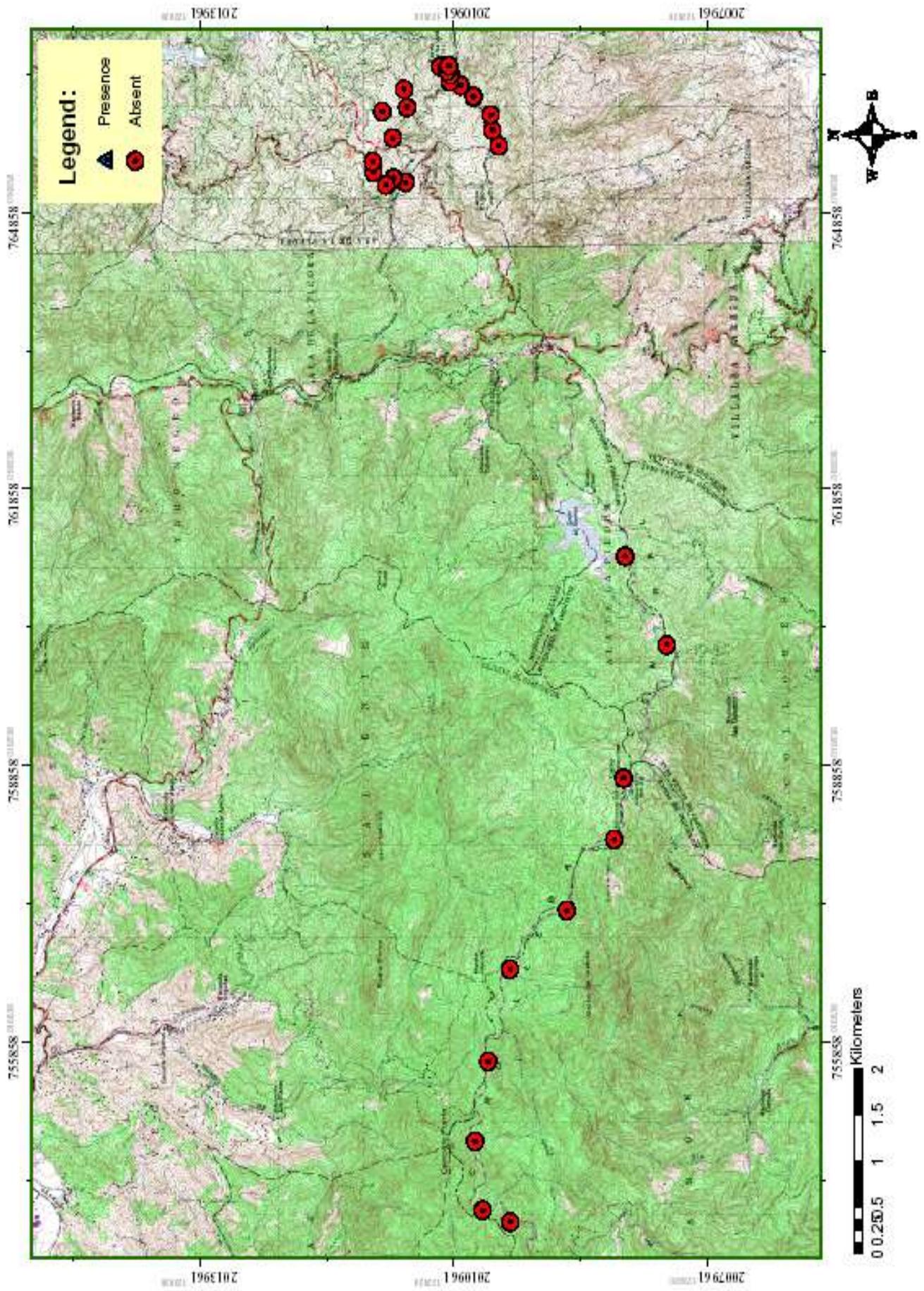


Project EWA 2003

Appendix 2. Distribution patterns of the EWA per point-count stations in Maricao Forest.



Appendix 4. Distribution patterns of the EWWA per point-count stations in Guilarte Forest.



Appendix 6. Distribution patterns of the EWA per point-count stations in Toro Negro Forest.

Appendix 7. IUCN Red List Categories and Criteria.

Category: Endangered (EN)

Based Criteria:

B. 1. Extent of occurrence estimated to be less than 5000 km², and estimates indicating:

- a. Severely fragmented or known to exist at no more than five locations.
- b. Continuing decline, observed, inferred or projected, in many of the following:
 - iv. number of locations or subpopulations
- c. Extreme fluctuations in any of the following:
 - iii. number of locations or subpopulations

B 2. Area of occupancy estimated to be less than 500 km², and estimates indicating:

- a. Severely fragmented or known to exist at no more than five locations.
- b. Continuing decline, observed, inferred or projected, in any of the following:
 - iv. number of locations or subpopulations.
- c. Extreme fluctuations in any of the following:
 - iii. number of locations or subpopulations