ECOLOGY, REPRODUCTIVE BIOLOGY, AND CONSERVATION OF ALDER AMAZON (*Amazona tucumana*) IN THE MONTANE FORESTS OF ARGENTINA

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Proyecto Loro Alisero

INTRODUCTION

Basic biological information for many Neotropical parrot species is lacking; this information is a prerequisite to identify threats, effectively monitor population trends, and evaluate the conservation and management actions required (Masello and Quillfeldt 2002). Specifically, there is a lack of this essential information for Alder Amazon (*Amazona tucumana*), an endemic parrot species of the subtropical montane forests of Argentina and Bolivia (Fig. 1)– called Yungas (Fig. 2). Furthermore, population numbers have declined dramatically in the 20th century due to habitat loss and pet trade driven this species to be considered rare and endangered (Collar and Juniper 1992). The species has been assigned as high conservation and research priority (Parker et al. 1996).

Figure 1. Panoramic view of subtropical montane forest (called Yungas). Photo taken in Santa Bárbara mountain range, Argentina.

Figure 2. Distribution of subtropical montane forest (called Yungas).

The Yungas is the only habitat where the Alder Amazon occurs. Unfortunately, the Yungas forests are disappearing at an alarming annual rate of 1.1 (FAO 2001) and 60% has already been lost (Vervoorst 1979) due to unsustainable timber harvesting (Fig. 3) and land transformation for agriculture (WWF/IUCN 1997). The Yungas is a region of high biodiversity (Cinti 2000) and endemism and is recognized as an Endemic Bird Area of the World with urgent priority for conservation, which includes 9 restricted range bird species (Stattersfield et al. 1998). In Argentina, this is the area with the highest regional priority for conservation (Dinerstein et al. 1995).

Figure 3. Unsustainable timber harvesting jeopardizes the conservation of subtropical montane forests.

The Yungas can further be divided into three distinct vegetation types according to its elevation (i.e., piedmont forest: 400-700 m, montane: 700-1500 m, and cloud forest: 1500-2200 m). For breeding, Alder Amazon (*Amazona tucumana*) is dependent on the highest elevation forest –cloud forest (Fig. 4). However, this elevational zone is being reduced by locals that set fires to promote high elevation grasslands sprouting for cattle raising and by timber industries that make an unsustainable use of the forest resources. Conservation and management of remnant forests is essential and urgent for the survival of viable populations of Alder Amazon (Collar and Juniper 1992).

Figure 4. Panoramic view of the cloud forest. Photo taken in Santa Bárbara mountain range, Argentina.

Previous studies have reported ancillary information on Alder Amazon (Bond and Meyer de Schauensee 1943, Hoy 1968, Nores and Yzurieta 1994, Orfila 1938, Wetmore 1926). Inference from these studies can be very limited when trying to delineate conservation and management strategies. In a previous project, we estimated that the population number of Alder Amazon in Argentina is of no more than 11,000 individuals and of those only 5,000 could be breeding individuals (Rivera & Politi 2004); this highlights the importance of understanding demographic parameters since it seems that the species has not been able to recover from the combination of past pet trade and habitat loss. We also recorded active nests of Alder Amazon with chicks in mature trees of more than 40 cm of diameter at breast height in cloud forests (Rivera & Politi 2004). As many other parrot species (Snyder et al. 2000, Lanning and Shiflett 1983), Alder Amazon is dependent on old-growth forest for breeding and feeding and snags could have an important role as nesting sites (Rivera & Politi 2004).

The specific habitat requirements that Alder Amazons needs for breeding will have implications on the management and conservation strategies designed. If Alder Amazons are generalists on the physical characteristics of the cavities they use for nesting then, one could set a minimum of the habitat requirements (Snyder et al. 1987). However, one might hypothesize that since Alder Amazon is an endemic species with a small distribution range it would have specific habitat requirements (Enkerlin-Hoeflich 1995) and the management strategy for the species would have to account for those specific characteristics essential for Alder Amazon to breed. Nest success can give insight as to whether Alder Amazon is negatively affected by changes in its habitat. Additionally, there is a need to understand the relationship of parrot population to food resources to determine key resources, habitats, and areas required for conservation (Saunders 1990).

Timber exploitation can be sustainable if local people, industries, and governmental agencies linked to forestry activities are given guidance on how to act responsibly. Forests that are not managed sustainably will eventually lose their economic and ecological value and are likely to be converted to non-forest land uses and thus jeopardize the conservation of Alder Amazon. It is essential to provide management guidelines for timber harvesting practices in the Yungas that assure the conservation of biodiversity at a regional scale. Recommendations will be based on the habitat requirements for Alder Amazon.

GOAL

The goal of this project is to determine the breeding habitat requirements, reproductive biology, and feeding ecology of Alder Amazon *Amazona tucumana* in Argentine Yungas to identify important areas for conservation and to understand how timber harvesting affects the species. This information is lacking but needed to develop conservation strategies and management recommendations for policy makers, administrators, park rangers, forest industries and local people to assure the long-term survival of the species and its habitat. We will use Alder Amazon as a flagship species to promote the maintenance of the Yungas ecosystem and biodiversity enhancing local people awareness and pride

Specific objectives

a) Determine brood size, number of hatchlings and fledglings, and nest survival of Alder Amazon.
b) Determine breeding habitat requirements of Alder Amazon at tree and stand level.
c) Determine food requirements of Alder Amazon and temporal and spatial variability in food resource abundance.
d) Provide management recommendations for Alder Amazon and Yungas to policy makers and timber industries.
e) Promote conservation of Alder Amazon and Yungas forests among local people.

METHODS

Intensive searches in El Rey National Park (Fig. 5) to identify Alder Amazon nests were conducted. This Park has been previously identified as an important breeding site for Alder Amazon (Rivera & Politi 2004). The park is very inaccessible and can only be visited with four-wheel drive vehicle, but even with this type of vehicle in rainy days it is quite inaccessible. To survey nests in the cloud forest we required the collaboration of park rangers that helped with the equipment and logistics with horses in a trip through trails form more than four hours (Fig. 6). Nests were identified by observation of Alder Amazons breeding pair behaviour and when adult parrots are absent from the nest (usually noon) nests were inspected with a camera system attached to an extensible pole (i.e., tree-peeper) (Fig. 7).

Nests were monitored every two weeks to determine its occupancy (Enkerlin-Hoeflich 1995) and to obtain detailed information on date of egg lay, clutch size (i.e., number of eggs laid per nest), hatching success (i.e., percentage of eggs laid that hatched), and fledging success (i.e., percentage of hatchlings that fledged). At each nest the following habitat variables were measured: 1) height to the cavity opening; 2) diameter at cavity height; 3) internal characteristics of the cavity (horizontal and vertical depth); 4) cavity entrance size (vertical and horizontal diameters), aspect and inclination; 5) tree diameter at breast height (DBH); 6) tree height, and 7) tree species. The following stand variables were measured in a circular plot of 0.05 ha with the nest tree as centre: 1) tree species, 2) tree DBH, 3) stand slope and aspect, and 5) altitude and coordinates of the site.

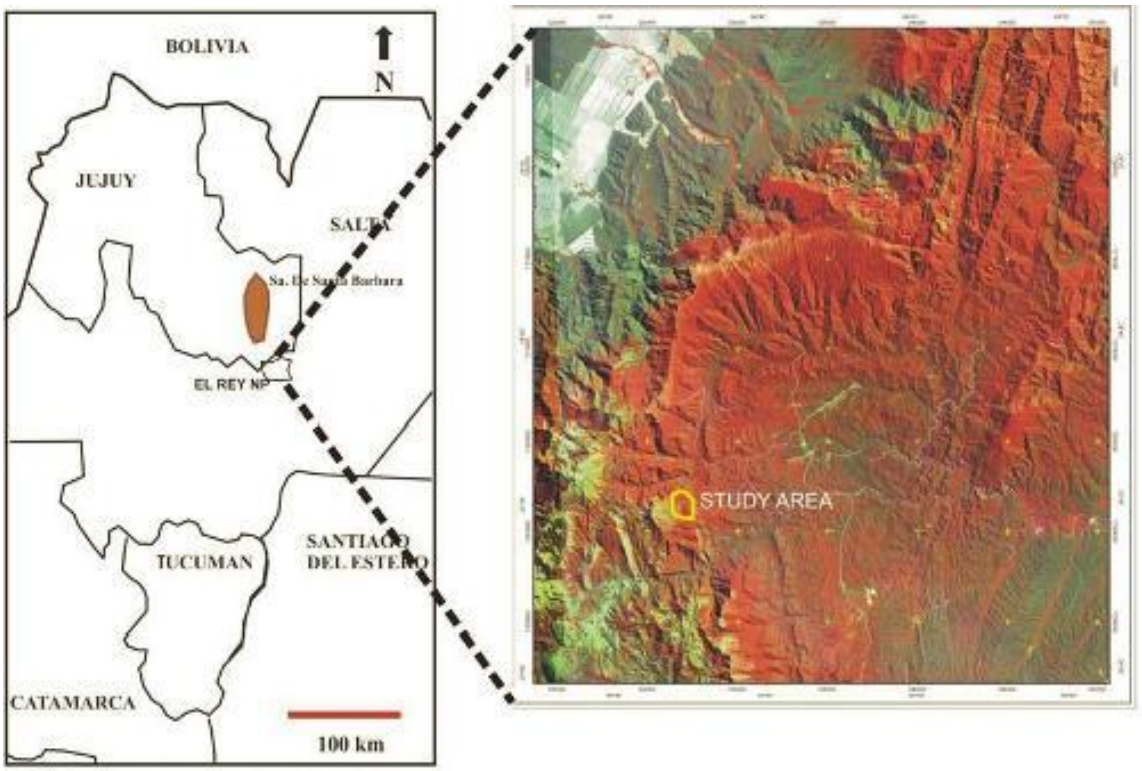

Figure 5. Study area in El Rey National Park, Argentina.

The diet of Alder Amazon throughout the year was determined by direct observation of feeding activity. Every month of the year, 2 km long transects were walked for two days in each of the three elevation strata of the Yungas to detect the food item consumed. Transects were surveyed during the two foraging activity periods (during the first four hours of the morning and the last three hours of the afternoon) (Renton 2001) and we recorded the flock size and their feeding activity. Additionally, we established ten phenology transects of 100 m

long throughout the study area and collect information for all seasons of the year to relate the abundance of food resources with those consumed by Alder Amazon. We recorded seasonal abundance of flowers and fruits along transects. Along phenology transects we marked trees and recorded the number of flowers and fruits on each marked tree and developed an index to examine seasonal food abundance (Collazo et al. 2003; Carlo et al. 2003).

Figure 6. Park rangers load equipment in horses to travel through trails for more than four hours to access the cloud forest.

Figure 7. Inspection of cavities with camera system mounted to a 15 m extensible pole.

The management guidelines for the area were based on the habitat requirements of Alder Amazon. For example, these guidelines included recommendations that potential cavity-nest trees (trees of preferred species above certain size thresholds) be retained (at least a minimum number per hectare) in harvested forests. Additionally, the conservation education campaign that is already underway was broadened to include more schools in remote areas that contain populations and habitat of Alder Amazon

RESULTS

We searched 100 ha intensively for Alder Amazon nests from November 2005 to March 2006 in El Rey National Park. We were able to identify nine nests of Alder Amazon: five in *Blephalocalyx salicifolius*, two in *Podocarpus parlatorei*, one in *Juglans australis*, and one in a snag (Table 1). Nests were found in trees that had a mean DBH of 0.88 m (minimum DBH of 0.6 m and maximum of 1.14 m). Comparisons of variables in plots with cavity nest as

centre tree and those with random trees as centre tree showed no significant difference ($p>0.05$) (Table 2). Table 3 shows percentage of tree species composition in the breeding habitat of Alder Amazon in El Rey National Park.

We monitored only six nests with the camera system attached to a 15 m extensible pole since the other three nests were too high to be reached with the camera system. The six nests monitored were successful in producing fledglings (Fig. 8). Egg laying started in the beginning of December. Nests produced a mean of 3.6 eggs and 3.1 fledglings. As other Amazon parrot species, Alder Amazon shows brood reduction, i.e., some chicks die in a clutch but siblings survive. We observed three nests with brood reduction. Fledglings (Fig. 8) left nests after mid February. The density of nests was 0.09 nest/ha (i.e., 1 nest in 11.1 ha).

We were able to detect Alder Amazon foraging in nine foraging items not previously described: *Rhamnus polimorphus*, *Chusquea lorentziana, Enterolobium contortosiliquum, Anadenantera macrocarpa, Gleditsia amorphioides*, *Tipuana tipu*, *Eucaliptus sp.*, *Morus sp*., and *Prunus Persic* (the last three are exotic species). These nine items add to 16 items already identified. Food offer reached its peak during the summer, showing less offer in other seasons (Fig. 9) Seeds were consumed in the non-breeding season, while in breeding season flowers, fruits, and seeds were consumed (Photo 10). Throughout the breeding season parrots were observed two or three times each day flying from the nests in the cloud forest (1500-1700 meters of elevation) to the montane forest (1200-1300 meters of elevation) to feed extensively on fruits from September until March. *Podocarpus parlatorei* produced many fruits this year, and feeding observations of Alder Amazon seem to suggest that this could be a key feeding item in chick's diet.

Table 1. Characteristics of nest of Alder Amazon found in El Rey National Park in 2005-2006 breeding season.

Nest	1	2	3	4	5	6	7	8	9	Mean
Coordinates	24º45´21.6" S 64º42´42.9" W	24º44´54.9" S 64º42´53.2" W	24º44´53.4" S 64º42´50.8" W	24º45´04.3" S 64º42´40.6" W	24º45´03.6" S 64º42´38.8" W	24º45´33.2" S 64º42´34.3" W	24º45´02.3" S 64º42´34.0" W	24º45´20.3" S 64º42´43.3" W	24º45´21.8" S 64º42´43.5" W	
Species	Snag	*Blepharocalyx salicifolius*	*Blepharocalyx salicifolius*	*Juglans australis*	*Blepharocalyx salicifolius*	*Podocarpus parlatorei*	*Blepharocalyx salicifolius*	*Podocarpus parlatorei*	*Blepharocalyx salicifolius*	
Diameter at breast height	0.97	0.76	0.85	0.74	0.94	1.14	1.07	0.88	0.6	0.88±0.17
Elevation	1707	1638	1629	1599	1595	1679	1585	1642	1540	
Nest height	9.09	18	10.03	17	20.34	10.71	15.5	15	13.61	14.36±3.84
Tree height	11	24	24	25	25	18	20	22	18 20.	78±4.60
Nest depth	0.3	?	0.1	0.4	?	?	0.1	0.3	0.15	0.23±0.12
Vertical diameter of cavity entrance	0.15	0.2	0.3	0.4	0.4	0.15	0.2	0.15	0.25	0.18±0.05
Horizontal diameter of cavity entrance	0.15	0.2	0.3	0.15	0.2	0.15	0.15	0.15	0.15	-
Cavity entrance aspect	259ºN	70ºN	100ºN	356ºN	32ºN	45ºN	88º	226ºN 3	02ºN	-
Tree inclination	10º	0º	15º	0º	0º	20º	15º	5º	15º	-
Cavity origin	Excavated	Decay	Decay	Decay	Decay	Decay	Decay	Decay	Decay	-
Cavity entrance height	0.6	0.4	0.6	0.4	0.45	0.6	0.4	0.4	0.4	0.47±0.09
Diameter at Incubation chamber height	0.65	0.4	0.6	0.4	0.45	0.65	0.4	0.4	0.4	0.48±0.11
Internal diameter of Incubation chamber	0.4	?	0.45	0.35	?	?	0.3	0.3	0.25	0.34±0.07
inclination	0º	0º	0º	0º	0º	0º	0º	(-)15º	30º	-
Location of the cavity	Trunk	Branch	2º Trunk	Trunk	Branch 2º	Branch 1º	Branch 1º	Branch 1º	Trunk	-

Table 2. Variables in plots of 0.05 ha with cavity nest as centre tree and random tree as centre tree in El Rey National Park.

	Slope (º)	Canopy cover (%)	DBH (m)	Stem density (stems/ha)	Basal area (m²/ha)
Nest plot	12.8± 8.2	81.1±9.6	0.38±0.09	310±98	49.2±9.8
Random plot	13.3±7.8	-	0.31±0.04	402±124	47.6±3.6

Table 3. List of tree species and percentage of stems found in 0.05 ha plots in the breeding habitat of Alder Amazon in El Rey National Park.

Species	%
Myrcianthes mato	22.22
Allophilus edulis	14.10
Blepharocalyx salicifolius	13.25
Snag	8.55
Podocarpus parlatorei	8.55
Cinnamomum porphyria	8.12
Myrrhinium loranthoides	5.98
Cedrela lilloi	5.13
Prunus tucumanensis	3.85
Juglans australis	3.42
Sambucus peruviana	1.28
Ilex argentina	1.28
Myrcianthes sp.	0.85
Randia spinosa	0.85
Scutia buxifolia	0.85
Erythrina falcata	0.43
Dunalia breviflora	0.43
Parapiptadenia excelsa	0.43
Durante serratifolia	0.43

Figure 8. Nests of Alder Amazon in the breeding season 2005-2006. *Upper left*: eggs; *upper right*: recently hatched chicks; *lower left:* grown chicks; *lower right*: fledglings.

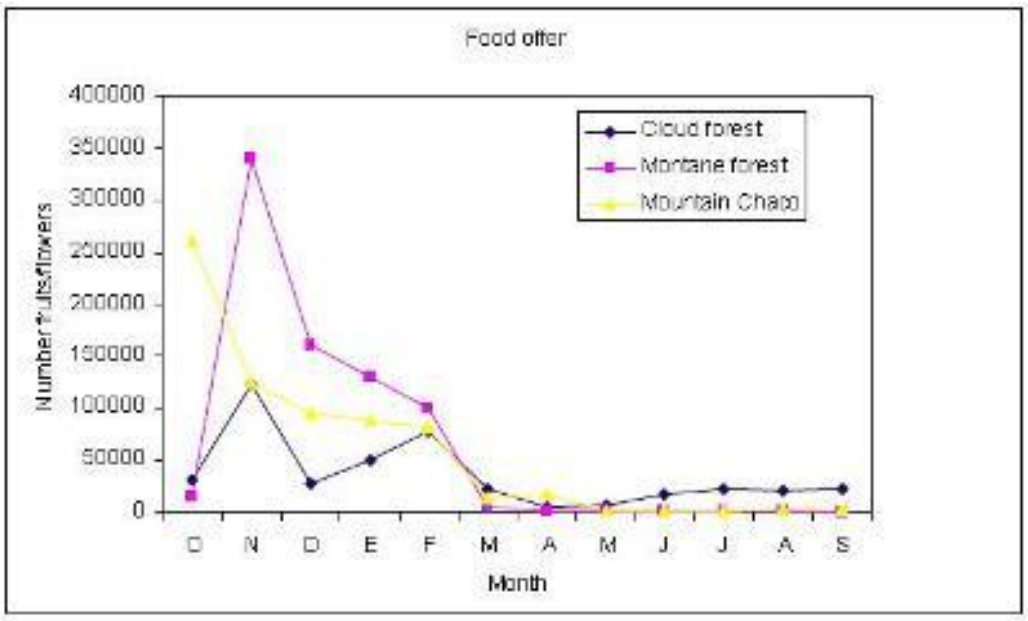

Figure 9. Availability of food items during October 2005 through September 2006 for Alder Amazon.

Figure 10. Alder Amazon feeding on *Junglans australis* flowers.

Conservation education

Through the conservation education campaign we gave talks to raise awareness of the conservation needs of Alder Amazon and the Yungas, and about the research project. In October 2005, we gave a talk in the Subtropical Seminar Series for students, professors, and a general audience**.** In August 2006, we went to the city of Rosario de la Frontera; Salta to talk in the Environment Meeting organized by GIMA NGO (Environment Research Group), there was a wide participation of teachers, students, government authorities, and a general audience. We also organized a short course for undergraduate students of the University of Jujuy in July 2006 where we focalized on biodiversity conservation projects in North-western Argentina; specifically we addressed the Alder Amazon Project. In all the talks we distributed the support material (brochures and posters) that give details on the project. We also published an article in Naturaleza y Conservación produced by Aves Argentinas NGO –the most important conservation NGO for the study and conservation of birds of Argentina. Additionally, we constructed the project´s webpage, which is maintained by CEBIO NGO **http://www.fundacioncebio.com.ar/proyectos/loro_alisero/proyecto-loroalisero.html**

Presentation in Scientific Meeting

We presented a poster at the XXII Argentine Ecology Meeting in Córdoba (August 25- 29, 2006).

Biología reproductiva del Loro alisero (*Amazona tucumana*) en la Sierra de Santa Bárbara, Jujuy, Argentina

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INTRODUCCION

El Loro Alisero (*Amazona tucumana*) es una especie endémica de los bosques de montaña tropicales y subtropicales de Argentina y Bolivia (Fig. 1), cuyo hábitat reproductivo es una delgada franja de bosques nublados (Fig. 2) sobre la ladera este de los Andes (Fjeldsa & Krabbe 1990), cuya ecología y biología reproductiva son poco conocidas. La especie ha declinado dramáticamente durante el siglo 20, debido a la pérdida de hábitat y al comercio, llevándola a ser considerada rara y amenazada (Collar & Juniper 1992) y aún no ha recuperado sus niveles poblacionales anteriores (Rivera et al. 2006). Para llevar adelante acciones efectivas de conservación y manejo del Loro Alisero es necesario conocer su productividad y éxito reproductivo. La información sobre este aspecto era casi inexistente, ya que sólo existía un registro de un nido en Chuquisaca, Bolivia (Bond & Meyer de Schauensee 1943).

OBJETIVO

Estudiar la biología reproductiva del Loro Alisero evaluando su productividad y éxito de nidos

MATERIALES Y METODOS

Área de estudio

El trabajo se llevó a cabo en la Sierra de Santa Bárbara, ubicada al Este de la Provincia de Jujuy (Fig. 3). Esta serranía contiene una representación de bosques nublados que han estado sujetos a explotación forestal en el pasado.

Búsqueda de nidos

Buscamos nidos en 250 ha de bosque nublado desde Noviembre de 2005 a Marzo de 2006. Los nidos fueron confirmados a través de su inspección con un sistema de minicámara. Cada nido fue monitoreado semanalmente para seguir su desarrollo, registrando la cantidad de huevos (Fig. 4), cantidad de pichones que eclosionaron (Fig. 5 y 6) y cantidad de pichones que volaron del nido (Fig. 7).

RESULTADOS

Encontramos 21 nidos de Loro Alisero: 15 (79%) fueron exitosos en producir volantones, 3 (15 %) fracasaron durante la incubación ya que fueron abandonados por causas desconocidas y 1 (5%) fracasó durante el crecimiento de pichones. En 13 nidos pudimos seguir el desarrollo desde huevo a volantones. El promedio de huevos fue 4.38±0.65, de pichones que eclosionaron por nido de 3.69±0.63, y de volantones de 3.23±0.83. El éxito de eclosión fue de 0.84 (proporción de huevos que eclosionaron) y el de volantones de 0.87 (proporción de pichones que volaron).

DISCUSIÓN

Estos son los primeros datos de éxito de nidos y productividad para esta especie. El tamaño promedio de nidada, el número de volantones por nido exitoso y el éxito de nidos fueron elevados comparados con otras especies de loros (Monterrubio et al. 2002).

CONCLUSIÓN

La productividad no estaría influenciando la recuperación de la especie, por lo tanto es necesario estudiar otros factores que pudiesen estar limitando sus niveles poblacionales.

LITERATURA CITADA

Fjeldsa J. & N. Krabbe. 1990. Birds of the high Andes. Zoological Museum, University of Copenhagen. **Collar N.J. & A.T Juniper.** 1992. Dimensions and causes of the parrot conservation crisis. En: New World parrots in crisis: solutions from conservation biology. S.R. Beissinger & N.F.R. Snyder (Eds) Smithsonian Institute Press. **Bond J. & R. Meyer de Schauensee.** 1943. The birds of Bolivia. part II. Proc. Acad. Nat. Sci. Philad. 95:167-231. **Monterrubio T., Enkerlin-Hoeflich E.C. & Hamilton R.** 2002. Productivity and nesting success of thick-billed parrots. Condor104:758-764. **Rivera L., N. Politi, & E. Bucher.** 2006. Decline of Alder Amazon *Amazona tucumana* in Argentina: present status and conservation needs. Oryx en prensa

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MANAGEMENT RECOMMENDATIONS

With our results to date we are able to give some preliminary information for the management of forest in sites outside of the National Park to conserve Alder Amazon, although we strongly suggest that further research should be conduct in these aspects to strengthen the conclusions. Our recommendations are:

1. When promoting the creation of a protected area the entire elevational gradient should be included in its designation. From our results it emerges that Alder Amazon nests in the cloud forest but it is dependent on lower elevations (montane forests) to provide food resources for their offspring.
2. It is necessary to maintain a representative sample of *Podocarpus parlatorei* in forests stands, since it seems to be a key feeding resource for Alder Amazon throughout the breeding season.

3. It is necessary to maintain a representative sample of *Podocarpus parlatorei*, *Blepharocalyx salicifolius, Juglans australis* and snags, since they represent key nesting sites for Alder Amazon. These trees are primarily the ones that contain cavities.
4. Trees with cavities of more than 0.60 m of *Podocarpus parlatorei*, *Blepharocalyx salicifolius, Juglans australis* and snags with cavities should not be harvested.
5. Conservation efforts should be put in El Rey National Park, since it contains the greatest population number of Alder Amazon and probably contain one of the last remnants of mature forest that serves as breeding habitat for the species.

BUDGET

Item	£	Spent £
Field expenses		
Batteries	45.00	20
Gas bottle for cooking-lighting	37.50	40
Insect repellent	80.00	70
Food 3 people for 186 days	1350.00	1260
Photographic films	40.00	60
Camera system	271.81	350
Maps to cover the study area	60.00	30
Fuel	400.00	580
4-wheel vehicle rental	1080.00	1080
Local guides and support	200.00	500
Post-Project expenses		
Brochures	600.00	300
Photography process	35.00	45
Report writing	100.00	50
Subtotal	**4299.31**	4385
Contingency (10%)	429.93	346
Total	**4729.24**	4731

FUTURE PERSPECTIVES

On September 26, 27, and 28, 2006 we detected in lower zone of El Rey National Park flocks of Alder Amazon that gathered in a roost. We were able to count approximately 6000 parrots, which represent the largest gathering known for the species (Fig. 11). The great number of individuals detected and the good conservation status of the cloud forest seem to suggest that the density of breeding pairs is very high in the Park. This encourages us to continue working in this protected area that seems a key area for the conservation of Alder Amazon and a control or reference area to compare other areas where human activities can affect its populations. We will continue our nest searches in the area to study survival and mortality patterns to obtain information of the key variables that affect the selection of nesting sites. We have already established phenology transects and this will allow us to continue our assessment of the availability of feeding items through the year and will allow us to understand food offer variation between years. We also think it is important to assess daily and seasonal movement patterns, which would allow us to understand the habitat use inside and outside the park.

Figure 11. Flocks of Alder Amazon gather to roost in the lower part of El Rey National Park.

We have started to work in collaboration with conservationists and researchers of Bolivia turning the project to a BI-NATIONAL PROGRAM FOR THE CONSERVATION OF ALDER AMAZON AND YUNGAS. We hope to stimulate administrators to develop strategic policies to implement legislation and conservation measures for the conservation of the species, i.e., the creation of new protected areas, or the enlargement of already existing areas. We have the opportunity to rise local community and other key sectors on the importance of the conservation of the Yungas using Alder Amazon as a flagship species.

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