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THE CHALLENGE OF ESTIMATING POPULATION TRENDS IN THE ENDANGERED PERUVIAN PLANTCUTTER (*PHYTOTOMA RAIMONDII*) AND IMPLICATIONS FOR CONSERVATION

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Resumen. – El reto de estimar tendencias poblacionales en la amenazada Cortarrama Peruana (*Phytotoma raimondii*) e implicancias para la conservación. – La Cortarrama Peruana (*Phytotoma raimondii*, Cotingidae), endémica al noroeste del Perú, está en peligro debido al incremento de la pérdida de su hábitat. Aquí describimos el ciclo reproductivo desde el que intentamos inferir patrones de su historia de vida y posibles estrategias de conservación. Capturamos y marcamos a 16 parejas en el Santuario Histórico Bosque de Pómac (área natural protegida) en el año 2011, de las cuales 15 permanecieron el año 2012. Buscamos y monitoreamos nidos (n = 19) de febrero a abril del 2012. La cortarrama es socialmente monógama y con un éxito de nidificación extremadamente bajo (0,879 day^{-1}, ES = 0,028) comparado con otras aves del Neotrópico. Los depredadores más importantes en el área de estudio fueron Ardilla de Nuca Blanca (*Sciurus stramineus*), Cucarachero con Ceja (*Cantorchilus superciliaris*) y Urraca de Cola Blanca (*Cyanocorax mystacalis*). Sugerimos que la alta tasa de depredación y la naturaleza ubicua de estos abundantes depredadores de nidos mantendrán tasas de éxito de nidificación bajas en este sitio y que el control de depredadores no sería una opción viable para su conservación. La reproducción también estuvo influenciada por cambios impredecibles del clima que pueden resultar en pausas reproductivas, resultando en un aparente periodo de nidificación bimodal. Entender la historia de vida de organismos poco comunes es difícil porque información adecuada que permita la estimación de la longevidad y éxito reproductivo requiere tamaños de muestra amplios y muchos años de colecta de datos, aspectos que pueden resultar imposibles de alcanzar para la mayoría de especies amenazadas. Sugerimos un enfoque de manejo adaptativo que se inicie con un incremento del hábitat disponible.

Abstract. – The Peruvian Plantcutter (*Phytotoma raimondii*, Cotingidae), endemic to northwestern Peru, is endangered due to increasing habitat loss. Here, we describe the breeding cycle from which we attempt to infer life history patterns and possible conservation strategies. We captured and marked 16 pairs of plantcutters in 2011 at the Pómac Forest Historical Sanctuary (a natural protected area), of which 15 pairs remained in 2012. We searched for and monitored nests (n = 19) from February to April 2012.

The plantcutter is socially monogamous with an extremely low nest success rate (0.879 day^{-1}, SE = 0.028) compared to other Neotropical birds. The most important predators in the study area are Guayaquil Squirrel (*Sciurus stramineus*), Superciliated Wren (*Cantorchilus superciliaris*), and White-tailed Jay (*Cyanocorax mystacalis*). We suggest that high predation rates and the ubiquitous nature of these abundant nest predators will maintain low nest success rates at this site and predator control is probably not a viable option for plantcutter conservation management. Reproduction was also influenced by vagaries of climate that may result in reproductive pauses, resulting in an apparent bimodal nesting period. Understanding life history of uncommon organisms is difficult, because good information that allows estimation of longevity and breeding success requires large sample sizes and several years of data, both of which may be impossible for most endangered species. We suggest an adaptive management approach that begins with increasing available habitat. *Accepted 12 June 2014.*

Key words: Peruvian Plantcutter, *Phytotoma raimondii, Cantorchilus superciliaris*, *Cyanocorax mystacalis*, *Glaucidium peruanum*, *Sciurus stramineus*, daily survival rate, MARK software, population viability analysis, Santuario Histórico Bosque de Pómac, Tumbesian Region.

INTRODUCTION

The Peruvian Plantcutter (*Phytotoma raimondii*, Cotingidae) is endangered due to habitat loss in the lowland woodlands of northwestern Peru. This plantcutter is sexually dimorphic, territorial, and specialized in feeding on leaves, along with some fruits and flowers (Nolazco & Roper 2013, Liñán & Nolazco 2013). Of the three species of plantcutter, the Peruvian Plantcutter has, by far, the smallest range, which is restricted to a small portion of the Endemic Bird Area (EBA) Tumbesian Region in northwestern Peru (hereafter TR) (Best & Kessler 1995, Flanagan *et al.* 2009). Within the TR, the plantcutter is found in the dry coastal region from near sea level to about 550 m in association with dry shrublands, scrublands, and open canopy forests with dense understory and nearly closed-canopy forest with shrubby understory (Collar *et al.* 1992). Historically, its distribution comprised the entire coastal region, where habitat was available, from the department of Tumbes in the north to Lima in the south. Today, its range is much restricted, no longer reaching Lima, but rather the southern limit is now Ancash, and strongly aggregated habitat remaining is rapidly disappearing (Flanagan *et al.* 2009, Sánchez *et al.* 2012; Fig. 1).

The habitat of the plantcutter is threatened throughout its current range due to uncontrolled deforestation for charcoal, firewood and construction material; agriculture and livestock grazing (goat, sheep, and cattle) along with urban expansion. Today, a mere ~ 5% of the original forest remains in the TR and that is often degraded (Best & Kessler 1995). Nonetheless, the remaining habitat may still support the plantcutter, which, for unknown reasons, is absent from many areas of apparently suitable habitat (Schulenberg *et al.* 2007). Understanding its habitat requirements is important so that the conditions that favor, and inhibit, occupancy by the plantcutter may be identified. A few recent studies are revealing the importance of some habitat resources suggesting strong dependence (Rosina & Romo 2012, Nolazco & Roper 2013, Liñán & Nolazco 2013) but more research is still needed to explain the actual distribution of the species and to develop an integrated conservation strategy.

Here, we attempt to provide important information for understanding population dynamics by examining the breeding cycle of the Peruvian Plantcutter. We estimate whether reproduction is sufficient to maintain the population (birth and survival to fledging

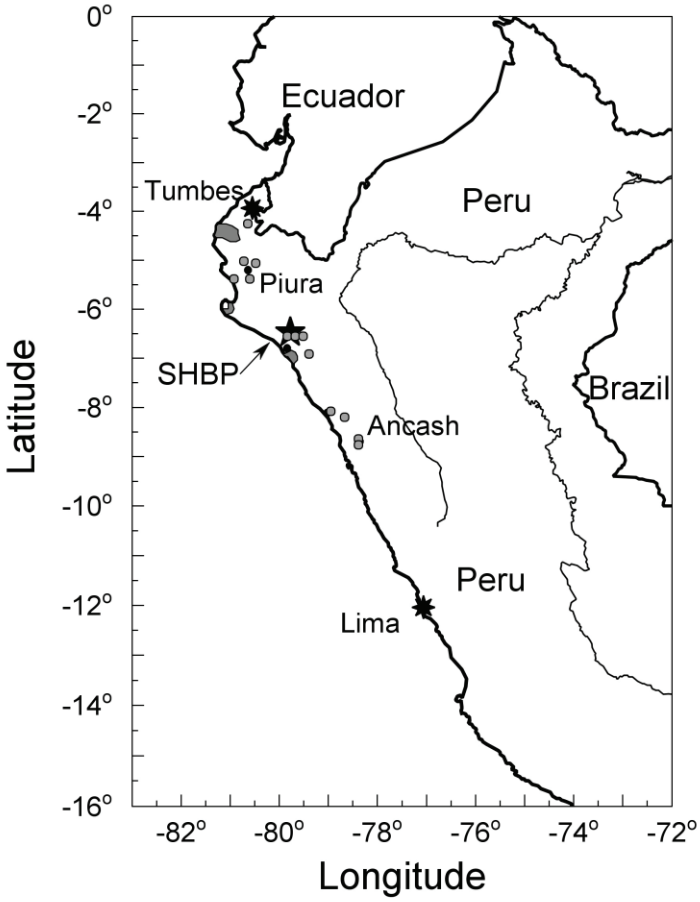

FIG. 1. Current approximate distribution of the Peruvian Plantcutter (*Phytotoma raimondii*). Darker gray areas indicate where known populations can be found and the star indicates the Santuario Histórico Bosque de Pómac (SHBP), where this study took place. Please note that at this scale, not all locations where the plantcutter may be found are visible.

at least equal to mortality). Using this information, we deduce which part of the life-cycle is most at risk for the plantcutter and thus is most in need of protection. We discuss population viability analysis based on these data.

METHODS

Study area. The study area is within the protected area known in Peru as the 'Santuario Histórico Bosque de Pómac' (Pómac Forest Historical Sanctuary, hereafter SHBP, 5887 ha, Fig. 2) and was chosen because of its population of plantcutters (Nolazco *et al.* in prep.). The SHBP is one of the last strongholds of the plantcutter (BirdLife International 2013) and the only place where it is actively being protected. The SHBP is in the lower Lercanlaech River watershed in NW Peru, in the department of Lambayeque (06°28'25"S, 79°46'35"W). Climate, as elsewhere in the plantcutter range, is hot, with a monthly average high temperature of 33.1°C (February, March) and low of 11.5°C (July, August). Rainfall is low and very sporadic with an annual average of 108 mm with rare years (during ENSO) reaching 1500 mm. As a consequence, droughts of several years are common between ENSO events. Vegetation is dominated by the trees algarrobo (*Prosopis pallida*, family Fabaceae), sapote (*Colicodendron scabridum*), and the shrub vichayo (*Capparis avicennifolia,* the latter two in the family Capparaceae). Other common plants that are strongly aggregated include the tree faique (*Vachellia macracantha*, family Fabaceae, abundant along the Lercanlaech river) and the shrub canutillo (*Grabowskia boerhaaviaefolia*, family Solanaceae, common but patchy in northeastern SHBP). Forest types are typical of the region, from closed canopy with sparse understory, open canopy with shrubby understory to low vegetation with as little as 14% tree cover (SERNANP 2011).

Main threats to the SHBP are logging of algarrobo (*Prosopis pallida*) and faique (*Vachellia macracantha*) and livestock grazing. Today, these impacts are at least partially controlled by the park guards; nonetheless deforestation was intense between 2001–2009, and resulted in the abuse of 1706 ha (nearly 30% of the SHBP). Attempts at resolving the problem and reforestation began in 2009 and the SHBP seems to be gradually recovering (SERNANP 2011).

Capture and marking. In February and March 2011, we used mist-nets (12 m long x 2.5 m high x 25 mm mesh) to capture Peruvian Plantcutters. Because the objective in banding was to mark adults, no systematic organization for net layout or timing was used. Two to five nets were placed in non-overlapping territories (Nolazco *et al.* in prep.) and birds were attracted to nets by playback. Males were usually quickly captured, females less so, and all were marked with a unique combination of anodized aluminum color bands for later visual identification. Three breeding pairs also had radio transmitters (1.2 g transmitters, 4 mo battery life; Advanced Telemetry Systems, www.atstrack.com) installed in March 2012. Five of their nestlings (successful clutches from just two breeding pairs) also received transmitters (0.9 g transmitters, 3 mo battery life) to follow dispersal after fledging. Transmitters weighed about 3% of adult weight and less than 2% of fledgling weight (Fair *et al.* 2010). Transmitters were placed just below the interscapular region with Loctite© superglue (Henkel Corporation, Rocky Hill CT) following Raim (1978).

The breeding cycle. Nest searches were carried out from February to April 2012 by searching appropriate substrates and following adults to nests. Once nests were found, we checked them daily, or every other day, to note details of the nesting cycle, including time intervals for construction, egg-laying, incubation, nestling period and success. In two nests that were logistically difficult to check daily, we used changing temperature (by data-loggers, 2-channel Hobo H8, Onset Computer Corporation) to determine when these nests failed (Hartman & Oring 2006). Behavior at nests was occasionally observed from a blind using a 20–60x spotting scope at varying distances, but always far enough to avoid interfering with the nests. Daily survival rate of nests was calculated using the program MARK (White & Burnham 1999, Dinsmore *et al.* 2002). To identify potential nest predators we placed two camera traps at artificial nests with one quail egg each, in different territories for 10 days or until predation occurred (the nest was also checked daily). Once 10 days passed, or predation occurred, we moved the cameras and nests to new territories. Artificial nests were in similar locations to those of nests of the plantcutter.

RESULTS

A total of 16 pairs of birds were captured and marked in early 2011. Of these, 15 pairs were still in the same territory in March 2012. The male of the other pair disappeared and the female found a new mate by two weeks after the loss of the first (Fig. 2). Thus, the plantcutter is socially monogamous and apparently forms long term pair bonds.

*Nests***.** A total of 19 nests were found active in 2012, the first of which was found on 7 February 2012, and the last day a nest was active was 25 April 2012, for a breeding interval of 79 days. Meanwhile, no new nests were initiated between 1–28 March; we think this due to vagaries of climate in this extreme environment. Perhaps bimodal nesting periods may sometimes occur, when the breeding season is interrupted by a short period of extreme weather. Nests (flimsy cup-shaped) were in *G. boerhaaviaefolia* (n = 11), *P. pallida* (4), *C. avicennifolia* (2) and in contact with branches of both *G. boerhaaviaefolia* and *C. avicennifolia* (2). All nests were in the middle, or above the middle, of the plant (1.6–8.5 m) in a fork or where several branches overlap (details on nests in Nolazco & Roper 2013).

We did not have complete dates for all parts of the nesting cycle (all active nests were monitored) so we can estimate minimum time intervals. For example, construction can take more than a week (n = 4). Most nests were found during construction (n = 4), or incubation (n = 9) in February. Eggs are laid daily and the modal clutch size was three (range 2–4). With 16 days incubation (one nest was followed throughout incubation) and 15–16 days for nestlings (two nests were followed throughout this phase), total nesting interval from the laying of the first egg to fledging takes about 34–36 days.

Nesting success. Only two of 19 nests were successful (~ 10%) producing a total of five young. Two of the 19 were renesting attempts. Sixteen of the 17 failed nests were lost to predation and the other was abandoned, probably due to adverse weather. Both radio-tagged adults of that nest were subsequently found elsewhere. An unusual dry spell at the end of March (when it normally rains) resulted in leaf loss (perhaps due to a combination of drought and sphingid moth caterpillar herbivory) of the very important canutillo (a very important food resource, Liñán & Nolazco 2013). All adults had left the eastern portion of the study area (where all captures took place and 15 nests were monitored) when the abandoned nest was found. The radio-tagged adults were subsequently found 3–4 km from where they were captured, still within the SHBP (around northwest site in the study area polygon, Fig. 2), where canutillo leaves, flowers and fruit were still available. This is also where all the final nesting attempts were found, in April (n = 4), none of which was successful.

Nest survival rate was estimated at 0.879 day^{-1} (SE = 0.028, 95% CI = 0.811–0.924). Daily survival rate was apparently constant over the time interval (ΔAICc = 130 for the model that includes time when nesting occurred and which was the second most parsimonious model). While time was unimportant, four nests failed during egg-laying, 12 nests failed during incubation, and only one failed due to abandonment during the nestling phase (radio-tagged adults were subsequently located as detailed in the paragraph above).

Potential and real nest predators in the area include White-tailed Jay (*Cyanocorax mystacalis*, observed preying on eggs of another bird species), Superciliated Wren (*Cantorchilus superciliaris*) and Guayaquil squirrel (*Sciurus stramineus*) (both caught by camera trap at artificial nests), and Peruvian Pygmy-Owl (*Glaucidium peruanum*, observed eating nestlings of

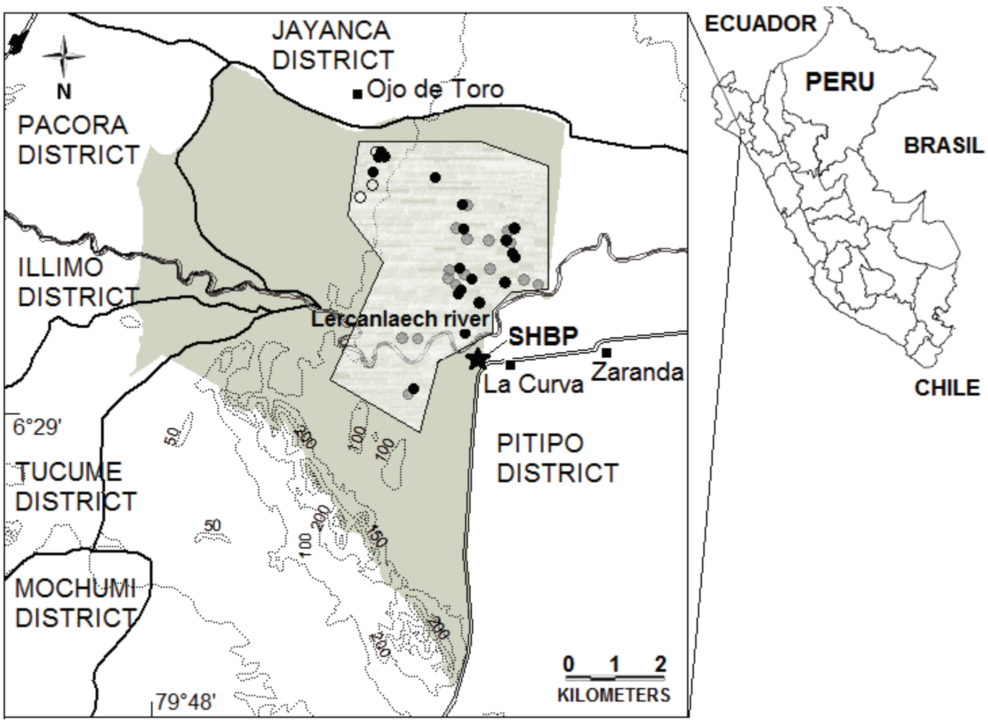

FIG. 2. Location of the SHBP (larger area with gray background) and study area (lighter gray polygon within the SHBP). Small gray circles indicate captures, small black circles indicate active nest locations and empty circles indicate tagged pairs relocations. Numbers indicate elevation (m a.s.l.) of contour lines.

an unidentifiable bird and nestlings of the Croaking Ground-Dove *Columbina cruziana*). Both squirrel and wren were photographed preying eggs at four of nine artificial nests during ~ 70 camera-trap days in seven territories. For plantcutters, just three out of 17 failed nests showed clear signs of the predator -in the rest, the eggs simply disappeared. Eggs in two of the nests were perforated with small holes typical of those made by wrens (1–4 mm) and egg shell fragments were found on the ground beneath another nest, similar to those preyed on by squirrels at the nests monitored by camera traps.

*Parental care***.** While only the female incubates, both sexes share all other aspects of nest construction and caring for the nest and young. After an egg is laid, the nest is left unattended until time for the subsequent laying. During incubation, the interval of time the female is off the nest varies from 1–5 min (average = 3.5 min), and incubation bout duration varies from 3–105 min (average = 41 min, n = 2 nests monitored during three consecutive days each from 08:00 h to 12:00 h). Subsequent behavioral observations at these two successful nests were carried out from 09:00 h to 16:00 h for a total effort of 44 h (6 h at one nest, 38 h at the other). While the female is brooding, or when she is foraging, the male remains near the nest (apparently monitoring the nest). Parents also eat nestling feces throughout the nestling phase.

Apparently only the male actively defends the nest (by chasing intruders). Males were seen chasing Long-tailed Mockingbirds (*Mimus longicaudatus*), Superciliated Wrens (*Cantorchilus superciliaris*), Necklaced Spinetails (*Synallaxis stictothorax*), and once a Harris' Hawk (*Parabuteo unicinctus*) that was soaring above the nest (c. 8–10 m). Defense against the hawk was only vocal, with short fast flights towards, but not very near, the hawk (accompanied by a Long-tailed Mockingbird that was nesting nearby). Mockingbirds and spinetails were caught (camera trap) once each taking out nest material directly from the artificial nests.

For the first few days after fledging, the young birds stayed within 10 m of the nest, where parents continued to feed them and consumed their feces. The adult male was usually nearby at this time. Young soon begin feeding themselves (while still fed by adults) and by the first week fly short (~ 10 m) distances accompanied by the adults. Young birds stayed within their natal territory for at least 20 d, after which time we were unable to continue monitoring them. A month after fledging we attempted to find young birds but transmitters were lost due to feather growth. This is in contrast to adults, who retained transmitters for up to four months (the battery lifetime) when these were recovered by recapture.

DISCUSSION

Nesting success (0.879 day^{-1}, SE = 0.028) is alarmingly low for the Peruvian Plantcutter, and lower than that reported for Neotropical birds in general. At the observed nest success rate of 0.879 day^{-1} and with approximately 35 day nest exposure, the expected proportion of successful nests is a mere 0.011 (~ 1%, 95% confidence interval of 0.07% to 6.4% success). While this low rate is estimated for only one season, the upper limit of the 95% confidence interval (0.924 day^{-1}) is still low (Ricklefs 1969, Skutch 1985, Lima & Roper 2009, Roper *et al.* 2010). With this nest failure rate, adult survival would have to be extremely high (> 85% yr^{-1} if we take two nest successes in a total of 17 pairs for one year and a total of five offspring produced that survive to adulthood) for the population to be stable (Karr *et al.* 1990, Thompson *et al.* 2001, McGregor *et al.* 2007). We believe that high predation rate and the ubiquitous nature of the nest predators, together suggest that nest success will remain low at the SHBP. The absence of some predators (e.g. squirrels) along with greater food availability, may result in greater nest survival rates and a longer breeding season, which is likely in the Province of Ascope (department of La Libertad) where nests are more common (SN pers. observ.).

Predators of plantcutter nests (Guayaquil Squirrel, White-tailed Jay, and Superciliated Wren) are common not just in forests, but also in many agricultural landscapes and often in urban areas (SN pers. observ., Nolazco & Flynn in prep.). Thus, predator control is probably not a viable option for conservation management of this species. Recognizing that nest predation is probably not amenable to control, the best management strategies should include increasing available habitat and promote adult survival that will be required to allow repeated nesting attempts (Roper *et al.* 2010).

A maximum of two successful nests per pair per year might occasionally be possible, considering the time interval of the breeding season (early February to late April). Also, if a pair remains unsuccessful by late March or April, insufficient time probably remains to rear another successful clutch and thus, a maximum of one successful nest per year is most likely (Roper 2005, Lima & Roper 2009, Roper *et al.* 2010). It seems that breeding begins in January (one nest was seen under construction and one with eggs, but neither was monitored), which may imply a somewhat longer breeding season, but not enough to allow another successful nesting attempt. In a year with greater rainfall (ENSO years), perhaps the breeding season is extended even more, which might result in greater success as well, with more abundant resources. This idea will need testing during an ENSO breeding season, because it is also possible that predators become more abundant at that time.

Since habitat for nesting is also habitat for foraging, a better understanding of plant phenology and growth, and diet selection throughout its range will be required to understand how to manage habitat to favor the establishment of territories. Also, greater vegetation density and more complex structure may reduce predation rates (Martin & Roper 1988). The impact of, and balance between, the many drought years and few rainy years, must also be studied to understand long-term population dynamics.

For the endangered Peruvian Plantcutter, and presumably other threatened and uncommon species, gathering data to determine the population parameters required to understand population dynamics is nearly impossible (Roper 2006). Nest predation rates are high and population densities are low, and small populations are scattered over a large area (Flanagan *et al.* 2009, Nolazco *et al.* in prep.).

These are the challenges to gathering data for declining populations of organisms. With few data, not only researchers but also managers question their validity as well as conclusions derived from those data (Lima & Roper 2009). In our title we imply that estimating nesting success is difficult and it is, but estimating adult longevity is even more difficult. While we banded several adult birds, sample size and other conditions for successful research and financial security to insure continued study for several generations with high quality estimates of adult survival are not forthcoming. We presume that this is a problem common to most studies of endangered plants and animals. Ironically, the recommendations for successful population viability studies all suggest multi-year, detailed life-history data, and well-justified assumptions (Morris *et al.* 1999, Wintle 2013). Because we do not have these data, and hence are unable to calculate a reasonable population viability estimate, we suggest an adaptive management approach (Meffe *et al.* 2002) to be implemented as soon as possible. Especially, as in the case of the Peruvian Plantcutter, adaptive management would include the simple act of begin planting those species that will be used for both foraging and nesting. It is critical that this simple management strategy be implemented, because ongoing reduction in available habitat and the few, scattered reports of the Peruvian Plantcutter, together suggest that this species may be in greater danger than is currently recognized.

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