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Behavioral plasticity of a threatened parrot in human-modified landscapes

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ABSTRACT

Behavioral plasticity is a strategy employed by many species to cope with both naturally occurring and human-mediated environmental variability. Such plasticity may be especially important for long-lived and wide-ranging species, such as parrots, that likely face great temporal and spatial variation within their long lifespans, and are often disproportionately affected by anthropogenic habitat change. We used radio-telemetry and roost counts to assess ranging patterns, habitat usage, and roosting behaviors of the Yellow-naped Amazon (*Amazona auropalliata*) at two sites in northern Costa Rica with different degrees of anthropogenic habitat alteration. We compared behaviors for residents at the two sites and for experimentally translocated individuals to test the hypothesis that this species would employ behavioral plasticity in response to habitat differences. We found that individuals in the region with dispersed vegetation recorded ranging movements and communal roosting behavior ten times larger than the region with concentrated vegetation. Translocated individuals showed flexibility in these behaviors and matched the behavioral patterns of resident birds at the release site rather than maintaining behaviors characteristic of their capture site. Our results illustrate a generalized rapid plastic response to human-induced changes in habitat for a number of behavioral traits in the Yellow-naped Amazon. Such plasticity is directly relevant to reintroduction efforts that are commonly employed as a conservation tool in parrots. Our study provides an example of how behavioral plasticity may allow some wild populations to withstand anthropogenic change.

1. Introduction

Variability in resource availability is widely recognized as a factor affecting the movement patterns and habitat preferences of animals. Food resources, such as fruits, may show temporal and spatial fluctuations in abundance within and among different habitats (Blake and Loiselle, 1991; Karr, 1976; Levey, 1988; Renton, 2001). Animals may respond to these fluctuations through behavioral plasticity such as seasonal movements (Levey, 1988; Levey and Stiles, 1992; Loiselle and Blake, 1991), modification of local movements (Renton, 2001; Rey, 1995; Saracco et al., 2004), diet switching (Galetti and Pedroni, 1994; Gautier-Hion, 1980), or social living strategies (Richner and Heeb, 1995; Ward and Zahavi, 1973). The influence of food resource fluctuations in animal movement is so profound that it has been suggested as an evolutionary factor predisposing Neotropical birds to perform long-distance migrations (Levey and Stiles, 1992).

Understanding the response of animals to resource fluctuations has taken on a new urgency with the pervasive and severe changes in the environment caused by human activities. Species may differ in the degree and rapidity with which they are able to modify their behaviors when facing human-induced changes in the environment (Tuomainen and Candolin, 2011; Visser, 2008). Some species may exhibit a high degree of plasticity in the phenology of life history traits and distribution range when facing new environmental conditions (Crozier et al., 2008; Tuomainen and Candolin, 2011; Walther et al., 2002). Conversely, in other cases animals may lack a plastic response to environmental changes, causing a mismatch between a species' traits and the new conditions (Both et al., 2006; Edwards and Richardson, 2004). While behavioral plasticity is normally expected to positively impact fitness, this response may sometimes be maladaptive. An example of this maladaptive behavior are ecological traps, in which individuals use human-modified habitats that appear to be high-quality but are in fact low-quality in function (Robertson and Hutto, 2007). The degree to which animals can adapt to anthropogenic change may be determined in part by the degree to which they are plastic in their behavioral responses to historic environmental variability.

Parrots (Order Psittaciformes) are social birds with a largely tropical distribution (Forshaw, 1989) and a high degree of conservation concern (Snyder et al., 2000). They are seed predators that typically range over large areas to locate fruits and seeds that are

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heterogeneously distributed in space and time (Renton, 2001). As such, their behavior likely reflects adaptations for responding to fluctuations in resource distributions. Previous research in both Neotropical and Australasian parrots (Ortíz-Maciel et al., 2010; Salinas-Melgoza, 2003; Saunders, 1980, 1990) indicates that low resource environments may trigger an increase in the magnitude of their movements. Many species, both invasive and native, will also use human-altered landscapes and the resources available therein for foraging, roosting, and nesting (Eberhard, 1998; Manning et al., 2009; Manning and Lindenmayer, 2009; Nally and Horrocks, 2000; Saunders, 1980, 1990). These traits may predispose parrots to exhibit flexibility in their behavioral response to either natural or anthropogenic changes in habitat and resources availability. However, the fact that habitat modification is one of the main factors threatening wild populations of a large number of parrot species (Snyder et al., 2000) suggests that not all species are capable of such behavioral plasticity, or alternatively, that there are threshold levels of habitat modification beyond which parrots cannot respond with behavioral plasticity. Therefore, studies focusing on behavioral plasticity in response to anthropogenic change will help determine when and to what extent such plasticity can occur and improve our understanding of conservation threats and solutions for this highly endangered avian order.

The Yellow-naped Amazon (*Amazona auropalliata*) is a parrot species that inhabits the tropical dry forest of the Pacific slope from southern Mexico to northern Costa Rica. It is categorized as vulnerable by IUCN, mostly due to habitat loss (IUCN, 2012). Like many parrot species it gathers in large communal night roosts from which it disperses in smaller groups to forage widely during the day. In northern Costa Rica, the tropical dry forest exhibits a seasonal pattern of resource availability and a considerable degree of human-induced habitat modification (Edelman, 1992; Janzen, 1967). There are also marked geographic differences in the spatial distribution of vegetation patches and hence density of resources that result from different land-use strategies (Edelman, 1992). Population genetic studies (Wright et al., 2005; Wright and Wilkinson, 2001) and tracking data (A. Salinas-Melgoza and T.F. Wright, unp. data) suggest that individual Yellow-naped Amazons travel widely across these different land use areas, potentially exposing them to changes in the environment as they move. Hence, individuals might benefit from modifying resource exploitation strategies such as habitat preferences, and roosting and ranging behaviors in different areas. Plasticity in their vocal behavior has been observed when changes in social environment occur (Salinas-Melgoza and Wright, 2012).

The goals of this study were: (a) to evaluate the behavioral strategies for ranging and roosting used by radio-tagged Yellow-naped Amazons to maximize foraging efficiency in the tropical dry forest of northern Costa Rica, and (b) to determine the degree of plasticity in habitat preferences, and the movement and roosting behavior of this parrot species in human-altered landscapes under two land-use regimes. We compared radio-telemetry data of resident birds captured in ranching and farming sites in Guanacaste, Costa Rica to examine the behavioral responses performed by parrots to local conditions. We also looked at the plastic response in the behavior of birds experimentally translocated from the farming to the ranching site.

2. Materials and methods

2.1. Study area

The study was conducted at the southern distributional limit of the Yellow-naped Amazon in the tropical dry forest of the Guanacaste Province of northwestern Costa Rica (Fig. 1). The topography in the northern region of this Province is slightly hilly with well drained soils (Vásquez-Morera, 1983), which supports predominantly sub-deciduous forest along with premontane moist forest in some areas and a limited gallery forest along water-courses (Hartshorn, 1983). In the southern region of the Province, two landscape units can be distinguished with vegetation differing in structure. The highlands sub-deciduous forest is similar to that found in most of the northern region, while the lowland sub-deciduous forest occurs on the poorly drained soils of the Tempisquito River basin. This lowland sub-deciduous forest is reported to have a combination of a taller, greener dense riparian vegetation combined with swamps in flooded areas (Gordon et al., 1974; Hartshorn, 1983). The rainy season occurs from June to November, and accounts for 85% of the 1656 mm average total annual rainfall for 1980–2009 in Santa Rosa National Park in the northern region (M. M. Chavarria-Díaz, pers. comm.).

Much of the vegetation in this portion of Costa Rica has been altered by human activities, leaving a landscape mosaic of primary forest, human-managed areas, and regenerating patches (Edelman, 1992). The differing economic activities in the northern and southern regions are reflected in region-specific changes in the distribution of the vegetation. The northern region of Guanacaste is dominated by cattle-ranching, with remaining patches of natural vegetation of mainly tropical dry forest in long strips along creeks embedded in an extensive grassland matrix with scattered trees (Hartshorn, 1983; Tosi, 1969). In the southern region, management for intensive agriculture has resulted in clustered remnant patches of dense riparian forest surrounded by large areas of crop fields, a human settlement, and the original highlands sub-deciduous forest. These two regions are located about 30 km apart and separated by urban/industrial areas around the town of Liberia (Fig. 1). The ranching site is composed of two contiguous cattle ranches known

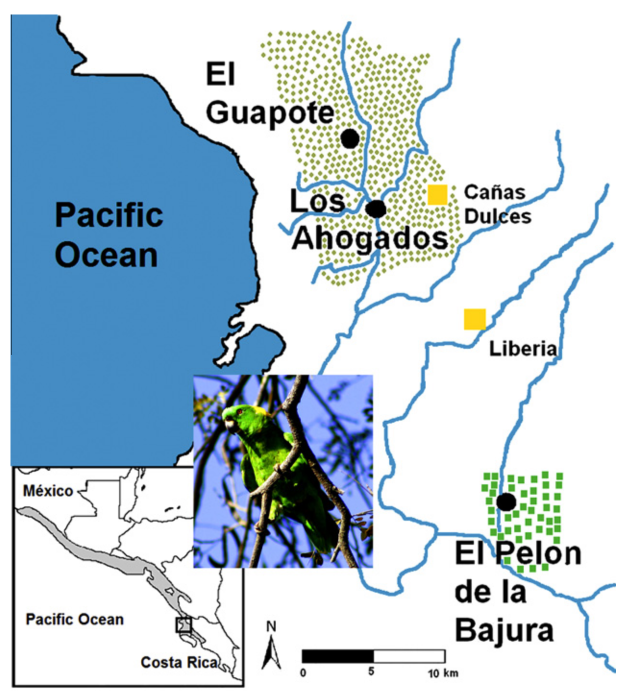

Fig. 1. Location of the two study regions in northern Costa Rica. Small green-rounded dots indicate the ranching region and green-squared dots indicate the farming region. Blue lines indicate streams, large black dots indicate roosts where trapping was performed, and yellow squares indicate towns. Inset indicates location of depicted area in the distribution range of the Yellow-naped Amazon (gray shading). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)