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Letter to editor

Conservation of paramo birds in Ecuador in the face of climate change: on the need for a detailed classification of high-altitude habitats

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When we think of "the paramo" most of us would think of waves of grass moving in the wind. However, our concept of paramo is limited by the lack of prehistoric data on what this ecosystem would have been like in the absence of human activity. Throughout the Holocene, humans have been part of the Andean landscape, shaping it through fire and by hunting important herbivores, such as deer and cottontails. Pollen records are scant due to glaciers having scraped high Andean lakes and peatlands off the landscape. What we find today at high altitudes is not "one paramo" but "several types of paramo" that are likely the result of various intensities of human activity. The different vegetation forms we see today are habitats for various birds within the ecosystem. The classification of vegetation for the Ecuadorian Andes by Sierra [1] recognizes several high Andean plant assemblages, yet these do not accurately describe the diversity of plant communities vis-à-vis avian habitats.

For instance, the Antisana paramo is composed of a mixture of plant formations not recognized in previous classifications [2] that birds depend on for at least one life stage.

Figure 1. The only Ecuadorian population of *Theristicus branickii* is found at the southern border of the Cayambe National Park, south of the Cotopaxi National Park. They are most commonly encountered in the meadows of the Antisana Water Conservation Area. Foto: Markus P. Tellkamp

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Figure 2. Known locally as curiquingue, *Daptrius carunculatus*, can be easily seen by the dozens in meadows and low grasses at the Antisana Water Conservation Area. In other paramos, fewer than five individuals are usually seen during a bird-watching day. Foto: Markus P. Tellkamp

Figure 3. Bogs and high Andean lakes are important resting and feeding sites for Nearctic migrants, such as the *Tringa melanoleuca* (Greater Yellowlegs) feeding at the Santa Lucía lake at 4300 meters. Foto: Markus P. Tellkamp

Figure 4. A *Muscisaxicola alpinus* perched on a rock near human habitations where this species is frequently encountered. Foto: Markus P. Tellkamp

Figure 5. A *Cinclodes albidiventris* feeding near human habitations where it is common. Foto: Markus P. Tellkamp

Paramos are island-like ecosystems for those bird species that depend on them [3]. Due to global warming, the islands are moving upslope and, therefore, will begin to shrink in size. According to one study on the Chingaza National Park in Colombia, the area of paramo might contract by 39 to 52% within the next 50 years [4]. If numbers are similar throughout the extent of paramo ecosystems, island biogeography predicts that the number of species on diminishing islands will decline.

Given the degree of specialization of some paramo birds and the expected decline of paramo habitats, the small number of threatened birds according to the IUCN is surprising. Detailed studies on bird habitat selection in paramo are required for better threat assessments. Four points need to be considered. 1) Some bird species depend on habitats that have not been recognized as different, even though they appear to be very important to birds. 2) Some habitats are likely to experience major changes in the future. 3) Several species appear to be more common than they really are. 4) Most studies on Ecuadorian paramos have been conducted in the same protected areas and thus do not inform us on bird responses to the anthropogenic pressures experienced by these ecosystems elsewhere.

1) Two meadow habitats that appear to be of great importance for several species, such as *Theristicus branickii* (Andean Ibis; Figure 1) and *Daptrius carunculatus* (Carunculated Caracara; Figure 2), but are not recognized in current vegetation classifications. Without these two meadow habitats, we hypothesize that these two species might drastically decline in the Antisana Hydrological Conservation Area. Presently, we are botanically characterizing these habitats. Deer also preferentially spend time in these meadows [2]. In the sense that *Vultur gryphus* (Andean Condor) depends on *Odocoileus virginianus* (White-tailed deer) carrion, as cattle have been removed from this area, this huge bird also greatly depends on these two vegetation types.

2) Paramo habitats and microhabitats will likely change soon, as all life-forms respond to climate change. In addition, the extent of paramos will decline as all ecosystems move upslope. These changes will also influence the interaction between birds and their habitats. For instance, paramo hummingbirds, especially *Oreotrochilus* spp. (*Oreotrochilus chimborazo* and *Oreotrochilus cyanolaemus*) depend heavily on plants such as *Chuquiraga jussieui* and will closely track that plant species for as long as the changes of the plant's distribution does not interfere with the bird's physiological tolerance limits. As a second example and as previously mentioned, *T. branickii* appears to have a strong preference for meadows. Nearly all our observations of this species made over several years were in this habitat. As meadows transform into other vegetation types, the ibis is likely to disappear. The habitats associated with the lagoons and peat bogs are important for aquatic species and shorebirds, which includes several migrant species (Figure 3). Most glaciers, however, will retreat or even disappear (see [5] for Antisana Volcano), and precipitation is expected to increase and decrease during the wet and dry seasons, respectively, within a few decades [6].

3) Our current state of knowledge on paramo birds are based on a few detailed studies as well as casual observation and personal experiences. This leads to at least three sources of bias.

A. Some species that are common near human structures such as houses and roads, do not seem to be that abundant once you move away from human-made structures. These species include *Musasaxicola alpinus* (Plain-capped Ground-Tyrant; Figure 4) and those belonging to the genus *Cinclodes,* such as *C. excelsior* (Stout-billed Cinclodes) and *C. albidiventris* (Chestnut-winged Cinclodes; Figure 5). Sites where they are usually seen include bare ground and outcrops where perhaps local temperatures are slightly higher due to the warming of the rocks.
B. Very few studies have been conducted in paramo habitats outside of natural reserves [7]. Thus, we do not have an accurate picture of population trends in large swaths of paramo ecosystems that bear a larger human footprint. Observations uploaded on eBird (https://ebird.org/home), for example for *Cinclodes* spp., *Muscisaxicola alpinus*. and *T. branickii*, are spread over a great area, although there are many gaps.

Apart from observations that are obviously erroneous, most observations are from within nature reserves and near roads.

C. As a consequence of the previous points, bird population estimates and tendencies for the assessments of threat seem to be biased by the observer's perception of "commonness" rather than by analyses that consider (micro)habitat selection and rigorous scientific designs.

We are concerned that current classification by the IUCN underestimates the level of threat faced by paramo birds. Of the 26 species that depend to a large degree on paramo habitats, 88% are considered Least Concern. In total, 31% have declining populations of which 63% are in Least Concern category (Table 1). Given the above discussed biases, we might be overlooking population declines in understudied and unvisited areas. In Ecuador, 19% of the species whose primary habitat is paramo are in a higher category of threat compared to the global red list (Table 2). Of the seven species assigned to a threat category, six are currently declining, according to Freile et al. [8]. At least in Ecuador, confidence in the long-term conservation of these species is somewhat more pessimistic. In this sense, bird populations considered stable could be declining, and populations expected to decrease may have steeper declining rates than today's estimates suggest. Therefore, species within a particular threat category possibly should be in a more worrying category. Similarly, species that do not seem to be threatened should be assigned to a UICN category [8,9,10].

Global Red List Category	Number of Species (Percentage)	Population Tendency	Number of Species (Percentage)
LC	23 (88.46%)	Stable	14 (53.85%)
		Decreasing	5 (19.23%)
		Increasing	2 (7.69%)
		Unknown	2 (7.69%)
NT	2 (7.69%)	Decreasing	2 (7.69%)
CR	1 (3.85%)	Decreasing	1 (3.85%)

Table 1. Ecuadorian paramo-dependent bird species within threat categories and their population tendencies.

	Category	Number of Species (Percentage)
Global Red List Category	LC	23 (88.46%)
	NT	2 (7.69%)
	CR	1 (3.85%)
Ecuador Red List Category	LC	19 (73.08%)
	NT	1 (3.85%)
	VU	2 (7.69%)
	EN	2 (7.69%)
	CR	2 (7.69%)

Table 2. A comparison of species in threat categories for global and Ecuador specific assessments.

We simply lack good population estimates for an environment that is expected to see profound changes within the next 100 years [4]. It is necessary to analyze the current situation in the paramos of Ecuador as well as Colombia, Perú and Venezuela. We urgently need comparative studies that allow us to properly model future changes in the populations of paramo birds and enhance our understanding of the contribution of local (habitat) versus large-scale (climate) factors. An innovative approach for predicting future population changes is warranted that considers novel definitions of paramo habitats, specific habitat requirements of birds, and the reduction of areas with paramo area due to climate change. Methodologically, besides random sampling, experimental design must include stratification to produce accurate and precise population size estimates with low variance in variables of interest [11,12]. Stratification, of course, requires well-defined and meaningful habitat classifications and accurate area estimates.

We would like to draw attention to the fact that paramo species are probably more threatened in the medium term than the IUCN classification reflects. Without an analysis of paramo occupancy, we may one day wake up to the news that paramo bird populations are on the verge of extinction.

CONCLUSIONS

In conclusion, the current understanding of paramo ecosystems and their avian inhabitants is limited by a lack of comprehensive research and biased observations. The existing vegetation classifications fail to capture the diversity of habitats crucial for specific bird species, such as the Andean Ibis and Carunculated Caracara. These habitats are essential for birds and other animals like deer, indirectly affecting top predators like the Andean Condor.

The looming threat of climate change further exacerbates the situation, as rising temperatures will likely shrink and alter paramo habitats. This, coupled with the underestimated threat levels assigned by the IUCN, paints a concerning picture for the future of paramo birds. Addressing these issues requires a multi-pronged approach, including refined habitat classifications, rigorous population studies, and innovative predictive models that account for local and large-scale factors. Only through a comprehensive understanding of the complex interplay between birds and their paramo habitats can we hope to develop effective conservation strategies and ensure the survival of these unique avian species.

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